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MVTPS:

Multiple Vehicle Transit Power Simulation
Users' Guide
and Program Description

RKE
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MVTPS: MULTIPLE VEHICLE TRANSIT POWER SIMULATION

MVTPS is a transit program which simulates the power requirements of electrical substations in a transit system with multiple vehicles. It has the advantage that up to 45 substations and 90 vehicles can be placed in the circuit at any one time; vehicle resistance can be caused to vary with mileposts; and it is relatively easy to add or remove vehicles or substations from the system.

Four data files provide information on track resistance, substation voltage, civil, and vehicle data. Output includes power, voltage, and current for each substation for each step including RMS data for that substation; details of vehicle motion, current, and voltage; a RMS summary of vehicle data; and a summary of substation RMS data.

The transit system is divided into a continuous series of Loop Sets (see diagram) which are defined as a set of circuits having a substation on the left and right. Each loop set has electrical characteristics provided as resistance and voltage data, and civil properties such as the stationing of the substations and the original positions of the vehicles. The resistances and voltages are computed and placed into a matrix which is then solved to yield the current in each circuit in each loop set.

The user specifies a number of distance steps for which the calculations are to be made. Over the period of these steps each vehicle moves forward a proportional distance toward the next vehicle so that it ultimately occupies the starting position of the vehicle in front of it. The last outbound vehicle (in the right hand loop set) moves to the position of the first inbound vehicle (also in the right hand loop set) changing direction over the duration of the run of the program. The last inbound vehicle becomes the first outbound vehicle.

To simplify the equations used by the program, each loop set can contain at most one outbound vehicle and one inbound vehicle drawing current at any one time. Because of this restriction, a vehicle must wait stopped at the end of a loop set if the loop set it is about to enter contains a moving vehicle. A stopped vehicle normally is assigned a high resistance so that it draws a minimum of current. A vehicle which has stopped will travel faster later on to reach its destination at the end of the run. If the loop set a vehicle is about to enter contains a stopped vehicle, the moving vehicle may enter that loop set. The vehicle that was stopped is dropped out of the circuit entirely under the assumption that it draws such little power as to be negligible when compared to a moving vehicle. This method of allowing a moving vehicle to override a stopped vehicle prevents the case of 33 vehicles waiting stopped in their loop sets until the slowest one, the 34th, moves into the next loop set.

Calculations are made to solve for track currents and voltages at each distance step. Resistances of running and contact rails are determined mathematically from the position of the train and the track resistance per mile. Vehicle resistances are determined by interpolation of the vehicle resistance file which gives resistance at different mileposts. The vehicle resistance file comes from data produced by TOM programs.

Two hard data output files are produced by the first half of the MVTPS system of programs. These two files, a substation file and a vehicle file, are essentially unreadable. They are sorted into an appropriate order by the computer and then acted on by the second half of the system of porgrams, the report writing program. The report writer produces a detailed, readable report which can be sent to a printer to give you a copy of the results. Changes can then be easily made to the input files and the program run again.

DATA SETS FOR MVTPS

There are four data sets which are used with the MVTPS program: a substation data set, a vehicle civil data set, and two vehicle resistance data sets. The substation data set contains relevant information about the substations. It has the station name, milepost, resistance, voltage, and the resistances of the running rail and contact rail to the right of the station. The vehicle civil data set contains the location and direction of all vehicles as well as the run date of the program, and the number of distance steps to be used in the calculations. The vehicle resistance files contain vehicle resistance at certain mileposts. There is one resistance file for inbound vehicles and one for outbound vehicles.

SUBSTATION DATA

The format of the substation data set (File 1) is as follows:

N_1

$NAME_1$

MP_1

$R1S_1$ $VOLTS_1$

$RR1_1$ $RR2_1$

$TR1_1$ $TR2_1$

N_2

$NAME_2$

MP_2

$R1S_2$ $VOLTS_2$

$RR1_2$ $RR2_2$

$TR1_2$ $TR2_2$

N_n

$NAME_n$

MP_n

$R1S_n$ $VOLTS_n$

SUBSTATION DATA(Cont'd)

Where:

N - An identifying number of the substation, usually sequential

NAME - A name of the substation, up to 20 characters

MP - Milepost of the substation

R1S - Substation resistance

VOLTS - Substation voltage

RR1 - Outbound running rail resistance /mile

RR2 - Inbound running rail resistance /mile

TR1 - Outbound third rail resistance /mile

TR2 - Inbound third rail resistance /mile

Notice that since RR1, RR2, TR1, and TR2 refer to rails to the right of the substation, the last substation in the data set does not have these values.

Substations must be in order of increasing mileposts.

VEHICLE POSITIONS

The format for the vehicle civil data file (File 2) is as follows:

NSTEP

DATE

N_1 MP_1 DIR_1

N_2 MP_2 DIR_2

N_3 MP_3 DIR_3

\- - -

\- - -

\- - -

N_n MP_n DIR_n

Where:

NSTEP - The number of distance steps to be used in the calculations, an integer.

DATE - A date for the run of the data set, up to 12 characters (e.g. Mar 05, 1983)

N - An identifying number for the vehicle. This number, an integer, is not used by the program, but is necessary in the data set.

MP - The milepost of the vehicle, a decimal number.

DIR - The direction of the vehicle. An integer, 0 = outbound, 1 - inbound.

The vehicles must be in the file in order of increasing mileposts for all of the outbound vehicles followed by decreasing mileposts for the inbound vehicles. This way a circular path is described around the track so that when the vehicles move, their final position is that of the next vehicle in the list. The last vehicle in the list (which must be an inbound vehicle) will ultimately become an outbound vehicle at the milepost of the first vehicle on the list.

The list must contain at least one outbound and one inbound vehicle. No more than one vehicle should be placed between two substations in any one direction.

VEHICLE RESISTANCE

The outbound (File 8) and the inbound (File 9) vehicle resistance data sets are formatted as follows:

0	R_o
MP_1	R_1
MP_2	R_2
MP_3	R_3
MP_4	R_4
-	
-	
-	
9999.	R_o

Where:

MP - A milepost, a real number
R - The vehicle's electrical resistance at the associated milepost

Data should be in the order of increasing mileposts. The first milepost should be zero or a milepost at or before the first milepost in the system. The last milepost should be 9999 or a number sufficiently large as to be beyond the last milepost in the system.

CHANGES

To remove a vehicle from the system it can simply be deleted from the vehicle civil data set. A substation can be removed by deleting six lines from the substation data set. When adding either a vehicle or substation, care must be taken to preserve the correct order of mileposts as explained above.

MVTPS VARIABLE DESCRIPTION

D - Distance between a substation and the next

D1 - Milepost of a train, or used for vehicle resistance interpolation

D2 - Used in interpolating vehicle resistance

D3 - Third rail resistance per mile

D4 - Running rail resistance per mile.

I, J, JJ, K, KK, L, V - Temporary counters for loops, trains, etc.

N - Number of rows in the matrix

M - Number of columns in the Matrix (N +1)

MPED, IREV,
M1, M2, Y - Used in matrix reduction

MP - Milepost of a vehicle or substation

SV - Current between substation and previous outbound vehicle

SV1- Current between substation and previous inbound vehicle

S1 - Milepost of left hand substation

S2 - Milepost of right hand substation

T1 - Milepost of a train used in resolving loop conflicts and output

T2 - Milepost of a train used in resolving loop conflicts

DIR- Direction of a train, 1 = outbound, 2 = inbound

LCR- Previous contact rail circulating current

LRR- Previous running rail circulating current

TIN- Number of an inbound train

TOUT - Number of an outbound train

See diagram:

R1S, R2S - Substation resistances

R1R, R3R - Outbound running rail resistances

R2R, R4R,- Inbound running rail resistances

R1C, R3C - Outbound contact rail resistances

R2C, R4C - Inbound contact rail resistances

R1V - Outbound vehicle resistance

R2V - Inbound vehicle resistance

LOOP - Number of a circuit loop

NRIN - Number of resistances in INRES array

PROUT - Number of resistances in OUTRES array

NSTEP - Number of distance steps for calculation

MVTPS VARIABLE DESCRIPTION (Cont'd)

NTRAIN - Total number of trains in the system

NLOOP - Total number of curcuit loops in the system

RMAX - Maximum resistance, for use when train is stopped at a station drawing current

LENGTH - End milepost of the route

CPED (N,M) - The main matrix used in computation

RR (J) - The running rail resistance per mile for loop set J

TR (J) - The third rail resistance per mile for loop set J

SU (J) - The left-hand substation resistance for loop set J

STA (J) - The left-hand substation milepost for loop set J

VOLT (J) - The left-hand substation voltage for loop set J

CIRC (2,J) - The circulating current resistances for loop set J

CIRC (1,J) = R1C + R2C + R3C + R4C

CIRC (2,J) = R1R + R2R + R3R + R4R

MVP (K) - Current milepost for vchicle K

ENDMP (K) - Final milepost for vehicle K

TRES (K) - Vehicle resistance for vehicle K

VDIR (K) - Direction of travel for vehicle K, 0 = outbound, 1 = inbound

VSTATE (K) - State of motion for vehicle K, 0 = stopped, 1 = moving

R1RMAT (K) - R1R for vehicle K

R2RMAT (K) - R2R for vehicle K

R1CMAT (K) - R1C for vehicle K

R2MAT (K) - R2C for vehicle K

TRUSED (K) - Current loop occupied by vehicle K, or zero ir train is stopped

INDEX (2,J)- INDEX (1,J) = Number of outbound vehicle in loop J

INDEX (2,J) = Number of inbound vehicle in loop J

CURRNT (N) - Currents from solution of CPED matrix

INRES (2,500) - Mileposts and related resistances for inbound vehicles

OUTRES (2,500)- Mileposts and related resistances for outbound vehicles

VIP (11), VIT2 (5) - Temporary storage of data to be output.

MVTPSRPT VARIABLE DESCRIPTION

I, J	- Counters
IN	- The word "IN"
OUT	- The word "OUT"
MP	- Milepost
DIR	- Direction of vehicle travel 0 = out, 1 = in
FLAG	- Flag = 1 when last substation item has been received
LOOP	- Number of a circuit loop
PAGE	- Page number of report
SAMP	- Substation amperage
SWAT	- Substation wattage
SVOLT	- Substation voltage
STEP	- Number of a computation step
S1OUT	- Current between substation and outbound vehicle
PS1OUT	- Current between substation and previous outbound vehicle
S1IN	- Current between substation and inbound vehicle
PS1IN	- Current between substation and previous inbound vehicle
RRCIR	- Running rail circulating current
PRRCIR	- Previous running rail circulating current
CRCIR	- Contact rail circulating current
PCRCIR	- Previous contact rail circulating current
TRAIN	- Number of a train
OUTMP	- Milepost of a vehicle
OUTRES	- Resistance of a vehicle
OVOLT	- Voltage of a vehicle
OUTAMP	- Amperage of a vehicle
ORRVLT	- Running rail voltage of a vehicle
NTRAIN	- Number of vehicles in system
LLOOP	- Number of the last circuit loop read in as substation data
LSTEP	- Number of the last computation step read in as train data

MVTPSRPT VARIABLE DESCRIPTION(Cont'd)

DATE (3)	- Twelve character run date
TMP (K)	- Milepost of vehicle K
TRR (K)	- RMS running rail voltage for vehicle K
TRES (K)	- RMS resistance of vehicle K
TVOLT (K)	- RMS voltage of vehicle K
TAMP (K)	- RMS amperage of vehicle K
TCOUNT (K)	- Number of occurances of vehicle K used in RMS calculations
RMS (10)	- Array for storing and computing substation RMS data
SUBNAM (5,J)	- 20 character name of substation J
SUBWAT (J)	- Wattage of substation J
SUBAMP (J)	- Amperage of substation J
SUBMP (J)	- Milepost of substation J

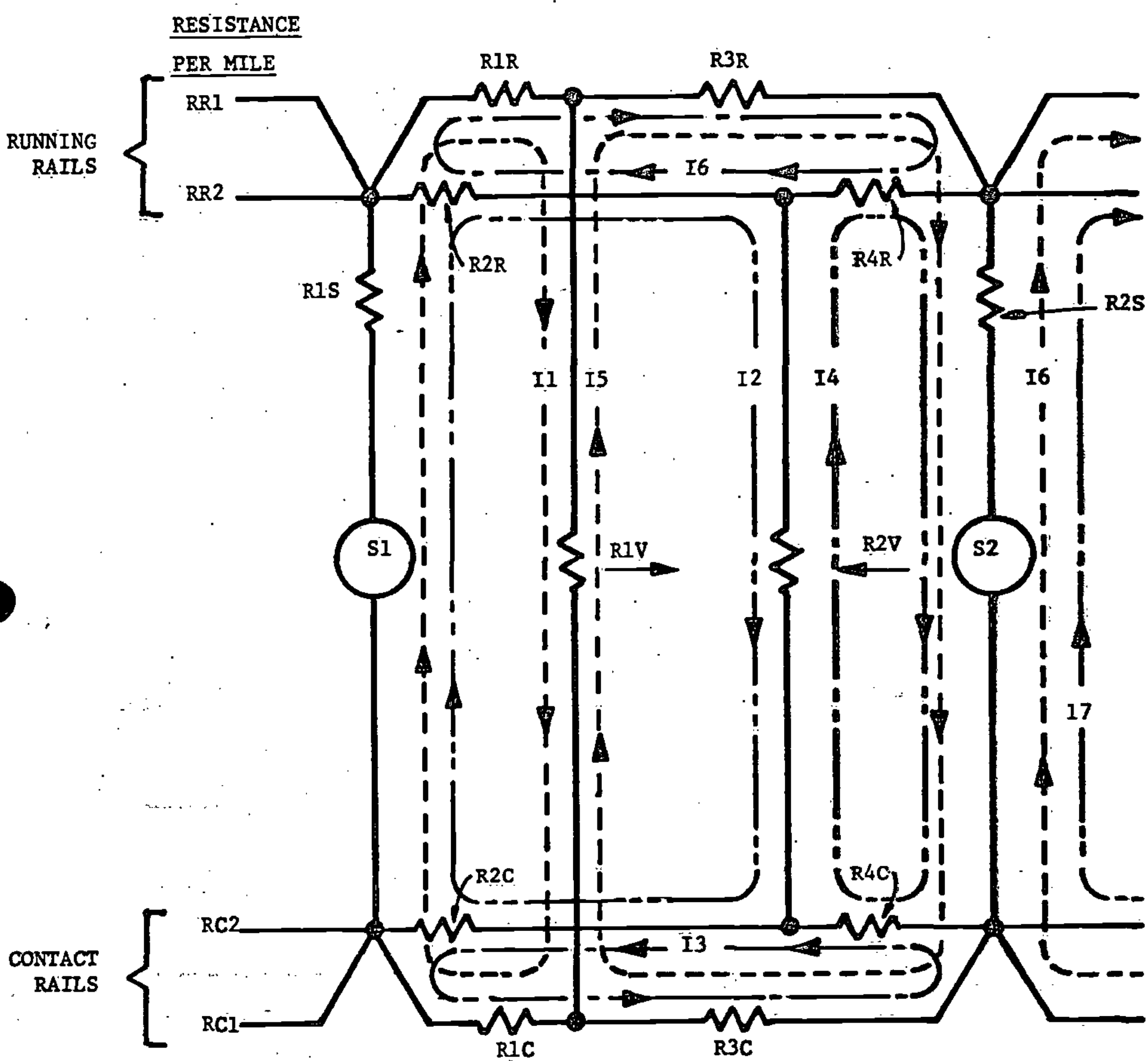
MATRIX DESCRIPTION

For any loop "J" K = 6 x J - 5

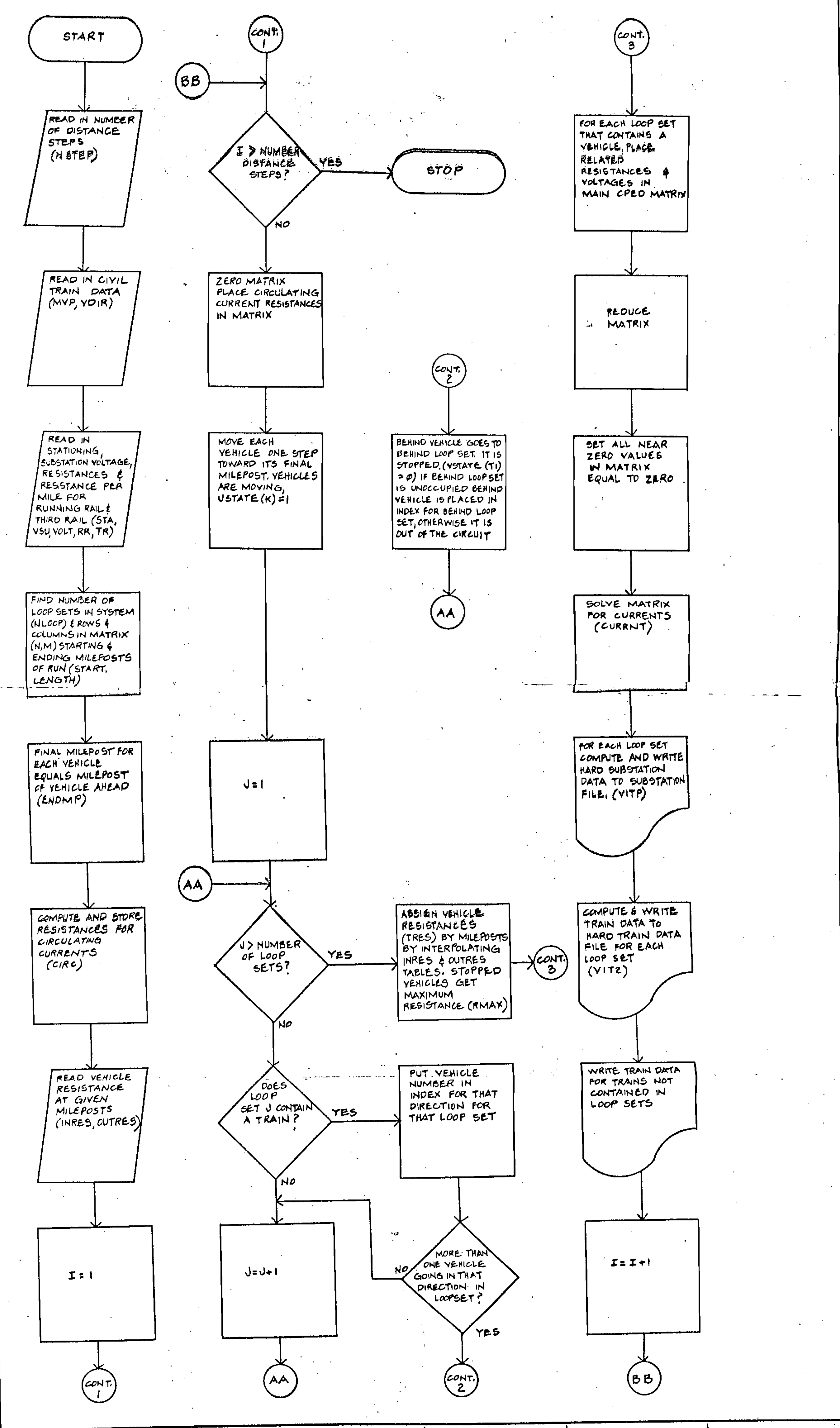
J	K
1	1
2	7
3	13
4	19
5	25

		K	K+1	K+2	K+3	K+4	K+5	K+6	K+7	6 x Number of loops +1
		I1	I2	I3	I4	I5	I6	I7	I8	Voltage
K	I1	Σ I1	R1S	-R1C		-R1V	-R1R			V_{S1}
K+1	I2	R1S	Σ I2	R2C	-R2V		R2R			V_{S1}
K+2	I3	-R1C	R2C	Σ I3	R4C	-R3C				0
K+3	I4		-R2V	R4C	Σ I4	R2S	R4R	-R2S	-R2S	$-V_{S2}$
K+4	I5	-R1V		-R3C	R2S	Σ I5	-R3R	-R2S	-R2S	$-V_{S2}$
K+5	I6	-R1R	R2R		R4R	-R3R	Σ I6			0
K+6	I7				-R2S	-R2S		Σ I7	R2S	V_{S2}
K+7	I8				-R2S	-R2S		R2S	Σ I8	V_{S2}

LOOP SET DESCRIPTION



R1V IS OUTBOUND VEHICLE RESISTANCE
R2V IS INBOUND VEHICLE RESISTANCE
S1, S2 - SUBSTATION VOLTAGES



NO. | DATE | REVISION | BY | APP. | APP.

NOTES

DESCRIPTION | COST ACCOUNT

CONSTRUCTION APPR.

APPROVAL | DATE

SCALE:
DESIGNED BY A. FINKE
DRAWN BY B. GROSS
CHECKED BY
APPROVED BY
APPROVED BY

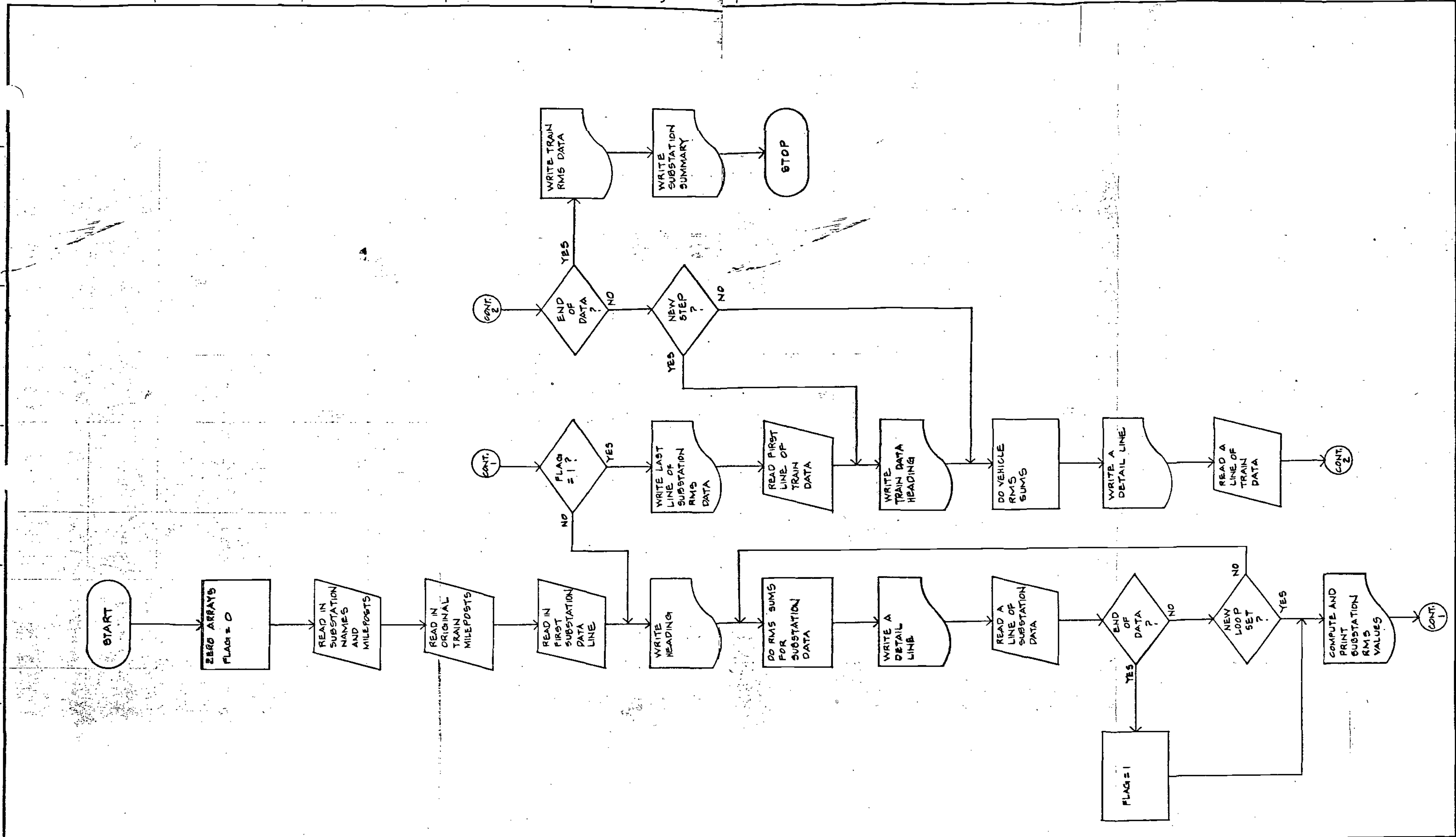
DATE

PROFESSIONAL SEAL

KAISER ENGINEERS

MVTPS

JOB No. | DWG. No. | REVISION R.



NO.	DATE	REVISION	BY	CHK.	APP.	APP.

NOTES

DESCRIPTION | COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL	DATE

SCALE: DATE

DESIGNED BY A. FINK

DRAWN BY B. GROSS

CHECKED BY

APPROVED BY

APPROVED BY

PROFESSIONAL SEAL

KAISER ENGINEERS

MVTPSRPT

JOB No. | DWG. No. | REVISION R-

IBM SYSTEM

HOW TO LOG-ON

1. Press Enter.
2. Type: Log-on CSGKE1/CSGKE1 (ENTER)
   (Get password from Don Price)
3. Press Enter.
4. When "Ready" appears, type: ISPF (Enter).
5. A menu appears, type: number associated with a function.
   Next to command, press enter.
6. After every command, press the enter button.

HOW TO LOG-OFF

Type =X (Enter) on command line

When "Ready", type log-off.

EDITING A FILE

1. After a log-on type 2, go to member line, type:
   Train or Substa, MVTPS Run.
2. If train is typed, train data appears on screen. If substation is typed, substation data appears. If MVTPS run is typed, program can be run. When finished editing, use pf3 key.
3. Editing commands are: (These are prefix commands - they go in the region to the left of the data.)

I		To insert; i.e., type on line 10 to insert between 10 and 11
A		After line
B		Before line
C	With A & B	To copy a line
CC		To copy a block
DD		To delete a block
D		To delete one line
M	With A or B	To move a line or section
MM		To go to end of file
R	With A or B	Repeat line
RR		Repeat block

4. Special Buttons

PFI	Help
PF2	Split
PF3	End Function
PF4	Return
PF5	Repeat find
PF6	Repeat change
PF7	*Up - If M is on command line, it goes to top
PF8	*Down - If M is on command line, you will see the end of the file
PF9	Swap
PF10	Left
PF11	Right
PF12	Cancel
T	Tutorial

* If a number is on the command line, the file will move up or down that number of lines.

TO RUN A PROGRAM

1. Press alt PF3.
2. Type: MVTPS Run next to member line.
3. When Jel file appears, type: submit.
4. After 3 stars, press enter.
5. When command appears, type: =3.8.
6. Another command appears, type: F "cond code".
7. If 0000 appears, no errors. Repeat PF5 to check all condition codes.
8. If no errors, press pf3. You will see outlist at top of screen. Tupe: D (enter) m option line to delete the report concerning the program.
9. Type: =2 (enter) on command or option line. This will bring you to the editor.

10. When member appears, type: printmv (enter) on member line.

11. When Jcl file appears, type: submit.
When 3 *'s appear, hit enter key.

12. To logoff, type next to command: =X (enter).

13. When ready appears, type: logoff.

TO VIEW SOURCE PROGRAMS & OUTPUT

1. Go to editor. a) ISPF 2(enter) at logon time, or
b) =2(enter) on command or option line.

2. To see all files available, (enter). "S" next to any file name will select that file to be edited. You can also write the file name on the first edit screen after "Member". Pf3 or =2 takes you there.

Important files are:

MVTPS1 - Fortran source code for Step1

MVTPS2 - Fortran source code for Step~~2~~4

MVTPSRUN - JCL which executes entire program.

TRAIN - Train data

SUBSTA - Substation data

3. To finish editing, use pf3 key.

4. 2 special files also exist. On the data set line, type: LOADLIBN to see the load library.

5. On the data set line, type: MVTPSPUT to see the output file before you print it.