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BILLET CRANE SIMULATION

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AUGUST 1976

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US ARMY ARMAMENT COMMAND

SYSTEMS ANALYSIS DIRECTORATE

ROCK ISLAND, ILLINOIS 61201

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this study is to develop and provide an analytical model which can be used to evaluate the capability of proposed alternative crane systems to perform the material handling task at the Scranton Army Ammunition Plant. The Logistics Division of the Systems Analysis Directorate developed a computerized model to evaluate the capability of a proposed new crane systems. The conclusion was reached that the 200-ft-per minute top velocity crane should more than adequately be able to handle the proposed mobilization workload.		

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INTRODUCTION

This study is in response to a request of the Commander, Scranton Army Ammunition Plant, to determine if a proposed replacement yard crane system can satisfactorily perform the material handling task. The overhead rails of the existing crane are becoming structurally inadequate. Upon studying the physical layout of the yard and the structural integrity of the soil and supporting columns of the present system, the Army Corps of Engineers has recommended tearing out the present system and replacing it with a much slower traveling gantry crane. Since a substantial amount of money is involved, the Commanding Officer at the Scranton Plant has requested the development of a prove-out computerized simulation model. In response to this request, the Logistics Division of the Systems Analysis Directorate developed a FORTRAN based computerized model described in the balance of this note.

PURPOSE

- a. Develop and provide an analytical model which can be used to evaluate the capability of proposed alternative crane systems to perform the material handling task at the Scranton Army Ammunition Plant.
- b. Determine if the new yard crane proposed by the Army Corps of Engineers can satisfactorily perform the material handling task at the Scranton Army Ammunition Plant.

METHODOLOGY

The FORTRAN program developed for this simulation model is event-oriented with the capability to take samples from the model at discrete uniform time intervals. There are two classes of events in this model: (1) independent events, those events the crane has no control over, and (2) dependent events, those events the crane creates in responding to the independent events. The independent events are as follows:

1. A charging call from Feeder or Line No. 1.
2. A charging call from Feeder or Line No. 2.
3. A charging call from Feeder or Line No. 3.
4. The arrival of a 5-1/4 inch heat.
5. The arrival of a 6 inch heat.
6. The arrival of a 7-3/8 inch heat.
7. The morning coffee break.
8. The lunch break.

9. The afternoon coffee break

10. The shift break.

Specific distributions have been derived for the length of time between repeated occurrences of the same event (see APPENDIX B).

The dependent events of preparing and loading charges into the feeders and unloading and stacking billets in open storage bays consisted of 7 basic tasks as follows:

1. Picking billets up.
2. Setting billets down.
3. Squaring billets up.
4. Swinging billets into position.
5. Breaking for coffee, lunch and shift turnover.
6. Traveling.
7. Idleness.

Specific time distributions for each of the first 5 tasks were derived for each of the unique operations in which these tasks occurred. The standard Newtonian Equations of Motion were employed to model the crane's travel. These equations were further supplied with data generated from acceleration, deceleration, and top velocity distributions. These distributions allowed for operator-to-operator speed variation. Break times were modeled as distributions; however, the management cautioned that these periods could be eliminated if a high level of impending activity warranted it. Idleness was the residual. If the crane had nothing to do, it was idle. (See APPENDIX B for a review of the previously described inputs.) These 7 basic crane tasks were monitored during the simulation to enable the crane's consumption of time to be reviewed.

The basic structure of this model consists of a 1 dimensional array which stores the next time each of the 10 independent events will occur, and a clock which is event-incremented. These events include all the independent events and the various tasks of the dependent events. Each time the clock is incremented after completing a dependent event, the next independent event is checked to see if it has occurred. If an independent event has occurred, it is processed and a new time is generated to determine when this event will next occur. If an independent event has not occurred, the program continues processing the crane's dependent events. If there are not any dependent events to process, the model advances to processing the next independent event.

ASSUMPTIONS

When constructing a mathematical model, some assumptions or ground rules must be formed to define a base for the study. Further, some assumptions must be made on noncritical entities to avoid creating more structure than is necessary to create a desired or adequate level of realism. A high level of resolution of noncritical activities cannot be economically justified. These assumptions (except the first one) can easily be altered within the computerized model. They are as follows:

1. Only one crane will be in operation at a time.
2. 100 percent reliability is required (at least one crane will be operable at all times).
3. The billets arrive in groups of cars carrying one heat rather than in individual cars strung out over an extended period of time, thus creating an intermixing of heats.
4. The heats will be unloaded in car segments with the cars being individually positioned with an offset from the center line of the receiving bay.
5. Billets are stored and charged or loaded into the feeders in heats which are assumed to be groups of about 175 billets each.
6. Bays are assigned usage priorities and a maximum load capacity for the given type of billet (5-1/4, 6, or 7-3/8 inches) which the bay can handle.
7. At least one charge for all three feeders will be ready at all times and will be residing in a work area where the billets are assimilated into squared groupings ready for loading or charging into the feeder.
8. When answering a feeder request for a charge, the crane, as soon as it releases any billets it might be carrying, will load the feed table. Another charge will be immediately prepared for that feeder unless another feeder calls for a charge; in which case the crane will load that feeder and then proceed to prepare charge(s) for any feeders not having a charge in reserve.
9. Breaks occur throughout the plant. Therefore, no crane activity occurs during any of the breaks.
10. Crane travel is uninterrupted. Lift trucks, etc. don't get in the way of the crane.
11. The assumed level of manufacturing activity will be for mobilization.

12. The crane operator has sufficient skill and is unencumbered by union control or management policy to allow him to operate the crane at maximum speed. He could, thus, start the X and Y movements*, simultaneously, before completely clearing a railroad car or bay stock-pile containing a load of billets, i.e., not be confined to slow rectangular motion.

13. When computing travel times and distances, the X and Y center line coordinates of the bays, work areas, feeders, and railroad cars are used to calculate the distance between these objects.

DISCUSSION

After making some preliminary test runs to validate the model, two runs were made to verify the adequacy of the 200-feet-per-minute top velocity of the proposed new crane. Both runs used the previously described priority and bay layout in APPENDIX A plus the numeric inputs as described in APPENDIX B.

To review the major numeric items, the top velocity in the X and Y direction was entered as a uniform distribution ranging between 150 and 200 feet-per-minute. This range allowed for operator-to-operator and circumstance-to-circumstance variation. Additionally, the acceleration and deceleration rates in the X and Y directions were entered as a constant of 1-foot-per-second squared. Since 200 feet-per-minute is equivalent to only 2.23 miles per hour, it was generally believed that acceleration and deceleration to and from this level would take place at the maximum rate of 1-foot-per-second squared. Further, at this maximum acceleration rate, the small distance of 5.56 feet is required to achieve this top velocity of 200 feet-per-minute when starting from a standstill. These runs were simulated for a period in excess of 1 year under steady state conditions. Additionally, these runs did not have any unload queue build-up and all the bays in the storage yard had an inventory of 175 billets--1 heat. Run 1 represented a fairly good way of operating. While not optimal, the bay layout and priority scheme used was believed to be near optimal if management kept the work or staging areas in their present location as exhibited on the layout in APPENDIX A. Under these conditions, the crane was able to handle billets at a fast enough rate to enable it to be idle 27% of the average day with an additional break time (2 coffee and 1 lunch and 1 shift) idleness of nearly 18%. Additionally, the feed tables had to wait an average of only 2-3/4 minutes for a recharge. Once, feeder table number 2 had to wait 9.19 minutes for a recharge; however, the histogram plots of wait times reveal that this situation has very

*The X direction is the direction of travel parallel to the crane rails. The Y direction is perpendicular to the rails. See the bay layout in APPENDIX A.

little probability of occurrence. These histograms showed that, in general, the feed table recharge wait time was 5 minutes or less 95% of the time, and about 6-1/4 minutes or less 99% of the time. It was further observed in some of the validation runs that moving the work area or staging area directly across the railroad tracks to the open space presently on the layout and utilizing the present work area for storage space could significantly reduce the feed table recharge wait time.

Input data for run 2 was the same as for run 1 except the bay priorities were inverted, i.e., the bays farther away from the feed tables were used the most. This setup represents a very poor operating procedure. Under these conditions, the crane was idle only about 7% of the typical day. The average feed table wait time increased about 1-3/4 minutes to yield an average of 4-1/2 minutes. Additionally, the maximum wait times observed increased along with an exhibited downward shift in the wait time histograms. However, under these adverse operating conditions, the crane still performed adequately.

Finally, a third run was made to observe how the crane would respond to a shock load. Run 3 was initiated at the end of run 1 using the ending values of the simulation variables obtained at the end of run 1 with the exception of an addition of 1 month's consumption of inventory being placed in the unload queues. It took the crane 770 hours or about 1-1/4 months to empty the unload queues and thus return to steady state conditions. While the crane was working off this extra load, business was being conducted as usual. It would thus appear that this response is more than adequate since management does not expect any shocks of this magnitude to be imposed on the system.

CONCLUSION

The computer runs reviewed in the DISCUSSION section amply illustrate that the 200-feet-per-minute top velocity gantry crane proposed by the Army Corps of Engineers should more than adequately be able to handle the proposed mobilization workload. Further, it is apparent that the priority arrangement of bays and the location of the work or staging areas can critically affect the crane workload. It is strongly urged that this model be exercised to optimize the preceding 2 parameters.

Finally, the various runs made for this study along with a critical review by the Scranton management indicates that the model is very realistic. Thus, the objectives of this study as listed in the PURPOSE section of this report have been satisfactorily completed.

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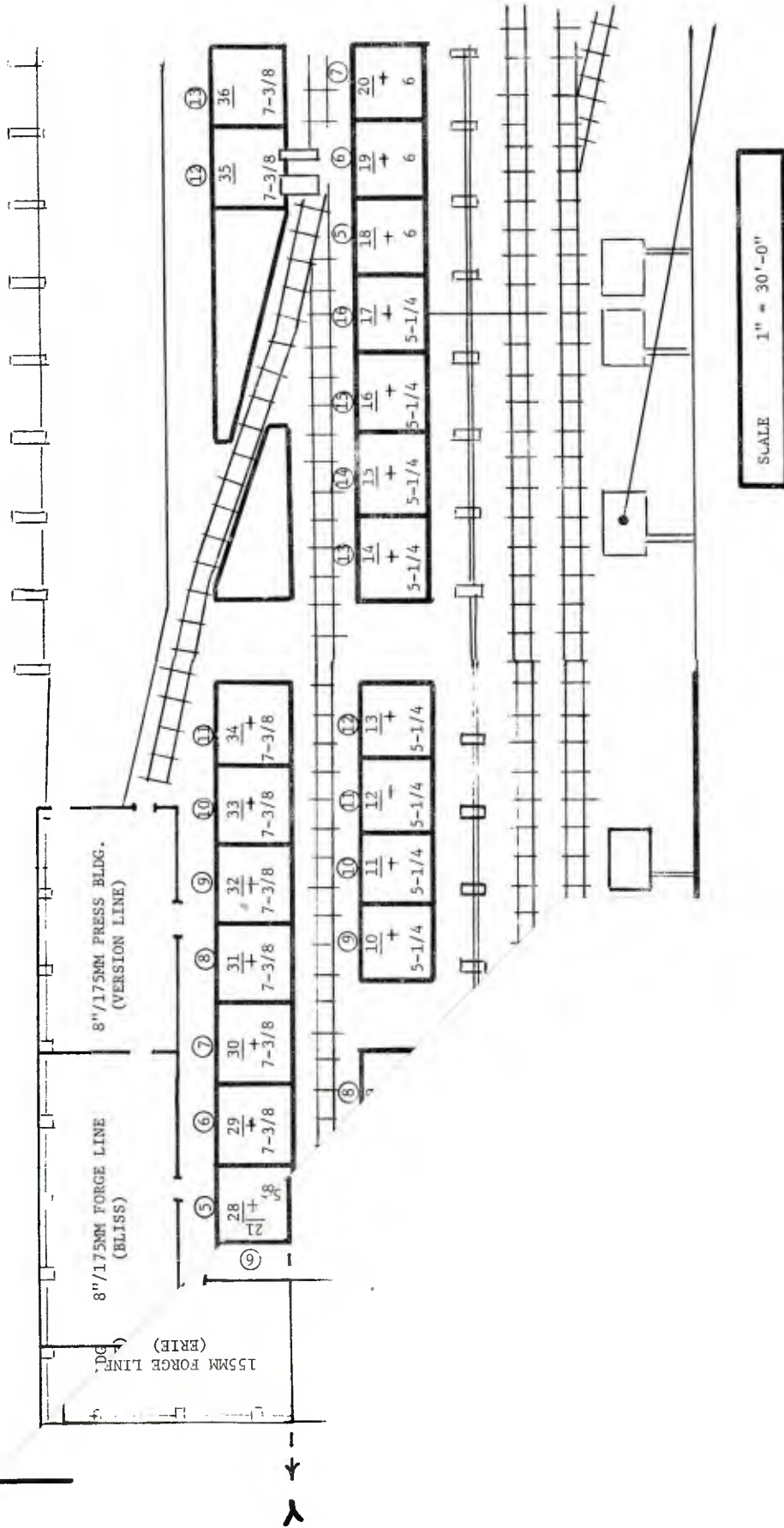
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APPENDIX A

BAY LAYOUT

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APPENDIX B
CARD LAYOUT

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APPENDIX B

CARD LAYOUTS AND DATA

A. CONTROL CARDS

First Card

Col 1 (Format I1) Enter a zero in this column or leave blank if the event and inventory listing is desired for the length of time constrained by the times entered in fields 2 (cols 7-12) and 3 (cols 13-18) of this card. Otherwise, enter a 1 in this column to suppress the listing.

Col 2 (Format I1) Enter a zero in this column or leave blank if the bay trace listing is desired for the length of time constrained by the times entered in fields 2 (cols 7-12) and 3 (cols 13-18) of this card. Otherwise, enter a 1 in this column to suppress the listing.

Col 3 (Format I1) Enter a zero in this column or leave blank if the time listing is desired for the length of time constrained by the times entered in fields 2 (cols 7-12) and 3 (cols 13-18) of this card. Otherwise, enter a 1 in this column to suppress the listing.

Col 4 (Format I1) Enter a zero in this column or leave blank if the distance listing is desired for the length of time constrained by the times entered in fields 2 (cols 7-12) and 3 (cols 13-18) of this card. Otherwise, enter a 1 in this column to suppress the listing.

Col 5 (Format I1) Enter a zero in this column or leave blank if a 50 observation listing of generations of the stochastic data entered in this program is desired. Otherwise, enter a 1 in this column to suppress the listing.

Col 6 (Format I1) Enter a zero in this column or leave blank if a time vs. inventory plot of the bays is desired and a histogram plot of the work areas is desired. Otherwise, enter a 1 in this column to suppress this listing.

Cols 7-12 (Format F6.0) Enter (in minutes) the time when it is desired to start listing the entries of columns 1-4 above.

Cols 13-18 (Format F6.0) Enter (in minutes) the time when it is desired to stop listing the data in the preceding defined lists.

Cols 19-24 (Format F6.0) Enter (in minutes) the time when it is desired to stop the simulation.

Cols 25-26 (Format F2.0) Enter (in minutes) the length of time desired between intervals when taking observations of the simulation.

Cols 27-30 (Format F4.1) Enter (in feet) according to the origin defined in the yard layout, the X coordinate of the center line of the crane magnet when starting the simulation.

Cols 31-34 (Format F4.1) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 35-44 (Format I10) Enter the value initially assigned to the seed of the uniform (0 to 1) random number generator. The last value of the seed will be punched out at the end of the run. This seed may then be used for a follow on run, thus enabling the user to make a replication over a different sequence of random numbers. (A suggested initial seed is 435459 - IBM's RANDU).

Cols 45-46 (Format I2) Enter the type of material desired to be unloaded first - 0 (zero) or blank = no particular choice, 1 = 5-1/4, 2 = 6, 3 = 7-3/8. If something other than 0 (zero) or blank is entered in this field, some of the indicated type of billets must reside in the unload heat queue.

Cols 47-48 (Format I2) Enter the bay number where the billets are to be unloaded. Leave blank or enter a 0 (zero) if it is desired to let the program select the bay.

Cols 49-50 (Format I2) Enter the heat level of the preceding bay which is receiving the billets being unloaded. Leave this field blank or enter a 0 (zero) if it is desired to let the program select the heat level.

Cols 51-52 (Format I2) Enter the number of the bay currently supplying the 5-1/4 inch feed table with billets. Leave blank or enter a 0 (zero) if it is desired to let the program perform this task.

Cols 53-54 (Format I2) Enter the number of the bay currently supplying the 6 inch feed table with billets. Leave blank or enter a 0 (zero) if it is desired to let the program perform this task.

Cols 55-56 (Format I2) Enter the number of the bay currently supplying the 7-3/8 inch feed table with billets. Leave blank or enter a 0 (zero) if it is desired to let the program perform this task.

Cols 57-58 (Format I2) Enter the heat level of the bay currently providing the 5-1/4 inch billets. Leave this field blank or enter a 0 (zero) if it is desired to let the program select this heat level.

Cols 59-60 (Format I2) Enter the heat level of the bay currently providing the 6 inch billets. Leave this field blank or enter a 0 (zero) if it is desired to let the program select this heat level.

Cols 61-62 (Format I2) Enter the heat level of the bay currently providing the 7-3/8 inch billets. Leave this field blank or enter a 0 (zero) if it is desired to let the program select this heat level.

Cols 63-64 (Format I2) Enter the minimum number of 5-1/4 inch billets required in the squaring-up charges work area.

Cols 65-66 (Format I2) Enter the minimum number of 6 inch billets required in the squaring up charges work area.

Cols 67-68 (Format I2) Enter the minimum number of 7-3/8 inch billets required in the squaring-up charges work area.

Cols 69-70 (Format I2) Enter the number of 5-1/4 inch billets in a standard charge or loading of the feeder.

Cols 71-72 (Format I2) Enter the number of 6 inch billets in a standard charge or loading of the feeder.

Cols 73-74 (Format I2) Enter the number of 7-3/8 inch billets in a standard charge or loading of the feeder.

Cols 75-76 (Format I2) Enter the maximum number of 5-1/4 inch billets the crane can carry to the feeder.

Cols 77-78 (Format I2) Enter the maximum number of 6 inch billets the crane can carry to the feeder.

Cols 79-80 (Format I2) Enter the maximum number of 7-3/8 inch billets the crane can carry to the feeder.

Second Card

Cols 1-6 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 5-1/4 inch billet feeder.

Cols 7-12 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 13-18 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 6 inch billet feeder.

Cols 19-24 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 25-30 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 7-3/8 inch billet feeder.

Cols 31-36 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 37-42 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 5-1/4 inch billet work area used for squaring-up a group of billets to be loaded into the 5-1/4 inch billet feeder.

Cols 43-48 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 49-54 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 6 inch billet work area used for squaring-up a group of billets to be loaded into the 6 inch billet feeder.

Cols 55-60 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 61-66 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of the 7-3/8 inch billet work area used for squaring-up a group of billets to be loaded into the 7-3/8 inch billet feeder.

Cols 67-72 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 73-80 Blank.

Third Card

Cols 1-4 (Format I4) Enter the number of billets in the oldest 5-1/4 inch billet heat now residing in the unload queue.

Continue the preceding using fields of 4 consecutive columns until the list of 5-1/4 heats queued-up is completely exhausted or until the 21 heat is required. Since only 20 heats are currently allowed, entering more heats will require expanding the check variable maxque and all the arrays mnemonically dimensioned in terms of this variable as shown in subroutine load.

Fourth Card

Follow the same procedure as outlined for the third card except enter data for the 6 inch billets.

Fifth Card

Follow the same procedure as outlined for the third card except enter data for the 7-3/8 inch billets.

Sixth Card

Cols 1-8 (Format F8.0) Enter the future time when independent event number 1 will next occur.

Continue the preceding using fields of 8 consecutive columns until future event times for all ten independent events have been entered.

B. BAY CARDS

(One card is required for each bay. The last card of this series must have -9 punched in cols 1-2 and the rest of the card must be left blank.)

Cols 1-2 (Format I2) Enter the bay number (the bays must be sequentially numbered).

Cols 3-4 (Format I2) If this bay is dedicated to storing 5-1/4 inch billets, enter a bay priority number (lower numbers are of higher priority). Otherwise, leave this field blank.

Cols 5-6 (Format I2) If this bay is dedicated to storing 6 inch billets, enter a bay priority number (lower numbers are of higher priority). Otherwise, leave this field blank.

Cols 7-8 (Format I2) If this bay is dedicated to storing 7-3/8 inch billets, enter a bay priority number (lower numbers are of higher priority). Otherwise, leave this field blank.

Cols 9-14 (Format F6.0) Enter (in feet), according to the origin defined in the yard layout, the X coordinate of the center line of this bay.

Cols 15-20 (Format F6.0) Enter (in feet) the Y coordinate as defined in the preceding field.

Cols 21-25 (Format I5) Enter the maximum number of billets allowed in this bay.

Cols 26-30 (Format I5) Enter the actual number of billets currently inventoried in this bay for the first heat level. Continue entering, using fields of 5 consecutive columns until the billets of all heats residing in this bay have been entered.

NOTE: All the cards described up to this point, except for the first 26 columns of the first card (card one of the control cards), are punched out at the end of each run with the end of run data entered. However, the future event times (card six of the control cards) have been reduced by the magnitude of the simulation stop time (columns 19-24 of control card number 1). This setup will enable breaking long simulation runs into segments, thereby, enabling examining pieces of the run via use of some or all of the various long form event-by-event printouts offered in this program.

C. STOCHASTIC DATA CARDS CARRY FIX POINT (A CONSTANT) AND RANDOM (STOCHASTIC) DATA INTO THE PROGRAM.

The types of distributions available and the definitions of inputs for the various fields are as follows:

TYPE OF DISTRIBUTION	FIELD NO. 1	FIELD NO. 2	FIELD NO. 3	FIELD NO. 4	FIELD NO. 5	FIELD NO. 6	FIELD NO. 7
CONSTANT	1	CONSTANT					
UNIFORM	2	MIN OBS	MAX OBS				
TRIANGULAR	3	MIN OBS	MAX OBS	MOST LIKELY OBS			
NORMAL	4	MIN OBS	MAX OBS	MEAN	STANDARD DEVIATION		
LOGNORMAL	5	MIN OBS	MAX OBS	MEAN	STANDARD DEVIATION		
GAMMA	6	MIN OBS	MAX OBS	MEAN	STANDARD DEVIATION		
WEIBULL *	7	MIN OBS	MAX OBS	SCALE PARAMETER	SHAPE PARAMETER		
ERLANG	8	MIN OBS	MAX OBS	MEAN	NO. OF EXPONENTIAL DEVIATES		
(EXPONENTIAL)	8	MIN OBS	MAX OBS	MEAN	1		
CHI SQUARE	9	MIN OBS	MAX OBS	NO. DEGREES FREEDOM			

* THE MINIMUM OBSERVATION IS THE LOCATION PARAMETER.

TYPE OF DISTRIBUTION	FIELD NO. 1	FIELD NO. 2	FIELD NO. 3	FIELD NO. 4	FIELD NO. 5	FIELD NO. 6	FIELD NO. 7
BETA **	10	MIN OBS	MAX OBS	A	B		
POISSON	11	MIN OBS	MAX OBS	MEAN			
PASCAL ***	12	MIN OBS	MAX OBS	P	K		
(GEOMETRIC) ***	12	MIN OBS	MAX OBS	P	K= 1		
BINOMIAL ****	13	MIN OBS	MAX OBS	P	N		
HYPERGEOMETRIC *****	14	MIN OBS	MAX OBS	P	N	M	
HISTOGRAM *****	15	A	B	C	D	E	F

$$** F(X) = \frac{G(A+B)X^{A-1} (1-X)^{B-1}}{G(A)G(B)}$$

A = Greater than Zero
B = Greater than Zero
G = Gamma Function

$$*** F(X) = \frac{(K+X-1)P^K Q^X}{(X)}$$

X = 0, 1, 2...
Q = 1-P

$$**** F(X) = \frac{(N)P^X Q^{N-X}}{(X)}$$

X = 0, 1, 2...N
Q = 1-P

$$***** F(X) = \frac{(NP) (NQ)}{(X) (M-X)} \frac{(N)}{(M)}$$

X = 0, 1, 2...N
M-X = 0, 1, 2...NQ
Q = 1-P

1. A - Enter the value of the left hand boundary of probability Cell No. 1.

2. B - Enter the probability of realizing Cell No. 1.

3. C - Enter the value of the right hand boundary of probability Cell No. 1 and the left hand boundary of probability Cell No. 2.

4. D - Enter the probability of realizing Cell No. 2.

5. E - Enter the value of the right hand boundary of probability Cell No. 2 and the left hand boundary of probability Cell No. 3.

6. F - Enter the probability of realizing Cell No. 3.

7. In Field No. 1 of the next card enter the value of the right hand boundary of probability Cell No. 3 and the left hand boundary of probability Cell No. 4.

8. Continue entering the elements of the histogram in these 7 field patterns using as many cards as necessary until the entire histogram has been completely loaded.

9. The next field after the last field used to load the histogram data must have a -999.0 entered in it to mark the end of the histogram information.

The stochastic data card's field layouts are as follows:

Cols 1-3 (Format I3) Enter the key number the program uses to fetch an observation from a given stochastic input. The data definitions of the key numbers are as follows:

KEY NO. DATA DEFINITION

1. The distribution of resupply calls from Feeder No. 1. First it is necessary to calculate the time between charges given the mobilization rate of production per month and the working hours per month. Since the calls of Feeders 2 and 3 require similar information, some of the necessary preliminary calculations required for them will also be exhibited.

<u>ROUND</u>	<u>GUN</u>	<u>MOB RATE</u>	<u>SCRAP</u>	<u>MULT WT</u>	<u>PLANT INPUT</u>	<u>RAW STOCK (TONS/MONTH)</u>		
		No./Month	5%	In Lbs	Tons/Month	5-1/4"	6"	7-3/8"
M107	155MM	100,000	5000	107	5618	7865		
M110	155MM	40,000	2000	107	2247			
M437	175MM	40,000	2000	172	3612		3612	
M106	8 Inch	40,000	2000	220	4620			6384
M404	8 Inch	15,000	750	224	1764			

Number of Working Hours Per Month, Using 1976 as a Base for Calculations:

1. Jan 31 - 5 = 26	5. May 31 - 6 = 25	9. Sept 30 - 5 = 25
2. Feb 29 - 6 = 23	6. Jun 30 - 4 = 26	10. Oct 31 - 7 = 24
3. Mar 31 - 4 = 27	7. July 31 - 5 = 26	11. Nov 30 - 5 = 25
4. Apr 30 - 4 = 26	8. Aug 31 - 5 = 26	12. Dec 31 - 5 = 26

*****Sums to 305 Working Days
Year (1976)

$$\frac{\text{Working Days} \times \text{Year}}{12 \text{ Months}} = 25.42 \quad \frac{\text{Working Days}}{\text{Month}} \times 24 \frac{\text{Hours}}{\text{Working Day}} = 610 \frac{\text{Hours}}{\text{Month}} \quad \frac{\text{Breaks Total}}{8 \text{ Contact Hours}}$$

$$\text{Actual Working Hours} = (610) \left(1 - \frac{80}{480}\right) = \frac{508 \text{ Working Hours}}{\text{Month}}$$

$$\frac{7865 \text{ Tons}}{\text{Month}} = \frac{839.38 \text{ Charges}}{\text{Month}} \quad \text{Thus} \quad \frac{508 \text{ Working Hrs} \times 60 \text{ Minutes}}{\text{Month}} = \frac{36.31 \text{ Minutes}}{\text{Hour}} \quad \frac{\text{Minutes}}{\text{Charge}}$$

$$\frac{10 \text{ Billets} \times 1874 \text{ Lbs}}{\text{Charge}} = \frac{2000 \text{ Lbs}}{\text{Billet}} \quad \frac{2000 \text{ Lbs}}{\text{Ton}}$$

27 To create some manufacturing variability, it will be assumed that this 36.31 minutes between charges is the mean of a normal distribution having 95 % of its area within 15% of its mean.

$$\text{Thus, the STD DEV} = \frac{(0.15) (.36.31)}{1.96} = 2.78, \text{ also, } 3 \text{ STD DEV CUT OFFS} = 27.97 \text{ AND } 44.64.$$

2. The distribution of resupply calls from Feeder No. 2. Following the calculations for Feeder No. 1 yields the following:

$$\frac{3612 \text{ Tons}}{\text{Month}} = \frac{227.00 \text{ Charges}}{\text{Month}} \quad \text{Thus} \quad \frac{508 \text{ Working Hrs} \times 60 \text{ Minutes}}{\text{Month}} = \frac{134.27 \text{ Minutes}}{\text{Hour}} \quad \frac{\text{Minutes}}{\text{Charge}}$$

$$\frac{13 \text{ Billets} \times 2448 \text{ Lbs}}{\text{Charge}} = \frac{2000 \text{ Lbs}}{\text{Billet}} \quad \frac{2000 \text{ Lbs}}{\text{Ton}}$$

$$\text{Thus, the STD DEV} = \frac{(0.15) (134.27)}{1.96} = 10.28 \text{ also } 3 \text{ STD DEV CUT-OFFS} = 103.44 \text{ and } 165.10.$$

3. The Distribution of resupply calls from Feeder No. 3. Following the calculations for Feeder No. 1 yields the following:

$$\begin{array}{rcl}
 6384 \text{ Tons} & & 508 \text{ Working Hrs x 60 Minutes} \\
 \text{Month} & & \text{Month} \quad \text{Hour} \\
 \hline
 13 \text{ Billets x 3698 Lbs} & = & 265.59 \text{ Charges} \quad \text{THUS} \\
 \text{Charge} & & \text{Month} \\
 \hline
 & & 265.59 \text{ Charges} \\
 & & \text{Month} \\
 & & \hline
 & & = 114.76 \text{ Minutes} \\
 & & \text{Charge}
 \end{array}$$

$$\begin{array}{rcl}
 2000 \text{ Lbs} & & \\
 \text{Ton} & &
 \end{array}$$

Thus, the STD DEV = $\frac{(0.15)(114.76)}{1.96}$ = 8.78 ALSO 3 STD DEV CUT OFFS = 88.41 and 141.11.

4. Arrival of a 5-1/4 Inch Heat.

$$\begin{array}{rcl}
 7865 \text{ Tons} & & 610 \text{ Contact Hours x 60 Minutes} \\
 \text{Month} & & \text{Month} \quad \text{Hour} \\
 \hline
 175 \text{ Billets x 1874 Lbs} & = & 47.96 \text{ Heats} \quad \text{OR} \\
 \text{Heat} & & \text{Month} \\
 \hline
 & & 47.96 \text{ Heats} \\
 & & \text{Month} \\
 & & \hline
 & & = 763.06 \text{ Minutes} \\
 & & \text{Heat Arrival}
 \end{array}$$

$$\begin{array}{rcl}
 2000 \text{ Lbs} & & \\
 \text{Ton} & &
 \end{array}$$

Since most arrivals are poisson, it will be assumed this arrival is also poisson distributed. Further, 3 STD DEV CUT OFFS will be employed since the variate will essentially be generated as a normal deviate because of its high parameter value.

Thus 3 STD DEV CUT OFFS = 680.19 and 845.93.

5. Arrival of a 6 Inch Heat.

$$\begin{array}{rcl}
 \frac{3612 \text{ Tons}}{\text{Month}} & & \\
 \frac{175 \text{ Billets} \times 2448 \text{ Lbs}}{\text{Heat}} & = & \frac{16.86 \text{ Heats}}{\text{Month}} \quad \text{OR} \quad \frac{610 \text{ Contact Hours} \times 60 \text{ Minutes}}{\text{Month}} \\
 \frac{2000 \text{ Lbs}}{\text{Ton}} & & \frac{16.86 \text{ Heats}}{\text{Month}} \quad \text{OR} \quad \frac{2170.47 \text{ Minutes}}{\text{Heat Arrival}}
 \end{array}$$

Thus, 3 STD DEV CUT OFFS = 2030.70 and 2310.23.

6. Arrival of a 7-3/8 Inch Heat.

$$\begin{array}{rcl}
 \frac{6384 \text{ Tons}}{\text{Month}} & & \\
 \frac{175 \text{ Billets} \times 3698 \text{ Lbs}}{\text{Heat}} & = & \frac{19.73 \text{ Heats}}{\text{Month}} \quad \text{OR} \quad \frac{610 \text{ Contact Hours} \times 60 \text{ Minutes}}{\text{Month}} \\
 \frac{2000 \text{ Lbs}}{\text{Ton}} & & \frac{19.73 \text{ Heats}}{\text{Month}} \quad \text{OR} \quad \frac{1855.08 \text{ Minutes}}{\text{Heat Arrival}}
 \end{array}$$

Thus, 3 STD DEV CUT OFFS = 1725.87 and 1984.29.

7. The time from the first coffee break to the next occurrence of this same event was entered as a constant of 480 minutes.

8. The time from the lunch break to the next occurrence of this same event was entered as a constant of 480 minutes.

9. The time from the second coffee break to the next occurrence of this same event was entered as a constant of 480 minutes.

10. The time from the shift break to the next occurrence of this same event was entered as a constant of 480 minutes.
11. The time required to pick billets out of a railroad car was entered as a Triangular Distribution having a minimum time of 0.25 minutes, a maximum time of 1.5 minutes, and a most-likely time of 0.75 minutes. This is the time required between stopping X and Y motion to position the magnet over the car and starting X and Y motion to transport the load of billets to the storage bay.
12. The time required to swing a load of billets into position so this load can be stacked on the pile in a storage bay was entered as Triangular Distribution having a minimum time of 0.25 minutes, a maximum time of 1.0 minutes, and a most-likely time of 0.5 minutes. Since this task is essentially accomplished by a man on the pile, the crane's travel to the pile has been completed. Therefore, this time is defined as the time from the end of travel--to the pile--to the start of setting the load of billets down on the pile.
13. The time required to set the load of billets on the storage pile begins at the end of swing time and continues until the X and Y travel away from the pile begins. This time includes pile shape up time and billet packing time. This time was entered as a Triangular Distribution having a minimum time of 0.5 minutes, a maximum time of 2.0 minutes, and a most-likely time of 0.85 minutes.
14. The X distance in feet between the center line of the railroad car and the receiving storage bay was entered as a histogram as follows: 20% of the time the distance will be between 0 and 50 feet, 20% of the time the the distance will be between 50 and 100 feet, 30% of the time the distance will be between 100 and 150 feet, and finally 30% of the time the distance will be between 150 and 200 feet.
15. The number of 5-1/4 inch billets picked out of a railroad car per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 12.0 as the maximum number of billets, and 8.0 as the most-likely number of billets.
16. The number of 6 inch billets picked out of a railroad car per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 12.0 as the maximum number of billets, and 7.0 as the most-likely number of billets.
17. The number of 7-3/8 inch billets picked out of a railroad car per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 8.0 as the maximum number of billets, and 6.0 as the most-likely number of billets.
18. The length of the morning coffee break was entered as a constant of 15.0 minutes.

19. The length of the lunch break was entered as a constant of 35.0 minutes.
20. The length of the afternoon coffee break was entered as a constant of 15.0 minutes.
21. The length of the shift break was entered as a constant of 15.0 minutes.
22. The time required to pick billets off of the storage pile in some bay was entered as a Triangular Distribution, having a minimum time of 0.25 minutes, a maximum time of 1.0 minutes, and a most-likely time of 0.5 minutes. This is the time expended between stopping all X and Y motion to positioning the magnet over the bay and starting X and Y motion to transport the load of billets to the work area.
23. The number of 5-1/4 inch billets picked off of a storage pile per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 10.0 as the maximum number of billets, and 10.0 as the most-likely number of billets.
24. The number of 6 inch billets picked off of a storage pile per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 9.0 as the maximum number of billets, and 9.0 as the most-likely number of billets.
25. The number of 7-3/8 inch billets picked off of a storage pile per unit pick was entered as a Triangular Distribution having 1.0 as the minimum number of billets, 7.0 as the maximum number of billets, and 7.0 as the most-likely number of billets.
26. The time required to set a load of billets down in the work area begins when the X and Y travel into the work area ends and continues until the X and Y travel away from the set down position begins. This time was entered as a Triangular Distribution having a minimum value of 0.1 minutes, a maximum value of 0.5 minutes and a most-likely value of 0.3 minutes.
27. The time required to pick up a charge or a portion of a charge was entered as a Triangular Distribution having a minimum value of 0.25 minutes, a maximum value of 1.0 minutes and a most-likely value of 0.5 minutes. This is the time expended between stopping X and Y travel to positioning the magnet over the charge and the starting of X and Y travel to transport the charge to the feed table.
28. The time required to set a charge or a portion of a charge on the feed table begins when X and Y travel to the feeder table ends and continues until X and Y travel away from the feeder table begins. This time was entered as a Triangular Distribution having a minimum value of 0.25 minutes, a maximum value of 0.75 minutes, and a most-likely value of 0.45 minutes.

29. The time required to square up a group of loose billets into a square array of tightly packed billets ready for loading on the feed table was entered as a Triangular Distribution having a minimum value of 0.75 minutes, a maximum value of 2.0 minutes and a most-likely value of 1.25 minutes. This is time expended between stopping X and Y travel to positioning the magnet over the loose billets in the work area and starting of X and Y travel away from the work area to the next task.

30. Acceleration in the X direction was entered as a constant of 1.0 feet-per-second squared.

31. Deceleration in the X direction was entered as a constant of 1.0 feet-per-second squared.

32. The top velocity attainable in the X direction was entered as a Uniform Distribution ranging from 150 - 200 feet-per-minute.

33. Acceleration in the Y direction was entered as a constant of 1.0 feet-per-second squared.

34. Deceleration in the Y direction was entered as a constant of 1.0 feet-per-second squared.

35. The top velocity attainable in the Y direction was entered as a Uniform Distribution ranging from 150 - 200 feet-per-minute.

36. The size of a typical 5-1/4 inch heat was entered as a constant of 175 billets.

37. The size of a typical 6 inch heat was entered as a constant of 175 billets.

38. The size of a typical 7-3/8 inch heat was entered as a constant of 175 billets.

39. The typical number of 5-1/4 inch billets on a railroad car was entered as a constant of 60 billets.

40. The typical number of 6 inch billets on a railroad car was entered as a constant of 60 billets.

41. The typical number of 7-3/8 inch billets on a railroad car was entered as a constant of 60 billets.

42. The time in minutes a feeder is allowed to wait before scratching the run was entered as a constant of 20.

Cols 4-5 (Format I2) The cards required to accomplish this task must be sequentially numbered. The histogram option is the only input option which may require more than 1 card to input all the necessary

data elements. Therefore, for distributions and a constant, the user need only enter a 1 in this field. However, for histogram data the first card must have a 1 entered in this field, a 2 must be entered in this field for card 2, and so on for as many cards as necessary.

Cols 6-15 (Format F10.0) Enter the necessary data for Field 1 as defined above.

Cols 16-25 (Format F10.0) Enter the necessary data for Field 2 as defined above.

Cols 26-35 (Format F10.0) Enter the necessary data for Field 3 as defined above.

Cols 36-45 (Format F10.0) Enter the necessary data for Field 4 as defined above.

Cols 46-55 (Format F10.0) Enter the necessary data for Field 5 as defined above.

Cols 56-65 (Format F10.0) Enter the necessary data for Field 6 as defined above.

Cols 66-75 (Format F10.0) Enter the necessary data for Field 7 as defined above.

Cols 76-80 Leave Blank.

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APPENDIX C
ERROR MESSAGES

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APPENDIX C
ERROR MESSAGES

Number and Description of Error Messages.

- 1233 - Length of time between systems simulation samples is either negative or larger than the simulation stop time.
- 1244 - Starting time for taking a sample of the processing of the independent events is larger than the ending time.
- 1255 - Starting time for taking a system simulation sample of the processing of the independent events is negative.
- 1266 - X coordinate of the crane's starting point is beyond the boundaries of the yard.
- 1277 - Y coordinate of the crane's starting point is beyond the boundaries of the yard.
- 1288 - Initial value assigned to the Random Number Seed is less than or equal to zero.
- 1299 - The pool level for one of the types of billets is less than the number of billets contained in a charge.
- 1300 - The number of billets contained in a charge is a nonpositive number.
- 1311 - The maximum number of billets that the crane can carry for one of the types of billets is a nonpositive number.
- 1322 - The X coordinate of one of the feeders is beyond the boundaries of the yard.
- 1333 - The Y coordinate of one of the feeders is beyond the boundaries of the yard.
- 1344 - The X coordinate of one of the work areas is beyond the boundaries of the yard.
- 1355 - The Y coordinate of one of the work areas is beyond the boundaries of the yard.
- 1377 - The initial queue of heats in railroad cars waiting to be unloaded for one of the three types of billets is negative.
- 1399 - An initial value of one of the independent events is negative.

- 1433 - The bay number for the preceding card was feasible.
- 1455 - The current maximum number of billets allowed in the bay card just read in is not a positive number.
- 1466 - One of the heats being stored in the bay just read is either negative or larger than the maximum number of billets allowed.
- 1488 - The total number of billets entered in the bay just read in is larger than the maximum number allowed.
- 1499 - The X coordinate of the bay currently being read in is beyond the boundaries of the yard.
- 1500 - The Y coordinate of the bay currently being read in is beyond the boundaries of the yard.
- 1544 - More than just one priority has been assigned to the bay currently being read in.
- 1555 - The priority number assigned to this bay is faulty.
- 1577 - The type of material and the bay receiving billets currently being unloaded do not have acceptable consistent values, i.e., they must both be zero or both be greater than zero at the same time.
- 1599 - Either the type of material being unloaded, the bay receiving the material, or the heat level is beyond the maximum values allowed. These items exceed their check variables of MAXTYP, MAXBAY or MAXHET.
- 1611 - The bay designated to receive the billets queued for unloading does not accommodate this type of material.
- 1644 - The heat level of the bay receiving material is faulty.
- 1655 - The queue, which was designated to be unloaded, is empty.
- 1677 - One of the bays providing billets to one of the feed tables and its heat level does not have consistent values. They must both be zero or both be greater than zero at the same time.
- 1699 - One of the bays providing billets to the feed tables or its heat level exceeds its maximum allowable level. One or both of these variables exceed their check variables of MAXBAY or MAXHET.
- 1711 - One of the bays designated to providing billets to a given feed table does not store the correct type of billet for the table it is supplying.

1744 - The heat level of one of the bays supplying billets to a feed table is faulty. It is not aimed at the top of the pile.

1822 - A -999.0 was not entered as the last item of data for the histogram information previously read in.

1844 - The pointer or internal reference number assigned to the stochastic data being read in is faulty.

1866 - The distribution number assigned to the stochastic data being read in is faulty.

1899 - The storage area for stochastic data has been exceeded.

1922 - The card number is out of sequence for the stochastic data being read in.

1977 - The Lognormal Distribution requested on the previous input card requires positive non-zero parameters.

2000 - The Gamma Distribution requested on the previous input card requires positive non-zero parameters.

2022 - The Gamma Distribution requested on the previous input card has a standard deviation which is too large or the mean is too small to yield at least one exponential deviate.

2044 - The Weibull Distribution requested on the previous input card requires positive non-zero parameters.

2077 - The Erlang Distribution requested on the previous input card requires positive non-zero parameters and integer exponential deviates.

2100 - The Chi Square Distribution requested on the previous input card requires positive non-zero parameters and integer degrees of freedom.

2133 - The Beta Distribution requested on the previous input card requires positive non-zero parameters.

2155 - The Poisson Distribution requested on the previous input card requires positive non-zero parameters.

2200 - The Pascal Distribution requested on the previous input card does not meet one of the following requirements:

1. The value assigned to P must lie between 0 and 1.
2. The value assigned to K must be a positive integer.

3. The minimum observation must not be negative.

$$\text{PASCAL} - F(X) = \frac{(K+X-1)!}{X!} P^K Q^X \quad X = 0, 1, 2, \dots \text{ AND } Q = 1-P$$

2244. The Binomial Distribution requested on the previous input card does not meet one of the following requirements:

1. The value assigned to P must lie between 0 and 1.
2. The value assigned to N must be a positive integer.
3. The minimum observation must not be negative.

$$\text{BINOMIAL} - F(X) = \frac{N!}{X!} P^X Q^{N-X} \quad X = 0, 1, 2, \dots, N \text{ AND } Q = 1-P$$

2288 - The Hypergeometric Distribution requested on the previous input card does not meet one of the following requirements:

1. The value assigned to P must lie between 0 and 1.
2. The value assigned to N must be a positive integer.
3. The value assigned to M must be a positive integer less than N.

4. The minimum observation must not be negative.

$$\text{HYPERGEOMETRIC} - F(X) = \frac{\frac{(NP)!}{X!} \frac{(NQ)!}{(M-X)!}}{\frac{(N)!}{(M)!}} \quad \begin{array}{l} X = 0, 1, \dots, NP \\ M-X = 0, 1, \dots, NQ \\ Q = 1-P \end{array}$$

2311 - The distribution requested on the previous card requires a positive standard deviation which was not entered.

2333 - The distribution requested on the previous card has a mean value which lies outside the minimum - maximum value range.

2355 - The distribution requested on the previous card has a zero or negative minimum - maximum value range.

2399 - The histogram data just entered has a probability cell with a negative value entered in it.

2400 - The histogram data just entered has a probability cell with the same right and left hand boundaries with a positive density.

2422 - The histogram data just entered indicates that a probability cell has a left hand boundary which is larger than the right hand boundary.

2433 - The sum of all the probability cells for the histogram data just entered does not sum to one.

2655 - At least one of the bays requires more heat levels. Expand check variable MAXHET and all the arrays mnemonically dimensioned in terms of this variable.

2777 - A feeder had to wait for resupplying longer than the time allowed as per stochastic input number 42.

2811 - At least one of the heat queues requires more heat levels. Expand check variable MAXQUE and all the arrays mnemonically dimensioned in terms of this variable.

2955 - The yard is cleaned out of one of the three different types of billets. The error number listed after this one indicates the type of billet (1 = 5-1/4, 2 = 6, 3 = 7-3/8) the yard is out of.

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APPENDIX D

COMPUTER LISTING OF PROGRAM

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FORTRAN IV G LEVEL 21

MAIN

DATE = 76252

08/12/32

```

0001      0COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM 10
          1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM 20
          2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM 30
          3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM 40
          4IRRR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM 50
          5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM 60
          60 GLM 70
          70 GLM 80
          80 GLM 90
          90 GLM 100
          100 GLM 110
          110 GLM 120
          120 GLM 130
          130 GLM 140
          140 GLM 150
          150 GLM 160

C          SCRANTON UNLOADING AND FEEDING CRANE SIMULATION
C
C      1111 CALL LOAD
C      1111 IF (IRRR.GT.0) GO TO 1111
C      CALL SIM
C      IF (INVIAL.LE.0) GO TO 1111
C      CALL PLOTTS
C      GO TO 1111
C      END
0002
0003
0004
0005
0006
0007
0008

```

```

0001 SUBROUTINE ERROR (N) GLM 170
0002 OCOMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM 180
1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM 190
2IPN, IW1, IW2, IW3, MAXBAY, MAXSIO, MAXKEY, MAXTYP, MAXEVI, GLM 200
3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM 210
4IPROR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM 220
5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM 230
GLM 240
GLM 250
GLM 260
GLM 270
GLM 280
GLM 290
GLM 300
GLM 310

C THIS SUBROUTINE LIST ERRORS
C
0003 ERROR = ERROR + 1
0004 WRITE (IOUT,1122) ERROR, N
0005 1122 FORMAT (1H0, 20X, I4, 17H. E R R O R NO., I6)
0006 RETURN
0007 END

```



```

0017 MAXKEY= 50      GLM 850
0018 MAXTYP= 3      GLM 860
0019 MAXEVT= 10     GLM 870
0020 MAXHET= 6      GLM 880
0021 MAXQUE= 20     GLM 890
                  GLM 900
                  GLM 910
                  GLM 920
                  GLM 930
                  GLM 940
                  GLM 950
                  GLM 960
                  GLM 970
                  GLM 980
                  GLM 990
                  GLM 1000
                  GLM 1010
                  GLM 1020
                  GLM 1030
                  GLM 1040
                  GLM 1050
                  GLM 1060
                  GLM 1070
                  GLM 1080
                  GLM 1090
                  GLM 1100
                  GLM 1110
                  GLM 1120
                  GLM 1130
                  GLM 1140
                  GLM 1150
                  GLM 1160
                  GLM 1170
                  GLM 1180
                  GLM 1190
                  GLM 1200
                  GLM 1210
                  GLM 1220
                  GLM 1230
                  GLM 1240
                  GLM 1250
                  GLM 1260
                  GLM 1270
                  GLM 1280
                  GLM 1290
                  GLM 1300
                  GLM 1310
                  GLM 1320
                  GLM 1330
                  GLM 1340
                  GLM 1350
                  GLM 1360
                  GLM 1370

C      INITIALIZE THE FOLLOWING WORK VARIABLES
C      ERROR - ERROR COUNTER
C      SETUP - LARGEST NUMBER THE COMPUTER CAN HANDLE
C      CLOCK - TIME KEEPER IN THE SYSTEM
C      CLAST - LAST TIME A SNAPSHOT OF THE SYSTEM WAS TAKEN
C      LOOK - RECORDS NUMBER OF TIMES THE SNAPSHOTS WERE TAKEN
C      ICOUNT - COUNTER ON THE DETAIL INDEPENDENT EVENT LISTING
C      ITRAV - NO. OF TIMES TRAVEL IN THE X DIRECTION OCCURRED
C      JTRAV - NO. OF TIMES TRAVEL IN THE Y DIRECTION OCCURRED
C      XTRAV - TOTAL TRAVEL IN THE X DIRECTION
C      YTRAV - TOTAL TRAVEL IN THE Y DIRECTION
C      XTIME - TOTAL TRAVEL TIME IN THE X DIRECTION
C      YTIME - TOTAL TRAVEL TIME IN THE Y DIRECTION
C      YCENTR - CENTER OF THE YARD - THE RR TRACKS
C      WAIT - TOTAL AMOUNT OF TIME EVENTS WAIT FOR PROCESSING
C      NWAIT - NUMBER OF TIMES EVENTS WAITED FOR PROCESSING
C      WMIN - MINIMUM WAIT TIME
C      WMAX - MAXIMUM WAIT TIME
C      NGET - NUMBER OF TIMES REQUIRED A HAUL BEFORE FEEDING
C      NCOUNT - COUNTS NUMBER OF TIMES A FEEDING WAS MADE
C
0022 ERROR= 0
0023 SETUP= 9.0E70
0024 CLOCK= 0.0
0025 CLAST= 0.0
0026 LOOK = 0
0027 ICOUNT = 0
0028 ITRAV= 0
0029 JTRAV= 0
0030 XTRAV= 0.0
0031 YTRAV= 0.0
0032 XTIME = 0.0
0033 YTIME = 0.0
0034 YCENTR = 30.0
0035 WAIT = 0.0
0036 NWAIT = 0
0037 WMIN = SETUP
0038 WMAX =-SETUP
0039 NGET = 0
0040 NCOUNT = 0

C      INITIALIZE AND READ THE FOLLOWING
C      IBAYP - BAY USAGE PRIORITY FOR EACH OF THE VARIOUS STEELS
C      XBAY - X COORDINATE OF EACH BAY
C      YBAY - Y COORDINATE OF EACH BAY
C      MXINVB - MAXIMUM NUMBER OF BILLETS ALLOWED IN EACH BAY
C      INVB - INVENTORY IN EACH BAY - NO. OF BILLETS PER HEAT

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```

0051      C
          OREAD (INPT,1155) IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, ISTART,ISTOP,GLM 1890
          1SMSTOP, TLOOK, XNOW, YNOW, ISEED, MATUNL, IPTBAY, ITOP, IFEED, GLM 1900
          2IBTOP, LEVELP, NCHAR, NFEED, (XFEED(I), I=1,MAXTYP), GLM 1910
          3IXWORK(I), YWORK(I), I=1,MAXTYP), ((INVQ(I,J), J=1,MAXQUE), GLM 1920
          4I=1,MAXTYP), (ETIME(I), I=1,MAXEVT) GLM 1930
          11550FORMAT (6I1, 3F6.0, F2.0, 2F4.1, I10, 18I2/ 12F6.2/ 20I4/ 20I4/ GLM 1940
          120I4/ 10F8.0) GLM 1950
          IF (IPS1.EQ.9) STOP GLM 1960
          WRITE (IOUT,1166) IPS1, IPS2, IPS3, IPS4, IPS5, IPS6 GLM 1970
          11660FORMAT(71HIPRINT SWITCH FOR THE EVENT AND INVENTORY LISTING(0-LISTGLM 1980
          1, ELSE-NO LIST),14(IH-),112/61H PRINT SWITCH FOR THE BAY TRACE LISGLM 1990
          2TING(0-LIST, ELSE-NO LIST),24(IH-),112/56H PRINT SWITCH FOR THE TIGLM 2000
          3ME LISTING(0-LIST, ELSE-NO LIST),29(IH-),112/60H PRINT SWITCH FOR GLM 2020
          4THE DISTANCE LISTING(0-LIST, ELSE-NO LIST),25(IH-),112/63H PRINT SGLM 2030
          SWITCH FOR STOCHASTIC DATA SAMPLES(0-LIST, ELSE-NO LIST),22(IH-), GLM 2040
          6112/63H PRINT SWITCH FOR BAY, QUE AND POOL PLOTS(0-LIST, ELSE-NO LGLM 2050
          7IST), 22(IH-), 112) GLM 2060
          WRITE (IOUT,1177) ISTART, TSTOP, SMSTOP, TLOOK, XNOW, YNOW, ISEED GLM 2070
          11770FORMAT (75H0STARTING TIME FOR LISTING THE PROCESSING OF EACH OF THGLM 2080
          1E INDEPENDENT EVENTS, 10(IH-), F12.2/ 73H ENDING TIME FOR LISTING GLM 2090
          2THE PROCESSING OF EACH OF THE INDEPENDENT EVENTS, 12(IH-), F12.2/ GLM 2100
          341H TIME WHEN THE SIMULATION WILL BE STOPPED, 44(IH-), F12.2/ 64H GLM 2110
          4LENGTH OF TIME BETWEEN TAKING SAMPLE STATISTICS FROM THE SYSTEM, GLM 2120
          521(IH-), F12.2/ 59H X COORDINATE OF THE SIMULATION STARTING POINT GLM 2130
          6OF THE CRANE, 26(IH-), F12.2/ 59H Y COORDINATE OF THE SIMULATION SGLM 2140
          7TARTING POINT OF THE CRANE, 26(IH-), F12.2/ 58H INITIAL VALUE OF TGLM 2150
          8HE SEED FOR THE RANDOM NUMBER GENERATOR, 27(IH-), 112) GLM 2160
          WRITE (IOUT,1188) MATUNL, IPTBAY, ITOP, IFEED, IBTOP GLM 2170
          11880FORMAT (68H MATERIAL CURRENTLY BEING UNLOADED(0=NOTHING, 1=5 1/4, GLM 2180
          12=6, 3=7 3/8), 17(IH-), 112/ 38H BAY RECEIVING MATERIAL BEING UNLOGLM 2190
          2ADED, 47(IH-), 112/ 67H HEAT LEVEL IN RECEIVING BAY WHICH RECEIVESGLM 2200
          3 MATERIAL BEING UNLOADED, 18(IH-), 112/ 1H, 91X, 5H5 1/4, 11X, GLM 2210
          41H6, 7X, 5H7 3/8/ 41H BAYS CURRENTLY SUPPLYING THE FEED TABLES, GLM 2220
          544(IH-), 3112/ 80H HEAT LEVEL (TOP OF PILE) OF THE PRECEEDING BAYSGLM 2230
          6 WHICH ARE SUPPLYING THE BILLETS, 5(IH-), 3112) GLM 2240
          WRITE (IOUT,1199) LEVELP, NCHAR, NFEED, XFEED, YFEED, XWORK, YWORKGLM 2250
          11990FORMAT (72H MINIMUM NUMBER OF BILLETS DESIRED IN THE WORK POOL (INGLM 2260
          1TIAL LEVEL ALSO), 13(IH-), 3112/ 30H NUMBER OF BILLETS IN A CHARGGLM 2270
          2E, 55(IH-), 3112/ 60H MAXIMUM NUMBER OF BILLETS THE CRANE CAN CARRGLM 2280
          3Y TO THE FEEDER, 25(IH-), 3112/ 29H X COORDINATES OF THE FEEDERS, GLM 2290
          456(IH-), 3F12.2/ 29H Y COORDINATES OF THE FEEDERS, 56(IH-),3F12.2/GLM 2300
          532H X COORDINATES OF THE WORK AREAS, 53(IH-), 3F12.2/ 32H Y COORDIGLM 2310
          6NATES OF THE WORK AREAS, 53(IH-), 3F12.2/ 49H NUMBER OF BILLETS PEGLM 2320
          7R HEAT QUED UP FOR UNLOADING, 34(IH-)) GLM 2330
          DO 1200 J=1,MAXQUE GLM 2340
          1200 WRITE (IOUT,1211) J, (INVQ(I,J), I=1,3) GLM 2350
          1211 FORMAT (1H+, 79X, I5, 3112/) GLM 2360
          WRITE (IOUT,1222) (I, I=1,MAXEVT), ETIME, (I, I=1,MAXHET) GLM 2370
          12220FORMAT (42H INITIAL VALUES FOR THE INDEPENDENT EVENTS/ 1H, GLM 2380
          110(I11,IH-)/ 1H, 10F12.2/ 4H1BAY, 6X, 8HPRIORITY, 13X, 11HCOORDINGLM 2390
          2ATES, 2X, 3HMAX, 2X, 20HNO. BILLETS PER HEAT/ 1H, 4X, 5H5 1/4, GLM 2400
          35X, 1H6, 1X, 5H7 3/8, 9X, 1HX, 9X, 1HY, 5X, 10I5) GLM 2410

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C      MAKE AN ERROR CHECK ON THE CONTROL CARDS AND INITIALIZE
C      INVTAL = COUNTS NO. OF TIMES A TOTAL INVENTORY CHECK WAS MADE
C      MININV = RECORDS THE MINIMUM TOTAL INVENTORY FOR THE RUN
C      MAXINV = RECORDS THE MAXIMUM TOTAL INVENTORY FOR THE RUN
C      AVEINV = RECORDS THE AVERAGE TOTAL INVENTORY FOR THE RUN
C      IF THE STOP TIME FOR LISTING THE PROCESSING OF THE EVENTS IS EQUAL
C      TO THE END OF RUN TIME, SET STOP LIST TIME TO A LARGE VALUE
C
C      IF (TSTOP.EQ.SMSTOP) TSTOP = SETUP
C      IF (TLOOK.LE.0.0.OR.TLOOK.GT.SMSTOP) CALL ERROR (1233)
C      IF (TSTOP.LT.TSTART) CALL ERROR (1244)
C      IF (TSTART.LT.0.0) CALL ERROR (1255)
C      IF (XNOW.LT.-51.0.OR.XNOW.GT.570.0) CALL ERROR (1266)
C      IF (YNOW.LT.0.0.OR.YNOW.GT.100.0) CALL ERROR (1277)
C      IF (ISEED.LE.0) CALL ERROR (1288)
C      INVTAL = 0
C      DO 1366 I=1,MAXTYP
C      MININV(I) = 999999
C      MAXINV(I) = -999999
C      AVEINV(I) = 0.0
C      IF (LEVELP(I).LT.NCHAR(I)) CALL ERROR (1299)
C      IF (NCHAR(I).LE.0) CALL ERROR (1300)
C      IF (NFEED(I).LE.0) CALL ERROR (1311)
C      IF (XFEED(I).LT.-51.0.OR.XFEED(I).GT.570.0) CALL ERROR (1322)
C      IF (YFEED(I).LT.0.0.OR.YFEED(I).GT.100.0) CALL ERROR (1333)
C      IF (XWORK(I).LT.-51.0.OR.XWORK(I).GT.570.0) CALL ERROR (1344)
C      IF (YWORK(I).LT.0.0.OR.YWORK(I).GT.100.0) CALL ERROR (1355)
C      IPOOL(I) = LEVELP(I)
C      INVQT(I) = 0
C      DO 1366 J=1,MAXQUE
C      INVQT(I) = INVQT(I) + INVQ(I,J)
C      1366 IF (INVQ(I,J).LT.0) CALL ERROR (1377)
C      1388 IF (ETIME(I).LT.0.0) CALL ERROR (1399)
C
C      READ IN THE BAY INFO
C
C      1400 READ (INPT,1411) I, MASK, X, Y, J, (NTIME(K), K=1,MAXHET)
C      1411 FORMAT (4I2, 2F6.0, 11I5)
C      IF (I.EQ.-9) GO TO 1566
C      WRITE (IOUT,1422) I, MASK, X, Y, J, (NTIME(K), K=1,MAXHET)
C      1422 FORMAT (1H, I3, 316, 2F10.2, 11I5)
C      IF (I.GE.1.AND.I.LE.MAXBAY) GO TO 1444
C      CALL ERROR (1433)
C      GO TO 1400
C      1444 IF (J.LE.0) CALL ERROR (1455)
C      MAXINVB(I) = J
C      DO 1477 K=1,MAXHET
C      IF (NTIME(K).LT.0.0.OR.NTIME(K).GT.J) CALL ERROR (1466)
C      INVB(I) = INVB(I) + NTIME(K)
C      1477 INVB(I,K) = NTIME(K)
C      IF (INVB(I).GT.J) CALL ERROR (1488)

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0108 XBAY(I) = X
0109 IF(X.LT.-51.0.OR.X.GT.570.0) CALL ERROR (1499)
0110 YBAY(I) = Y
0111 IF(Y.LT.0.0.OR.Y.GT.100.0) CALL ERROR (1500)
0112 DO 1511 K=1,MAXTYP
0113 1511 IBAYP(I,K) = MASK(K)
0114 N = 0
0115 K = 0
0116 DO 1533 L=1,MAXTYP
0117 IF(IBAYP(I,L).NE.0) GO TO 1522
0118 N = N + 1
0119 GO TO 1533
0120 1522 K = L
0121 1533 CONTINUE
0122 IF(N.NE.2) CALL ERROR (1544)
0123 IF(K.EQ.0) GO TO 1400
0124 J = IBAYP(I,K)
0125 IF(J.LE.0.OR.J.GT.MAXBAY) CALL ERROR (1555)
0126 GO TO 1400

C
C CROSS CHECK BAY DATA WITH UNLOAD MATERIAL TYPE, BAY AND HEAT LEVEL
C POINTER DATA - FIRST CHECK PERMISSIBLE RANGE OF THE POINTERS
C
1566 IF(MATUNL.GT.0.AND.IPTBAY.GT.0.AND.ITOP.GT.0) GO TO 1588
1567 IF(MATUNL.EQ.0.AND.IPTBAY.EQ.0.AND.ITOP.EQ.0) GO TO 1666
1568 CALL ERROR (1577)
1569 GO TO 1666
1588 IF(MATUNL.LE.MAXTYP.AND.IPTBAY.LE.MAXBAY.AND.ITOP.LE.MAXHET)
1589 1600 TO 1600
1590 CALL ERROR (1599)
1591 GO TO 1666

C
C CHECK BAY-BILLET TYPE, HEAT LEVEL AND MATERIAL IN UNLOAD QUE
C
1600 IF(IBAYP(IPTBAY,MATUNL).LE.0) CALL ERROR (1611)
1601 DO 1622 I=1,MAXHET
1602 IF(INVB(IPTBAY,I).EQ.0) GO TO 1633
1622 J = I
1633 IF(ITOP.LT.J.OR.ITOP.GT.J+1) CALL ERROR (1644)
1634 IF(INVQ(MATUNL,I).LE.0) CALL ERROR (1655)

C
C CROSS CHECK BAY DATA WITH FEEDER AND HEAT LEVEL POINTER DATA
C
1666 DO 1766 I=1,MAXTYP
1667 M = IFEE(I)
1668 N = IBTOP(I)
1669 IF(M.GT.0.AND.N.GT.0) GO TO 1688
1670 IF(M.EQ.0.AND.N.EQ.0) GO TO 1766
1671 CALL ERROR (1677)
1672 GO TO 1766
1688 IF(M.LE.MAXBAY.AND.N.LE.MAXHET) GO TO 1700
1689 CALL ERROR (1699)
1690 GO TO 1766

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GLM 2950
GLM 2960
GLM 2970
GLM 2980
GLM 2990
GLM 3000
GLM 3010
GLM 3020
GLM 3030
GLM 3040
GLM 3050
GLM 3060
GLM 3070
GLM 3080
GLM 3090
GLM 3100
GLM 3110
GLM 3120
GLM 3130
GLM 3140
GLM 3150
GLM 3160
GLM 3170
GLM 3180
GLM 3190
GLM 3200
GLM 3210
GLM 3220
GLM 3230
GLM 3240
GLM 3250
GLM 3260
GLM 3270
GLM 3280
GLM 3290
GLM 3300
GLM 3310
GLM 3320
GLM 3330
GLM 3340
GLM 3350
GLM 3360
GLM 3370
GLM 3380
GLM 3390
GLM 3400
GLM 3410
GLM 3420
GLM 3430
GLM 3440
GLM 3450
GLM 3460
GLM 3470

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0150      C      CHECK BILLET TYPE FOR THIS BAY AND HEAT LEVEL
0151      C
0152      C
0153      1700 IF (IBAYP(M,I).LE.0) CALL ERROR (1711)
0154      DO 1722 J=1,MAXHET
0155      K = MAXHET + 1 - J
0156      IF (INVB(M,K).NE.0) GO TO 1755
0157      1722 CONTINUE
0158      1733 CALL ERROR (1744)
0159      GO TO 1766
0160      1755 IF (K.NE.N) GO TO 1733
0161      1766 CONTINUE
0162      C
0163      C      READ IN STOCHASTIC DATA
0164      C
0165      KOUNT = 0
0166      M = -9999
0167      ISAVE = -9999
0168      WRITE (IOUT,1777) (I, I=1,10)
0169      1777 FORMAT (1H1, 20X, 15HSTOCHASTIC DATA/ 2H0 , 6HKEY NO, 7I16/ 1H ,
0170      17X, 3I16, 7H--ETC.)
0171      1788 K = -9999
0172      1799 READ (INPT,1800) I, J, (STIME(N), N=1,7)
0173      1800 FORMAT (I3, I2, 7F10.0)
0174      IF (I.EQ.-99) GO TO 2444
0175      IF (I.GT.LOOK) LOOK = I
0176      WRITE (IOUT,1811) I, J, (STIME(N), N=1,7)
0177      1811 FORMAT (1H , I4, I3, 7F16.3)
0178      IF (I.EQ.K) GO TO 1911
0179      IF (M.NE.15) GO TO 1833
0180      IF (ISAVE.NE.-9998) CALL ERROR (1822)
0181      1833 IF (I.GE.1.AND.I.LE.MAXKEY) GO TO 1855
0182      CALL ERROR (1844)
0183      GO TO 1788
0184      C
0185      C      CREATE WORK VARIABLES, LOAD KEY, INCREMENT THE COUNTER
0186      C
0187      1855 M0 = KOUNT + 1
0188      M1 = KOUNT + 2
0189      M2 = KOUNT + 3
0190      M3 = KOUNT + 4
0191      M4 = KOUNT + 5
0192      M5 = KOUNT + 6
0193      KEY(1) = M0
0194      K = I
0195      L = 0
0196      M = STIME(1) + 0.1
0197      IF (M.GE.1.AND.M.LE.15) GO TO 1877
0198      CALL ERROR (1866)
0199      GO TO 1788
0200      1877 IF (M.EQ.15) GO TO 1911
0201      N = IDIST(M)
0202      KOUNT = KOUNT + N
0203      GLM 3480
0204      GLM 3490
0205      GLM 3500
0206      GLM 3510
0207      GLM 3520
0208      GLM 3530
0209      GLM 3540
0210      GLM 3550
0211      GLM 3560
0212      GLM 3570
0213      GLM 3580
0214      GLM 3590
0215      GLM 3600
0216      GLM 3610
0217      GLM 3620
0218      GLM 3630
0219      GLM 3640
0220      GLM 3650
0221      GLM 3660
0222      GLM 3670
0223      GLM 3680
0224      GLM 3690
0225      GLM 3700
0226      GLM 3710
0227      GLM 3720
0228      GLM 3730
0229      GLM 3740
0230      GLM 3750
0231      GLM 3760
0232      GLM 3770
0233      GLM 3780
0234      GLM 3790
0235      GLM 3800
0236      GLM 3810
0237      GLM 3820
0238      GLM 3830
0239      GLM 3840
0240      GLM 3850
0241      GLM 3860
0242      GLM 3870
0243      GLM 3880
0244      GLM 3890
0245      GLM 3900
0246      GLM 3910
0247      GLM 3920
0248      GLM 3930
0249      GLM 3940
0250      GLM 3950
0251      GLM 3960
0252      GLM 3970
0253      GLM 3980
0254      GLM 3990
0255      GLM 4000

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0193 IF(KOUNT,LE,MAXSTO) GO TO 1900
0194 1888 CALL ERROR (1899)
0195 STOP
0196 1900 IF(N,GE,1) STORE(M0) = STIME(1)
0197 IF(N,GE,2) STORE(M1) = STIME(2)
0198 IF(N,GE,3) STORE(M2) = STIME(3)
0199 IF(N,GE,4) STORE(M3) = STIME(4)
0200 IF(N,GE,5) STORE(M4) = STIME(5)
0201 IF(N,GE,6) STORE(M5) = STIME(6)
0202 L = L + 1
0203 IF(J,EQ,L) GO TO 1933
0204 CALL ERROR (1922)
0205 GO TO 1788

C
C CHECK DISTRIBUTION PARAMETERS
C
0206 1933 GO TO (1788,2344,1944,1955,1966,1999,2033,2066,2099,2122,2144,
12188,2222,2266,2366),M

C
C TRIANGULAR
C
0207 1944 X = STORE(M3)
0208 GO TO 2322

C
C NORMAL
C
0209 1955 X = STORE(M3)
0210 Y = STORE(M4)
0211 GO TO 2300

C
C LOGNORMAL
C
0212 1966 X = STORE(M3)
0213 Y = STORE(M4)
0214 IF(STORE(M1).GT.0.0.AND.X.GT.0.0) GO TO 1988
0215 CALL ERROR (1977)
0216 GO TO 1788
0217 1988 Z = ALOG((Y*Y)/(X*X) + 1.0)
0218 STORE(M3) = ALOG(X) - 0.5*Z
0219 STORE(M4) = SQRT(Z)
0220 GO TO 2300

C
C GAMMA
C
0221 1999 X = STORE(M3)
0222 Y = STORE(M4)
0223 IF(STORE(M1).GT.0.0.AND.X.GT.0.0.AND.STORE(M4).GT.0.0) GO TO 2011
0224 CALL ERROR (2000)
0225 GO TO 1788
0226 2011 Z = Y*Y
0227 STORE(M3) = X/Z
0228 STORE(M4) = X/STORE(M3)
0229 IF(STORE(M4).LE.0.0) CALL ERROR (2022)

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GLM 4010
GLM 4020
GLM 4030
GLM 4040
GLM 4050
GLM 4060
GLM 4070
GLM 4080
GLM 4090
GLM 4100
GLM 4110
GLM 4120
GLM 4130
GLM 4140
GLM 4150
GLM 4160
GLM 4170
GLM 4180
GLM 4190
GLM 4200
GLM 4210
GLM 4220
GLM 4230
GLM 4240
GLM 4250
GLM 4260
GLM 4270
GLM 4280
GLM 4290
GLM 4300
GLM 4310
GLM 4320
GLM 4330
GLM 4340
GLM 4350
GLM 4360
GLM 4370
GLM 4380
GLM 4390
GLM 4400
GLM 4410
GLM 4420
GLM 4430
GLM 4440
GLM 4450
GLM 4460
GLM 4470
GLM 4480
GLM 4490
GLM 4500
GLM 4510
GLM 4520
GLM 4530

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08/12/32

DATE = 76252

LOAD

FORTAN IV G LEVEL 21

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0230      GO TO 2300      GLM 4540
      C      WEIBULL      GLM 4550
      C      GLM 4560
      C      GLM 4570
      C      GLM 4580
      C      GLM 4590
      C      GLM 4600
      C      GLM 4610
      C      GLM 4620
      C      GLM 4630
      C      GLM 4640
      C      GLM 4650
      C      GLM 4660
      C      GLM 4670
      C      GLM 4680
      C      GLM 4690
      C      GLM 4700
      C      GLM 4710
      C      GLM 4720
      C      GLM 4730
      C      GLM 4740
      C      GLM 4750
      C      GLM 4760
      C      GLM 4770
      C      GLM 4780
      C      GLM 4790
      C      GLM 4800
      C      GLM 4810
      C      GLM 4820
      C      GLM 4830
      C      GLM 4840
      C      GLM 4850
      C      GLM 4860
      C      GLM 4870
      C      GLM 4880
      C      GLM 4890
      C      GLM 4900
      C      GLM 4910
      C      GLM 4920
      C      GLM 4930
      C      GLM 4940
      C      GLM 4950
      C      GLM 4960
      C      GLM 4970
      C      GLM 4980
      C      GLM 4990
      C      GLM 5000
      C      GLM 5010
      C      GLM 5020
      C      GLM 5030
      C      GLM 5040
      C      GLM 5050
      C      GLM 5060

0231      20330 IF (STORE(M1).GE.0.0.AND.STORE(M3).GT.0.0.AND.STORE(M4).GT.0.0)
      1GO TO 2055
      CALL ERROR (2044)
      GO TO 1788
      2055 STORE(M4) = 1.0/STORE(M4)
      GO TO 2344
      C
      C      ERLANG
      C
      2066 X = STORE(M3)
      N = STORE(M4) + 0.001
      Z = N
      0IF (STORE(M1).GT.0.0.AND.X.GT.0.0.AND.STORE(M4).GT.0.0.AND.
      1STORE(M4).EQ.Z) GO TO 2088
      CALL ERROR (2077)
      GO TO 1788
      2088 STORE(M3) = STORE(M4)/X
      Y = STORE(M4)/(STORE(M3)*STORE(M3))
      GO TO 2300
      C
      C      CHI SQUARE
      C
      2099 X = STORE(M3)
      N = X + 0.001
      Z = N
      IF (STORE(M1).GT.0.0.AND.Z.EQ.X.AND.X.GT.0.0) GO TO 2111
      CALL ERROR (2100)
      GO TO 1788
      2111 Y = 2.0*X
      ISAVE = N/2
      M0 = ISAVE*2
      IF (N.NE.M0) ISAVE = -ISAVE
      STORE(M3) = ISAVE
      GO TO 2300
      C
      C      BETA
      C
      21220 IF (STORE(M1).GT.0.0.AND.STORE(M3).GT.0.0.AND.STORE(M4).GT.0.0)
      1GO TO 2344
      CALL ERROR (2133)
      GO TO 1788
      C
      C      POISSON
      C
      2144 IF (STORE(M1).GE.0.0.AND.STORE(M3).GT.0.0) GO TO 2166
      CALL ERROR (2155)
      GO TO 1788
      2166 IF (STORE(M3).LE.10.0) GO TO 2177
      KOUNT = KOUNT + 1

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0265 IF(KOUNT.GT.MAXSTO) GO TO 1888
0266 STORE(M0) = 4.0
0267 STORE(M4) = SORT(STORE(M3))
0268 GO TO 1955
0269 2177 X = STORE(M3)
0270 STORE(M3) = EXP(-STORE(M3))
0271 GO TO 2322
C
C PASCAL
C
0272 2188 IF(STORE(M3).LE.0.0.OR.STORE(M3).GE.1.0) GO TO 2199
0273 N = STORE(M4) + 0.001
0274 Z = N
0275 IF(Z.EQ.STORE(M4).AND.N.GT.0.AND.STORE(M1).GE.0.0) GO TO 2211
0276 CALL ERROR (2200)
0277 GO TO 1788
0278 2211 X = (STORE(M4)*(1.0 - STORE(M3)))/STORE(M3)
0279 Y = X/STORE(M3)
0280 STORE(M3) = -ALOG(1.0 - STORE(M3))
0281 GO TO 2300
C
C BINOMIAL
C
0282 2222 IF(STORE(M3).LE.0.0.OR.STORE(M3).GE.1.0) GO TO 2233
0283 N = STORE(M4) + 0.001
0284 Z = N
0285 IF(Z.EQ.STORE(M4).AND.N.GT.0.AND.STORE(M1).GE.0.0) GO TO 2255
0286 CALL ERROR (2244)
0287 GO TO 1788
0288 2255 X = STORE(M4)*STORE(M3)
0289 Y = X*(1.0 - STORE(M3))
0290 GO TO 2300
C
C HYPERGEOMETRIC
C
0291 2266 IF(STORE(M3).GT.0.0.AND.STORE(M3).LT.1.0) GO TO 2299
0292 2277 CALL ERROR (2288)
0293 GO TO 1788
0294 2299 N = STORE(M4) + 0.001
0295 Z = N
0296 ISAVE = STORE(M5) + 0.001
0297 X = ISAVE
0298 OIF(Z.NE.STORE(M4).OR.X.NE.STORE(M5).OR.N.LE.1.0.
0299 1 ISAVE.LE.0.0.N.LE.ISAVE.OR.STORE(M1).LT.0.0) GO TO 2277
0300 X = STORE(M5)*STORE(M3)
0301 Z = (STORE(M4) - STORE(M5))/(STORE(M4) - 1.0)
Y = X*(1.0 - STORE(M3))*Z
C
C CHECK FOR POSITIVE VARIANCE, MEAN WITHIN MIN-MAX, MIN-MAX OKAY
C
0302 2300 IF(Y.LE.0.0) CALL ERROR (2311)
0303 2322 IF(X.LT.STORE(M1).OR.X.GT.STORE(M2)) CALL ERROR (2333)
0304 2344 IF(STORE(M1).GE.STORE(M2)) CALL ERROR (2355)

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GLM 5070
GLM 5080
GLM 5090
GLM 5100
GLM 5110
GLM 5120
GLM 5130
GLM 5140
GLM 5150
GLM 5160
GLM 5170
GLM 5180
GLM 5190
GLM 5200
GLM 5210
GLM 5220
GLM 5230
GLM 5240
GLM 5250
GLM 5260
GLM 5270
GLM 5280
GLM 5290
GLM 5300
GLM 5310
GLM 5320
GLM 5330
GLM 5340
GLM 5350
GLM 5360
GLM 5370
GLM 5380
GLM 5390
GLM 5400
GLM 5410
GLM 5420
GLM 5430
GLM 5440
GLM 5450
GLM 5460
GLM 5470
GLM 5480
GLM 5490
GLM 5500
GLM 5510
GLM 5520
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GLM 5540
GLM 5550
GLM 5560
GLM 5570
GLM 5580
GLM 5590

```

0305      GO TO 1788
C
C      STORE HISTOGRAM DATA
C
2366 DO 2377 N=1,7
      KOUNT = KOUNT + 1
      IF(KOUNT.GT.MAXSTO) GO TO 1888
      STORE(KOUNT) = STIME(N)
      IF(STIME(N).EQ.-999.0) GO TO 2388
2377 CONTINUE
      GO TO 1799
C
C      CHECK OUT THE HISTOGRAM
C
2388 ISAVE = -9998
      M5 = KOUNT - 1
      X = 0.0
      DO 2411 N=M2,M5,2
        IF(STORE(N).LT.0.0) CALL ERROR (2399)
        X = X + STORE(N)
        IF(STORE(N-1).EQ.STORE(N+1).AND.STORE(N).GT.0.0) CALL ERROR (2400)
2411 IF(STORE(N-1).GT.STORE(N+1)) CALL ERROR (2422)
      IF(X.GT.0.99.AND.X.LT.1.01) GO TO 1788
      CALL ERROR (2433)
      GO TO 1788
C
C      PRINT VARIABLE STORAGE UTILIZATION AND PREPARE FOR SIMULATION
C
2444 X = (100.0*FLOAT(KOUNT))/FLOAT(MAXSTO)
      WRITE (IOUT,2455) X
2455 FORMAT (1H0, 20X, 36H0/0 OF STOCHASTIC STORAGE UTILIZED =, F6.2)
C
C      THE FOLLOWING 2 ARRAYS COLLECT THE NUMBER OF TIMES AND THE LENGTH
C      OF TIME THE FOLLOWING ITEMS OF INTEREST OCCURRED
C
      1. THE TIME THE CRANE SPENTS TRAVELING
      2. THE TIME THE CRANE IS NOT DOING ANYTHING
      3. THE TIME THE CRANE SPENTS PICKING BILLETS UP
      4. THE TIME THE CRANE SPENTS SETTING BILLETS DOWN
      5. THE TIME THE CRANE SPENTS SQUARING BILLETS UP FOR THE FEEDER
      6. THE TIME THE CRANE SPENTS SWING BILLETS INTO POSITION ON THE
      OPEN BAY STORAGE STACKS
      7. THE TIME THE CRANE IS IDLED BY BREAKS (COFFEE, LUNCH, SHIFT)
      8. THE TIME FEEDER NUMBER 1 WAITS FOR SERVICE
      9. THE TIME FEEDER NUMBER 2 WAITS FOR SERVICE
      10. THE TIME FEEDER NUMBER 3 WAITS FOR SERVICE
C
      DO 2466 I=1,10
        NTIME(I) = 0
        STIME(I) = 0.0
        SMIN(I) = SETUP
2466 SMAX(I) = -SETUP
      RETURN
      END

```

0327
0328
0329
0330
0331
0332
0333

```

0001 SUBROUTINE SIM
0002 0COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM 6140
      1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM 6150
      2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM 6160
      3MAXQH, MAXHEI, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM 6180
      4RORR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM 6190
      5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM 6200
      0COMMON/STO/STORE( 300), KEY(50), ETIME(10), IBAY(36,3), XBAY(36), GLM 6210
      1YBAY(36), INV8(36,6), MXINVB(36), INVT(36), IUSE(36), INV8(3,20), GLM 6220
      2INVQT(3), IPOOL(3), LEVELP(3), IFEEP(3), IBTOP(3), NCHAR(3), NFEED(3), GLM 6230
      3MASK(3), XFEED(3), YFEED(3), XWORK(3), YWORK(3), MININV(3), GLM 6240
      4MAXINV(3), AVEINV(3), NTIME(10), STIME(10), SMIN(10), SMAX(10) GLM 6250
      GLM 6260
      GLM 6270
      GLM 6280
      GLM 6290
      GLM 6300
      GLM 6310
      GLM 6320
      GLM 6330
      GLM 6340
      GLM 6350
      GLM 6360
      GLM 6370
      GLM 6380
      GLM 6390
      GLM 6400
      GLM 6410
      GLM 6420
      GLM 6430
      GLM 6440
      GLM 6450
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      GLM 6470
      GLM 6480
      GLM 6490
      GLM 6500
      GLM 6510
      GLM 6520
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      GLM 6540
      GLM 6550
      GLM 6560
      GLM 6570
      GLM 6580
      GLM 6590
      GLM 6600
      GLM 6610
      GLM 6620
      GLM 6630
      GLM 6640
      GLM 6650
      GLM 6660

0003 CHECK THE DISTRIBUTIONS FOR THEIR PERFORMANCE

      IF(IP55.NE.0) GO TO 2533
      L = ISEED
      M = 1
      N = 10
2477 IF(N.GT.LOOK) N = LOOK
      WRITE (IOUT,2488) (I, I=M,N)
2488 FORMAT (1H1, 20X, 23HSTOCHASTIC DATA SAMPLES/ 1H0, 6X, 10I12)
      DO 2500 I=1,50
      K = 0
      DO 2499 J=M,N
      K = K + 1
      CALL GEN(J)
2499 ETIME(K) = X
2500 WRITE (IOUT,2511) I, (ETIME(J), J=1,K)
2511 FORMAT (1H, 15, 1H., 10F12.2)
      IF(N.EQ.LOOK) GO TO 2522
      M = M + 10
      N = N + 10
      GO TO 2477

C INITIALIZE WORK VARIABLES
C NCAR = NUMBER BILLET LEFT IN THE RAILROAD CAR BEING UNLOADED
C IPAGE = PAGE COUNTER
C LINE = LINE COUNTER
C WAITMX = MAX TIME AN EVENT WAITS BEFORE PROGRAM STOP
C
2522 ISEED = L
2533 LOOK = 0
      NCAR = 0
      IPAGE = 1
      LINE = 999
      CALL GEN(42)
      WAITMX = X

C DETERMINE WHICH EVENT WILL OCCUR NEXT
C
2544 TNEXT = SETUP
      DO 2555 I=1,MAXEVT

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0032 IF(ETIME(I).GE.TNEXT) GO TO 2555
0033 IVENT = I
0034 TNEXT = ETIME(I)
0035 2555 CONTINUE
0036 IF(TNEXT.LT.SMSTOP) GO TO 2566
0037 TNEXT = SMSTOP
0038 IVENT = 11
C
C IF AN INDEPENDENT EVENT HAS NOT OCCURRED, DETERMINE IF A WORK AREA
C (STAGGING AREA) NEEDS MORE RAW STOCK
C
0039 2566 IF(CLOCK.GE.TNEXT) GO TO 2722
0040 K = 0
0041 N = 0
0042 DO 2577 I=1,MAXTYP
0043 IF(IPOOL(I).GE.LEVELP(I)) GO TO 2577
0044 L = LEVELP(I) - IPOOL(I)
0045 IF(L.LE.N) GO TO 2577
0046 K = I
0047 N = L
0048 2577 CONTINUE
0049 IF(K.EQ.0) GO TO 2588
0050 CALL CARRY(K)
0051 IF(K.EQ.999) RETURN
0052 GO TO 2566
C
C IS A HEAT CURRENTLY BEING UNLOADED, IF NOT, ARE THERE HEATS QUEUED
C IN THE RAILROAD CARS WAITING TO BE UNLOADED
C
0053 2588 IF(MATUNL.NE.0) GO TO 2666
0054 N = 0
0055 DO 2599 I=1,MAXTYP
0056 N = N + INVQT(I)
0057 MASK(I) = 0
0058 IF(N.EQ.0) GO TO 2711
C
C SELECT THE TYPE OF MATERIAL (5 1/4, 6, 7 3/8) TO UNLOAD, DEPENDING
C ON QUE LENGTH AND PROVIDING THERE IS ROOM TO UNLOAD IT
C
0059 2600 N = 0
0060 DO 2611 I=1,MAXTYP
0061 IF(MASK(I).NE.0) GO TO 2611
0062 IF(N.GE.INVQT(I)) GO TO 2611
0063 N = INVQT(I)
0064 MATUNL = I
0065 2611 CONTINUE
0066 IF(N.EQ.0) GO TO 2711
C
C SELECT THE BAY TO UNLOAD INTO IF IT HAS ENOUGH ROOM AND IT IS NOT
C CURRENTLY SUPPLYING A FEEDER
C
0067 K = 9999
0068 DO 2622 I=1,MAXBAY

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0069 IF(I.EQ.IFEED(MATUNL)) GO TO 2622 GLM 7190
0070 J = IBAYP(I,MATUNL) GLM 7200
0071 IF(J.LE.0.OR.J.GT.K) GO TO 2622 GLM 7210
0072 IF(INVQ(MATUNL,1)+INVB(I).GT.MXINVB(I)) GO TO 2622 GLM 7220
0073 K = J GLM 7230
0074 IPTBAY = I GLM 7240
0075 2622 CONTINUE GLM 7250
GLM 7260
C ARE THE BAYS WHICH HOLD THIS TYPE OF MATERIAL FULL, IF YES, MASK GLM 7270
C THIS MATERIAL FROM FURTHER UNLOADING CONSIDERATION AND THEN GO GLM 7280
C BACK TO SELECT UNLOADING ANOTHER TYPE OF MATERIAL GLM 7290
C GLM 7300
IF(K.NE.9999) GO TO 2633 GLM 7310
MASK(MATUNL) = 1 GLM 7320
IPTBAY = 0 GLM 7330
MATUNL = 0 GLM 7340
ITOP = 0 GLM 7350
GO TO 2600 GLM 7360
C GLM 7370
C RECORD BAY USAGE AND FIND TOP OF THE PILE IN TERMS OF HEATS GLM 7380
C GLM 7385
2633 IUSE(IPTBAY) = IUSE(IPTBAY) + 1 GLM 7390
DO 2644 J=1,MAXHET GLM 7400
ITOP = J GLM 7410
IF(INVB(IPTBAY,J).EQ.0) GO TO 2666 GLM 7420
2644 CONTINUE GLM 7430
CALL ERROR (2655) GLM 7440
RETURN GLM 7450
C GLM 7460
C GLM 7470
C GLM 7480
C GLM 7490
C GLM 7500
C GLM 7510
C GLM 7520
C GLM 7530
C GLM 7540
C GLM 7550
C GLM 7560
C GLM 7570
C GLM 7580
C COMPUTE THE TRAVEL TIME TO THE RAILROAD CAR AND CHECK TO SEE IF ANGLM 7590
C INDEPENDENT EVENT HAS OCCURRED GLM 7600
C GLM 7610
C GLM 7620
C GLM 7630
C GLM 7640
C GLM 7650
C GLM 7660
C GLM 7670
C GLM 7680
C GLM 7690
C GLM 7700
2677 XDIS = ABS(XNOW - XCAR)
YDIS = ABS(YNOW - YCENTR)
CALL TRPREP(XDIS,YDIS)
XNOW = XCAR
YNOW = YCENTR
IF(CLOCK.GE.TNEXT) GO TO 2722
C
C GENERATE A PICK, TRANSFER, SWING AND LASTLY A SET DOWN TIME
C

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FORTAN	IV	G	LEVEL	21	SIM	DATE = 76252	08/12/32
0104	CALL	GEN(11)				GLM 7710	
0105	NTIME(3) = NTIME(3) + 1					GLM 7720	
0106	STIME(3) = STIME(3) + X					GLM 7730	
0107	IF(X.LT.SMIN(3)) SMIN(3) = X					GLM 7740	
0108	IF(X.GT.SMAX(3)) SMAX(3) = X					GLM 7750	
0109	CALL SNAP					GLM 7760	
0110	XDIS = ABS(XNOW - XBAY(IPTBAY))					GLM 7770	
0111	YDIS = ABS(YNOW - YBAY(IPTBAY))					GLM 7780	
0112	CALL TRPREP(XDIS,YDIS)					GLM 7790	
0113	XNOW = XBAY(IPTBAY)					GLM 7800	
0114	YNOW = YBAY(IPTBAY)					GLM 7810	
0115	CALL GEN(12)					GLM 7820	
0116	NTIME(6) = NTIME(6) + 1					GLM 7830	
0117	STIME(6) = STIME(6) + X					GLM 7840	
0118	IF(X.LT.SMIN(6)) SMIN(6) = X					GLM 7850	
0119	IF(X.GT.SMAX(6)) SMAX(6) = X					GLM 7860	
0120	CALL SNAP					GLM 7870	
0121	CALL GEN(13)					GLM 7880	
0122	NTIME(4) = NTIME(4) + 1					GLM 7890	
0123	STIME(4) = STIME(4) + X					GLM 7900	
0124	IF(X.LT.SMIN(4)) SMIN(4) = X					GLM 7910	
0125	IF(X.GT.SMAX(4)) SMAX(4) = X					GLM 7920	
0126	CALL SNAP					GLM 7930	
C						GLM 7940	
C	GENERATE THE NO. OF BILLETS PICKED OUT OF THE CAR, DECREASE THE					GLM 7950	
C	CAR AND QUE INVENTORY AND INCREASE THE BAY INVENTORY BY THE					GLM 7960	
C	PICK LOAD, IF AN INDEPENDENT EVENT HAS NOT OCCURRED, RETURN TO					GLM 7970	
C	PICK UP ANOTHER LOAD OUT OF THE RAILROAD CAR					GLM 7980	
C						GLM 7990	
0127	CALL GEN(MATUNL+14)					GLM 8000	
0128	I = X + 0.5					GLM 8010	
0129	J = NCAR - I					GLM 8020	
0130	IF(J.LT.0) I = NCAR					GLM 8030	
0131	NCAR = NCAR - I					GLM 8040	
0132	INVB(IPTBAY,I TOP) = INVB(IPTBAY,I TOP) + I					GLM 8050	
0133	INVT(IPTBAY) = INVT(IPTBAY) + I					GLM 8060	
0134	INVQ(MATUNL,1) = INVQ(MATUNL,1) - I					GLM 8070	
0135	INVGT(MATUNL) = INVGT(MATUNL) - I					GLM 8080	
0136	IF(INVQ(MATUNL,1).EQ.0) GO TO 2688					GLM 8090	
0137	IF(CLOCK.GE.TNEXT) GO TO 2722					GLM 8100	
0138	GO TO 2666					GLM 8110	
C						GLM 8120	
C	THE HEAT BEING UNLOADED IS NOW COMPLETELY UNLOADED, RESTACK THE					GLM 8130	
C	CAR QUE, ZERO THE BAY AND MATERIAL UNLOAD POINTERS					GLM 8140	
C						GLM 8150	
2688	DO 2699 L=2,MAXQUE					GLM 8160	
	INVQ(MATUNL,L-1) = INVQ(MATUNL,L)					GLM 8170	
	IF(INVQ(MATUNL,L).EQ.0) GO TO 2700					GLM 8180	
2699	CONTINUE					GLM 8190	
	INVQ(MATUNL,MAXQUE) = 0					GLM 8200	
2700	IPTBAY = 0					GLM 8210	
	MATUNL = 0					GLM 8220	
0146	ITOP = 0					GLM 8230	

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0147      GO TO 2566
C
C      SLACK HAS OCCURRED (THE CRANE HAS NOTHING TO DO FOR AWHILE) COM-
C      PUTE AND RECORD THE LENGTH OF THIS REST PERIOD
C
2711  X = TNEXT - CLOCK
      NTIME(2) = NTIME(2) + 1
      STIME(2) = STIME(2) + X
      IF(X.LT.SMIN(2)) SMIN(2) = X
      IF(X.GT.SMAX(2)) SMAX(2) = X
      CALL SNAP
C
C      IT IS TIME TO PROCESS AN INDEPENDENT EVENT.  COMPUTE & RECORD THE
C      AMOUNT OF WAIT TIME
C
2722  RESUP = 0.0
      STARTE = CLOCK
      WAITT = STARTE - TNEXT
      IF(WAITT.LE.0.0) GO TO 2733
      IF(WAITT.LT.WMIN) WMIN = WAITT
      IF(WAITT.GT.WMAX) WMAX = WAITT
      WAIT = WAIT + WAITT
      NWAIT = NWAIT + 1
C
C      IF THE CURRENT EVENT IS A FEEDER CALL CHECK TO SEE IF THERE IS
C      ENOUGH BILLETS IN THE WORK AREA FOR 1 CHARGE, IF NOT HAUL SOME
C
2733  IF(IVENT.GT.3) GO TO 2799
2744  IF(IPOOL(IVENT).GE.NCHAR(IVENT)) GO TO 2755
      K = IVENT
      CALL CARRY(K)
      IF(K.EQ.999) RETURN
      NGET = NGET + 1
      GO TO 2744
2755  K = 0
C
C      TRAVEL TO THE WORK AREA
C
2766  XDIS = ABS(XNOW - XWORK(IVENT))
      YDIS = ABS(YNOW - YWORK(IVENT))
      CALL TRPREP(XDIS,YDIS)
      XNOW = XWORK(IVENT)
      YNOW = YWORK(IVENT)
C
C      PICK UP A CHARGE OR A PORTION OF A CHARGE
C
      CALL GEN(27)
      NTIME(3) = NTIME(3) + 1
      STIME(3) = STIME(3) + X
      IF(X.LT.SMIN(3)) SMIN(3) = X
      IF(X.GT.SMAX(3)) SMAX(3) = X
      CALL SNAP
C
GLM 8240
GLM 8250
GLM 8260
GLM 8270
GLM 8280
GLM 8290
GLM 8300
GLM 8310
GLM 8320
GLM 8330
GLM 8340
GLM 8350
GLM 8360
GLM 8370
GLM 8380
GLM 8390
GLM 8400
GLM 8410
GLM 8420
GLM 8430
GLM 8440
GLM 8450
GLM 8460
GLM 8470
GLM 8480
GLM 8490
GLM 8500
GLM 8510
GLM 8520
GLM 8530
GLM 8540
GLM 8545
GLM 8550
GLM 8560
GLM 8570
GLM 8580
GLM 8590
GLM 8600
GLM 8610
GLM 8620
GLM 8630
GLM 8640
GLM 8650
GLM 8660
GLM 8670
GLM 8680
GLM 8690
GLM 8700
GLM 8710
GLM 8720
GLM 8730
GLM 8740
GLM 8750

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C      TRAVEL TO THE FEED TABLE
C
0181      XD1S = ABS(XNOW - XFEED(IVENT))
0182      YD1S = ABS(YNOW - YFEED(IVENT))
0183      CALL TRPREP(XD1S,YD1S)
0184      XNOW = XFEED(IVENT)
0185      YNOW = YFEED(IVENT)
C
C      SET THE CHARGE OR PORTION OF THE CHARGE ON THE FEED TABLE
C
C      CALL GEN(28)
C      NTIME(4) = NTIME(4) + 1
C      STIME(4) = STIME(4) + X
C      IF(X.LT.SMIN(4)) SMIN(4) = X
C      IF(X.GT.SMAX(4)) SMAX(4) = X
C
C      RECORD THE NO. BILLETS TAKEN OUT OF THE POOL AND DETERMINE IF THE
C      CHARGE HAS BEEN COMPLETELY LOADED
C
C      L = NFEED(IVENT)
C      J = K + L
C      IF(J.GT.NCHAR(IVENT)) L = NCHAR(IVENT) - K
C      IPOOL(IVENT) = IPOOL(IVENT) - L
C      CALL SNAP
C
C      IF FIRST LOAD OF THE CHARGE, RECORD AMOUNT OF WAIT TIME
C
C      IF(K.GT.0) GO TO 2788
C      RESUP = CLOCK - TNEXT
C      N = IVENT + 7
C      NTIME(N) = NTIME(N) + 1
C      STIME(N) = STIME(N) + RESUP
C      IF(RESUP.LT.SMIN(N)) SMIN(N) = RESUP
C      IF(RESUP.GT.SMAX(N)) SMAX(N) = RESUP
C      NCOUNT = NCOUNT + 1
C      WRITE (IWF3) N, RESUP
C      IF(RESUP.LE.WAITMX) GO TO 2788
C      CALL ERROR (2777)
C      RETURN
C
C      2788 K = K + L
C      IF(K - NCHAR(IVENT))2766,2855,2855
C
C      IF THE CURRENT EVENT IS AN ARRIVAL OF A HEAT, GENERATE THE SIZE OF
C      THE HEAT, STORE THIS IN THE HEAT QUE
C
C      2799 IF(IVENT.GT.6) GO TO 2833
C      K = IVENT - 3
C      DO 2800 L=1,MAXQUE
C      M = L
C      IF(INVQ(K,L).EQ.0) GO TO 2822
C      2800 CONTINUE
C      CALL ERROR (2811)
C      RETURN
C
GLM 8760
GLM 8770
GLM 8780
GLM 8790
GLM 8800
GLM 8810
GLM 8820
GLM 8830
GLM 8840
GLM 8850
GLM 8860
GLM 8870
GLM 8880
GLM 8890
GLM 8900
GLM 8910
GLM 8920
GLM 8930
GLM 8940
GLM 8950
GLM 8960
GLM 8970
GLM 8980
GLM 8990
GLM 9000
GLM 9010
GLM 9020
GLM 9030
GLM 9040
GLM 9050
GLM 9060
GLM 9070
GLM 9080
GLM 9090
GLM 9100
GLM 9110
GLM 9120
GLM 9130
GLM 9140
GLM 9150
GLM 9160
GLM 9170
GLM 9180
GLM 9190
GLM 9200
GLM 9210
GLM 9220
GLM 9230
GLM 9240
GLM 9250
GLM 9260
GLM 9270
GLM 9280

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0218      2822 CALL GEN(K+35)
0219      I = X + 0.5
0220      INVQ(K+M) = I
0221      INVQT(K) = INVQT(K) + I
0222      GO TO 2855
C
C      IF THE CURRENT EVENT IS A BREAK, GENERATE THE LENGTH OF THIS BREAK
C      RECORD IT. SLIP THE FEEDER CALLS BY THIS TIME AND GENERATE THE
C      NEXT TIME THIS EVENT WILL NEXT OCCUR AND TAKE INVENTORY
C
2833      Y = 0.0
      IF (IVENT.GT.10) GO TO 2866
      CALL GEN(IVENT+11)
      NTIME(7) = NTIME(7) + 1
      STIME(7) = STIME(7) + X
      IF (X.LT.SMIN(7)) SMIN(7) = X
      IF (X.GT.SMAX(7)) SMAX(7) = X
      DO 2844 I=1,3
2844      ETIME(I) = ETIME(I) + X
      CALL SNAP
2855      CALL GEN(IVENT)
      Y = TNEXT + X
2866      INVTAL = INVTAL + 1
      DO 2888 J=1,MAXTYP
      K = 0
      DO 2877 I=1,MAXBAY
2877      IF (IBAYP(I,J).GT.0) K = K + INVT(I)
      MASK(J) = K + INVQT(J) + IPOOL(J)
      IF (MASK(J).LT.MININV(J)) MININV(J) = MASK(J)
      IF (MASK(J).GT.MAXINV(J)) MAXINV(J) = MASK(J)
2888      AVEINV(J) = AVEINV(J) + MASK(J)
C
C      IS THIS TIME SEGMENT IS WANTED FOR REVIEW?
C
      IF (CLOCK.LT.TSTART.OR.CLOCK.GT.TSTOP) GO TO 2933
      ICOUNT = ICOUNT + 1
      IF (IPS1.NE.0) GO TO 2922
      I = 0
      J = 0
      K = 0
      IF (IFEED(1).GT.0) I = INVB(IFEED(1),IBTOP(1))
      IF (IFEED(2).GT.0) J = INVB(IFEED(2),IBTOP(2))
      IF (IFEED(3).GT.0) K = INVB(IFEED(3),IBTOP(3))
      IF (LINE.LT.50) GO TO 2900
      WRITE (IOUT,2899) IPAGE
2899      FORMAT (1H1, 50X, 19H EVENT AND INVENTORY, 49X, 6HPAGE =, I4/ 9H0
      1REF EV, 5X, 5HREADY, 5X, 5HSTART, 2X, 4HWAIT, 2X, 2HDO, 3X,
      25HRESUP, 4X, 6HFINISH, 5X, 4HNEXT, 1X, 15HTOTAL INVENTORY, 1X,
      310HBILLETS IN, 2X, 11HBILLET LEFT, 2X, 6HFEEDER, 3X, 10HUNLOAD QUE, GLM 9770
      41X, 3HREC/ 9H NO NO, 5X, 4HTIME, 6X, 4HTIME, 2X,
      54HTIME, 2X, 4HTIME, 6X, 4HTIME, 5X, 4HTIME, 1X, 15H5 1/4 6 7 3/8, GLM 9790
      62X, 9HWORK POOL, 2X, 11HSUPPLY HEAT, 1X, 8HSUPPLIER, 2X,
      710HNO BILLETS, 1X, 3HBAY)
      GLM 9290
      GLM 9300
      GLM 9310
      GLM 9320
      GLM 9330
      GLM 9340
      GLM 9350
      GLM 9360
      GLM 9370
      GLM 9380
      GLM 9390
      GLM 9400
      GLM 9410
      GLM 9420
      GLM 9430
      GLM 9440
      GLM 9450
      GLM 9460
      GLM 9470
      GLM 9480
      GLM 9490
      GLM 9500
      GLM 9510
      GLM 9520
      GLM 9530
      GLM 9540
      GLM 9550
      GLM 9560
      GLM 9570
      GLM 9580
      GLM 9590
      GLM 9600
      GLM 9610
      GLM 9620
      GLM 9630
      GLM 9640
      GLM 9650
      GLM 9660
      GLM 9670
      GLM 9680
      GLM 9690
      GLM 9700
      GLM 9710
      GLM 9720
      GLM 9730
      GLM 9740
      GLM 9750
      GLM 9760
      GLM 9770
      GLM 9780
      GLM 9790
      GLM 9800
      GLM 9810

```

```

FORTRAN IV G LEVEL 21          SIM          DATE = 76252          08/12/32          GLM 9820
0256          IPAGE = IPAGE + 1          GLM 9830
0257          LINE = 0          GLM 9840
0258          2900 LINE = LINE + 1          GLM 9850
0259          X = CLOCK - STARTE          GLM 9860
0260          0WRITE (IOUT,2911) ICOUNT, IVENT, TNEXT, STARTE, WAITT, X, RESUP,          GLM 9870
          ICLOCK, Y, MASK, IPOOL, I, J, K, IFEEED, INVQT, IPTBAY.          GLM 9880
          2911 FORMAT (1H, I5, I3, 2F10.2, 3F6.2, 2F10.2, 315, 614, 313, 414)          GLM 9890
          2922 WRITE (1WF2) INVBT,STIME,XTRAV,YTRAV,XTIME,YTIME,NTIME,ITRAV,JTRAV          GLM 9900
          2933 IF (IVENT.EQ.11) RETURN          GLM 9910
          ETIME(IVENT) = Y          GLM 9920
          GO TO 2544          GLM 9930
          END
0261
0262
0263
0264
0265
0266

```

```

0001 SUBROUTINE CARRY(M)
0002 OCOMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM 9940
1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM 9950
2IPNH, IW1, IW2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM 9960
3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM 9970
4IRORR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM 9980
5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM 9990
OCOMMON/STO/STORE( 300), KEY(50), ETIME(10), IBAYP(36,3), XBAY(36), GLM10000
1YBAY(36), INVB(36,6), MXINVB(36), INVBT(36), IUSE(36), INVQ(3,20), GLM10010
2INVOT(3), IPOOL(3), LEVELP(3), IFEEED(3), IBTOP(3), NCHAR(3), NFEED(3), GLM10020
3MASK(3), XFEED(3), YFEED(3), XWORK(3), YWORK(3), MININV(3), GLM10030
4MAXINV(3), AVEINV(3), NTIME(10), STIME(10), SMIN(10), SMAX(10) GLM10040
GLM10050
GLM10060
C THE FUNCTION OF THIS SUBROUTINE IS THAT OF MODELING THE TRANSPORT-GLM10070
C ING OF ONE LOAD OF BILLETS FROM A BAY TO THE WORK AREA GLM10080
C FIRST, DETERMINE WHICH BAY TO DRAW STOCK FROM, IF BETWEEN HEATSGLM10090
C GLM10100
L = IFEEED(M)
J = IBTOP(M)
IF (L.NE.0) GO TO 2999
K = 9999
DO 2944 I=1,MAXBAY
IF (I.EQ.IPTBAY) GO TO 2944
J = IBAYP(I,M)
IF (J.LE.0.OR.J.GT.K) GO TO 2944
IF (INVB(I,1).LE.0) GO TO 2944
K = J
L = I
2944 CONTINUE
IF (K.NE.9999) GO TO 2966
CALL ERROR (2955)
IRORR = IRORR - 1
CALL ERROR (M)
M = 999
RETURN
C RECORD BAY USAGE AND LOAD THE TOP OF PILE AND BAY POINTERS
C
C 2966 IUSE(L) = IUSE(L) + 1
DO 2977 I=1,MAXHET
J = MAXHET + 1 - I
IF (INVB(L,J).NE.0) GO TO 2988
2977 CONTINUE
2988 IBTOP(M) = J
IFEED(M) = L
C GENERATE TRAVEL TO BAY AND PICK TIME
C
C 2999 XDIS = ABS(XNOW - XBAY(L))
YDIS = ABS(YNOW - YBAY(L))
CALL TRPREP(XDIS,YDIS)
XNOW = YBAY(L)
YNOW = YBAY(L)
GLM 9940
GLM 9950
GLM 9960
GLM 9970
GLM 9980
GLM 9990
GLM10000
GLM10010
GLM10020
GLM10030
GLM10040
GLM10050
GLM10060
GLM10070
GLM10080
GLM10090
GLM10100
GLM10110
GLM10120
GLM10130
GLM10140
GLM10150
GLM10160
GLM10170
GLM10180
GLM10190
GLM10200
GLM10210
GLM10220
GLM10230
GLM10240
GLM10250
GLM10260
GLM10270
GLM10275
GLM10280
GLM10290
GLM10295
GLM10300
GLM10310
GLM10320
GLM10330
GLM10340
GLM10350
GLM10360
GLM10370
GLM10380
GLM10390
GLM10400
GLM10410
GLM10420
GLM10430
GLM10440

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FORTRAN IV G LEVEL 21

```

0034 CALL GEN(22)
0035 NTIME(3) = NTIME(3) + 1
0036 STIME(3) = STIME(3) + X
0037 IF(X.LT.SMIN(3)) SMIN(3) = X
0038 IF(X.GT.SMAX(3)) SMAX(3) = X
0039 CALL SNAP
C
C   GENERATE THE TIME TO TRAVEL TO THE WORK AREA, SET UNSQUARED LOAD
C   DOWN TIME AND THE NUMBER OF BILLETS MOVED
C
0040 YDIS = ABS(XNOW - XWORK(M))
0041 YDIS = ABS(YNOW - YWORK(M))
0042 CALL TRPREP(XDIS,YDIS)
0043 XNOW = XWORK(M)
0044 YNOW = YWORK(M)
0045 CALL GEN(26)
0046 NTIME(4) = NTIME(4) + 1
0047 STIME(4) = STIME(4) + X
0048 IF(X.LT.SMIN(4)) SMIN(4) = X
0049 IF(X.GT.SMAX(4)) SMAX(4) = X
0050 CALL SNAP
0051 CALL GEN(M+22)
0052 I = X + 0.5
0053 IF(INVB(L,J).GT.I) GO TO 3000
0054 I = INVB(L,J)
0055 IF(EED(M) = 0)
0056 I=TOP(M) = 0
0057 INVB(L,J) = INVB(L,J) - I
0058 INVB(L) = INVB(L) - I
0059 IPOOL(M) = IPOOL(M) + I
C
C   GENERATE THE TIME REQUIRED TO SQUARE UP THIS NEW LOAD
C
C
0060 CALL GEN(29)
0061 NTIME(5) = NTIME(5) + 1
0062 STIME(5) = STIME(5) + X
0063 IF(X.LT.SMIN(5)) SMIN(5) = X
0064 IF(X.GT.SMAX(5)) SMAX(5) = X
0065 CALL SNAP
0066 RETURN
0067 END

```

```

0001 SUBROUTINE TRPREP(XDIS,YDIS)
0002 0COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM10860
      1YCENR, SMSTOP, TLOOK, CLAST, TSTARI, TSTOP, X, Y, Z, INPT, IOUT, GLM10870
      2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM10880
      3MAXQUE, MAXHEI, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM10890
      4IRORR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM10900
      5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM10910
      6COMMON/STO/STORE( 300), KEY(50), ETIME(10), IBAYP(36,3), XBAY(36), GLM10920
      71YBAY(36), INV8(36,6), MXINVB(36), INVB(36), IUSE(36), INVC(3,20), GLM10930
      82INVQT(3), IPOOL(3), LEVELP(3), IFEEED(3), IRTOP(3), NCHAR(3), NFEED(3), GLM10940
      93MASK(3), XFEED(3), YFEED(3), XWORK(3), YWORK(3), MININV(3), GLM10950
      4MAXINV(3), AVEINV(3), NTIME(10), STIME(10), SMIN(10), SMAX(10), GLM10960
      5GLM10970
      6GLM10980
      7GLM10990
      8GLM11000
      9GLM11010
      10GLM11020
      11GLM11030
      12GLM11040
      13GLM11050
      14GLM11060
      15GLM11070
      16GLM11080
      17GLM11090
      18GLM11100
      19GLM11110
      20GLM11120
      21GLM11130
      22GLM11140
      23GLM11150
      24GLM11160
      25GLM11170
      26GLM11180
      27GLM11190
      28GLM11200
      29GLM11210
      30GLM11220
      31GLM11230
      32GLM11240
      33GLM11250
      34GLM11260
      35GLM11270
      36GLM11280
      37GLM11290
      38GLM11300
      39GLM11310
      40GLM11320
      41GLM11330
      42GLM11340
      43GLM11350
      44GLM11360
      45GLM11370
      46GLM11380
      47GLM11390

C THIS SUBROUTINE PREPARES DATA FOR COMPUTING X AND Y TRAVEL TIME
C FIRST, COMPUTE THE X TRAVEL TIME
C
      Z = 0.0
      IF(XDIS.EQ.0.0) GO TO 3011
      ITRAV = ITRAV + 1
      XTRAV = XTRAV + XDIS
      CALL GEN(30)
      ACC = X
      CALL GEN(31)
      DCC = X
      CALL GEN(32)
      VTOP = X/60.0
      CALL TRTIME (T,XDIS,ACC,DCC,VTOP)
      XTIME = XTIME + T
      Z = T

C COMPUTE THE Y TRAVEL TIME
C
      3011 T = 0.0
      IF(YDIS.EQ.0.0) GO TO 3022
      JTRAV = JTRAV + 1
      YTRAV = YTRAV + YDIS
      CALL GEN(33)
      ACC = X
      CALL GEN(34)
      DCC = X
      CALL GEN(35)
      VTOP = X/60.0
      CALL TRTIME (T,YDIS,ACC,DCC,VTOP)
      YTIME = YTIME + T
      3022 IF(T.GT.Z) Z = T
      X = Z
      IF(X.EQ.0.0) RETURN
      NTIME(1) = NTIME(1) + 1
      STIME(1) = STIME(1) + X
      IF(X.LT.SMIN(1)) SMIN(1) = X
      IF(X.GT.SMAX(1)) SMAX(1) = X
      CALL SNAP
      RETURN
      END

```

```

FORTTRAN IV G LEVEL 21          TRTIME          DATE = 76252          08/12/32
0001      SUBROUTINE TRTIME (T,DIS,ACC,DCC,VTOP)          GLM11400
C          THIS SUBROUTINE COMPUTES TRAVEL TIME, FIRST TASK IS TO COMPUTE          GLM11410
C          THE ACCELERATION AND DECELERATION DISTANCES          GLM11420
C          GLM11430
C          GLM11440
0002      VTOPSQ = VTOP*VTOP          GLM11450
0003      ADIS = VTOPSQ/(2.0*ACC)          GLM11460
0004      DDIS = VTOPSQ/(2.0*DCC)          GLM11470
0005      R = DIS - (ADIS + DDIS)          GLM11480
C          GLM11490
C          IF THE SUM OF THE ACCELERATION AND DECELERATION DISTANCE IS LESS          GLM11500
C          THAN THE TOTAL TRAVEL DISTANCE, COMPUTE THE TIME OF TRAVEL IN          GLM11510
C          THE 3 SEGMENTS OF ACCELERATION, CONSTANT SPEED, DECELERATION          GLM11520
C          GLM11530
0006      IF(R.LT.0.0) GO TO 3033          GLM11540
0007      T = SQRT((2.0*ADIS)/ACC) + R/VTOP + SQRT((2.0*DDIS)/DCC)          GLM11550
0008      GO TO 3044          GLM11560
C          GLM11570
C          TOP VELOCITY CANNOT BE OBTAINED, COMPUTE ACCELERATION AND DECEL-          GLM11580
C          ERATION TIME BY FINDING THE TRANSFER VELOCITY          GLM11590
C          GLM11600
0009      3033 R = DCC/ACC          GLM11610
0010      T = SQRT((2.0*DIS)/(DCC*(1.0 + R)))          GLM11620
0011      T = R*T + T          GLM11630
0012      T = T/60.0          GLM11640
0013      RETURN          GLM11650
0014      END          GLM11660

```

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SNAP

FORTTRAN IV G LEVEL 21

```

0001 SUBROUTINE SNAP
0002 0COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM11670
1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM11680
2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM11690
3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM11700
4IRROF, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM11710
5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM11720
0COMMON/STO/STORE( 300), KEY(50), ETIME(10), IBAYP(36,3), XBAY(36), GLM11730
1YBAY(36), INVB(36,6), MXINVB(36), INVT(36), IUSE(36), INVQ(3,20), GLM11740
2INVQT(3), IPOOL(3), LEVELP(3), IFEE(3), IBTOP(3), NCHAR(3), NFEED(3), GLM11750
3MASK(3), XFEED(3), YFEED(3), XWORK(3), YWORK(3), MININV(3), GLM11760
4MAXINV(3), AVEINV(3), NTIME(10), STIME(10), SMIN(10), SMAX(10) GLM11770
GLM11780
GLM11790
GLM11800
GLM11810
GLM11820
GLM11830
GLM11840
GLM11850
GLM11860
GLM11870
GLM11880
GLM11890
GLM11900
GLM11910
GLM11920
GLM11930

C THIS SUBROUTINE TAKES A PERIODIC SNAPSHOT OF KEY PARAMETERS OF THE
C SYSTEM TLOOK TIME UNITS APART
C
C
C
CLOCK = CLOCK + X
IF(IPS6.NE.0) RETURN
X = CLOCK - CLAST
IF(X.LT.TLOOK) RETURN
J = X/TLOOK
DO 3055 I=1,J
LOOK = LOOK + 1
CLAST = CLAST + TLOOK
3055 WRITE (IWF1) CLAST, INVBT, INVQT, IPOOL
RETURN
END

```

```

0001
0002
0003
0004
0005
0006
0007
0008
0009

FORTRAN IV G LEVEL 21
SUBROUTINE RANDOM
COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM11940
1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM11950
2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM11960
3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM11970
4IRORR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVTAL, ITRAV, GLM11980
5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM11990
GLM12000
GLM12010
GLM12020
GLM12030
GLM12040
GLM12050
GLM12060
GLM12070
GLM12080
GLM12090
GLM12100
GLM12110
GLM12120
GLM12130
GLM12140

C THIS SUBROUTINE GENERATES UNIFORM DEVIATES ON AN IBM 360 MACHINE
C IN THE EVENT THIS PROGRAM IS PUT ON SOMETHING OTHER THAN 360
C GEAR, ANOTHER UNIFORM GENERATOR MAY BE REQUIRED. ISEED CARRIES
C THE SEED UTILIZED TO MAINTAIN AND CREATE NEW UNIFORM DEVIATES.
C X CARRIES THE UNIFORM DEVIATE. (THIS IS IBM'S RANDU.)
C
ISEED = ISEED*65539
IF (ISEED) 3066, 3077, 3077
3066 ISEED = ISEED + 2147483647 + 1
3077 X = ISEED
X = X*.4656613E-9
RETURN
END

```


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FORTRAN IV G LEVEL 21

GEN

```

0030 C 3166 PROB1 = STORE(I2) - STORE(I1)
0031 Y = (STORE(I3) - STORE(I1))/PROB1
0032 CALL RANDOM
0033 IF(X.GT.Y) GO TO 3177
0034 Y = SQRT(X*Y)
0035 GO TO 3188
0036 3177 Y = 1.0 - SQRT(1.0 - Y - X + X*Y)
0037 3188 X = STORE(I1) + Y*PROB1
0038 GO TO 3377

C
C CREATE A NORMAL OR LOGNORMAL-(M.EQ.5) VARIATE
C
C 3199 CALL NORM
C X = X*STORE(I4) + STORE(I3)
C IF(M.EQ.5) X = EXP(X)
C GO TO 3366

C
C CREATE A GAMMA(M.EQ.6), ERLANG(M.EQ.8) OR PASCAL(M.EQ.12)
C
C 3200 ISAVE = STORE(I4) + 0.001
C IF(M.GT.6) GO TO 3211
C Y = ISAVE
C Y = STORE(I4) - Y
C CALL RANDOM
C IF(X.GT.Y) GO TO 3211
C ISAVE = ISAVE + 1
C 3211 CALL GAM
C X = Y/STORE(I3)
C IF(M.EQ.12) GO TO 3299
C GO TO 3366

C
C CREATE A WEIBULL VARIATE
C
C 3222 CALL RANDOM
C X = STORE(I1) + STORE(I3)*((-ALOG(X))*STORE(I4))
C GO TO 3366

C
C CREATE A CHI SQUARE VARIATE
C
C 3233 PROB1 = 0.0
C IF(STORE(I3).GT.0.0) GO TO 3244
C CALL NORM
C PROB1 = X*X
C 3244 ISAVE = ABS(STORE(I3)) + 0.001
C CALL GAM
C X = Y/0.5 + PROB1
C GO TO 3366

C
C CREATE A BETA VARIATE
C
C 3255 ISAVE = STORE(I3) + 0.5
C CALL GAM

```

GLM12680
GLM12690
GLM12700
GLM12710
GLM12720
GLM12730
GLM12740
GLM12750
GLM12760
GLM12770
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GLM12790
GLM12800
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GLM13180
GLM13190
GLM13200

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GEN

FORTRAN IV G LEVEL 21

```

0067      PROBI = Y
0068      ISAVE = STORE(I4) + 0.5
0069      CALL GAM
0070      X = PROBI/(PROBI + Y)
0071      X = X*(STORE(I2) - STORE(I1)) + STORE(I1)
0072      GO TO 3366

C
C
C      CREATE A POISSON VARIATE
C
3266      ISAVE = 0
0073      Y = 1.0
0074      3277 CALL RANDOM
0075      Y = X*Y
0076      IF(Y.LT.STORE(I3)) GO TO 3288
0077      ISAVE = ISAVE + 1
0078      GO TO 3277
0079      3288 X = ISAVE
0080      GO TO 3366
0081

C
C
C      CREATE A PASCAL VARIATE
C
3299      ISAVE = X
0082      X = ISAVE
0083      GO TO 3366
0084

C
C
C      CREATE A BINOMIAL VARIATE
C
3300      ISAVE = 0
0085      M = STORE(I4) + 0.001
0086      DO 3311 L=1,M
0087      CALL RANDOM
0088      IF(X.GT.STORE(I3)) GO TO 3311
0089      ISAVE = ISAVE + 1
0090      3311 CONTINUE
0091      X = ISAVE
0092      GO TO 3366
0093

C
C
C      CREATE A HYPERGEOMETRIC VARIATE
C
3322      PROBI = STORE(I3)
0094      PROBI2 = STORE(I4)
0095      M = STORE(I1+5) + 0.001
0096      ISAVE = 0
0097      DO 3355 L=1,M
0098      CALL RANDOM
0099      IF(X.GT.PROBI) GO TO 3333
0100      Y = 1.0
0101      ISAVE = ISAVE + 1
0102      GO TO 3344
0103      3333 Y = 0.0
0104      3344 PROBI = (PROBI2*PROBI - Y)/(PROBI2 - 1.0)
0105      3355 PROBI2 = PROBI2 - 1.0
0106      X = ISAVE
0107
GLM13210
GLM13220
GLM13230
GLM13240
GLM13250
GLM13260
GLM13270
GLM13280
GLM13290
GLM13300
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GLM13660
GLM13670
GLM13680
GLM13690
GLM13700
GLM13710
GLM13720
GLM13730

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FORTRAN IV G LEVEL 21	GEN	DATE = 76252	08/12/32	PAGE 0004
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0108	C	PERFORM CHECKS	GLM13740
0109	C		GLM13750
0110	C		GLM13760
0111			GLM13770
			GLM13780
			GLM13790
			GLM13800

```

3366 IF (X.LT.STORE(I1)) X = STORE(I1)
      IF (X.GT.STORE(I2)) X = STORE(I2)
3377 RETURN
      END

```

```

0001 SUBROUTINE NORM
0002 0COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM13810
      1YCENTR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM13820
      2IPNH, IW1, IW2, IW3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM13830
      3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM13840
      4IRRROR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM13850
      5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT, GLM13860
      CALL RANDOM, GLM13870
      Y = X, GLM13880
      CALL RANDOM, GLM13890
      X = ((-2.0*ALOG(Y))**0.5)*(COS(6.283*X))
      RETURN, GLM13900
      END, GLM13910
      GLM13920
      GLM13930

```

```

FORTTRAN IV G LEVEL 21          GAM          DATE = 76252          08/12/32          GLM13940
0001          SUBROUTINE GAM          GLM13950
0002          OCOMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME, GLM13960
          1YCENTR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT, GLM13970
          2IPNH, IW1, IW2, IW3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT, GLM13980
          3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED, GLM13990
          4IRRROR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV, GLM14000
          5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT GLM14010
          Y = 0.0 GLM14020
          DO 3399 I=1,ISAVE GLM14030
          3388 CALL RANDOM GLM14040
          IF(X.LT.0.1E-77) GO TO 3388 GLM14050
          X = ALOG(X) GLM14060
          3399 Y = Y - X GLM14070
          RETURN GLM14080
          END
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0001 SUBROUTINE PLOTS
0002 COMMON CLOCK, SETUP, TNEXT, XNOW, YNOW, XTRAV, YTRAV, XTIME, YTIME,
      1YCENR, SMSTOP, TLOOK, CLAST, TSTART, TSTOP, X, Y, Z, INPT, IOUT,
      2IPNH, IWF1, IWF2, IWF3, MAXBAY, MAXSTO, MAXKEY, MAXTYP, MAXEVT,
      3MAXQUE, MAXHET, IPS1, IPS2, IPS3, IPS4, IPS5, IPS6, IVENT, ISEED,
      4IERROR, LOOK, ICOUNT, ISAVE, MATUNL, IPTBAY, ITOP, INVIAL, ITRAV,
      5JTRAV, WAIT, NWAIT, WMIN, WMAX, NGET, NCOUNT
      6COMMON/STO/STORE( 300), KEY(50), ETIME(10), IBAYP(36,3), XBAY(36), GLM14090
      7GLM14100
      8GLM14110
      9GLM14120
      10GLM14130
      11GLM14140
      12GLM14150
      13GLM14160
      14GLM14170
      15GLM14180
      16GLM14190
      17GLM14200
      18GLM14210
      19GLM14220
      20GLM14230
      21GLM14240
      22GLM14250
      23GLM14260
      24GLM14270
      25GLM14280
      26GLM14290
      27GLM14300
      28GLM14310
      29GLM14320
      30GLM14330
      31GLM14340
      32GLM14350
      33GLM14360
      34GLM14370
      35GLM14380
      36GLM14390
      37GLM14400
      38GLM14410
      39GLM14420
      40GLM14430
      41GLM14440
      42GLM14450
      43GLM14460
      44GLM14470
      45GLM14480
      46GLM14490
      47GLM14500
      48GLM14510
      49GLM14520
      50GLM14530
      51GLM14540
      52GLM14550
      53GLM14560
      54GLM14570
      55GLM14580
      56GLM14590
      57GLM14600
      58GLM14610

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      DATA ABSA7,05,1,15,2,25,1,2,3,4,5,6,7,8,9,1,0/
      0DATA IRLK,1PLUS,1D1,1D2,1D3,1D4,1H,1H,4HTRAV,4HIDLE,4HPICK,
      14HSET,4HSQUA,4HSMWIN,4HBREA,4HELIN,4H-FRE,4H BIL,4HBILL,4HRE B,
      24HG BI,4HK TI,4HG 4HE TI,4HLETS,4HETS 4HILLE,4HLETT,4HMES ,
      34H 4HME 4H UP 4HDOWN,4HETS 4HMS 4H /

      THIS SUBROUTINE DEVELOPS PLOTS AND HISTOGRAMS. FIRST, IF THERE IS
      ANY BAY DATA TO PRINT, PRINT IT

      NOTE---THE FIRST 5 VARIABLES IN THE DIMENSION STATEMENT MUST BE
      ASSIGNED THE SAME VALUE AS THE CHECK VARIABLE NUMB WHICH
      IS USED IN THE FOLLOWING MNEMONIC DIMENSIONING SCHEME.

      DIMENSION NOBS(NUMB), MIN(NUMB), MAX(NUMB), AVE(NUMB), STD(NUMB),
      1IPLOT(100),SIDE(27),RFD(26),CFD(26),ABSA(15),LINEP(25),LINEC(50)
      2GLM14090
      3GLM14100
      4GLM14110
      5GLM14120
      6GLM14130
      7GLM14140
      8GLM14150
      9GLM14160
      10GLM14170
      11GLM14180
      12GLM14190
      13GLM14200
      14GLM14210
      15GLM14220
      16GLM14230
      17GLM14240
      18GLM14250
      19GLM14260
      20GLM14270
      21GLM14280
      22GLM14290
      23GLM14300
      24GLM14310
      25GLM14320
      26GLM14330
      27GLM14340
      28GLM14350
      29GLM14360
      30GLM14370
      31GLM14380
      32GLM14390
      33GLM14400
      34GLM14410
      35GLM14420
      36GLM14430
      37GLM14440
      38GLM14450
      39GLM14460
      40GLM14470
      41GLM14480
      42GLM14490
      43GLM14500
      44GLM14510
      45GLM14520
      46GLM14530
      47GLM14540
      48GLM14550
      49GLM14560
      50GLM14570
      51GLM14580
      52GLM14590
      53GLM14600
      54GLM14610

      NUMB = MAXBAY + 2*MAXTYP
      IF (ICOUNT.EQ.0) GO TO 3544

      LIST THE BAY DATA

      IF (IPS2.NE.0) GO TO 3444
      IPAGE = 1
      LINE = 999
      REWIND IWF2
      DO 3422 I=1,ICOUNT
      IF (LINE.LT.50) GO TO 3411
      WRITE (IOUT,3400) IPAGE, (J, J=1,MAXBAY)
      34000FORMAT (1H1, 54X, 9HBAY TRACE, 55X, 6HPAGE =, 14/ 5HOREF., 40X,
      11HBAY NUMBERS/ 4H NO., 3X, 40I3)
      IPAGE = IPAGE + 1
      LINE = 0
      3411 LINE = LINE + 1
      READ (IWF2) (NOBS(J), J=1,MAXBAY), (AVE(J), J=1,14), (MIN(J), J=1,12)
      3422 WRITE (IOUT,3433) I, (NOBS(J), J=1,MAXBAY)
      3433 FORMAT (1H, 15, 1X, 40I3)
      LIST THE TIME DATA

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0023      C
0024      3444 IF(IPS3.NE.0) GO TO 3499
0025      IPAGE = 1
0026      LINE = 999
0027      REWIND IWF2
0028      DO 3477 I=1,ICOUNT
0029      IF(LINE.LT.50) GO TO 3466
0030      WRITE (IOUT,3455) IPAGE
0031      34550FORMAT (1H1, 54X, 9HTIME DATA, 55X, 6HPAGE =, I4/ 5H0REF., 6X,
0032      16HTRAVEL, 8X, 9HIDLE-FREE, 2X, 15HPICK UP BILLETS, 1X, 14HSET DOWNGLM14710
0033      2 BILL., 1X, 14HSQUARE BILLETS, 2X, 13HSHWING BILLETS, 5X, 6HBREAKS/GLM14720
0034      34H NO., 2X, 7(2X,3HNO.,6X,4HTIME))
0035      IPAGE = IPAGE + 1
0036      LINE = 0
0037      3466 LINE = LINE + 1
0038      READ (IWF2) (NOBS(J),J=1,MAXBAY),(AVE(J),J=1,14),(MIN(J),J=1,12)
0039      3477 WRITE (IOUT,3488) I, (MIN(J), AVE(J), J=1,7)
0040      3488 FORMAT (1H , 15, 7(15,F10.2))
0041      C
0042      C LIST THE TRAVEL DATA
0043      C
0044      3499 IF(IPS4.NE.0) GO TO 3544
0045      IPAGE = 1
0046      LINE = 999
0047      REWIND IWF2
0048      DO 3522 I=1,ICOUNT
0049      IF(LINE.LT.50) GO TO 3511
0050      WRITE (IOUT,3500) IPAGE, (J, J=1,MAXITYP)
0051      35000FORMAT (1H1, 47X, 24HDISTANCE AND FEEDER DATA, 47X, 6HPAGE =, I4/
0052      15H0REF., 4X, 6(1H-), 1X, 11HX DIRECTION, 1X, 6(1H-), 5X, 6(1H-),
0053      21X, 11HY DIRECTION, 1X, 6(1H-), 10X, 32HFEEDER CALLS AND TOTAL WAITGLM14920
0054      3 TIME/ 4H NO.,5X,2(2X,3HNO.,2X,8HDISTANCE,6X,4HTIME,5X),112,2115)
0055      IPAGE = IPAGE + 1
0056      LINE = 0
0057      3511 LINE = LINE + 1
0058      READ (IWF2) (NOBS(J),J=1,MAXBAY),(AVE(J),J=1,14),(MIN(J),J=1,12)
0059      35220WRITE (IOUT,3533) I, MIN(11), AVE(11), AVE(13), MIN(12), AVE(12),
0060      1AVE(14), (MIN(J), AVE(J), J=8,10)
0061      3533 FORMAT (1H , 15,18,F10.0,F10.2,110,F10.0,F10.2,2X,3(15,F10.2))
0062      C
0063      C LIST THE VITAL RUN STATISTICS
0064      C
0065      3544 WRITE (IOUT,3555) CLOCK
0066      35550FORMAT (1H1,20X,67HTRAVEL RESULTS---DISTANCE IN FEET---TOTAL ELAPSGLM15050
0067      1ED TIME IN MINUTES =,F10.2/ 1H0,56X,24HX DIRECTION Y DIRECTION)
0068      DO 3566 I=1,6
0069      AVE(I) = 0.0
0070      IF (ITRAV.NE.0) AVE(1) = XTRAV/FLOAT(ITRAV)
0071      IF (JTRAV.NE.0) AVE(2) = YTRAV/FLOAT(JTRAV)
0072      IF (ITRAV.NE.0) AVE(3) = XTIME/FLOAT(ITRAV)
0073      IF (JTRAV.NE.0) AVE(4) = YTIME/FLOAT(JTRAV)
0074      IF (XTIME.NE.0.0) AVE(5) = XTRAV/XTIME
0075      IF (YTIME.NE.0.0) AVE(6) = YTRAV/YTIME
0076      GLM14620
0077      GLM14630
0078      GLM14640
0079      GLM14650
0080      GLM14660
0081      GLM14670
0082      GLM14680
0083      GLM14690
0084      GLM14700
0085      GLM14710
0086      GLM14720
0087      GLM14730
0088      GLM14740
0089      GLM14750
0090      GLM14760
0091      GLM14770
0092      GLM14780
0093      GLM14790
0094      GLM14800
0095      GLM14810
0096      GLM14820
0097      GLM14830
0098      GLM14840
0099      GLM14850
0100      GLM14860
0101      GLM14870
0102      GLM14880
0103      GLM14890
0104      GLM14900
0105      GLM14910
0106      GLM14920
0107      GLM14930
0108      GLM14940
0109      GLM14950
0110      GLM14960
0111      GLM14970
0112      GLM14980
0113      GLM14990
0114      GLM15000
0115      GLM15010
0116      GLM15020
0117      GLM15030
0118      GLM15040
0119      GLM15050
0120      GLM15060
0121      GLM15070
0122      GLM15080
0123      GLM15090
0124      GLM15100
0125      GLM15110
0126      GLM15120
0127      GLM15130
0128      GLM15140

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0061      0WRITE (IOUT,3577) ITRAV, JTRAV, XTRAV, YTRAV, AVE(1), AVE(2), GLM15150
0062      1XTIME, YTIME, AVE(3), AVE(4), AVE(5), AVE(6) GLM15160
35770FORMAT (32H NUMBER OF TIMES TRAVEL OCCURRED, 23(1H-), 21(3/ 24H TOGLM15170
1TAL DISTANCE TRAVELED, 31(1H-), 2F13.2/ 25H AVERAGE LENGTH OF TRAVGLM15180
2EL, 30(1H-), 2F13.2/ 21H TOTAL TIME OF TRAVEL, 34(1H-), 2F13.2/ GLM15190
323H AVERAGE TIME OF TRAVEL, 32(1H-), 2F13.2/ 24H AVERAGE SPEED OF GLM15200
4TRAVEL, 31(1H-), 2F13.2) GLM15210
      WRITE (IOUT,3588) GLM15220
35880FORMAT (1H0, 20X, 58HPORTION OF TIME THE CRANE SPENT ON ITS ARRAY GLM15230
10F ACTIVITIES/ 1H0, 2X, 8HACTIVITY, 6X, 27HNO. TIMES ACTIVITY OCCUGLM15240
2RRED, 2X, 16HTOTAL TIME SPENT, 8X, 8HAVE TIME, 8X, 8HMIN TIME, 8X, GLM15250
38HMAX TIME, 3X, 17H0/0 OF TOTAL TIME) GLM15260
      DO 3599 I=1,7 GLM15270
      X = 0.0 GLM15280
      Y = 0.0 GLM15290
      IF(NTIME(I).NE.0) X = STIME(I)/FLOAT(NTIME(I)) GLM15300
      IF(CLOCK.NE.0.0) Y = (100.0*STIME(I))/CLOCK GLM15310
35990WRITE (IOUT,3600) ID1(I), ID2(I), ID3(I), ID4(I), NTIME(I), GLM15320
1STIME(I), X, SMIN(I), SMAX(I), Y GLM15330
3600 FORMAT (1H , 4A4, 120, F25.2, 5F16.2) GLM15340
      C GLM15350
      C GLM15360
      C GLM15370
      C GLM15380
      C GLM15390
      X = WAIT/FLOAT(NWAIT)
      WRITE (IOUT,3611) NWAIT, WAIT, X, WMIN, WMAX, NGET
36110FORMAT (1H0, 20X, 60HAMOUNT OF TIME INDEPENDENT EVENTS HAD TO WAITGLM15400
1 FOR PROCESSING/ 28H NO TIMES WAITING OCCURRED =, 16, 3X, 7HTOTAL GLM15410
2=, F12.2, 3X, 5HAVE =, F6.2, 3X, 5HMIN =, F6.2, 3X, 5HMAX =, F6.2/GLM15420
382HNO OF TIMES A FEEDER HAD TO WAIT FOR THE HAULING OF BILLETS PRGLM15430
4IOR TO LOADING IT =, 16/ 1H0, 20X, 50HFEED TABLE REVIEW (NOTE FOLLGLM15440
50W ON HISTOGRAMS ALSO)/ 11H FEED TABLE, 4X, 20HNO OF TIMES SERVICEGLM15450
6D, 3X, 15HTOTAL WAIT TIME, 3X, 13HAVE WAIT TIME, 3X, 13HMIN WAIT TGLM15460
7IME, 3X, 13HMAX WAIT TIME)
      DO 3622 I=8,10 GLM15470
      J = I - 7 GLM15480
      AVE(J) = 0.0 GLM15490
      IF(NTIME(I).NE.0) AVE(J) = STIME(I)/FLOAT(NTIME(I)) GLM15500
3622 WRITE (IOUT,3633) J, NTIME(I), STIME(I), AVE(J), SMIN(I), SMAX(I) GLM15510
3633 FORMAT (1H , 18, 120, F24.2, 3F16.2) GLM15520
      C GLM15530
      C GLM15540
      C GLM15550
      C GLM15560
      C GLM15570
      C GLM15580
      C GLM15590
      DO 3644 I=1,MAXTYP
3644 MIN(I) = AVEINV(I)/FLOAT(INVTAL) * 0.5
      WRITE (IOUT,3655) INVTAL,MININV,MAXINV,(MIN(I), I=1,3),MASK,INVQT GLM15600
36550FORMAT (1H0, 20X, 26HINVENTORY REVIEW (BILLETS)/ 16H TOTAL INVENTOGLM15610
1RY, 5X, 5H5 1/4, 9X, 1H6, 5X, 16H7 3/8 - NO OBS =, 110/ 1H , 12X, GLM15620
23HMIN, 3110/ 1H , 12X, 3HMAX, 3110/ 1H , 12X, 3HAVE, 3110/ 1H , GLM15630
312X, 3HEND, 3110/ 16HOCAR QUES AT END, 3110/ 1H0, 4(28H BAY END INGLM15640
4V NO USES 0/0 USE,2X)) GLM15650
      K = 0 GLM15660
      DO 3666 I=1,MAXBAY GLM15670
3666 K = K + IUSE(I)

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0088 DO 3677 I=1,NUMR
0089 NOBS(I)= 0
0090 MIN(I) = 0
0091 MAX(I) = 0
0092 STD(I) = 0.0
0093 IF(I.GT.MAXBAY) GO TO 3677
0094 NOBS(I)= I
0095 MIN(I) = INVT(I)
0096 MAX(I) = IUSE(I)
0097 STD(I) = 100.0*(FLOAT(IUSE(I))/FLOAT(K))
0098
0099 3677 CONTINUE
0100 ISAVE = FLOAT(MAXBAY)/4.0 + 0.999
0101 DO 3688 I=1,ISAVE
0102 J = I + ISAVE
0103 K = I + ISAVE*2
0104 L = I + ISAVE*3
0105
0106 3688 WRITE (IOUT,3699) NOBS(I), MIN(I), MAX(I), STD(I), NOBS(J),
0107 1MIN(J), MAX(J), STD(J), NOBS(K), MIN(K), MAX(K), STD(K), NOBS(L),
0108 2MIN(L), MAX(L), STD(L)
0109
0110 3699 FORMAT (1H , 4(13,1H.,2I8,F8.3,2X))
0111
0112 C
0113 C PUNCH CONTINUATION CARDS FOR FUTURE RUNS - CONTROL AND BAY CARDS
0114 C FIRST - REDUCE FUTURE EVENT TIMES BY THE CURRENT CLOCK READING
0115 C
0116 DO 3700 I=1,MAXEVT
0117 3700 ETIME(I) = ETIME(I) - SMSTOP
0118
0119 0WRITE (IPNH,3711) XNOW, YNOW, ISEED, MATUNL, IPTBAY, ITOP, IFEEED,
0120 1IBTOP, LEVELP, NCHAR, NFEED, (XFEED(I), YFEED(I), I=1,MAXTYP),
0121 2(XWORK(I), YWORK(I), I=1,MAXTYP), ((INVO(I,J), J=1,MAXQUE),
0122 3I=1,MAXTYP), (ETIME(I), I=1,MAXEVT)
0123
0124 3711 FORMAT (26X, 2F4.0, 110, 18I2/ 12F6.1/ 2014/ 2014/ 10F8.2)
0125
0126 DO 3722 I=1,MAXBAY
0127 3722 WRITE (IPNH,3733) I, (IBAYP(I,J), J=1,MAXTYP), XRAY(I), YBAY(I),
0128 1MXINVB(I), (INVB(I,J), J=1,MAXHET)
0129
0130 3733 FORMAT (4I2, 2F6.1, 11I5)
0131
0132 C
0133 C CONSTRUCT HISTOGRAMS OF THE WAIT TIME EXPERIENCED BY EACH FEEDER
0134 C
0135 DO 3877 I=1, MAXTYP
0136 WRITE (IOUT,3744) I
0137 3744 FORMAT (1H1, 20X, 27HWAIT TIME OF FEED TABLE NO., I3)
0138
0139 REWIND IWF3
0140 STD(I) = 0.0
0141 M = I + 7
0142
0143 SIDE(I) = SMIN(M)
0144 SIDE(27)= SMAX(M)
0145 X = (SIDE(27) - SIDE(I))/26.0
0146
0147 DO 3755 J=1,25
0148 3755 SIDE(J+1) = SIDE(J) + X
0149
0150 DO 3766 J=1,26
0151 3766 RFD(J) = 0.0
0152
0153 DO 3799 J=1,NCOUNT
0154 READ (IWF3) N, X
0155
0156 GLM15680
0157 GLM15690
0158 GLM15700
0159 GLM15710
0160 GLM15720
0161 GLM15730
0162 GLM15740
0163 GLM15750
0164 GLM15760
0165 GLM15770
0166 GLM15780
0167 GLM15790
0168 GLM15800
0169 GLM15810
0170 GLM15820
0171 GLM15830
0172 GLM15840
0173 GLM15850
0174 GLM15860
0175 GLM15870
0176 GLM15880
0177 GLM15890
0178 GLM15900
0179 GLM15910
0180 GLM15920
0181 GLM15930
0182 GLM15940
0183 GLM15950
0184 GLM15960
0185 GLM15970
0186 GLM15980
0187 GLM15990
0188 GLM16000
0189 GLM16010
0190 GLM16020
0191 GLM16030
0192 GLM16040
0193 GLM16050
0194 GLM16060
0195 GLM16070
0196 GLM16080
0197 GLM16090
0198 GLM16100
0199 GLM16110
0200 GLM16120
0201 GLM16130
0202 GLM16140
0203 GLM16150
0204 GLM16160
0205 GLM16170
0206 GLM16180
0207 GLM16190
0208 GLM16200

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0128 IF(N,NE,M) GO TO 3799
0129 Y = AVE(I) - X
0130 STD(I) = STD(I) + Y*Y
0131 DO 3777 K=2,26
0132 L = K - 1
0133 IF(X,LT,SIDE(K)) GO TO 3788
0134 3777 CONTINUE
0135 L = 26
0136 3788 RFD(L) = RFD(L) + 1.0
0137 3799 CONTINUE
0138 DO 3800 J=1,26
0139 RFD(J) = RFD(J)/FLOAT(NTIME(M))
0140 CFD(J) = RFD(J)
0141 3800 IF(J,GT,1) CFD(J) = CFD(J) + CFD(J-1)
C
C PRINT THE HISTOGRAM
C
0142 WRITE (IOUT,3811) ABSA, SIDE(1), SIDE(1)
0143 38110FORMAT (1H0, 18X, 4H RFD, 5F5.2, 21X, 4H CFD, 10(F4.1, 1X)/ 1H,
1F18.4, 2H I, 5(5H----I), 4H MIN, F19.4, 2H I, 10(5H----I), 4H MIN)GLM16210
DO 3866 J=1,26
DO 3822 K=1,25
LINEP(K) = IBLK
X = FLOAT(K)/100.0
3822 IF(X,LE,RFD(J)) LINEP(K) = IPLUS
0144 DO 3833 K=2,100.2
0145 L = K/2
0146 LINEC(L) = IBLK
0147 X = FLOAT(K)/100.0 - 0.01
0148 3833 IF(X,LE,CFD(J)) LINEC(L) = IPLUS
0149 38440WRITE (IOUT,3855) LINEP,RFD(J),LINEC,CFD(J),SIDE(J+1),SIDE(J+1)
0150 38550FORMAT (1H, 18X, 2H I, 25A1, F5.3, 18X, 2H I, 50A1, F5.3/ 1H,
12(F18.4, 2H I, 30X))GLM16220
3866 CONTINUE
X = NTIME(M) - 1
STD(I) = SQRT(STD(I)/X)
0151 3877 WRITE (IOUT,3888) STD(I)
0152 3888 FORMAT (1H, 45X, 4H MAX, 72X, 4H MAX/ 10H0STD DEV =, F10.2)
0153 IF(IPS6,NE,0) RETURN
C
C COMPUTE MIN, MAX, AVE, STD
C
0162 DO 3899 I=1,NUMB
0163 MIN(I) = 999999
0164 MAX(I) = -999999
0165 AVE(I) = 0.0
0166 STD(I) = 0.0
0167 3899 CONTINUE
DO 3911 I=1,LOOK
READ (IWF1) CLOCK, NOBS
0168 DO 3900 J=1,NUMB
0169 IF(NOBS(J),LT,MIN(J)) MIN(J) = NOBS(J)
0170 IF(NOBS(J),GT,MAX(J)) MAX(J) = NOBS(J)
0171 IF(NOBS(J),GT,MAX(J)) MAX(J) = NOBS(J)
0172

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0173 3900 AVE(J) = AVE(J) + NOBS(J)
0174 3911 CONTINUE
0175 DO 3922 J=1,NUMB
0176 3922 AVE(J) = AVE(J)/FLOAT(LOOK)
0177 REWIND IWF1
0178 DO 3944 I=1,LOOK
0179 READ (IWF1) CLOCK, NOBS
0180 DO 3933 J=1,NUMB
0181 X = FLOAT(NOBS(J)) - AVE(J)
0182 X = X*X
0183 3933 STD(J) = STD(J) + X
0184 3944 CONTINUE
0185 X = LOOK - 1
0186 IF(X.LE.0.0) GO TO 3999
0187 DO 3955 J=1,NUMB
0188 3955 STD(J) = SORT(STD(J)/X)
C
C LIST STATISTICS FOR SNAPSHOT INTERVALS
C
0189 WRITE (IOUT,3966) LOOK
0190 3966 FORMAT (1H1, 10X, 38HSTATISTICS FOR ITEMS LISTED - NO OBS =, 16/
18H0ITEM NO, 9X, 3HMIN, 9X, 3HMAX, 9X, 3HAVE, 5X, 7HSTD DEV)
0191 DO 3977 I=1,NUMB
0192 3977 WRITE (IOUT,3988) I, MIN(I), MAX(I), AVE(I), STD(I)
0193 3988 FORMAT (1H, 16, 1H., 21I2, 2F12.2)
C
C PLOT BAY STOCK LEVEL
C
0194 DO 4044 I=1,MAXBAY
0195 IF(MAX(I).EQ.MIN(I)) GO TO 4044
0196 REWIND IWF1
0197 LAST = -99999
0198 X = MXINVB(I)
0199 WRITE (IOUT,4000) I
0200 FORMAT (1H0, 10X, 28HSTOCK LEVEL (BILLETS) OF BAY, 13)
0201 DO 4033 J=1,LOOK
0202 READ (IWF1) CLOCK, NOBS
0203 IF(LAST.EQ.NOBS(I)) GO TO 4033
0204 LAST = NOBS(I)
0205 K = 99.0*(1.0 - (X - FLOAT(NOBS(I)))/X) + 1.5
0206 DO 4011 L=1,100
0207 IPLOT(L) = IBLK
0208 IPLOT(K) = IPLUS
0209 WRITE (IOUT,4022) J, CLOCK, IPLOT, NOBS(I)
0210 4022 FORMAT (1H, 15, F12.2, 1H*, 100AL, 1H*, 16)
0211 4033 CONTINUE
0212 4044 CONTINUE
C
C PLOT MATERIAL IN CARS QUES
C
0213 LOW = MAXBAY + 1
0214 IUP = MAXBAY + MAXTYP
0215 DO 4088 I=LOW,IUP

```

```

0216      REWIND IWFL
0217      LAST = -99999
0218      WRITE (IOUT,4055) I
0219      FORMAT (I10, 10X, 24HCAR QUE PLOT OF MATERIAL, IS)
0220      IRAN = MAX(I) - MIN(I)
0221      DO 4077 J=1,LOOK
0222      READ (IWFL) CLOCK, NOBS
0223      IF (LAST.EQ.NOBS(I)) GO TO 4077
0224      LAST = NOBS(I)
0225      K = 99.0*(1.0 - (FLOAT(MAX(I) - NOBS(I))/FLOAT(IRAN))) * 1.5
0226      DO 4066 L=1,100
0227      IPLOT(L) = IBLK
0228      IPLOT(K) = IPLUS
0229      WRITE (IOUT,4022) J, CLOCK, IPLOT, NOBS(I)
0230      4077 CONTINUE
0231      4088 CONTINUE
C
C      CONSTRUCT HISTOGRAMS OF THE WORK POOL
C
      LOW = LOW + MAXTYP
      IUP = IUP + MAXTYP
      DO 4200 I=LOW,IUP
      WRITE (IOUT,4099) I
      4099      FORMAT (I11, 20X, 13HWORK POOL NO., I3)
      REWIND IWFL
      SIDE(1) = MIN(I)
      SIDE(27) = MAX(I)
      X = (SIDE(27) - SIDE(1))/26.0
      DO 4100 J=1,25
      4100      SIDE(J+1) = SIDE(J) + X
      4111      RFD(J) = 0.0
      DO 4144 J=1,LOOK
      READ (IWFL) CLOCK, NOBS
      X = NOBS(I)
      DO 4122 K=2,26
      L = K - 1
      IF (X.LT.SIDE(K)) GO TO 4133
      4122      CONTINUE
      L = 26
      4133      RFD(L) = RFD(L) + 1.0
      4144      CONTINUE
      DO 4155 J=1,26
      RFD(J) = RFD(J)/FLOAT(LOOK)
      CFD(J) = RFD(J)
      4155      IF (J.GT.1) CFD(J) = CFD(J) + CFD(J-1)
C
C      PRINT THE HISTOGRAM
C
      WRITE (IOUT,3811) ABSA, SIDE(1), SIDE(1)
      DO 4199 J=1,26
      DO 4166 K=1,25
      LINEP(K) = IBLK

```

GLM17270
GLM17280
GLM17290
GLM17300
GLM17310
GLM17320
GLM17330
GLM17340
GLM17350
GLM17360
GLM17370
GLM17380
GLM17390
GLM17400
GLM17410
GLM17420
GLM17430
GLM17440
GLM17450
GLM17460
GLM17470
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GLM17600
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GLM17670
GLM17680
GLM17690
GLM17700
GLM17710
GLM17720
GLM17730
GLM17740
GLM17750
GLM17760
GLM17770
GLM17780
GLM17790

08/12/32

DATE = 76252

PLOTS

FORTAN IV G LEVEL 21

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0263      X = FLOAT(K)/100.0
0264      4166 IF(X.LE.RFD(J)) LINEP(K) = IPLUS
0265      DO 4177 K=2,100.2
0266      L = K/2
0267      LINEC(L) = IBLK
0268      X = FLOAT(K)/100.0 - 0.01
0269      4177 IF(X.LE.CFD(J)) LINEC(L) = IPLUS
0270      4188 WRITE (IOUT,3855) LINEP,RFD(J),LINEC,CFD(J),SIDE(J+1),SIDE(J+1)
0271      4199 CONTINUE
0272      4200 WRITE (IOUT,4211)
0273      4211 FORMAT (1H+, 45X, 4H MAX, 72X, 4H MAX)
0274      RETURN
0275      END
GLM17800
GLM17810
GLM17820
GLM17830
GLM17840
GLM17850
GLM17860
GLM17870
GLM17880
GLM17890
GLM17900
GLM17910
GLM17920

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APPENDIX E
LETTER OF REQUEST FOR THE STUDY

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DEPARTMENT OF THE ARMY
SCRANTON ARMY AMMUNITION PLANT
SCRANTON, PENNSYLVANIA 18501

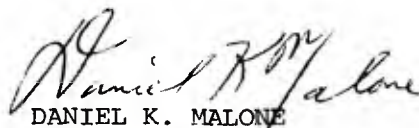
IN REPLY REFER TO:
SARSC - C

19 December 1975

SUBJECT: Billet Yard Crane

Commander
US Army Armament Command
ATTN: AMSAR-SA
Rock Island, IL 61201

1. Reference is made to the visit of Mr. Jerry Moeller to Scranton AAP relative to preparing a mathematical model of the Billet Yard Crane operation.
2. Subsequent to reference visit and further discussions thereof, this letter formalizes our request for support.
3. It is understood that a mathematical model can be structured but that additional operational data is required for satisfactory input. Your office is requested to provide the model. When adequate data is collected, a further review of action will be made.
4. Your assistance in this matter is greatly appreciated.


DANIEL K. MALONE
LTC, OrdC
Commanding

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