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USER GUIDE TO CONTRAM VERSION 4

by

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ABSTRACT

CONTRAM is a traffic assignment model for use in the design of traffic management schemes. The model predicts vehicle routes, flows and queues in a network of streets and junctions; junctions may be controlled by traffic signals or 'give-way' rules. It is assumed that the numbers of trips between each origin and destination are known and that they may vary with time so that the growth and decay of congestion in peak periods can be studied. Allowance is made for the physical size of queues which may block back and restrict the throughput capacity at upstream junctions. Up to three classes of vehicles (eg cars, buses and lorries) can be represented, and selected vehicles (usually buses) can be sent along fixed routes.

CONTRAM provides comprehensive information on traffic conditions, including link delay times, turning movements and fuel consumption, to help the traffic engineer to understand and assess the merits of alternative traffic management schemes.

This User Guide gives a brief description of the model, details of data input and output, a test example to illustrate the use of the model and an outline of the structure and operation of the computer program.

1. INTRODUCTION

CONTRAM is a computer-based traffic assignment model for use in the design of traffic management schemes. It assumes that drivers are familiar with traffic conditions and choose their minimum journey time routes through a network. The model produces information on the time varying pattern of flows, queues and delays, fuel consumption and average speeds through the network. Data are required by the model to define the physical characteristics of the network, to specify the number of vehicle trips for each origin-destination movement and their variation with time, and to run the computer program.

The principal features of CONTRAM are that it:–

- Models signal controlled junctions, 'give-way' junctions (including roundabouts) and bottlenecks at merges.
- Represents variation in traffic conditions with time, particularly where demands temporarily exceed capacity, eg during peak periods.
- Allows for blocking-back effects where a queue from one junction fills a street and restricts the capacity at an upstream junction.
- Subdivides results into three classes of vehicle – usually cars, buses and lorries (heavy goods vehicles).
- Bans selected traffic movements – prohibiting access to selected streets for any or all of the specified vehicle classes.

– Includes a fixed route option – eg for modelling bus services.

– Incorporates three methods for setting signals.

– Estimates fuel consumption for each class of vehicle.

– Calculates average 'linear' speeds for selected origin-destination movements as a measure of fairness.

The original version of the program was written by Mr P D Whiting. This user guide describes the latest version – Version 4.

Section 2 gives a brief description of CONTRAM. Section 3 describes data input requirements and Section 4 describes the output from the model. Section 5 describes the input and output for a worked example and Section 6 gives information on the structure and operation of the computer program.

A general introduction to CONTRAM and its application is given in Reference 1. Since the publication of that report there have been a number of major developments in the modelling. Hence, for completeness, Section 2 also gives a summary of the main features of the current model. A more detailed description of the theory is being prepared.

2. BRIEF DESCRIPTION OF CONTRAM

CONTRAM (which stands for CONtinuous TRaffic Assignment Model) is a traffic assignment model which can deal with time-varying traffic conditions in a network. The network of streets in a town is represented by a series of unidirectional links and junctions. Traffic demands enter the network at origins and leave at destinations. Origins and destinations may occur within the network as well as on the periphery. Time-variation is modelled by dividing the simulation period into a number of consecutive time intervals of, typically, fifteen minutes duration. The demands for each origin-destination movement are specified as a flow rate (vehicles/hour) for each time interval.

Vehicles from each origin-destination pair are grouped together to form 'packets'. The packets from any origin-destination pair enter the network equally-spaced in each time interval. The vehicles in a packet are assumed to remain together, for computational purposes, as they travel through the network; each packet is assigned to its minimum journey time route. The journey time for a packet along each link of its route consists of two parts – a 'cruise' time (ie a 'free running time'), which corresponds to an average unimpeded travel time, and a delay time which is dependent on the level of flow on a link and on the method of junction control. Three types of junction are modelled: signal controlled, give way and uncontrolled. The latter arise where roads merge or diverge with no one traffic stream having priority, and are the controlling links at give-way junctions. Roundabouts are modelled by considering each approach road as a give-way link and the road around the island as a series of uncontrolled links.

Delay calculations are based on an estimate of the average queue on each link at the end of each time interval. The estimate of queue depends on the queue at the end of the previous time interval (the 'initial' queue), the number of arrivals at the stopline in the interval, the maximum rate at which vehicles can leave the link and the duration of the time-interval. The theory of time-varying queues[2] is used to take account of random variations in vehicle arrival patterns and the type of junction (eg signal controlled, give-way, etc). It is assumed that the queue varies linearly between the queue values at the start and end of the interval. The delay for an individual packet is calculated from the length of the queue encountered by the packet at the time that it reaches the stopline (stopline arrival time = entry time to link + cruise time on link). The delay is then the time taken for the queue encountered by the packet to be discharged. The rate of discharge is the maximum throughput capacity rate for that link (ie allowing for the type of junction control).

CONTRAM uses an iterative procedure to predict the patterns of routes, flows, queues and delays on a network which result when drivers are familiar with network conditions. An iteration of the model consists of assigning each packet of vehicles to its minimum journey time route through the network using a tree building algorithm. This produces patterns of traffic on the network which are used in the next iteration when each packet is reassigned to its new quickest route. Before each packet is assigned the flow corresponding to that packet is removed from each link of the route determined in the previous iteration. Thus a packet does not incur delays due to itself when being assigned to a new route. As the reassignment of packets is made in the time order in which packets enter the network then the delays calculated for a given packet will be determined by flows due to packets which have entered the network prior to that packet, during the current iteration, and by flows due to subsequent packets assigned to routes in the previous iteration. Several iterations are required before stable traffic patterns are obtained. Full convergence of the process is attained when all vehicles are assigned to their same routes during successive iterations. This iterative process can be considered as modelling the gradual familiarisation of drivers to network and traffic conditions.

There are three options for calculating signal settings in the model:— In the first the fixed cycle/fixed split (FC/FS) option uses prescribed data values for cycle and split times. In the second and third options, which are fixed cycle/optimised splits (FC/OS) and optimised cycle/optimised splits (OC/OS), the optimised values are calculated using the link flows from the previous iteration. The signal setting options do not model response to individual packets and hence do not model vehicle-actuated signals. This is not considered to be too restrictive as option OC/OS is thought to give a satisfactory approximation to vehicle-actuated control[3]. Signal options for junctions are selected from a signal plan list in which the different types of option can be mixed. This allows considerable flexibility in specifying plans for individual junctions as different plans can be selected for each time interval.

CONTRAM models the growth and decay of queues from time interval to time interval including the effects of temporary oversaturation, such as occurs during peak periods, resulting in the growth and decay of queues. Allowance is made for blocking back effects at junctions when vehicles queue back along the full length of links, blocking upstream junctions, and thereby restricting the flow of vehicles from links feeding these junctions.

The 'banned vehicle' facility can be used to prevent selected vehicle classes from using specified links in a network. This provides an easy method for examining, for example, the pedestrianisation of links or restricted access for heavy goods vehicles. The modelling allows for up to three classes of vehicle — C, B and L, where C represents cars and B and L usually represent buses and lorries. Bus routes are modelled using a 'fixed route' option in which the routes for specified origin-destination movements are prescribed even though they may not correspond to the minimum journey time routes for those movements.

For each time interval the amount of fuel consumed is estimated for each class of vehicle, for economic assessment purposes. The 'linear' or 'crow-flight' speeds are calculated for selected origin-destination movements as a measure of 'fairness' so that the effect of alternative traffic management schemes on individual journeys can be compared.

CONTRAM 4 can model up to 200 links (maximum of 75 give-way links) and 50 signals. Maxima of 50 origins and 50 destinations are allowed and up to 500 origin-destination movements. Alterations can be made to the array sizes in the program, to allow for larger networks and a greater number of origin-destination movements; these are described in Section 6.4.

3. DATA INPUT REQUIREMENTS

There are three types of data required for CONTRAM: NETWORK and TIME, TRAFFIC DEMAND (origin-destination movements) and CONTROL data. The latter consists of Program Control, Signal Control and Fixed Route data.

Data input is normally by punched cards (each card contains 80 columns). Each group of data comprises a 'title' card, consisting of any 'alpha numeric' characters, followed by data cards containing the numerical data. All numerical data entries are *right justified* in fields of 5 columns and consist of *integers;* in general integers are non-negative with the exception of certain entries for program and signal control (Sections 3.3.4 to 3.3.9 and 3.3.13). The numerical data cards for the Network and Time and the Control packs are each identified by type numbers. In general all data cards with the same type number must be grouped together in their data packs. Exceptions to this grouping are Change of Mind cards (Sections 3.1.8 and 3.2.3), which are interleaved with the appropriate cards, and type 71, 72 and 73 cards (Sections 3.3.11 to 3.3.14) which may be mixed together. It should be noted that gaps have been left in the sequence of card 'type numbers' to enable further facilities to be inserted at a later date.

Bounds for the input parameters are listed in Section 6.3.

An example of a method for coding the data for a network is given in Section 5.

3.1 *Network and time data*

The NETWORK and TIME data defines the time period to be simulated and the geometric properties of the network. The latter describes how origins, links and destinations are interconnected, link properties such as length and saturation flow, and certain junction parameters. Additional data for signal controlled junctions are described in Sections 3.3.11 to 3.3.16 on Signal Control. The following cards are required:

Card type number	Contents of card	Section
–	title card	3.1.1
1	time	3.1.2
3	origin	3.1.3
4	uncontrolled link	3.1.4
5	give-way link	3.1.5
6	signal controlled link	3.1.6
7	signal lost time	3.1.7
8	change of mind	3.1.8
9	vehicle classes	3.1.9
10	fuel consumption	3.1.10

3.1.1 Title card: The first card for the NETWORK and TIME data pack *must* be a title card (normally used to identify the network and network parameters currently being investigated). It can consist of any 'alpha-numeric' characters – all 80 columns of the card can be used. There is only one title card:–

Columns used	Entry
1–80	Identifier

3.1.2 Card type 1 (Time): The time data card defines the duration of the simulation period and the time intervals into which the period is divided. The length for each time interval is chosen to allow an adequate modelling of traffic conditions over that interval in the simulation period – thus time intervals will tend to be shortest when traffic conditions are most critical for the network. Typical lengths for the shorter time intervals could be 10 to 15 minutes. A maximum of 13 time intervals is allowed and the maximum permissible duration for a simulation period is 8 hours. There is only one time data card:–

Columns used		Entry
1–5	1	(Card type number)
6–10	1	(Time unit for calculations = 1 sec)*
11–15		The time of start of the first time interval in hours and minutes (hhmm), for example 815 for 8.15 am and 1730 for 5.30 pm.
16–20		The time of finish of the first time interval in hours and minutes (hhmm).
21–25 76–80		The time of finish of succeeding time intervals (hhmm).

NB: The program requires that every packet must reach its destination within the simulation period. It is therefore necessary to specify one time interval at the end of the simulation period during which there is zero traffic demand (see Section 3.2.2), and which is sufficiently long for any packets still travelling to clear the network.

If the period to be modelled includes 24.00 hrs (ie midnight), then the ends of time intervals after 24.00 hrs, must be increased by 2400. Thus 1.30 am would be entered as 2530.

There is no CARD TYPE 2.

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* The entry '1' in column 10 (representing a time unit of 1 second) is the value normally used when modelling peak periods for urban areas – this allows for a maximum simulation period of 8 hours. The entry is retained so that future versions of the program can use a coarser time resolution if needed.

3.1.3 Card type 3 (Origins): This card lists the links to which an origin is connected. One card is required for each origin:—

Columns used		Entry	
5	3	(Card type number)	
6–10		The origin number (maximum of 5 digits)	
11–14		The number of a downstream link to which the origin is connected (NB. This cannot be a destination)	
15		Banned vehicle code:— 1 if class C vehs (cars) cannot travel from the origin to the link 2 if class B vehs (buses) cannot travel from the origin to the link 4 if class L vehs (lorries) cannot travel from the origin to the link 3 if class C and B vehs cannot travel from the origin to the link 5 if class C and L vehs cannot travel from the origin to the link 6 if class B and L vehs cannot travel from the origin to the link 7 if all classes C, B and L vehs cannot travel from the origin to the link 0 if all classes C, B and L *can* travel from the origin to the link	
16–19		The number of a 2nd link to which the origin is connected	If there are less than 5 links to which the origin is connected blank spaces must be left (it does not matter which spaces are left blank).
20		Banned vehicle code (as above)	
21–24		The number of a 3rd link to which the origin is connected	
25		Banned vehicle code (as above)	
26–29		The number of a 4th link to which the origin is connected	
30		Banned vehicle code (as above)	
31–34		The number of a 5th link to which the origin is connected	
35		Banned vehicle code (as above)	
36–80		Not used	

All data cards of type 3 *must* occur together in the NETWORK and TIME data pack. A maximum of 50 origins is allowed. Origins are connected to the upstream ends of links.

3.1.4 Card type 4 (Uncontrolled links): This card gives details required for an uncontrolled link. One card is required for each link:—

Columns used		Entry
5	4	(Card type number)
6–10		The link number (maximum of 4 digits)
11–14		The number of a downstream link or destination to which the link is connected.
15		Banned vehicle code:– 1 if class C vehs (cars) cannot travel from the link to the link or destination 2 if class B vehs (buses) cannot travel from the link to the link or destination 4 if class L vehs (lorries) cannot travel from the link to the link or destination 3 if class C and B vehs cannot travel from the link to the link or destination 5 if class C and L vehs cannot travel from the link to the link or destination 6 if class B and L vehs cannot travel from the link to the link or destination 7 if all classes C, B and L cannot travel from the link to the link or destination 0 if all classes C, B and L *can* travel from the link to the link or destination
16–19		The number of a 2nd link or destination to which the link is connected
20		Banned vehicle code (as above)
21–24		The number of a 3rd link or destination to which the link is connected
25		Banned vehicle code (as above)
26–29		The number of a 4th link or destination to which the link is connected
30		Banned vehicle code (as above)
31–34		The number of a 5th link or destination to which the link is connected
35		Banned vehicle code (as above)
36–40		The cruise time in seconds along the link for class C vehs (cars)
41–45		The length of the link in metres
46–50		The saturation flow at the downstream end of the link in PCUs/hr
51–55		The storage capacity of the link in PCUs. This is the maximum number of PCUs which can queue on the link at any time. If columns 51–55 are left blank then a default value is calculated (see below)
56–60		The number of the junction controlling the link (zero is not permitted)
61–80		Not used

(Columns 16–35:) If there are less than 5 links or destinations to which the link is connected blank spaces must be left (it does not matter which spaces are left blank).

If columns 51–55 are left blank then a default value of storage capacity is calculated by the program. This is given by (Ls)/10800 where L is the length of the link in metres and s is the link saturation flow in PCUs/hr. (This formula uses the link saturation flow as a proxy for lane width and assumes that each PCU takes up 6 metres of a lane). It is recommended that storage capacities are entered for links less than 60 metres, particularly for give-way links (Section 3.1.5).

All data cards of type 4 *must* occur together in the NETWORK and TIME data pack. Any uncontrolled link can control at most 2 give-way links (see Section 3.1.5).

Note – destinations are not specified as such since they are deduced by the program from the data given on card types 4, 5 and 6. Destination numbers have a maximum of 4 digits – they must not duplicate link numbers.

3.1.5 Card type 5 (Give-way links): This card gives details required for a give-way link. One card is required for each link:–

Columns used		Entry	
5	5	(Card type number)	
6–10		The link number (maximum of 4 digits)	
11–14		The number of a downstream link or destination to which the link is connected	
15		Banned vehicle code:– 1 if class C vehs (cars) cannot travel from the link to the link or destination 2 if class B vehs (buses) cannot travel from the link to the link or destination 4 if class L vehs (lorries) cannot travel from the link to the link or destination 3 if class C and B vehs cannot travel from the link to the link or destination 5 if class C and L vehs cannot travel from the link to the link or destination 6 if class B and L vehs cannot travel from the link to the link or destination 7 if all classes C, B and L cannot travel from the link to the link or destination 0 if all classes C, B and L *can* travel from the link to the link or destination	
16–19		The number of a 2nd link or destination to which the link is connected	If there are less than 5 links or destinations to which the link is connected blank spaces must be left (it does not matter which spaces are left blank).
20		Banned vehicle code (as above)	
21–24		The number of a 3rd link or destination to which the link is connected	
25		Banned vehicle code (as above)	
26–29		The number of a 4th link or destination to which the link is connected	
30		Banned vehicle code (as above)	
31–34		The number of a 5th link or destination to which the link is connected	
35		Banned vehicle code (as above)	
36–40		The cruise time in seconds along the link for class C vehs (cars)	
41–45		The length of the link in metres	
46–50		The saturation flow at the downstream end of the link (q_s) in PCUs/hr – see below	
51–55		The storage capacity of the link in PCUs. This is the maximum number of PCUs which can queue on the link at any time. (It is recommended that measured values are used for storage capacities for give-way links. If columns 51 to 55 are left blank then a default value is calculated using the formula on page 7 and assuming that, for give-way links, the minimum value for saturation flow is 1800 PCU/hr)	
56–60		The number of an uncontrolled link controlling the throughput capacity of the give-way link.	
61–65		The number of a second uncontrolled link controlling the throughput capacity of the give-way link. (If there is no second link then the space should be left blank.)	
66–70		The negative of the gradient (f) relating the throughput capacity of the give-way link to the total demand in the controlling links, multiplied by 100 – see below. Note: f is a positive number.	
71–75		The number of the junction controlling the link (zero is not permitted).	
76–80		Not used	

It is assumed that the throughput capacity Q (PCUs/hr) calculated by the program for a give-way link depends linearly on the total controlling flow q (PCUs/hr) – the formula used is $Q = q_s - fq$ where q_s (PCUs/hr), entered in columns 46–50, is the saturation flow of the give-way link and f is a constant (note: 100f is the value entered in columns 66–70). In the program it is assumed that Q cannot be less than 60 PCUs/hr – this allows for drivers who will force their way into the main traffic stream.

For an isolated T-junction with only left-turning traffic from the give-way link, typical values of f and q_s are $f = 0.25$, $q_s = 600$. For a general T-junction (with 6 turning movements) typical values of f and q_s are $f = 0.22$, $q_s = 600$. If more detailed information is available about turning flows and junction geometry the values for f and q_s can be estimated more accurately using formulae given in Reference 4.

For all at-grade roundabouts formulae for f and q_s are

$$f = 0.210 t_D (1 + 0.2 x_2)\, k, \qquad q_s = 303 x_2 k$$

where

$$t_D = 1 + 0.5/(1 + \exp((D-60)/10))$$
$$x_2 = v + (e-v)/(1 + 2S)$$
$$S = 1.6(e - v)/\ell'$$
$$k = 1 - 0.00347\,(\phi - 30) - 0.978\,((1/r) - 0.05)$$

and D is the inscribed circle diameter (metres), v is the approach road half-width (metres), e is the entry width measured along a normal to the nearside kerbline (metres), ℓ' is the flow length (metres), ϕ is the entry angle (radians) and r is the entry radius at the kerbline (metres) – these formulae are described in Reference 5.

Roundabouts at grade-separation interchanges have slightly different operating characteristics from at-grade roundabouts; scaling factors for f and q_s for such roundabouts are shortly to be published by TRRL.

All data cards of type 5 *must* occur together in the NETWORK and TIME data pack.

3.1.6 Card type 6 (Signal-controlled links): This card gives details required for a signal-controlled link. One card is required for each link:–

Columns used	Entry
5 6	(Card type number)
6–10	The link number (maximum of 4 digits)
11–14	The number of a downstream link or destination to which the link is connected
15	Banned vehicle code:– 1 if class C vehs (cars) cannot travel from the link to the link or destination 2 if class B vehs (buses) cannot travel from the link to the link or destination 4 if class L vehs (lorries) cannot travel from the link to the link or destination 3 if class C and B vehs cannot travel from the link to the link or destination 5 if class C and L vehs cannot travel from the link to the link or destination 6 if class B and L vehs cannot travel from the link to the link or destination 7 if all classes C, B and L cannot travel from the link to the link or destination 0 if all classes C, B and L *can* travel from the link to the link or destination

Columns used	Entry	
16–19	The number of a 2nd link or destination to which the link is connected	If there are less than 5 links or destinations to which the link is connected blank spaces must be left (it does not matter which spaces are left blank).
20	Banned vehicle code (as above)	
21–24	The number of a 3rd link or destination to which the link is connected	
25	Banned vehicle code (as above)	
26–29	The number of a 4th link or destination to which the link is connected	
30	Banned vehicle code (as above)	
31–34	The number of a 5th link or destination to which the link is connected	
35	Banned vehicle code (as above)	
36–40	The cruise time in seconds along the link for class C vehs (cars)	
41–45	The length of the link in metres	
46–50	The saturation flow at the downstream end of the link in PCUs/hr	
51–55	The storage capacity of the link in PCUs. This is the maximum number of PCUs which can queue on the link at any time. If columns 51–55 are left blank then a default value is calculated (see page 7).	
56–60	The number of the signal controlling the link (same as junction number) (Signal/junction numbers must not be zero.)	
61–65	The number of the signal stage during which the link faces green (see below)	
66–70	The percentage of the stage time which is available to the link (numbers less than 100 can represent links whose traffic can only move during part of the stage, eg right-turning filters; numbers greater than 100 can represent links where traffic runs on more than one stage). A default value of 100 is assumed for a blank or entry of 0.	
71–75	The percentage of the calculated signal delay which is used to represent the link delay (isolated junctions will normally have 100 for this figure but lower figures can be used to model signal-coordination). A default value of 100 is assumed for a blank or entry of 0.	
76–80	Not used	

All data cards of type 6 *must* occur together in the data pack. Each signal can have at most 4 stages. The stage number for a 1-stage signal (eg a pedestrian signal) *must* be 1. The stage numbers for a 2-stage signal *must* be 1 and 2, and for a 3-stage signal 1, 2 and 3. Each signal stage can control at most 4 links.

3.1.7 Card type 7 (Signal lost-times): This card gives the lost-time at a signal. One card is required for each signal:–

Columns used		Entry
5	7	(Card type number)
6–10		The signal number
11–15		The lost-time per cycle of the signal in seconds. It is assumed that the same lost-time applies to all time intervals. (The lost-time is only used by the program when calculating optimised settings, ie FC/OS or OC/OS settings.)

All data cards of type 7 *must* occur together in the NETWORK and TIME data pack. A maximum of 50 signal junctions can be used.

3.1.8 Card type 8 (Change of mind): In order to vary values of parameters, without changing the original data cards, 'change of mind' cards can be introduced into the data pack to alter specified parameters to predetermined percentages of the punched values. The following parameters can be changed:– Cruise times, link lengths, saturation flows and storage capacities for all types of link; capacity/flow slopes for give-way links; the percentage stage time and percentage calculated junction delay for signal controlled links; and the lost-time for signals.

A change of mind card is inserted into the pack immediately before a card carrying a parameter whose value is to be changed. Each change of mind card specifies a parameter P, a card type T and a percentage F; it has the effect on all *subsequent* data cards of type T of multiplying the punched values for parameter P by F per cent.

More than one change of mind card can be used at the same time. In the case of 2 change of mind cards specifying the same parameter P, the same card type T and percentages F_1, F_2 respectively, the data cards of type T following the second change of mind card would have the punched values for parameter P multiplied by F_2 per cent – that is, the second change of mind card 'cancels' the first one. The card format is:–

Columns used		Entry
1–5	8	(Card type number)
6–10		4 Data on subsequent uncontrolled link cards to be changed
		5 Data on subsequent give-way link cards to be changed
		6 Data on subsequent signal controlled link cards to be changed
		7 Data on subsequent signal cards to be changed
11–15		8 Cruise times on subsequent link cards of the specified type to be changed
		9 Link lengths on subsequent link cards of the specified type to be changed
		10 Saturation flows on subsequent link cards of the specified type to be changed
		11 Storage capacities on subsequent link cards of the specified type to be changed
		14 Throughput capacity 'slopes' on subsequent give-way cards to be changed (if the digit 5 occurs in column 10)
		14 Percentages of stage green-times on subsequent signal-controlled links to be changed (if the digit 6 occurs in column 10)
		15 Percentages of calculated delays on subsequent signal-controlled links to be changed (if the digit 6 occurs in column 10)
		3 Lost-times on subsequent signal cards to be changed (if the digit 7 occurs in column 10)
16–20		Percentage of punched value to be used (can exceed 100).

A change of mind card affecting card type T *must* occur among (or at the beginning of) the data cards of type T.

3.1.9 Card type 9 (Vehicle classes): This card gives information on the different classes of vehicle to be modelled. The model distinguishes 3 classes of vehicle, denoted by the letters C, B and L. The assumption is made that class C vehicles denotes cars – the user *is free to use classes B and L as he wishes* but normally class B would represent buses and class L lorries.

For each class of vehicle the number of PCUs equivalent to one vehicle must be specified. These PCU equivalences are used in the calculation of both flows and queues. For example if 1 class L vehicle is equivalent to 1.8 PCUs then each class L vehicle would contribute 1.8 PCUs to flow calculations and would take up 1.8 PCUs of queueing space.

The cruise times of vehicles of classes B and L along links are assumed to be percentages of the corresponding cruise times for class C vehicles.

The card format is:

Columns used		Entry
5	9	(Card type number)
6–10		10 (≡ 10 x 1 PCU for cars)
11–15		The number of PCUs multiplied by 10, equivalent to 1 class B vehicle
16–20		The number of PCUs multiplied by 10, equivalent to 1 class L vehicle
21–25		The percentage of class C (car) cruise times to be used for class B times
26–30		The percentage of class C (car) cruise times to be used for class L times
31–80		Not used

The type 9 data card *must* be the penultimate card type in the NETWORK and TIME data pack.

NOTE: PCU equivalents are required to be corrected to the first decimal place (eg L ≡ 1.8 PCUs) so that the entries in columns 11–15 and 16–20 are integer values (ie 18 in columns 16–20).

3.1.10 Card type 10 (Fuel consumption): This card specifies coefficients for relating time delayed and distance travelled, by each class of vehicle, to fuel consumption – 6 coefficients are required for each class of vehicle. For each class i it is assumed that the fuel used in litres per veh.km is given by $a_i/(10^3) - b_i\, v/(10^5) + c_i\, v^2/(10^7)$ where v is the cruise speed (km/hr), and the fuel used in litres per veh.hr of delay is given by $a'_i/(10^2) + b'_i\, v/(10^4) + c'_i\, v^2/(10^6)$. For the derivation of these formulae see Reference 6. For each class i of vehicle modelled the coefficients a_i, b_i, c_i, a'_i, b'_i and c'_i are specified as follows:–

Columns used		Entry
1–5	10	(Card type number)
6–10		Vehicle class code: 1 for class C vehs (cars) 2 for class B vehs 4 for class L vehs
11–15		a_i
16–20		b_i
21–25		c_i
26–30		a'_i
31–35		b'_i
36–40		c'_i
41–80		Not used

The type 10 data cards *must* occur together at the end of the NETWORK and TIME data pack.

Typical values for a_i, b_i, c_i, a'_i, b'_i, c'_i for cars are 164, 240, 200, 150, 107 and 340 respectively. Corresponding estimates for buses and lorries can be obtained by multiplying the car coefficients by 3 to give 492, 720, 600, 450, 321 and 1020 respectively. These coefficients were derived from relatively few measurements and should be corrected if more information is available.

It is necessary to include a type 10 card for each class of vehicle which is specified in the TRAFFIC DEMAND data pack (Section 3.2).

3.2 *Traffic demand data*

The TRAFFIC DEMAND data specifies the flow rate during each time interval for each origin-destination movement. The following cards are required:–

Card type number	Contents of card	Section
–	title card	3.2.1
–	origin-destination demands	3.2.2
–	change of mind	3.2.3

It should be noted that *there are no card type numbers in this data pack.*

3.2.1 Title card: The first card in the TRAFFIC DEMAND (origin-destination) data pack *must* be a title card (normally used to identify the values for the current run of the program). It can consist of any 'alpha-numeric' characters – all 80 columns of the card can be used.

There is only one title card. The card format is:–

Columns used	Entry
1–80	Identifier

3.2.2 Origin-destination demands: The traffic demand for each origin-destination movement in a network is specified as a series of flow rates *(vehicles/hr)* for each time interval. For a given origin-destination pair one data card is used for each classified vehicle demand, ie for C's, B's or L's. The card also contains the packet size, a 'start' code, and the 'linear distance' between the origin and destination. If more than 11 time intervals are used then the flows for time intervals 12 and 13 are listed on a continuation card. The model allows for up to 50 origins and 50 destinations, and a total of 500 origin-destination pairs. It is possible to model the movements of more than one demand for the same class of vehicle, between the same origin and destination, by using separate cards. (This could, for example, be used to investigate the relative effects of journeys to work and social trips.)

The card format for each classified traffic demand is:–

Columns used	Entry
1–5	The origin number
6–10	The destination number
11–14	The number of vehicles in each packet
15	Vehicle class code: 1 for class C vehs (cars) 2 for class B vehs 4 for class L vehs
16–20	The 'straight-line' distance between the origin and destination in metres (optional see below)
21–25	A number in the range 1–10000 (this is the start-code – see below). If columns 21–25 are left blank then a default value of 5000 is assumed.
26–30	The flow in *vehicles/hr* entering the network in the first time interval for the classified origin-destination pair.
31–35 76–80	The flows in succeeding time intervals. (NB The flow for the last time interval must be zero – see Section 3.1.2)

If the straight-line distance between the origin and destination is entered in columns 16–20 then the average straight-line speed is printed-out for this classified traffic demand for each time interval. If columns 16–20 are left blank then no such values are printed. A maximum of 50 straight-line distances can be specified.

The start-code in columns 21–25 determines the time of start of the first packet from the origin-destination demand to enter the network in the first time interval. This time is given by 3600 (sc) p/(10000 q) secs. after the start of the simulation period where (sc) is the start-code, p is the number of vehicles in a packet and q is the entry flow rate (vehs/hr) for the first time interval. A start-code of 5000 is normally used giving a start time of half the time spacing between packets, and is the default value assumed if zero or blank is entered.

If there are more than 11 time intervals *every one* of the above cards *must* be followed by a continuation card with the following format:–

Columns used	Entry
1–25	Not used
26–30	The flow in time interval 12
31–35	The flow in time interval 13
36–80	Not used

A maximum of 500 classified origin-destination traffic demands can be used in the TRAFFIC DEMAND data pack.

3.2.3 Change of mind – flow rates: Change of mind cards can be used within the TRAFFIC DEMAND data pack to change specified flow rates. A change of mind card is inserted into the pack immediately before a card for which the flow rates are to be changed; it has the effect of multiplying the punched values for the parameter on that card, and on all subsequent cards, by the percentage specified on the change of mind card. Several change of mind cards can be used – they all have blanks in columns 1–5. Note – a change of mind card overrules the changes made by a previous change of mind card if there is any conflict. The card format for changing flow-rates in specified time intervals is:–

Columns used	Entry
1–5	Not used
6–10	The number of the first time interval for which flow rates are to be changed
11–15	The number of the last time interval for which flow rates are to be changed
16–20	Percentage of the punched flow rates to be used
21–80	Not used

3.3 *Control data*

The data in the CONTROL DATA pack has two 'control' functions. The first, describing the running of the program, defines the number of iterations to be carried out and the types of output required (see Section 4 for a description of the options available). The second provides the additional data required for signal controlled junctions. The data required for vehicles with fixed routes are also specified in this pack.

The following cards specify the data:

	Card type number	Contents of card	Section
	–	Title card	3.3.1
No. of iterations	50	Number of iterations	3.3.2
Selection of outputs	51	Network summary information	3.3.4
	52	Change in vehicle arrivals – convergence matrix	3.3.5
	53	Link-by-link data – all parameters	3.3.6
	54	Link-by-link values-flows, queues, queue times, average speeds	3.3.7
	55	Measure of fairness	3.3.8
	56	Turning movements	3.3.9
	57	Junction list for turning movements	3.3.10
Additional signal data	71	Signal plans – fixed cycle/fixed splits (FC/FS)	3.3.12
	72	Signal plans – fixed cycle/optimised splits (FC/OS)	3.3.13
	73	Signal plans – optimised cycle/optimised splits (OC/OS)	3.3.14
	77	Signals – plan numbers for each time interval	3.3.15

	Card type number	Contents of card	Section
Fixed routes data	81	Fixed routes data	3.3.18
	85	O-D movements having fixed routes	3.3.19

3.3.1 Title card: The first card for the CONTROL data pack *must* be a title card (normally used to identify the control strategies currently being used). It can consist of any alpha-numeric characters – all 80 columns of the card can be used. There is only one title card:

Columns used	Entry
1–80	Identifier

3.3.2 Card type 50 (Number of iterations): The second card in the CONTROL data pack *must* be of type 50 – this card specifies the number of iterations of the model to be carried out:

Columns used		Entry
1–5	50	(Card type number)
6–10		Number of iterations to be carried out. (An entry of '0' can be used for data checking without any iterations being made.)
11–80		Not used

3.3.3 Selection of outputs: There are six forms of output any selection of which can be called by the appropriate card types 51–56 described below. For each type of output there is a choice of 3 methods for specifying the iterations for which the data are to be printed – these are: (1) for all iterations, (2) for the last N iterations, and (3) for up to 5 selected iterations. The types of output selected and the iterations to be printed depend on whether the information is for traffic engineering or traffic management purposes. It is recommended that only those outputs which are likely to be of direct interest, and a minimum number of iterations for a given purpose, should be selected for output so as to minimise computer running times. The formats and uses of the outputs are described more fully in Section 4.

3.3.4 Card type 51 (Data output – network summary information for assessing convergence): Total values for Time and Distance Travelled throughout the complete network are summarised for each time-interval and for the total simulation period. These values are used to examine convergence of the iterative process. If this output is selected then a Summary Table is automatically printed, after the last iteration, of the values for the last 5 iterations of a run. The card format is:

Columns used		Entry	
1–5	51	(Card type)	
6–10	999	if all iterations are to be printed	/or
	(-N)	if last N iterations are to be printed	/or
	I	Where I, J, K, L, M represent the Ith, Jth, ... iteration (up to a total of 5) to be printed. If data are required for less than 5 iterations then the remaining columns are left blank.	
11–15	J		
16–20	K		
21–25	L		
26–30	M		
31–80		Not used	

Note: The formats for card types 52 to 55, below, are all similar to card type 51 with the appropriate card type number entered in columns 1 to 5.

3.3.5 Card type 52 (Data output – change in vehicle arrivals – convergence matrix): The changes in stopline arrivals between successive iterations are printed as a matrix for all links v all time intervals. The units are PCUs and show, for a specified iteration number i, the change in numbers of PCU arrivals on each link between iteration (i) and iteration (i–1), for each time interval. The matrix (or matrices if more than one iteration number is specified) is used in conjunction with the Network Summaries to examine convergence of the model. The card format is:

Columns used		Entry
1–5	52	(Card type)
6–80		as for card type 51

3.3.6 Card type 53 (Data output – link-by-link data – all parameters): The parameters printed are described in Section 4.5. There is some overlap of information between this output and the outputs called by card types 54 and 56 (described in Sections 4.6 and 4.8), the choice being dependent on the use of the data. The card format is:

Columns used		Entry
1–5	53	(Card type)
6–80		as for card type 51

3.3.7 Card type 54 (Data output – link-by-link values – flows, queues, queue times and average speeds): This output summarises, in separate tables, the time variation in 4 of the parameters called by card type 53. It is described in detail in Section 4.6. The card format is:

Columns used		Entry
1–5	54	(Card type)
6–80		as for card type 51

3.3.8 Card type 55 (Data output – measure of fairness): This matrix tabulates the time-variation in average 'straight-line' speeds between origins and destinations for selected O-D traffic movements. The movements for which the values are printed also require straight-line distances to be entered on the Origin-Destination Demand cards (Section 3.2.2). The form of the matrix is described in Section 4.7. The card format is:

Columns used		Entry
1–5	55	(Card type)
6–80		as for card type 51

3.3.9 Card type 56 (Data output – turning movements): There are 2 options for specifying turning movements. The first (with a 0 in column 35) is junction oriented and, in addition to printing out time-variation in turning flows (PCU/hr) from each approach to a junction, prints arrival flows, final queues and mean queue times for approach links. It also prints the signal plans and timings for signal controlled junctions. The second option (with a 1 in column 35) is link oriented and only prints out the time variation in turning flows from each link. If the second option is chosen then turning movements are printed for all links; the first option requires a list of junctions to be supplied (card type 57). The outputs are described in Section 4.8. The card format is:

Columns used		Entry	
1–5	56	(Card type)	
6–10	999	if all iterations are to be printed	/or
	(-N)	if last N iterations are to be printed	/or
	I	Where I, J, K, L, M represent the Ith, Jth, ... iteration (up to a total of 5) to be printed. If data are required for less than 5 iterations then the remaining columns are left blank.	
11–15	J		
16–20	K		
21–25	L		
26–30	M		
31–35	0 –	if printout required for selected junctions	
	1 –	if printout required for all links	
36–80		Not used	

3.3.10 Card type 57 (Junction list for turning movements): If turning movements are required for selected junctions (0 in column 35 on card type 56) then a list of the junctions *must* be specified. The list can be interspersed with blanks so that junction numbers can be added or removed without having to re-punch the whole list. The output gives a list of the junctions selected and the turning movement information (Section 4.8) for each junction in the order entered on the list. Up to a maximum of 100 junction numbers can be entered. The card format is:

Columns used		Entry
1–5	57	(Card type)
6–10		List of junction numbers in order of printing – the list can contain blank entries.
11–15		
.. ..		
.. ..		
76–80		

3.3.11 Signal data: The following cards (types 71, 72, 73 and 77) complete the information required for signal controlled junctions. These define the types of plan and timings to be used, and the time intervals during which a plan is called. The structure adopted for entering these data allows a number of plans to be 'stored' so that combinations of the plans can be selected for different runs of the program. There are 3 types of signal plan: fixed-cycle/fixed splits (FC/FS) called by card type 71, fixed-cycle/optimised-splits (FC/OS) called by card type 72 and optimised-cycle/optimised-splits (OC/OS) called by card type 73. Each fixed-cycle/fixed-splits plan uses the fixed cycle time and effective green times specified. A fixed-cycle/optimised-splits plan uses the specified cycle time and uses the 'equisaturation' Webster and Cobbe formulae[3] to obtain effective stage green duration times – in this case the time interval or intervals over which signal-arm flows are taken for use in the formulae must be specified. Each optimised-cycle/optimised-splits plan uses the Webster and Cobbe formulae to obtain cycle time and effective stage green duration times – in this case, as well as specifying the time interval or intervals over which signal-arm flows are taken, the percentage of these flows to be used in the formulae must be specified. For signal plans involving optimisation the timings for the first iteration of a run can be specified if thought necessary, ie preset to fixed values, as the initialising procedure in the modelling (equal sharing of green times between stages) may result in unrealistic initial assignments in the network. The cards for the 3 plan types can be mixed together in any order provided that they are not separated by cards of another type. An example of the way in which signal data is specified is given in Section 3.3.16. The formats for the cards are:

3.3.12 Card type 71 (Signal settings – fixed-cycle/fixed-splits): The format for each plan is:

Columns used		Entry
1–5	71	(Card type)
6–10		The number of the signal plan (must be in the range 1 to 100)
11–15		Cycle time in seconds
16–20		Effective stage 1 green duration time in seconds
21–25		Effective stage 2 green duration time in seconds
26–30		Effective stage 3 green duration time in seconds
31–35		Effective stage 4 green duration time in seconds
36–80		Not used

3.3.13 Card type 72 (Signal settings – fixed-cycle/optimised-splits): The format for each plan is:

Columns used		Entry	
1–5	72	(Card type)	
6–10		The number of the signal plan (must be in the range 1 to 100)	
11–15		(–cycle time) in seconds (negative to indicate optimisation of splits)	
16–20		Number of first time interval from which signal-arm flows are to be taken	
21–25		Number of last time interval from which signal-arm flows are to be taken (repeat the number in columns 16–20 if flows taken only from one interval)	
26–30		Stage 1 green time in seconds	optional values (otherwise leave blank). Apply only to first iteration.
31–35		Stage 2 green time in seconds	
36–40		Stage 3 green time in seconds	
41–45		Stage 4 green time in seconds	
46–80		Not used	

3.3.14 Card type 73 (Signal settings – optimised-cycle/optimised-splits): The format for each plan is:

Columns used		Entry	
1–5	73	(Card type)	
6–10		The number of the signal plan (must be in the range 1 to 100)	
11–15	999	(to identify optimising on cycle and splits)	
16–20		Number of first time interval from which signal-arm flows are to be taken	
21–25		Number of last time interval from which signal-arm flows are to be taken (repeat the number in columns 16–20 if flows taken only from one time interval)	
26–30		The percentage of the signal-arm flows to be used	
31–35		Cycle time in seconds	optional values (otherwise leave blank). Apply only to first iteration.
36–40		Stage 1 green time in seconds	
41–45		Stage 2 green time in seconds	
46–50		Stage 3 green time in seconds	
51–55		Stage 4 green time in seconds	
56–80		Not used	

3.3.15 Card type 77 (Signals – plan numbers for each time interval): One card is required for each signalised junction to specify the signal plans which operate during each time interval. The card format for each signal is:

Columns used		Entry
1–5	77	(Card type)
6–10		Number of the signal
11–15		Number of signal plan for time interval 1
16–20 71–75		Number of the signal plan for succeeding time intervals (if there are fewer than 13 time intervals then blank spaces should be left)
76–80		Not used

3.3.16 Example of coding for signal settings: As an example of the data formats for setting signals consider a network including 3 signals numbered 21, 31 and 41, and suppose signals 21 and 31 have 4 stages and signal 41 has 3 stages. Suppose the simulation period is divided into 3 time intervals. Suppose also,

(1) Signals 21 and 31 share the same signal plans,

a. in time interval 1 the signals operate a fixed-cycle/fixed-splits plan with cycle time 90 seconds and stage 1, 2, 3, 4 effective green duration times of 15, 10, 20 and 25 seconds respectively,

b. in time interval 2 the signals operate a fixed-cycle/optimised-splits plan with cycle time 100 seconds and signal-arm flows taken from time intervals 2 and 3,

c. in time interval 3 the signals operate another fixed-cycle/optimised-splits plan with cycle time 75 seconds and signal-arm flows taken from time interval 3.

(2) Signal 41 operates the following plans

a. in time intervals 1 and 2 the signal operates an optimised-cycle/optimised-splits plan with signal-arm flows taken from time intervals 1 to 3 – using 150 per cent of the flow values,

b. in time interval 3 the signal operates a fixed-cycle/fixed-splits plan with cycle time 70 seconds and stage 1, 2, 3 effective green duration times of 10, 15 and 25 seconds respectively.

For this example there are 5 signal plans. A satisfactory coding for the data is as follows

71	1	90	15	10	20	25	(Plan 1, 90 sec fixed cycle and splits)
72	2	–100	2	3			(Plan 2, 100 sec fixed cycle, optimised splits)
72	3	–75	3	3			(Plan 3, 75 sec fixed cycle, optimised splits)
71	5	70	10	15	25		(Plan 5, 70 sec fixed cycle and splits)
73	4	999	1	3	150		(Plan 4, optimised cycle and splits)
77	21	1	2	3			(Signal 21, plans 1, 2, 3)
77	31	1	2	3			(Signal 31, plans 1, 2, 3)
77	41	4	4	5			(Signal 41, plans 4, 4, 5)

Note: The above example is designed to demonstrate the use of type 71, 72, 73 and 77 cards and does not refer to the network described in Section 5.

3.3.17 Fixed route data: The fixed routes option constrains specified origin-destination movements to travel along given routes. The option can be used, for example, to assign buses to scheduled routes.

The fixed routes data consist of two parts (card types 81 and 85). The first details the chain of links which make up each fixed route. The second identifies the O-D movements which use the fixed routes. An 'O-D movement' must correspond to one of the O-D demands in the Traffic Demand data pack – Section 3.2.2. If only some of the vehicles of a particular class, travelling between the same origin and destination, are constrained to follow a fixed route (ie the other vehicles having a free choice of route) then it is necessary to introduce a second origin (or destination), duplicating the original one but with a different identification number, to differentiate the traffic movements. The same method would be used to model two independent bus routes. The data are specified as follows:

3.3.18 Card type 81 (Data for each fixed route): Each card specifies the number of a fixed route, the number of links on the route and the sequential chain of link numbers which make up the route. Only one card is required if a route has 13 or less links otherwise a continuation card is required. The maximum number of links in a fixed route is 25. A maximum of 100 fixed routes can be used. All type 81 cards must occur together in the CONTROL data pack. The card format is:

Column numbers		Entry
1–5	81	(Card type)
6–10		Identification number of fixed route (must be in the range 1 to 100).
11–15		The number of links on the route
16–20		The number of the first link in the fixed route
21–25 76–80		The numbers of the succeeding links on the fixed route (if there are fewer than 13 then blank spaces should be left)

If there are more than 13 links on a fixed route then a *continuation card* is required:

Columns used		Entry
1–5	81	(Card type)
6–10 11–15		Not used
16–20		The number of the 14th link on the fixed route
21–25 71–75		The numbers of the succeeding links on the route
76–80		Not used

3.3.19 Card type 85 (Data for each classified origin-destination movement with a fixed route): These data relate to the corresponding demand in the Traffic Demand data pack. The origin number is listed together with the destination number, the class of vehicle and the number of the fixed route along which the classified traffic is constrained to travel. One data card is required for each such classified traffic demand. A maximum of 100 classified origin-destination demands with fixed routes can be used. All type 85 cards must occur together in the CONTROL data pack. The card format is:

Column numbers		Entry
1–5	85	(Card type)
6–10		The origin number of the classified traffic demand
11–15		The destination number of the classified traffic demand
16–20		1 if class C vehicles (cars) with the fixed route 2 if class B vehicles with the fixed route 4 if class L vehicles with the fixed route
21–25		The number of the fixed route
26–80		Not used

3.3.20 Example of coding for fixed routes: As an example of the data coding required for the fixed routes option consider 5 origin-destination pairs 5111–9111, 5112–9112, 5113–9113, 5114–9114 and 5115–9115. Suppose,

a. class C vehs (cars) from origin-destination pairs 5111–9111 and 5112–9112 must travel along links 111, 112, 113, 114, 115 and 116,

b. class B vehs from origin-destination pairs 5111–9111, 5113–9113 and 5114–9114 must travel along links 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226 and 227,

c. class B and L vehs from origin-destination pair 5115–9115 must travel along links 311, 312, 313, 314 and 315.

Then a satisfactory coding for these data is as follows,

81	1	6	111	112	113	114	115	116 (route of 6 links)								
81	2	17	211	212	213	214	215	216	217	218	219	220	221	222	223	
81			224	225	226	227		(continuation for route of 17 links)								
81	3	5	311	312	313	314	315	(route of 5 links)								
85	5111	9111	1	1				(1st O-D pair: Class C on route 1)								
85	5112	9112	1	1				(2nd O-D pair: Class C on route 1)								
85	5111	9111	2	2				(1st O-D pair: Class B on route 2)								
85	5113	9113	2	2				(3rd O-D pair: Class B on route 2)								
85	5114	9114	2	2				(4th O-D pair: Class B on route 2)								
85	5115	9115	2	3				(5th O-D pair: Class B on route 3)								
85	5115	9115	4	3				(6th O-D pair: Class L on route 3)								

Note: The above example is designed to demonstrate the use of type 81 and 85 cards and does not refer to the text example in Section 5.

4. DATA OUTPUT

The Output from CONTRAM consists of two parts – a printout of the INPUT data and the OUTPUT for the simulation period. The Output for the Test Example, described in Section 5, is used to illustrate the facilities available. The network for this example is shown in Figure 1; Figure 2(a) and 2(b) illustrate the traffic demands on the network, and Figure 3 demonstrates the method of coding described in Section 5. Figure 4 summarises the network properties for the test network.

4.1 *Record of input data*

The INPUT data (Figures 5(a) to 5(e)) are automatically reproduced for each run of the model in the order: Network and Time data (Figures 5(a) and 5(b)); Traffic Demand data (Figure 5(c)); and Control data (Figures 5(d) and 5(e)). In general the output reproduces the input data cards, Section 3, in the order that the data are entered, together with explanatory headings and error messages. The error messages are a valuable aid for detecting problems with the data as the program attempts to complete the input stage even if logical errors in the data prevent the program from proceeding further. (Clearly, incorrect numerical values cannot be identified unless they are such as to cause a logical problem for the program.) An explanation of error messages is given in Section 6.2.

For ease of reference the vehicle codes for cars, buses and lorries are printed out as C, B and L, where appropriate, instead of the numerical coding used for entering data, and 'XX' is used to denote prohibited entry for all classes of vehicles. The letter E, after any link storage value, indicates that the storage capacity has been estimated by the program when no value has been specified by the user.

After the printout of the network input data, Figure 5(b), totals are given of the number of links of each type and the number of all links in the network. Finally, a list of destinations is printed – these are deduced by the program and enable a check to be made that destinations defined in the traffic demand data pack exist within the network.

The traffic demand data, Figure 5(c), also gives totals for the flows leaving each origin and the flows directed towards each destination. A single total, at the end of the figure, gives the total number of packets which enter the network. Figure 5(d) gives the number of iterations and the output options selected, and Figure 5(e) lists signal plan and fixed route data.

4.2 *Output options*

The OUTPUT data for CONTRAM is calculated from the link by link and route information stored during the assignment procedure. The types of output available and the parameters calculated are described in the sections below. There are generally three printout options for each type of output, relating to the number of iterations to be printed; the first prints data for all iterations, the second for the last N iterations and the third for up to 5 selected iterations. This wide choice of output is intended to cater both for applications work (traffic engineering or traffic management purposes) and for research studies; however, as each additional output requires additional computational time it is advisable to limit the choice to essential outputs. The types and numbers of outputs and their use will largely be determined by experience – some guidance for practical applications is given below.

There are six forms of output, any selection of which can be called by the appropriate card-types 51 to 56 (Section 3.3). Each of the outputs is preceded by a heading defining the option selected and (if available on the computer used) the date of the current run of the program. These are followed by the titles for the 3 input data packs so that all printouts can be easily identified. The various outputs have been designed principally for use for traffic engineering and traffic management purposes and, in consequence, there is an overlap of information between some of the outputs. The types of output and their uses are as follows:–

4.3 *Network summary information* (called by card type 51)

The data printed are the Total Distance Travelled by all vehicles in the network (veh.kms), and the Total Time Spent in the network (veh. hrs). These are printed for each time-interval (across a page) together with the totals for the whole simulation period, for each selected iteration – see Figure 6(a). For convenience of comparison a table of network summaries for the last 5 iterations of a run is printed, after the last iteration, if any summaries have been requested – Figure 6(b).

The purpose of these printouts is to provide data for assessing convergence. It is important to establish when an adequate state of convergence has been reached in order to have confidence that the program has produced stable traffic patterns. There are no rules for establishing the number of iterations needed – in practice between 5 and 8 has been sufficient for the real town networks tested by the Transport and Road Research Laboratory. However the number is likely to depend on local conditions, particularly on the number of alternative routes in a network. (Note: although the program is based on the prediction of the minimum journey time routes for individual packets this does not necessarily imply that the total time spent by vehicles in the network will be a minimum.) Variation between iterations of the total distance travelled is an indication of the extent to which packets are being reassigned to alternative routes. Normally the table for the last 5 iterations of a run will be sufficient for most practical purposes.

It is not intended that this output should be used in isolation from the outputs which follow as the only means for assessing the merits of different traffic management schemes.

4.4 *Change in vehicle arrivals – convergence matrix* (called by card type 52)

Because the total journey time and total distance travelled (Section 4.3) are relatively coarse indicators of convergence for deciding when sufficiently stable traffic patterns have been attained, a second convergence indicator can be selected (Figure 7). This prints out the changes in stopline arrivals (PCUs) between consecutive iterations, for all links for each time interval. The values printed are the signed values for 'iteration (i) – iteration (i–1)', thus showing whether the arrivals on a link have increased or decreased. The values are summed for all time intervals for each link, together with an overall total for all links and all time intervals. The modulus of the totals is also given. Normally a printout for iteration 1 would not be selected but if it is, then the values in the matrix correspond to the arrivals for the first iteration.

When interpreting the changes between iterations the magnitude of the change should be related to packet size – thus a difference in arrivals on a link of 20 PCUs, when a packet size of 10 is used, only represents a change of 2 packets (assuming in this case that 1 vehicle = 1 PCU). In addition it is possible that an increase during one time interval may be accompanied by a decrease of similar size in the next due to the differences in times that packets reach a stopline – such changes might therefore be of little practical significance. The change in arrivals in relation to the total flow (Section 4.5) is also important.

Taken in conjunction with the Total Network Summary data, described above, the Vehicle Arrivals Convergence Matrix gives a comprehensive picture of how traffic patterns have stabilised over a network. It would be useful to print this matrix for at least the last two iterations of a run.

4.5 *Link-by-link data – all parameters* (called by card type 53)

These data (Figure 8) contain link-by-link values of the parameters listed below, for each time interval. The parameters selected are intended for use for both traffic engineering and traffic management purposes; the printout includes network summaries of certain of these parameters for economic evaluation. Only a printout for the final iteration of a run is of practical use.

Title – After the usual headings for identification there is a line of text specifying the Time Interval and the Iteration Number for which the data are printed.

Link numbers and type – the number of the link and a code which indicates the link type – U for uncontrolled, G for give-ways and S for signal controlled. Links are printed out in numerical order for ease of reference (ie they are not necessarily in the order of data entry). A recommended method for coding links is given in Section 5.1.

Initial queue (PCUs) – the number of passenger car units queueing on the link at the start of the time interval.

Vehicle arrivals (vehs) – the number of vehicles in each class – C, B and L, reaching the stopline on the link in the time interval.

Departures from queue (PCUs) – the number of PCUs which leave the link in the time interval. The letter 'R' is printed if the throughput capacity of the link is restricted by blocking-back on one or more of the adjacent downstream links.

Final queue (PCUs) – the number of PCUs queueing on the link at the end of the time interval.

Spare throughput capacity (PCUs) – the difference between the maximum throughput capacity of the link and the number of PCUs which leave the link in the time interval.

Link store left (PCUs) – the amount of road space, in PCUs, between the upstream end of the queue and the upstream end of the link, at the end of the time interval. If this value is 0 then it indicates that the link is full – the letter 'F' is printed as a warning.

Degree of saturation (%) – is the demand on the link, ie (initial queue + stopline arrivals) divided by the maximum throughput capacity. The interpretation of this value cannot easily be defined when a link is affected by blocking-back because the maximum throughput capacity will vary during the time-interval – the value should then be regarded as an 'indicator' of the state of the traffic on a link rather than as a precise measurement. A '*' character is printed when the degree of saturation exceeds 90 per cent as a warning that the link is reaching its maximum throughput capacity.

Mean queue time or delay (secs) – the time taken for the average queue [ie ½(initial queue + final queue)] to discharge assuming a discharge rate of the maximum throughput capacity for the link. An allowance is included to take account of random arrivals in the traffic pattern.

Total time spent (veh. hours) – subdivided by class of vehicle, is (the sum of the vehicle arrivals in a class x the cruise time for the class) + (the mean queue x length of time interval x the proportion of vehicle arrivals in the class). For example (200 veh. arrivals x 20 secs. cruise/3600) + (10 vehs. queueing x ¼ hr. x 20%).

Total travel distance (veh. kms) – subdivided by class of vehicle C, B and L, is the total distance travelled by those vehicles arriving at the stopline during the time interval (= number of vehicle arrivals in a class x length of link).

Average speed of a car (km/hr) – this represents an 'average' speed for a car travelling along a link based on the free running time along the link and the mean queue time.

Junction number – the number of the junction controlling the link; in the case of signal controlled links this is the same as the signal number.

The three following pieces of information are given for signal controlled links:–

Plan type – the type of the signal plan controlling the link during the time interval – FCFS for fixed-cycle/fixed-splits, FCOS for fixed-cycle/optimised splits and OCOS for optimised-cycle/optimised splits.

Cycle time (secs) – the cycle time for the signal controlling the link, during the time interval.

Green time (secs) – the green time of the stage of the signal controlling the link, during the time interval.

The following network totals for the time interval are printed out at the end of the data:–

Total times (veh.hrs.) – for all links, by class of vehicle – broken down into time spent travelling, time spent delayed, and total journey time. These totals, factored by appropriate coefficients to allow for vehicle occupancy, are used for economic assessment purposes.

Total distance travelled (veh.kms) – for all links, by class of vehicle – these are only for the vehicles 'travelling' during the time interval, ie for 'stopline arrivals'.

Total fuel consumption (litres) – for all links, by class of vehicle – broken down into fuel used travelling, fuel used delayed and total fuel used.

A single value gives the total fuel used in the network.

4.6 *Link-by-link values of flows, queues, queue times and average speeds* (called by card type 54)

Four tables – Figures 9(a) to 9(d) – summarise selected data from Section 4.5 in tabular form. The tables are primarily intended for use for traffic engineering purposes and show the variation with time of link flows, queues, mean queue times (delays) and average speeds for each link. These are four of the more useful parameters for indicating the state of traffic conditions in a network. Only a printout for the final iteration of a run is of practical use. The information printed is:–

Title – The usual identification headings followed by one of four parameter headings:

Link-by-link values – Flows (PCU/hr)
Link-by-link values – Final queues (PCU)
Link-by-link values – Mean queue times (secs)
Link-by-link values – Average speeds (kms/hr)

the heading for each table is completed by the Iteration Number.

Note:– the vehicle arrivals (in PCUs) for each time interval have been converted to a flow *rate* (PCU/hr) as this is a more useful form for traffic engineers.

Each table has the same format:

Across the page – Time interval numbers (1 up to 13) and time interval boundaries (hrs. mins).
Down the page – Link numbers and types (in numerical order).

A final column identifies the time interval during which maximum values occur (minimum values in the case of average speeds). If the maximum (or minimum) value occurs for more than one time interval only the first is identified.

Within the 'Flows' table time intervals for which the degree of saturation exceed 90 per cent are marked with an '*', and an 'R' if the flow from the stopline is restricted by blocking-back. If both conditions exist simultaneously then an '&' is printed. At the end of the 'Flows' table (Figure 9(a)) a summary is given of the total number of PCUs leaving all origins during each time interval, followed by a summary of the total number of PCUs reaching all destinations during each time interval.

At the bottom of the 'Final Queues' table (Figure 9(b)) there is a summary of the queues on all links for each time interval.

4.7 *Measure of fairness* (called by card type 55)

This output, Figure 10, indicates the variation with time of the 'average straight-line speed' or 'crow flight' speed for selected origin-destination movements specified in the demand data. It is intended for use as a means of comparing the effect of traffic management schemes on overall journey speeds to ensure that improvements for one set of movements are not made, unwittingly, at the expense of other movements. For example a traffic management scheme may force some users to travel much longer distances to reach their destination. This would show up as a low 'crow flight' speed even if the actual travel speed was high. Normally this printout would only be selected for the final iteration of a run.

After the usual identification heading the printout lists, across the page, the Origin and Destination numbers which identify the traffic movement, the Vehicle Class, Linear Distance between origin and destination (metres) and the heading 'Average Straight-line Speed (km/hr) for packets entering in time interval: ....'. The next lines list the Time Interval Number (1 up to 13) and the Time Interval Boundaries. These are followed by the table of speeds.

4.8 *Turning movements: for selected junctions or for all links* (called by card type 56)

These data, Figures 11(a) or 11(b), provide detailed information for all time intervals of turning movements for traffic engineering purposes. The first form of this option, Figure 11(a), is junction oriented and contains additional information on flows, signal timings (if appropriate), final queues and mean queue time for the links feeding the junction. The second form, Figure 11(b), provides turning movements from all links without any additional information. Normally only one or other of these printouts would be selected for the final iteration of a run. The forms of the output are:

For junctions (Figure 11(a)):–

Title The usual identification heading followed by the Junction Number, the Type of Junction and the Iteration Number.

Across the page – time interval numbers (1 up to 13) and time interval boundaries (hrs. mins), followed by a heading 'Turning Movements – PCU/hr'.

Down the page – the number and type of the links feeding the junction, each followed by a sub-list of the links fed by the link. (The order of the links 'fed' is the same as that on the input data cards type 4, 5 and 6 (columns 11 to 35). It is useful to enter these on the input cards in the order – left turning, straight ahead and right turning lanes, for ease of interpreting the turning movements.

The turning movements are followed by the Arrival Flows (PCU/hr) for each of the links feeding the junction – for each time interval. Flows for time intervals during which the degree of saturation exceeds 90 per cent are marked with an '*', and an 'R' if the flow from the stopline is restricted by blocking-back. If both conditions exist simultaneously then an '&' is printed.

Signal control details (cycle time (secs), lost time (secs), type of plan and stage green time (secs)) are given for each time interval if the junction is signal controlled.

For links (Figure 11(b)):–

Title The usual identification heading is followed by 'Link-by-link turning movements' and the Iteration Number.

Across the page – time interval numbers (1 up to 13), and time interval boundaries (hrs.mins), followed by a heading 'Turning Movements – PCU/hr'.

Down the page – the number and type of all links on the network in sequential order. Each link is followed by a sub-list of the links fed by the link. As before the order of the links 'fed' is the same as that on the input data cards (card types 4, 5 and 6 – columns 11 to 35).

5. TEST EXAMPLE

The test network shown in Figure 1 has been designed to demonstrate the use of the facilities in CONTRAM – it contains many of the network conditions found in urban areas. The network represents a small town with a main through route which passes through the centre of a shopping area. There are two alternative routes around the town: a fast, but longer, ring road and a back route, through a residential area, on which there are two give-way junctions. The network contains a roundabout, four signal controlled junctions – one of which is a pedestrian signal, and a central car park.

Traffic demands for the network are shown diagrammatically in Figures 2(a) and 2(b). There is both local and through traffic. One bus route is included and lorries are prohibited from using the road links which pass through the shopping area. The time period modelled represents a morning peak period.

There is clearly a conflict of interests in this network between local and through traffic which compete for use of the same central routes; but any diversion of the through traffic would result in longer distances travelled or in increased traffic through the residential area.

The section below describes coding details for setting up the input data for the network. An example of the completed coding sheets is contained in the Appendix. Comments on the outputs for this example are given in Section 5.2; the form of the outputs, Figures 5 to 11, has already been described in Section 4.

5.1 *Coding of input data*

Each link in the network consists of a uni-directional length of road between two junctions. More than one link is used for the same stretch of road if specific turning movements have to be modelled. A scheme for coding the network is shown in Figure 3 and is recommended for general use. The system adopted uses a 2 digit number, to identify each junction, followed by single digits to define links that enter the junction, eg junction 21 has entry links 211, 212, 213, 214 and 215. (The numbers begin with links from the North and increase clockwise around the junction.) Here link 212 is used to represent right turning movements only. As the printout of turning movements for each feeding link (Figures 11(a) and 11(b)) are in the same order as the links 'fed' specified on cards type 4, 5 and 6 (columns 11–15, 16–20, ..., 31–35) it is useful, for interpreting turning movements, to arrange the links fed in an easily recognisable order. The order suggested for this example is: left turning, straight ahead and right turning movements. For example, link 213 (on card type 6) feeds links 433 (l.t.), 012 (s.a.) and 312 (r.t.).

Network properties – link lengths, cruise times and saturation flows – are summarised in Figure 4. A diagram of this type is useful to check that all of the network data has been collected. The cruise times entered on cards type 4, 5 and 6 are most easily obtained by measurement by driving through a network and measuring 'unimpeded' run times between stop lines. The measurements automatically allow for geometric effects in the network such as gradients and approaches to junctions which have poor sightlines. Saturation flows should be measured on site, if possible, particularly for important junctions, to take account of local conditions. If direct measurement is not possible then values can be estimated from road widths[3], for signal controlled and uncontrolled links, or from the formulae in Reference 4 for give-way junctions. Link lengths can be obtained from large scale maps. Storage capacities should be estimated for links with lengths less than 60m. These would normally be measured on site, if queues exist, or estimated using plans for a junction taking into account the practical number of lanes at a stopline and assuming that each PCU occupies 6m of storage space.

Origin numbers have been prefixed with a 5 and destinations with a 9 so that they can be easily distinguished from link numbers.

The system of coding described is not unique and other systems can be used. The coding of the network data used for the text example is shown on pages 52 to 57.

Traffic demands for this example (Figures 2(a) and 2(b)) and the input data for these demands are shown on the coding sheets on pages 58 and 59. These show the time variation in demand for all the origin-destination movements. An example of the demand profile from origin 5002 to destination 9002 is illustrated in Figure 2(b). In this example the lengths of time-intervals have been chosen to take into account the time variation in traffic conditions. Change of mind cards are used to increase all the demands from origin 5001 by a factor of 1.05 (ie an increase of 5 per cent).

Program control, signal control and fixed route data are illustrated on pages 60 to 68. Comments on the program control and some of the information in the outputs are given in the next section.

The coding for two types of signal setting is illustrated on pages 63 to 66. Fixed time settings (FC/FS) are used for all time intervals for signals 20, 21 and 01; here signal 01 represents a pedestrian signal. A fixed cycle/ optimised splits plan (FC/OS) is used for signal 22 during time intervals 5 and 6 and fixed time settings for the rest of the time intervals.

The data for the fixed route of the bus movements, from origin 5005 to destination 9001, are shown on pages 67 and 68.

5.2 *Output*

The input data (pages 52 to 68) is printed at the beginning of the output – Figures 5(a) to 5(e). Figures 5(a) and 5(b) give the time and network data, Figure 5(c) the traffic demand data and Figures 5(d) and 5(e) the control data. Figure 5(d) shows that, for this test example, 10 iterations have been specified; Summary data is called for iteration 2; Flow convergence data for the last 3 iterations; Link-by-link data for all parameters for the last iteration; Link-by-link values for flows, queues, queue times and average speeds for the last iteration; Measure of fairness for the last iteration and Turning movements for selected junctions for the last iteration. Error messages would be included in these printouts if errors were detected.

The printouts, Figures 6 to 11, include examples of each type of output option which is available. Normally only a selection of these would be used.

Figure 6(a) gives the overall network journey time and distance summaries for iteration 2, and Figure 6(b) the table of summaries for the last 5 iterations (iterations 6 to 10). The latter shows that the overall summary values have converged to within 1 per cent by iteration 7.

The matrix of changes in vehicle arrivals, Figure 7, provides more detailed information on the convergence of traffic patterns than is given by the table of network summaries. This printout, for iteration 10, shows the change in the numbers of PCUs on individual links is within 2 packet sizes for practically all time intervals. This, taken in conjunction with the network summary table, suggests that the model has converged by iteration 10 for practical purposes – a printout of the convergence table for earlier iterations would be used to assess whether less than 10 iterations was acceptable for practical use. It is possible that this example may not be typical of the way in which the model will converge for real towns.

Figure 8 illustrates the link-by-link data for all parameters for each time interval – in this case time interval 6 from 08.45 to 09.00 am. The link full marker 'F' for link 202, in the column headed 'Link store left', shows that vehicles on this link are blocking-back and restricting the flow from the previous junction. This is confirmed by a letter 'R', for restricted flow, for link 012 in the column headed 'Departure from queue'. The blocking-back in this example is caused by the limited storage capacity on link 202 which is only 50m long. The asterisks '*' in the column headed 'Degree of saturation' indicate greater than 90 per cent saturation for those links. The last 3 columns give the type of signal plan in operation during the time interval, the cycle time and green time for each signal controlled link.

Figures 9(a) to 9(d) show the tables of link-by-link values for flows, final queues, mean queue times and average speeds. In the flows table 5(a) the '&' for link 012 shows that the link is both affected by blocking-back and is greater than 90 per cent saturated. As in Figure 8 an asterisk '*' indicates greater than 90 per cent saturation. These tables show directly the variations in traffic conditions over the network throughout the simulation period and enable troublesome links to be identified. It will be noted that the model predicts zero traffic flow on link 443 for all time intervals – this is to be expected as that link does not form part of a route for any of the O-D movements used for this example.

Figure 10 shows the time variation in 'linear speeds' between origins and destinations for selected traffic movements. This table indicates how traffic movements are affected by network conditions. As a measure of 'fairness' it enables benefits for one set of users to be balanced against disbenefits for others using the network.

Figures 11(a) and 11(b) illustrate the 2 forms of output for turning movements. Figure 11(a) is for selected junctions. Details are given of arrival flows for all links approaching the junction and, for signal controlled links, the signal settings. This information allows different junction control strategies to be investigated.

The second type of output for turning movements, Figure 11(b), gives turning movements for all links but does not include the additional traffic information. (Note – only one of the outputs 11(a) or 11(b) can be called for a particular run of the model using card type 56.) An examination of Figures 11(a) and 11(b) shows that there are no flows for some of the permitted movements. This largely arises because of the simplified origin-destination movements assumed for this test example and is unlikely to occur for a real town. Zero turning movements in the middle of the simulation period, eg for movements 312 → 511 and 502 → 212 show that routes using other links become more attractive as the demand on the network reaches its peak.

6. STRUCTURE AND OPERATION OF CONTRAM PROGRAM

6.1 *Structure*

The program was originally written in FORTRAN IV as modified to run on an ICL 4–70 computer. It has been further modified to run on a CYBER 170–720. In general only small modifications are needed to the FORTRAN source to use the program on other computers. The program consists of a main program routine and six subroutines called INNET, INFLOW, CONTRL, RMODEL, ROUTPT and TURMOV. The main program, CONTRAM, transfers control from one subroutine to another, usually via the subroutine CONTRL. INNET reads the Network and Time data from a card image file, unit 51. The Traffic Demand data is read by INFLOW from a similar data file, unit 52. The Control data is read from unit 53 by the CONTRL subroutine, which also provides the instructions used by the main program when transferring program control from subroutine to subroutine. CONTRL also calculates traffic signal times where necessary. The subroutine RMODEL reads route information for each packet from a scratch file (unit D1), calculates the packet's quickest route through the network and stores the updated information for each packet on a second scratch file (unit D2). The calculation of the routes for all of the packets constitutes one iteration of the program. The procedure is repeated as many times as specified in the input data. After each iteration, any traffic information called by the output options (Section 4) is calculated and printed by ROUTPT. The program output is normally through a line printer (unit 99) which has 132 characters per line. The subroutine TURMOV is called from ROUTPT if turning movement data are required.

The program is designed to be overlaid with a root segment containing the main program routine, common areas and system routines. The system routines called by the program are DATE, EXIT and SQRT (square root). All the subroutines are called individually, so that at any stage in the operation the main core store contains the root segment and the single subroutine currently in use. On the CYBER 170–720 computer the core store requirements for CONTRAM version 4, which can model up to 200 links and 13 time intervals are as follows:

	Routine	Store (K bytes)	
	Main program	–	
Root segment	Common Areas	425	467
	System routines	42	
	INNET	13	
	INFLOW	62	
	CONTRL	46	
	RMODEL	30	
	ROUTPT	28	
	TURMOV	103	

Thus the total core store required when overlaid as described above is 467 + 103 = 570K bytes. This is larger than many machines will require because the CYBER 170–720 has a 60 bit word size and because none of the data is packed.

As an indication of the computer time used, the program takes about 30 minutes of CPU time on a CYBER 170–720 to run five iterations on a network of 184 links with 64 junctions (14 of them signal controlled) for 6000 packets of traffic.

6.2 *Error messages*

Messages are printed at the data-output stage if errors have been detected in the input data or during the running of the program. Two classes of error are identified; these are preceded by the words 'error' or 'warning':–

'Error'. The program incorporates a number of checks on the input data (for consistency, range of parameter values, etc), and during the iterative process and calculation of the traffic data for the output stage. An *error* message indicates that a *serious* fault has been detected which would prevent the program from operating correctly.

A run would normally be terminated at that stage with an appropriate message. However, to aid detection of further errors in the input data the program has been organised so that it completes the reading of all the input data even if more than one serious error has occurred – an appropriate message for each error is printed.

'Warning'. Where possible checks have also been incorporated to identify abnormal parameter values or unusual conditions in the operation of the program. Such 'warnings' do not cause the program to stop but are considered to be sufficiently important for them to be identified and examined by the user before the output from a run is accepted.

The error checks and messages are largely self-explanatory:

Error messages:	generated in routine
Interval boundary times not in chronological order	INNET
Negative number found in network and time data	INNET
Card type not in range expected	INNET,CONTRL
Too many origins	INNET
Too many destinations (deduced from network data)	INNET
Incorrect banned vehicle code (not C, B or L)	INNET
Too many links	INNET
Give-way link has unknown main road link	INNET
Too many signal junctions	INNET
Too many signal stages	INNET
Too many links with same signal stage	INNET
Change of mind cards inconsistent	INNET
Incorrect vehicle class code (not C, B or L)	INNET,INFLOW,CONTRL
Saturation flow value is zero	INNET
Too many origin-destination pairs	INFLOW
Incorrect reference to time intervals as specified in network and time data	INFLOW
O-D specified in demand data not consistent with network data	INFLOW
Packet size of zero	INFLOW
PCU value not specified for given vehicle type	INFLOW
Fixed route not consistent with link data	CONTRL
Too many signal plans	CONTRL
More signal data cards (type 77) than number of signals previously declared	CONTRL
Too many fixed routes	CONTRL
Too many O-D pairs with specified fixed routes	CONTRL
Packet unable to complete journey before end of last time interval	RMODEL
Impossible journey – a packet cannot reach its destination in the network as specified	RMODEL

Warning messages:	generated in routine
Time unit specified is greater than 1 second	INNET
Saturation flow (PCUs/hr) outside usual ranges (300–5000 for give-way links, 500–20 000 for others)	INNET
Change of mind card sets a parameter to zero	INNET,INFLOW
Signal data provided for a signal not specified on a link data card	INNET
Too many O-D pairs with straightline distances	INFLOW
No turning movements are printed because type 57 card is missing or blank	CONTRL
Junction number for turning movements has not been declared	CONTRL
Stage number not identified when checking minimum signal delay on a link	RMODEL
Packet route requires more than 30 links (this is acceptable for the early iterations of a run)	RMODEL
Packet route not consistent with network data	TURMOV
Signal junction fed by more than 35 links	TURMOV

6.3 *Bounds for input parameters*

Bounds for input parameters for the standard version of the program are summarised in the table below. Certain changes in these parameters, for increasing the number of links in a network and/or the number of O-D movements, are described in the next section.

Parameter	Maximum value
Time intervals	13
Origins	50
Destinations	50
Links	200
Links connected to an origin	5
Links or destinations connected to a link	5
Give-way links controlled by an uncontrolled link	2
Give-way links	75
Uncontrolled links controlling a give-way link	2
Signalised junctions	50
Stages per signal	4
Signal-controlled links per stage per signal	4
Vehicle classes	3
Classified origin-destination pairs	500
Fixed-time plans	100
Fixed routes	100
Links on a fixed route	25
Classified origin-destination pairs with fixed routes	100
Classified origin-destination pairs with specified linear distances	50

6.4 *Change of program size*

The standard form of the program allows for up to 200 links in a network and up to 500 O-D movements. The numbers of links and/or O-D movements can be increased or decreased by changing the parameters and arrays listed below. A decrease in the number of links or O-D movements may be necessary if computer storage space is limited.

Network size

If 'n' is the maximum number of links permitted by the program the values to be reset are:—

	Location
XXNL = n	INNET
XXSNL = n	INNET
LNM (n + 50)	COMMON/GENERAL/
VNL (5, n + 50)	COMMON/GENERAL/
VVNL (5, n + 50)	COMMON/GENERAL/
WCTJ (n, 13)	COMMON/GENERAL/
NODFED (n)	COMMON/GENERAL/
*TABLE (n, 13)	COMMON/GENERAL/
YLTJ (n)	COMMON/GENERAL/
AKTF (n, 13, 2)	COMMON/GENERAL/
ZKTF (n, 13, 2)	COMMON/GENERAL/
KTF (n, 13, 4)	COMMON/GENERAL/
MLC (n)	COMMON/GENERAL/
XXLTF (n)	COMMON/GENERAL/
UNCNLK (n, 2)	COMMON/GENERAL/
STOCAP (n)	COMMON/GENERAL/
LNKORD (n)	COMMON/GENERAL/
CAPRED (n, 13)	COMMON/GENERAL/
LTL (n)	COMMON/INOUT/
SNL (n)	COMMON/INOUT/
LES (n+1)	COMMON/SHARED/in RMODEL
ENL (n+1)	COMMON/SHARED/in RMODEL
ALTJ (n+1)	COMMON/SHARED/in RMODEL
BHSL (n+1)	COMMON/SHARED/in RMODEL
ZES (n+1)	COMMON/SHARED/in RMODEL
MAXTHR (n, 13)	RMODEL
WWQU (n, 3)	ROUTPT
WWQUX (n, 3)	ROUTPT
WTURNS (n, 5, 13)	TURMOV

* Note: The array TABLE can only be *increased* in size, ie n must not be less than 200.

O-D movements

If 'm' is the maximum number of O-D movements which can be specified the values to be reset are:

	Location
XNP = m	INNET
NC (m)	INFLOW
FRACTN (13, m)	INFLOW
TALLY (m)	INFLOW
PFOET (m)	INFLOW
NO (m)	INFLOW
ND (m)	INFLOW
PTF (m)	INFLOW
KED (13, m)	INFLOW

7. ACKNOWLEDGEMENTS

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8. REFERENCES

1. LEONARD, D R, J B TOUGH and P C BAGULEY. CONTRAM: a traffic assignment model for predicting flows and queues during peak periods. *Department of the Environment Department of Transport, TRRL Report* LR 841. Crowthorne, 1978 (Transport and Road Research Laboratory).

2. KIMBER, R M and Erica M HOLLIS. Traffic queues and delays at road junctions. *Department of the Environment Department of Transport, TRRL Report* LR 909. Crowthorne, 1979 (Transport and Road Research Laboratory).

3. WEBSTER, F V and B M COBBE. Traffic Signals. *Ministry of Transport, Road Research Technical Paper* No 56. London, 1966 (H M Stationery Office).

4. KIMBER, R M (TRRL) and R D COOMBE (Martin and Voorhees Associates). The traffic capacity of major/minor priority junctions. *Department of the Environment Department of Transport, TRRL Report* SR 582. Crowthorne, 1980 (Transport and Road Research Laboratory).

5. KIMBER, R M. The traffic capacity of roundabouts. *Department of the Environment Department of Transport, TRRL Report* LR 942. Crowthorne, 1980 (Transport and Road Research Laboratory).

6. ROBERTSON, D I, C F LUCAS and R BAKER. Coordinating traffic signals to reduce fuel consumption. *Department of the Environment Department of Transport, TRRL Report* LR 934. Crowthorne, 1980 (Transport and Road Research Laboratory).

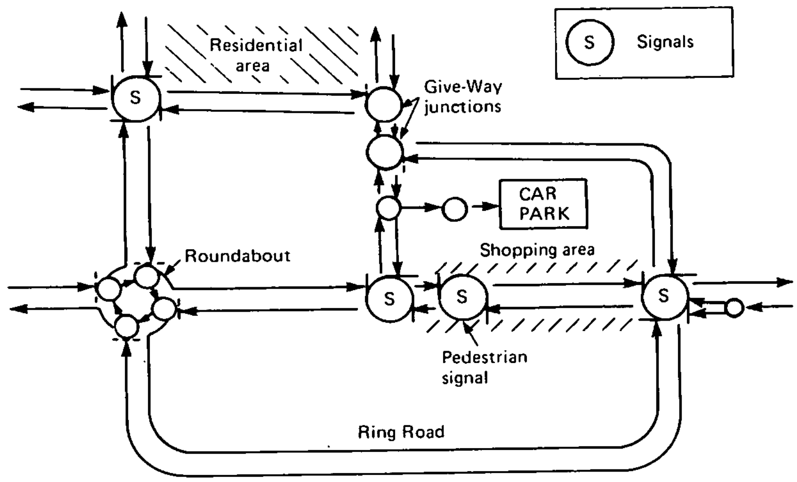

Fig. 1 Test network

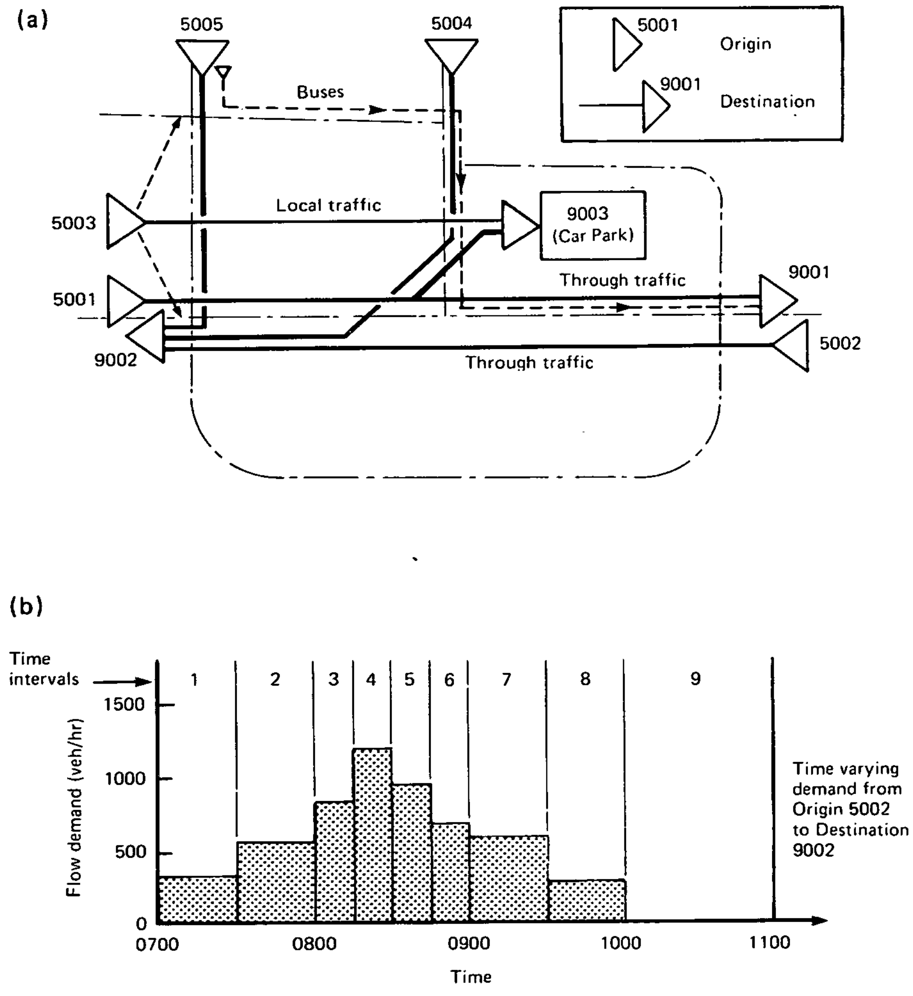

Fig. 2 Traffic demands on test network

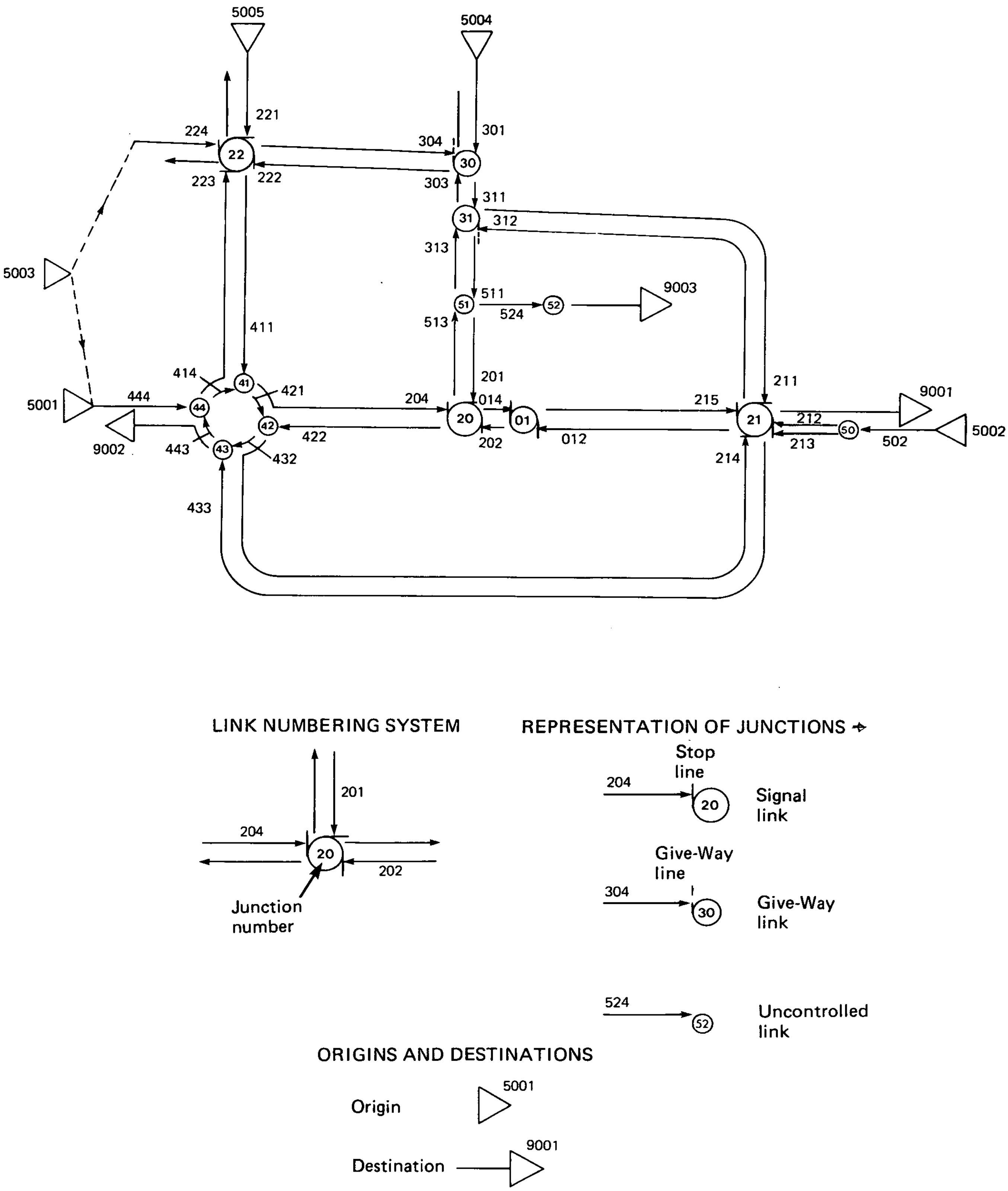

Fig. 3 Coding for the Test Network

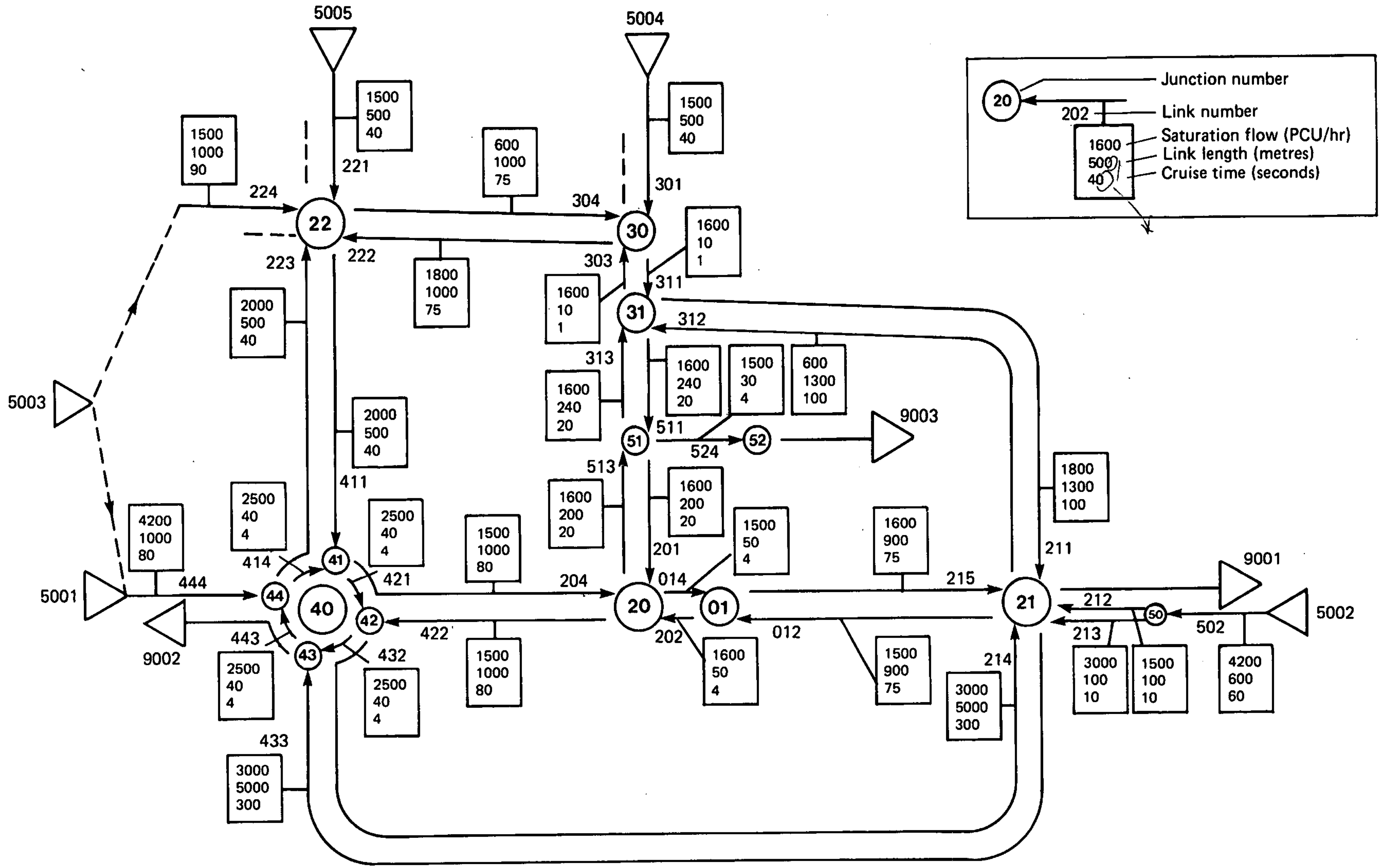

Fig. 4 Link data for test network

TRAFFIC DEMANDS

O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)

ORIG NO.	DEST NO.	PKT SIZE (VEH)	LIN. DIST (MTR)	ENTRY FLOW-RATE IN TIME INTERVALS (VEH/HR) : 1	2	3	4	5	6	7	8	9	10	11	12	13
RESET				105%	105%	105%	105%	105%	105%	105%	105%	105%				
5001	9001	10C	3000	375	750	1125	1500	1350	1050	750	375	0				
5001	9001	5L	3000	40	80	120	180	160	170	160	100	0				
5001	9003	10C	2300	150	300	450	600	525	375	300	150	0				
RESET				100%	100%	100%	100%	100%	100%	100%	100%	100%				
5002	9002	10C	2700	320	560	800	1200	950	700	600	300	0				
5003	9003	10C	2300	50	200	300	350	400	250	150	50	0				
5004	9002	10L	2000	40	120	200	300	270	240	210	150	0				
5005	9001	2B	2900	10	20	20	20	20	20	20	20	0				
5005	9002	10C	1000	100	120	150	200	180	150	120	80	0				

VEHICLE FLOW RATES FROM EACH ORIGIN (VEH/HR)

ORIGINS	FLOWS								
5001	592	1186	1779	2394	2136	1673	1270	655	0
5002	320	560	800	1200	950	700	600	300	0
5003	50	200	300	350	400	250	150	50	0
5004	40	120	200	300	270	240	210	150	0
5005	110	140	170	220	200	170	140	100	0

VEHICLE FLOW RATES DIRECTED TOWARDS EACH DESTINATION (VEH/HR)

DESTINATIONS	FLOWS								
9002	460	800	1150	1700	1400	1090	930	530	0
9003	207	515	772	980	951	643	465	207	0
9001	445	891	1327	1784	1605	1300	975	518	0

THE TOTAL NUMBER OF PACKETS ENTERING THE NETWORK IS 772

Fig. 5(c) Origin — destination demands

CONTRAM4 TEST NETWORK – GIVE WAYS AT 30,31 – STANDARD CASE (AUGUST 1981)

CARD TYPE	TIME UNIT (SECS)	TIME INTERVAL BOUNDARIES FOR SIMULATION PERIOD. (HOURS AND MINUTES) INTERVAL NUMBER : 1	2	3	4	5	6	7	8	9	10	11	12	13	
1	1	700	730	800	815	830	845	900	930	1000	1100	0	0	0	0

Fig. 5(a) Time data

CARD TYPE	ORIGIN NUMBER	FEEDS UP TO 5 LINKS : (LETTERS DENOTE BANNED MOVEMENTS)				
3	5001	444	0	0	0	0
3	5002	502	0	0	0	0
3	5003	224	444	0	0	0
3	5004	301	0	0	0	0
3	5005	221	0	0	0	0

CARD TYPE	FREE LINK NUMBER	FEEDS UP TO 5 LINKS OR DESTINATIONS : (LETTERS DENOTE BANNED MOVEMENTS)					CRUISE TIME (SECS)	LENGTH (METRS)	SAT,N FLOW (PCU/H)	STORE CAP. (PCUS)	JUNCTION NUMBER
4	301	311	222	0	0	0	40	500	1500	69E	30
4	303	222	0	0	0	0	1	10	1600	2	30
4	311	211	511	0	0	0	1	10	1600	2	31
4	313	303	211	0	0	0	20	240	1600	35E	31
4	414	204	421	0	0	0	4	40	2500	9E	41
4	421	214	432	0	0	0	4	40	2500	9E	42
4	432	9002	443	0	0	0	4	40	2500	9E	43
4	443	223	414	0	0	0	4	40	2500	9E	44
4	502	213	212	0	0	0	60	600	4200	233E	50
4	511	524	201	0	0	0	20	240	1600	35E	51
4	513	313	524	0	0	0	20	200	1600	29E	51
4	524	9003	0	0	0	0	4	30	1500	40	52

CARD TYPE	GIVE-WAY LINK NUMBER	FEEDS UP TO 5 LINKS OR DESTINATIONS : (LETTERS DENOTE BANNED MOVEMENTS)					CRUISE TIME (SECS)	LENGTH (METRS)	SAT,N FLOW (PCU/H)	STORE CAP. (PCUS)	GIVES WAY TO LINK NUMBERS A	B	-CAP,Y SLOPE *100	JUNCTION NUMBER
5	304	311	0	0	0	0	75	1000	600	180	303	301	25	30
5	312	511	303	0	0	0	100	1300	600	200	311	313	25	31
5	411	204	421	0	0	0	40	500	2000	92E	414	0	70	41
5	422	214	432	0	0	0	80	1000	1500	166E	421	0	50	42
5	433	9002	443	0	0	0	300	5000	3000	1388E	432	0	95	43
5	444	223	414	0	0	0	80	1000	3000	277E	443	0	95	44

CARD TYPE	SIGNL,D LINK NUMBER	FEEDS UP TO 5 LINKS OR DESTINATIONS : (LETTERS DENOTE BANNED MOVEMENTS)					CRUISE TIME (SECS)	LENGTH (METRS)	SAT,N FLOW (PCU/H)	STORE CAP. (PCUS)	SIGNAL /JUNCT NUMBER	STAGE WHEN GREEN	STAGE GREEN %	LINK DELAY %
6	12	202L	0	0	0	0	75	900	1500	125E	1	2	100	100
6	14	215L	0	0	0	0	4	50	1500	8	1	2	100	60
6	201	14L	422	0	0	0	20	200	1600	29E	20	1	100	100
6	202	422	513	0	0	0	4	50	1600	8	20	2	100	100
6	204	513	14L	0	0	0	80	1000	1500	138E	20	2	100	100
6	211	9001	433	12L	0	0	100	1300	1800	216E	21	1	100	100
6	212	312	0	0	0	0	10	100	1500	13E	21	2	50	100
6	213	433	12L	0	0	0	10	100	3000	27E	21	2	100	100
6	214	12L	312	9001	0	0	300	5000	3000	1388E	21	1	100	100
6	215	312	9001	433	0	0	75	900	1600	133E	21	2	50	70
6	221	304	411	0	0	0	40	500	1500	69E	22	1	100	100
6	222	411	0	0	0	0	75	1000	1800	155E	22	2	100	100
6	223	304	0	0	0	0	40	500	2000	92E	22	1	100	100
6	224	304	411	0	0	0	90	1000	1500	138E	22	2	100	100

CARD TYPE	SIGNAL NUMBER	LOST TIME (SECS)
7	1	25
7	20	10
7	21	10
7	22	10

CARD TYPE	PCUS PER CLASS CAR	B	L	CRUISE TIMES(% CAR VALUE) CAR	B	L
9	1.0	2.2	1.8	100	140	120

CARD TYPE NO.	VEH CLASS	FUEL COEFFICIENTS DISTANCE A	B	C	DELAY A	B	C
10	C	164	240	200	150	107	340
10	B	492	720	600	450	321	1020
10	L	492	720	600	450	321	1020

12 UNCONTROLLED LINKS
6 GIVE-WAY LINKS
14 SIGNALIZED LINKS
32 LINKS IN ALL

DESTINATIONS:-
9002 9003 9001

Fig. 5(b) Network data

NETWORK SUMMARY - FOR ASSESSING CONVERGENCE RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 2

TOTAL JOURNEY TIME (VEH-HRS) AND TOTAL DISTANCE TRAVELLED (VEH-KMS) FOR ALL TIME INTERVALS

TIME INTERVALS :

	1	2	3	4	5	6	7	8	9					TOTAL
	700 730	730 800	800 815	815 830	830 845	845 900	900 930	930 1000	1000 1100					
JOURNEY TIME	43	109	87	134	155	136	186	97	34	0	0	0	0	981
DISTANCE	1348	3203	2781	4281	4488	3431	4712	2210	173	0	0	0	0	26627

Fig. 6(a) Data output — Network summary information — Iteration 2

NETWORK SUMMARY FOR THE LAST 5 ITERATIONS RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

TOTAL JOURNEY TIME (VEH-HRS) FOR EACH TIME INTERVAL

TIME INTERVALS :

1	2	3	4	5	6	7	8	9					TOTAL	ITRN.NO.
700 730	730 800	800 815	815 830	830 845	845 900	900 930	930 1000	1000 1100						
43	109	88	130	151	132	182	95	34	0	0	0	0	964	6
43	109	88	130	152	134	184	94	35	0	0	0	0	969	7
43	109	89	129	150	133	183	95	35	0	0	0	0	966	8
43	109	88	130	151	130	183	94	33	0	0	0	0	961	9
43	109	88	130	151	133	188	93	33	0	0	0	0	968	10

TOTAL DISTANCE TRAVELLED (VEH-KMS) FOR EACH TIME INTERVAL

1348	3203	2842	4359	4409	3362	4812	2142	173	0	0	0	0	26650	6
1348	3203	2842	4359	4459	3352	4778	2169	173	0	0	0	0	26683	7
1348	3203	2892	4380	4438	3390	4679	2163	179	0	0	0	0	26672	8
1348	3203	2879	4340	4551	3239	4738	2189	179	0	0	0	0	26666	9
1348	3203	2879	4340	4541	3294	4736	2138	216	0	0	0	0	26695	10

Fig. 6(b) Data output — Network summary information — Last 5 iterations

CONTROL DATA

SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

CARD TYPE NO.	
50	NUMBER OF ITERATIONS = 10
51	SUMMARY DATA PRINTED FOR ITERATIONS : 2, 3,
52	FLOW CONVERGENCE DATA PRINTED FOR LAST 4 ITERATIONS
53	LINK-BY-LINK DATA (ALL PARAMETERS) PRINTED FOR LAST 1 ITERATIONS
54	LINK-BY-LINK VALUES (FLOWS,QUEUES,QUEUE TIMES,AVERAGE SPEEDS) PRINTED FOR LAST 1 ITERATIONS
55	MEASURE OF FAIRNESS (SPEEDS) PRINTED FOR LAST 1 ITERATIONS
56	TURNING MOVEMENTS PRINTED FOR LAST 1 ITERATIONS FOR THE FOLLOWING JUNCTIONS: 1 20 21 22

Fig. 5(d) Output options

	SIGNAL PLAN NO.	PLAN TYPE	CYCLE TIME (SEC)	STAGE 1 GREEN (SEC)	STAGE 2 GREEN (SEC)	STAGE 3 GREEN (SEC)	STAGE 4 GREEN (SEC)
71	1	FIXED CYCLE & FIXED SPLITS	110	50	50	0	0
71	2	FIXED CYCLE & FIXED SPLITS	110	50	50	0	0
72	6	FIXED CYCLE & OPTIMISED SPLITS (USING FLOWS FROM TIME-INTERVALS 4 - 6)	110				
71	3	FIXED CYCLE & FIXED SPLITS	55	0	30	0	0
71	4	FIXED CYCLE & FIXED SPLITS	110	40	60	0	0
71	5	FIXED CYCLE & FIXED SPLITS	110	50	50	0	0

NUMBER OF THE FIXED-TIME PLAN OPERATED IN TIME-INTERVAL :

	SIGNAL NO.	1	2	3	4	5	6	7	8	9	10	11	12	13
77	1	3	3	3	3	3	3	3	3	3				
77	20	2	2	2	2	2	2	2	2	2				
77	21	5	5	5	5	5	5	5	5	5				
77	22	1	1	1	1	6	6	1	1	1				

	FIXED ROUTE NO.	NO. OF LINKS	LINKS ALONG ROUTE :						
81	1	7	221	304	311	511	201	14	215

DEMAND WITH FIXED ROUTE :

	ORIGIN NO.	DEST,N NO.	VEH CLASS	FIXED ROUTE NO.
85	5005	9001	8	1

Fig. 5(e) Signal control and fixed routes data

CHANGE IN VEHICLE ARRIVALS (CONVERGENCE MATRIX) - (PCUS)   RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

LINK NO.& TYPE	TIME INTERVALS : 1	2	3	4	5	6	7	8	9					TOTAL	!TOTAL!
	700	730	800	815	830	845	900	930	1000	1100					
12S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14S	0	0	0	0	0	0	-6	-4	0	0	0	0	0	-10	10
201S	0	0	0	0	0	36	-8	8	0	0	0	0	0	36	52
202S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
204S	0	0	0	0	0	0	10	-10	0	0	0	0	0	0	20
211S	0	0	0	0	0	0	8	10	-10	0	0	0	0	8	28
212S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
213S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
214S	0	0	0	0	0	10	-18	0	10	0	0	0	0	2	38
215S	0	0	0	0	0	0	0	-10	0	0	0	0	0	-10	10
221S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
222S	0	0	0	0	0	-36	18	-18	0	0	0	0	0	-36	72
223S	0	0	0	0	0	9	-1	0	0	0	0	0	0	8	10
224S	0	0	0	0	-10	10	-10	0	0	0	0	0	0	-10	30
301U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
303U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304G	0	0	0	0	0	0	-2	0	0	0	0	0	0	-2	2
311U	0	0	0	0	0	36	-20	18	0	0	0	0	0	34	74
312G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
313U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
411G	0	0	0	0	0	-26	8	-18	0	0	0	0	0	-36	52
414U	0	0	0	0	10	-28	20	0	0	0	0	0	0	2	58
421U	0	0	0	0	0	-44	18	-8	0	0	0	0	0	-34	70
422G	0	0	0	0	-10	36	-18	28	0	0	0	0	0	36	92
432U	0	0	0	0	-10	10	-10	10	0	0	0	0	0	0	40
433G	0	0	0	0	0	0	10	-10	0	0	0	0	0	0	20
443U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
444G	0	0	0	0	10	-10	10	0	0	0	0	0	0	10	30
502U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
511U	0	0	0	0	0	36	-18	8	0	0	0	0	0	26	62
513U	0	0	0	0	0	0	10	0	0	0	0	0	0	10	10
524U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
													TOTALS	34	780

Fig. 7 Data output — Link flow convergence matrix

LINK-BY-LINK DATA - ALL PARAMETERS - FOR TRAFFIC AND ECONOMIC ASSESSMENTS   RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

TIME INTERVAL 6   START 845   FINISH 900   ITERATION NUMBER 10

LINK NO. AND TYPE	INIT. QUEUE (PCU)	VEHICLE ARRIVALS (VEH) C	B	L	DEPART FROM QUEUE (PCU)	FINAL QUEUE (PCU)	SPARE THRU-PUT CAPTY (PCU)	LINK STORE LEFT	DEG. OF SAT. (%)	MEAN QUEUE TIME (SEC)	TOTAL TIME SPENT (VEH-HRS) C	B	L	TOTAL TRAVEL DISTANCE (VEH-KM) C	B	L	AV. JOURNEY SPEED (KM/H)	JUNCT. NO.	PLAN	CYCLE TIME (SEC)	GREEN TIME (SEC)
12S	3	90			79R	14	4	110	112*	103	4.0	0.0	0.0	81			18	1	FCFS	55	30
14S	1	10	5		22	1	182	6	11	9	.2	.2	0.0	1			14	1	FCFS	55	30
201S	6		4	30	62	6	119	22	38	35	0.0	.3	1.7		1	6	13	20	FCFS	110	50
202S	7	99			98	8	83	0F	59	42	2.0	0.0	0.0	5			4	20	FCFS	110	50
204S	58	160			168	50	2	88	128*	291	17.1	0.0	0.0	160			10	20	FCFS	110	50
211S	3	30		10	47	4	157	212	25	20	1.1	0.0	.9	39		13	39	21	FCFS	110	50
212S	0	30			25	5	60	7	35	37	.7	0.0	0.0	3			8	21	FCFS	110	50
213S	13	150			155	8	185	19	48	30	3.0	0.0	0.0	15			9	21	FCFS	110	50
214S	73	280		35	337	79	3	1309	122*	204	39.5	0.0	7.3	1400		175	36	21	FCFS	110	50
215S	8	10	5		25	5	65	128	33	75	1.4	1.0	0.0	9	5		22	21	FCFS	110	50
221S	6	40	4		48	6	110	63	34	40	1.7	.4	0.0	20	2		22	22	FCOS	110	47
222S	5	20		30	74	5	144	161	36	25	.6	0.0	1.9	20		30	36	22	FCOS	110	53
223S	5	20		15	48	4	163	87	25	23	.8	0.0	.9	10		7	29	22	FCOS	110	47
224S	5	60			60	5	121	133	36	30	2.8	0.0	0.0	60			30	22	FCOS	110	53
301U	0			60	108	0	267	69	29	0	0.0	0.0	.8			30	45	30		0	0
303U	0	30			30	0	370	2	8	0	.0	0.0	0.0				36	30		0	0
304G	37	80	5	10	113	34	3	146	127*	283	8.1	1.3	2.1	80	5	10	10	30		0	0
311U	0	90	4	30	152	0	248	2	38	0	.0	.0	.0	1			36	31		0	0
312G	0	30			30	0	82	200	27	8	.8	0.0	0.0	39			43	31		0	0
313U	0				0	0	400	35	0	0	0.0	0.0	0.0				43	31		0	0
411G	29	50		30	131	2	86	89	61	68	2.2	0.0	1.8	25		15	17	41		0	0
414U	0	360		25	405	0	220	9	65	0	.4	0.0	.0	14		1	36	41		0	0
421U	0	270		65	387	0	238	9	62	0	.3	0.0	.1	11		3	36	42		0	0
422G	8	120		30	169	13	13	153	100*	57	4.3	0.0	2.0	120		30	26	42		0	0
432U	0	190		70	316	0	309	9	51	0	.2	0.0	.1	8		3	36	43		0	0
433G	1	50			51	0	399	1388	11	3	4.3	0.0	0.0	250			59	43		0	0
443U	0				0	0	625	9	0	0	0.0	0.0	0.0				36	44		0	0
444G	5	380		45	464	2	286	274	62	5	9.3	0.0	1.3	380		45	42	44		0	0
502U	0	180			180	0	870	233	17	0	3.0	0.0	0.0	108			36	50		0	0
511U	0	60	4	20	104	0	296	35	26	0	.3	.0	.1	14	1	5	43	51		0	0
513U	0	140			140	0	260	29	35	0	.8	0.0	0.0	28			36	51		0	0
524U	0	200			200	0	175	40	53	0	.2	0.0	0.0	6			27	52		0	0

NOTE: R = REDUCED CAPACITY
* = DEG. OF SAT. OVER 90%
F = FULL LINK

TOTAL JOURNEY TIMES		C	B	L	TOTAL
(VEH-HRS)	TRAVELLING	57	0	9	
	DELAYED	53	3	12	
	TOTAL	109	3	21	
TOTAL DISTANCES					
(VEH-KMS)	TRAVELLING	2907	14	373	
TOTAL FUEL CONSUMPTION					
(LITRES)	TRAVELLING	274	5	109	388
	DELAYED	154	18	94	266
	TOTAL	428	23	203	654

Fig. 8 Data output — Link by link data — all parameters

LINK-BY-LINK VALUES - FLOWS (PCU/HR) RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

LINK NO.& TYPE	TIME INTERVALS : 1	2	3	4	5	6	7	8	9					TIME INTERVALS WITH MAX. FLOWS
	700	730	800	815	830	845	900	930	1000	1100				
12S	300	340&	400&	240	360	360&	360&	340R	10	0	0	0	0	3
14S	196	160	112	112	112	88	148	200	0	0	0	0	0	8
201S	16	160	112	392	264	248	200	112	0	0	0	0	0	4
202S	280	360	400	240	320	400	360	340	10	0	0	0	0	3
204S	320	536	680*	760*	720*	640*	500	316	0	0	0	0	0	4
211S	194	426	152	232	144	192	278	396	57	0	0	0	0	2
212S	0	120	80	0	0	120	80	0	0	0	0	0	0	2
213S	300	440	680	1200*	960	600	520	320	0	0	0	0	0	4
214S	0	260	984	1420*	1500*	1372*	788	140	10	0	0	0	0	5
215S	196	152	128	32	192	88	140	200	4	0	0	0	0	8
221S	116	160	208	232	208	192	160	120	0	0	0	0	0	4
222S	72	216	288	144	288	296	344	216	0	0	0	0	0	7
223S	252	332	348	224	228	188	298	322	19	0	0	0	0	3
224S	40	120	120	240	240	240	80	60	0	0	0	0	0	4
301U	72	216	360	504	504	432	360	288	0	0	0	0	0	4
303U	0	0	0	0	0	120	0	0	0	0	0	0	0	6
304G	288	512*	500*	512*	500*	440*	398*	402	48	0	0	0	0	2
311U	288	512	572	632	684	608	576	492	48	0	0	0	0	5
312G	0	120	80	0	0	120	80	0	0	0	0	0	0	2
313U	0	36	0	0	0	0	0	36	0	0	0	0	0	2
411G	172	300	480	344*	488*	416	448	332	0	0	0	0	0	5
414U	320	992	1628	2380*	2256*	1620	1208	456	0	0	0	0	0	4
421U	172	736	1388	1852	1984	1548	1176	492	0	0	0	0	0	5
422G	260	500	480	600*	416*	696*	492	396	38	0	0	0	0	6
432U	432	800	960	872	784	1264	960	728	38	0	0	0	0	6
433G	0	0	200	800	920	200	180	20	0	0	0	0	0	5
443U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
444G	592	1304	1976	2604	2484	1844	1506	760	19	0	0	0	0	4
502U	300	560	800	1160	960	720	600	320	0	0	0	0	0	4
511U	56	280	304	560	576	416	300	192	0	0	0	0	0	5
513U	140	376	600	560	640	560	440	216	10	0	0	0	0	5
524U	180	460	720	760	920	800	540	260	10	0	0	0	0	5

NOTE: R = REDUCED CAPACITY
* = DEG. OF SAT. OVER 90%
& = BOTH R AND *

NUMBERS OF PCUS ENTERING AND LEAVING THE NETWORK IN EACH TIME INTERVAL

ENTERING	604	1199	872	1227	1067	851	1352	721	0
LEAVING	501	1053	782	994	1085	976	1505	882	115

Fig. 9(a) Data output — Link by link values — Flows

LINK-BY-LINK VALUES - FINAL QUEUES (PCUS) RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

TIME INTERVALS : 1 2 3 4 5 6 7 8 9

700 730 800 815 830 845 900 930 1000 1100

LINK NO.& TYPE														TIME INTERVALS MAX. FINAL QUEUE
12S	2	17	15	2	3	14	17	4	0	0	0	0	0	2
14S	1	1	1	1	1	1	1	1	0	0	0	0	0	1
201S	0	3	3	9	6	6	5	3	0	0	0	0	0	4
202S	6	8	8	6	7	8	8	8	0	0	0	0	0	2
204S	8	14	23	46	58	50	16	8	0	0	0	0	0	5
211S	4	9	4	5	3	4	6	8	0	0	0	0	0	2
212S	0	5	4	0	0	5	4	0	0	0	0	0	0	2
213S	4	5	8	17	13	8	6	4	0	0	0	0	0	4
214S	0	3	12	35	73	79	12	2	0	0	0	0	0	6
215S	8	7	6	2	8	5	6	9	0	0	0	0	0	8
221S	3	4	5	6	6	6	4	3	0	0	0	0	0	4
222S	1	4	6	3	5	5	7	4	0	0	0	0	0	7
223S	4	6	6	4	5	4	5	6	0	0	0	0	0	2
224S	1	3	3	6	5	5	2	1	0	0	0	0	0	4
301U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
303U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304G	1	10	15	28	37	34	8	4	0	0	0	0	0	5
311U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
312G	0	0	0	0	0	0	0	0	0	0	0	0	0	0
313U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
411G	0	0	1	10	29	2	1	0	0	0	0	0	0	5
414U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
421U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
422G	0	1	1	16	8	13	1	0	0	0	0	0	0	4
432U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
433G	0	0	0	1	1	0	0	0	0	0	0	0	0	4
443U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
444G	0	1	2	6	5	2	1	0	0	0	0	0	0	4
502U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
511U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
513U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
524U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	43	101	123	203	273	251	110	65	0					

Fig. 9(b) Data output — Link by link values — Queues

LINK-BY-LINK VALUES - MEAN QUEUE TIMES (SECS) RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

TIME INTERVALS : 1 2 3 4 5 6 7 8 9

700 730 800 815 830 845 900 930 1000 1100

LINK NO.& TYPE														TIME INTERVALS WITH MAX. QUEUE TIME
12S	9	117	143	42	15	103	161	64	13	0	0	0	0	7
14S	7	9	9	9	9	9	9	9	7	0	0	0	0	2
201S	16	16	20	35	42	35	32	25	16	0	0	0	0	5
202S	20	40	45	40	37	42	45	45	25	0	0	0	0	3
204S	26	64	103	188	281	291	180	69	26	0	0	0	0	6
211S	16	33	33	24	22	20	26	35	22	0	0	0	0	8
212S	16	37	58	32	16	37	58	32	16	0	0	0	0	3
213S	16	16	20	36	42	30	21	16	16	0	0	0	0	5
214S	16	16	23	65	146	204	123	21	16	0	0	0	0	6
215S	50	85	75	50	60	75	65	85	55	0	0	0	0	2
221S	16	24	29	34	40	40	32	24	16	0	0	0	0	5
222S	16	16	26	24	21	25	31	29	16	0	0	0	0	7
223S	16	24	28	24	23	23	22	26	16	0	0	0	0	3
224S	16	16	21	29	32	30	24	16	16	0	0	0	0	5
301U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
303U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304G	9	43	95	170	253	283	155	48	18	0	0	0	0	6
311U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
312G	0	8	8	0	0	8	8	0	0	0	0	0	0	2
313U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
411G	2	3	6	70	174	68	8	3	0	0	0	0	0	5
414U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
421U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
422G	3	5	9	59	92	57	32	4	2	0	0	0	0	5
432U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
433G	0	0	2	2	3	3	2	2	0	0	0	0	0	5
443U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
444G	1	2	3	6	8	5	3	2	1	0	0	0	0	5
502U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
511U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
513U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
524U	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 9(c) Data output — Link by link values — Delays (Mean queue time)

LINK-BY-LINK VALUES - AVERAGE SPEED OF A CAR (KMS/HR) RUN/ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

TIME INTERVALS : 700 730 800 815 830 845 900 930 1000 1100

LINK NO.& TYPE	1	2	3	4	5	6	7	8	9					TIME INTERVALS WITH MIN. AV. SPEED
12S	39	17	15	28	36	18	14	23	37	0	0	0	0	7
14S	16	14	14	14	14	14	14	14	16	0	0	0	0	2
201S	20	20	18	13	12	13	14	16	20	0	0	0	0	5
202S	7	4	4	4	4	4	4	4	6	0	0	0	0	2
204S	34	25	20	13	10	10	14	24	34	0	0	0	0	5
211S	40	35	35	38	38	39	37	35	38	0	0	0	0	2
212S	14	8	5	9	14	8	5	9	14	0	0	0	0	3
213S	14	14	12	8	7	9	12	14	14	0	0	0	0	5
214S	57	57	56	49	40	36	43	56	57	0	0	0	0	6
215S	26	20	22	26	24	22	23	20	25	0	0	0	0	2
221S	32	28	26	24	22	22	25	28	32	0	0	0	0	5
222S	40	40	36	36	37	36	34	35	40	0	0	0	0	7
223S	32	28	26	28	29	29	29	27	32	0	0	0	0	3
224S	34	34	32	30	30	30	32	34	34	0	0	0	0	4
301U	45	45	45	45	45	45	45	45	45	0	0	0	0	1
303U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
304G	43	31	21	15	11	10	16	29	39	0	0	0	0	6
311U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
312G	44	43	43	43	43	43	43	43	44	0	0	0	0	2
313U	43	43	43	43	43	43	43	43	43	0	0	0	0	1
411G	43	42	39	16	8	17	37	42	43	0	0	0	0	5
414U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
421U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
422G	43	42	40	26	21	26	32	43	44	0	0	0	0	5
432U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
433G	60	60	60	60	59	59	60	60	60	0	0	0	0	5
443U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
444G	44	44	43	42	41	42	43	44	44	0	0	0	0	5
502U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
511U	43	43	43	43	43	43	43	43	43	0	0	0	0	1
513U	36	36	36	36	36	36	36	36	36	0	0	0	0	1
524U	27	27	27	27	27	27	27	27	27	0	0	0	0	1

Fig. 9(d) Data output — Link by link values — Average speeds

TURNING MOVEMENTS (PCU/HR) - ALL LINKS RUN ON 82/05/24

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGS 20,21 SET AT 50/50 S SIG 01 AT 0/30 S **ALL LINK TURNS**

ITERATION 10

TIME INTERVALS

LINK TO LINK	1	2	3	4	5	6	7	8	9
	700–730	730–800	800–815	815–830	830–845	845–900	900–930	930–1000	1000–1100
12 - 202	300	340	400	240	360	360	360	340	10
14 - 215	198	164	115	115	115	93	153	204	0
201 - 14	18	44	35	35	53	35	53	44	0
201 - 422	0	120	80	360	216	216	152	72	0
202 - 422	280	360	400	240	320	400	360	340	10
202 - 513	0	0	0	0	0	0	0	0	0
204 - 513	140	416	600	600	720	480	400	216	0
204 - 14	180	120	80	160	0	160	100	100	0
211 - 9001	194	426	152	232	144	192	278	396	57
211 - 433	0	0	0	0	0	0	0	0	0
211 - 12	0	0	0	0	0	0	0	0	0
212 - 312	0	120	80	0	0	120	80	0	0
213 - 433	0	60	360	960	480	360	120	0	0
213 - 12	300	380	320	240	480	240	400	320	0
214 - 12	0	0	0	0	0	0	0	0	0
214 - 312	0	0	0	0	0	0	0	0	0
214 - 9001	0	260	984	1420	1500	1372	788	140	10
215 - 312	0	0	0	0	0	0	0	0	0
215 - 9001	198	155	133	35	195	93	144	204	4
215 - 433	0	0	0	0	0	0	0	0	0
221 - 304	18	44	53	35	53	35	44	44	0
221 - 411	100	120	160	200	160	160	120	80	0
222 - 411	72	216	288	144	288	296	344	216	0
223 - 304	252	332	348	224	228	188	298	322	19
224 - 304	40	120	120	240	240	240	80	60	0
224 - 411	0	0	0	0	0	0	0	0	0
301 - 311	0	0	72	288	288	144	72	72	0
301 - 222	72	216	288	216	216	288	288	216	0
303 - 222	0	0	0	0	0	120	0	0	0
304 - 311	290	516	503	517	503	445	402	406	48
311 - 211	232	352	348	72	108	192	336	320	48
311 - 511	58	164	227	563	581	419	245	176	0
312 - 511	0	120	80	0	0	0	80	0	0
312 - 303	0	0	0	0	0	120	0	0	0
313 - 303	0	0	0	0	0	0	0	0	0
313 - 211	0	36	0	0	0	0	0	36	0
411 - 204	0	0	0	0	0	0	0	0	0
411 - 421	172	300	480	344	488	416	448	332	0
414 - 204	320	556	680	840	720	560	500	296	0
414 - 421	0	436	948	1540	1536	1060	708	160	0
421 - 214	0	436	908	1580	1536	1060	708	160	0
421 - 432	172	300	480	272	448	488	468	332	0
422 - 214	0	0	0	0	0	0	0	0	0
422 - 432	260	500	480	600	416	696	492	396	38
432 - 9002	432	800	960	872	784	1264	960	728	38
432 - 443	0	0	0	0	0	0	0	0	0
433 - 9002	0	0	200	800	920	200	180	20	0
433 - 443	0	0	0	0	0	0	0	0	0
443 - 223	0	0	0	0	0	0	0	0	0
443 - 414	0	0	0	0	0	0	0	0	0
444 - 223	272	312	348	224	228	224	298	304	19
444 - 414	320	992	1628	2380	2256	1620	1208	456	0
502 - 213	300	440	720	1160	960	600	520	320	0
502 - 212	0	120	80	0	0	120	80	0	0
511 - 524	40	120	120	240	240	240	100	80	0
511 - 201	18	164	187	323	341	179	205	116	0
513 - 313	0	36	0	0	0	0	0	36	0
513 - 524	140	340	600	560	640	560	440	180	10
524 - 9003	180	460	720	760	920	800	540	260	10

Fig. 11(b) Data output — Turning movements— for all links

MEASURE OF FAIRNESS RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

ITERATION NUMBER 10

ORIG NO.	DEST NO.	VEH. CLAS	LIN. DIST (MTR)	AVERAGE STRAIGHT LINE SPEED (KMS/HR) FOR PACKETS ENTERING IN TIME INTERVAL : 1	2	3	4	5	6	7	8	9	10	11	12	13
5001	9001	C	3000	32	26	24	21	18	18	22	26	0				
5001	9001	L	3000	27	23	21	18	16	16	19	22	0				
5001	9003	C	2300	37	31	27	21	17	17	23	31	0				
5002	9002	C	2700	35	28	24	23	23	24	25	28	0				
5003	9003	C	2300	39	33	28	21	17	18	24	32	0				
5004	9002	L	2000	34	32	31	26	23	27	30	31	0				
5005	9001	B	2900	24	20	18	16	13	15	16	19	0				
5005	9002	C	1000	34	31	28	19	15	20	27	31	0				

Fig. 10 Data output — Measure of fairness

TURNING MOVEMENTS (PCU/HR) - SELECTED JUNCTIONS RUN ON 82/05/18

CONTRAM4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)
O - D DEMANDS (105 % ON 5001, 100 % ON ALL OTHERS)
SIGNALS 20 AND 21 SET AT 50/50 SECS, SIGNAL 01 AT 0/30 SECS.

JUNCTION NUMBER 21 SIGNAL CONTROLLED ITERATION 10

LINK TO LINK	TIME INTERVALS 1 (700–730)	2 (730–800)	3 (800–815)	4 (815–830)	5 (830–845)	6 (845–900)	7 (900–930)	8 (930–1000)	9 (1000–1100)
211 - 9001	194	426	152	232	144	192	278	396	57
211 - 433	0	0	0	0	0	0	0	0	0
211 - 12	0	0	0	0	0	0	0	0	0
212 - 312	0	120	80	0	0	120	80	0	0
213 - 433	0	60	360	960	480	360	120	0	0
213 - 12	300	380	320	240	480	240	400	320	0
214 - 12	0	0	0	0	0	0	0	0	0
214 - 312	0	0	0	0	0	0	0	0	0
214 - 9001	0	260	984	1420	1500	1372	788	140	10
215 - 312	0	0	0	0	0	0	0	0	0
215 - 9001	198	155	133	35	195	93	144	204	4
215 - 433	0	0	0	0	0	0	0	0	0

ARRIVAL FLOWS (PCUS/HR)

LINK	1	2	3	4	5	6	7	8	9
211	194	426	152	232	144	192	278	396	57
212	0	120	80	0	0	120	80	0	0
213	300	440	680	1200*	960	600	520	320	0
214	0	260	984	1420*	1500*	1372*	788	140	10
215	196	152	128	32	192	88	140	200	4

SIGNAL CYCLE TIMES (SECS) LOST TIME = 10 SECONDS

110	110	110	110	110	110	110	110	110

SIGNAL PLAN TYPE

FCFS	FCFS	FCFS	FCFS	FCFS	FCFS	FCFS	FCFS	FCFS

GREEN TIMES (SECS)

211	50	50	50	50	50	50	50	50	50
212	50	50	50	50	50	50	50	50	50
213	50	50	50	50	50	50	50	50	50
214	50	50	50	50	50	50	50	50	50
215	50	50	50	50	50	50	50	50	50

Fig. 11(a) Data output — Turning movements — for selected junctions

9. APPENDIX

Data input cards – example of completed coding sheets for the test example described in Section 5

CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case – Date 7.8.81 – Sheet 1 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Title card

CONTRAM 4 TEST NETWORK - GIVE WAYS AT 30,31 - STANDARD CASE (AUGUST 1981)

Time card

Card type	Time unit	Start time (hhmm)	End of time interval (hhmm):– 1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	7ØØ	73Ø	8ØØ	815	83Ø	845	9ØØ	93Ø	1ØØØ	11ØØ				

Origin card

Card type	Origin number	1st link 14	b v c 15	2nd link 19	b v c 20	3rd link 24	b v c 25	4th link 29	b v c 30	5th link 34	b v c 35	Not used →
3	5ØØ1	444	Ø									
3	5ØØ2	5Ø2	Ø									
3	5ØØ3	224	Ø	444	Ø							
3	5ØØ4	3Ø1	Ø									
3	5ØØ5	221	Ø									
3												
3												
3												
3												
3												
3												
3												
3												
3												
3												
3												
3												

Banned vehicle code (b.v.c.)

CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7 · 8 · 81 Sheet 2 of 17

Card column: 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80

Uncontrolled link data

Card type	Link number	1st link 14	b.v.c. 15	2nd link 19	b.v.c. 20	3rd link 24	b.v.c. 25	4th link 29	b.v.c. 30	5th link 34	b.v.c. 35	Cruise time (secs)	Link length (metres)	Saturation flow (pcu/hr)	Link store (pcu) (optional)	Junction number	Not used →
4	3Ø1	311	Ø	222	Ø							4Ø	5ØØ	15ØØ		3Ø	
4	3Ø3	222	Ø									1	1Ø	16ØØ	2	3Ø	
4	311	211	Ø	511	Ø							1	1Ø	16ØØ	2	31	
4	313	3Ø3	Ø	211	Ø							2Ø	24Ø	16ØØ		31	
4	414	2Ø4	Ø	421	Ø							4	4Ø	25ØØ		41	
4	421	214	Ø	432	Ø							4	4Ø	25ØØ		42	
4	432	9ØØ2	Ø	443	Ø							4	4Ø	25ØØ		43	
4	443	223	Ø	414	Ø							4	4Ø	25ØØ		44	
4	5Ø2	213	Ø	212	Ø							6Ø	6ØØ	42ØØ		5Ø	
4	511	524	Ø	2Ø1	Ø							2Ø	24Ø	16ØØ		51	
4	513	313	Ø	524	Ø							2Ø	2ØØ	16ØØ		51	
4	524	9ØØ3	Ø									4	3Ø	15ØØ	4Ø	52	
4																	
4																	
4																	
4																	
4																	
4																	
4																	
4																	
4																	

Banned vehicle code (b.v.c.)

CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7. 8. 81 Sheet 3 of 17

Give way link data

Card type	Link number	1st link (14)	b.v.c (15)	2nd link (19)	b.v.c (20)	3rd link (24)	b.v.c (25)	4th link (29)	b.v.c (30)	5th link (34)	b.v.c (35)	Cruise time (secs)	Link length (metres)	Saturation flow (pcu/hr)	Link store (pcu) (optional)	1st controlling link	2nd controlling link	Capacity slope x100 (−ve)	Junction number	Not used
Card column: 5	10		15		20		25		30		35	40	45	50	55	60	65	70	75	80
5	3Ø4	311	Ø									75	1ØØØ	6ØØ	18Ø	3Ø3	3Ø1	25	3Ø	
5	312	511	Ø	3Ø3	Ø							1ØØ	13ØØ	6ØØ	2ØØ	311	313	25	31	
5	411	2Ø4	Ø	421	Ø							4Ø	5ØØ	2ØØØ		414		7Ø	41	
5	422	214	Ø	432	Ø							8Ø	1ØØØ	15ØØ		421		5Ø	42	
5	433	9ØØ2	Ø	443	Ø							3ØØ	5ØØØ	3ØØØ		432		95	43	
5	444	223	Ø	414	Ø							8Ø	1ØØØ	3ØØØ		443		95	44	
5																				
5																				
5																				
5																				
5																				
5																				
5																				
5																				
5																				
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5																				

Banned vehicle code (b.v.c.)

CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30,31 - Standard Case Date 7.8.81. Sheet 4 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Signal controlled link data

Card type	Link number	1st link 14	b v c 15	2nd link 19	b v c 20	3rd link 24	b v c 25	4th link 29	b v c 30	5th link 34	b v c 35	Cruise time (secs)	Link length (metres)	Saturation flow (pcu/hr)	Link store (pcu) (optional)	Signal/junction number	Stage number	% green time	% link delay	Not used
6	Ø12	2Ø2	4									75	9ØØ	15ØØ		Ø1	2	1ØØ	1ØØ	
6	Ø14	215	4									4	5Ø	15ØØ	8	Ø1	2	1ØØ	6Ø	
6	2Ø1	Ø14	4	422	Ø							2Ø	2ØØ	16ØØ		2Ø	1	1ØØ	1ØØ	
6	2Ø2	422	Ø	513	Ø							4	5Ø	16ØØ	8	2Ø	2	1ØØ	1ØØ	
6	2Ø4	513	Ø	Ø14	4							8Ø	1ØØØ	15ØØ		2Ø	2	1ØØ	1ØØ	
6	211	9ØØ1	Ø	433	Ø	Ø12	4					1ØØ	13ØØ	18ØØ		21	1	1ØØ	1ØØ	
6	212	312	Ø									1Ø	1ØØ	15ØØ		21	2	5Ø	1ØØ	
6	213	433	Ø	Ø12	4							1Ø	1ØØ	3ØØØ		21	2	1ØØ	1ØØ	
6	214	Ø12	4	312	Ø	9ØØ1	Ø					3ØØ	5ØØØ	3ØØØ		21	1	1ØØ	1ØØ	
6	215	312	Ø	9ØØ1	Ø	433	Ø					75	9ØØ	16ØØ		21	2	5Ø	7Ø	
6	221	3Ø4	Ø	411	Ø							4Ø	5ØØ	15ØØ		22	1	1ØØ	1ØØ	
6	222	411	Ø									75	1ØØØ	18ØØ		22	2	1ØØ	1ØØ	
6	223	3Ø4	Ø									4Ø	5ØØ	2ØØØ		22	1	1ØØ	1ØØ	
6	224	3Ø4	Ø	411	Ø							9Ø	1ØØØ	15ØØ		22	2	1ØØ	1ØØ	
6																				
6																				
6																				
6																				
6																				
6																				
6																				

Banned vehicle code (b.v.c.)

CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30,31 - Standard Case Date 7.8.81 Sheet 5 of 17

Signal lost time

Card column: 5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Card type	Number of signal	Lost time (secs)	Not used →												
7	Ø1	25													
7	2Ø	1Ø													
7	21	1Ø													
7	22	1Ø													
7															
7															
7															
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CONTRAM 4 NETWORK AND TIME DATA

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case. Date 7. 8. 81 Sheet 6 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Change of mind

(To be interleaved)

Card type	Card to be changed	Para-meter code	% change	Not used →
8				
8				
8				
8				
8				
8				
8				
8				
8				
8				
8				
8				
8				

Vehicle classes

Card type	Car pcu's x 10	Bus pcu's x 10	Lorry pcu's x 10	% bus cruise time	% lorry cruise time	Not used →
9	10	22	18	14Ø	12Ø	

Fuel consumption

Card type	Vehicle class code	Fuel coefficients a	b	c	a′	b′	c′	Not used →
10	1	164	24Ø	2ØØ	15Ø	1Ø7	34Ø	
10	2	492	72Ø	6ØØ	45Ø	321	1Ø2Ø	
10	4	492	72Ø	6ØØ	45Ø	321	1Ø2Ø	

CONTRAM 4 TRAFFIC DEMAND DATA

(Identifier) Test Network - give ways at junctions - 30, 31 Standard Case Date 7.8.81 Sheet 7 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Title card: O-D DEMANDS (105% ON 5001, 100% ON ALL OTHERS)

Origin–Destination demands

Origin number	Destination no.	Pkt size (vehs) [14]	Veh code [15]	O–D linear dist. (metres) (optional)	Start code	Flow demand in time interval (vehicles/hr): 1	2	3	4	5	6	7	8	9	10	11
5001	9001	10	1	3000		375	750	1125	1500	1350	1050	750	375	0		

Continuation card (if more than 11 time intervals)

Not used →						Flow demand in t.i. 12	13	Not used →								
—	—	—	—	—				—	—	—	—	—	—	—	—	—

Origin number	Destination no.	Pkt size	Veh code	O–D linear dist.	Start code	1	2	3	4	5	6	7	8	9	10	11
5001	9001	5	4	3000		40	80	120	180	160	170	160	100	0		
5001	9003	10	1	2300		150	300	450	600	525	375	300	150	0		
5002	9002	10	1	2700		320	560	800	1200	950	700	600	300	0		
5003	9003	10	1	2300		50	200	300	350	400	250	150	50	0		
5004	9002	10	4	2000		40	120	200	300	270	240	210	150	0		
5005	9001	2	2	2900		10	20	20	20	20	20	20	20	0		
5005	9002	10	1	1000		100	120	150	200	180	150	120	80	0		

↑ Vehicle class code

CONTRAM 4 TRAFFIC DEMAND DATA

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7.8.81 Sheet 8 of 17

Card column: 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80

Change of mind – Demand flows (To be interleaved)

Not used	1st time int. to be changed	Last time int. to be changed	% change to flow	Not used →
—	1	9	105	(insert before all O-D movements from 5001)
—				
—	1	9	100	(insert before all other O-D movements)
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				
—				

CONTRAM 4 — CONTROL DATA – PROGRAM CONTROL

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case ---- Date 7.8.81 --- Sheet 9 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

Title card: SIGNALS 2Ø AND 21 SET AT 5Ø/5Ø SECS, SIGNAL Ø1 AT Ø/3Ø SECS.

Number of iterations

Card type	Number of iterations	Not used →
50	1Ø	

NETWORK SUMMARY DATA OUTPUT (Select 1 of 3 options)

Options	Card type						
1. All iterations		999	Not used →				
2. Last N iterations		–N	Not used →				
3. Selected iterations I,J...M		I	J	K	L	M	Not used
	51	2	3				

CHANGE IN VEHICLE ARRIVALS – CONVERGENCE MATRIX (Select 1 of 3 options)

Options	Card type						
1. All iterations		999	Not used →				
2. Last N iterations		–N	Not used →				
3. Selected iterations I,J...M		I	J	K	L	M	
	52	–4					

LINK-BY-LINK DATA OUTPUT – ALL PARAMETERS (Select 1 of 3 options)

Options	Card type						
1. All iterations		999	Not used →				
2. Last N iterations		–N	Not used →				
3. Selected iterations I,J...M		I	J	K	L	M	Not used →
	53	–1					

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case _ _ Date 7·8·81 _ _ Sheet 70 of 77

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

LINK-BY-LINK DATA OUTPUT – FLOWS, QUEUES, QUEUE TIMES, AVERAGE SPEEDS (Select 1 of 3 options) :–

Options	Card type						
1. All iterations		999	Not used →				
2. Last N iterations		–N	Not used →				
3, Selected iterations I,J...M		I	J	K	L	M	Not used →
	54	-1					

MEASURE OF FAIRNESS – DATA OUTPUT (Select 1 of 3 options) :–

Options	Card type						
1. All iterations		999	Not used →				
2. Last N iterations		–N	Not used →				
3. Selected iterations I,J...M		I	J	K	L	M	Not used
	55	-1					

TURNING MOVEMENTS – DATA OUTPUT (Select 1 of 3 options):–

Options	Card type						0-selected jncts 1-all links	
1. All iterations		999	← Not used →					Not used →
2. Last N iterations		–N	← Not used →					Not used →
3. Selected iterations I,J...M		I	J	K	L	M		Not used →
	56	-1					Ø	

CONTRAM 4 CONTROL DATA–PROGRAM CONTROL

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7-8-81 Sheet 11 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

JUNCTION LIST FOR TURNING MOVEMENTS (if 1 in column 35 on type 56 card)

Card type	List of junction numbers (maximum of 100)														
57	ϕ1	2ϕ	21	22											
57															
57															
57															
57															
57															
57															
57															
57															
57															

CONTRAM 4 CONTROL DATA-SIGNAL CONTROL

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7.8.81 Sheet 12 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

DATA FOR FIXED CYCLE/FIXED SPLITS (FC/FS) PLANS

Card type	Number of signal plan	Cycle time (secs)	Effective green times :– Stage 1 (secs)	Stage 2 (secs)	Stage 3 (secs)	Stage 4 (secs)	Not used →
71	1	11Ø	5Ø	5Ø			
71	2	11Ø	5Ø	5Ø			
71	3	55	Ø	3Ø			
71	4	11Ø	4Ø	6Ø			
71	5	11Ø	5Ø	5Ø			
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							
71							

CONTRAM 4 CONTROL DATA-SIGNAL CONTROL

(Identifier) *Test Network - give ways at junctions 30,31-Standard Case* Date *7. 8. 81* Sheet *13* of *17*

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

DATA FOR FIXED CYCLE/OPTIMISED SPLITS (FC/OS) PLANS

Card type	Number of signal plan	(−cycle time) (secs)	No. of 1st t.i. for flows	No. of last t.i.. for flows	Initial settings (optional):— Stage 1 green (secs)	Stage 2 green (secs)	Stage 3 green (secs)	Stage 4 green (secs)	Not used →						
72	*6*	*−110*	*4*	*6*											
72															
72															
72															
72															
72															
72															
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72															
72															
72															
72															

CONTRAM 4 CONTROL DATA-SIGNAL CONTROL

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7·8·81 Sheet 14 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

DATA FOR OPTIMISED CYCLE/OPTIMISED SPLITS (OC/OS) PLANS

Card type	Number of signal plan	999	No. of 1st t.i. for flows	No. of last t.i. for flows	% flows to be used	Initial settings (optional):– Cycle time (secs)	Stage 1 green (secs)	Stage 2 green (secs)	Stage 3 green (secs)	Stage 4 green (secs)	Not used →				
73															
73															
73															
73															
73															
73															
73															
73															
73															
73															
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73															
73															

CONTRAM 4 CONTROL DATA-SIGNAL CONTROL

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case. Date 7.8.81 Sheet 15 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

SIGNAL PLAN NUMBER FOR EACH TIME INTERVAL

Card type	Number of signal	Number of signal plan for time intervals:– 1	2	3	4	5	6	7	8	9	10	11	12	13	Not used
77	Ø1	3	3	3	3	3	3	3	3	3					
77	2Ø	2	2	2	2	2	2	2	2	2					
77	21	5	5	5	5	5	5	5	5	5					
77	22	1	1	1	1	6	6	1	1	1					
77															
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CONTRAM 4 CONTROL DATA-FIXED ROUTES

(Identifier) Test Network - give ways at junctions 30, 31 - Standard Case Date 7-8-81 Sheet 16 of 17

Card column	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

DATA FOR EACH FIXED ROUTE:–

Route no. and links

Card type	No. of fixed route	Number of links on route	Link numbers along route:– 1st link	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
81	1	7	221	3φ4	311	511	2φ1	φ14	215						

Continuation card (if more than 14 links)

Card type	Not used →		Link numbers along route (cont'd) 14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	Not used
81	—	—													

81															
81															
81															
81															
81															
81															
81															
81															
81															
81															
81															
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81															
81															
81															
81															
81															

CONTRAM 4 CONTROL DATA-FIXED ROUTES

(Identifier) Test Network - give ways at junctions 30,31 - Standard case ______ Date 7. 8. 81 Sheet 17 of 17

Card column																
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

DATA FOR EACH CLASSIFIED O–D WITH A FIXED ROUTE:–

Card type	Origin number	Destination number	Veh. class code	Number of fixed route	Not used →										
85	5ϕϕ5	9ϕϕ1	2	1											
85															
85															
85															
85															
85															
85															
85															
85															
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CONTRAM provides comprehensive information on traffic conditions, including link delay times, turning movements and fuel consumption, to help the traffic engineer to understand and assess the merits of alternative traffic management schemes.

This User Guide gives a brief description of the model, details of data input and output, a test example to illustrate the use of the model and an outline of the structure and operation of the computer program.

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