USDA Forest Service General Technical Report SE-3 December 1973

Program Manual for Producing Weight-Scaling Conversion Tables

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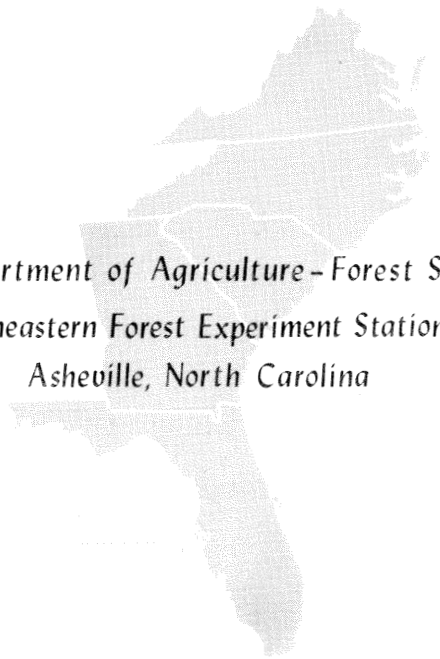

U.S. Department of Agriculture - Forest Service

Southeastern Forest Experiment Station

Asheville, North Carolina

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Weight-scaling--weighing truckloads of timber to determine volume--is much faster and cheaper than scaling individual pieces (7, 8, 11). Simple rules of thumb that convert weights into sawtimber or veneer volumes are usually insufficient over short periods, however, because they cannot account for the high variation common in individual loads or in small tracts. Long-log and tree-length logging increase the problems in applying rules of thumb because volumes of a variety of products must be estimated for individual truckloads.

Researchers have developed techniques for accurately estimating volumes of various products on individual loads when the weight and the number of trees on the load are known (2, 9, 10). These techniques have been tailored to long-log and tree-length logging (1, 3, 4, 6), and to the merchantability limits of individual firms.

This manual presents a computerized system that will yield weight-scaling estimates for individual firms. The system is flexible enough to accommodate normal logging techniques while producing scale estimates for any combination of three basic roundwood products: veneer logs, sawmill logs, and pulpwood. It is geared directly to inventory control and allocation of raw material to processing centers and includes a program which helps relate scaling data to prospective stumpage sales and harvesting operations. Details of the development of the statistical

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Research reported here was done by the Forest Products Marketing Research Project, Southeastern Forest Experiment Station in cooperation with the Southeastern Area State and Private Forestry, USDA Forest Service.

models have already been reported (3). Three programs are provided. Program WTVOL generates estimates of veneer volumes, sawmill volumes, and pulpwood volumes in any combination desired. Program CHECK uses regression coefficients developed by WTVOL plus weight-volume data from periodic check scales to calculate volume and percentage differences between estimated and observed volumes. Program VOLWT estimates average total and saw-log weights by form class, d.b.h., and number of usable 16-foot logs from volume per tree and average tree length. These tables can be related back to earlier stumpage sales and harvests.

Description of Linear Models

Earlier reports show that linear regression models can provide reliable estimates for this weight-scaling system. The general form of the equations for programs WTVOL and CHECK is:

$$Y_i = b_{0i} + b_{1i}NT + b_{2i}WT + b_{3i}(WT \times NT)^{\frac{1}{2}}$$

where

Y_i = either veneer volume, total saw-log volume, or total saw-log weight.

NT = number of trees, long logs or short logs per load (not mixed).

WT = total net weight of the load.

In program VOLWT the form is:

$$Y_i = b_{0i} + b_{1i}AV + b_{2i}AL$$

where

Y_i = either average total weight or average saw-log weight per tree.

and

AV = average volume per tree.

AL = average length per tree (number of usable 16-foot logs).

A number of models were tested but those indicated above were consistently better in estimating the dependent variables and were judged to be of higher practical value. Freese's manual (5) describes the stepwise regression procedures by which the models were developed.

Not all estimates produced by the programs described here are generated directly by regression. For instance, where estimates are

desired for sawtimber and pulpwood from tree-length material, sawtimber weights are generated by regression, but pulpwood weights are calculated by subtracting estimated sawtimber weight from total weight. Such estimates are simpler and more consistent. Similarly, where estimates are desired for veneer, sawmill, and pulpwood volumes, total sawtimber volume and veneer volume are estimated by regression, and sawmill volumes are estimated by the difference between the two regression estimates.

Data Handling and Management

Data required to produce conversion tables are:

1. Total board-foot volume (sawmill plus veneer volume).
2. Sawmill volume.
3. Veneer volume.
4. Total weight (all products).
5. Pulp weight.
6. Number of trees, long logs, or short logs (not mixed).

These data are collected for each load and recorded as indicated by exhibits 1 and 2. Other data are required by the three programs included here, but these special data requirements are noted in the discussions of the individual programs.

Keypunch formats for the data are shown in Appendix 4. None of the programs discussed here edit input data; therefore, considerable care must be taken in recording and keypunching.

Estimating Volumes from Weight

Program WTVOL is the cornerstone of this system; it provides estimates of product volumes. The program permits users to choose from five options depending on logging technique and product raw materials. These options are:

1. Long or short logs
   a. Sawtimber only (option 1).
   b. Veneer only (option 2).
   c. Sawmill and veneer logs (option 3).
2. Tree-length logs
   a. Sawtimber and pulpwood (option 4).
   b. Veneer, sawmill, and pulpwood (option 5).

Exhibit 1. Weight ticket

WEIGHT TICKET NO. 26803

Date _____ F. NO. _____
Customers Name _____ Trk. NO. _____
Butts _____ Total Pcs. _____
☐ No Pulpwood _____ ☐ Pulpwood _____
Sec. _____ T. _____ R. _____ County _____
Remarks: _____

Lbs. Gross Driver _____
Lbs. Tare Driver ☐ On ☐ Off
Lbs. Net at: _____ Per Lb. Price _____
Footage- Shipper _____
Pulpwood- Weigher _____

/ / Scales Tare Weight Permit
Name _____ ☐ No Pulpwood
Butts _____
Total Pcs. _____
Ticket No. 26803

/ / Log Yard Scale Permit
Name _____ ☐ No Pulpwood
Butts _____
Total Pcs. _____
Ticket No. 26803

Exhibit 2. Data collection form

Name of Firm Date

Load Number	Total Scale	Small Log Scale	Veneer Log Scale	Net Load Weight	Pulpwood Weight	Number of Stems or Butts

The input data decks for this program are:

1. Name header card--for firm name, dates, tract identification, or any other information needed to identify the tables.

2. Option card[1]
   a. Option code (1-5 as described previously).
   b. Pounds per cord of pulpwood conversion.
   c. Minimum number of trees for which a table is desired.
   d. Maximum number of trees for which a table is desired.
   e. Minimum net load weight to appear on each table.
   f. Maximum net load weight to appear on each table.

3. Truckload data cards
   a. Identification.
   b. Total volume (veneer and sawmill).
   c. Sawmill volume.
   d. Veneer volume.
   e. Total net load weight.
   f. Pulp weight.
   g. Number of trees, long logs, or short logs.

4. Trailer card--blank if other data sets follow; 9999 in columns 1-4 if no other data follow.

These decks make up one complete data set and WTVOL requires that these cards all be present and in the order noted. Since firms usually are receiving timber from several tracts whose average timber sizes may vary considerably, WTVOL is programed to produce multiple sets of tables in a single run. The maximum number of sets of tables that can be produced in one run is limited only by the specific requirements of the computer system developing the tables. In producing a set of tables, the program reads a set of header control cards then reads basic data cards until a trailer card is encountered. Next, regression analysis is performed and tables are generated. If the trailer card previously encountered is blank in the first four columns, the program reads the next set of header cards and basic data cards and produces a second set of tables. This sequence is followed until a trailer card is encountered with the value 9999 in columns 1 through 4, which indicates the last data set.

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[1]Items (b) through (f) of the option card may be left blank. Where (b) is left blank, pulpwood will be tabulated in pounds rather than cords. Where (c) through (f) are left blank, the program will produce tables based on the actual ranges of number of trees and net load weight observed in the sample data.

Once the name card and option card are read, the regression analysis is begun and sums of squares and products are developed as each truckload data card is read. After all cards are read, the regression equations are developed and the tables are generated by substituting values for number of trees and total net load weight. Table range is limited by the minimum and maximum values for number of trees and net load weight shown in the option card or as calculated from the sample data when minimum and maximum values are not shown in the option card. This sequence is followed for all sets of input data.

The form of the output from WTVOL depends upon the nature of the raw material and the consequent option chosen. Each set of volume tables is preceded by a summary sheet showing means and standard deviations, regression equations developed, and the coefficients of determination (R^2) and standard errors associated with each equation. An example of this summary page is shown in exhibit 3. Tables showing volumes by weight follow the summary page and are illustrated for all options in exhibits 4 through 8.

To use these tables, record net load weight and number of trees or logs for each truckload. Refer to the table corresponding with the number of trees or logs recorded, go down the left-hand column to find weight in thousands of pounds, and finally go across this row to locate the volume(s) shown under weight in hundreds of pounds. Note that weights are shown to the nearest even hundred pounds which should be sufficient for most applications. When further precision is required, users should interpolate or use net weight and number of trees (or logs) in the regression equations shown on the summary page to calculate volumes directly.

Appendix 3a indicates the deck setup for this program, a program listing is shown in Appendix 2a, all input data formats are shown in Appendix 4, and definitions of the variable names are given in Appendix 1. As indicated in Appendix 3a, program WTVOL also uses two supporting subroutines, MATINV and MULT, in developing the regression analysis. These subroutines are briefly discussed in a following section.

Check-Scaling

Once WTVOL has been applied to initial sample data, this weight-scaling system may be regarded operative if the firm's limits of precision have been met. But constant checks are essential to determine continuing accuracy of the system and to demonstrate its integrity. For this purpose, truckload samples should be continually taken and program CHECK can then be applied.

CHECK compares actual measured volumes of truckload samples (check-scale samples) with tabular volumes generated by WTVOL from the base data. The CHECK program reproduces tabular values from the weight/volume tables by calculating the weights and volumes with the

Exhibit 3. Summary page of WTVOL output

WEIGHT SCALING OF TREES FOR VENEER,SAWMILL AND PULPWOOD VOLUME

NAME OF FIRM OR ORGANIZATION

NUMBER OF LOADS = 10 (NO.)

	MEAN		STANDARD DEVIATION	
NUMBER OF TREES =	34.9000	(NO.)	6.8223	(NO.)
PULPWOOD VOLUME =	2.7629	(CORDS)	1.2612	(CORDS)
PULPWOOD WEIGHT =	14.7813	(MLBS)	6.7473	(MLBS)
SAWMILL VOLUME =	0.9569	(MBF)	0.3045	(MBF)
VENEER VOLUME =	1.2246	(MBF)	0.5948	(MBF)
TOTAL WEIGHT =	55.7380	(MLBS)	9.1239	(MLBS)
SAWLOG WEIGHT =	40.9567	(MLBS)	5.1091	(MLBS)

THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG VOLUME IS

TOTAL SAWLOG VOLUME = 1.1071 + 0.5674 (NO OF TREES) + 0.3932 (TOTAL WEIGHT) + -0.9250 (SQRT(TOTAL WEIGHT * NO OF TREES))

MULTIPLE R SQUARED = 0.8736
STANDARD ERROR = 0.1656

THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG WEIGHT IS

TOTAL SAWLOG WEIGHT = 19.2999 + 5.2443 (NO OF TREES) + 3.9024 (TOTAL WEIGHT) + -8.6234 (SQRT(TOTAL WEIGHT * NO OF TREES))

MULTIPLE R SQUARED = 0.8584
STANDARD ERROR = 2.3546

THE REGRESSION EQUATION FOR ESTIMATING TOTAL VENEER VOLUME IS

VENEER VOLUME = 1.3769+ 0.5570 (NO OF TREES) + 0.4117 (TOTAL WEIGHT) + -0.9682 (SQRT(TOTAL WEIGHT * NO OF TREES))

MULTIPLE R SQUARED = 0.7958
STANDARD ERROR = 0.3292

same linear regression equations that were used in the table-generating program, WTVOL. The coefficients for these equations are printed on the summary page at the beginning of the WTVOL output.

Input for the CHECK program is:

1. Name header card--same as name card identification for WTVOL.

2. Option card--the program handles five options which are identified on this card, and are the same as those outlined for WTVOL. This card also contains the weight per cord of pulpwood being used for options 4 and 5.

3. Linear regression equation coefficients card--coefficients must be read in the order noted below.

   a. Option 1 requires only one card (the constant and regression coefficients for total saw-log volume).

   b. Option 2 requires only one card (the constant and regression coefficients for veneer-log volume).

   c. Option 3 requires two cards (the constant and regression coefficients for total saw-log volume and total veneer volume).

   d. Option 4 requires two cards (the constant and regression coefficients for total saw-log volume and total saw-log weight).

   e. Option 5 requires three cards (the constant and regression coefficients for total saw-log volume, total saw-log weight, and total veneer volume).

4. Truckload data cards--same as truckload data cards for WTVOL.

5. Trailer card--same as trailer card in WTVOL.

In CHECK, no calculations are made until the first truckload data card is read. At that time tabular values are developed using the constant and regression coefficients and the values for number of trees and total net weight read from the truckload data card. These values are subtracted from the measured check-scale volumes on the truckload data card. These differences are printed on the output, added into summary areas, and the next truckload data card is read. After all check-scale cards are read, percentage differences are computed and printed along with actual differences.

Exhibit 4. Example of table for sawmill-only option

NAME OF FIRM OR ORGANIZATION

30 LOGS

THOUS. OF POUNDS	HUNDREDS OF POUNDS 0 SAWTIMBER (MBF)	2 SAWTIMBER (MBF)	4 SAWTIMBER (MBF)	6 SAWTIMBER (MBF)	8 SAWTIMBER (MBF)
30	2.173	2.160	2.146	2.133	2.120
31	2.108	2.096	2.084	2.072	2.061
32	2.050	2.039	2.028	2.018	2.008
33	1.998	1.989	1.980	1.971	1.962
34	1.954	1.946	1.938	1.930	1.923
35	1.916	1.909	1.902	1.896	1.890
36	1.884	1.878	1.873	1.867	1.862
37	1.858	1.853	1.849	1.845	1.841
38	1.837	1.834	1.830	1.827	1.824
39	1.822	1.819	1.817	1.815	1.814
40	1.812	1.811	1.809	1.808	1.808
41	1.807	1.807	1.806	1.806	1.807
42	1.807	1.808	1.808	1.809	1.810
43	1.812	1.813	1.815	1.816	1.818
44	1.821	1.823	1.825	1.828	1.831
45	1.834	1.837	1.841	1.844	1.848
46	1.852	1.856	1.860	1.864	1.869
47	1.873	1.878	1.883	1.888	1.893
48	1.899	1.904	1.910	1.916	1.922
49	1.928	1.935	1.941	1.948	1.954
50	1.961	1.968	1.976	1.983	1.990
51	1.998	2.006	2.014	2.022	2.030
52	2.038	2.047	2.055	2.064	2.073
53	2.082	2.091	2.100	2.109	2.119
54	2.129	2.138	2.148	2.158	2.168
55	2.179	2.189	2.199	2.210	2.221
56	2.232	2.243	2.254	2.265	2.276
57	2.288	2.299	2.311	2.323	2.335
58	2.347	2.359	2.371	2.384	2.396
59	2.409	2.422	2.434	2.447	2.460
60	2.474	2.487	2.500	2.514	2.527
61	2.541	2.555	2.569	2.583	2.597
62	2.611	2.626	2.640	2.654	2.669
63	2.684	2.699	2.714	2.729	2.744
64	2.759	2.774	2.790	2.805	2.821
65	2.837	2.853	2.869	2.885	2.901
66	2.917	2.933	2.950	2.966	2.983

Exhibit 5. Example of table for veneer-only option

NAME OF FIRM OR ORGANIZATION

30 LOGS

THOUS. OF POUNDS	HUNDREDS OF POUNDS 0 VENEER (MBF)	2 VENEER (MBF)	4 VENEER (MBF)	6 VENEER (MBF)	8 VENEER (MBF)
30	1.392	1.378	1.364	1.350	1.337
31	1.324	1.311	1.299	1.287	1.275
32	1.263	1.252	1.241	1.230	1.220
33	1.210	1.200	1.190	1.181	1.172
34	1.163	1.155	1.147	1.139	1.131
35	1.123	1.116	1.109	1.103	1.096
36	1.090	1.084	1.079	1.073	1.068
37	1.063	1.058	1.054	1.049	1.045
38	1.042	1.038	1.035	1.032	1.029
39	1.026	1.023	1.021	1.019	1.017
40	1.016	1.014	1.013	1.012	1.011
41	1.011	1.010	1.010	1.010	1.010
42	1.011	1.011	1.012	1.013	1.014
43	1.016	1.017	1.019	1.021	1.023
44	1.025	1.028	1.031	1.033	1.036
45	1.040	1.043	1.047	1.050	1.054
46	1.058	1.062	1.067	1.071	1.076
47	1.081	1.086	1.091	1.097	1.102
48	1.108	1.114	1.120	1.126	1.132
49	1.139	1.146	1.152	1.159	1.167
50	1.174	1.181	1.189	1.196	1.204
51	1.212	1.221	1.229	1.237	1.246
52	1.255	1.263	1.272	1.282	1.291
53	1.300	1.310	1.320	1.329	1.339
54	1.349	1.360	1.370	1.381	1.391
55	1.402	1.413	1.424	1.435	1.446
56	1.458	1.469	1.481	1.493	1.505
57	1.517	1.529	1.541	1.554	1.566
58	1.579	1.591	1.604	1.617	1.630
59	1.644	1.657	1.671	1.684	1.698
60	1.712	1.726	1.740	1.754	1.768
61	1.782	1.797	1.812	1.826	1.841
62	1.856	1.871	1.886	1.901	1.917
63	1.932	1.948	1.964	1.979	1.995
64	2.011	2.027	2.044	2.060	2.076
65	2.093	2.109	2.126	2.143	2.160
66	2.177	2.194	2.211	2.228	2.246

Exhibit 6. Example of table for veneer and sawmill option

NAME OF FIRM OR ORGANIZATION

30 LOGS

THOUS. OF POUNDS	HUNDREDS OF POUNDS 0 VENEER (MBF)	0 SAWMILL (MBF)	2 VENEER (MBF)	2 SAWMILL (MBF)	4 VENEER (MBF)	4 SAWMILL (MBF)	6 VENEER (MBF)	6 SAWMILL (MBF)	8 VENEER (MBF)	8 SAWMILL (MBF)
30	1.392	0.781	1.378	0.782	1.364	0.782	1.350	0.783	1.337	0.783
31	1.324	0.784	1.311	0.784	1.299	0.785	1.287	0.786	1.275	0.786
32	1.263	0.787	1.252	0.787	1.241	0.787	1.230	0.788	1.220	0.788
33	1.210	0.789	1.200	0.789	1.190	0.790	1.181	0.790	1.172	0.790
34	1.163	0.791	1.155	0.791	1.147	0.791	1.139	0.792	1.131	0.792
35	1.123	0.792	1.116	0.793	1.109	0.793	1.103	0.793	1.096	0.793
36	1.090	0.794	1.084	0.794	1.079	0.794	1.073	0.794	1.068	0.794
37	1.063	0.795	1.058	0.795	1.054	0.795	1.049	0.795	1.045	0.795
38	1.042	0.795	1.038	0.796	1.035	0.796	1.032	0.796	1.029	0.796
39	1.026	0.796	1.023	0.796	1.021	0.796	1.019	0.796	1.017	0.796
40	1.016	0.796	1.014	0.796	1.013	0.796	1.012	0.796	1.011	0.796
41	1.011	0.796	1.010	0.796	1.010	0.796	1.010	0.796	1.010	0.796
42	1.011	0.796	1.011	0.796	1.012	0.796	1.013	0.796	1.014	0.796
43	1.016	0.796	1.017	0.796	1.019	0.796	1.021	0.795	1.023	0.795
44	1.025	0.795	1.028	0.795	1.031	0.795	1.033	0.795	1.036	0.795
45	1.040	0.794	1.043	0.794	1.047	0.794	1.050	0.794	1.054	0.794
46	1.058	0.793	1.062	0.793	1.067	0.793	1.071	0.793	1.076	0.792
47	1.081	0.792	1.086	0.792	1.091	0.792	1.097	0.791	1.102	0.791
48	1.108	0.791	1.114	0.791	1.120	0.790	1.126	0.790	1.132	0.790
49	1.139	0.789	1.146	0.789	1.152	0.789	1.159	0.788	1.167	0.788
50	1.174	0.788	1.181	0.787	1.189	0.787	1.196	0.786	1.204	0.786
51	1.212	0.786	1.221	0.785	1.229	0.785	1.237	0.784	1.246	0.784
52	1.255	0.784	1.263	0.783	1.272	0.783	1.282	0.782	1.291	0.782
53	1.300	0.781	1.310	0.781	1.320	0.780	1.329	0.780	1.339	0.780
54	1.349	0.779	1.360	0.779	1.370	0.778	1.381	0.778	1.391	0.777
55	1.402	0.777	1.413	0.776	1.424	0.776	1.435	0.775	1.446	0.774
56	1.458	0.774	1.469	0.773	1.481	0.773	1.493	0.772	1.505	0.772
57	1.517	0.771	1.529	0.771	1.541	0.770	1.554	0.769	1.566	0.769
58	1.579	0.768	1.591	0.768	1.604	0.767	1.617	0.766	1.630	0.766
59	1.644	0.765	1.657	0.764	1.671	0.764	1.684	0.763	1.698	0.763
60	1.712	0.762	1.726	0.761	1.740	0.761	1.754	0.760	1.768	0.759
61	1.782	0.759	1.797	0.758	1.812	0.757	1.826	0.757	1.841	0.756
62	1.856	0.755	1.871	0.754	1.886	0.754	1.901	0.753	1.917	0.752
63	1.932	0.752	1.948	0.751	1.964	0.750	1.979	0.749	1.995	0.749
64	2.011	0.748	2.027	0.747	2.044	0.746	2.060	0.746	2.076	0.745
65	2.093	0.744	2.109	0.743	2.126	0.743	2.143	0.742	2.160	0.741
66	2.177	0.740	2.194	0.739	2.211	0.739	2.228	0.738	2.246	0.737

Exhibit 7. Example of table for sawmill and pulpwood option

NAME OF FIRM OR ORGANIZATION

30 TREES

THOUS. OF POUNDS	HUNDREDS OF POUNDS 0 SAWTIMBER (MBF)	0 PULP (CORDS)	2 SAWTIMBER (MBF)	2 PULP (CORDS)	4 SAWTIMBER (MBF)	4 PULP (CORDS)	6 SAWTIMBER (MBF)	6 PULP (CORDS)	8 SAWTIMBER (MBF)	8 PULP (CORDS)
30	2.173	0.0	2.160	0.0	2.146	0.0	2.133	0.0	2.120	0.0
31	2.108	0.0	2.096	0.0	2.084	0.0	2.072	0.0	2.061	0.0
32	2.050	0.0	2.039	0.0	2.028	0.0	2.018	0.0	2.008	0.0
33	1.998	0.0	1.989	0.0	1.980	0.0	1.971	0.0	1.962	0.0
34	1.954	0.019	1.946	0.061	1.938	0.104	1.930	0.145	1.923	0.187
35	1.916	0.228	1.909	0.268	1.902	0.308	1.896	0.348	1.890	0.387
36	1.884	0.426	1.878	0.464	1.873	0.502	1.867	0.540	1.862	0.577
37	1.858	0.614	1.853	0.651	1.849	0.687	1.845	0.722	1.841	0.758
38	1.837	0.793	1.834	0.827	1.830	0.861	1.827	0.895	1.824	0.928
39	1.822	0.961	1.819	0.994	1.817	1.026	1.815	1.058	1.814	1.090
40	1.812	1.121	1.811	1.152	1.809	1.183	1.808	1.213	1.808	1.243
41	1.807	1.272	1.807	1.302	1.806	1.331	1.806	1.359	1.807	1.387
42	1.807	1.415	1.808	1.443	1.808	1.470	1.809	1.497	1.810	1.524
43	1.812	1.550	1.813	1.576	1.815	1.601	1.816	1.627	1.818	1.652
44	1.821	1.677	1.823	1.701	1.825	1.725	1.828	1.749	1.831	1.773
45	1.834	1.796	1.837	1.819	1.841	1.841	1.844	1.864	1.848	1.886
46	1.852	1.908	1.856	1.929	1.860	1.951	1.864	1.972	1.869	1.992
47	1.873	2.013	1.878	2.033	1.883	2.053	1.888	2.072	1.893	2.092
48	1.899	2.111	1.904	2.129	1.910	2.148	1.916	2.166	1.922	2.184
49	1.928	2.202	1.935	2.219	1.941	2.237	1.948	2.254	1.954	2.270
50	1.961	2.287	1.968	2.303	1.976	2.319	1.983	2.335	1.990	2.350
51	1.998	2.366	2.006	2.381	2.014	2.395	2.022	2.410	2.030	2.424
52	2.038	2.438	2.047	2.452	2.055	2.466	2.064	2.479	2.073	2.492
53	2.082	2.505	2.091	2.518	2.100	2.530	2.109	2.542	2.119	2.554
54	2.129	2.566	2.138	2.577	2.148	2.589	2.158	2.600	2.168	2.611
55	2.179	2.621	2.189	2.632	2.199	2.642	2.210	2.652	2.221	2.662
56	2.232	2.671	2.243	2.681	2.254	2.690	2.265	2.699	2.276	2.708
57	2.288	2.716	2.299	2.724	2.311	2.733	2.323	2.741	2.335	2.748
58	2.347	2.756	2.359	2.763	2.371	2.770	2.384	2.777	2.396	2.784
59	2.409	2.790	2.422	2.797	2.434	2.803	2.447	2.809	2.460	2.815
60	2.474	2.820	2.487	2.826	2.500	2.831	2.514	2.836	2.527	2.841
61	2.541	2.845	2.555	2.850	2.569	2.854	2.583	2.858	2.597	2.862
62	2.611	2.866	2.625	2.869	2.640	2.872	2.654	2.876	2.669	2.879
63	2.684	2.881	2.699	2.884	2.714	2.887	2.729	2.889	2.744	2.891
64	2.759	2.893	2.774	2.895	2.790	2.896	2.805	2.898	2.821	2.899
65	2.837	2.900	2.853	2.901	2.869	2.902	2.885	2.902	2.901	2.903
66	2.917	2.903	2.933	2.903	2.950	2.903	2.966	2.903	2.983	2.902

Exhibit 8. Example of table for veneer, sawmill, and pulpwood option

NAME OF FIRM OR ORGANIZATION

30 TREES

THOUS. OF POUNDS	0			2			4			6			8		
	VENEER (MBF)	SAWMILL (MBF)	PULP (CORDS)	VENEER (MBF)	SAWMILL (MBF)	PULP (CORDS)	VENEER (MBF)	SAWMILL (MBF)	PULP (CORDS)	VENEER (MBF)	SAWMILL (MBF)	PULP (CORDS)	VENEER (MBF)	SAWMILL (MBF)	PULP (CORDS)
							HUNDREDS OF POUNDS								
30	1.392	0.781	0.0	1.378	0.782	0.0	1.364	0.782	0.0	1.350	0.783	0.0	1.337	0.783	0.0
31	1.324	0.784	0.0	1.311	0.784	0.0	1.299	0.785	0.0	1.287	0.786	0.0	1.275	0.786	0.0
32	1.263	0.787	0.0	1.252	0.787	0.0	1.241	0.787	0.0	1.230	0.788	0.0	1.220	0.788	0.0
33	1.210	0.789	0.0	1.200	0.789	0.0	1.190	0.790	0.0	1.181	0.790	0.0	1.172	0.790	0.0
34	1.163	0.791	0.019	1.155	0.791	0.061	1.147	0.791	0.104	1.139	0.792	0.145	1.131	0.792	0.187
35	1.123	0.792	0.228	1.116	0.793	0.268	1.109	0.793	0.308	1.103	0.793	0.348	1.096	0.793	0.387
36	1.090	0.794	0.426	1.084	0.794	0.464	1.079	0.794	0.502	1.073	0.794	0.540	1.068	0.794	0.577
37	1.063	0.795	0.614	1.058	0.795	0.651	1.054	0.795	0.687	1.049	0.795	0.722	1.045	0.795	0.758
38	1.042	0.795	0.793	1.038	0.796	0.827	1.035	0.796	0.861	1.032	0.796	0.895	1.029	0.796	0.928
39	1.026	0.796	0.961	1.023	0.796	0.994	1.021	0.796	1.026	1.019	0.796	1.058	1.017	0.796	1.090
40	1.016	0.796	1.121	1.014	0.796	1.152	1.013	0.796	1.183	1.012	0.796	1.213	1.011	0.796	1.243
41	1.011	0.796	1.272	1.010	0.796	1.302	1.010	0.796	1.331	1.010	0.796	1.359	1.010	0.796	1.387
42	1.011	0.796	1.415	1.011	0.796	1.443	1.012	0.796	1.470	1.013	0.796	1.497	1.014	0.796	1.524
43	1.016	0.796	1.550	1.017	0.796	1.576	1.019	0.796	1.601	1.021	0.795	1.627	1.023	0.795	1.652
44	1.025	0.795	1.677	1.028	0.795	1.701	1.031	0.795	1.725	1.033	0.795	1.749	1.036	0.795	1.773
45	1.040	0.794	1.796	1.043	0.794	1.819	1.047	0.794	1.841	1.050	0.794	1.864	1.054	0.794	1.886
46	1.058	0.793	1.908	1.062	0.793	1.929	1.067	0.793	1.951	1.071	0.793	1.972	1.076	0.792	1.992
47	1.081	0.792	2.013	1.086	0.792	2.033	1.091	0.792	2.053	1.097	0.791	2.072	1.102	0.791	2.092
48	1.108	0.791	2.111	1.114	0.791	2.129	1.120	0.790	2.148	1.126	0.790	2.166	1.132	0.790	2.184
49	1.139	0.789	2.202	1.146	0.789	2.219	1.152	0.789	2.237	1.159	0.788	2.254	1.167	0.788	2.270
50	1.174	0.788	2.287	1.181	0.787	2.303	1.189	0.787	2.319	1.196	0.786	2.335	1.204	0.786	2.350
51	1.212	0.786	2.366	1.221	0.785	2.381	1.229	0.785	2.395	1.237	0.784	2.410	1.246	0.784	2.424
52	1.255	0.784	2.438	1.263	0.783	2.452	1.272	0.783	2.466	1.282	0.782	2.479	1.291	0.782	2.492
53	1.300	0.781	2.505	1.310	0.781	2.518	1.320	0.780	2.530	1.329	0.780	2.542	1.339	0.780	2.554
54	1.349	0.779	2.566	1.360	0.779	2.577	1.370	0.778	2.589	1.381	0.778	2.600	1.391	0.777	2.611
55	1.402	0.777	2.621	1.413	0.776	2.632	1.424	0.776	2.642	1.435	0.775	2.652	1.446	0.774	2.662
56	1.458	0.774	2.671	1.469	0.773	2.681	1.481	0.773	2.690	1.493	0.772	2.699	1.505	0.772	2.708
57	1.517	0.771	2.716	1.529	0.771	2.724	1.541	0.770	2.733	1.554	0.769	2.741	1.566	0.769	2.748
58	1.579	0.768	2.756	1.591	0.768	2.763	1.604	0.767	2.770	1.617	0.766	2.777	1.630	0.766	2.784
59	1.644	0.765	2.790	1.657	0.764	2.797	1.671	0.764	2.803	1.684	0.763	2.809	1.698	0.763	2.815
60	1.712	0.762	2.820	1.726	0.761	2.826	1.740	0.761	2.831	1.754	0.760	2.836	1.768	0.759	2.841
61	1.782	0.759	2.845	1.797	0.758	2.850	1.812	0.757	2.854	1.826	0.757	2.858	1.841	0.756	2.862
62	1.856	0.755	2.866	1.871	0.754	2.869	1.886	0.754	2.872	1.901	0.753	2.876	1.917	0.752	2.879
63	1.932	0.752	2.881	1.948	0.751	2.884	1.964	0.750	2.887	1.979	0.749	2.889	1.995	0.749	2.891
64	2.011	0.748	2.893	2.027	0.747	2.895	2.044	0.746	2.896	2.060	0.746	2.898	2.076	0.745	2.899
65	2.093	0.744	2.900	2.109	0.743	2.901	2.126	0.743	2.902	2.143	0.742	2.902	2.160	0.741	2.903
66	2.177	0.740	2.903	2.194	0.739	2.903	2.211	0.739	2.903	2.228	0.738	2.903	2.246	0.737	2.902

Output from this program consists of a table (exhibit 9) giving the ID number of each individual check-scale load and the difference between its actual measured product volumes and those calculated by using regression equations developed in generating the previous weight-volume tables. These differences for each product are summed and printed on the table as the "Total Difference." The program also sums the actual volumes of each product contained in the check-scale sample and the total percentage difference is calculated as a percentage of the actual total volume. This percentage gives an indication of the error in the tabular values being checked.

In options 3 and 5 which check both veneer and sawmill volumes, the total veneer difference and the total sawmill difference are added to get a "Total Saw-Log Difference." The total sawmill and veneer volumes of the sample are also combined to get the "Total Saw-Log Volume," and the total saw-log difference is calculated as a percentage of the total volume.

Exhibit 9. Example of CHECK output for pulpwood, veneer, and sawmill option

NAME OF FIRM OR ORGANIZATION
CHECK SCALES

DIFFERENCES IN ACTUAL AND CALCULATED DATA

(ACTUAL-CALCULATED)

ID	PULP CORDS (NO)	VENEER (MBF)	SAWMILL (MBF)
435	0.265	-0.744	0.273
436	0.187	-0.117	0.104
437	-0.465	-0.107	0.029
438	-0.533	0.580	0.013
439	-0.584	0.324	0.017
440	0.301	-0.214	0.090
441	-0.600	-0.033	0.070
TOTAL DIFF.	-1.430	-0.312	0.597
PERCENT OF ACTUAL	-11.9	-1.4	14.6

TOTAL SAWLOG DIFF. (V.VOL.DIFF.+S.VOL.DIFF.) 0.285

TOTAL SAWLOG DIFF. AS PERCENT OF ACTUAL SAWLOG VOL. 1.1

Similar to WTVOL, CHECK is set up to handle any number of data sets at one time. A blank trailer card must follow each data set if more data sets are to follow. If no more sets follow, the trailer card should contain 9999 in columns 1 through 4. A new name header card, option card, and regression equation coefficients card must head each data set in the program.

Appendix 1 shows definitions of variable names, Appendix 2b includes the program listing for CHECK, Appendix 3b illustrates the deck setup, and Appendix 4 describes input data formats. No subroutines are used in CHECK.

Estimating Weights from Volumes

This program is designed to produce, through regression analysis, tables showing average weight per tree by diameter class and number of usable 16-foot logs. The program is flexible enough to handle any number of form classes, ranging from 65 to 90, any type of log rule (i.e., Scribner, International $\frac{1}{4}$-inch, or Doyle), any volume table giving cubic-foot or board-foot volumes, and any range of diameters for different species.

Five types of data cards are required as input to the program:

1. Name card--same as for WTVOL and CHECK.

2. Option card--includes number of form classes for which tables are desired and the minimum and maximum diameters for which weights are to be estimated in each table.

3. Truckload data cards--same as for WTVOL and CHECK with an additional variable--total saw-log length in linear feet per load.

4. Trailer card--same as for WTVOL and CHECK.

5. Volume cards--volume data by form class, diameter, and number of 16-foot logs (simply volume tables punched into cards).

After the truckload data cards are read, the regression coefficients for determining average total weight per tree and average saw-log weight per tree are determined. They are then applied to the volume data by d.b.h. and number of usable 16-foot logs to produce weight tables by diameter and length for each desired form class and species. In addition to the tabular weights, average total weight per tree, average saw-log weight per tree, average total volume per tree, average number of usable 16-foot logs per tree, percentage variation explained by the regression equations, and their standard errors are computed and are footnoted on each table as illustrated in exhibits 10 and 11.

Exhibit 10. Example of VOLWT average total weight per tree table for form class 78

NAME OF FIRM OR ORGANIZATION

FORM CLASS 78

AVERAGE TOTAL WEIGHT PER TREE*

TREE DIAMETER (INCHES)	WEIGHT (M.LBS.) BY NUMBER OF USABLE 16-FOOT LOGS							
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
10	0.639	0.915	1.191	1.452	1.712	------	------	------
11	0.702	0.993	1.285	1.561	1.837	------	------	------
12	0.756	1.063	1.371	1.662	1.954	2.214	2.482	------
13	0.827	1.157	1.495	1.803	2.110	2.386	2.669	------
14	0.904	1.266	1.620	1.943	2.266	2.557	2.849	------
15	0.998	1.391	1.784	2.130	2.484	2.791	3.106	------
16	1.092	1.516	1.940	2.317	2.702	3.041	3.371	------
17	1.201	1.664	2.127	2.543	2.959	3.321	3.675	------
18	1.310	1.812	2.314	2.769	3.217	3.602	3.979	------
19	1.450	1.999	2.548	3.042	3.536	3.945	4.361	------
20	1.583	2.186	2.790	3.323	3.856	4.303	4.743	5.136
21	1.731	2.397	3.062	3.642	4.222	4.709	5.195	5.635
22	1.887	2.607	3.335	3.970	4.597	5.122	5.647	6.134
23	2.050	2.841	3.624	4.313	5.002	5.559	6.115	6.648
24	2.214	3.067	3.920	4.664	5.407	5.995	6.583	7.171
25	2.409	3.340	4.263	5.077	5.891	6.541	7.191	7.826
26	2.604	3.605	4.614	5.490	6.366	7.079	7.791	8.480
27	2.807	3.886	4.972	5.919	6.873	7.632	8.392	9.135
28	3.002	4.166	5.331	6.355	7.388	8.186	8.984	9.790
29	3.228	4.486	5.744	6.854	7.964	8.825	9.686	10.570
30	3.462	4.813	6.165	7.353	8.541	9.464	10.380	11.342
31	3.711	5.164	6.625	7.915	9.204	10.213	11.214	12.223
32	3.968	5.523	7.085	8.476	9.867	10.961	12.048	13.103
33	4.226	5.881	7.545	9.037	10.521	11.678	12.843	13.969
34	4.475	6.240	8.005	9.583	11.169	12.403	13.638	14.834
35	4.771	6.661	8.551	10.246	11.940	13.269	14.597	15.887

THE ABOVE TABLE FOR ESTIMATING AVERAGE TOTAL WEIGHT PER TREE WAS DERIVED BY SOLVING THE FOLLOWING---

*AVERAGE TOTAL WEIGHT PER TREE = 0.02511 + 7.79592 (AVER. VOL./TREE) + 0.50516 (NO. OF USABLE 16-FOOT LOGS)

MEAN AVERAGE TOTAL WEIGHT PER TREE = 3.509 (M.LBS.)

STANDARD DEVIATION OF AVERAGE TOTAL WEIGHT PER TREE = 0.950 (M.LBS.)

MEAN TOTAL VOLUME PER TREE = 0.257 (M.B.F.)

STANDARD DEVIATION OF AVERAGE VOLUME PER TREE = 0.091 (M.B.F.)

VARIATION EXPLAINED BY REGRESSION EQUATION = 88.57 PERCENT

STANDARD ERROR OF REGRESSION EQUATION = 0.325 (M.LBS.)

MEAN NO. OF USABLE 16-FOOT LOGS = 2.931 (16-FOOT LOGS)

STANDARD DEVIATION OF NO. OF USABLE 16-FOOT LOGS = 0.528 (16-FOOT LOGS)

*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON DOYLE LOG RULE VOLUMES--
MESAVAGE AND GIRARD

Exhibit 11. Example of VOLWT average saw-log weight per tree table for form class 78

NAME OF FIRM OR ORGANIZATION

FORM CLASS 78 TREE DIAMETER (INCHES)	AVERAGE SAWLOG WEIGHT PER TREE* WEIGHT (M.LBS.) BY NUMBER OF USABLE 16-FOOT LOGS							
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
10	0.530	0.783	1.036	1.274	1.511	------	------	------
11	0.591	0.859	1.127	1.380	1.633	------	------	------
12	0.644	0.928	1.211	1.480	1.748	1.986	2.231	------
13	0.713	1.019	1.334	1.617	1.901	2.154	2.414	------
14	0.789	1.126	1.456	1.754	2.053	2.321	2.590	------
15	0.881	1.248	1.616	1.938	2.267	2.551	2.842	------
16	0.973	1.371	1.769	2.121	2.481	2.795	3.101	------
17	1.079	1.516	1.952	2.342	2.733	3.070	3.399	------
18	1.186	1.661	2.135	2.564	2.985	3.344	3.697	------
19	1.324	1.844	2.364	2.831	3.298	3.680	4.071	------
20	1.453	2.027	2.601	3.106	3.611	4.031	4.445	4.812
21	1.599	2.233	2.868	3.419	3.969	4.428	4.887	5.301
22	1.751	2.439	3.135	3.739	4.336	4.833	5.330	5.789
23	1.911	2.668	3.417	4.075	4.733	5.260	5.788	6.293
24	2.072	2.890	3.708	4.419	5.130	5.688	6.246	6.805
25	2.263	3.157	4.043	4.823	5.603	6.222	6.842	7.446
26	2.453	3.416	4.387	5.228	6.069	6.749	7.430	8.087
27	2.652	3.691	4.738	5.648	6.565	7.291	8.017	8.728
28	2.843	3.966	5.089	6.075	7.069	7.833	8.597	9.370
29	3.064	4.279	5.494	6.564	7.633	8.459	9.285	10.133
30	3.293	4.600	5.906	7.052	8.198	9.085	9.964	10.889
31	3.537	4.943	6.356	7.602	8.847	9.818	10.781	11.751
32	3.789	5.294	6.807	8.151	9.496	10.551	11.598	12.614
33	4.041	5.645	7.257	8.701	10.137	11.253	12.376	13.461
34	4.286	5.997	7.708	9.235	10.771	11.963	13.155	14.309
35	4.576	6.409	8.242	9.884	11.527	12.810	14.094	15.339

THE ABOVE TABLE FOR ESTIMATING AVERAGE SAWLOG WEIGHT PER TREE WAS DERIVED BY SOLVING THE FOLLOWING---

*AVERAGE SAWLOG WEIGHT PER TREE = -0.03726 + 7.63369 (AVER. VOL./TREE) + 0.46018 (NO. OF USABLE 16-FOOT LOGS)

MEAN AVERAGE SAWLOG WEIGHT PER TREE = 3.274 (M.LBS.)

STANDARD DEVIATION OF AVERAGE SAWLOG WEIGHT PER TREE = 0.906 (M.LBS.)

MEAN TOTAL VOLUME PER TREE = 0.257 (M.B.F.)

STANDARD DEVIATION OF AVERAGE VOLUME PER TREE = 0.091 (M.B.F.)

VARIATION EXPLAINED BY REGRESSION EQUATION = 90.53 PERCENT

STANDARD ERROR OF REGRESSION EQUATION = 0.282 (M.LBS.)

MEAN NO. OF USABLE 16-FOOT LOGS = 2.931 (16-FOOT LOGS)

STANDARD DEVIATION OF NO. OF USABLE 16-FOOT LOGS = 0.528 (16-FOOT LOGS)

*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON DOYLE LOG RULE VOLUMES--
MESAVAGE AND GIRARD

VOLWT is as flexible as other programs described here and, in producing multiple sets of tables in a single run, is controlled by the trailer cards similar to those for the other programs. Here, though, the trailer card is used to indicate an end of truckload data and the beginning of volume data in addition to informing the program of an end of data sets. The trailer card should be placed after the truckload data deck as before and should be blank in columns 1 through 4 when additional data sets follow and should contain 9999 in columns 1 through 4 when the data set being read is the last one. When multiple data sets are being read, volume data must follow each data set.

The deck setup for VOLWT is shown in Appendix 3c, input data formats are shown in Appendix 4, and definitions of variable names are shown in Appendix 1. VOLWT also uses subroutines MATINV and MULT as part of its regression analysis.

Subroutines

Subroutines MATINV and MULT are required in both programs WTVOL and VOLWT to perform the regression analysis. MATINV inverts the matrix consisting of sums of squares and sums of products of the independent regression variables. This matrix is given to MATINV by the main programs and MATINV replaces this matrix by its inverse. The inverse matrix and the matrix containing the sums of the dependent variables and the sums of products of the dependent variables times the independent variables are input to MULT. MULT multiplies these two matrices to develop a matrix of regression coefficients which are returned to the main program.

These two subroutines are not hardware dependent and should require no alteration or programer action regardless of the program in which they are used or which option is chosen. No definitions of variable names used in them are included here, but listings for both can be found in Appendices 2d and 2e.

Literature Cited

1. Anonymous
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Appendix 1

Definitions of Program Variable Names

AMEAN	Array of averages for number of trees per load, total weight per load, board-foot volume per load (sawmill plus veneer volume), saw-log weight per load, board-foot veneer volume per load.
AMNPUL	Mean pulp volume.
AMNPWT	Mean pulp weight.
AMNSML	Mean sawmill volume.
AMSE	Array of mean square errors for the regression equations.
ANLOGS	Number of usable 16-foot logs.
APV	Pulp volume (or weight) per truckload.
ATPV	Total pulp volume (or weight) in all sample truckloads.
ATSLV	Total saw-log volume in all sample truckloads.
ATSV	Total sawmill volume in all sample truckloads.
ATVV	Total veneer volume in all sample truckloads.
B	Array of regression constants and coefficients.
CPV	Calculated pulp volume (or weight).
CSMV	Calculated sawmill volume.
DET	Determinant of the matrix continuing sums, sums of squares and products of the independent variables.
ICOUNT	Line count controlling printer.
ID	Truckload identification number.
IFC	Form class.
IFRAC	Fraction of load weight not in even thousands of pounds.
IO	Code used to select program option which varies according to product raw material.

ITREES	Identifies the number of trees per load to which each table applies. Appears in heading of each table.
ITWT	Truckload weight, in even thousands of pounds, appearing in left-most column of each table.
IW	TWTMIN rounded back to nearest lowest thousands of pounds.
IWTM	Total net load weight.
IX	Do-loop index.
JJ	Diameter class varying from 10-40 inches.
K	Counter used in determining when the number of form classes for which weights have been computed equals NK.
KARRAY	Array of volumes by form class, length, and diameter.
LOGRL	Log rule.
MAXD	Maximum diameter appearing in weight table.
MIND	Minimum diameter appearing in weight table.
NAME	Name of firm or organization.
NCASE	Number of form classes for which tables are to be produced.
NOLDS	Total number of loads.
PPD	Percentage difference in actual pulp volume (or weight) and calculated pulp volume (or weight).
PSLVD	Percentage difference in actual saw-log volume and calculated saw-log volume.
PSVD	Percentage difference in actual sawmill volume and calculated sawmill volume.
PULPWT	Pulpwood weight read from truckload data cards.
PVD	Difference in actual pulp volume (or weight) and calculated pulp volume (or weight) by load.
PVVD	Percentage difference in actual veneer volume and calculated veneer volume.

PWFCTR	Weight per cord factor used in converting pulpwood from pounds to cords.
PWT	Array of pulpwood weights (or volumes) calculated and printed in tables.
REGSS	Regression sum of squares.
RHS	Right-hand side of normal equations.
RSQR	Coefficient of multiple determination.
SAWWT	Array of average saw-log weights.
SCALE	Total truckload volume.
SLVD	Saw-log volume difference per load.
SMLVOL	Sawmill volume.
SOLRHS	Array containing product of B times RHS. Used in calculating sums of squares due to error.
SPWTSQ	Sum of squares of pulp weight.
SPX	Sums, sums of squares and products of the independent variables.
SPYX	Sums, sums of squares and products of independent and dependent variables.
SSE	Sums of squares due to error.
SSMLSQ	Sum of squares of sawmill volume.
SSY	Sum of squares of the dependent variable corrected for the mean.
STD	Standard deviation of variables whose means are defined in AMEAN.
STDPUL	Standard deviation of pulp volume.
STDPWT	Standard deviation of pulp weight.
SUMSML	Sum of sawmill volume.
SVD	Sawmill volume difference per load.
SVOL	Calculated tabular values of sawmill volume.

SWT	Calculated saw-log weight.
TITLE	Name of firm or organization.
TMAX	Maximum number of trees per load observed among sample loads.
TMIN	Minimum number of trees per load observed among sample loads.
TOSAWL	Total saw-log length per truckload.
TOTWT	Total weight per tree.
TPVD	Total pulpwood volume (or weight) difference in the sample.
TREES	Synonymous with ITREES but is in real mode used to calculate tabular values.
TREMAX	Maximum number of trees per load. Used as a delimiter in producing tables.
TREMIN	Minimum number of trees per load. Used as a delimiter in producing tables.
TSLVD	Total saw-log volume difference in the sample.
TSML	Total sawmill volume for all loads.
TSVD	Total sawmill volume difference in the sample.
TVVD	Total veneer volume difference in the sample.
TWT	Net load weight, in even hundreds of pounds, used in calculating tabular values.
TWTI	Synonymous with ITWT but in real mode.
TWTMAX	Maximum net load weight per truckload. Used as a delimiter in producing tables.
TWTMIN	Minimum net load weight per truckload. Used as a delimiter in producing tables.
VAR(1)	The number, one.
VAR(2)	Number of trees per load in WTVOL. Average volume per tree per truckload in VOLWT.
VAR(3)	Total net weight per load in WTVOL. Average saw-log length per tree per truckload in 16-foot logs in VOLWT.

VAR(4)	Square root of total net weight times number of trees per load in WTVOL. Average total weight per tree per truckload in VOLWT.
VAR(5)	Total board-foot volume (sawmill plus veneer) in WTVOL. In VOLWT, the average saw-log weight per tree per truckload.
VAR(6)	Total saw-log weight.
VAR(7)	Total veneer volume.
VVD	Veneer volume difference per load.
VVOL	Calculated tabular veneer volume.
WMAX	Maximum number of trees per load observed among sample loads.
WMIN	Minimum number of trees per load observed among sample loads.
XIFRAC	Synonymous with IFRAC but in real mode.
XIWT	Net load weight rounded to the nearest 200 pounds.
XIWTM	Synonymous with IWTM but in real mode.
XNO	Number of trees or logs per load.
Y	Dependent variables.

Appendix 2a. Listing for WTVOL

```
0001              DIMENSION NAME(20),VAR(7),SPXY(7,7),SPX(4,4),AMEAN(7),RHS(4,3),REG
                 1SS(3),SSE(3),AMSE(3),RSQR(3),PWT(5),SVOL(5),B(4,3),VVOL(5)
0002              DIMENSION SSY(3),SOLRHS(3),STD(7)
0003              DOUBLE PRECISION VAR,SPXY,SPX,RHS,VOL,WTS,AMEAN,TREMIN,TREMAX,TWTM
                 1IN,TWTMAX,DET,AMNPWT,SSE,AMSE,RSQR,REGSS,PULPWT,PWT,SVOL,TREES,TWT
                 2I,SWT,B,SOLRHS,VVOL
0004              DOUBLE PRECISION SSY,TWT,PWFCTR,STD,STDPWT,SUMPWT,SPWTSQ,STDPVL,SU
                 1MSML,SSMLSQ,STDSML,TMIN,TMAX,WMIN,WMAX
0005             1 DO 2 I=1,7
0006               DO 2 J=1,7
0007             2 SPXY(I,J)=0.
0008               TSML=0
0009               SUMPWT=0.
0010               SPWTSQ=0.
0011               SUMSML=0.
0012               SSMLSQ=0.
0013               READ(5,3) (NAME(I),I=1,20)
0014               READ(5,4)IO,PWFCTR,TREMIN,TREMAX,TWTMIN,TWTMAX
0015             3 FORMAT(20A4)
0016             4 FORMAT(I1,F4.3,4F3.0)
                 C
                 C     VAR(1) IS ONE.
                 C     VAR(2) IS THE NUMBER OF TREES PER LOAD.
                 C     VAR(3) IS TOTAL NET WEIGHT PER LOAD.
                 C     VAR(4) IS THE SQUARE ROOT OF TOTAL NET WEIGHT X NUMBER OF TREES PER LOAD.
                 C     VAR(5) IS TOTAL BOARD FOOT VOLUME (SAWMILL + VENEER VOLUME).
                 C     VAR(6) IS TOTAL SAWLOG WEIGHT.
                 C     VAR(7) IS TOTAL VENEER VOLUME.
                 C
0017             5 READ(5,6)ID,VAR(5),SMLVOL,VAR(7),VAR(3),PULPWT,VAR(2)
0018             6 FORMAT(I4,3F4.3,2F5.3,F3.0)
                 C
                 C   WHERE ID IS EQUAL TO 0 OR 9999, AN END OF SAMPLE DATA HAS BEEN EN-
                 C   COUNTERED.  WHERE ID IS 0, OTHER DATA SETS WILL FOLLOW.  WHERE ID
                 C   IS 9999, ALL DATA SETS HAVE BEEN READ.
                 C
0019               IF(ID.EQ.0.OR.ID.EQ.9999)GO TO 12
                 C
                 C   IF OPTION 1,2, OR 4 IS DESIRED, BOARD-FOOT VOLUMES MAY BE PUNCHED IN
                 C   THE TOTAL VOLUME FIELD OR IN THE SPECIFIC VOLUME FIELD OR BOTH.  THE
                 C   FOLLOWING STATEMENTS PLACE VALUES IN FIELDS LEFT BLANK FOR THESE
                 C   OPTIONS WHEN SPECIFIC AND TOTAL VOLUME FIELDS ARE NOT PUNCHED.
                 C
0020               IF(IO.EQ.3.OR.IO.EQ.5)GO TO 7
0021               IF(VAR(5).EQ.0.)VAR(5)=SMLVOL
0022               IF(SMLVOL.EQ.0.)SMLVOL=VAR(5)
0023               IF(VAR(7).EQ.0.)VAR(7)=VAR(5)
                 C
                 C   THE FOLLOWING STATEMENTS DETERMINE MINIMUM & MAXIMUM NUMBER OF
                 C   TREES PER LOAD FROM THE SAMPLE DATA WHEN THESE VALUES ARE NOT
                 C   SPECIFIED IN THE OPTIONS CARD.
                 C
0024             7 IF(TREMIN.NE.0.OR.TREMAX.NE.0)GO TO 8
0025               IF(SPXY(1,1).EQ.0)TMIN=900.
0026               IF(SPXY(1,1).EQ.0)TMAX=0.
0027               IF(VAR(2).LT.TMIN)TMIN=VAR(2)
0028               IF(VAR(2).GT.TMAX)TMAX=VAR(2)
                 C
                 C   THE FOLLOWING STATEMENTS DETERMINE MINIMUM & MAXIMUM LOAD WEIGHTS
                 C   FROM THE SAMPLE DATA WHEN THESE VALUES ARE NOT SPECIFIED IN THE
                 C   OPTIONS CARD.
                 C
0029             8 IF(TWTMIN.NE.0.OR.TWTMAX.NE.0)GO TO 9
0030               IF(SPXY(1,1).EQ.0)WMIN=900000.
0031               IF(SPXY(1,1).EQ.0)WMAX=0.
0032               IF(VAR(3).LT.WMIN)WMIN=VAR(3)
0033               IF(VAR(3).GT.WMAX)WMAX=VAR(3)
                 C
                 C   VARIABLES USED IN REGRESSION ANALYSIS WHICH ARE NOT READ DIRECTLY
                 C  ARE DETERMINED BELOW, SUMS AND SUMS OF SQUARES & PRODUCTS ARE ALSO
                 C   CALCULATED.
                 C
0034             9 VAR(1)=1.0
0035               VAR(4)=(DSQRT(VAR(3)*VAR(2)))
0036               VAR(6)=VAR(3)-PULPWT
0037               TSML =TSML + SMLVOL
```

```
0038              IF(IO.EQ.4.OR.IO.EQ.5)GO TO 10
0039              IF(PULPWT.EQ.0)PULPWT=1
0040           10 SUMPWT=SUMPWT+PULPWT
0041              SPWTSQ=SPWTSQ+PULPWT**2
0042              SUMSML=SUMSML+SMLVOL
0043              SSMLSQ=SSMLSQ+SMLVOL**2
0044              DO 11 I=1,7
0045              DO 11 J=1,7
0046           11 SPXY(I,J)=SPXY(I,J)+VAR(I)*VAR(J)
0047              GO TO 5
                C
                C   SPXY IS SEPARATED INTO SPX (SUMS,SUMS OF SQUARES & PRODUCTS FOR
                C   THE INDEPENDENT VARIABLES) AND RHS (THE RIGHT-HAND SIDE OF THE
                C   NORMAL EQUATIONS).
                C
0048           12 DO 14 I=1,4
0049              DO 13 J=1,4
0050           13 SPX(I,J)=SPXY(I,J)
0051              RHS(I,1)=SPXY(I,5)
0052              RHS(I,2)=SPXY(I,6)
0053           14 RHS(I,3)=SPXY(I,7)
                C
                C   SUBROUTINE MATINV IS CALLED TO INVERT THE MATRIX SPX.  SUBROUTINE
                C   MULT MULTIPLIES THE INVERSE OF SPX AND RHS TO DETERMINE B, THE
                C   REGRESSION COEFFICIENTS.
                C
0054              CALL MATINV(SPX,4,DET)
0055              CALL MULT(SPX,RHS,4,3,4,B)
                C
                C   STANDARD DEVIATIONS, MEANS, ERROR SUMS OF SQUARES, REGRESSION SUMS OF
                C   SQUARES, MEAN SQUARE ERRORS, AND COEFFICIENTS OF VARIATION ARE CALCULATED.
                C
0056              DO 15 I=2,7
0057              STD(I)=(SPXY(I,I)-((SPXY(1,I)**2)/SPXY(1,1)))/(SPXY(1,1)-1.0)
0058              STD(I)=DSQRT(STD(I))
0059           15 AMEAN(I)=SPXY(1,I)/SPXY(1,1)
0060              AMNPWT=SUMPWT/SPXY(1,1)
0061              AMNSML = TSML/SPXY(1,1)
0062              IF(PWFCTR.LE.0.)PWFCTR=1.
0063              AMNPVL=AMNPWT/PWFCTR
0064              STDPWT=DSQRT((SPWTSQ-((SUMPWT**2)/SPXY(1,1)))/(SPXY(1,1)-1.0))
0065              STDPVL=STDPWT/PWFCTR
0066              STDSML=DSQRT((SSMLSQ-((SUMSML**2)/SPXY(1,1)))/(SPXY(1,1)-1.0))
0067              DO 19 J=1,3
0068              SOLRHS(J)=0.
0069              DO 17 I=1,4
0070           17 SOLRHS(J)=SOLRHS(J)+B(I,J)*RHS(I,J)
0071              SSE(J)=SPXY(J+4,J+4)-SOLRHS(J)
0072              SSY(J)=SPXY(J+4,J+4)-(RHS(1,J)**2/SPXY(1,1))
0073              REGSS(J)=SSY(J)-SSE(J)
0074              AMSE(J)=SSE(J)/(SPXY(1,1)-4.0)
0075              AMSE(J)= (DSQRT (AMSE(J)))
0076           19 RSQR(J)=REGSS(J)/SSY(J)
0077              NOLDS=SPXY(1,1)
0078              IF(TREMIN.EQ.0.)TREMIN=TMIN
0079              IF(TREMAX.EQ.0.)TREMAX=TMAX
0080              IF(TWTMIN.EQ.0.)TWTMIN=WMIN
0081              IF(TWTMAX.EQ.0.)TWTMAX=WMAX
0082              IW=TWTMIN
0083              TWTMIN=IW
0084              GO TO (20,30,40,50,60),IO
                C
                C   SUMMARY PAGE FOR OPTION 1 IS PRINTED
                C
0085           20 WRITE(6,200)
0086              WRITE(6,100)(NAME(I),I=1,20)
0087              WRITE(6,202)NOLDS,AMEAN(2),STD(2),AMNSML,STDSML,AMEAN(6),STD(6)
0088              WRITE(6,204)(B(I,1),I=1,4)
0089              WRITE(6,102)RSQR(1),AMSE(1)
                C
                C   DELIMITERS ARE SET FOR PRODUCING THE TABLES.
                C
0090           21 TREES=TREMIN-1.
0091           22 TWT=TWTMIN
0092              TWTI=TWTMIN
0093              TREES=TREES+1.
0094              IF(TREES.GT.TREMAX)GO TO 80
0095              ITREES=TREES
```

```
0096              IF(IO.LE.3)WRITE(6,104)(NAME(I),I=1,20),ITREES
0097              IF(IO.GT.3)WRITE(6,106)(NAME(I),I=1,20),ITREES
0098              GO TO (23,33,43,53,63),IO
                  C
                  C    TABLE HEADING FOR OPTION 1 IS PRINTED THEN TABULAR VALUES ARE
                  C    CALCULATED & PRINTED FOR EACH LINE IN THE TABLES.
                  C
0099              23 WRITE(6,206)
0100              24 DO 26 I=1,5
0101                 SVOL(I)=B(1,1)+B(2,1)*TREES+B(3,1)*TWT+B(4,1)*DSQRT(TWT*TREES)
0102                 IF(SVOL(I).LE.0.)SVOL(I)=0.
0103              26 TWT=TWT+.2
0104                 ITWT=TWTI
0105                 WRITE(6,208)ITWT,(SVOL(I),I=1,5)
0106                 TWTI=TWTI+1.
0107                 IF(TWT.GT.TWTMAX)GO TO 22
0108                 GO TO 24
                  C
                  C    SUMMARY PAGE FOR OPTION 2 IS PRINTED
                  C
0109              30 WRITE(6,300)
0110                 WRITE(6,100) (NAME(I),I=1,20)
0111                 WRITE(6,302) NOLOS,AMEAN(2),STD(2),AMEAN(7),STD(7),AMEAN(6),STD(6)
0112                 WRITE(6,304) (B(I,3),I=1,4)
0113                 WRITE(6,102) RSQR(3),AMSE(3)
0114                 GO TO 21
                  C
                  C    TABLE HEADING FOR OPTION 2 IS PRINTED THEN TABULAR VALUES ARE
                  C    CALCULATED & PRINTED FOR EACH LINE IN THE TABLES.
                  C
0115              33 WRITE(6,306)
0116              34 DO 36 I=1,5
0117                 VVOL(I)=B(1,3)+B(2,3)*TREES+B(3,3)*TWT+B(4,3)*DSQRT(TWT*TREES)
0118                 IF(VVOL(I).LE.0.) VVOL(I)=0.
0119              36 TWT=TWT+.2
0120                 ITWT=TWTI
0121                 WRITE(6,208)ITWT,(VVOL(I),I=1,5)
0122                 TWTI=TWTI+1.
0123                 IF(TWT.GT.TWTMAX)GO TO 22
0124                 GO TO 34
                  C
                  C    SUMMARY PAGE FOR OPTION 3 IS PRINTED
                  C
0125              40 WRITE(6,400)
0126                 WRITE(6,100)(NAME(I),I=1,20)
0127                 WRITE(6,402)NOLOS,AMEAN(2),STD(2),AMNSML,STDSML,AMEAN(7),STD(7),AM
                    1EAN(6),STD(6)
0128                 WRITE(6,204)(B(I,1),I=1,4)
0129                 WRITE(6,102)RSQR(1),AMSE(1)
0130                 WRITE(6,404)(B(I,2),I=1,4)
0131                 WRITE(6,102)RSQR(2),AMSE(2)
0132                 WRITE(6,304)(B(I,3),I=1,4)
0133                 WRITE(6,102)RSQR(3),AMSE(3)
0134                 GO TO 21
                  C
                  C    TABLE HEADING FOR OPTION 3 IS PRINTED THEN TABULAR VALUES ARE
                  C    CALCULATED & PRINTED FOR EACH LINE IN THE TABLES.
                  C
0135              43 WRITE(6,408)
0136              44 DO 46 I=1,5
0137                 SVOL(I)=B(1,1)+B(2,1)*TREES+B(3,1)*TWT+B(4,1)*DSQRT(TWT*TREES)
0138                 VVOL(I)=B(1,3)+B(2,3)*TREES+B(3,3)*TWT+B(4,3)*DSQRT(TWT*TREES)
0139                 IF(VVOL(I).LE.0.)VVOL(I)=0.
0140                 IF(SVOL(I).LE.0.)SVOL(I)=0.
0141                 IF(VVOL(I).LT.SVOL(I))GO TO 45
0142                 VVOL(I)=SVOL(I)
0143                 SVOL(I)=0.
0144                 GO TO 46
0145              45 SVOL(I)=SVOL(I)-VVOL(I)
0146              46 TWT=TWT+.2
0147                 ITWT=TWTI
0148                 WRITE(6,142)ITWT,VVOL(1),SVOL(1),VVOL(2),SVOL(2),VVOL(3),SVOL(3),V
                    1VOL(4),SVOL(4),VVOL(5),SVOL(5)
0149                 TWTI=TWTI+1.
0150                 IF(TWT.GT.TWTMAX)GO TO 22
0151                 GO TO 44
                  C
                  C    SUMMARY PAGE FOR OPTION 4 IS PRINTED
```

```
                C
0152                50 WRITE(6,500)
0153                   WRITE(6,100)(NAME(I),I=1,20)
0154                   IF(PWFCTR.LE.1.)GO TO 51
0155                   WRITE(6,502)NOLDS,AMEAN(2),STD(2),AMNPVL,STDPVL,AMNPWT,STDPWT,AMNS
                     1ML,STDSML,AMEAN(3),STD(3),AMEAN(6),STD(6)
0156                   GO TO 52
0157                51 WRITE(6,503)NOLDS,AMEAN(2),STD(2),AMNPWT,STDPWT,AMNSML,STDSML,AMEA
                     1N(3),STD(3),AMEAN(6),STD(6)
0158                52 WRITE(6,504)(B(I,1),I=1,4)
0159                   WRITE(6,102)RSQR(1),AMSE(1)
0160                   WRITE(6,506)(B(I,2),I=1,4)
0161                   WRITE(6,102)RSQR(2),AMSE(2)
0162                   GO TO 21
                C
                C    TABLE HEADING FOR OPTION 4 IS PRINTED THEN TABULAR VALUES ARE
                C    CALCULATED & PRINTED FOR EACH LINE IN THE TABLES.
                C
0163                53 IF(PWFCTR.LE.1.)WRITE(6,510)
0164                   IF(PWFCTR.GT.1.)WRITE(6,508)
0165                54 DO 56 I=1,5
0166                   SVOL(I)=B(1,1)+B(2,1)*TREES+B(3,1)*TWT+B(4,1)*DSQRT(TWT*TREES)
0167                   SWT=B(1,2)+B(2,2)*TREES+B(3,2)*TWT+B(4,2)*DSQRT(TWT*TREES)
0168                   PWT(I)=(TWT-SWT)/PWFCTR
0169                   IF(SVOL(I).LE.0.)SVOL(I)=0.
0170                   IF(PWT(I).LE.0.)PWT(I)=0.
0171                56 TWT=TWT+.2
0172                   ITWT=TWTI
0173                   WRITE(6,512)ITWT,SVOL(1),PWT(1),SVOL(2),PWT(2),SVOL(3),PWT(3),SVOL
                     1(4),PWT(4),SVOL(5),PWT(5)
0174                   TWTI=TWTI+1.
0175                   IF(TWT.GT.TWTMAX)GO TO 22
0176                   GO TO 54
                C
                C    SUMMARY PAGE FOR OPTION 5 IS PRINTED
                C
0177                60 WRITE(6,600)
0178                   WRITE(6,100)(NAME(I),I=1,20)
0179                   IF(PWFCTR.LE.1.)GO TO 61
0180                   WRITE(6,602)NOLDS,AMEAN(2),STD(2),AMNPVL,STDPVL,AMNPWT,STDPWT,AMNS
                     1ML,STDSML,AMEAN(7),STD(7),AMEAN(3),STD(3),AMEAN(6),STD(6)
0181                   GO TO 62
0182                61 WRITE(6,603)NOLDS,AMEAN(2),STD(2),AMNPWT,STDPWT,AMNSML,STDSML,AMEA
                     1N(7),STD(7),AMEAN(3),STD(3),AMEAN(6),STD(6)
0183                62 WRITE(6,504)(B(I,1),I=1,4)
0184                   WRITE(6,102)RSQR(1),AMSE(1)
0185                   WRITE(6,506)(B(I,2),I=1,4)
0186                   WRITE(6,102)RSQR(2),AMSE(2)
0187                   WRITE(6,604)(B(I,3),I=1,4)
0188                   WRITE(6,102)RSQR(3),AMSE(3)
0189                   GO TO 21
                C
                C    TABLE HEADING FOR OPTION 5 IS PRINTED THEN TABULAR VALUES ARE
                C    CALCULATED & PRINTED FOR EACH LINE IN THE TABLES.
                C
0190                63 IF(PWFCTR.LE.1.)WRITE(6,607)
0191                   IF(PWFCTR.GT.1.)WRITE(6,606)
0192                64 DO 66 I=1,5
0193                   SVOL(I)=B(1,1)+B(2,1)*TREES+B(3,1)*TWT+B(4,1)*DSQRT(TWT*TREES)
0194                   SWT=B(1,2)+B(2,2)*TREES+B(3,2)*TWT+B(4,2)*DSQRT(TWT*TREES)
0195                   PWT(I)=(TWT-SWT)/PWFCTR
0196                   VVOL(I)=B(1,3)+B(2,3)*TREES+B(3,3)*TWT+B(4,3)*DSQRT(TWT*TREES)
0197                   IF(VVOL(I).LE.0.)VVOL(I)=0.
0198                   IF(SVOL(I).LE.0.)SVOL(I)=0.
0199                   IF(PWT(I).LE.0.)PWT(I)=0.
0200                   IF(VVOL(I).LT.SVOL(I))GO TO 65
0201                   VVOL(I)=SVOL(I)
0202                   SVOL(I)=0.
0203                   GO TO 66
0204                65 SVOL(I)=SVOL(I)-VVOL(I)
0205                66 TWT=TWT+.2
0206                   ITWT=TWTI
0207                   WRITE(6,608)ITWT,VVOL(1),SVOL(1),PWT(1),VVOL(2),SVOL(2),PWT(2),VVO
                     1L(3),SVOL(3),PWT(3),VVOL(4),SVOL(4),PWT(4),VVOL(5),SVOL(5),PWT(5)
0208                   TWTI=TWTI+1.
0209                   IF(TWT.GT.TWTMAX)GO TO 22
0210                   GO TO 64
```

```
C
C   IF ID IS 0 GO TO 1 & READ THE NEXT SET OF DATA, OTHERWISE
C   TERMINITATE PROGRAM.
C
0211        80 IF(ID.EQ.0)GO TO 1
0212       100 FORMAT(1HO,///,6X,20A4)
0213       102 FORMAT(1HO,5X,'MULTIPLE R SQUARED = ',F9.4,/,
              1'       STANDARD ERROR = ',F9.4,////)
0214       104 FORMAT(1H1,5X,20A4,11X,I3,' LOGS')
0215       106 FORMAT(1H1,5X,20A4,11X,I3,' TREES')
0216       142 FORMAT(1H ,1X,I3,4X,5(F7.3,4X,F8.3,5X))
0217       200 FORMAT(1H1,38X,43HWEIGHT SCALING OF LOGS FOR SAWTIMBER VOLUME)
0218       202 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
              1,'MEAN',22X,'STANDARD DEVIATION',//,
              26X,'NUMBER OF LOGS  = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
              36X,'SAWLOG VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              46X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0219       204 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG
              1 VOLUME IS',//,2X,'TOTAL SAWLOG VOLUME = ',F9.4,' + ',F9.4,
              2' (NO OF LOGS) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
              3' (SQRT(TOTAL WEIGHT * NO OF LOGS))')
0220       206 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,
              1'2',23X,'4',23X,'6',23X,'8',/,'   OF',9X,4(9HSAWTIMBER,15X),
              29HSAWTIMBER,/,' POUNDS',9X,4(5H(MBF),19X),5H(MBF))
0221       208 FORMAT(1H ,1X,I3,8X,4(F8.3,16X),F8.3)
0222       300 FORMAT(1H1,41X,40HWEIGHT SCALING OF LOGS FOR VENEER VOLUME)
0223       302 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
              1,'MEAN',22X,'STANDARD DEVIATION',//,
              26X,'NUMBER OF LOGS  = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
              36X,'VENEER VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              46X,'VENEER WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0224       304 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL VENEER
              1 VOLUME IS',//,2X,'VENEER VOLUME = ',F9.4,' + ',F9.4,
              2' (NO OF LOGS) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
              3' (SQRT(TOTAL WEIGHT * NO OF LOGS))')
0225       306 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,
              1'2',23X,'4',23X,'6',23X,'8',/,'   OF',11X,4(6HVENEER,18X),
              26HVENEER,/,' POUNDS',10X,4(5H(MBF),19X),5H(MBF))
0226       400 FORMAT(1H1,33X,52HWEIGHT SCALING OF LOGS FOR VENEER AND SAWMILL VO
              1LUME)
0227       402 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
              1,'MEAN',22X,'STANDARD DEVIATION',//,
              26X,'NUMBER OF LOGS  = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
              36X,'SAWMILL VOLUME  = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              46X,'VENEER VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              56X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0228       404 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG
              1 WEIGHT IS',//,2X,'TOTAL SAWLOG WEIGHT = ',F9.4,' + ',F9.4,
              2' (NO OF LOGS) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
              3' (SQRT(TOTAL WEIGHT * NO OF LOGS))')
0229       408 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,
              1'2',23X,'4',23X,'6',23X,'8',/,'   OF',5X,
              25(18HVENEER     SAWMILL,6X),/,' POUNDS',4X,5(5H(MBF),6X,5H(MBF),8X
              3))
0230       500 FORMAT(1H1,33X,57HWEIGHT SCALING OF TREES FOR SAWTIMBER AND PULPWO
              1OD VOLUME)
0231       502 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
              1,'MEAN',22X,'STANDARD DEVIATION',//,
              26X,'NUMBER OF TREES = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
              36X,'PULPWOOD VOLUME = ',F9.4,'  (CORDS)',16X,F9.4,'  (CORDS)',/,
              46X,'PULPWOOD WEIGHT = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
              56X,'SAWLOG VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              66X,'TOTAL WEIGHT    = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
              76X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0232       503 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
              1,'MEAN',22X,'STANDARD DEVIATION',//,
              26X,'NUMBER OF TREES = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
              36X,'PULPWOOD WEIGHT = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
              46X,'SAWLOG VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
              56X,'TOTAL WEIGHT    = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
              66X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0233       504 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG
              1 VOLUME IS',//,2X,'TOTAL SAWLOG VOLUME = ',F9.4,' + ',F9.4,
              2' (NO OF TREES) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
              3' (SQRT(TOTAL WEIGHT * NO OF TREES))')
0234       506 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL SAWLOG
              1 WEIGHT IS',//,2X,'TOTAL SAWLOG WEIGHT = ',F9.4,' + ',F9.4,
              2' (NO OF TREES) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
```

```
     3' (SQRT(TOTAL WEIGHT * NO OF TREES))')
0235  508 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,
     1'2',23X,'4',23X,'6',23X,'8',/,'   OF',5X,5(17HSAWTIMBER    PULP,7X
     2),/,' POUNDS',5X,5(17H(MBF)     (CORDS),7X))
0236  510 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,
     1'2',23X,'4',23X,'6',23X,'8',/,'   OF',5X,5(17HSAWTIMBER    PULP,7X
     2),/,' POUNDS',5X,5(17H(MBF)    (POUNDS),7X))
0237  512 FORMAT(1H ,1X,I3,4X,5(F8.3,4X,F7.3,5X))
0238  600 FORMAT(1H1,29X,62HWEIGHT SCALING OF TREES FOR VENEER,SAWMILL AND P
     1ULPWOOD VOLUME)
0239  602 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
     1,'MEAN',22X,'STANDARD DEVIATION',//,
     26X,'NUMBER OF TREES = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
     36X,'PULPWOOD VOLUME = ',F9.4,'  (CORDS)',16X,F9.4,'  (CORDS)',/,
     46X,'PULPWOOD WEIGHT = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
     56X,'SAWMILL VOLUME  = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
     66X,'VENEER VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
     76X,'TOTAL WEIGHT    = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
     86X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0240  603 FORMAT(1HO,/////,6X,'NUMBER OF LOADS',6X,'= ',I4,'  (NO.)',///,27X
     1,'MEAN',22X,'STANDARD DEVIATION',//,
     26X,'NUMBER OF TREES = ',F9.4,'  (NO.)',18X,F9.4,'  (NO.)',/,
     36X,'PULPWOOD WEIGHT = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
     46X,'SAWMILL VOLUME  = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
     56X,'VENEER VOLUME   = ',F9.4,'  (MBF)',18X,F9.4,'  (MBF)',/,
     66X,'TOTAL WEIGHT    = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)',/,
     76X,'SAWLOG WEIGHT   = ',F9.4,'  (MLBS)',17X,F9.4,'  (MLBS)')
0241  604 FORMAT(1HO,5X,'THE REGRESSION EQUATION FOR ESTIMATING TOTAL VENEER
     1 VOLUME IS',//,2X,'VENEER VOLUME = ',F9.4,'+ ',F9.4,
     2' (NO OF TREES) + ',F9.4,' (TOTAL WEIGHT) + ',F9.4,
     3' (SQRT(TOTAL WEIGHT * NO OF TREES))')
0242  606 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,'2',
     123X,'4',23X,'6',23X,'8',/,'   OF',4X,5(24HVENEER SAWMILL  PULP
     2),/,' POUNDS',3X,5(24H(MBF)    (MBF) (CORDS)   ))
0243  607 FORMAT(1H ,59X,'HUNDREDS OF POUNDS',/,' THOUS.',11X,'0',23X,'2',
     123X,'4',23X,'6',23X,'8',/,'   OF',4X,5(24HVENEER SAWMILL  PULP
     2),/,' POUNDS',3X,5(24H(MBF)  (MBF) (POUNDS)   ))
0244  608 FORMAT(1H ,2X,I3,2X,5(F7.3,F8.3,F7.3,2X))
0245       STOP
0246       END
```

Appendix 2b. Listing for CHECK

```
0001              DIMENSION NAME(20),B(3,4),Y(3),VAR(7)
0002            1 ICOUNT=0
0003              ATVV=0.
0004              ATSV=0.
0005              TVVD=0.
0006              ATPV=0.
0007              TSVD=0.
0008              TPVD=0.
0009              TSLVD=0.
0010              ATSLV=0.
0011              READ(5,3)(NAME(I),I=1,20)
0012            3 FORMAT(20A4)
0013              READ(5,5)IO,PWFCTR
0014            5 FORMAT(I1,F4.3)
0015              IF(IO.EQ.1)WRITE(6,7)(NAME(I),I=1,20)
0016              IF(IO.EQ.2)WRITE(6,8)(NAME(I),I=1,20)
0017              IF(IO.EQ.3)WRITE(6,9)(NAME(I),I=1,20)
0018              IF(IO.EQ.4.AND.PWFCTR.EQ.0)WRITE(6,10)(NAME(I),I=1,20)
0019              IF(IO.EQ.4.AND.PWFCTR.NE.0)WRITE(6,11)(NAME(I),I=1,20)
0020              IF(IO.EQ.5.AND.PWFCTR.EQ.0)WRITE(6,12)(NAME(I),I=1,20)
0021              IF(IO.EQ.5.AND.PWFCTR.NE.0)WRITE(6,13)(NAME(I),I=1,20)
0022            7 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                 1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                 215X,'(ACTUAL-CALCULATED)',//,29X,'SAWLOG',/,18X,
                 3'ID',9X,'(MBF)',//)
0023            8 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                 1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                 215X,'(ACTUAL-CALCULATED)',//,29X,'VENEER',/,18X,
                 3'ID',9X,'(MBF)',//)
0024            9 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                 1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                 215X,'(ACTUAL-CALCULATED)',//,20X,'VENEER',7X,'SAWMILL',
                 3/,13X,'ID',5X,'(MBF)',8X,'(MBF)',//)
0025           10 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                  1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                  215X,'(ACTUAL-CALCULATED)',// 22X,'PULP',7X,'SAWLOG',
                  3/,13X,'ID',6X,'POUNDS',/,21X,'(MLBS)',7X,'(MBF)',//)
0026           11 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                  1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                  215X,'(ACTUAL-CALCULATED)',// 22X,'PULP',7X,'SAWLOG',
                  3/,13X,'ID',7X,'CORDS',/,22X,'(NO)',7X,'(MBF)',//)
0027           12 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                  1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                  215X,'(ACTUAL-CALCULATED)',//,10X,'PULP',6X,'VENEER',
                  35X,'SAWMILL',/,2X,'ID',5X,'POUNDS',/,9X,'(MLBS)',
                  46X,'(MBF)',6X,'(MBF)',//)
0028           13 FORMAT(1H1,20A4,/,19X,'CHECK SCALES',//,3X,
                  1'DIFFERENCES IN ACTUAL AND CALCULATED DATA',//,
                  215X,'(ACTUAL-CALCULATED)',//,10X,'PULP',6X,'VENEER',
                  35X,'SAWMILL',/,2X,'ID',6X,'CORDS',/,10X,'(NO)',
                  46X,'(MBF)',6X,'(MBF)',//)
0029           14 IX=1
0030              IF(IO.EQ.3)IX=2
0031              IF(IO.EQ.4)IX=2
0032              IF(IO.EQ.5)IX=3
0033              DO 17 I=1,IX
0034              READ(5,15)(B(I,J),J=1,4)
0035           15 FORMAT(4F9.4)
0036           17 CONTINUE
               C
               C   VAR(5) - TOTAL LOAD SCALE (ANY SCALE)
               C   VAR(7) - VENEER VOLUME (ANY SCALE)
               C   VAR(3) - TOTAL NET LOAD WEIGHT (M.LBS.)
               C   VAR(2) - NUMBER OF TREES OR LOGS ON LOAD
               C
0037           19 READ(5,20)ID,VAR(5),SMLVOL,VAR(7),VAR(3),PULPWT,VAR(2)
0038           20 FORMAT(I4,3F4.3,2F5.3,F3.0)
0039              IF(IO.EQ.3.OR.IO.EQ.5)GO TO 21
```

```
0040              IF(SMLVOL.EQ.0)SMLVOL=VAR(5)
0041              IF(VAR(5).EQ.0)VAR(5)=SMLVOL
0042              IF(VAR(7).EQ.0)VAR(7)=VAR(5)
0043           21 IF(ID.EQ.0.OR.ID.EQ.9999)GO TO 22
0044              GO TO 23
0045           22 IF(IO.EQ.1)GO TO 32
0046              IF(IO.EQ.2)GO TO 37
0047              IF(IO.EQ.3)GO TO 45
0048              IF(IO.EQ.4)GO TO 55
0049              IF(IO.EQ.5)GO TO 65
0050           23 ICOUNT=ICOUNT+1
                C
                C    THE FOLLOWING 12 STATEMENTS ROUND THE TRUCKLOAD
                C    WEIGHT TO THE NEAREST EVEN HUNDRED POUNDS.
                C
0051              IWTM=VAR(3)
0052              IFRAC=(VAR(3)-FLOAT(IWTM))*10.0
0053              DO 24 K=1,9,2
0054              IF(IFRAC.EQ.K)IFRAC=IFRAC+1
0055           24 CONTINUE
0056              IF(IFRAC.NE.10)GO TO 25
0057              IFRAC=0
0058              IWTM=IWTM+1
0059           25 XIWTM=IWTM
0060              XIFRAC=IFRAC
0061              XIWT=XIWTM+(XIFRAC/10.)
0062              XNO=VAR(2)
0063              DO 27 I=1,IX
                C
                C    THIS REGRESSION EQUATION CALCULATES THE SAME
                C    VALUES AS PRODUCED IN THE WTVOL TABLES.
                C
0064              Y(I)=B(I,1)+B(I,2)*XNO+B(I,3)*XIWT+B(I,4)*SQRT(XNO*XIWT)
0065              IF(Y(I).LE.0)Y(I)=0.
0066           27 CONTINUE
0067              IF(IO.EQ.1)GO TO 29
0068              IF(IO.EQ.2)GO TO 34
0069              IF(IO.EQ.3)GO TO 39
0070              IF(IO.EQ.4)GO TO 49
0071              IF(IO.EQ.5)GO TO 59
                C
                C    STATEMENT #29 THRU 'GO TO 1' IS OPTION NUMBER 1
                C
0072           29 SLVD=VAR(5)-Y(1)
0073              IF(ICOUNT.EQ.40)WRITE(6,30)
0074              IF(ICOUNT.EQ.82)WRITE(6,30)
0075              IF(ICOUNT.EQ.124)WRITE(6,30)
0076              IF(ICOUNT.EQ.166)WRITE(6,30)
0077           30 FORMAT(1H1)
0078              WRITE(6,31)ID,SLVD
0079           31 FORMAT(1H ,15X,I4,9X,F6.3)
0080              TSLVD=TSLVD+SLVD
0081              ATSLV=ATSLV+VAR(5)
0082              GO TO 19
0083           32 PSLVD=(TSLVD/ATSLV)*100.
0084              WRITE(6,33)TSLVD,PSLVD
0085           33 FORMAT(1H ,/,' - - - - - - - - - - - - - - - - - - - - -',
                 1/,17X,'TOTAL',/,17X,'DIFF.',6X,F7.3,//,17X,'PERCENT',/,
                 218X,'OF',9X,F5.1,/,17X,'ACTUAL')
0086              IF(ID.EQ.9999)GO TO 69
0087              GO TO 1
                C
                C    STATEMENT #34 THRU 'GO TO 1' IS OPTION NUMBER 2
                C
0088           34 VVD=VAR(7)-Y(1)
0089              IF(ICOUNT.EQ.40)WRITE(6,35)
0090              IF(ICOUNT.EQ.82)WRITE(6,35)
0091              IF(ICOUNT.EQ.124)WRITE(6,35)
0092              IF(ICOUNT.EQ.166)WRITE(6,35)
```

```
0093            35 FORMAT(1H1)
0094               WRITE(6,36)ID,VVD
0095            36 FORMAT(1H ,15X,I4,9X,F6.3)
0096               TVVD=TVVD+VVD
0097               ATVV=ATVV+VAR(7)
0098               GO TO 19
0099            37 PVVD=(TVVD/ATVV)*100.
0100               WRITE(6,38)TVVD,PVVD
0101            38 FORMAT(1H ,/,' - - - - - - - - - - - - - - - - - - - - - -',
                  1/,17X,'TOTAL',/,17X,'DIFF.',6X,F7.3,//,17X,'PERCENT',/,
                  218X,'OF',9X,F5.1,/,17X,'ACTUAL')
0102               IF(ID.EQ.9999)GO TO 69
0103               GO TO 1
                C
                C    STATEMENT #39 THRU 'GO TO 1' IS OPTION NUMBER 3
                C
0104            39 VVD=VAR(7)-Y(2)
0105               CSMV=Y(1)-Y(2)
0106               SVD=SMLVOL-CSMV
0107               IF(ICOUNT.EQ.32)WRITE(6,41)
0108               IF(ICOUNT.EQ.74)WRITE(6,41)
0109               IF(ICOUNT.EQ.116)WRITE(6,41)
0110               IF(ICOUNT.EQ.158)WRITE(6,41)
0111            41 FORMAT(1H1)
0112               WRITE(6,43)ID,VVD,SVD
0113            43 FORMAT(1H ,10X,I4,5X,F6.3,7X,F6.3)
0114               TVVD=TVVD+VVD
0115               TSVD=TSVD+SVD
0116               ATSV=ATSV+SMLVOL
0117               ATVV=ATVV+VAR(7)
0118               GO TO 19
0119            45 TSLVD=TVVD+TSVD
0120               ATSLV=ATSV+ATVV
0121               PSVD=(TSVD/ATSV)*100.
0122               PVVD=(TVVD/ATVV)*100.
0123               PSLVD=(TSLVD/ATSLV)*100.
0124               WRITE(6,47)TVVD,TSVD,PVVD,PSVD,TSLVD,PSLVD
0125            47 FORMAT(1H ,/,'- - - - - - - - - - - - - - - - - - - - - -',/,
                  110X,'TOTAL',/,10X,'DIFF.',4X,F7.3,6X,F7.3,//,10X,
                  2'PERCENT',/,11X,'OF',7X,F5.1,8X,F5.1,/,10X,'ACTUAL',/,
                  3'- - - - - - - - - - - - - - - - - - - - -',/,10X,
                  4'TOTAL SAWLOG',/,10X,'DIFF.',12X,F7.3,/,10X,
                  5'(V.VOL.DIFF.+S.VOL.DIFF.)',//,10X,'TOTAL SAWLOG DIFF',/,
                  610X,'AS PERCENT OF',5X,F5.1,/,10X,'ACTUAL SAWLOG VOL.',//)
0126               IF(ID.EQ.9999)GO TO 69
0127               GO TO 1
                C
                C    STATEMENT #49 THRU 'GO TO 1' IS OPTION NUMBER 4
                C
0128            49 IF(PWFCTR.EQ.0)GO TO 50
0129               CPV=(XIWT-Y(2))/PWFCTR
0130               APV=PULPWT/PWFCTR
0131               PVD=APV-CPV
0132               GO TO 51
0133            50 CPV=(XIWT-Y(2))
0134               APV=PULPWT
0135               PVD=APV-CPV
0136            51 SLVD=VAR(5)-Y(1)
0137               IF(ICOUNT.EQ.40)WRITE(6,52)
0138               IF(ICOUNT.EQ.82)WRITE(6,52)
0139               IF(ICOUNT.EQ.124)WRITE(6,52)
0140               IF(ICOUNT.EQ.166)WRITE(6,52)
0141            52 FORMAT(1H1)
0142               WRITE(6,53)ID,PVD,SLVD
0143            53 FORMAT(1H ,10X,I4,6X,F6.3,6X,F6.3)
0144               TPVD=TPVD+PVD
0145               TSLVD=TSLVD+SLVD
0146               ATPV=ATPV+APV
0147               ATSLV=ATSLV+VAR(5)
0148               GO TO 19
```

```
0149            55 PPD=(TPVD/ATPV)*100.
0150               PSLVD=(TSLVD/ATSLV)*100.
0151               WRITE(6,57)TPVD,TSLVD,PPD,PSLVD
0152            57 FORMAT(1H ,/,' - - - - - - - - - - - - - - - - - - - - - -',/,
                  112X,'TOTAL',/,12X,'DIFF.',3X,F7.3,5X,F7.3,//,12X,'PERCENT',
                  2/,13X,'OF',6X,F5.1,7X,F5.1,/,12X,'ACTUAL')
0153               IF(ID.EQ.9999)GO TO 69
0154               GO TO 1
                C
                C   STATEMENT #59 THRU 'GO TO 1' IS OPTION NUMBER 5
                C
0155            59 IF(PWFCTR.EQ.0)GO TO 60
0156               CPV=(XIWT-Y(2))/PWFCTR
0157               APV=PULPWT/PWFCTR
0158               PVD=APV-CPV
0159               GO TO 61
0160            60 CPV=(XIWT-Y(2))
0161               APV=PULPWT
0162               PVD=APV-CPV
0163            61 VVD=VAR(7)-Y(3)
0164               CSMV=Y(1)-Y(3)
0165               SVD=SMLVOL-CSMV
0166               IF(ICOUNT.EQ.32)WRITE(6,62)
0167               IF(ICOUNT.EQ.74)WRITE(6,62)
0168               IF(ICOUNT.EQ.116)WRITE(6,62)
0169               IF(ICOUNT.EQ.158)WRITE(6,62)
0170            62 FORMAT(1H1)
0171               WRITE(6,63)ID,PVD,VVD,SVD
0172            63 FORMAT(1H ,I4,4X,F6.3,5X,F6.3,5X,F6.3)
0173               TVVD=TVVD+VVD
0174               TSVD=TSVD+SVD
0175               TPVD=TPVD+PVD
0176               ATSV=ATSV+SMLVOL
0177               ATVV=ATVV+VAR(7)
0178               ATPV=ATPV+APV
0179               GO TO 19
0180            65 TSLVD=TVVD+TSVD
0181               ATSLV=ATSV+ATVV
0182               PSLVD=(TSLVD/ATSLV)*100.
0183               PPD=(TPVD/ATPV)*100.
0184               PSVD=(TSVD/ATSV)*100.
0185               PVVD=(TVVD/ATVV)*100.
0186               WRITE(6,67)TPVD,TVVD,TSVD,PPD,PVVD,PSVD,TSLVD,PSLVD
0187            67 FORMAT(1H ,/,' - - - - - - - - - - - - - - - - - - - - -',
                  1/,' TOTAL',/,' DIFF.',2X,F7.3,4X,F7.3,4X,F7.3,//,' PERCENT',/,
                  22X,'OF',5X,F5.1,6X,F5.1,6X,F5.1,/,' ACTUAL',/,
                  3' - - - - - - - - - - - - - - - - - - - - -',/,' TOTAL SAWLOG',
                  4/,' DIFF.',20X,F7.3,/,' (V.VOL.DIFF.+S.VOL.DIFF.)',//,
                  5' TOTAL SAWLOG DIFF.',/,' AS PERCENT OF',12X,F5.1,/,
                  6' ACTUAL SAWLOG VOL.')
0188               IF(ID.EQ.9999)GO TO 69
0189               GO TO 1
                C
                C   CHECK SCALE DATA ARE CHECKED AGAINST
                C   PREVIOUS MONTH'S WEIGHT/VOLUME TABLES
                C
0190            69 STOP
0191               END
```

Appendix 2c. Listing for VOLWT

```
0001            DIMENSION KARRAY(31,11),TOTWT(31,11),SAWWT(31,11),B(3,2),RSQR(2),A
               2MSE(2),TITLE(20),ID(31),SPXY(5,5),VAR(5),SPX(3,3),RHS(3,2),AMEAN(5
               3),SOLRHS(2),SSE(2),SSY(2),REGSS(2),STD(5)
0002            DOUBLE PRECISION TOTWT,SAWWT,RSQR,AMSE,B,VAR,SPXY,SPX,RHS,AMEAN,SO
               2LRHS,SSE,SSY,REGSS,DET,STD,ANLOGS,SCALE,SAWVOL,VENVOL,TOTWHT,PULPW
               3T,ATREES,TOSAWL
0003            DO 1 I=1,5
0004            DO 1 J=1,5
0005          1 SPXY(I,J)=0.
0006            DO 2 I=1,5
0007            VAR(I)=0.
0008          2 CONTINUE
0009            DO 4 I=1,3
0010            DO 3 J=1,3
0011            SPX(I,J)=0.
0012          3 CONTINUE
0013          4 CONTINUE
0014            DO 8 I=1,2
0015            SOLRHS(I)=0.
0016          8 CONTINUE
0017            DO 9 I=1,2
0018            SSE(I)=0.
0019            SSY(I)=0.
0020            REGSS(I)=0.
0021          9 CONTINUE
0022            DO 10 I=1,5
0023            STD(I)=0.
0024         10 CONTINUE
0025            K=0
0026            ND=0
               C
               C  AT THIS POINT A SINGLE CARD IS READ WHICH DEFINES THE NUMBER OF FORM
               C  CLASSES FOR WHICH TABLES ARE TO BE COMPUTED (NCASE), THE KIND OF LOG
               C  RULE TABLES USED (LOGRL), AND THE MINIMUM AND MAXIMUM DIAMETERS FOR
               C  WHICH THE RANGE OF DIAMETERS IS TO BE DEFINED (MIND AND MAXD).
               C
0027            11 READ(5,12)NCASE,LOGRL,MIND,MAXD
0028            12 FORMAT(I3,I1,2I3)
0029               ND=(MAXD-MIND)+1
               C
               C  NEXT A TITLE CARD IS READ INDICATING THE NAME OF THE ORGANIZATION FOR
               C  WHICH THE TABLES ARE BEING COMPUTED.
               C
0030               READ(5,13)(TITLE(I),I=1,20)
0031            13 FORMAT(20A4)
               C
               C  AT THIS POINT IN THE PROGRAM ALL TRUCK LOAD DATA IS READ INTO THE COM-
               C  PUTER AND VAR(1) THROUGH VAR(5) ARE DEFINED.  THESE VARIABLES REPRESENT
               C  1.0, AVERAGE VOLUME PER TREE, AVERAGE SAWLOG LENGTH PER TREE, AVERAGE
               C  WEIGHT PER TREE, AND AVERAGE SAWLOG WEIGHT PER TREE, RESPECTIVELY.
               C
0032            14 READ(5,15)IDNO,SCALE,SAWVOL,VENVOL,TOTWHT,PULPWT,ATREES,TOSAWL
0033            15 FORMAT(1X,I3,3F4.3,2F5.3,F3.0,F5.0)
0034               IF(SCALE.EQ.0.) SCALE=SAWVOL
0035               IF(IDNO.EQ.0.OR.IDNO.EQ.999) GO TO 17
0036               VAR(1)=1.0D0
0037               VAR(2)=SCALE/ATREES
0038               VAR(3)=((TOSAWL)/ATREES)/16.D0
0039               VAR(4)=TOTWHT/ATREES
0040               VAR(5)=(TOTWHT-PULPWT)/ATREES
0041               DO 16 I=1,5
0042               DO 16 J=1,5
0043            16 SPXY(I,J)=SPXY(I,J)+VAR(I)*VAR(J)
0044               GO TO 14
0045            17 DO 18 I=1,5
0046               DO 18 J=1,5
0047            18 IF(SPXY(I,J).EQ.0) SPXY(I,J)=1.
0048               DO 20 I=1,3
0049               DO 19 J=1,3
0050            19 SPX(I,J)=SPXY(I,J)
0051               RHS(I,1)=SPXY(I,4)
0052            20 RHS(I,2)=SPXY(I,5)
0053               CALL MATINV(SPX,3,DET)
0054               CALL MULT(SPX,RHS,3,2,3,B)
0055               DO 21 I=2,5
```

```
0056              STD(I)=(SPXY(I,I)-((SPXY(1,I)**2)/SPXY(1,1)))/(SPXY(I,1)-1.0D0)
0057              STD(I)=DSQRT(STD(I))
0058           21 AMEAN(I)=SPXY(1,I)/SPXY(1,1)
0059              DO 23 J=1,2
0060              SOLRHS(J)=0.
0061              DO 22 I=1,3
0062           22 SOLRHS(J)=SOLRHS(J)+B(I,J)*RHS(I,J)
0063              SSE(J)=SPXY(J+3,J+3)-SOLRHS(J)
0064              SSY(J)=SPXY(J+3,J+3)-(RHS(1,J)**2/SPXY(1,1))
0065              REGSS(J)=SSY(J)-SSE(J)
0066              AMSE(J)=SSE(J)/(SPXY(1,1)-2.0D0)
0067              AMSE(J)=DABS(AMSE(J))
0068              AMSE(J)=DSQRT(AMSE(J))
0069              RSQR(J)=REGSS(J)/SSY(J)
0070           23 RSQR(J)=RSQR(J)*100.D0
0071           24 K=K+1
                C
                C  ONE SET OF FORM CLASS VOLUMES ARE READ AT A TIME AND ALL TOTAL WEIGHT
                C  AND SAWLOG WEIGHT CALCULATIONS ARE MADE BEFORE ANOTHER FORM CLASS IS
                C  READ IN.
                C
0072              DO 26 I=1,ND
0073              READ(5,25)(KARRAY(I,J),J=1,11),ID(I)
0074           25 FORMAT(11I5,21X,I4)
0075           26 CONTINUE
0076              DO 27 I=1,ND
0077              ANLOGS=.5
0078              DO 27 J=1,8
0079              ANLOGS=ANLOGS+.5
0080              TOTWT(I,J)=B(1,1)+B(2,1)*((DFLOAT(KARRAY(I,J)))/1000.D0)+(B(3,1)*A
                  2NLOGS)
0081              SAWWT(I,J)=B(1,2)+B(2,2)*((DFLOAT(KARRAY(I,J)))/1000.D0)+(B(3,2)*A
                  2NLOGS)
0082           27 CONTINUE
                C
                C  THIS SET OF STATEMENTS DETERMINES THE FORM CLASS FOR WHICH THE CAL-
                C  CULATIONS HAVE BEEN MADE FROM THE ID PREVIOUSLY READ IN.
                C
0083              DO 28 I=6510,9010,100
0084              IF(ID(1).EQ.(I)) IFC=((I)-10)/100
0085           28 CONTINUE
                C
                C  FROM THIS POINT ON THE PROGRAM DETERMINES AND PRINTS OUT THE APPROPRIATE
                C  TITLE HEADINGS, FORM CLASS HEADINGS, AND WEIGHT CALCULATIONS.
                C
0086              DO 53 N=1,2
0087              WRITE(6,29)(TITLE(I),I=1,20)
0088           29 FORMAT(1H1,2X,20A4)
0089              IF(N.EQ.2) GO TO 31
0090              WRITE(6,30)IFC
0091           30 FORMAT(1HO,2X,'FORM CLASS ',I2,17X,'AVERAGE TOTAL WEIGHT PER TREE*
                  2')
0092              GO TO 33
0093           31 WRITE(6,32)IFC
0094           32 FORMAT(1HO,2X,'FORM CLASS ',I2,17X,'AVERAGE SAWLOG WEIGHT PER TREE
                  2*')
0095           33 WRITE(6,34)
0096           34 FORMAT(1H ,3X,'TREE',17X,'WEIGHT (M.LBS.) BY NUMBER OF USABLE 16-F
                  200T LOGS',28X/2X,'DIAMETER',90X/2X,'(INCHES)',8X,'1.0        1.5
                  3     2.0         2.5         3.0         3.5         4.0         4.5
                  4'/)
0097              IF(N.EQ.2) GO TO 47
0098              JJ=9
0099              DO 38 I=1,ND
0100              JJ=JJ+1
0101              IF(JJ.LE.11)WRITE(6,35)JJ,(TOTWT(I,J),J=1,5)
0102           35 FORMAT(1H ,3X,I3,9X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,4X,'-----
                  2-',4X,'------',4X,'------',6X)
0103              IF(JJ.GT.11.AND.JJ.LT.20)WRITE(6,36)JJ,(TOTWT(I,J),J=1,7)
0104           36 FORMAT(1H ,3X,I3,9X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3
                  2X,F7.3,4X,'------',6X)
0105              IF(JJ.GT.19.AND.JJ.LE.MAXD)WRITE(6,37)JJ,(TOTWT(I,J),J=1,8)
0106           37 FORMAT(1H ,3X,I3,9X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3X,F7.3,3
                  2X,F7.3,3X,F7.3,6X)
0107           38 CONTINUE
0108              WRITE(6,39)B(1,1),B(2,1),B(3,1),AMEAN(4),STD(4),AMEAN(2),STD(2),RS
```

```
     2QR(1),AMSE(1),AMEAN(3),STD(3)
0109  39 FORMAT(1HO,'THE ABOVE TABLE FOR ESTIMATING AVERAGE TOTAL WEIGHT PE
     2R TREE WAS DERIVED BY SOLVING THE FOLLOWING---'/3X,'*AVERAGE TOTAL
     3 WEIGHT PER TREE = ',F9.5,' + ',F9.5,' (AVER. VOL./TREE)',' + ',F9
     4.5,' (NO. OF USABLE 16-FOOT LOGS)'/6X,'MEAN AVERAGE TOTAL WEIGHT P
     5ER TREE = ',F8.3,' (M.LBS.)'/6X,'STANDARD DEVIATION OF AVERAGE TOT
     6AL WEIGHT PER TREE = ',F8.3,' (M.LBS.)'/6X,'MEAN TOTAL VOLUME PER
     7TREE = ',F8.3,' (M.B.F.)'/6X,'STANDARD DEVIATION OF AVERAGE VOLUME
     8 PER TREE = ',F8.3,' (M.B.F.)'/6X,'VARIATION EXPLAINED BY REGRESSI
     9ON EQUATION = ',F7.2,' PERCENT'/6X,'STANDARD ERROR OF REGRESSION E
     1QUATION = ',F8.3,' (M.LBS.)'/6X,'MEAN NO. OF USABLE 16-FOOT LOGS =
     2 ',F8.3,' (16-FOOT LOGS)'/6X,'STANDARD DEVIATION OF NO. OF USABLE
     316-FOOT  LOGS = ',F8.3,' (16-FOOT LOGS)')
0110       IF(LOGRL.NE.1) GO TO 41
0111       WRITE(6,40)
0112  40 FORMAT(1HO,2X,'*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON SCRIBNE
     2R LOG RULE VOLUMES--'/10X,'MESAVAGE AND GIRARD')
0113       GO TO 53
0114  41 IF(LOGRL.NE.2) GO TO 43
0115       WRITE(6,42)
0116  42 FORMAT(1HO,2X,'*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON INTERNA
     2TIONAL 1/4-INCH LOG RULE VOLUMES--'/10X,'MESAVAGE AND GIRARD')
0117       GO TO 53
0118  43 IF(LOGRL.NE.3) GO TO 45
0119       WRITE(6,44)
0120  44 FORMAT(1HO,2X,'*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON DOYLE L
     2OG RULE VOLUMES--'/10X,'MESAVAGE AND GIRARD')
0121       GO TO 53
0122  45 IF(LOGRL.EQ.4)WRITE(6,46)
0123  46 FORMAT(1HO,2X,'*NOTE: AVERAGE VOLUME PER TREE WAS BASED ON LOCAL V
     2OLUME TABLES')
0124       GO TO 53
0125  47 JJ=9
0126       DO 48 I=1,ND
0127       JJ=JJ+1
0128       IF(JJ.LE.11)WRITE(6,35)JJ,(SAWWT(I,J),J=1,5)
0129       IF(JJ.GT.11.AND.JJ.LT.20)WRITE(6,36)JJ,(SAWWT(I,J),J=1,7)
0130       IF(JJ.GT.19.AND.JJ.LE.MAXD)WRITE(6,37)JJ,(SAWWT(I,J),J=1,8)
0131  48 CONTINUE
0132       WRITE(6,49)B(1,2),B(2,2),B(3,2),AMEAN(5),STD(5),AMEAN(2),STD(2),RS
     2QR(2),AMSE(2),AMEAN(3),STD(3)
0133  49 FORMAT(1HO,'THE ABOVE TABLE FOR ESTIMATING AVERAGE SAWLOG WEIGHT P
     2ER TREE WAS DERIVED BY SOLVING THE FOLLOWING---'/3X,'*AVERAGE SAWL
     3OG WEIGHT PER TREE = ',F9.5,' + ',F9.5,' (AVER. VOL./TREE)',' + ',
     4F9.5,' (NO. OF USABLE 16-FOOT LOGS)'/6X,'MEAN AVERAGE SAWLOG WEIGH
     5T PER TREE = ',F8.3,' (M.LBS.)'/6X,'STANDARD DEVIATION OF AVERAGE
     6SAWLOG WEIGHT PER TREE = ',F8.3,' (M.LBS.)'/6X,'MEAN TOTAL VOLUME
     7PER TREE = ',F8.3,' (M.B.F.)'/6X,'STANDARD DEVIATION OF AVERAGE VO
     8LUME PER TREE = ',F8.3,' (M.B.F.)'/6X,'VARIATION EXPLAINED BY REGR
     9ESSION EQUATION = ',F7.2,' PERCENT'/6X,'STANDARD ERROR OF REGRESSI
     1ON EQUATION = ',F8.3,' (M.LBS.)'/6X,'MEAN NO. OF USABLE 16-FOOT LO
     2GS = ',F8.3,' (16-FOOT LOGS)'/6X,'STANDARD DEVIATION OF NO. OF USA
     3BLE 16-FOOT LOGS = ',F8.3,' (16-FOOT LOGS)')
0134       IF(LOGRL.NE.1) GO TO 50
0135       WRITE(6,40)
0136       GO TO 53
0137  50 IF(LOGRL.NE.2) GO TO 51
0138       WRITE(6,42)
0139       GO TO 53
0140  51 IF(LOGRL.NE.3) GO TO 52
0141       WRITE(6,44)
0142       GO TO 53
0143  52 IF(LOGRL.EQ.4)WRITE(6,46)
0144  53 CONTINUE
0145       IF(K.EQ.NCASE) GO TO 54
0146       GO TO 24
0147  54 K=0
0148       IF(IDNO.NE.999) GO TO 11
0149       STOP
0150       END
```

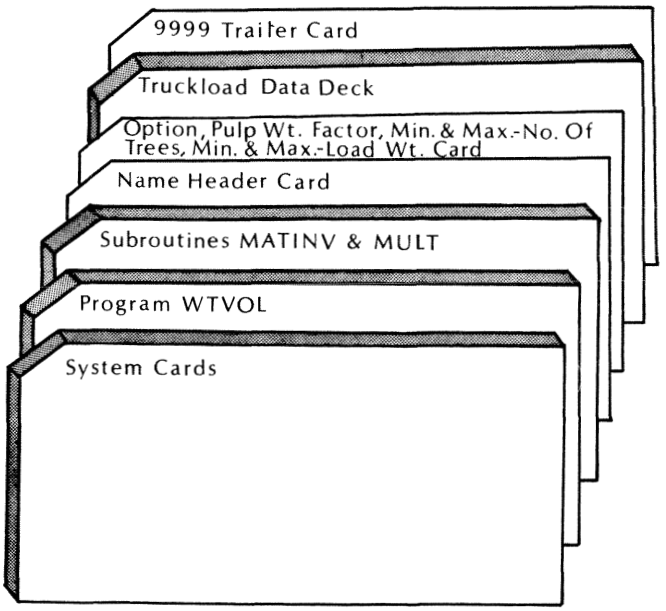
Appendix 2d. Listing for MATINV

```
0001                SUBROUTINE MATINV(A,N,DET)
0002                IMPLICIT REAL*8(A-H,O-Z)
0003                DIMENSION IPIVOT(20),INDEX(20,2)
0004                DOUBLE PRECISION A(4,4),PIVOT(20)
0005                EQUIVALENCE (IROW,JROW),(ICOLUM,JCOLUM),(AMAX,T,SWAP)
0006                IF(N.NE.1) GO TO 20
0007                DET=A(1,1)
0008                A(1,1)=1./A(1,1)
0009                GO TO 18
0010             20 DET=1.
0011                DO 1 J=1,N
0012              1 IPIVOT(J)=0
0013                DO 14 I=1,N
0014                AMAX=0.
0015                DO 6 J=1,N
0016                IF(IPIVOT(J).EQ.1) GO TO 6
0017              2 DO 5 K=1,N
0018                IF(IPIVOT(K)-1)3,5,18
0019              3 IF(DABS(AMAX)-DABS(A(J,K)))4,5,5
0020              4 IROW=J
0021                ICOLUM=K
0022                AMAX=A(J,K)
0023              5 CONTINUE
0024              6 CONTINUE
0025                IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
0026                IF(IROW-ICOLUM)7,9,7
0027              7 DET=-DET
0028                DO 8 L=1,N
0029                SWAP=A(IROW,L)
0030                A(IROW,L)=A(ICOLUM,L)
0031              8 A(ICOLUM,L)=SWAP
0032              9 INDEX(I,1)=IROW
0033                INDEX(I,2)=ICOLUM
0034                PIVOT(I)=A(ICOLUM,ICOLUM)
0035                DET=DET*PIVOT(I)
0036                A(ICOLUM,ICOLUM)=1.
0037                DO 10 L=1,N
0038             10 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
0039             11 DO 14 L1=1,N
0040                IF(L1.EQ.ICOLUM) GO TO 14
0041             12 T=A(L1,ICOLUM)
0042                A(L1,ICOLUM)=0.
0043                DO 13 L=1,N
0044             13 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
0045             14 CONTINUE
0046                DO 16 I=1,N
0047                L=N+1-I
0048                IF(INDEX(L,1).EQ.INDEX(L,2)) GO TO 16
0049                JROW=INDEX(L,1)
0050                JCOLUM=INDEX(L,2)
0051                DO 16 K=1,N
0052                SWAP=A(K,JROW)
0053                A(K,JROW)=A(K,JCOLUM)
0054                A(K,JCOLUM)=SWAP
0055             16 CONTINUE
0056             18 RETURN
0057                END
```

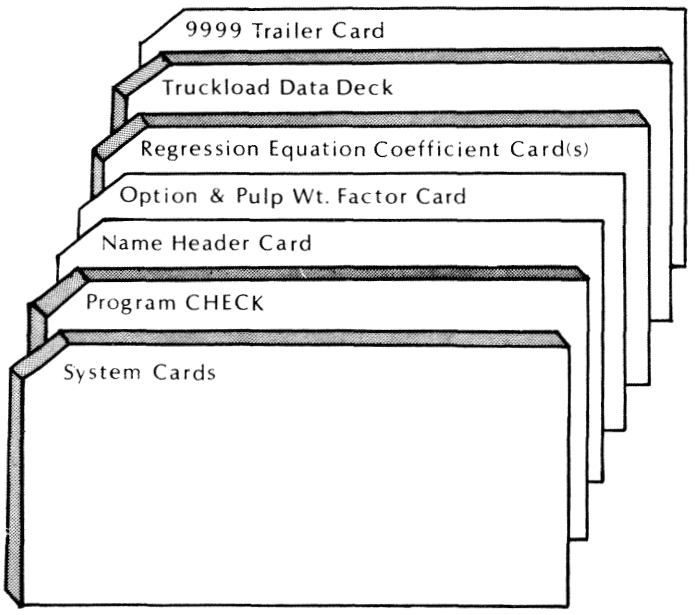
Appendix 2e. Listing for MULT

```
0001            SUBROUTINE MULT(A,B,N,L,M,C)
0002            DIMENSION A(N,M),B(M,L),C(N,L)
0003            DOUBLE PRECISION A,B,C
0004            DO 10 I=1,N
0005            DO 10 J=1,L
0006            C(I,J)=0.
0007            DO 10 K=1,M
0008         10 C(I,J)=C(I,J)+A(I,K)*B(K,J)
0009            RETURN
0010            END
```

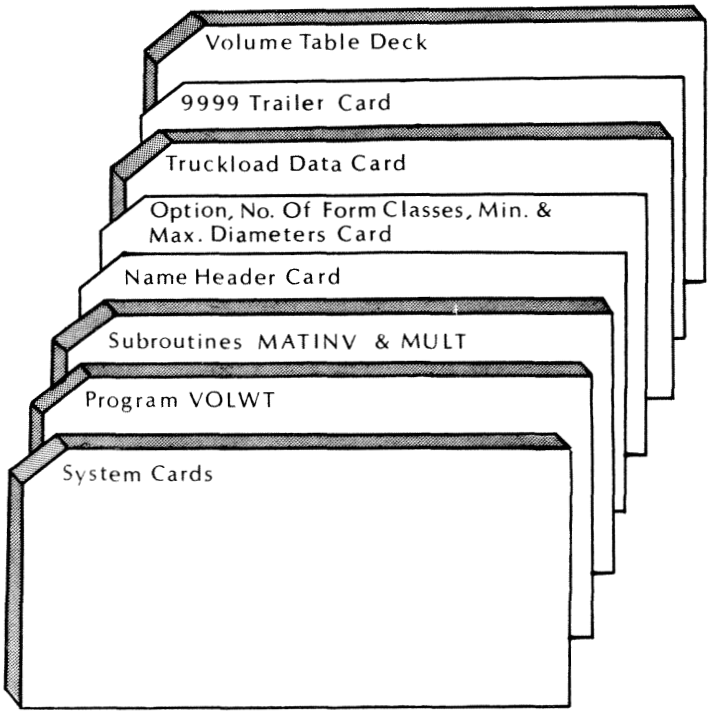
Appendix 3a. Illustration of deck setup for WTVOL



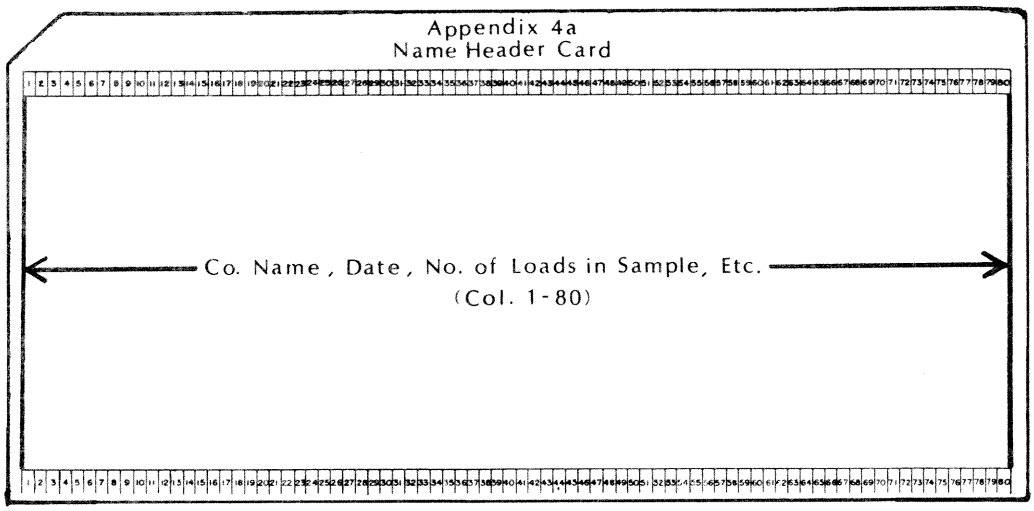
Appendix 3b. Illustration of deck setup for CHECK

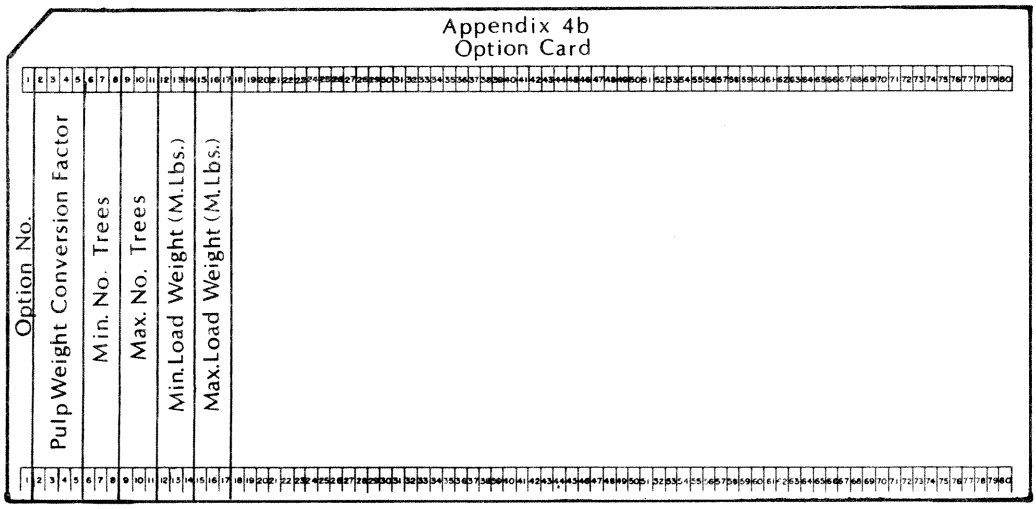


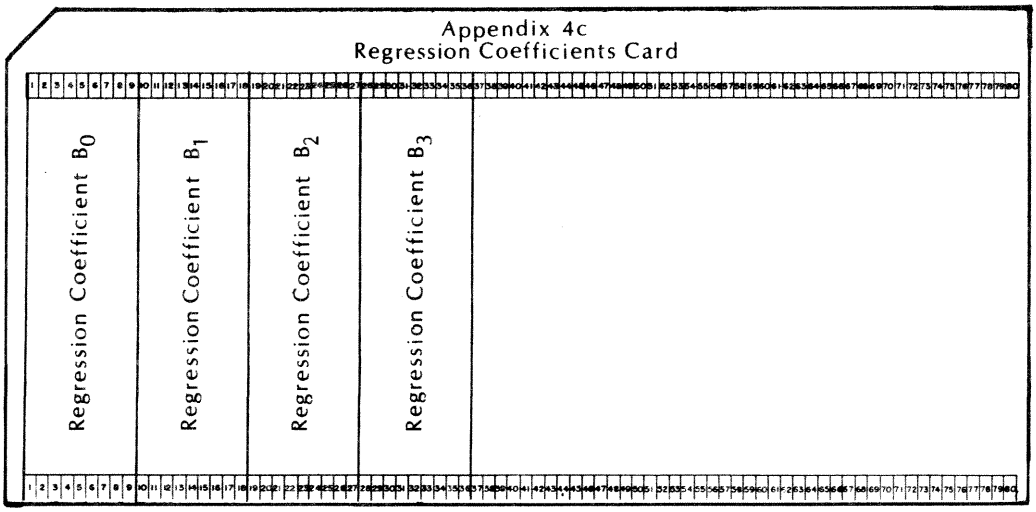
Appendix 3c. Illustration of deck setup for VOLWT



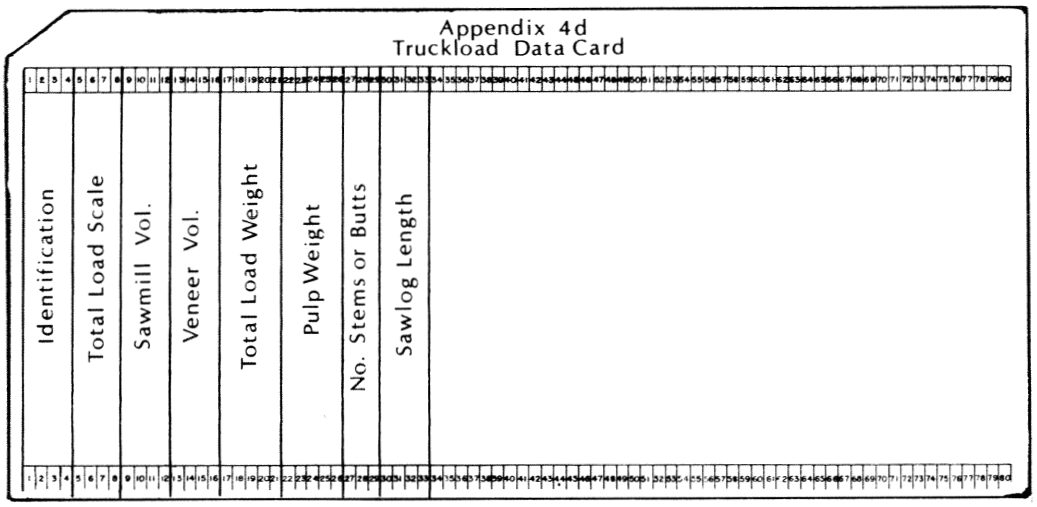
Appendix 4. Data formats



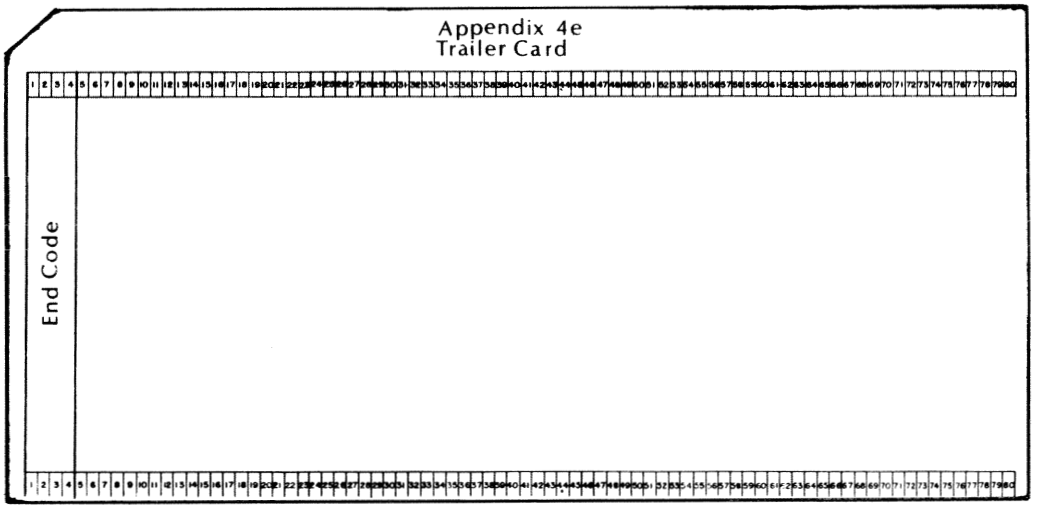




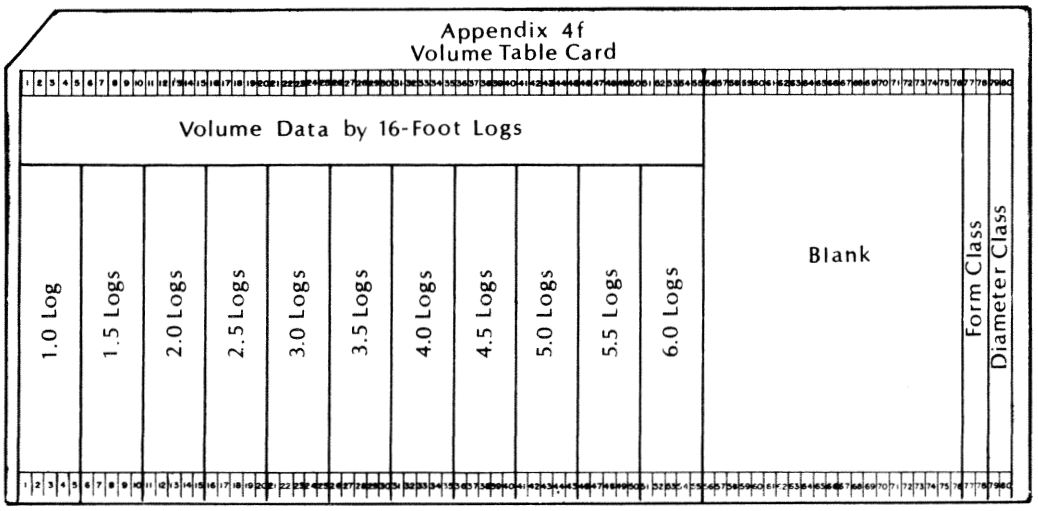
Appendix 4d
Truckload Data Card



Appendix 4e
Trailer Card



Appendix 4f
Volume Table Card



☆U.S. G.P.O.: 1974—747-899/1420, Region No. 4

Tyre, Gary L., Fasick, Clyde A., Riley, Frank M., Jr., and Lege, Frank O.
1973. Program manual for producing weight-scaling conversion tables. Southeast. For. Exp. Stn., USDA For. Serv. Gen. Tech. Rep. SE-3, 43 pp.

Three computer programs are presented which can be applied by individual firms to establish a weight-scaling information system. The first generates volume estimates from truckload weights for any combination of veneer, sawmill, and pulpwood volumes. The second provides quality-control information by tabulating differences between estimated volumes and observed check-scale volumes. The third produces weight estimates from volumes and generates tables that can be used to relate back to stumpage sales and current harvesting operations. The system depends upon regression analysis.

The Forest Service, U. S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.