

SIGNAL WAKE MODEL  
(SWM)

by Norma Welch

Senior Operational Research  
Analyst

Transportation Research  
CN Rail Operations  
March, 1982

## FORWARD

This report outlines the capabilities of the Signal Wake Model (SWM) and describes the design of the model from a user perspective.

Technical documentation is stored in Transportation Planning's online documentation package. This includes detailed instructions for using the model, system documentation and program documentation.

This model was developed by Operational Research in cooperation with Transportation Research. The following members of the Transportation Research staff aided in the design and validation of the model:

James Gussow - Transportation Research Engineer  
Gilbert Peverini - Transportation Engineer  
Charles Runnalls - Senior Transportation Engineer  
Don Watts - Transportation Engineer

Two students, Arthur Hsu and Louise Struthers, also assisted in the development of this model.

## EXECUTIVE SUMMARY

The Signal Wake Model (SWM) is a detailed computer simulation model which allows analysis of the effect of a signal system on the movement of following trains. Specifically, the simulation moves a fleet of trains over a given signal plant as close together as the signal system allows. Minimum train headways are determined at each signal location.

User-defined train fleets may be composed of trains with one or several train types and running characteristics. The signal system may follow UCOR or 294-300 series rules, and signals may be wayside or cab signals. Trains may run in either direction over the plant and may have scheduled stops. Slow orders can be applied to the plant.

Input to the simulation consists of three files: the "Trackfile", the Signal Rules File" and the "Reqfile". The trackfile contains adjusted gradients and train speed restrictions; it is prepared from the TDMS database by a preprocessor program. The signal rules file contains the speed restrictions imposed by each of the allowable signal indications; a separate signal rules file is required for UCOR and for the 294-300 series rules. The reqfile contains the user requirements for a set of simulations; it consists of a set of free format data tables describing the signal plant, trains, train stops and slow orders to be simulated.

This file is prepared by the analyst using a TSO screen. The requirements for several simulations on the same signal plant may be given on a single reqfile.

Output from the SWM consists of the following for each fleet at each signal location: the average headway between trains, the departure time of each train, the running time of the first train over the next block, and the running time of the first train over the next block plus train length. Available graphical outputs are a distance-time diagram, a velocity-time diagram, a velocity-position diagram and a signal wake graph. The graphs are useful to analyse the reasons for different train spacings caused by different signal arrangements.

Data preparation for SWM is easy and fast. Computer execution time is approximately 30 seconds of CPU for the simulation of a fleet of trains over a typical subdivision.

To date, the main use of the SWM has been to determine the minimum train headway input required by the Route Capacity Model.

## TABLE OF CONTENTS

Foreward

Executive Summary

1. Background to Model Development
2. Capabilities of the SWM
  - 2.1 Signal Rules
  - 2.2 Signal Plant
  - 2.3 Train Types and Running Characteristics
  - 2.4 Train Schedule and Stops
  - 2.5 Slow Orders
  - 2.6 Plot and Trace
  - 2.7 Miscellaneous Run Options
  - 2.8 Output
3. Computer System Description
  - 3.1 Overview
  - 3.2 Trackfile Creator
  - 3.3 Front End
  - 3.4 Simulation
    - 3.4.1 General
    - 3.4.2 Train Setup
    - 3.4.3 Train Movement
    - 3.4.4 Signal Changes
    - 3.4.5 Headway Calculations
4. Validation of SWM

### Appendices

- I Signal Rules File for UCOR
- II Sample Input
- III Simulation Output
- IV User Procedures

1. BACKGROUND TO MODEL DEVELOPMENT

Transportation previously had a signal wake program, which could draw the wake of signals behind a single train under two or three block braking. Although suitable for analysis of some basic concepts, this model is too restrictive for testing many operating scenarios. Particular problems are that the existing signal wake program cannot model special signal indications, (eg. stop and proceed, restricting) and cannot model cab signals. Further, it does not easily allow analysis of the effect of Temporary Slow Orders on headway.

The objective of this model is to allow the determination of train headways for use as input to the Route Capacity Model. Also, this model allows the design of a signal plant in such a way as to achieve required train headways.

A further use could be to analyse the effect, on minimum train headways, of changes to the signal rules.

## 2. CAPABILITIES OF SIGNAL WAKE MODEL

### 2.1 Signal Rules

Either the UCOR or the 294-300 series of rules can be described to the Signal Wake Model. The restrictions on train speeds imposed by the various signal indications, are described to the model by data on the signal rules file. This description is by three restrictive speeds for each indication: the maximum speed while passing a signal displaying the indication, the speed restriction between this signal and the next signal, and the maximum approach speed to the next signal. For example, an approach indication is described by the speeds 99, 30 and 0. A train arriving at a signal displaying an approach indication at unrestricted speed is required to reduce speed immediately to 30 mph and be prepared to stop at the next signal.

The signal rules file also contains a truth table which defines, for each indication, those indications which may be displayed on the signal ahead. This table is used for editing the signal data.

The signal rules file for UCOR rules, is listed in Appendix I.

## 2.2 Signal Plant

The simulated plant consists of a single rail line, usually the mainline. This line may be shorter than a subdivision but must have a signal located exactly at each end. Both directions can be simulated. Signals may display any of the indications which are defined in the signal rules file.

The signal plant is described by the location and behaviour of each of the signals on the line. The signals facing westbound trains and the signals facing eastbound trains, are each described by a single input table. Each signal location has a list of possible indications and the corresponding indication on the previous signal. For example:

113.2	Martinsn	X	A
		A	C
		C	C

describes a signal at Martinsn, mileage 113.2, which may show a stop (X), approach (A) or clear (C) indication. When this signal displays 'stop', the previous signal displays 'approach'; when this signal displays 'approach', the previous signal displays 'clear'; and when this signal is clear, so is the previous one.

In many cases, particularly for theoretical analysis, this method of input is long and repetitious. The SWM has an alternative method of input of the signal behaviour which allows the definition of a set of standard signal types. The entries in the signal definition table then contain only the mileage, description and signal type.

### 2.3 Train Types and Running Characteristics

Types of trains which may be simulated are designated unit, freight, passenger or express trains. Each type of train has different speed restrictions in the trackfile (from the TDMS database) and braking force as in the following table:

<u>Train Type</u>	<u>Level Track Deceleration (mph/sec)</u>
Designated Unit	0.4
Express	0.7
Freight	0.4
Passenger	1.0

Each class of trains simulated is further described by the following characteristics:

- maximum speed,
- horsepower,
- locomotive weight,
- train weight,
- number of cars and
- train length.

#### 2.4 Train Schedule and Stops

The train schedule allows the user to define several fleets of trains to be simulated. Each fleet is simulated independently.

A fleet may be composed of any number of trains, each of which may be of any defined train class. The trains may be scheduled to be ready to leave the first signal location at the base time of the fleet or at a later time. If any train is ready to leave before the train ahead has cleared the first signal, it follows closely behind the previous train (as if following on a stop and proceed signal), up to the first signal. Otherwise, trains arrive at the first signal operating at the specified entry speed.

Any train of a fleet may be caused to stop at any location. Such a stop is specified by the mileage, the minimum duration of the stop and the earliest allowable departure time.

## 2.5 Slow Orders

Slow orders can be requested to apply to individual fleets or to all fleets. Slow orders are specified by the mileage limits and the restrictive speed. Any slow order may affect the headend only or the entire train.

## 2.6 Plot and Trace

For each of the fleets, the user may request a trace output and/or several graphical outputs. All such outputs are requested within a time and mileage window.

Trace output may be requested at three levels of detail. The first level lists the arrival times of the headend and the tailend of each train at each signal and the times of the signal indication changes. The second level includes, also, the details of train speed and speed restrictions each time the train moves ahead by one increment and the third level includes internal details of the simulation.

Four graphical outputs are available: a distance-time diagram showing train movements and the time of signal indication changes, a distance-time diagram with the signal wake superimposed, a velocity-position diagram and velocity-time diagram.

## 2.7 Miscellaneous Run Options

Several parameters apply to all fleets simulated by one reqfile. The user specifies the west and east mileage of the line to be simulated and the maximum speed at which trains may enter and leave this line.

The simulation recalculates potential train speeds at fixed distance intervals, the user specifies the number of such increments to be used per mile. We have found 10 increments per mile to yield reasonable accuracy.

Other user-supplied parameters are the reaction time of the signal system, the minimum time required for a train to move from a stop signal, the sight distance of the signals and the minimum spacing between trains following on a stop and proceed indication.

The choice of cab or wayside signals is also a user option.

## 2.8 Output

Printed output includes an average headway report by signal, the departure time of each train from each signal location and a block runtime report for the first train of each fleet.

In addition, plot and trace output can be requested, as described in section 2.6.

Any of the following graphical outputs may be selected for a fleet : distance-time graph, signal wake graph, velocity-position graph and velocity-time graph.

### 3. COMPUTER SYSTEM DESCRIPTION

#### 3.1 Overview

The SWM consists of four computer programs written in SIMSCRIPT II.5. The first, referred to as the "trackfile creator", is used to extract speed restrictions and gradients from the TDMS database and create a trackfile for any subdivision. This program is executed once only for the subdivision under study. The other three: the front-end, simulation and graphing programs are executed, in sequence, to process each user-prepared reqfile.

The front-end program reads the data from the reqfile, edits this data for consistency with the signal rules data and for reasonableness, and prepares a midfile of reformatted and coded data for use by the simulation. An input echo is optional.

The simulation program reads the midfile, performs the simulation, writes train movement and signal change data to the graphfile and prints the reports.

The graphing program reads the graphfile and draws the requested graphs.

Complete system documentation, including samples of

the trackfile, reqfile, midfile and graphfile, is included in Transportation Planning System's documentation library. The system is shown schematically in the following figure.

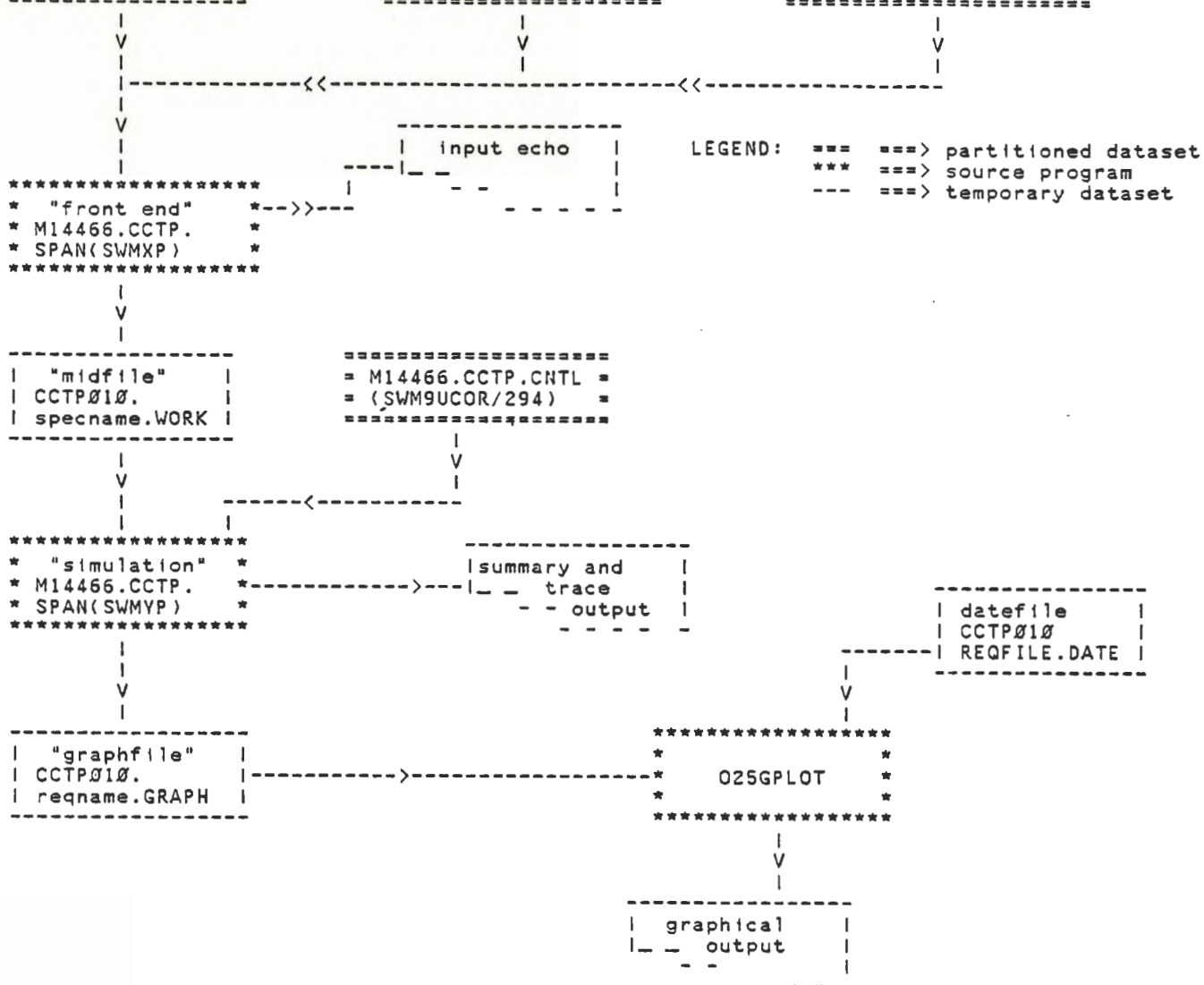
SYSTEM SCHEMATIC

=====

```
=====
= "req file" =
= M14466.CCTP. =
= CNTL(specname) =
=====
```

```
=====
= "trakfile" =
= M14466.CCTP. =
= CNTL(SWMTYALE) =
=====
```

```
=====
= "signal rules file" =
= M14466.CCTP.CNTL =
= (SWM9UCOR/SWM9294) =
=====
```



### 3.2 Trackfile Creator

The trackfile creator first runs the TPC program for a subdivision to obtain the "TPC dumpfile" on disk. A Simscript program processes the dumpfile and produces the trackfile for the subdivision.

The trackfile consists of three major parts: header records, special speeds and a data record for each increment. The number of increments is hard-wired at 10 per mile; this has been found to yield suitable accuracy.

The header records contain the east and west mileposts of the subdivision, number of increments per mile, number of data records and a list of train types which are handled. Each data record contains the mileage, adjusted gradient and permanent slow order speed restrictions for each train type in each direction. The special speed restrictions contain restrictions that cannot be handled in the data records, eg. station stops.

Detailed documentation of the TPC dumpfile and the processing performed by the Trackfile Creator program is contained in the documentation library.

### 3.3 Front-end

The front-end program first reads the data tables from the reqfile. Table headings and notes are echoed exactly; table contents are reformatted and echoed. Next, the program reads the header data from the trackfile and the truth table from the signal rules file; these are used for verification and coding of the reqfile data.

After conversion of the data to internal form, many checks are made for consistency and reasonableness.

The signal data is preprocessed in the following way. First, for those signals that were defined by type, the specific indications and the corresponding indications on the previous signal are substituted into the signal definition table. The resulting table is printed for verification. Then, the indication wake of each signal is determined; this is a list of upgraded indications that occur as a train clears signals ahead. This indication wake is also printed for verification.

All data is coded numerically and written to the midfile, which forms part of the input to the simulation module.

### 3.4 Simulation

#### 3.4.1 General

Data input to the simulation consists of reformatted user input from the reqfile, gradients and speed restrictions from the trackfile and signal-imposed restrictive speeds from the signal rules file.

Each user-defined fleet is simulated completely independently. Whilst processing any fleet, data on train schedule, train stops, slow orders, plot requests and trace requests for only that fleet are available to the simulation. The remainder of this discussion refers to processing that is performed for each of the fleets.

Trains of the fleet are simulated one at a time. First, there is a setup process for the train and then the train moves increment by increment across the simulated line. (The length of the increments is user-defined). At each increment, the arrival time and speed of the train are calculated. When the headend of a train crosses a signal, the indication is set to the most restrictive, and when the tailend of a train clears a signal, the indications displayed on signals behind are improved. The performance

of any train depends only on the train characteristics, the grade and the signals set by the previous train.

When a train clears the last signal, the train history (speed and time at each increment) is written on the graphfile. When all trains of the fleet have been simulated, average headways are computed, the reports are printed and the signal changes are written to the graphfile. The graphfile forms the input to the graphing program.

#### 3.4.2 Train Setup

During the simulation of a train, the state of the train is defined by the simulation time, the location of the train and the speed of the train. The train setup involves initialization of these values and the creation of an array of maximum train speeds.

There are two different setup processes, depending on whether the previous train (if any) has cleared the first signal block. For the first train of the fleet, and subsequent trains that arrive after the tailend of the train ahead has cleared the first signal, the train starts at the first signal travelling at the entry speed. For other trains, the train starts at the minimum spacing behind the train ahead, travelling at the lesser of the entry speed the

speed of the train ahead and 15 mph. In all cases, the simulation time is the schedule time.

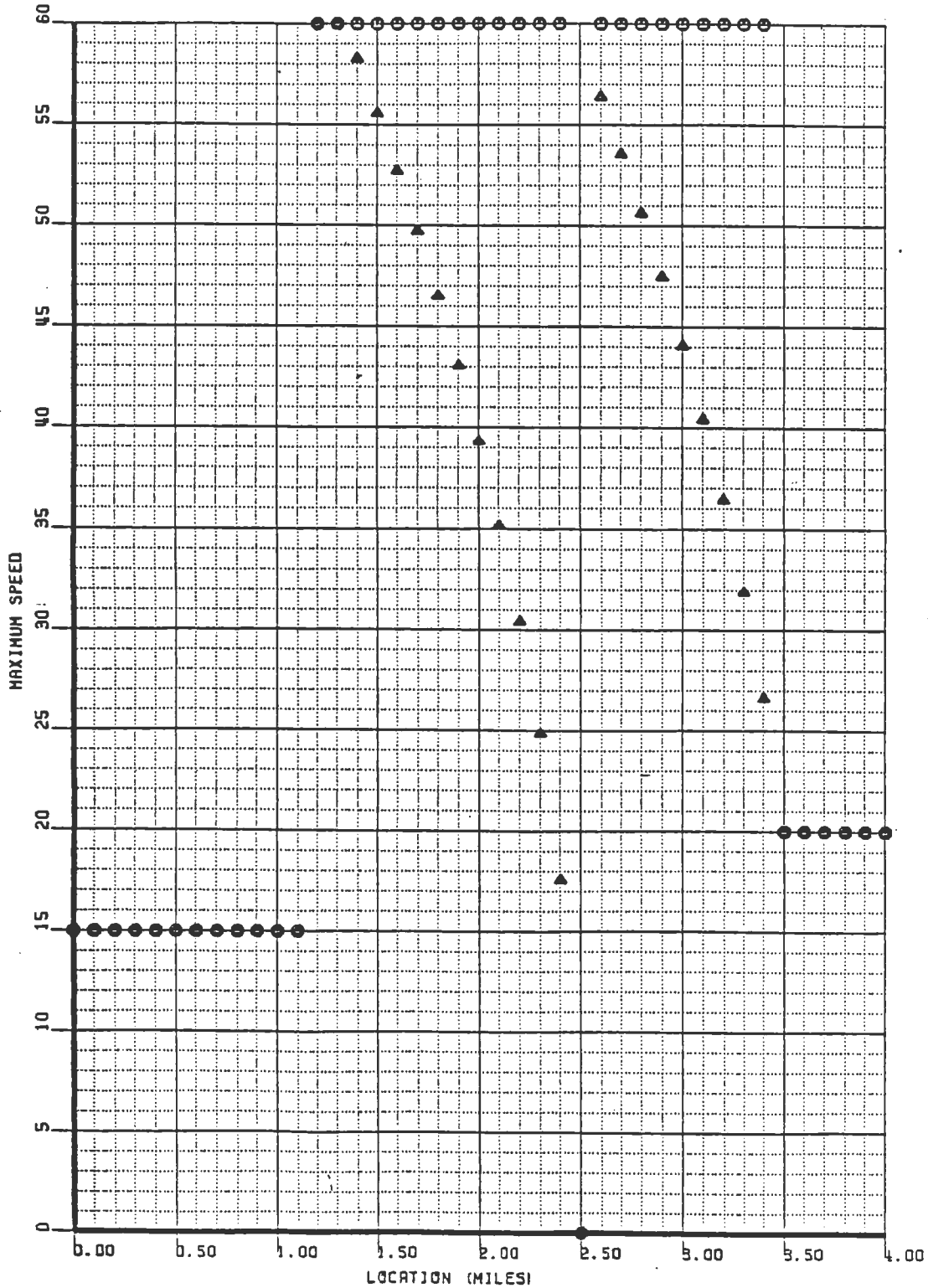
The array of maximum speeds at each increment is initialised as a composite of the most restrictive applicable speeds from the trackfile data, entry speed, exit speed, maximum train class speed, slow order restrictions and scheduled train stops. The slow order restrictions and special trackfile speeds are set to apply over the length of the train, if necessary. A train stop causes a single entry of zero at the location of the stop.

This array is now revised to allow for the braking characteristics of the train; the process is a reverse TPC which calculates the speed to which the train must reduce at each increment in order to stay below all of the restricted speeds in the initial array. The revised maximum speed array is the upper limit on the speed of a train travelling on clear signals.

Figure 3.1 shows an example of the initial and revised maximum speed array for the case where a train enters the line at mile 0.0, has an entry speed of 15 mph, a class maximum speed of 60, a train stop at mile 2.5 and a slow order of 20 mph starting at mile 3.5. It can be seen that the revised array contains braking curves from 60 to 0 at mile 2.5 and from 60 to 20 at mile 3.5.

# CANADIAN NATIONAL - TRANSPORTATION TRANSPORTATION PLANNING

SPEED CEILINGS FOR FREIGHT 1.0  
 ENTRY SPEED 15  
 STOP AT MILE 2.5  
 20 MPH SLOW ORDER AT MILE 3.5



● INITIAL MAXIMUM SPEED ARRAY  
 ▲ AFTER REVISION FOR BRAKING

### 3.4.3 Train Movement

The simulated train moves ahead increment by increment. Each step involves computation of the speed and arrival time of the train at the next increment. Special processes are involved when the train arrives at a signal, clears a signal, arrives at the location of a scheduled stop or is travelling in the same block as the preceding train. In addition, some processes are triggered when the arrival time, at the current increment, advances beyond the time of the next indication change on the signal ahead, the time when a cab signal indication changes, or the time that a preceding train left the block.

When the train arrives at a signal, it first obtains the indication currently displayed by the signal. If the train has stopped at the signal, it pauses for the minimum stop time before taking the indication. If the signal is a stop, the train time is advanced until the time of an improved indication.

Now, the restrictive speeds of the signal are applied to the train in the region between this signal and next one; this process involves the construction of speed ceilings for the signal block, they are a copy of the maximum speeds referred to in section 3.4.2, superimposed by the

restrictive speeds for passing this signal and approaching the next signal. This ceiling array is further reduced to allow braking to the next signal, if required. If there is a preceding train in the signal block, then the speed ceilings are further reduced to ensure that the train can stop before reaching the tailend of the train ahead.

When a train clears a signal, the state of previous signals is updated as described in the section 3.4.4.

When a train arrives at the location of a scheduled stop, the simulation time is simply advanced to the larger of the current time plus the length of the stop and the earliest departure time.

When a train is operating in the same signal block as the train ahead, it is necessary to find the new location of the tailend of the previous train each time the train moves. The ceilings at locations between the two trains are reset.

When the arrival time of the train at an increment exceeds the time that the signal ahead is upgraded, the ceilings are recalculated within the sight distance of the next signal.

If cab signals are in effect, the ceilings within the signal block are revised at the time of each signal improvement. However, in the case of a restricting signal, the ceilings are preserved for the length of the train.

Calculation of the speed of the train at the next increment depends on the relationship between current train speed, the ceiling at the next increment and the restrictive speed between signals. If the train is travelling faster than the speed allowed between signals, the new speed is calculated by applying the brakes at the service rate. Otherwise, potential speed at the next increment is calculated taking into account tractive effort, grade and resistance; the actual speed is the lessor of the potential speed and the ceiling speed. The arrival time at the next increment is calculated based on the average speed.

#### 3.4.4 Signal Changes

The data used to set signal indications is contained entirely in the indication wakes prepared, for each signal, by the front-end program. This is a list of indications in improving order. Figure 3.2 shows part of a signal arrangement with approach signals to sidings and double block braking over the sidings. The best indication that

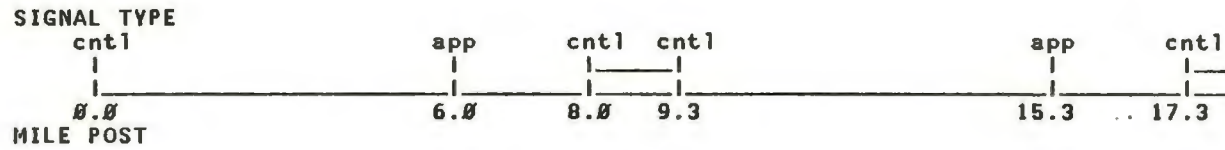
can be displayed at mile 0.0, the entry to the subdivision, is a Slow Clear. The indication wake for the signal at mile 6.0, for example, is the list: stop and proceed, approach, approach medium, approach medium, clear.

When the headend of a train moves over a signal location, the signal is set to the worst indication. When the tailend of a train clears a signal, the indication of all signals behind are improved to the next indication in their indication wake. Referring to the signal plant shown in Figure 3.2, at the reaction time after the tail-end of a train crosses mile 8.0, the indication on the signal at mile 6.0 changes from the worst indication of stop and proceed to approach and the indication on the signal at mile 0.0 is upgraded to a slow clear. When the train crosses mile 9.3, the indications at mile 8.0 and mile 6.0 are upgraded to an approach and a approach medium, respectively.

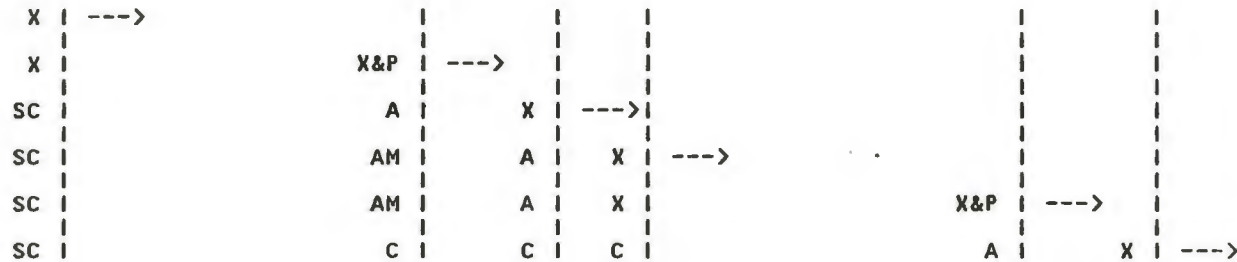
When a train clears the last signal, the indications of all signals behind are improved to the least restrictive indication that they may display.

Trace level 1 can be used to print out the times and indications of all signal changes.

INDICATION WAKE EXAMPLE



SIGNAL WAKE



SIGNAL CODES

- C - CLEAR SIGNAL
- SC - SLOW CLEAR SIGNAL
- A - APPROACH SIGNAL
- AM - APPROACH MEDIUM SIGNAL
- X&P - STOP AND PROCEED SIGNAL
- X - STOP SIGNAL

FIGURE 3.2

### 3.4.5 Headway Calculations

When a train leaves each signal location, the train time is recorded. The average headway at each signal is calculated as the difference between this departure time of the last and the first train, divided by the number of trains less one.

Average headways are printed both on the output listing and on the graphs.

4. VALIDATION OF SWM

The run time calculations of SWM have been validated by comparison with TPC outputs. For this comparison, three trains of different running characteristics and length were simulated across each of the mainline subdivisions west of Edmonton. The average difference in subdivision run time between SWM and TPC was 2.2 percent and the largest difference was 5 percent.

The signal changes and obedience of trains to the signal rules have been checked manually.

APPENDIX I

Signal Rules File for UCOR

UCOR SIGNAL RULES  
 =====

14 <-- NUMBER OF SIGNAL TYPES	/	SPEED APPROACHING NEXT SIGNAL --+	--+		
PREV/THIS INDICATION		SPEED BETWEEN SIGNALS --+	--+		
CAAAALLMSSRX		TRAIN ALLOWED BETWEEN SIGNALS --+	--+		
LMS CACACA &		(1=YES;Ø=NO)			
P		SPEED AT SIGNAL --+	--+		
				V	V
				V	V
C	*****			999	999999
AL	*****			999	999 45
AM	*****			999	999 3Ø
AS	**        **			999	3Ø 15
A	*            ****			999	3Ø Ø
LC	*****			45	999999
LA	*****			45	45 Ø
MC	*****			3Ø	999999
MA	*****			3Ø	3Ø Ø
SC	*****			15	999999
SA	*****			15	3Ø Ø
R	***			9991	15 Ø
X&P	***			Ø1	15 Ø
X	*			Ø	Ø Ø

## APPENDIX II

### Sample Input

This input describes the entry to Boston Bar from the Ashcroft subdivision. Trains enter the line at 12 minute headways at Martinson and have a roll by inspection at 6 mph as they enter the Boston Bar Terminal.

SIGNAL WAKE MODEL - REQUIREMENTS FILE  
=====

TITLE : ENTRY TO BOSTON BAR  
SUBDIVISION : ASHC

RULES FOR PREPARING DATA TABLES  
=====

READ THE NOTES CAREFULLY

1. DO NOT MOVE OR REMOVE ANY LINE BEGINNING WITH ---- OR END
2. COMMENTS WITH A "." IN COLUMN 1 WILL NOT BE PRINTED
3. ANY NUMBER OF LINES (OR NONE) MAY BE INSERTED IN TABLES
4. ALL DATA COLUMNS OF A TABLE MUST HAVE ENTRIES  
GENERALLY, Ø WILL GIVE THE OBVIOUS DEFAULT
5. THE END CARD OF EACH TABLE GIVES THE REQUIRED DATA TYPE  
A CHARACTER FIELD MAY CONTAIN NUMBERS  
A REAL FIELD MAY BE INTEGER, BUT NOT VICE VERSA  
A REAL OR INTEGER FIELD MAY NOT CONTAIN CHARACTERS
6. ALL MILEAGES ARE REAL EG. 78.23
7. ALL TIMES REFER TO THE TIME IN AN AGGREGATION

RUN PARAMETERS AND OPTIONS  
-----

FRONT END INPUT ECHO	- YES	
MODEL INPUT ECHO	- YES	
CAB SIGNALS	- NO	
WEST MILEPOST (MILE)	- 125.44	
EAST MILEPOST (MILE)	- 122.25	
REACTION TIME (SEC)	- 3Ø	
ENTRY SPEED (MPH)	- 4Ø	
EXIT SPEED (MPH)	- 15	
INTERTRAIN SPACE (FEET)	- 25Ø	
TERMINAL SIZE (MILE)	- 3	
INCREMENTS PER MILE	- 1Ø	
SIGHT DISTANCE (MILE)	- .1	
MINIMUM STOP AT SIGNAL(MIN)	- 1.Ø	EG 1.Ø MINUTES

SIGNAL RESET MATRICES  
=====

PREVIOUS  
TYPE TYPE THIS SIGNAL INDICATION  
-----  
END CH 4 CH 4 CH3 CH3 ETC.

NOTES

1. THE NAME OF THE SIGNAL TYPE FOR EVERY RESET MATRIX MUST BEGIN IN THE FIRST COLUMN. CONVERSELY, ONLY THE NAME OF THE SIGNAL TYPE FOR EVERY RESET MATRIX MUST BE IN THE FIRST FOUR COLUMNS (EXCEPT FOR THE END CARD).
2. ALL SIGNAL INDICATIONS MUST BE CODED IN AT MOST THREE CHARACTERS USING THE FOLLOWING CODE:  
C=CLEAR, L=LIMITED, M=MEDIUM, S=SLOW, X=STOP, A=APPROACH, R=RESTRICTING, P=PROCEED, -=TO, &=AND  
E.G. CLEAR TO STOP: "C-X"; APPROACH LIMITED: "AL "
3. THE FIRST DATA COLUMN IN "THIS SIGNAL INDICATION" MUST BE THE MOST RESTRICTIVE

SIGNAL LOCATIONS  
=====

WESTBOUND TRAINS (EASTWARD-FACING):				
MILEPOST (MILES)	SIGNAL NAME	SIGNAL TYPE	EXCEPTIONS THIS	EXCEPTIONS PREVIOUS
-----	-----	----	----	----
122.25	MARTINSN	NONE	X A C	A C C
123.40	SIGNAL	NONE	X A C	A C C
125.44	B.BAR	NONE	X A	A C
END REAL	CH 4	CH 4	ch 3	ch 3

EASTBOUND TRAINS (WESTWARD-FACING):

MILEPOST (MILES)	SIGNAL NAME	SIGNAL TYPE	EXCEPTIONS THIS	PREVIOUS
END REAL	CH 4	CH 4	ch 3	ch 3

NOTES

1. MILEPOSTS MUST START IN COLUMN 1.
2. SIGNAL TYPE MAY REFER TO A SIGNAL TYPE DEFINED IN THE RESET MATRIX TABLE OR NONE.
3. IF THE SIGNAL TYPE IS NONE, THEN THIS SIGNAL INDICATION- PREVIOUS SIGNAL INDICATION PAIRS MUST BE SUPPLIED FOR ALL POSSIBLE INDICATIONS ON THIS SIGNAL. EACH PAIR IS ON A NEW LINE AT LEAST BEYOND COLUMN 8.

TRAIN CLASS DATA

=====

CLASS NAME	DIR (E/W)	TYPE	MAXIM SPEED (MPH)	HORSE POWER (HP)	WGT. LOCO. (TONS)	WGT. TRN. (TONS)	# OF CARS	LENGTH OF TRN (FEET)
FREIGHT	W	F	50	8961	585	6788.5	99	5944
END CH8	CH 1	CH 1	REAL	REAL	REAL	REAL	INTEGER	REAL

NOTES

1. ALL SPEED CLASSES USED BELOW MUST BE DEFINED IN THIS TABLE
2. TYPES: D=DESIGNATED UNIT, E=EXPRESS, F=FREIGHT, P=PASSENGER

TRAIN SCHEDULE  
=====

AGGREG. NAME	CLASS NAME	DEPARTURE TIME		NUMBER
		HR	MIN	
-----	-----	-----	-----	-----
FLEET1	FREIGHT	Ø	Ø	1
	FREIGHT	Ø	12	1
	FREIGHT	Ø	24	1
END CH8	CH8	INTEGER	REAL	INTEGER

NOTES

1. THE AGGREGATION NAME MUST BE IN COLUMN 1. EACH AGGREGATION IS SIMULATED SEPARATELY. AVERAGE HEADWAY AT EACH SIGNAL IS DETERMINED FOR EACH AGGREGATION.
2. TRAIN CLASS REFERS TO ONE OR MORE OF THE TRAIN CLASSES DEFINED ABOVE.
3. DEPARTURE TIME IS RELATIVE TO THE BEGINNING OF THE AGGREGATION.
4. AN AGGREGATE MAY BE COMPOSED OF TRAINS FROM DIFFERENT CLASSES, START EACH SET OF TRAINS ON A NEW LINE (NOT IN COLUMN 1)

TRAIN STOPS  
=====

AGGREG. NAME	SEQUENCE NUMBER	MILEAGE	MINIMUM	EARLIEST
			DURATION (MIN)	DEPARTURE (HR MIN)
-----	-----	-----	-----	-----
END CH8	INTEGER	REAL	REAL	INTEGER REAL

NOTES

1. AGGREGATION NAME MUST START IN COLUMN 1
2. SEQUENCE NUMBER SPECIFIES WHICH TRAIN OF THE AGGREGATION IS TO STOP. A SEQUENCE NUMBER OF Ø STOPS ALL TRAINS IN THE AGGREGATION.

SLOW ORDER WINDOWS

=====

NAME	AGGREG. NAME	WEST MILEAGE	EAST MILEAGE	SPEED MPH	TYPE
SLOW	FLEET1	125.44	125.44	6	E
END CH 4	CH 8	REAL	REAL	REAL	CH1

NOTES

1. NAME IS 4 CHARACTERS AND IS MANDATORY
2. AGGREGATION NAME MAY BE THE AGGREGATION TO WHICH THE SLOW ORDER APPLIES. A NAME OF EAST/WEST CAUSES THE TSO TO BE APPLIED TO ALL EASTBOUND/WESTBOUND AGGREGATIONS. A NAME OF ALL CAUSES THE TSO TO BE APPLIED TO ALL AGGREGATIONS.
3. SPEED INDICATES MAXIMUM SPEED
4. POSSIBLE TYPES ARE "E" OR "H" DENOTING THE SPEED RESTRICTION APPLYING TO THE ENTIRE TRAIN OR THE HEAD-END ONLY

PLOT WINDOWS

=====

AGGREG. NAME	BEGIN HOUR	END HOUR	WEST MILEAGE	EAST MILEAGE	PLOT TYPE
FLEET1	Ø	Ø.75	Ø	Ø	1
FLEET1	Ø	Ø.75	Ø	Ø	3
FLEET1	Ø	Ø.75	Ø	Ø	4
FLEET1	Ø	Ø.75	Ø	Ø	5
END CH 8	REAL	REAL	REAL	REAL	INTEGER

NOTES

1. AGGREGATION NAME MAY BE THE NAME OF THE AGGREGATION TO BE GRAPHED OR ONE OF ALL, EAST, WEST.
2. AN END HOUR OF Ø. DEFAULTS TO THE END LIMIT
3. THE ALLOWABLE PLOT TYPES ARE:
  - 1 = STANDARD COLOURED SIGNAL WAKE
  - 2 = STYLISED SIGNAL WAKE - NOT IMPLEMENTED
  - 3 = UNCOLOURED SIGNAL WAKE WITH SIGNAL CHANGE INDICATIONS
  - 4 = VELOCITY-POSITION PLOT
  - 5 = VELOCITY-TIME PLOT
2. FOR THE VELOCITY-POSITION PLOT, THE BEGIN HOUR VALUE WILL BE USED TO SPECIFY THE INTERNAL TRAIN I.D. (I.E. THE NTH DEPARTURE). THE END HOUR VALUE WILL BE IGNORED.

TRACE WINDOWS

AGGREG. NAME	BEGIN HOUR	END HOUR	WEST MILEAGE	EAST MILEAGE	TRACE INDEX
FLEET1	0	0	0	0	1
FLEET1	0	0.2	0	0	2
END CH 8	REAL	REAL	REAL	REAL	INTEGER

NOTES

1. TRACE INDEX = 0 . MINIMAL OUTPUT  
 1 ABOVE + TRAIN START AND END + SIGNALS SEEN AND CHANGED  
 2 ABOVE + TRAIN MOVES  
 3 ABOVE + DEBUGGING

### APPENDIX III

Simulation output  
including reports, signal wake graph, velocity-time  
and velocity-position graphs

SIMULATION OUTPUT  
=====

RUNNING AGGREGATION FLEET1 IN DIRECTION WEST

STARTING TRAIN 1 , AGGREGATE FLEET1 , CLASS FREIGHT , SPEED CLASS F  
 TRAIN 1 IS QUEUED IN TERMINAL AT TIME 0.  
 STARTING AT AT INCREMENT 31 MILE 122.300  
 STARTING SPEED IS 40.00

HEAD-END ARRIVAL OF 1 AT SIGNAL 1 ,MILE 122.30 AT TIME 0. SPEED IS 40.00  
 SIGNAL INDICATION IS C  
 SIGNAL 1 AT 122.30 ==> 14(X ) TIME 0.

-----  
 DETAILED TRACE FOR TRAIN 1 AGGREGATE FLEET1  
 -----

INCREMENT	LOCATION	MAX.SPEED	BETWEEN SP	CEILING	SPEED	TIME
32	122.40	30.00	999.00	30.00	30.00	.17 ACCL
33	122.50	30.00	999.00	30.00	30.00	.37 ACCL
34	122.60	30.00	999.00	30.00	30.00	.57 ACCL
35	122.70	30.00	999.00	30.00	30.00	.77 ACCL
36	122.80	30.00	999.00	30.00	30.00	.97 ACCL
37	122.90	30.00	999.00	30.00	30.00	1.17 ACCL
38	123.00	30.00	999.00	30.00	30.00	1.37 ACCL
39	123.10	30.00	999.00	30.00	30.00	1.57 ACCL
40	123.20	30.00	999.00	30.00	30.00	1.77 ACCL
41	123.30	30.00	999.00	30.00	30.00	1.97 ACCL
42	123.40	30.00	999.00	30.00	30.00	2.17 ACCL

HEAD-END ARRIVAL OF 1 AT SIGNAL 2 ,MILE 123.40 AT TIME 2.17 SPEED IS 30.00  
 SIGNAL INDICATION IS C  
 SIGNAL 2 AT 123.40 ==> 14(X ) TIME 2.17

-----  
 DETAILED TRACE FOR TRAIN 1 AGGREGATE FLEET1  
 -----

INCREMENT	LOCATION	MAX.SPEED	BETWEEN SP	CEILING	SPEED	TIME
-----------	----------	-----------	------------	---------	-------	------

TAIL-END ARRIVAL OF 1 AT SIGNAL 1 ,MILE 122.30 AT TIME 2.17

DETAILED TRACE FOR TRAIN 1 AGGREGATE FLEET1

INCREMENT	LOCATION	MAX.SPEED	BETWEEN SP	CEILING	SPEED	TIME	
43	123.50	30.00	999.00	30.00	30.00	2.37	ACCL
44	123.60	30.00	999.00	30.00	30.00	2.57	ACCL
45	123.70	30.00	999.00	30.00	30.00	2.77	ACCL
46	123.80	30.00	999.00	30.00	30.00	2.97	ACCL
47	123.90	30.00	999.00	30.00	30.00	3.17	ACCL
48	124.00	30.00	999.00	30.00	30.00	3.37	ACCL
49	124.10	30.00	999.00	30.00	30.00	3.57	ACCL
50	124.20	30.00	999.00	30.00	30.00	3.77	ACCL
51	124.30	30.00	999.00	30.00	30.00	3.97	ACCL
52	124.40	30.00	999.00	30.00	30.00	4.17	ACCL
53	124.50	30.00	999.00	30.00	30.00	4.37	ACCL

TAIL-END ARRIVAL OF 1 AT SIGNAL 2 ,MILE 123.40 AT TIME 4.37  
 SIGNAL 1 AT 122.30 ==> 5(A ) TIME 4.87

DETAILED TRACE FOR TRAIN 1 AGGREGATE FLEET1

INCREMENT	LOCATION	MAX.SPEED	BETWEEN SP	CEILING	SPEED	TIME	
54	124.60	30.00	999.00	30.00	30.00	4.57	ACCL
55	124.70	30.00	999.00	30.00	30.00	4.77	ACCL
56	124.80	30.00	999.00	30.00	30.00	4.97	ACCL
57	124.90	30.00	999.00	30.00	30.00	5.17	ACCL
58	125.00	30.00	999.00	30.00	30.00	5.37	ACCL
59	125.10	30.00	999.00	30.00	30.00	5.57	ACCL
60	125.20	25.80	999.00	25.80	25.80	5.79	ACCL
61	125.30	18.81	999.00	18.81	18.81	6.06	ACCL
62	125.40	6.00	999.00	6.00	6.00	6.54	ACCL

HEAD-END ARRIVAL OF 1 AT SIGNAL 3 ,MILE 125.40 AT TIME 6.54 SPEED IS 6.00  
 SIGNAL INDICATION IS A  
 SIGNAL 3 AT 125.40 ==> 14(X ) TIME 6.54

DETAILED TRACE FOR TRAIN 1 AGGREGATE FLEET1

INCREMENT	LOCATION	MAX.SPEED	BETWEEN SP	CEILING	SPEED	TIME	
63	125.50	6.00	30.00	6.00	6.00	7.54	ACCL
64	125.60	6.00	30.00	6.00	6.00	8.54	ACCL
65	125.70	6.00	30.00	6.00	6.00	9.54	ACCL
66	125.80	6.00	30.00	6.00	6.00	10.54	ACCL
67	125.90	6.00	30.00	6.00	6.00	11.54	ACCL
68	126.00	6.00	30.00	6.00	6.00	12.54	ACCL

TRAIN 1 TERMINATED AT TIME 17.539  
 SIGNAL 3 AT 125.40 ==> 5(A ) AT 18.04  
 SIGNAL 2 AT 123.40 ==> 1(C ) AT 18.04  
 SIGNAL 1 AT 122.30 ==> 1(C ) AT 18.04

STARTING TRAIN 2 , AGGREGATE FLEET1 , CLASS FREIGHT , SPEED CLASS F  
TRAIN 2 IS QUEUED IN TERMINAL AT TIME 12.00  
FOLLOWING TRAIN 1 AT INCREMENT 31 MILE 122.300  
STARTING SPEED IS 40.00

HEAD-END ARRIVAL OF 2 AT SIGNAL 1 ,MILE 122.30 AT TIME 12.00 SPEED IS 40.00  
SIGNAL INDICATION IS A  
SIGNAL 1 AT 122.30 ==> 14(X ) TIME 12.00

HEAD-END ARRIVAL OF 2 AT SIGNAL 2 ,MILE 123.40 AT TIME 14.62 SPEED IS 0.  
SIGNAL INDICATION IS X.  
STOP SIGNAL, TIME ADVANCED TO 18.04  
SIGNAL INDICATION IS C  
SIGNAL 2 AT 123.40 ==> 14(X ) TIME 18.04

TAIL-END ARRIVAL OF 2 AT SIGNAL 1 ,MILE 122.30 AT TIME 18.04

TAIL-END ARRIVAL OF 2 AT SIGNAL 2 ,MILE 123.40 AT TIME 21.15  
SIGNAL 1 AT 122.30 ==> 5(A ) TIME 21.65

HEAD-END ARRIVAL OF 2 AT SIGNAL 3 ,MILE 125.40 AT TIME 23.32 SPEED IS 6.00  
SIGNAL INDICATION IS A  
SIGNAL 3 AT 125.40 ==> 14(X ) TIME 23.32

TRAIN 2 TERMINATED AT TIME 34.317  
SIGNAL 3 AT 125.40 ==> 5(A ) AT 34.82  
SIGNAL 2 AT 123.40 ==> 1(C ) AT 34.82  
SIGNAL 1 AT 122.30 ==> 1(C ) AT 34.82

STARTING TRAIN 3 , AGGREGATE FLEET1 , CLASS FREIGHT , SPEED CLASS F  
TRAIN 3 IS QUEUED IN TERMINAL AT TIME 24.00  
FOLLOWING TRAIN 2 AT INCREMENT 31 MILE 122.300  
STARTING SPEED IS 40.00

HEAD-END ARRIVAL OF 3 AT SIGNAL 1 ,MILE 122.30 AT TIME 24.00 SPEED IS 40.00  
SIGNAL INDICATION IS A  
SIGNAL 1 AT 122.30 ==> 14(X ) TIME 24.00

HEAD-END ARRIVAL OF 3 AT SIGNAL 2 ,MILE 123.40 AT TIME 26.82 SPEED IS 0.  
SIGNAL INDICATION IS X.  
STOP SIGNAL, TIME ADVANCED TO 34.82  
SIGNAL INDICATION IS C  
SIGNAL 2 AT 123.40 ==> 14(X ) TIME 34.82

TAIL-END ARRIVAL OF 3 AT SIGNAL 1 ,MILE 122.30 AT TIME 34.82

TAIL-END ARRIVAL OF 3 AT SIGNAL 2 ,MILE 123.40 AT TIME 37.93  
SIGNAL 1 AT 122.30 ==> 5(A ) TIME 38.43

HEAD-END ARRIVAL OF 3 AT SIGNAL 3 ,MILE 125.40 AT TIME 40.10 SPEED IS 6.00  
SIGNAL INDICATION IS A  
SIGNAL 3 AT 125.40 ==> 14(X ) TIME 40.10

TRAIN 3 TERMINATED AT TIME 51.096  
SIGNAL 3 AT 125.40 ==> 5(A ) AT 51.60  
SIGNAL 2 AT 123.40 ==> 1(C ) AT 51.60  
SIGNAL 1 AT 122.30 ==> 1(C ) AT 51.60

AVERAGE HEADWAYS FOR AGGREGATION FLEET1

SIGNAL	TYPE	LOCATION	HEADWAY
1	MARTINSN	NONE	122.30
2	SIGNAL	NONE	123.40
3	B.BAR	NONE	125.40

DEPARTURE TIMES FROM SIGNALS

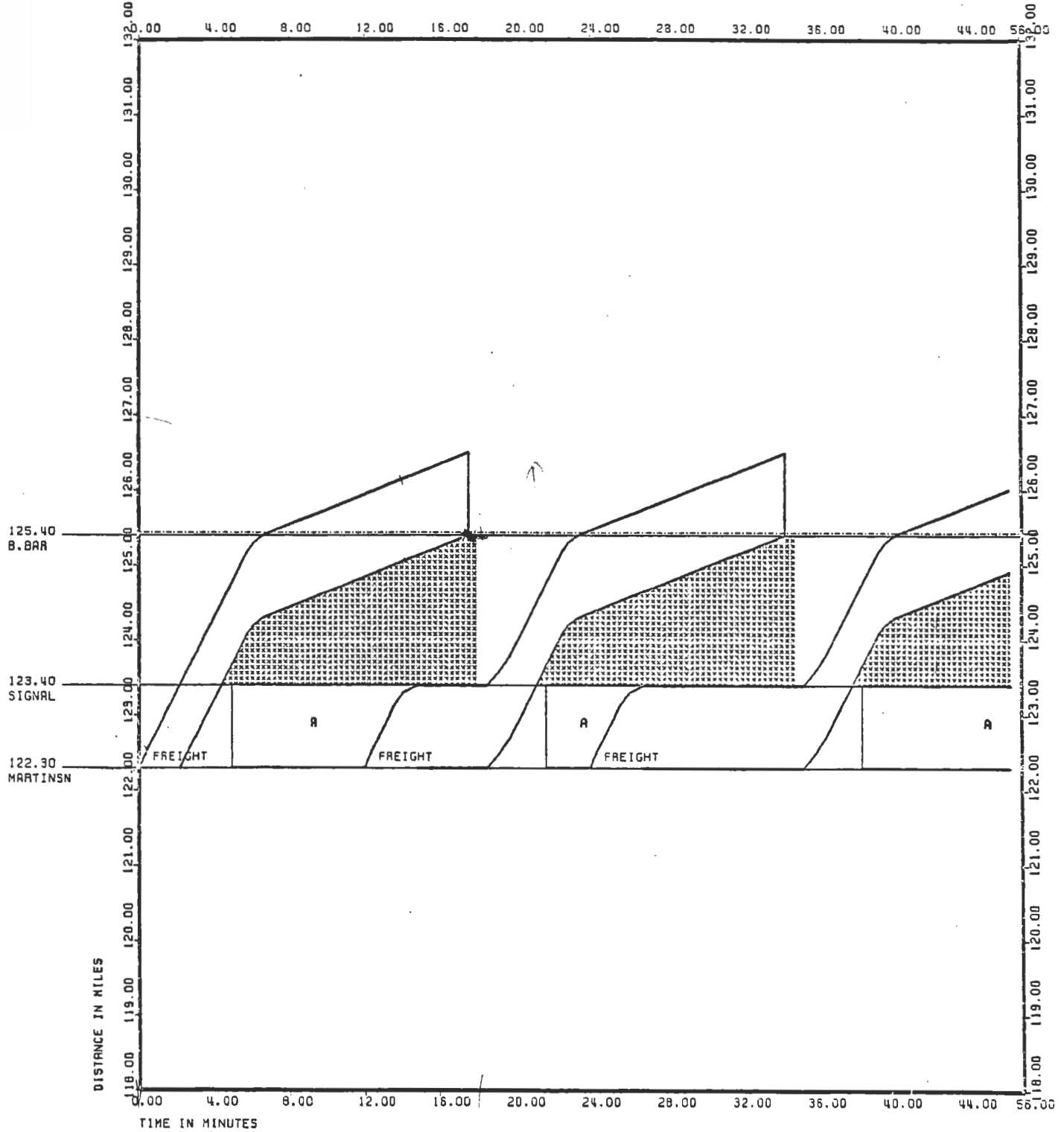
SIGNAL	TRAIN 1	TRAIN 2	TRAIN 3
1 MARTINSN	0.	12.00	24.00
2 SIGNAL	2.17	18.04	34.82
3 B.BAR	6.54	23.32	40.10

RUNNING TIMES OF FIRST TRAIN OVER

SIGNAL	TYPE	LOCATION	1 BLOCK	1 BLOCK+LENGTH	2 BLOCK	2 BLOCK+LENGTH
1	MARTINSN	NONE 122.30	2.2	4.4	6.5	17.5
2	SIGNAL	NONE 123.40	4.4	15.4		

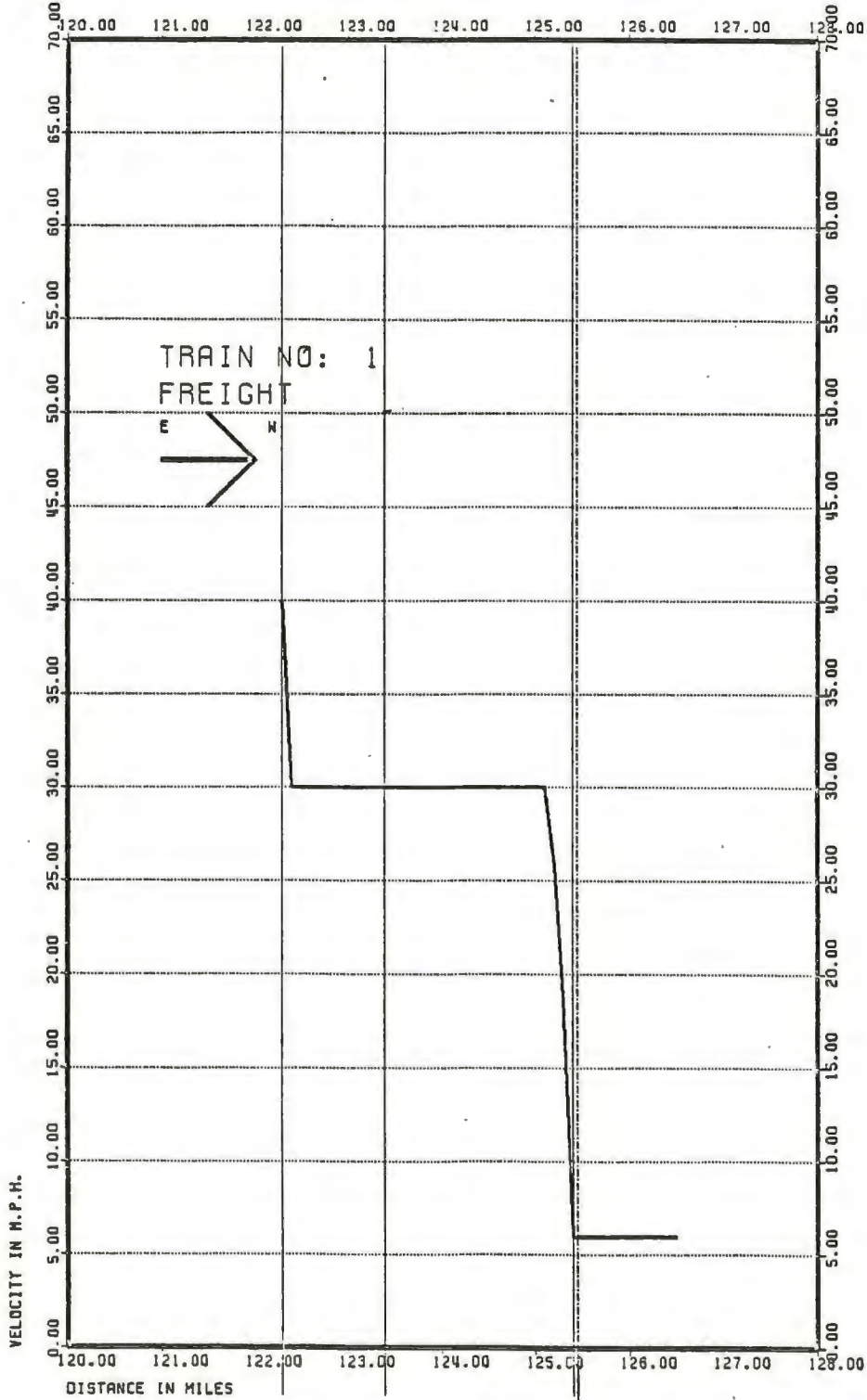
# CANADIAN NATIONAL - TRANSPORTATION PLANNING SIGNAL WAKE MODEL

AGGREGATION: FLEET1      REQFILE: BOS      TRACKFILE: ASHC  
 DATE: 03/10/82      TIME: 10:03:32      TITLE: ENTRY TO BOSTON BARR  
 PLOT TYPE: STANDARD SIGNAL WAKE



# CANADIAN NATIONAL - TRANSPORTATION PLANNING SIGNAL WAKE MODEL

AGGREGATION: FLEET1 REQFILE: 805 TRACKFILE: ASMC  
 DATE: 03/10/82 TIME: 10:03:32 TITLE: ENTRY TO BOSTON BARR  
 PLOT TYPE: VELOCITT - POSITION PLOT

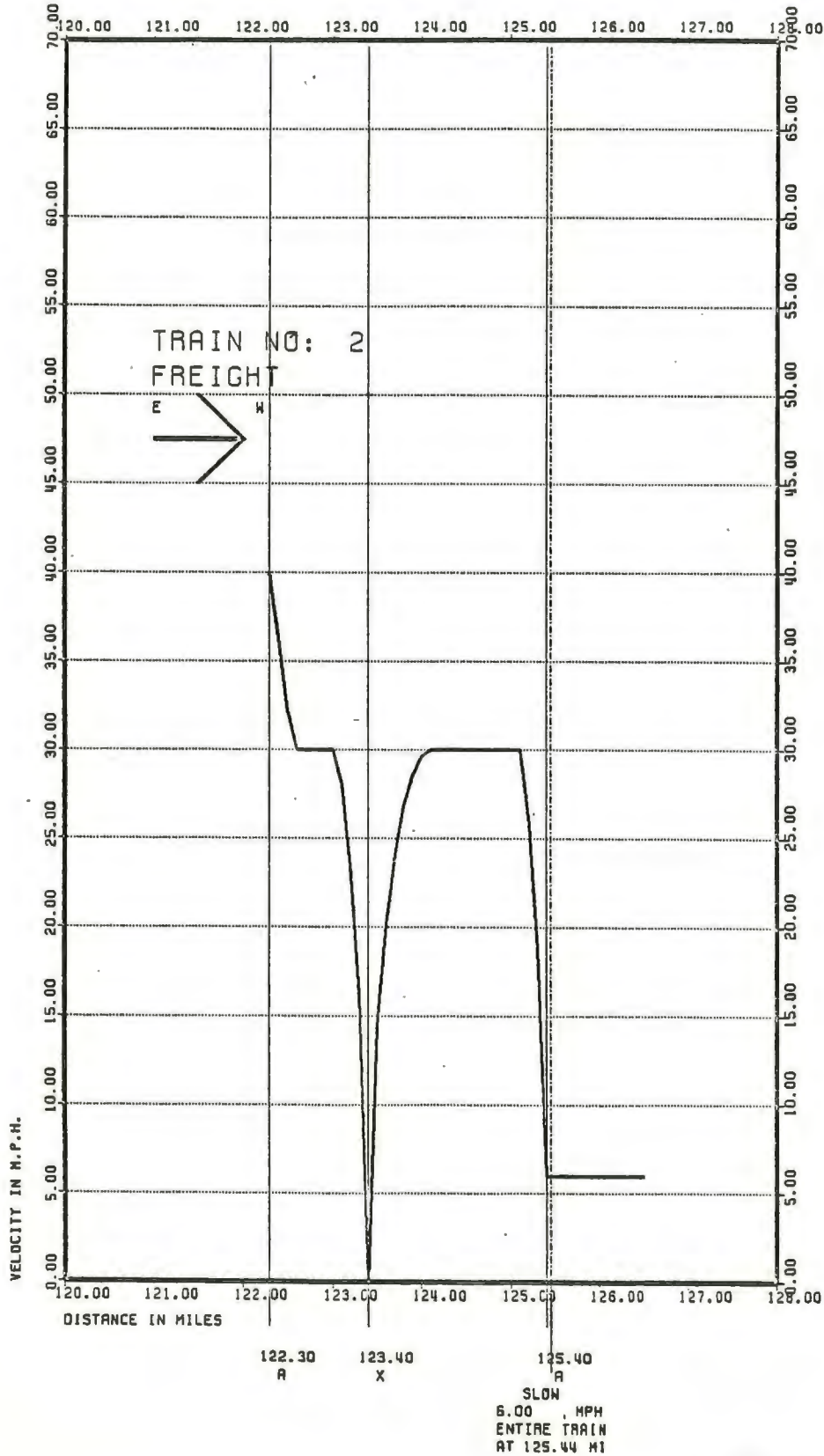


122.30 C      123.40 C      125.40 A

SLOW  
6.00 MPH  
ENTIRE TRAIN  
AT 125.44 MI

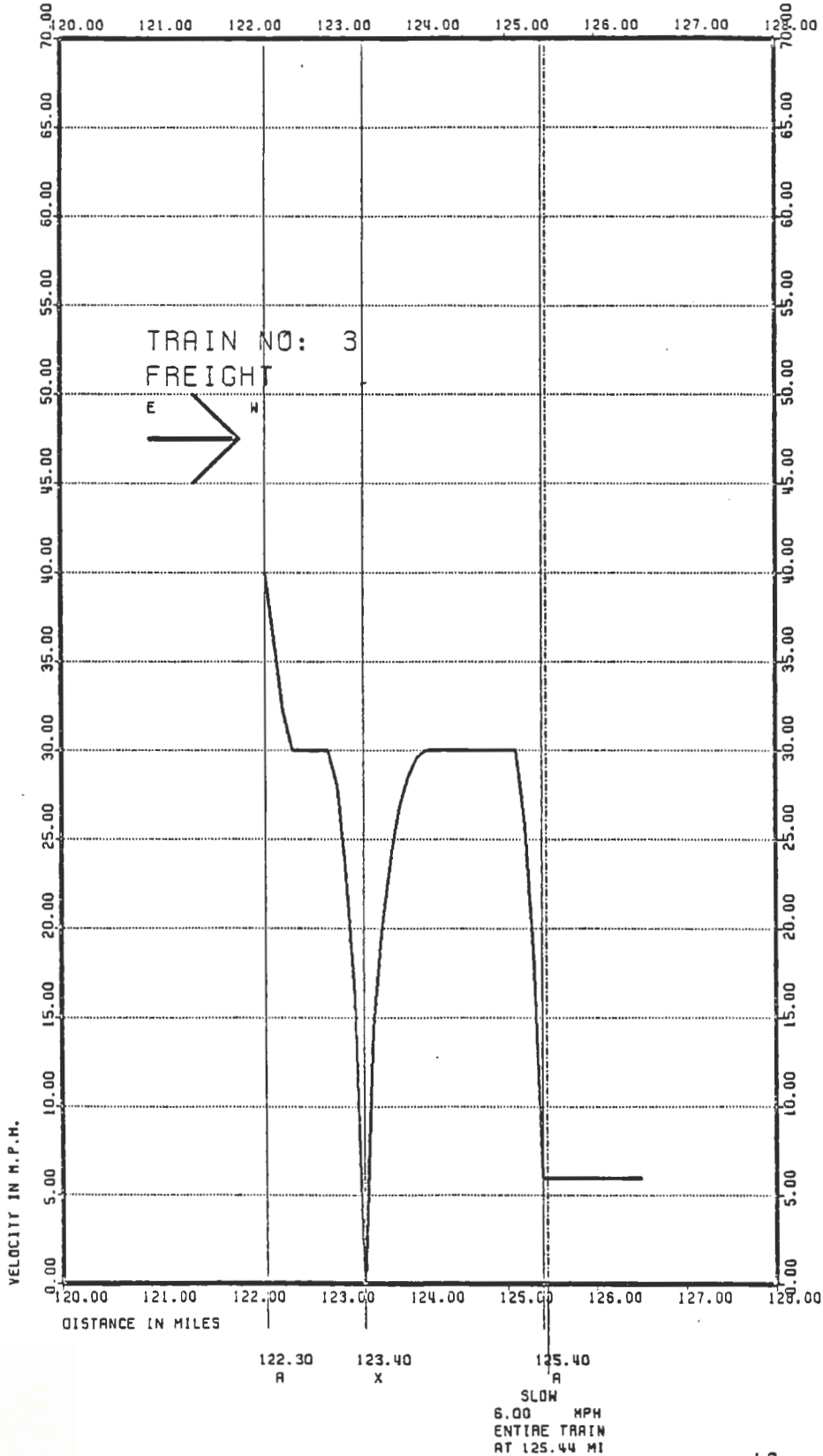
# CANADIAN NATIONAL - TRANSPORTATION PLANNING SIGNAL WAKE MODEL

AGGREGATION: FLEET1 REOFILE: 805 TRACKFILE: ASHC  
 DATE: 03/10/82 TIME: 10:03:32 TITLE: ENTRY TO BOSTON BAR  
 PLOT TYPE: VELOCITY - POSITION PLOT



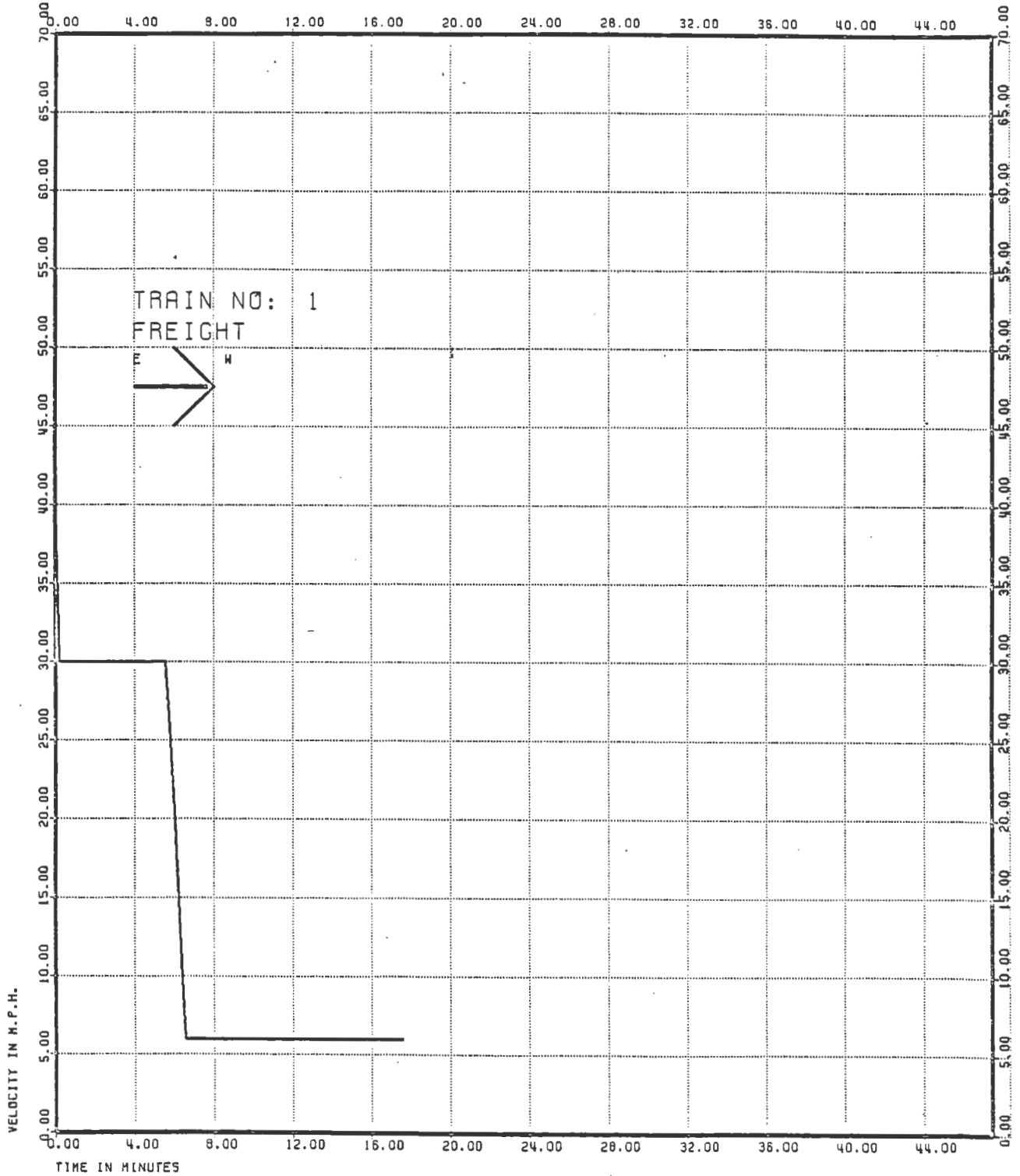
CANADIAN NATIONAL - TRANSPORTATION PLANNING  
 SIGNAL WAKE MODEL

AGGREGATION: FLEET1 REOFILE: 805 TRACKFILE: ASHC  
 DATE: 03/10/82 TIME: 10:03:32 TITLE: ENTRY TO BOSTON BAR  
 PLOT TYPE: VELOCITY - POSITION PLOT



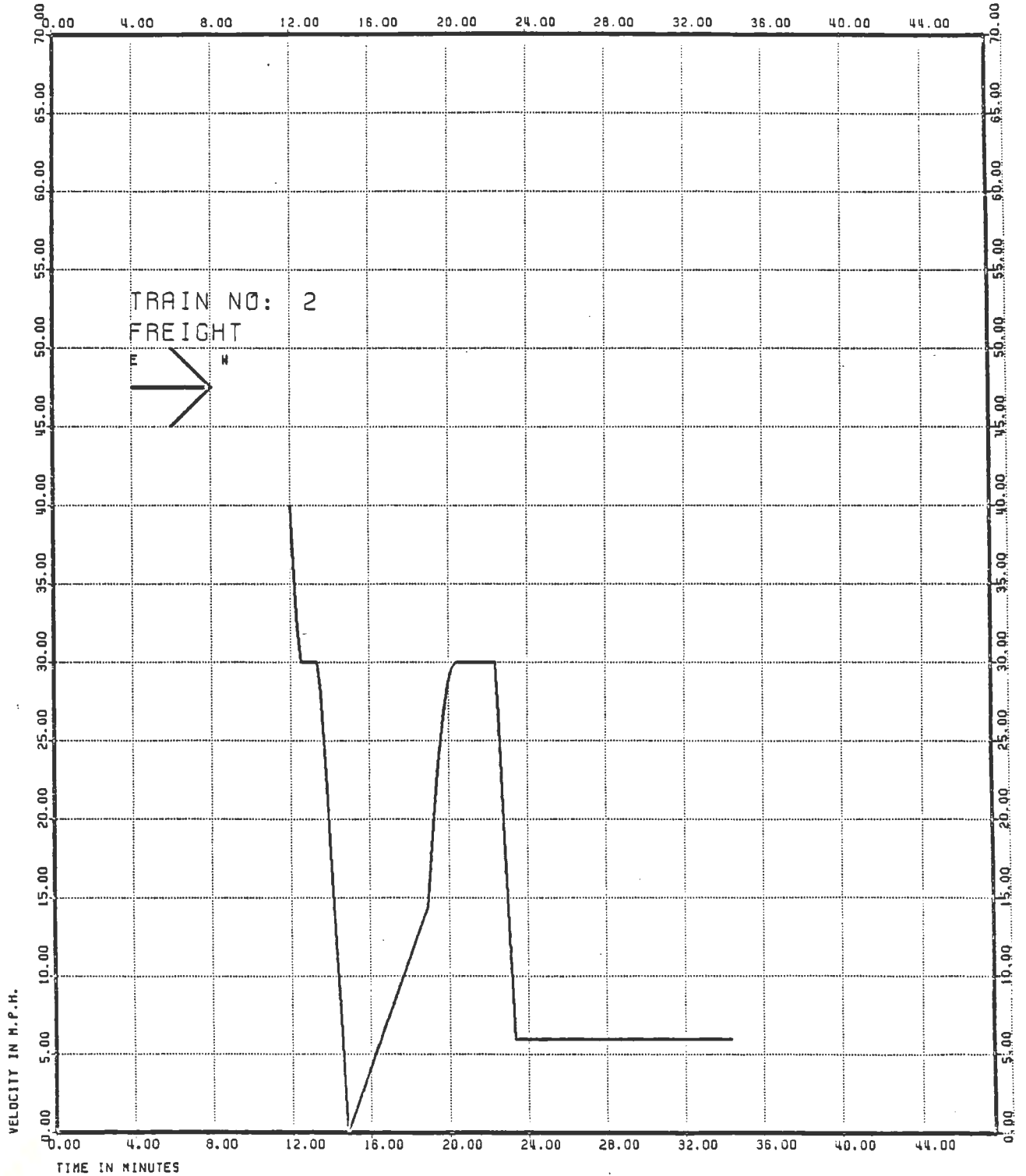
# CANADIAN NATIONAL - TRANSPORTATION PLANNING SIGNAL WAKE MODEL

AGGREGATION: FLEET1 REQFILE: 805 TRACKFILE: ASHC  
DATE: 03/10/82 TIME: 10:03:32 TITLE: ENTRY TO BOSTON BAR  
PLOT TYPE: VELOCITY - TIME PLOT



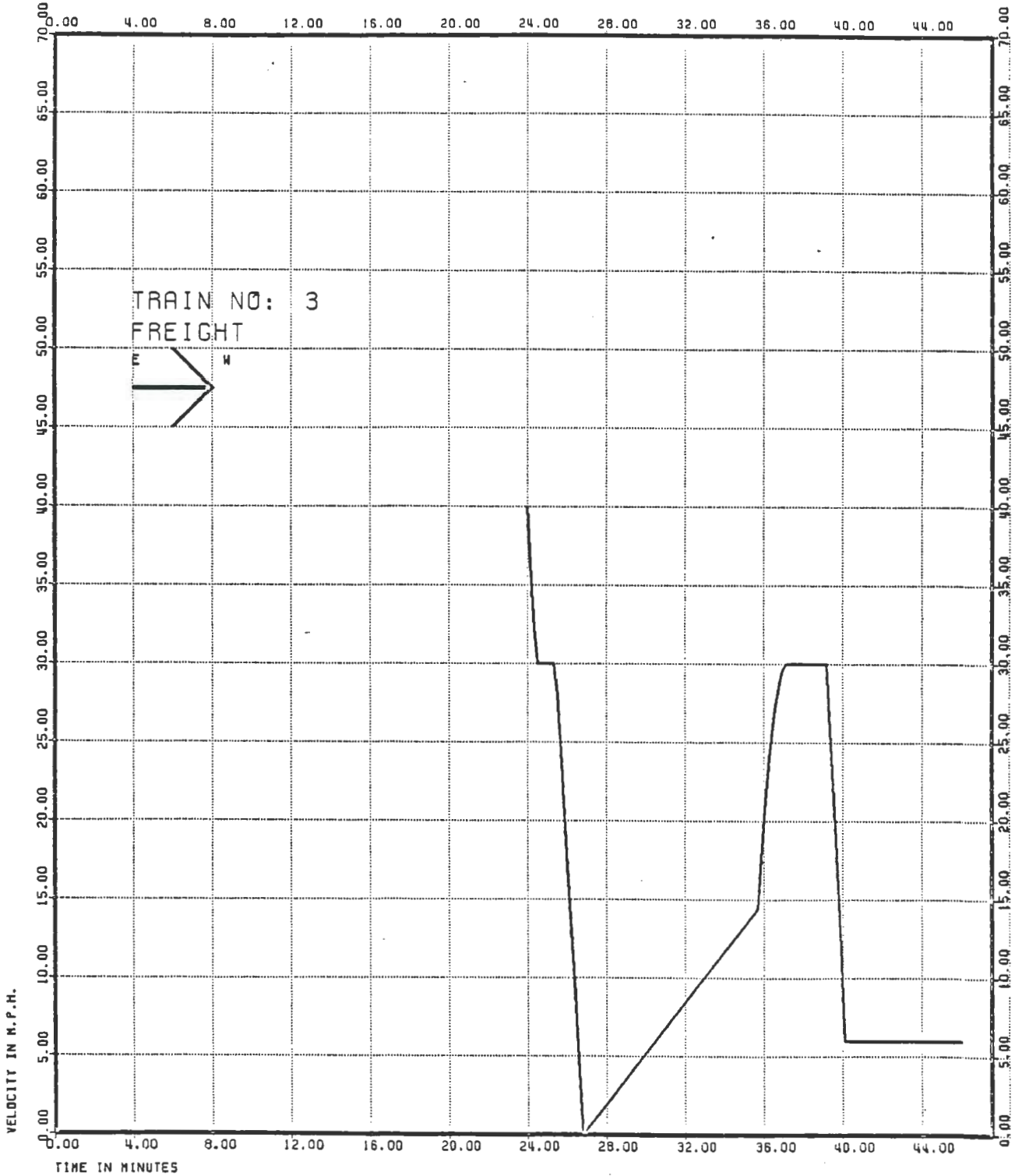
CANADIAN NATIONAL - TRANSPORTATION PLANNING  
SIGNAL WAKE MODEL

AGGREGATION: FLEET1    REQFILE:    805    TRAKFILE: ASHC  
DATE: 03/10/82    TIME: 10:03:32    TITLE: ENTRY TO BOSTON BARR  
PLOT TYPE: VELOCITT - TIME PLOT



CANADIAN NATIONAL - TRANSPORTATION PLANNING  
SIGNAL WAKE MODEL

AGGREGATION: FLEET1 REOF(LE: 805 TRAKFILE: ASHC  
DATE: 03/10/82 TIME: 10:03:32 TITLE: ENTRY TO BOSTON BAR  
PLOT TYPE: VELOCITY - TIME PLOT



**APPENDIX IV**

User procedures

Signal Wake Model - User Procedures  
=====

Contents  
-----

Ø Purpose

1 User Procedures

1.1 Preparation of Input Files

1.1.1 Trakfile

1.1.2 Reqfile

1.2 Job submission

1.3 Library maintenance

2 Naming conventions

2.1 Files

2.2 Programs

2.3 Jobs

**8 Purpose**  
=====

This documentation assumes that the user understands the capabilities of the Signal Wake Model (SWM) and/or has read the report filed under Or. project number OR73-2139. Detailed within are the methods for creating input files and for executing the model. File naming conventions are also included.

1 User Procedures  
-----

1.1 Preparation of Input Files  
-----

1.1.1 Trakfile  
-----

Each subdivision that is to be simulated using the Signal Wake Model must first have a Trakfile created. This file is obtained from the TPC database by executing the subsystem SWMW. The file contains data on train stops, speed restrictions and compensated gradients.

An example of the use of SWMW to create a new Trakfile follows:

```
* DATABASE (*=LER/WHATEVER) ==> pra
* REGION (MTN/...)           ==> pra
* SUBDIVISION NAME           ==> yorkton
* SUBDIVISION ABBREVIATION   ==> york
                               etc.
```

After this, the clist prompts the user for name, priority and jobclass for running background.

### 1.1.2 Requirements file

-----

To run the Signal Wake Model the user must prepare, manually, a Reqfile containing data on signals, a schedule for each fleet, slow orders, plot and trace requirements. Some run parameters must also be supplied. This file is on M14466.CCTP.CNTL(SWMR<reqname>) where <reqname> is the user chosen name for the Reqfile. The <reqname> may be four characters or less and the first character must be alphabetic.

To prepare this file,

- Use SPF option 2, edit M14466.CCTP.CNTL(SWMR<reqname>)
- Copy M14466.CCTP.DOCUM(SWMØMAST)
- Ignore warning messages about linesize
- Continue the edit session by putting your data in the tables
- Follow the footnotes of each table (these may be deleted)
- Do not leave blank lines in the body of any table
- Save

## 1.2 Job execution

The Signal Wake Model consists of three SIMSCRIPT II.5 programs:-

The front-end program checks the Reqfile for data errors, and passes a work file of reformatted and expanded data to the simulation program.

The simulation program reads the work file and performs the simulation and creates a graphfile.

The graphing program reads the graphfile and draws the requested graphs.

The clists described below initiate execution of the relevant programs.

### 1.2.1 Background submission

The clist SWMBRUN is used to submit background runs (front-end, simulation and graph) of one or more Reqfiles.

Many options are available to the user, defaults have been established for most of them and are selected by hitting enter in response to the following questions:-

\* PRODUCTION RUN (\*Y) ==>

Users should normally select the default (Y) here, this selects the production versions of both programs, uses signal rules for UCOR and deletes all the work files when the job is complete. Selection of N allows override of any of the above.

\* YOUR NAME ==>

Enter your name as it is to appear on the output.

\* DEPARTMENT (\*=RESEARCH/LP/DEV) ==>

The response to this question determines the account and budget code according to transportation planning standards.

\* PRIORITY (FREE,\*=7=SLOW,9=EXPENSIVE) ==>

Enter the priority for your job.

\* JOB CLASS (\*=A/Q) ==>

Generally, the default CLASS A is appropriate. For short simulations known to take less than 15 seconds of CPU time class Q may be selected.

\* PRINTER (\*=DISK/LOCAL/REMOTE8/...) ==>

The default here sends the job output to the R-queue on disk. In this case the simulation outputs can be browsed or printed local using SPF option 3.8. The user is responsible for deleting these when they are no longer needed. Hardcopy output can be obtained by selecting LOCAL or REMOTE8.

\* PLOTTER (\*=LOCAL/15/NONE) ==>

Select the plotter for the graphs.

This concludes the information which is common to each of the simulations submitted at one time. The Clist now echos all of the above, on a new screen, for verification. After you hit enter the screen clears again to permit you to enter the names of the Reqfiles that are to be run.

REQFILES TO BE SUBMITTED  
-----  
(HIT ENTER TO END)

\* REQFILE ==>

Enter the <reqname>s one at a time. Hit enter to terminate the list.

The following screen is now displayed and you may leave

```
*****  
*   BUSY SUBMITTING JOBS   *  
*         GO AWAY         *  
*****
```

PREPARING JCL

As each <reqname> is prepared and submitted the screen clears and displays the following:-

```
*****  
*   BUSY SUBMITTING JOBS   *  
*         GO AWAY         *  
*****
```

SUBMITTING REQFILE <reqname>

The name of the job submitted is CCTPSWMA.

\*\*\* END OF SWMBRUN \*\*\*

### 1.3.2 Foreground

The Clist SWMFRUN allows you to run the front end and /or the simulation module in foreground mode and concludes by submitting the graphing module in batch mode. It may be used to quickly test for data errors in the Reqfile and is also useful for submitting graphs of a previous simulation.

Either subsystem may be run with output to the screen or to a TSO dataset. In the latter case, the Clist informs you of the name of the file on which the output can be browsed.

Files CCTPØ11.<reqname>.MID/GRAPH/DATE are also saved and may be browsed. These files are not normally of interest to the user; the system documentation contains details of their contents.

2 Naming conventions  
=====

2.1 Files  
-----

2.1.1 M14466.CCTP.CNTL  
-----

Reqfiles - SWMR<reqname> <reqname> is four characters or less,  
the first one being alphabetic

Trakfiles- SWMT<trakname> <trakname> is four character subdivision abbreviation

Signal rules file

- SWM9UCOR UCOR rules
- SWM9294 294 - 300 series rules

Files used by C1ists

- SWM9BLNK
- SWM9BLAN

Other -SWM<ii> <any> <ii> are your initials  
<any> less than three characters

2.1.2 M14466.CCTP.DOCUM  
-----

Documentation - SWMØ<doc> <doc> is at most four characters

eg. SWMØmast - master reqfile

SWMØsyst - system documentation

SWMØproc - user procedures

SWMØprw - trackfile-creator program documentation

SWMØprx - front-end program documentation

SWMØpry - simulation program documentation

SWMØprz - graphing program documentation

2.1.3 M14466.CCTP.CLST

Master clist            - SWM .  
Other clists            - SWM<name>  
                      execute SWM for a list of available clists  
Backup of clists        - SWM<name>B  
Other                    - SWM<ii> <name>    <ii> initials of author

## 2.2 Program naming conventions

All source programs are on M14466.CCTP.SPAN

All load modules are on M14466.CCTP.LOAD with the same member name

Trackfile creator - SWMW<type>

Front-end programs - SWMX<type>

Simulation programs - SWMY<type>

Graphing programs - SWMZ<type>

where <type> = P for production  
              = B for back-up  
              = D for development

Subroutines - SWM<ii>SUB <ii>= initials of author>

Other - SWMO<name>

## 2.3 Job names

All job names have the form CCTPSWM<job>, where <job> is described below

Trakfile creator - <job> = W

Simulations - <job> = A

Compiles of wp, xp, yp, zp - <job> = C

Other compiles - <job> = z

Links - <job> = L

File listing - <job> = P

Graph - <job> = G