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THE COMBUSTION CHARACTERISTICS OF DOUGLAS FIR PLANER SHAVINGS

TECHNICAL PROGRESS REPORT NO. 4

DAVID C. JUNGE, PH.D.
OREGON STATE UNIVERSITY
CORVALLIS, OREGON 97331

PERIOD: SEPTEMBER 16, 1977 TO
SEPTEMBER 15, 1978

DATE OF REPORT: DECEMBER 1978

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY: CONTRACT EY-76-C-06-2227
TASK AGREEMENT NO. 22

DISCLAIMER

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ABSTRACT

Significant quantities of wood residue fuels are presently being used in industrial steam generating facilities. Recent studies indicate that substantial additional quantities of wood residue fuels are available for energy generation in the form of steam and/or electricity. A limited data base on the combustion characteristics of wood residue fuels has resulted in the installation and operation of inefficient combustion systems for these fuels.

This investigation of the combustion characteristics of wood residue fuels was undertaken to provide a data base which could be used to optimize the combustion of such fuels. Optimization of the combustion process in industrial boilers serves to improve combustion efficiency and to reduce air pollutant emissions generated in the combustion process.

This report presents data on the combustion characteristics of Douglas Fir planer shavings.

The data were obtained in a pilot scale combustion test facility at Oregon State University. Other technical reports present data on the combustion characteristics of:

Douglas Fir Bark

Red Alder Sawdust
Red Alder Bark
Ponderosa Pine Bark
Hemlock Bark
Eastern White Pine Bark

An Executive Summary Report is also available which compares the combustion characteristics of the various fuel species.

SUMMARY AND CONCLUSIONS

The following conclusions are drawn based on the experiments conducted for this species of wood residue fuel used in industrial spreader-stoker boilers:

1) Optimum combustion conditions occur when an overall level of 50% excess air is used;
2) The combustion ais should be distributed approximately equally between undergrate and overfire air to achieve minimum air pollutant emissions and maximum combustion efficiency;
3) The temperature of the combustion air does not have a pronounced effect on combustion efficiency or pollutant emissions. Therefore, the highest possible temperatures of combustion air should be used to achieve maximum thermal efficiency. However, caution must be used to avoid burning the grates under this mode of combustion.
4) The combustible content of the boiler emissions is very high for this species (typically greater than 85%). For the series of tests conducted, it ranged from 83.1% to 95%. Under optimal combustion conditions, it ranged from 88.3% to 94% with a mean value of 91.5%. Therefore, it is beneficial to recycle this ash in a separate combustion system to recover its heating value. However, reinjection into the boiler is not recommended because it will result in increased air pollutant emissions;
5) The mass mean size of the ash typically ranges from 0.51 mm to 0.86 mm. Under optimal combustion conditions, it ranges from 0.64 mm to 0.86 mm with a mean value of 0.72 mm.
6) The mass mean density of the ash typically ranges from 0.09 to 0.12 g/cm^3. Under optimal combustion conditions, it ranges from 0.09 to 0.10 g/cm^3 with a mean value of 0.09 g/cm^3.
7) Careful control of combustion conditions can reduce pollutant emissions by approximately 45%.

1. INTRODUCTION

In the wood products industry, large quantities of wood residue are used for fuel, principally to generate process steam by direct combustion in boilers. In the United States there are approximately 1700 industrial wood fired boilers in operation.

With increasing fossil fuel costs there is added incentive to utilize wood residue fuels. However, present technology affecting the design and operation of wood fired boilers is limited. As a result, a large percentage of both new and older boiler facilities are experiencing difficulty in operating efficiently and in meeting the environmental restrictions.

The technology "gap" focuses on the complete combustion of the wood fuel. It is desireable to completely burn all of the combustible components of the fuel in order to maximize the combustion efficiency and minimize the fuel requirements. Complete combustion will reduce emissions of air pollutant materials and reduce requirements for "tail end" control devices to meet stringent air pollution regulations.

There are specific questions pertinent to the design and operation of wood fired boilers which have not been satisfactorily answered. For example:

1) What is the optimum level of excess air (air to fuel ratio) to maximize the combustion process?
2) What is the influence of preheating combustion air on completion of the combustion process. (The effect of preheated air on thermal efficiency is well documented, but its effect on combustion efficiency is not documented).
3) What is the best method of distributing air in the combustion chamber?
4) What is the optimum size of wood fuel required to bring about complete combustion?
5) What is the influence of fuel moisture on the completion of the combustion reaction? (The effect of fuel moisture on thermal efficiency can be calculated but its effect on completion of

the combustion reaction has not been documented.)

6) What is the relationship of fuel feed rate to the completion of the combustion reaction?
7) For given combustion conditions, what is the rate of carryover of unburned fuel and inorganic ash out of the boiler and into the primary collector system? This questions pertains to the design requirements of primary collector systems.
8) What are the physical characteristics of wood fuel fly ash in terms of size distribution, density distribution, and combustible content for specific combustion conditions? This questions also pertains to the design requirements of primary collector systems.
9) What are the optimum combustion parameters for reducing opacity from the wood fired boiler exhaust gases?

The answers to these questions must take into account the design of the wood burning boilers system. There are four general design categories of boiler systems:

1) Spreader-stokers
2) Dutch ovens
3) Suspension burning systems
4) Fluidized bed combustion systems

Since the early 1950's, the majority of boilers constructed in this country have been of the spreader-stoker design. It is estimated that over 50% of the currently operating boilers are spreader-stokers. Therefore, the spreader-stoker design was emphasized in the research effort reported herein.

2. PURPOSE AND SCOPE OF THE PROJECT

The purpose of this research effort is to develop a design data base for the combustion of wood residue fuels. Each of the important variables in the combustion process is taken into consideration including the following:

1) Species of fuel
2) Size of fuel
3) Moisture content of fuel
4) Feed rate of fuel
5) Inlet air temperature
6) Air to fuel ratio - level of excess air
7) Distribution of the combustion air above and below the grate.

When the data base is complete it will allow engineers, designers, and boiler operators to more effectively utilize wood residue fuels for energy with improved combustion efficiency and reduced air pollutant emissions.

3. FINANCIAL SUPPORT

Support for this research effort has been provided principally by the Government of the United States as noted below:

1)	Phases I & II	Energy Research and Development Administration: Division of Conservation Research and Technology.	$100,000
2)	Continuation	Department of Energy: Fossil Fuels Utilization Program	$187,000
3)	Oregon State University		$ 7,350
4)	International Paper Company		$ 2,500
5)	Oregon Department of Environmental Quality		$ 2,000

4. PROJECT PARTICIPANTS

The principal investigator for the research effort is Dr. David C. Junge, Associate Professor of Mechanical Engineering (Senior Research Scientist). Dr. R. W. Boubel, F. Kayihan, J. G. Mingle have acted as supporting investigators. Dr. Kenneth Tuttle assisted during the period when he was a candidate for the degree of Doctor of Philosophy. Several undergraduate students have participated in the project as well as two full time technicians.

5. TIME FRAMEWORK OF THE PROJECT

The initial funding of the project began on April 1, 1976. The test facility was designed and constructed during the period of April 1, 1976 to January 31, 1977. Startup and debugging took place between February 1, 1977 and April 15, 1977. Initial data were collected on Douglas fir hogged bark from April 16, 1977 to June 30, 1977. Funding for the initial phases of the project concluded June 30, 1977.

The continuation work began September 16, 1977 with funding from the Dept. of Energy. Revisions to the test facility were accomplished between September 16, 1977 and December 31, 1977. Tests on a variety of species were conducted between January 1, 1978 and July 15, 1978. Funding for the continuation work is still in progress and is expected to continue through September 15, 1979.

The results reported in this document were obtained during the period January 1, 1978 to July 15, 1978.

6. DESCRIPTION OF THE TEST FACILITY

A test facility was designed and constructed to carry out this needed research program. It is located in Corvallis, Oregon at the Fairplay Research Center, a part of Oregon State University.

As indicated in Figure 1, the test facility is a small spreader stoker boiler designed to fire wood residue fuels (hogged fuel). The system includes:

1) A conveyor system to control and meter the fuel flow;
2) A mechanical "flinger" roll to distribute fuel uniformly across the grate;
3) A water wall lined combustion chamber with a fixed, pin-hole grate. The area of the grate is 10 square feet. The combustion zone extends approximately 11 feet above the grate. Steam is generated at atmospheric pressure with natural recirculation in the water walls;

4) A fin tube, forced air cooled, jacketed duct to carry combustion exhaust gases from the combustion zone to an air preheater;
5) A plate type, counter flow, tripple pass air preheater designed for up to 550 ^{o}F air exit;
6) A cyclone separator downstream from the air preheater to remove entrained particulate matter from the exhaust gas stream;
7) A forced draft fan to provide combustion air to the test facility;
8) A system of venturi orifice flow meters to measure the amount of air distributed above and below the grate;
9) A system of gate valves to control the flow of air above and below the grate
10) Instrumentation to measure independent and dependent variables of the test facility. (Instrumentation is discussed in greater detail in Section 7.)

A photograph of the test facility is shown in Figure 2. (P. 7)

The test facility is designed to combust fuel samples with heat release rates of up to 10×10^{6} BTU's per hour. Typical tests are carried out with heat release rates of 6×10^{6} BTU's per hour.

Fuel species, fuel size, and fuel moisture levels are not controlled by the test facility. These characteristics are determined with the purchase of the fuel from various suppliers.

SCHEMATIC ILLUSTRATION OF WOOD COMBUSTION TEST FACILITY

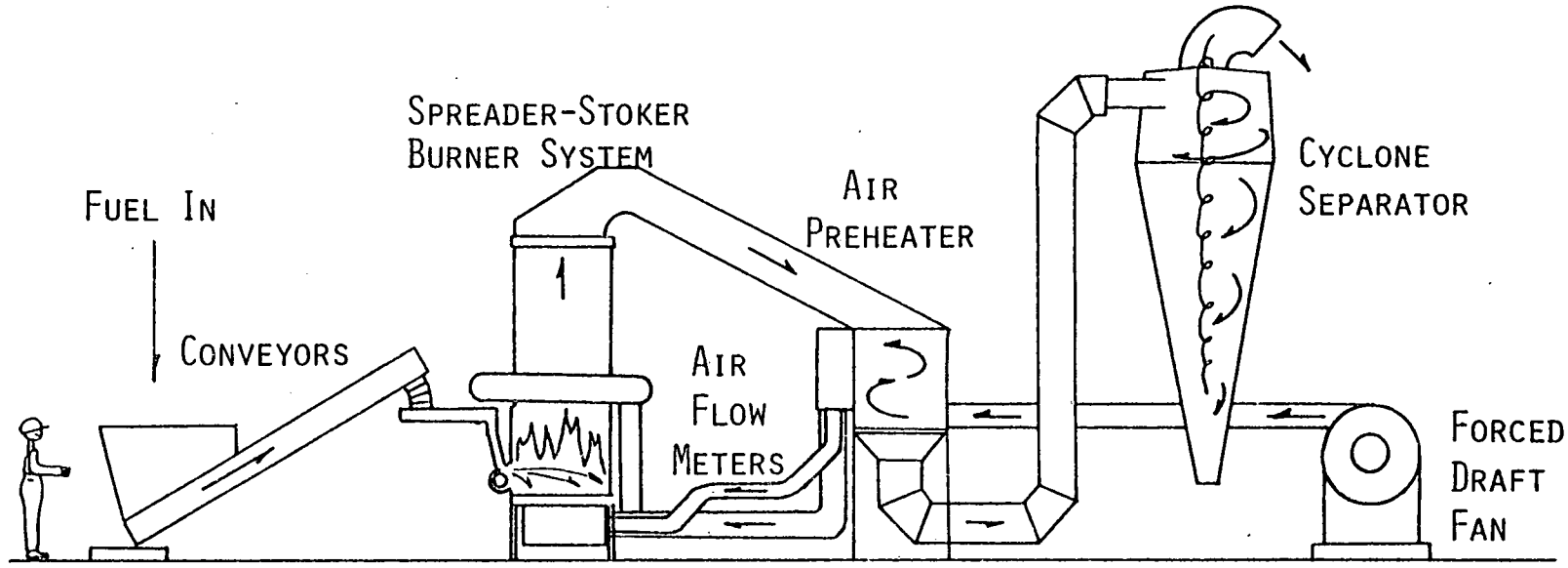

Figure 1: Wood Combustion Test Facility - Oregon State University

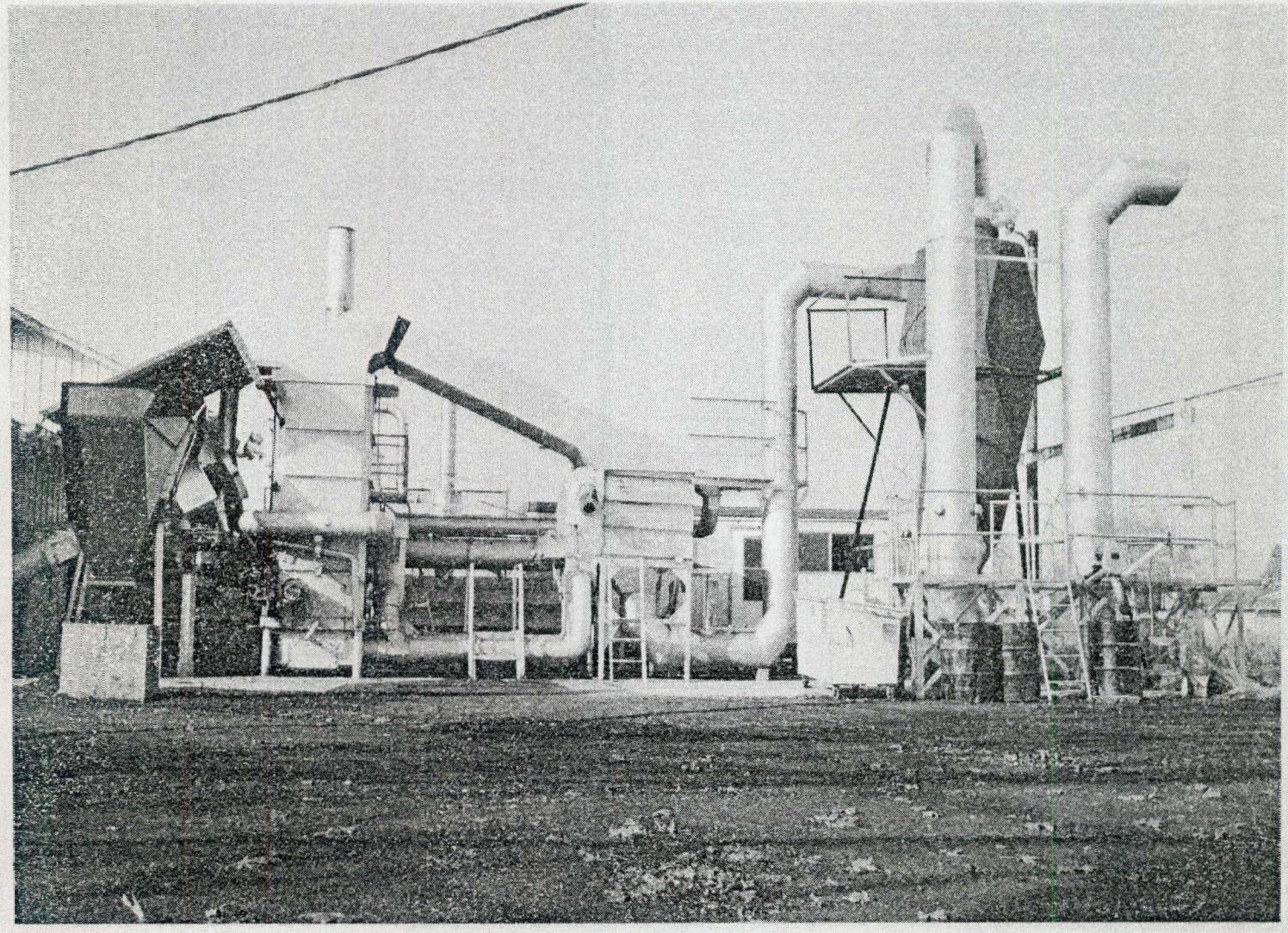

Figure 2: Photograph of the Experimental Test Facility - Oregon State University

7. DESCRIPTION OF THE INSTRUMENTATION

The instrumentation used in conjunction with the test facility is illustrated schematically in Figure 3. Specific comments are offered concerning particular aspects of the instruments:

1) Fuel Size Distribution: Fuel size was determined by a screen analysis on pre-dried fuel samples. Samples were placed in a laboratory oven at 106 ^{o}C until their weight reached a constant level indicating uniform, oven dry moisture levels. The samples were then screened in a series of standard (Tyler) screens to determine the mass/size distribution.

2) Fuel Moisture Content: Moisture content was determined by collecting random samples of the fuel from the storage pile and conducting standard gravimetric analyses. Drying was carried out at 106 ^{o}C until the samples reached constant weight.

3) Fuel Feed Rate: Feed rates were determined by calibrating the screw feed conveyor of the fuel feed system. Calibration was in terms of cubic feet of fuel delivered per hour for each specific fuel size and fuel moisture level. Calibration checks were made at regular intervals.

   Note: This method of determining fuel feed rate proved to have limitations in accuracy. The desired information on fuel feed rate was in terms of dry pounds of fuel per hour. To obtain information in this form, it was necessary to determine the volumetric flow rate of the fuel (ft^3/hr), the moisture content of the fuel (# H_2O/ # fuel), and the fuel density (# fuel/ft^3). Each of these measurements had inherent inaccuracies. It was found that greater accuracy in determining the fuel flow rate was possible by accurately metering the combustion air and the level of excess air in the exhaust gas. Simple calculations could then be used to determine the fuel feed rate to the combustion chamber based on the combustion air supplied to the chamber.

4) Fuel Density: Density of the fuel was determined by collecting samples of the fuel from a sample point mid-way in the screw feed conveyor. Know volume samples were weighed to determine their density. Caution was used to insure uniform compaction of the fuel samples.

5) Air Temperature Measurements: Air temperatures through the test facility were determined using standard laboratory and industrial thermometers.

6) Gas Flow Rates: Gas (air) flow rates were determined by the use of standard ASTM sharp edge orifices which were calibrated at various temperatures suing a standard pitot tube. Pitot traverses were done according to standard methods. Each orifice is equipped with a thermometer for simultaneous temperature measurement. Orifice pressure differentials were recorded for each test condition and gas flow rates were then found by the use of an orifice flow calibration chart.

   The main air flow lines to the combustion chamber were equipped with venturi orifice flow meters rather than sharp edge orifice flow meters. This was done to provide greater accuracy in measuring these two critical air flows. The calibration and pressure differential measurement were done as described above.

7) Temperatures in the Combustion Chamber: Exhaust gas temperatures inside the combustion chamber were determined by the use of shielded platinum-rodium thermocouples. The data from these thermocouples is highly suspect due to re-radiation problems at elevated temperatures.

8) Exhaust Gas Analyses: An exhaust gas sample line was installed at the inlet to the air preheater. The sampled was cooled to approximately 70 ^{o}F to condense the water vapor and remove it. Filters were placed in the sample line to remove particulate matter. Continuous oxygen, carbon monoxide, and carbon dioxide analyzers were used to evaluate the flue gas constituents. Fyrite portable analyzers were used to make spot checks on the accuracy of the continuous analyzers.

9) Total Ash Carryover: Ash carryover rates were determined gravimetrically using a simple laboratory scale. The ash collected at the base of the cyclone separator was weighed in a tared container and the elapsed time for the collection of the weighed sample was noted. Calculations were then made to determine the rate of ash carryover in terms of pounds/hr.

10) Ash Characteristics - Size, Density, Combustible Content: The characteristics of the ash were determined in the laboratory. Size distribution was obtained using standard sieve screen analyses. The density was determined by placing ash samples in graduated cylinders to determine volume, and then weighing the known volume samples to determine density in pounds/cubic foot (or g/cc). Representative samples of the collected ash were used to determine the percent of the ash which was combustible. Tared containers with known amounts of sample were placed in a muffle furnace at 600 ^{o}C for 8 hours. The remaining ash was then reweighed to determine the percent of combustible material in the sample.

11) Opacity Measurements: Opacity was determined visually.

DESCRIPTION OF INSTRUMENTATION

1. Fuel Species
2. Fuel Size Distribution
3. Fuel Moisture Content (% by weight - "as-is" basis)
4. Fuel Feed Rate
5. Fuel Density
6. Overfire Air Temperature
7. Underfire Air Temperature
8. Overfire Air Flow Rate
9. Underfire Air Flow Rate
10. Temperature 60" Above Grate
11. Temperature @ Air Heater Inlet
12. Temperature @ Air Heater Exit
13. Temperature @ Forced Draft Fan Exit
14. Air Flow Rate @ Forced Draft Fan Exit
15. Gas Sample Point For Flue Gas Analyses (O_2, CO, CO_2)
16. Ash Sample Point
17. Opacity Measurement Point

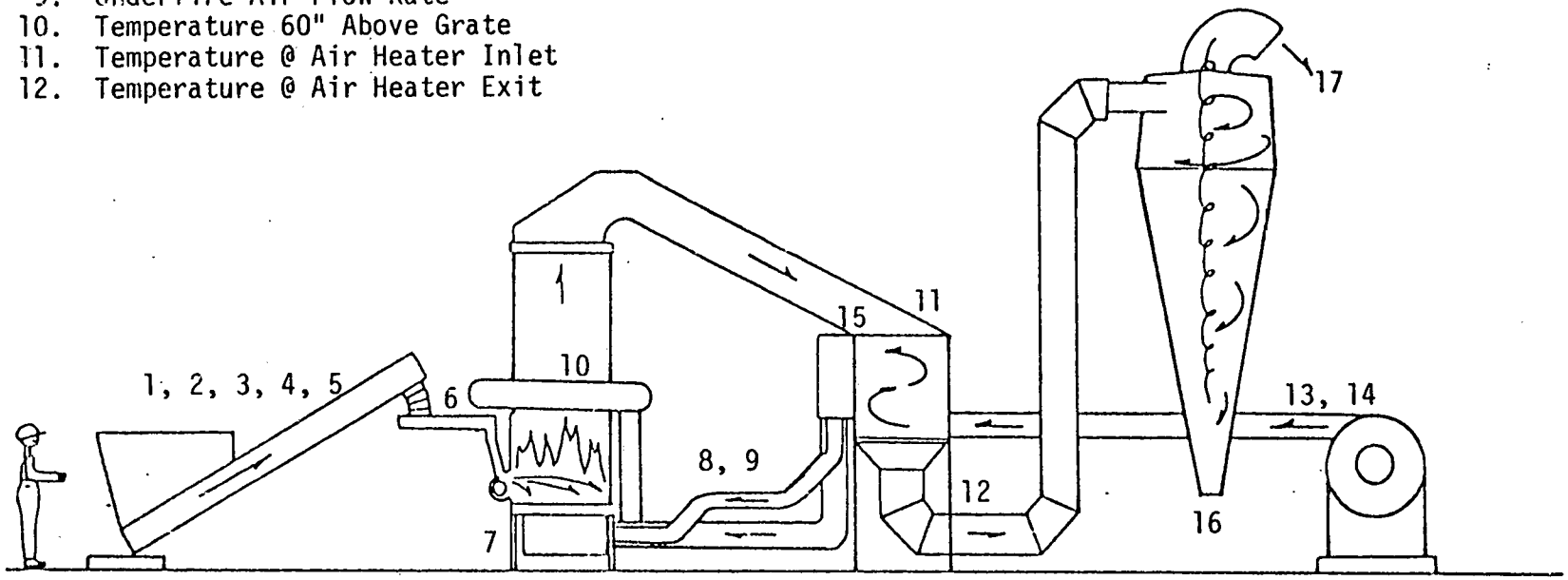

Figure 3: Schematic Illustration of Instrumentation Used With the Combustion Test Facility

8. DESIGN OF THE EXPERIMENTS

The overall experimental program was designed to study the influence on the combustion of wood residue fuels of the normal combustion variables found in industrial processes. These variables include:

Fuel Related Variables	Combustion Air Related Variables
Species	Inlet Air Temperature
Size	Level of Excess Air
Moisture	Distribution of Air Above and Below The Grate
Feed Rate	

The principal dependent variable of concern in the experiments is the amount of unburned carbon and non-combustible ash carried out of the combustion chamber per unit of time. This parameter is a measure of the completeness of the combustion reaction in the test facility. High levels of combustible carbon carryover indicate poor combustion conditions. Low levels of carryover indicate better combustion conditions.

The experimental data reported in this document are for only one species: Douglas Fir planer shavings. Experimental data for other species are reported in other technical reports. For experimental data in this report, the following parameters and ranges were used:

Variables		Range of Variables			
No. of Experimental Test Runs:	33				
Test Run Numbers:		14	To	52	
Range - Fuel Size Used		0.5	To	20	(mm)
Range - Fuel Moisture Levels Used:		36.4	To	44.5	(%H_2O: "As-Is")
Range - Fuel Feed Rates Used:		473	To	594	(Dry Pounds/Hr)
Range - Levels of Excess Air:		8	To	100	(%)
Range - Levels of Inlet Air Temp:		95	To	415	(^{O}F)
Range - Levels of Air Distribution:		30	To	84	(% Undergrate)

9. DATA COLLECTED

For each test run, data were collected for independent and dependent variables. The independent variables included the following:

1) Fuel Related

   Species
   Size Range
   Moisture Content
   Density
   Feed Rate

2) Air Related

   Temperatures at:

      Forced Draft Fan Exit
      Undergrate Air Duct
      Overfire Air Duct

   Air Flow Rates at:

      Forced Draft Fan Exit
      Undergrate Air Duct
      Overfire Air Duct
      Fuel Conveyor Air Duct

3) Weather Conditions

The dependent variables for which data were collected during each test run included the following:

1) Combustion Exhaust Gas Temperatures

   60" Above the Grate
   At the Inlet to the Air Preheater
   At the Exit of the Air Preheater

2) Ash Carryover Rate from the Discharge of the Cyclone

3) Ash Characteristics in Terms of Size Distribution, Combustible Content, and Density Distribution

4) Percent Excess Air as Determined by Oxygen Analyses

5) Opacity from the Exhaust Gases

For most but not all test conditions, two replications were made.

10. PROCEDURE FOR CONDUCT OF THE EXPERIMENTAL TEST RUNS

The procedure for conduct of the experimental test runs is outlined below:

1) Build a fire in the combustion zone and bring the test facility up to operating temperature. This generally requires 2 hours of operating time to bring the system into equilibrium.
2) Introduce fuel to the combustion zone where the fuel is of known and desired species, size distribution, moisture content, and fed at desired feed rates. Collect samples of the fuel to check moisture and density.
3) Establish the desired inlet air temperature by controlling the air flow through the air preheater and bypass lines. Establish the desired air flow rates through the overfire air lines and the underfire air duct. Check the level of excess air in the combustion zone as determined by the oxygen content of the exhaust gases. Re-adjust the overfire and underfire air flow rates to maintain desired levels of excess air and percentages of overfire and underfire air.
4) Begin data collection. Set the pre-tared ash collection bucket at the discharge of the cyclone collector and seal against leakage. Begin data collection from all temerpature, gas flow, and pressure indicators and from the gas analysis equipment. Data points are noted at 10 minute intervals on all indicators except the flue gas analysis equipment which is continuous. Log weather conditions, opacity from the cyclone exit duct, and time of starting the test.
5) After sufficient running time (typically 20 to 30 minutes per test), terminate the test. Note time of finish of test run and remove the ash carryover buck from the cyclone bottom outlet. Measure the total weight of collected ash and obtain a sample of the collected ash for laboratory analyses on its characteristics.

6) Begin replication run of the test.
7) At the end of the replication run, re-adjust fuel and air flow parameters for the next test condition.

11. DATA ANALYSES

1. Fuel Size Analyses

The fuel size distribution is determined by drying a sample of the fuel at 106 ^{o}C for a minimum period of 24 hours or until the weight of the fuel sample reaches an equilibrium point. The dried samples are then screened using Tyler Standard screens indicated below:

Screen No.	(Inches)	(mm)
1	1.050	26.67
2	.742	18.85
3	.371	9.423
4	.185	4.760
5	.131	3.327
6	.079	2.000
7	.039	1.000
8	.020	.500
Pan		

The weight of each sample collected on each screen is determined and the mass-size distribution plotted on log-probability graph paper.

2. Fuel Moisture Analyses

Fuel moisture analyses were made by collecting a known weight of sample in a pre-tared container. The samples were then dried using the procedure indicated above in (1.) and re-weighed. Calculations were made to determine moisture content on a wet basis or "as-is" basis.

3. Fuel Density Analyses

Fuel density was determined by collecting a sample of the fuel as it was carried up the fuel feed conveyor (screw conveyor). The sample

was dropped from the conveyor into a container of 0.811 curic feet volume. Wehn the container was full to the top (with no mechanical compaction), the weight of the container and the fuel were determined. A simple calculation then produced the density of the fuel sample.

The density was important in determining the fuel feed rate to the combustion system in terms of pounds per hour. The feed conveyor was calibrated in terms of cubic feet of fuel delivered per hour.

4. Flue Gas Analyses

The flue gas analysis system consisted of a stainless steel gas sample line connected to the inlet side of the air preheater and to a sample gas cooling and filtration system. The cooling system allowed the entrained water in the exhaust gas to condense and be removed from the sample line. The filtration system removed entrained particulate matter to avoid plugging the gas analyzers.

Downstream from the cooling and filtration system, a sealed pump was installed to move the sample gas through the system. The exit line from the pump was connected to a sample gas header which carried the gas to the analysis instruments.

Two instruments were used to determine the flue gas constituents. An oxygen analyzer and a CO, CO_2 analyzer were used for continuous readings of the component gas percentages in the dry gas sample.

5. Ash Analyses

Laboratory analyses were conducted to determine the combustible and non-combustible content of the ash collected during the test runs. The standard ASTM test procedure was used in which the ash samples were heated to 600 ^{o}C until they reached constant weight. Initial and final weights were used to calculate the amount of combustible material in each sample. Standard screen analyses were used to determine the size distribution of the ash samples. Ash density analyses were made by determining the volume of sample collected on each of the filter screens.

6. Computer Analyses of the Data

A program was written (Fortran IV) to make the calculations pertinent to the requirements of the experimental program. The printout groups the related tests for easy comparison of test parameters and lists the independent and dependent variables.

12. EXPERIMENTAL RESULTS

The experimental test results are summarized on pages 18 and 19. The effects of the important parameters are noted on page 18 (Summary of Research Results). The characteristics of the ash are summarized on page 19 for the entire range of test parameters and for optimum combustion conditions.

The experimental data for each test condition is found in the Experimental Data Summary beginning on page 20. This section has the data in tabulated form.

Graphical representation of the data is found in the section beginning on page 32. Several forms of graphic analysis are offered to provide the reader with a greater understanding of the effects due to the combustion variables.

The raw fuel used in the experimental tests was analyzed and its analyses are indicated in tabular and graphic form beginning on page 51.

The ash analyses results are noted in both tabular and graphic form beginning on page 60. The combustible content of the ash samples as a function of their size distribution is noted in tabular and graphic form beginning on page 112.

13. CONCLUSIONS

The conclusions reached from this experimental work are summarized in the beginning of this report under Summary and Conclusions.

SUMMARY OF RESEARCH RESULTS

SUMMARY OF EFFECTS DUE TO:

1. FUEL SIZE: Not determined - only one fuel size used.
2. FUEL MOISTURE: Not determined - only one fuel moisture level used.
3. FUEL FEED RATE: Range studied (dry lbs/hr): 473 to 586
   Effects statistically significant within the range studied:
   Yes _____ No XXX
4. INLET AIR TEMPERATURE:
   Effects statistically significant within the range studied:
   Yes _____ No XXX
   As air temperature increases, emissions increase ___ decrease ___
   Reference: See page 50.
5. LEVELS OF EXCESS AIR: Test results indicate an interaction effect between level of excess air and distribution of air above and below the grate: Yes _____ No XXX
   Optimum level of excess air for most test conditions: 50 (%)
   Reference: See pages 48-49
6. DISTRIBUTION OF AIR ABOVE AND BELOW THE GRATE: Lb Air/Lb Dry Fuel
   Optimum rate of air flow through the grate: 4.0-5.0
   Range of air flow rates through the grate which were successfully tested: 3.67 to 11.44
   Overall optimum air distribution:
   Above the grate (overfire air): 46 (%) to 57 (%)
   Below the grate (underfire air): 43 (%) to 54 (%)
   Reference: See pages 39 - 47.

SUMMARY OF ASH CHARACTERISTICS

	All Tests (Range)	Optimum Combustion Conditions (Mean)	Optimum Combustion Conditions (Range)
1. Rate of Total Carryover (lbs/hr)	7.50 to 18.6	10.1	7.5 to 13.2
2. Concentration of Total Particulate (gr/SCF - not corrected to 12% CO_2)	0.72 to 2.17	1.2	0.75 to 1.73
3. Rate of Total Carryover (lb/lb dry fuel)	1.26 to 3.02	1.69	1.26 to 2.05
4. Rate of Combustible Carryover (lb/lb dry fuel)	1.15 to 2.81	1.55	1.15 to 1.92
5. Rate of Inorganic Carryover (lb/lb dry fuel)	0.11 to 0.27	0.14	0.11 to 0.17
6. Mass Mean Size (mm)	0.51 to 0.86	0.72	0.64 to 0.86
7. Mass Mean Density (g/cm^3)	0.09 to 0.12	0.09	0.09 to 0.10
8. Mean Combustible Content (%)	83.1 to 95.0	91.5	88.3 to 94.0

9. Combustible content as a function of ash size distribution.

See pages 123, 124.

EXPERIMENTAL DATA SUMMARY SHEETS

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EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 14 TO 24 FUEL SPECIES: DOUGLAS FIR PLANER SHAVINGS

- - - - - - - - - - FUEL CHARACTERISTICS - - - - - - - - - - - - - - -

MASS MEAN SIZE (mm): 2.25 SIZE RANGE (mm): 20.0 TO 0.5

MASS MEAN DENSITY (g/cm^3): 0.17 DENSITY RANGE (g/cm^3): 0.05 TO 0.19

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 99.24

= =

	OPERATING PARAMETERS						TEST RESULTS				
TEST NO.	FUEL FEED RATE (LBS/HR)	FUEL H_2O (%)	EXCESS AIR (%)	UNDER GRATE AIR (%)	AIR TEMP. (^oF)	LBS AIR / LB FUEL @ GRATE	ASH RATE (LB/HR)	COMB. ASH (%)	MASS MEAN SIZE (mm)	MASS MEAN DENS. (g/cm^3)	OPACITY (%)
14	473	44.5	52	47	95	6.19	11.7	90.2	0.74	0.09	5
15	"	"	50	47	95	6.19	11.0	91.2	0.82	0.09	"
16	"	"	46	49	100	5.10	10.6	92.3	0.76	0.09	"
17	586	"	21	82	145	6.63	15.6	93.5	0.83	0.08	"
18	"	"	14	83	142	6.34	15.9				"
19	"	"	38	81	132	7.43	17.7	92.9	0.82	0.10	"
20	"	"	38	80	133	7.18	14.7				"
21	594	"	65	82	137	8.82	14.8	92.0	0.74	0.10	"
22	"	"	77	82	141	8.82	13.8				"
23	"	"	100	81	145	10.05	15.3				"
24	"	"	100	79	120	11.44	17.1				"

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 25 TO 52 FUEL SPECIES: DOUGLAS FIR PLANER SHAVINGS

- - - - - - - - - - FUEL CHARACTERISTICS - - - - - - - - - - - - - - -

MASS MEAN SIZE (mm): 2.25 SIZE RANGE (mm): 20.0 TO 0.5

MASS MEAN DENSITY (g/cm^3): 0.17 DENSITY RANGE (g/cm^3): 0.05 TO 0.19

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 99.24

= =

	OPERATING PARAMETERS						TEST RESULTS				
TEST NO.	FUEL FEED RATE (LBS/HR)	FUEL H_2O (%)	EXCESS AIR (%)	UNDER GRATE AIR (%)	AIR TEMP. (^oF)	LBS AIR / LB FUEL @ GRATE	ASH RATE (LB/HR)	COMB. ASH (%)	MASS MEAN SIZE (mm)	MASS MEAN DENS. (g/cm^3)	OPACITY (%)
25	586	36.4	26	53	150	4.61	13.2				5
26	"	"	34	52	155	4.59	11.4	92.7	0.72	0.09	"
27	"	"	44	51	153	4.92	8.7	88.3	0.64	0.09	"
28	"	"	47	49	152	4.48	7.8				"
29	594	"	58	47	142	4.85	8.4				"
30	"	"	53	45	157	4.41	7.5	91.0	0.64	0.10	"
31	"	"	66	49	145	5.95	10.9				"
32	"	"	76	49	150	5.95	9.3	83.1	0.51	0.11	"
39	"	"	91	31	177	3.74	9.3	88.9	0.63	0.11	"
40	"	"	91	30	173	3.67	9.0				"
41	586	"	50	84	402	7.01	18.3				"
42	"	"	51	83	402	6.78	12.0	92.9	0.78	0.10	"
43	"	"	83	84	395	8.66	18.0	92.6	0.82	0.09	"
44	"	"	91	84	393	8.50	17.4				"
45	"	"	62	82	415	9.27	13.8	90.8	0.80	0.10	"
46	"	"	55	82	415	9.73	17.7				"
47	"	"	87	82	390	11.47	18.0	90.0	0.68	0.10	"

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 25 TO 52 FUEL SPECIES: DOUGLAS FIR PLANER SHAVINGS

FUEL CHARACTERISTICS

MASS MEAN SIZE (mm): 2.25 SIZE RANGE (mm): 20.0 TO 0.5

MASS MEAN DENSITY (g/cm^3): 0.17 DENSITY RANGE (g/cm^3): 0.05 TO 0.19

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 99.24

OPERATING PARAMETERS							TEST RESULTS				
TEST NO.	FUEL FEED RATE (LBS/HR)	FUEL H_2O (%)	EXCESS AIR (%)	UNDER GRATE AIR (%)	AIR TEMP. (^oF)	LBS AIR / LB FUEL @ GRATE	ASH RATE (LB/HR)	COMB. ASH (%)	MASS MEAN SIZE (mm)	MASS MEAN DENS g/cm^3	OPACITY (%)
48	586	36.4	83	82	390	11.27	18.6				5
49	"	"	8	53	380	4.24	12.0	94.0	0.86	0.09	10
50	"	"	10	53	369	4.28	11.4				10
51	"	"	26	52	375	5.19	10.2				5
52	"	"	25	52	378	5.18	10.5	95.0	0.78	0.12	5

WOOD SPECIES: D. FIR PLANAR SHAV
SIZE RANGE: 1" MINUS
MOISTURE (%): 44.50
DENSITY (LBS/CU.FT): 8.20

RUN NO:	14.	15.	16.	17.	18.
DATE:	2-13-78	2-13-78	2-13-78	2-17-78	2-17-78
CONVEYOR SETTING:	65.	65.	65.	74.	74.
FUEL FEED RATE: (DRY LBS/HR)	473.	473.	473.	586.	586.
HEAT INPUT RATE: (BTU/HR)	4255886.	4255886.	4255886.	5272388.	5272388.
HEAT RELEASE RATE: (BTU/HR-SQFT)	425589.	425589.	425589.	527239.	527239.
UNDERFIRE:	6.INCH	6.INCH	6.INCH	12.INCH	12.INCH
OVERFIRE:	12.INCH	12.INCH	12.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	52.	50.	46.	21.	14.
TEMPERATURES (DEGREES F)					
T2:	1367.	1317.	1260.	1393.	1413.
T3:	977.	987.	1000.	1070.	1085.
T4:	643.	690.	620.	745.	757.
FAN OUTLET:	52.	53.	54.	53.	53.
UNDERGRATE:	95.	95.	100.	145.	142.
OVERFIRE:	95.	95.	100.	145.	100.
AIR HEATER:	110.	110.	110.	200.	200.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.2	.2	.2	.1	.1
6" VENTURI:	7.5	7.5	5.0	.2	.1
12" VENTURI:	.4	.4	.2	1.0	.9
3" CONVEYOR:	3.0	3.0	3.1	3.0	3.0
ACROSS GRATE:	1.3	1.3	1.3	1.4	1.3
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	7.3	7.1	6.7	4.0	3.0
CARBON DIOXIDE:	13.0	13.2	13.1	16.3	17.3
CARBON MONOXIDE:	.13	.12	.13	.11	.11
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	1377.	1305.	1229.	804.	915.
UNDERGRATE:	705.	705.	581.	1084.	1036.
OVERFIRE:	788.	788.	615.	245.	207.
AIR FLOW RATES (SCFM)					
MAIN:	1324.	1253.	1176.	772.	877.
UNDERGRATE:	608.	608.	501.	808.	772.
OVERFIRE:	680.	680.	531.	183.	154.
UNDER + OVER:	1289.	1289.	1032.	990.	926.
CALC. BASED ON :	922.	910.	885.	909.	856.
FUEL AND EX. AIR PERCENT UG:OF	47.:53.	47.:53.	49.:51.	82.:18.	83.:17.
CARRY OVER DATA					
LBS/HR:	11.7	11.0	10.6	15.6	15.9
GR/SCF:	1.481	1.411	1.399	2.002	2.166
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	18.	13.	20.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.600 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	18.	19.	20.	21.	22.
DATE:	2-17-78	2-17-78	2-17-78	2-17-78	2-17-78
CONVEYOR SETTING:	74.	74.	74.	75.	75.
FUEL FEED RATE: (DRY LBS/HR)	586.	586.	586.	594.	594.
HEAT INPUT RATE: (BTU/HR)	5272388.	5272388.	5272388.	5342752.	5342752.
HEAT RELEASE RATE: (BTU/HR-SQFT)	527239.	527239.	527239.	534275.	534275.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	14.	38.	38.	65.	77.
TEMPERATURES (DEGREES F)					
T2:	1413.	1367.	1363.	1353.	1330.
T3:	1085.	1020.	997.	1007.	992.
T4:	757.	735.	722.	727.	748.
FAN OUTLET:	53.	54.	54.	56.	57.
UNDERGRATE:	142.	132.	133.	137.	141.
OVERFIRE:	100.	132.	133.	137.	141.
AIR HEATER:	200.	200.	200.	200.	200.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.1	.2	.2	.3	.3
6" VENTURI:	.1	.3	.4	.5	.5
12" VENTURI:	.9	1.3	1.2	2.0	2.0
3" CONVEYOR:	3.0	2.9	2.9	2.7	3.1
ACROSS GRATE:	1.3	1.4	1.4	1.7	1.4
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	3.0	6.0	6.0	8.0	9.0
CARBON DIOXIDE:	17.3	14.0	14.0	12.0	11.0
CARBON MONOXIDE:	.11	.11	.11	.18	.20
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	915.	1377.	1377.	1695.	1637.
UNDERGRATE:	1036.	1214.	1172.	1461.	1461.
OVERFIRE:	207.	280.	296.	314.	321.
AIR FLOW RATES (SCFM)					
MAIN:	877.	1320.	1318.	1616.	1559.
UNDERGRATE:	772.	905.	874.	1089.	1089.
OVERFIRE:	154.	208.	221.	234.	239.
UNDER + OVER:	926.	1113.	1095.	1323.	1328.
CALC. BASED ON : FUEL AND EX. AIR	856.	1037.	1037.	1256.	1348.
PERCENT UG:OF	83.:17.	81.:19.	80.:20.	82.:18.	82.:18.
CARRY OVER DATA					
LBS/HR:	15.9	17.7	14.7	14.8	13.8
GR/SCF:	2.166	1.992	1.654	1.370	1.195
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	24.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.177 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV.
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	23.	24.	25.	26.	27.
DATE:	2-17-78	2-27-78	2-27-78	2-27-78	2-27-78
CONVEYOR SETTING:	75.	75.	74.	74.	74.
FUEL FEED RATE: (DRY LBS/HR)	594.	594.	586.	586.	586.
HEAT INPUT RATE: (BTU/HR)	5342752.	5342752.	5272388.	5272388.	5272388.
HEAT RELEASE RATE: (BTU/HR-SQFT)	534275.	534275.	527239.	527239.	527239.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	100.	100.	26.	34.	44.
TEMPERATURES (DEGREES F)					
T2:	1267.	1027.	1433.	1542.	1513.
T3:	957.	967.	1057.	1045.	1020.
T4:	740.	653.	680.	695.	683.
FAN OUTLET:	57.	49.	51.	54.	55.
UNDERGRATE:	145.	120.	150.	155.	153.
OVERFIRE:	145.	120.	150.	155.	153.
AIR HEATER:	200.	0.	160.	165.	200.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.4	.5	.3	.3	.3
6" VENTURI:	1.0	1.0	3.5	3.9	5.5
12" VENTURI:	2.7	2.4	.4	.4	.5
3" CONVEYOR:	3.0	3.0	3.0	2.9	3.0
ACROSS GRATE:	1.4	1.5	1.1	1.1	1.0
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.5	10.5	4.5	5.5	6.5
CARBON DIOXIDE:	9.5	10.0	15.5	14.2	14.0
CARBON MONOXIDE:	.37	.30	.25	.17	.18
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	1914.	2180.	1544.	1544.	1695.
UNDERGRATE:	1663.	1320.	707.	710.	804.
OVERFIRE:	400.	352.	621.	649.	764.
AIR FLOW RATES (SCFM)					
MAIN:	1821.	2109.	1487.	1478.	1618.
UNDERGRATE:	1240.	1412.	561.	559.	599.
OVERFIRE:	299.	377.	493.	511.	570.
UNDER + OVER:	1538.	1789.	1054.	1070.	1169.
CALC. BASED ON : FUEL AND EX. AIR	1523.	1523.	947.	1007.	1082.
PERCENT UG:OF	81.:19.	79.:21.	53.:47.	52.:48.	51.:49.
CARRY OVER DATA					
LBS/HR:	15.3	17.1	13.2	11.4	8.7
GR/SCF:	1.172	1.310	1.627	1.321	.941
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	22.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.575 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV.
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	28.	29.	30.	31.	32.
DATE:	2-27-78	2-27-78	2-27-78	2-27-78	2-27-78
CONVEYOR SETTING:	74.	75.	75.	75.	75.
FUEL FEED RATE: (DRY LBS/HR)	586.	594.	594.	594.	594.
HEAT INPUT RATE: (BTU/HR)	5272388.	5342752.	5342752.	5342752.	5342752.
HEAT RELEASE RATE: (BTU/HR-SQFT)	527239.	534275.	534275.	534275.	534275.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	47.	58.	53.	66.	76.
TEMPERATURES (DEGREES F)					
T2:	1512.	1403.	1523.	1335.	1308.
T3:	1017.	1017.	1020.	1020.	1007.
T4:	678.	673.	693.	720.	740.
FAN OUTLET:	56.	57.	58.	58.	57.
UNDERGRATE:	152.	142.	157.	145.	150.
OVERFIRE:	152.	142.	157.	145.	150.
AIR HEATER:	200.	200.	200.	200.	200.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.3	.4	.4	.5	.5
6" VENTURI:	5.4	8.2	8.2	11.6	11.6
12" VENTURI:	.4	.5	.4	.8	.8
3" CONVEYOR:	3.0	3.0	3.0	2.9	2.9
ACROSS GRATE:	1.0	1.0	1.1	1.0	1.0
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	6.8	7.8	7.3	8.3	9.0
CARBON DIOXIDE:	13.5	13.0	13.6	12.0	11.5
CARBON MONOXIDE:	.16	.06	.07	.08	.10
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	1695.	1914.	1861.	2111.	2087.
UNDERGRATE:	730.	804.	730.	984.	984.
OVERFIRE:	758.	901.	901.	1041.	1041.
AIR FLOW RATES (SCFM)					
MAIN:	1616.	1822.	1770.	2005.	1984.
UNDERGRATE:	544.	599.	544.	734.	734.
OVERFIRE:	565.	672.	672.	776.	776.
UNDER + OVER:	1110.	1271.	1216.	1510.	1510.
CALC. BASED ON : FUEL AND EX. AIR	1104.	1203.	1165.	1264.	1340.
PERCENT UG:OF	49.:51.	47.:53.	45.:55.	49.:51.	49.:51.
CARRY OVER DATA					
LBS/HR:	7.8	8.4	7.5	10.9	9.3
GR/SCF:	.824	.815	.751	1.007	.810
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	22.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.573 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV.
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	39.	40.	41.	42.	43.
DATE:	2-28-78	2-28-78	2-28-78	2-28-78	2-28-78
CONVEYOR SETTING:	75.	75.	74.	74.	74.
FUEL FEED RATE: (DRY LBS/HR)	594.	594.	586.	586.	586.
HEAT INPUT RATE: (BTU/HR)	5342752.	5342752.	5272388.	5272388.	5272388.
HEAT RELEASE RATE: (BTU/HR-SQFT)	534275.	534275.	527239.	527239.	527239.
UNDERFIRE:	6.INCH	6.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	12.INCH	12.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	91.	91.	50.	51.	83.
TEMPERATURES (DEGREES F)					
T2:	1583.	1560.	1458.	1463.	1433.
T3:	1063.	1072.	1058.	1045.	1033.
T4:	758.	753.	682.	685.	733.
FAN OUTLET:	51.	52.	56.	56.	56.
UNDERGRATE:	177.	173.	402.	402.	395.
OVERFIRE:	177.	178.	287.	293.	309.
AIR HEATER:	200.	200.	426.	435.	424.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.3	.4	.1	.1	.2
6" VENTURI:	4.9	4.7	.3	.3	.5
12" VENTURI:	1.5	1.5	1.6	1.5	2.6
3" CONVEYOR:	2.9	3.0	3.1	3.0	2.9
ACROSS GRATE:	1.2	1.3	1.4	1.4	1.7
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.0	10.0	7.0	7.2	9.5
CARBON DIOXIDE:	11.5	11.0	14.0	13.8	11.5
CARBON MONOXIDE:	.04	.02	.25	.27	.10
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	1808.	1939.	743.	677.	1189.
UNDERGRATE:	619.	607.	1538.	1503.	1894.
OVERFIRE:	1399.	1401.	301.	301.	350.
AIR FLOW RATES (SCFM)					
MAIN:	1742.	1863.	709.	645.	1134.
UNDERGRATE:	462.	453.	854.	826.	1054.
OVERFIRE:	1043.	1044.	167.	165.	195.
UNDER + OVER:	1504.	1497.	1021.	992.	1249.
CALC. BASED ON : FUEL AND EX. AIR	1454.	1454.	1127.	1134.	1375.
PERCENT UG:OF	31.:69.	30.:70.	84.:16.	83.:17.	84.:16.
CARRY OVER DATA					
LBS/HR:	9.3	9.0	18.3	12.0	18.0
GR/SCF:	.746	.722	1.894	1.234	1.527
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.160 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV.
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	44.	45.	46.	47.	48.
DATE:	2-28-78	3-1-78	3-1-78	3-1-78	3-1-78
CONVEYOR SETTING:	74.	74.	74.	74.	74.
FUEL FEED RATE: (DRY LBS/HR)	586.	586.	586.	586.	586.
HEAT INPUT RATE: (BTU/HR)	5272388.	5272388.	5272388.	5272388.	5272388.
HEAT RELEASE RATE: (BTU/HR-SQFT)	527239.	527239.	527239.	527239.	527239.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	91.	62.	55.	87.	83.
TEMPERATURES (DEGREES F)					
T2:	1452.	1340.	1353.	1213.	1230.
T3:	1027.	1010.	1025.	1053.	1058.
T4:	725.	652.	658.	727.	739.
FAN OUTLET:	56.	50.	50.	53.	53.
UNDERGRATE:	393.	415.	415.	390.	390.
OVERFIRE:	308.	320.	321.	315.	304.
AIR HEATER:	427.	412.	418.	409.	408.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.2	.2	.2	.3	.3
6" VENTURI:	.5	1.0	1.0	1.6	1.6
12" VENTURI:	2.5	3.0	3.0	4.9	4.7
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.7	1.7	1.7	1.7	1.4
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.0	8.0	7.5	9.8	9.5
CARBON DIOXIDE:	11.0	12.0	12.5	10.0	10.0
CARBON MONOXIDE:	.09	.10	.08	.20	.25
OXIDES OF NITROGEN:	0.0	.0	.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	1189.	1189.	1229.	1752.	1695.
UNDERGRATE:	1865.	2001.	2007.	2468.	2422.
OVERFIRE:	352.	444.	445.	527.	527.
AIR FLOW RATES (SCFM)					
MAIN:	1134.	1147.	1185.	1682.	1626.
UNDERGRATE:	1035.	1129.	1125.	1397.	1373.
OVERFIRE:	195.	250.	249.	298.	299.
UNDER. + OVER:	1230.	1379.	1374.	1695.	1672.
CALC. BASED ON : FUEL AND EX. AIR	1435.	1217.	1165.	1405.	1375.
PERCENT UG:OF	84.:16.	82.:18.	82.:18.	82.:18.	82.:18.
CARRY OVER DATA					
LBS/HR:	17.4	13.8	17.7	18.0	18.6
GR/SCF:	1.415	1.323	1.773	1.495	1.578
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	SUNNY	SUNNY	SUNNY	SUNNY

SRU 1.157 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV.
SIZE RANGE: 1" MINUS
MOISTURE (%): 36.40
DENSITY (LBS/CU.FT): 7.80

RUN NO:	49.	50.	51.	52.	0.
DATE:	3-1-78	3-1-78	3-1-78	3-1-78	:::::::
CONVEYOR SETTING:	74.	74.	74.	74.	0.
FUEL FEED RATE: (DRY LBS/HR)	586.	586.	586.	586.	0.
HEAT INPUT RATE: (BTU/HR)	5272388.	5272388.	5272388.	5272388.	0.
HEAT RELEASE RATE: (BTU/HR-SQFT)	527239.	527239.	527239.	527239.	0.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	0.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	0.INCH
PERCENT EX. AIR:	8.	10.	26.	25.	0.
TEMPERATURES (DEGREES F)					
T2:	1551.	1560.	1552.	1572.	0.
T3:	993.	980.	1022.	1048.	0.
T4:	632.	616.	643.	655.	0.
FAN OUTLET:	55.	56.	57.	57.	0.
UNDERGRATE:	380.	369.	375.	378.	0.
OVERFIRE:	365.	366.	376.	380.	0.
AIR HEATER:	429.	414.	429.	433.	0.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.0	.0	.1	.1	0.0
6" VENTURI:	5.0	5.0	8.9	8.9	0.0
12" VENTURI:	.5	.5	.8	.8	0.0
3" CONVEYOR:	3.0	2.9	3.0	3.0	0.0
ACROSS GRATE:	1.3	1.3	1.0	1.0	0.0
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	2.0	2.3	4.5	4.4	0.0
CARBON DIOXIDE:	180.0	17.0	15.6	16.0	0.0
CARBON MONOXIDE:	.90	1.30	.07	.08	0.00
OXIDES OF NITROGEN:	.0	0.0	.0	.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	423.	521.	915.	915.	0.
UNDERGRATE:	933.	925.	1142.	1145.	0.
OVERFIRE:	835.	828.	1065.	1067.	0.
AIR FLOW RATES (SCFM)					
MAIN:	404.	497.	871.	871.	0.
UNDERGRATE:	516.	521.	632.	631.	0.
OVERFIRE:	462.	466.	589.	588.	0.
UNDER + OVER:	979.	986.	1221.	1219.	0.
CALC. BASED ON : FUEL AND EX. AIR	811.	826.	947.	939.	0.
PERCENT UG:OF	53.:47.	53.:47.	52.:48.	52.:48.	0.: 0.
CARRY OVER DATA					
LBS/HR:	12.0	11.4	10.2	10.5	0.0
GR/SCF:	1.725	1.609	1.257	1.304	0.000
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	22.	20.	20.	20.	0.
OPACITY:	10.	10.	5.	5.	0.
WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	

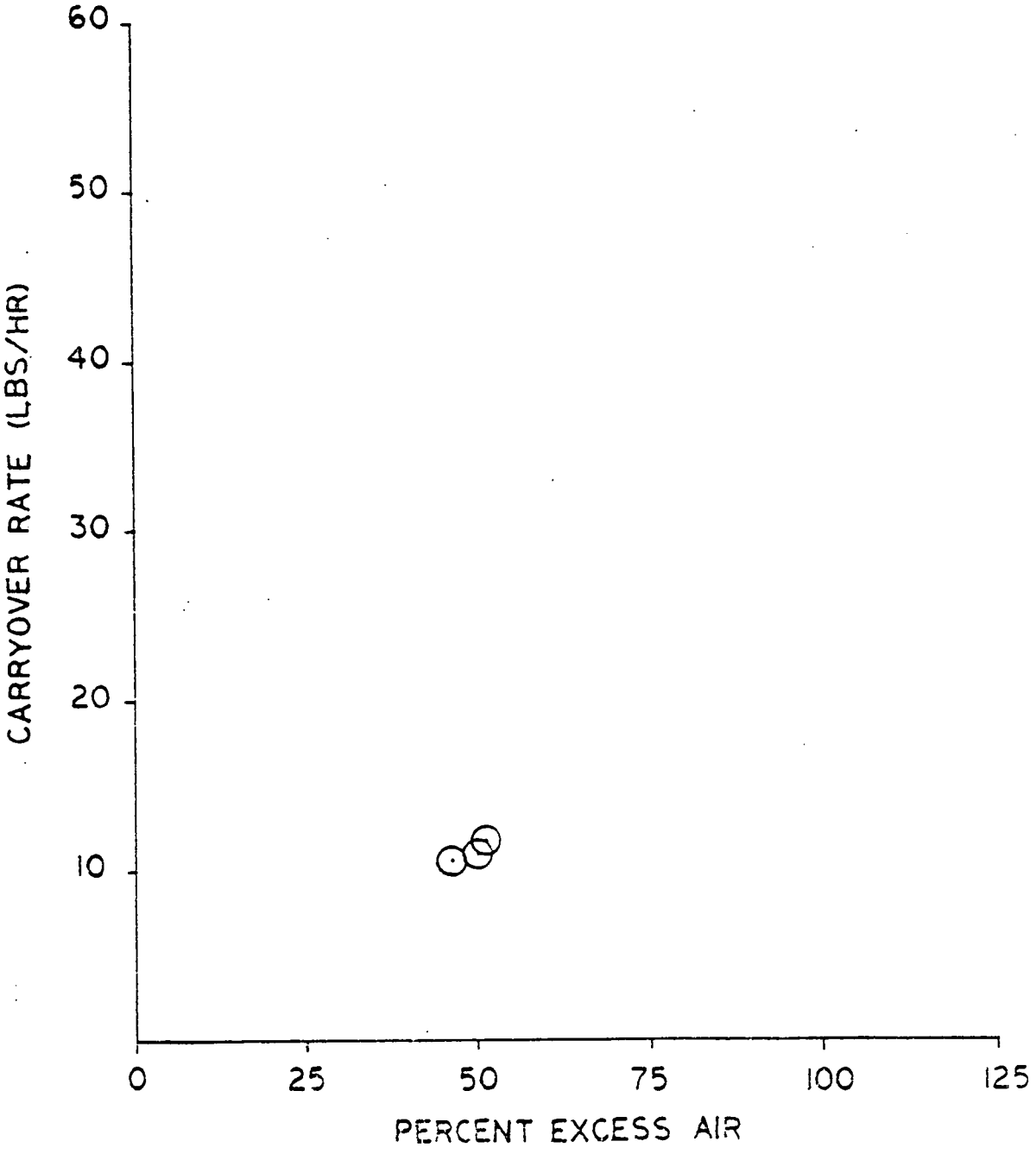
SRU 1.501 UNTS.

RUN COMPLETE.

GRAPHS OF COLLECTED DATA

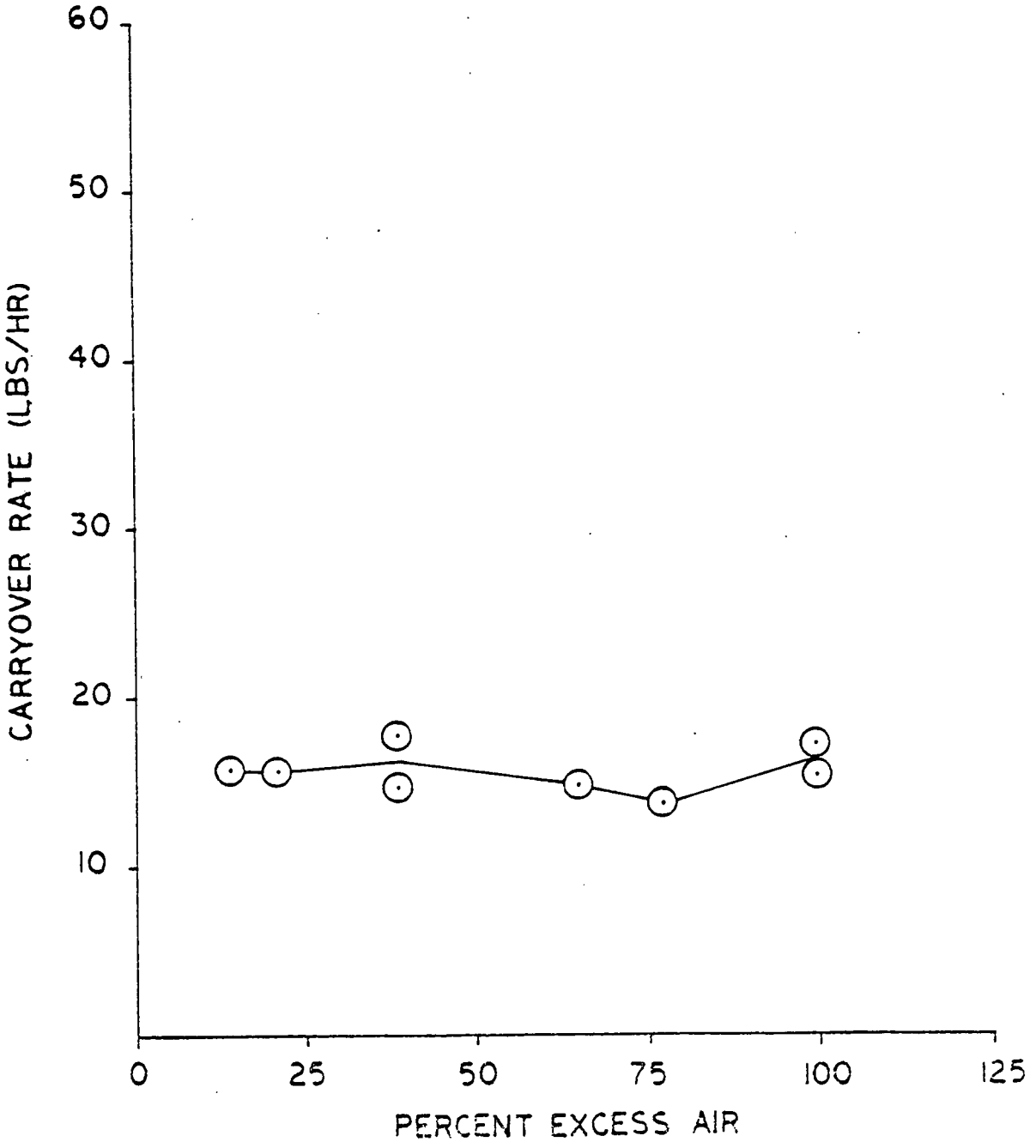
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	14-16	FUEL FEED RATE (DRY LBS/HR):	473
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	4.3×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	97
MOISTURE:	45%	PERCENT UNDERGRATE AIR:	48



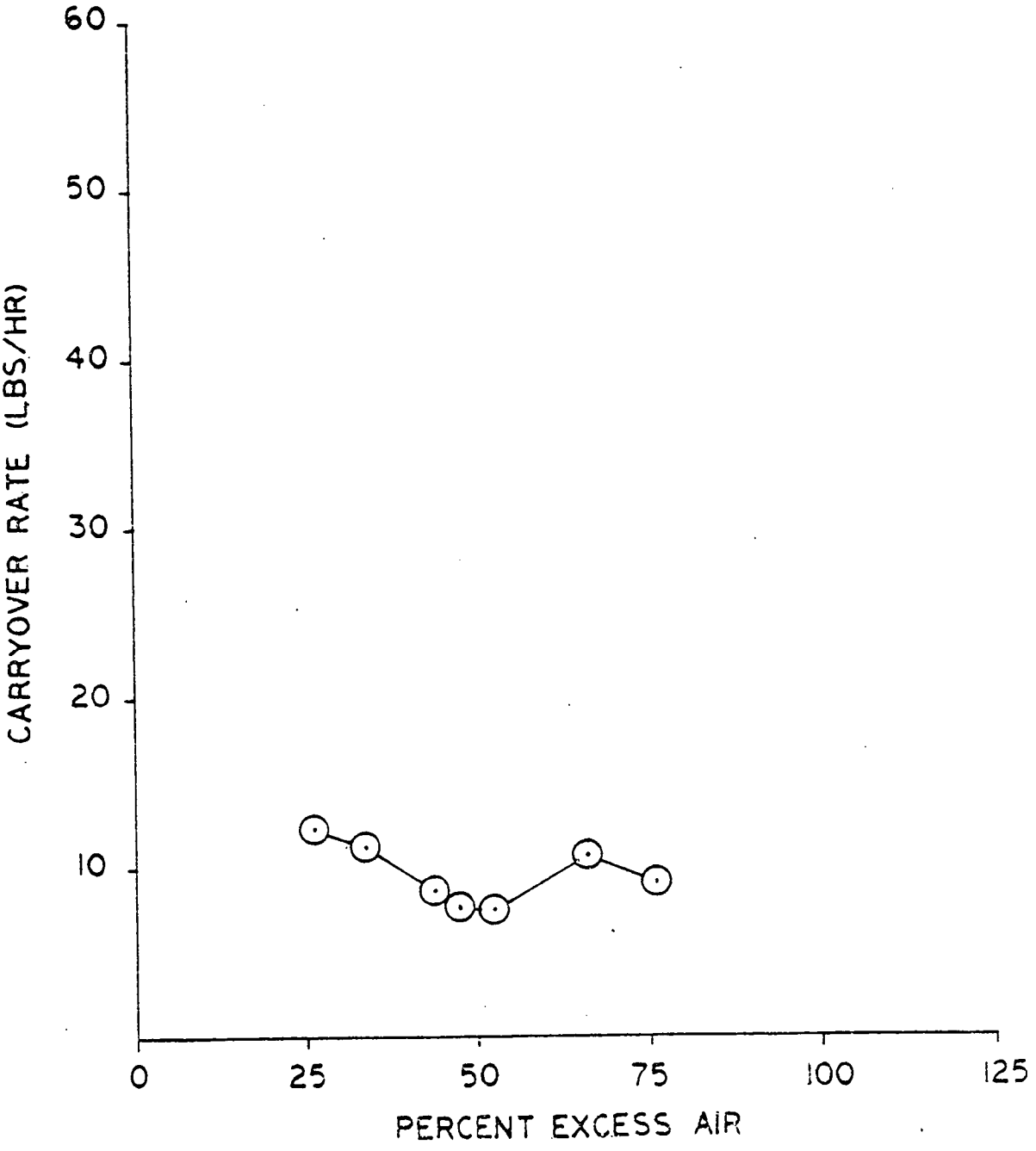
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	17-24	FUEL FEED RATE (DRY LBS/HR):	586
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	5.2×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	137
MOISTURE:	45%	PERCENT UNDERGRATE AIR:	81



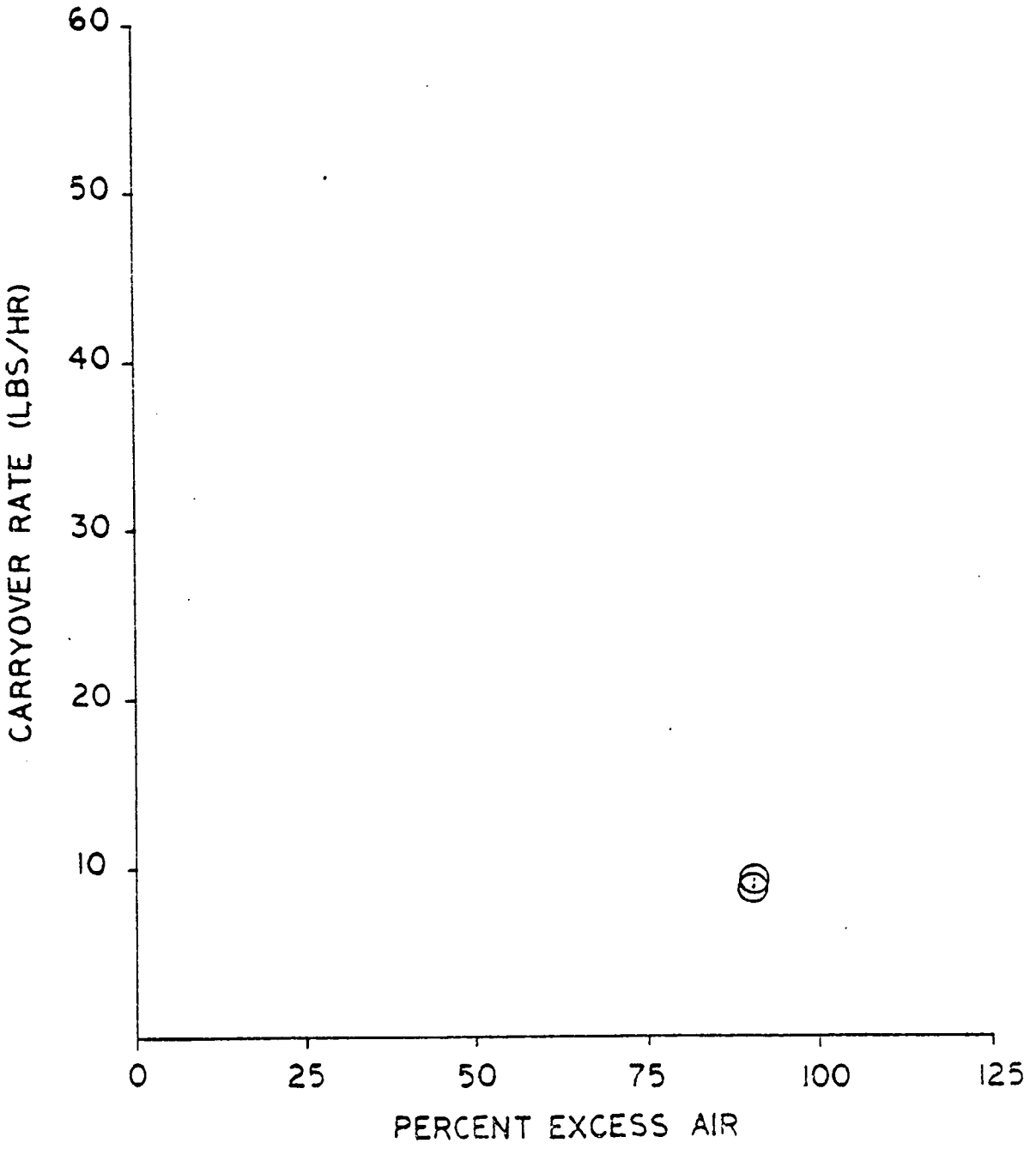
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	25-32	FUEL FEED RATE (DRY LBS/HR):	586
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	5.2×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	150
MOISTURE:	36%	PERCENT UNDERGRATE AIR:	50



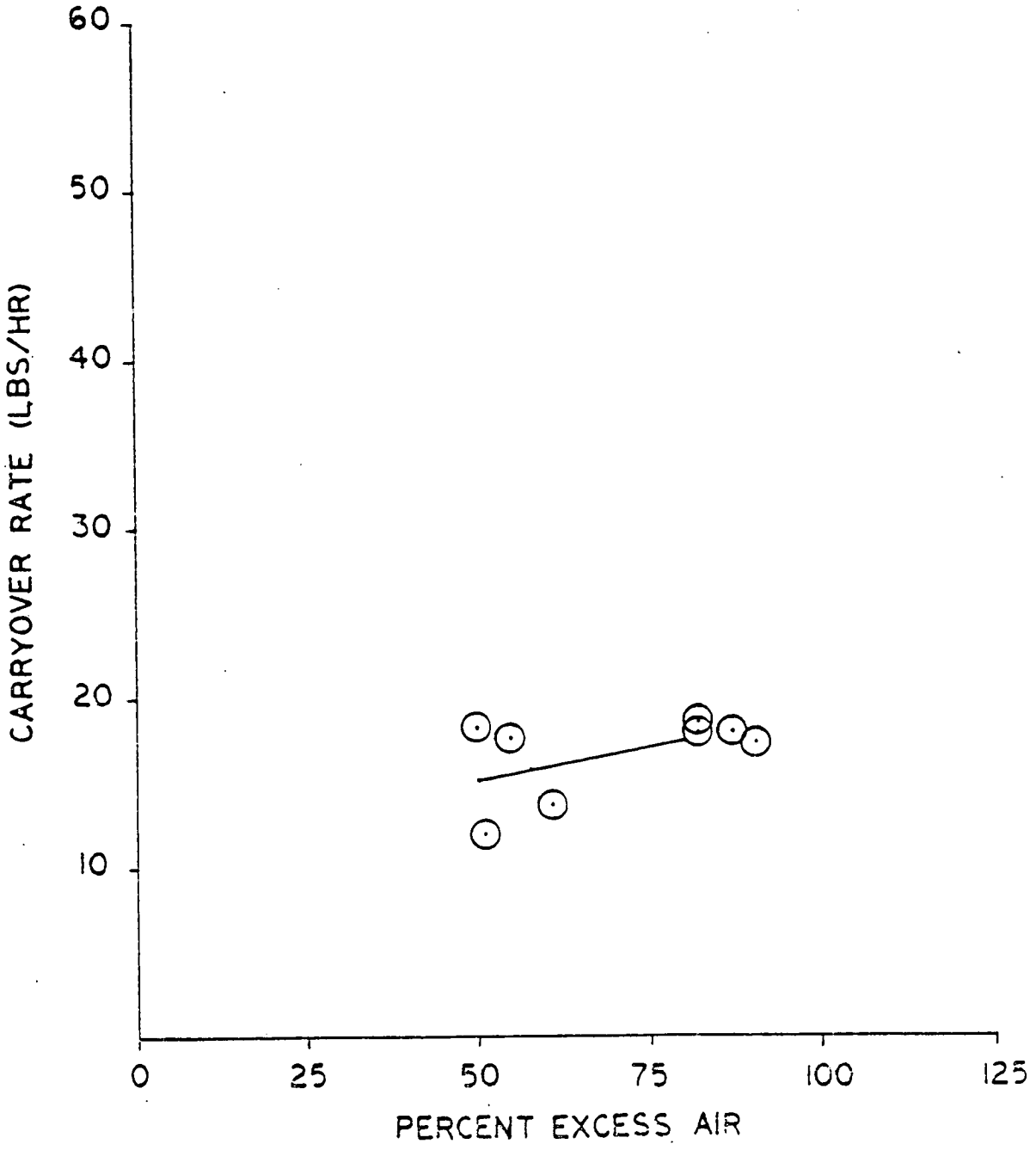
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	39 & 40	FUEL FEED RATE (DRY LBS/HR):	594
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	5.3×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	176
MOISTURE:	36%	PERCENT UNDERGRATE AIR:	31



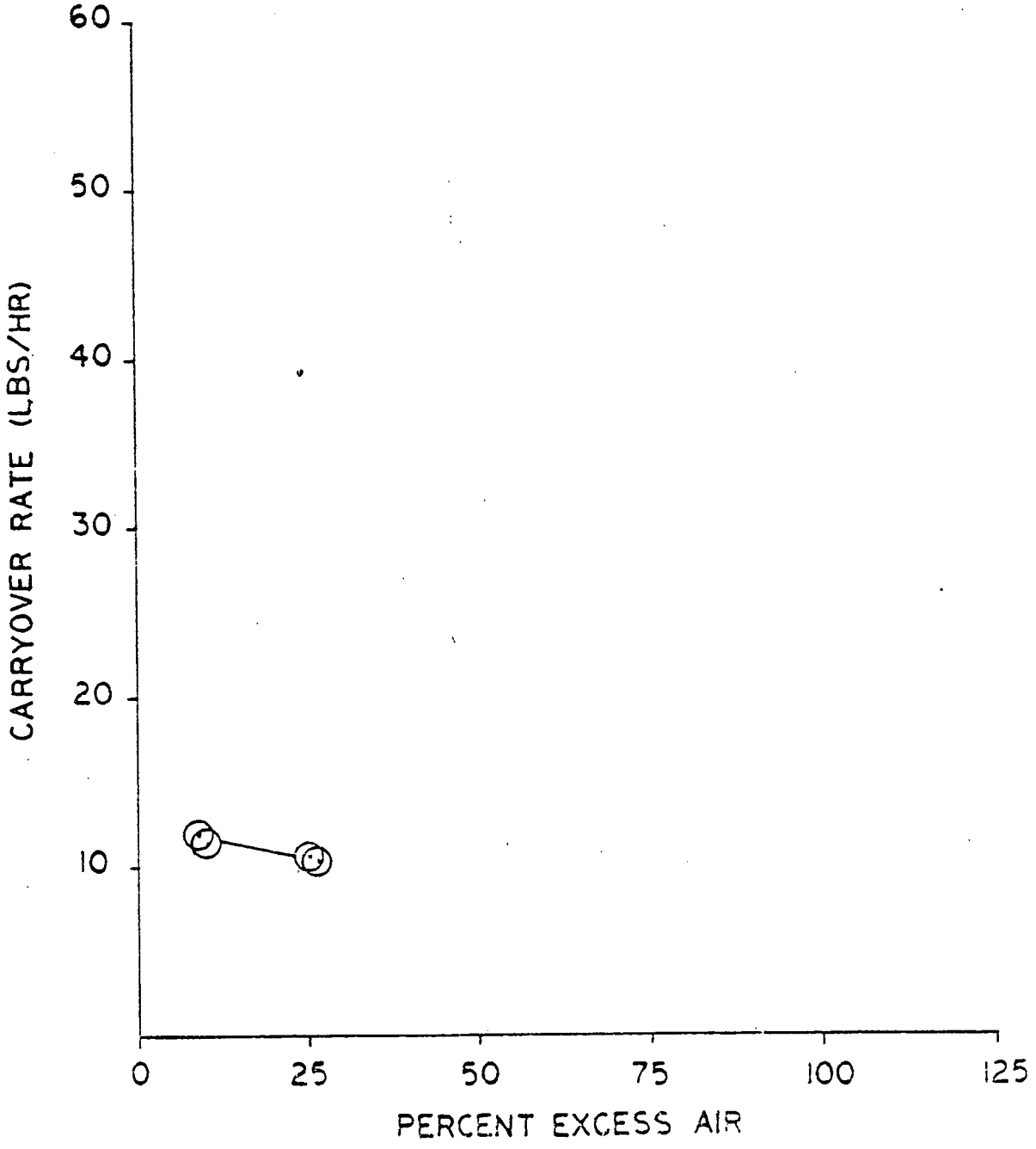
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

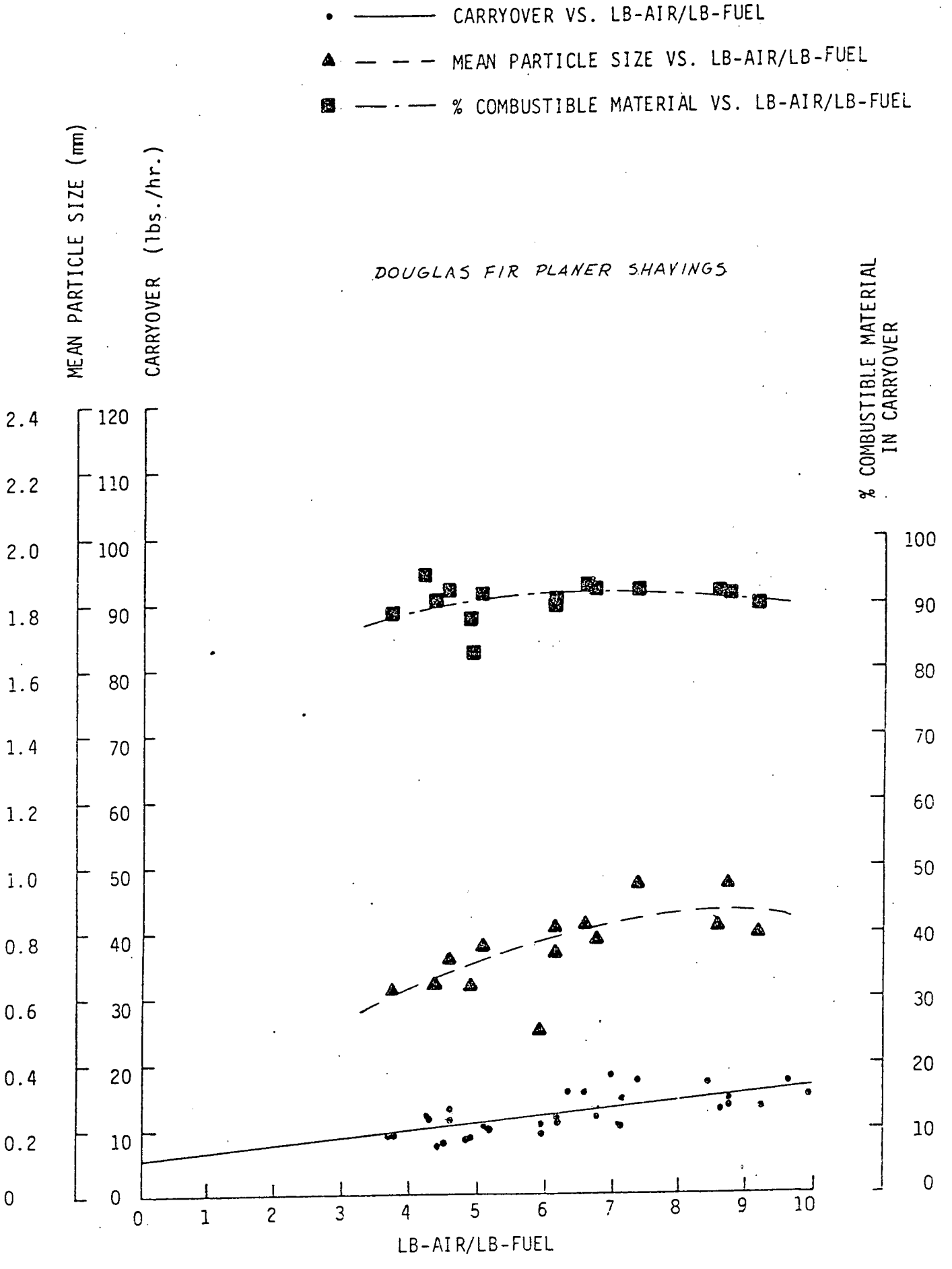
TEST NOS.:	41-48	FUEL FEED RATE (DRY LBS/HR):	586
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	5.2×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	400
MOISTURE:	36%	PERCENT UNDERGRATE AIR:	83

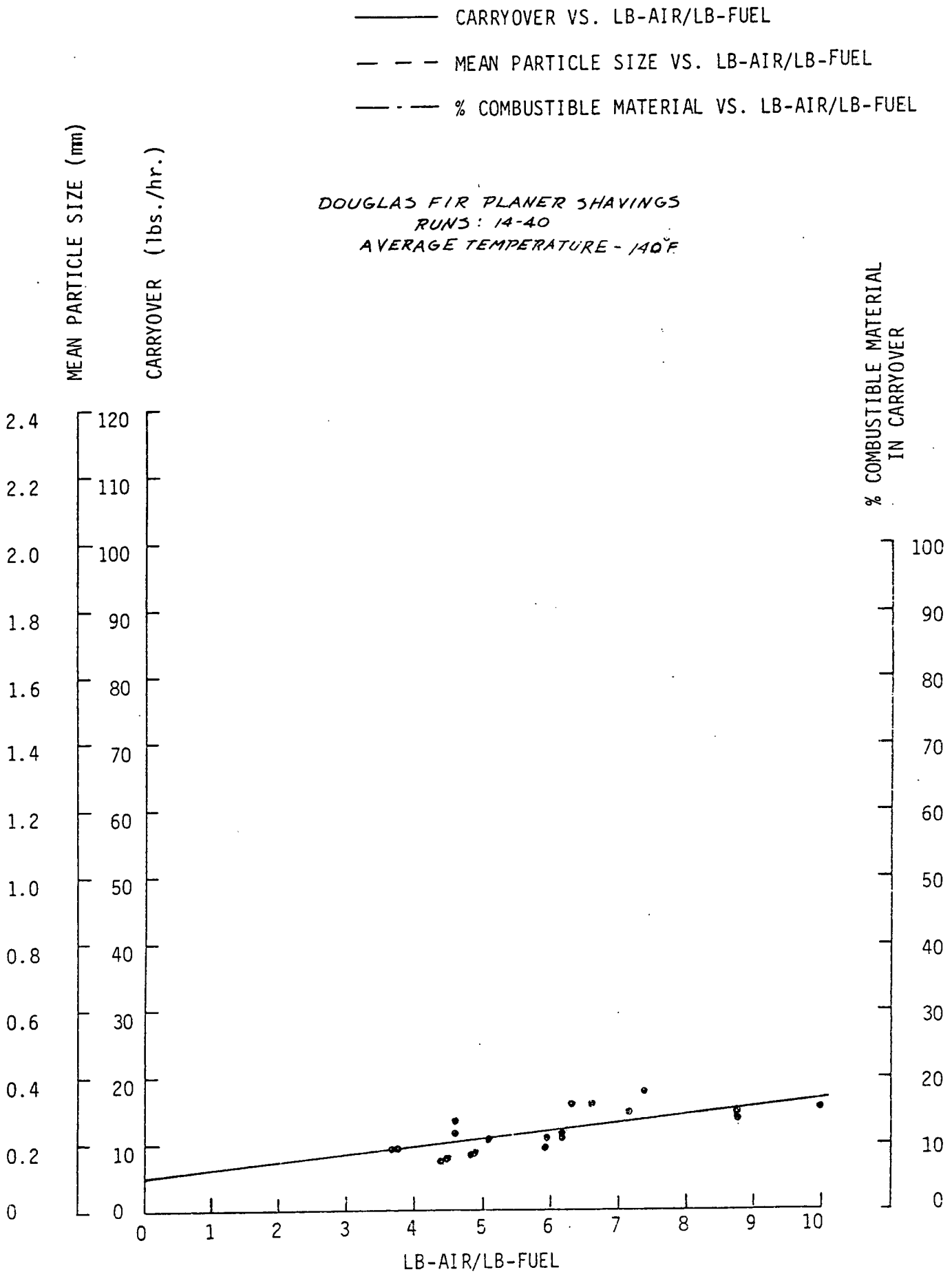


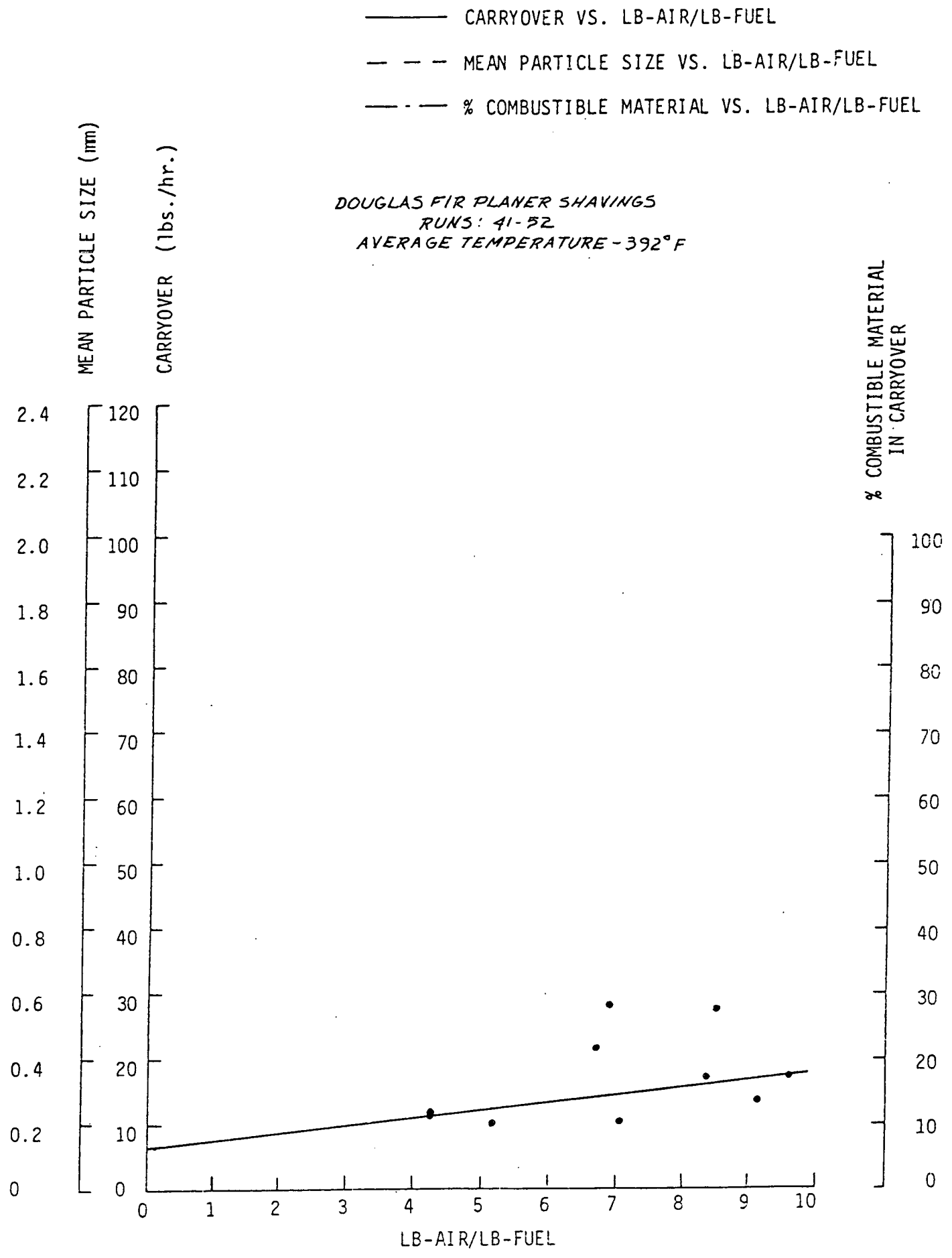
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	49-52	FUEL FEED RATE (DRY LBS/HR):	586
SPECIES:	Doug. Fir Planer Shav.	HEAT RELEASE RATE (BTU/HR):	5.2×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	375
MOISTURE:	36%	PERCENT UNDERGRATE AIR:	52



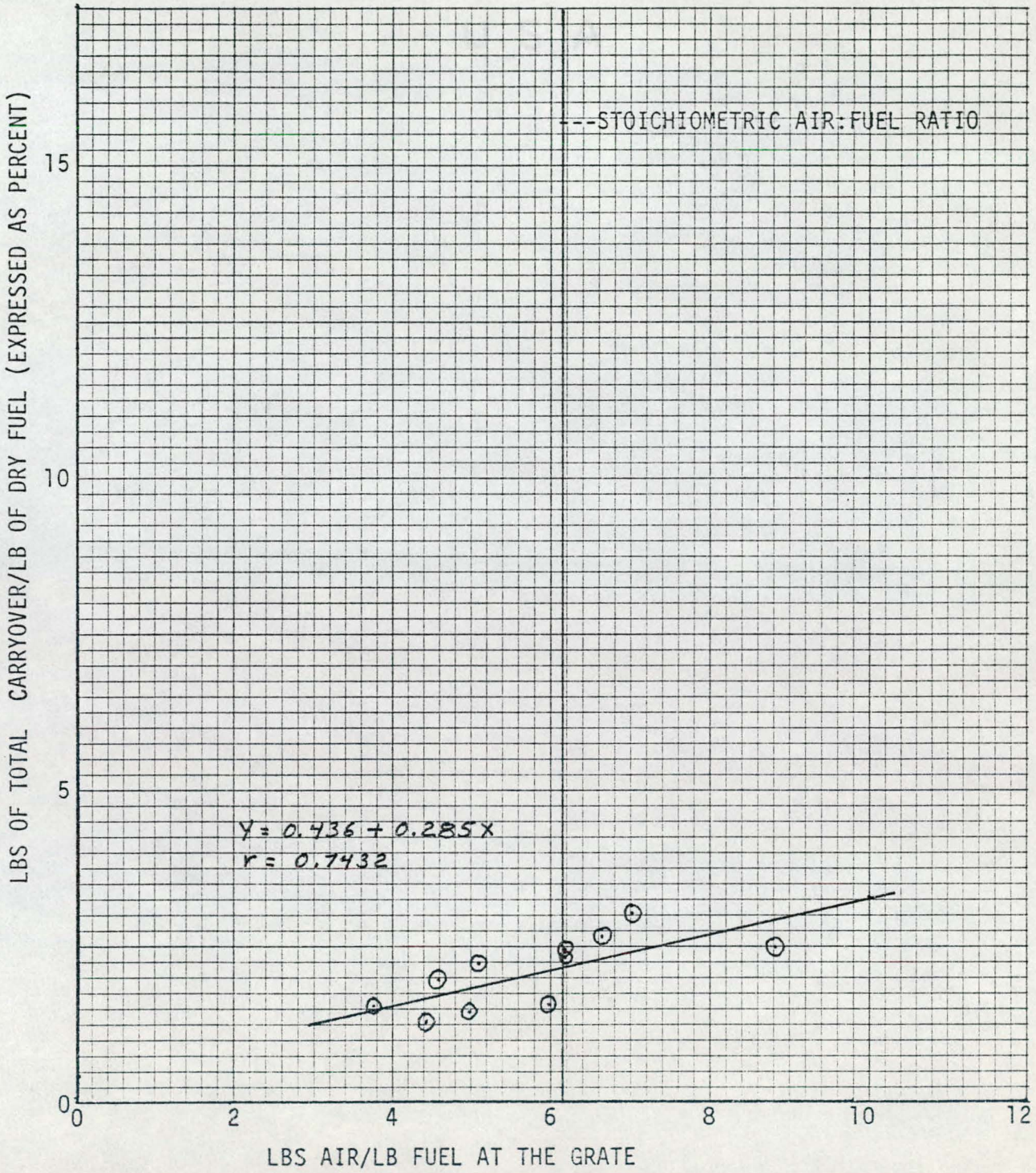

CARRYOVER VS. LB-AIR/LB-FUEL
MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
% COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL
DOUGLAS FIR PLANER SHAVINGS
MEAN PARTICLE SIZE (mm)
CARRYOVER (lbs./hr.)
% COMBUSTIBLE MATERIAL IN CARRYOVER
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
120
110
100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
LB-AIR/LB-FUEL


CARRYOVER VS. LB-AIR/LB-FUEL
MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
% COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL
DOUGLAS FIR PLANER SHAVINGS
RUNS: 14-40
AVERAGE TEMPERATURE - 140°F
MEAN PARTICLE SIZE (mm)
CARRYOVER (lbs./hr.)
% COMBUSTIBLE MATERIAL IN CARRYOVER
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
120
110
100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10
LB-AIR/LB-FUEL


CARRYOVER VS. LB-AIR/LB-FUEL
MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
% COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL
DOUGLAS FIR PLANER SHAVINGS
RUNS: 41-52
AVERAGE TEMPERATURE - 392°F
MEAN PARTICLE SIZE (mm)
CARRYOVER (lbs./hr.)
% COMBUSTIBLE MATERIAL IN CARRYOVER
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
120
110
100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10
LB-AIR/LB-FUEL

SPECIES: D. FIR PLANER SHAVINGS RUNS 14 TO 40

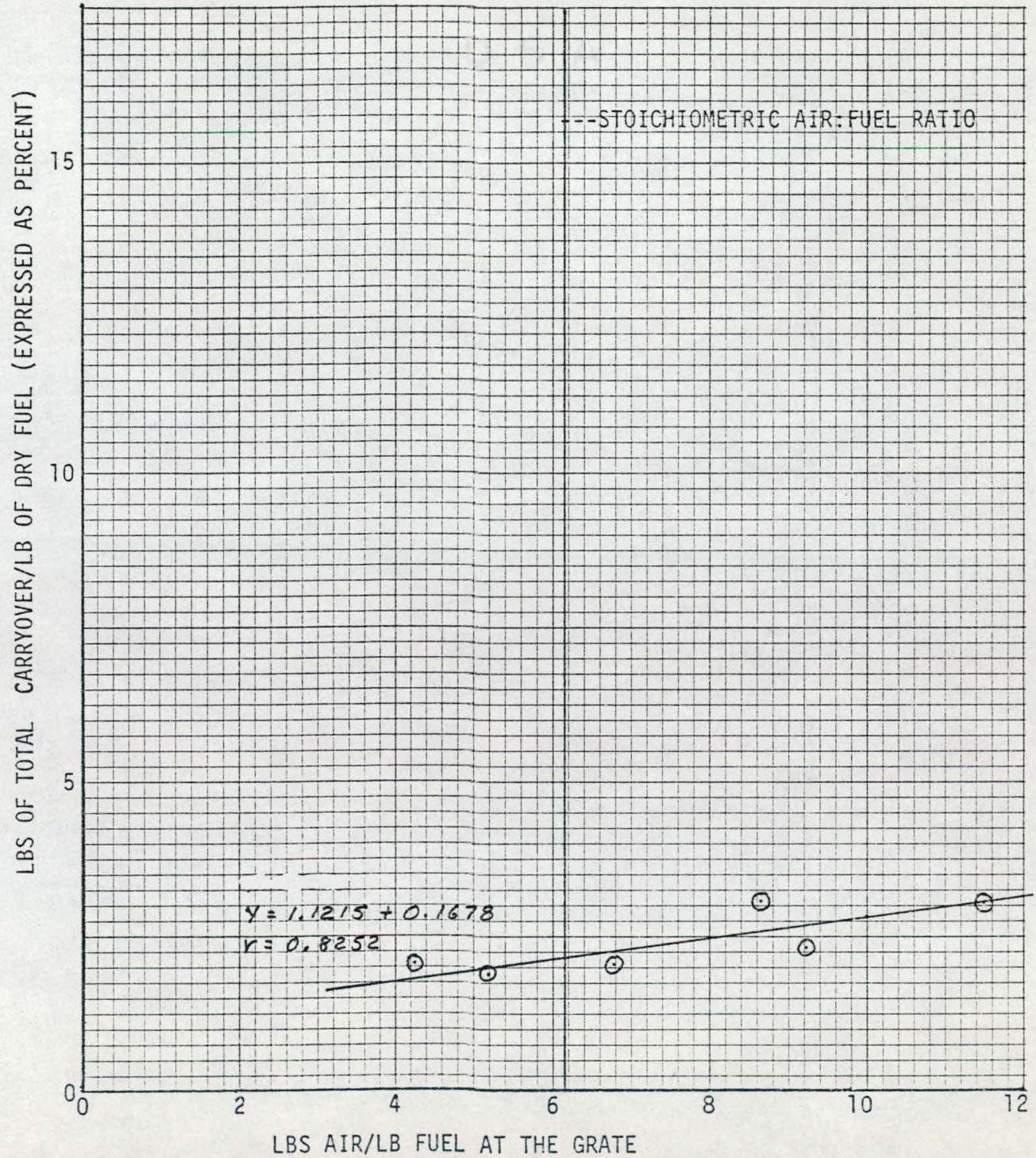
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 36.4 %



PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: D. FIR PLANER SHAVINGS RUNS 41 TO 52

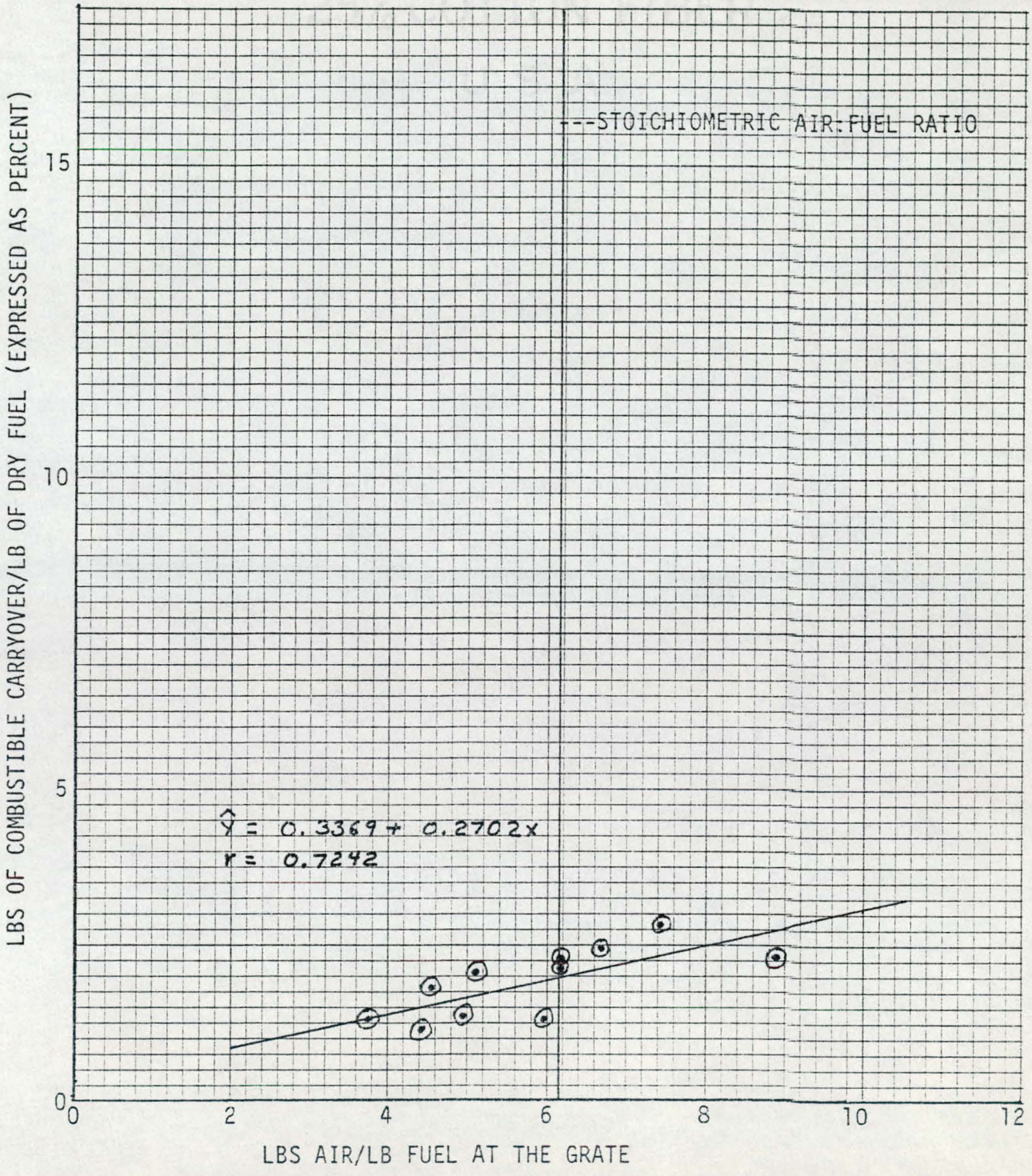
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 36.4 %



PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: D. FIR PLANER SHAVINGS RUNS 14 TO 39

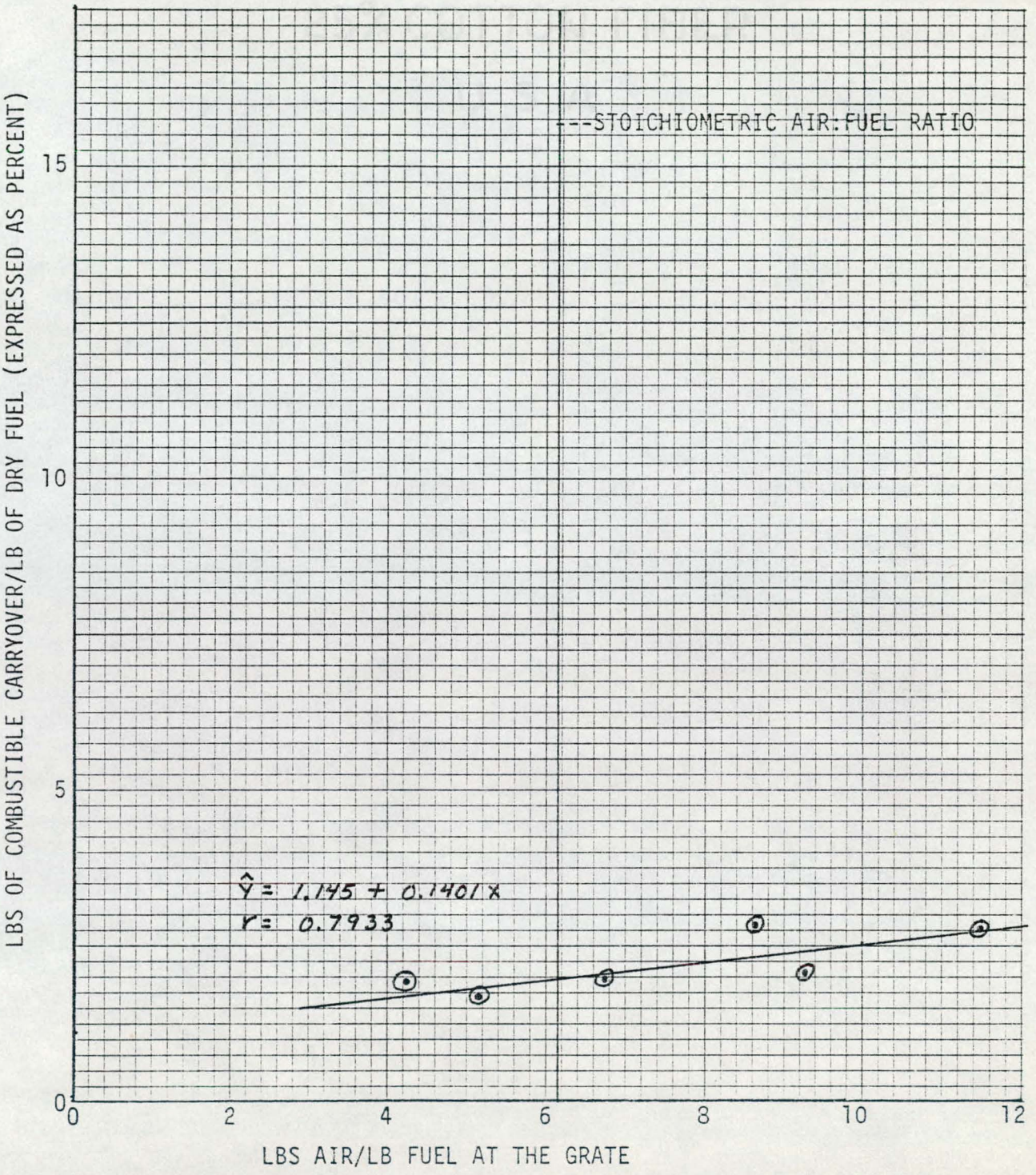
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 36 - 44 %



PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: D.FIR PLANER SHAVINGS RUNS 42 TO 52

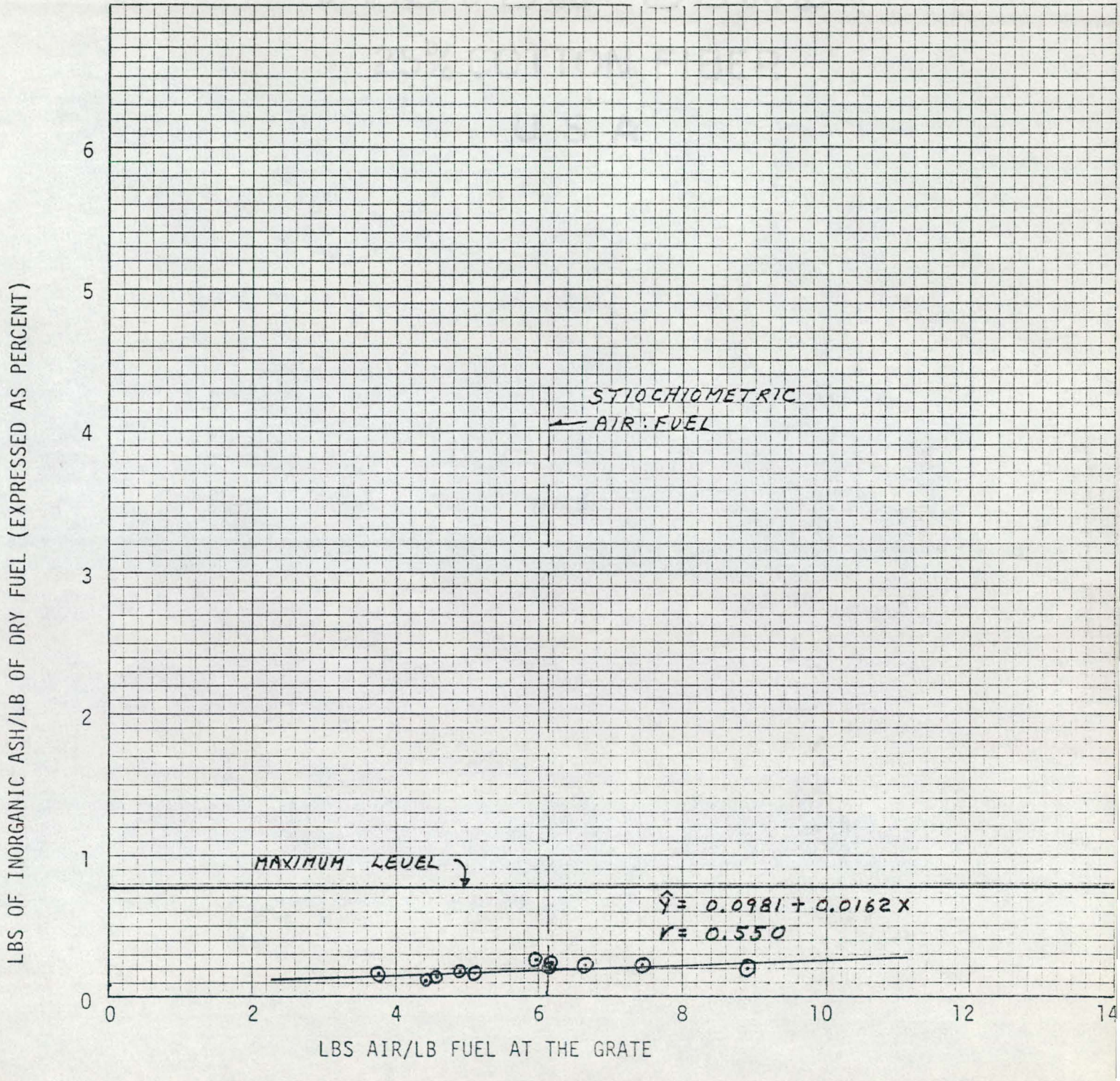
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 36 %



PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: D. FIR PLANER SHAVINGS RUNS: 14 TO 39

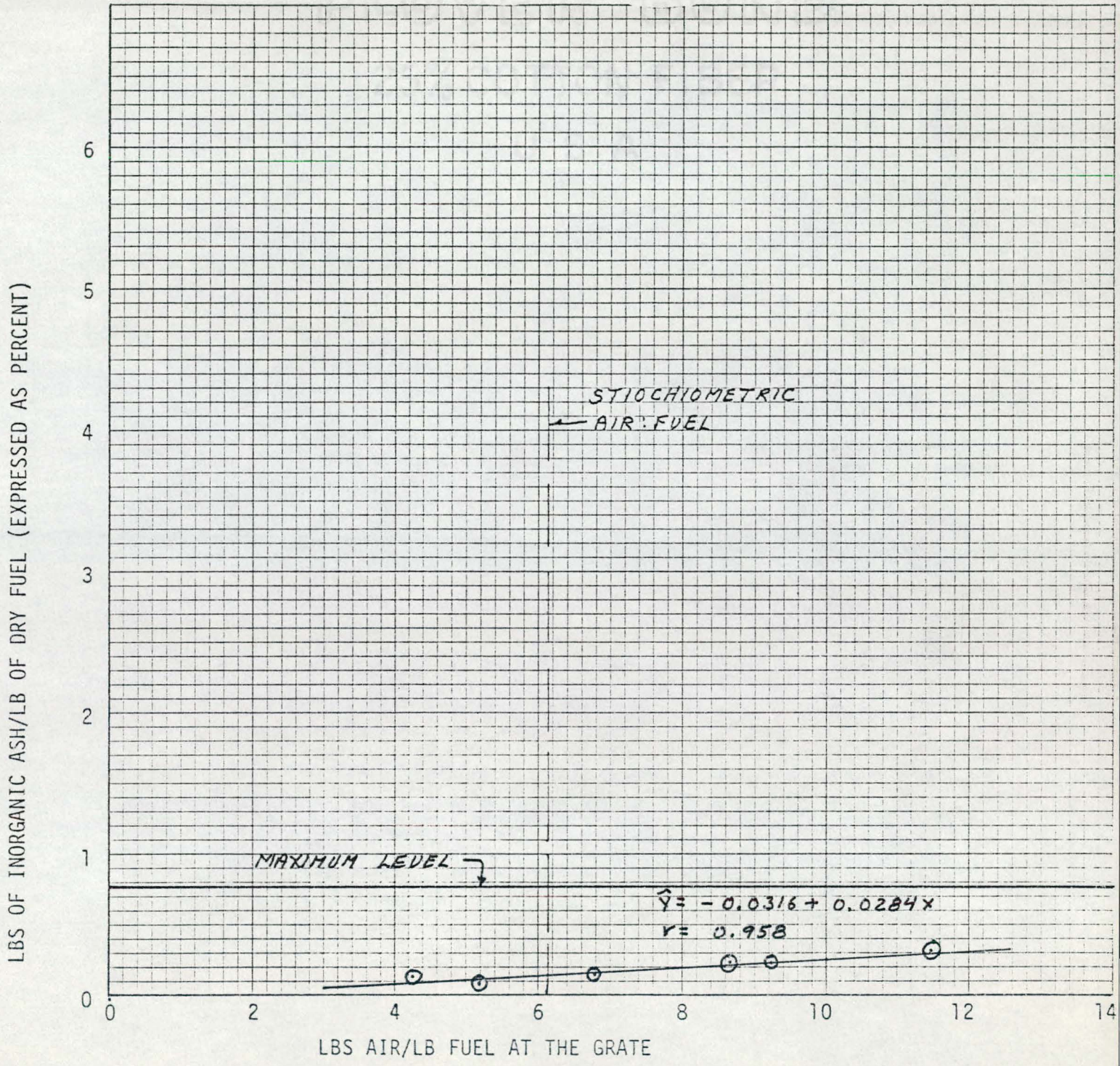
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 44 (%)



PLOT OF THE PERCENT OF REMOVAL OF INORGANIC ASH VS. AIR:FUEL AT THE GRATE

SPECIES: D. FIR PLANER SHAVINGS RUNS: 42 TO 52

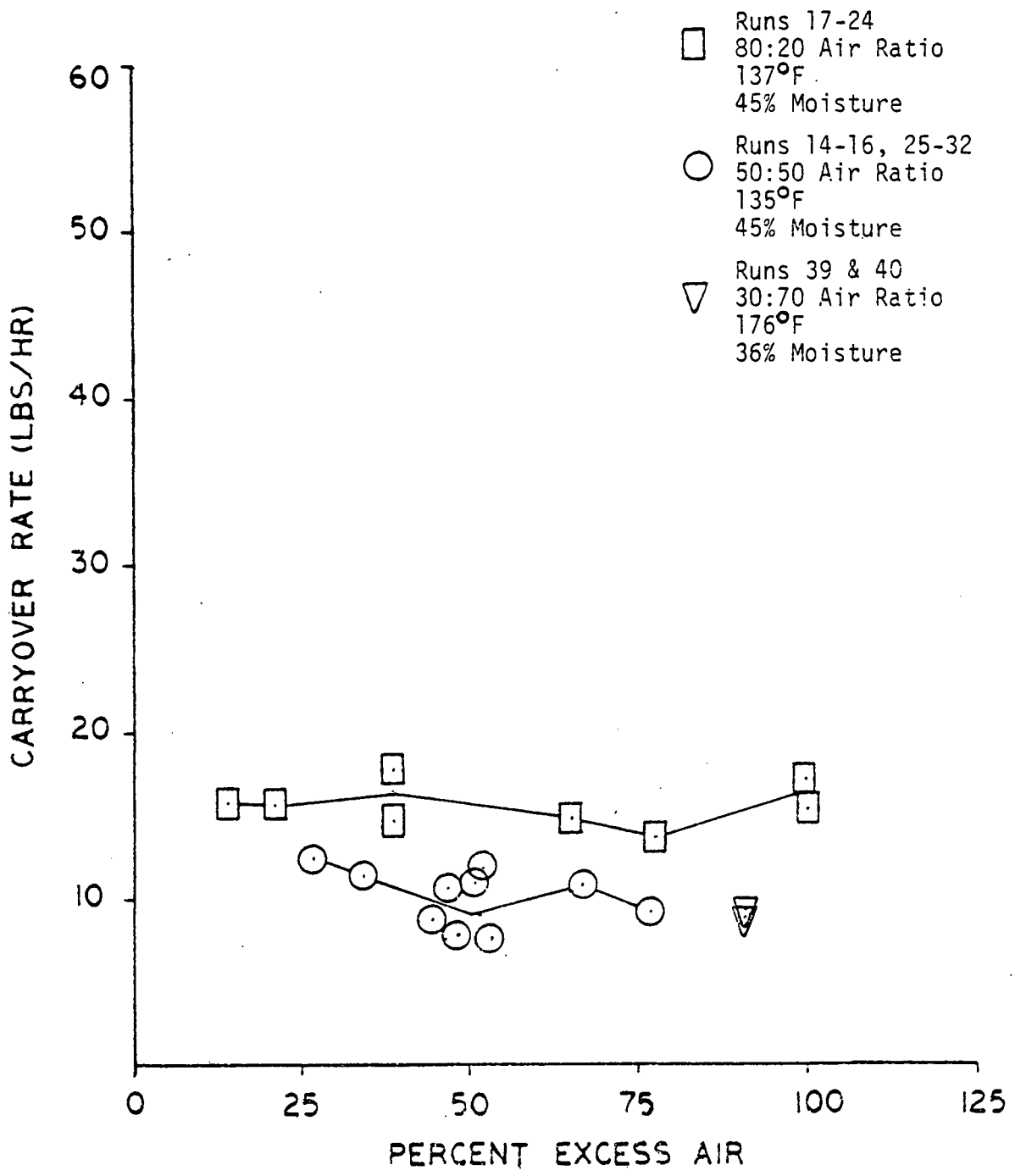
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 36.4 (%)



PLOT OF THE PERCENT OF REMOVAL OF INORGANIC ASH VS. AIR:FUEL AT THE GRATE

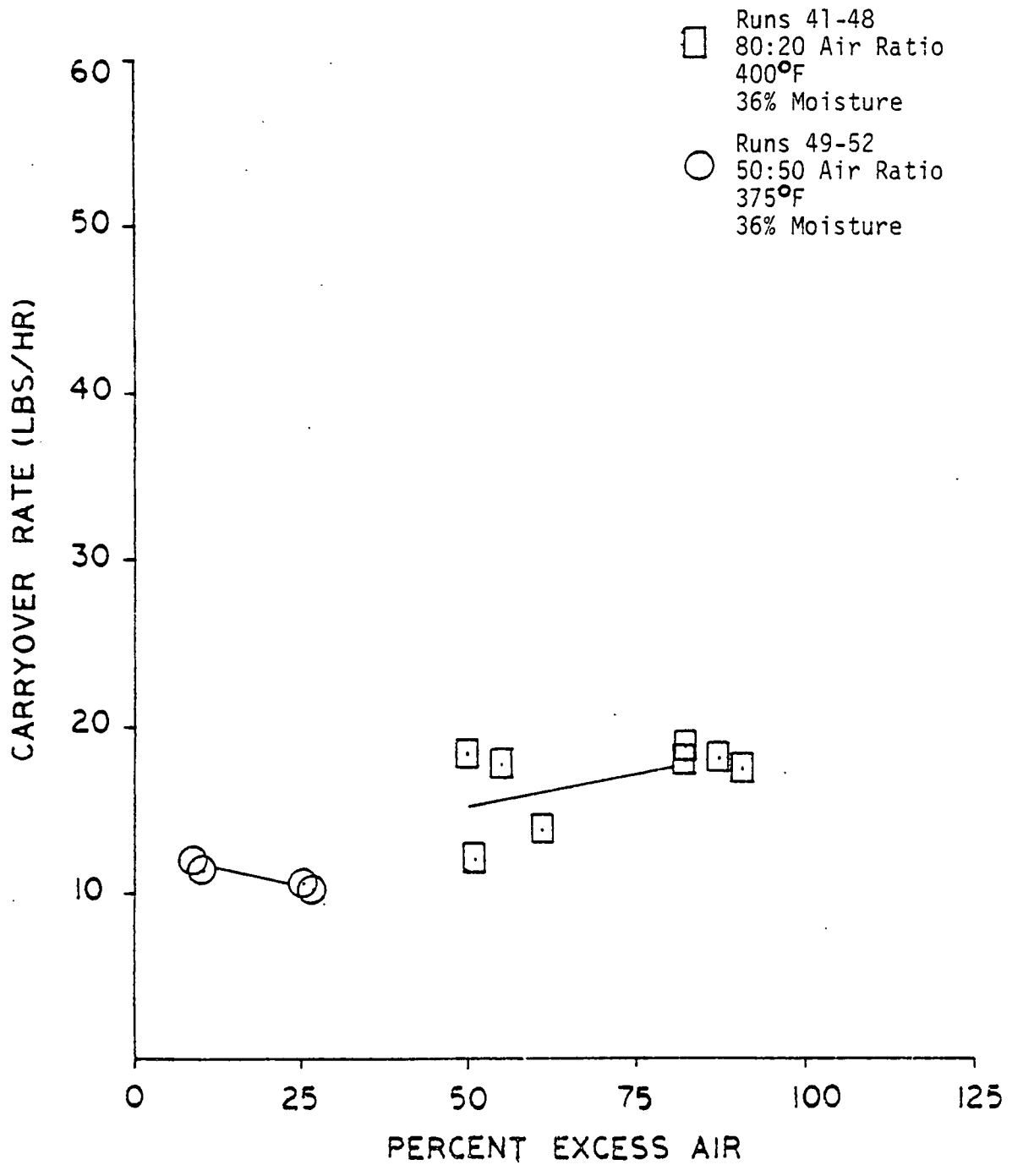
CARRYOVER RATE VS. EXCESS AIR
VARYING UNDERGRATE VS. OVERFIRE AIR RATIO

Doug. Fir Planer Shavings



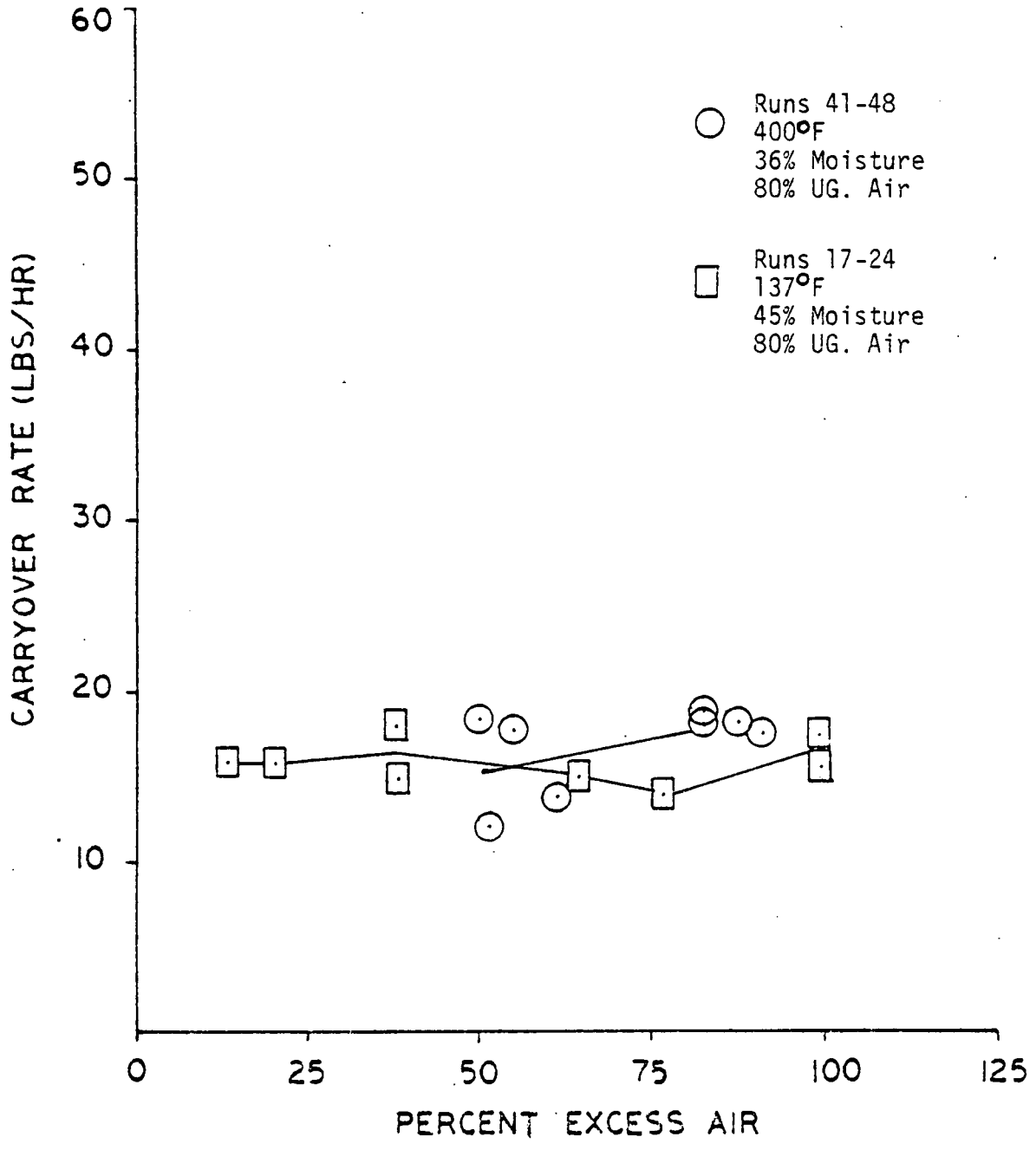
CARRYOVER RATE VS. EXCESS AIR
VARYING UNDERGRATE VS. OVERFIRE AIR RATIO

Doug. Fir Planer Shavings



CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Doug. Fir Planer Shavings



FUEL ANALYSIS DATA AND GRAPHS

DATA FORM - RAW FUEL ANALYSES

FUEL: DOUG. FIR PLANER SHAVINGS

COMBUSTIBLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2		SAMPLE NO. 3	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.84		33.90		33.24	
CRUCIBLE WT	(gm)	27.26		27.38		26.72	
SAMPLE WT	(gm)	4.58		6.52		6.52	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.28		27.43		26.79	
CRUCIBLE WT	(gm)	27.26		27.38		26.72	
ASH WT	(gm)	0.02	% 0.44	0.05	% 0.77	0.07	% 1.07
COMBUSTIBLE CARBON WT	(gm)	4.56	% 99.56	6.47	% 99.23	6.45	% 98.93

AVERAGE % INORGANIC ASH: 0.76   AVERAGE % COMBUSTIBLE CARBON: 99.24

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	18.61	17.12	1.49	96.97		25	0.060
4.760	26.12	17.12	9.00	95.48	98.46	85	0.106
3.327	31.08	17.12	13.96	86.48	89.18	105	0.133
2.000	41.07	17.12	23.95	72.52	74.79	155	0.155
1.000	44.32	17.12	27.20	48.57	50.09	145	0.188
0.500	31.72	17.12	14.60	21.37	22.04	80	0.183
PAN	23.89	17.12	6.77	6.77	6.98	35	0.193

SIZE AND DENSITY ANALYSES

DOUG. FIR PLANER SHAVINGS

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU-LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	18.80	17.12	1.68	104.52		30	0.056
4.760	32.64	17.12	15.52	102.84	98.39	135	0.115
3.327	35.74	17.12	18.62	87.32	83.54	135	0.138
2.000	42.31	17.12	25.19	68.70	65.73	170	0.148
1.000	43.51	17.12	26.39	43.51	41.63	170	0.155
0.500	29.06	17.12	11.94	17.12	16.38	70	0.171
PAN	22.30	17.12	5.18	5.18	4.96	28	0.185

SIZE AND DENSITY ANALYSES

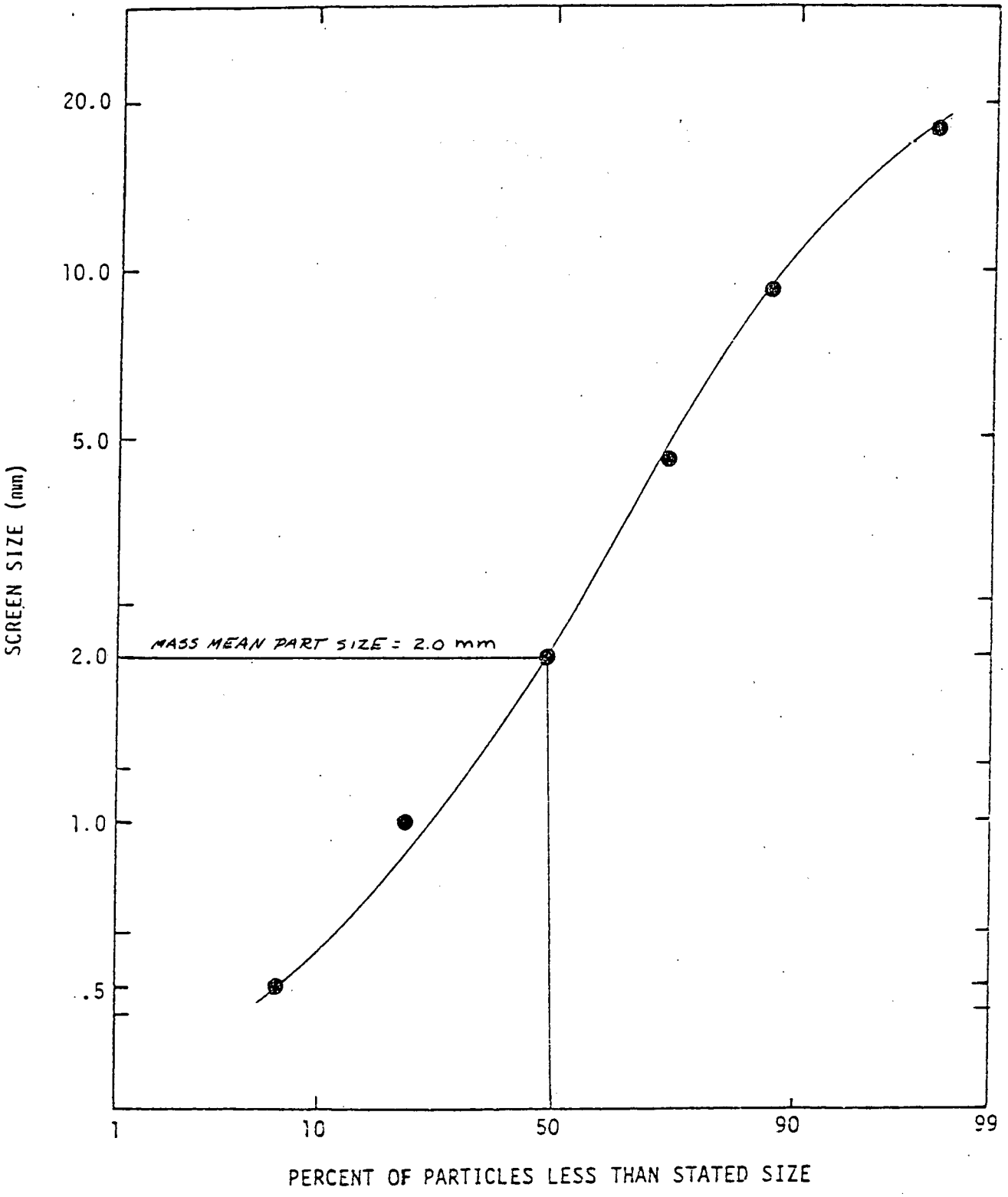
DOUG FIR PLANER SHAVINGS

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU-LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	18.94	17.12	1.82	108.86		35	0.052
4.760	29.29	17.12	12.17	107.04	98.33	110	0.111
3.327	32.90	17.12	15.78	94.87	87.15	90	0.175
2.000	42.40	17.12	25.28	79.09	72.65	185	0.137
1.000	47.89	17.12	30.77	53.81	49.43	200	0.154
0.500	33.29	17.12	16.17	23.04	21.17	90	0.180
PAN	23.99	17.12	6.87	6.87	6.31	38	0.181

PLOT OF PARTICLE SIZE DISTRIBUTION

DOUGLAS FIR PLANER SHAVINGS

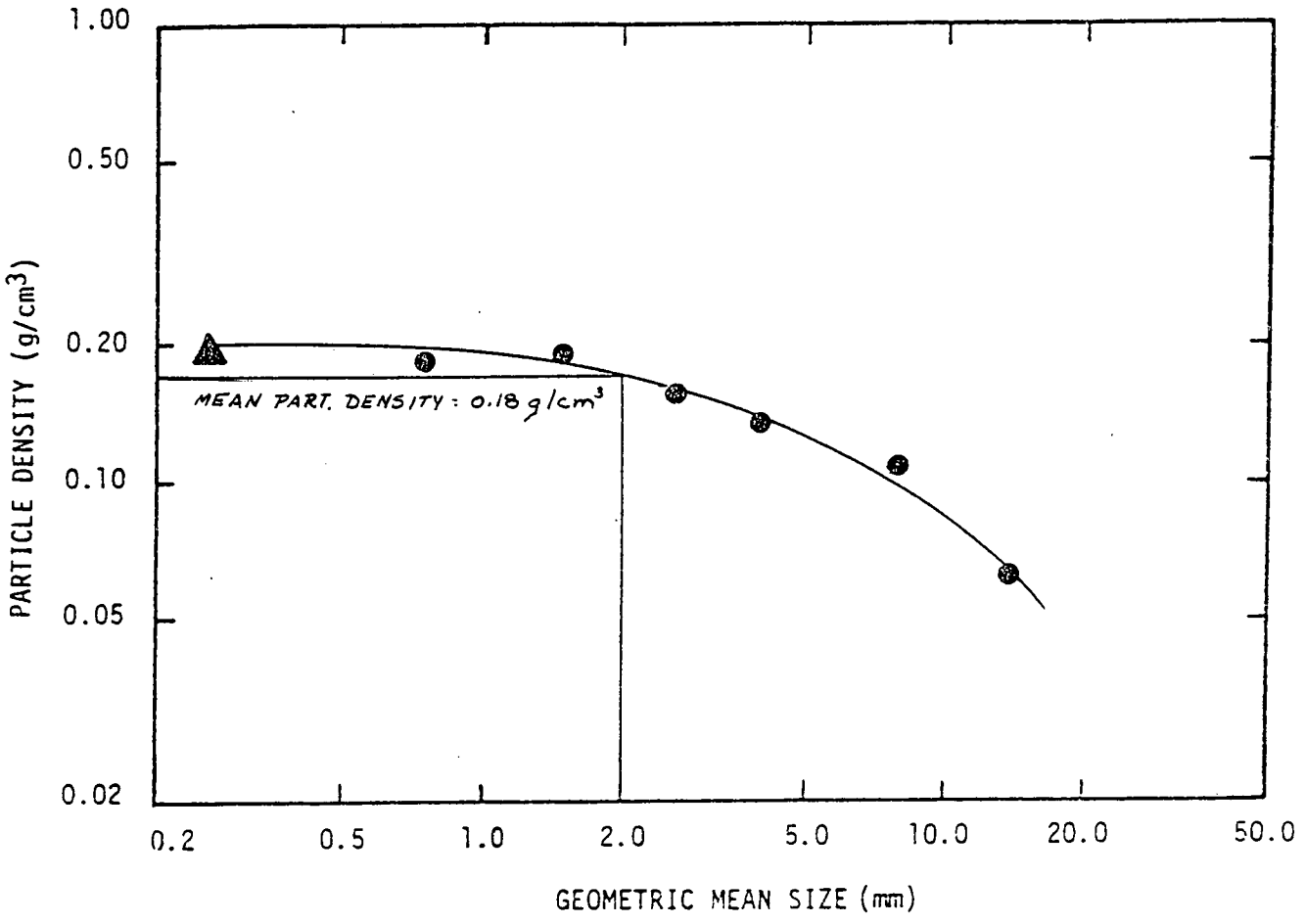
RUN NUMBER: 1



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 1

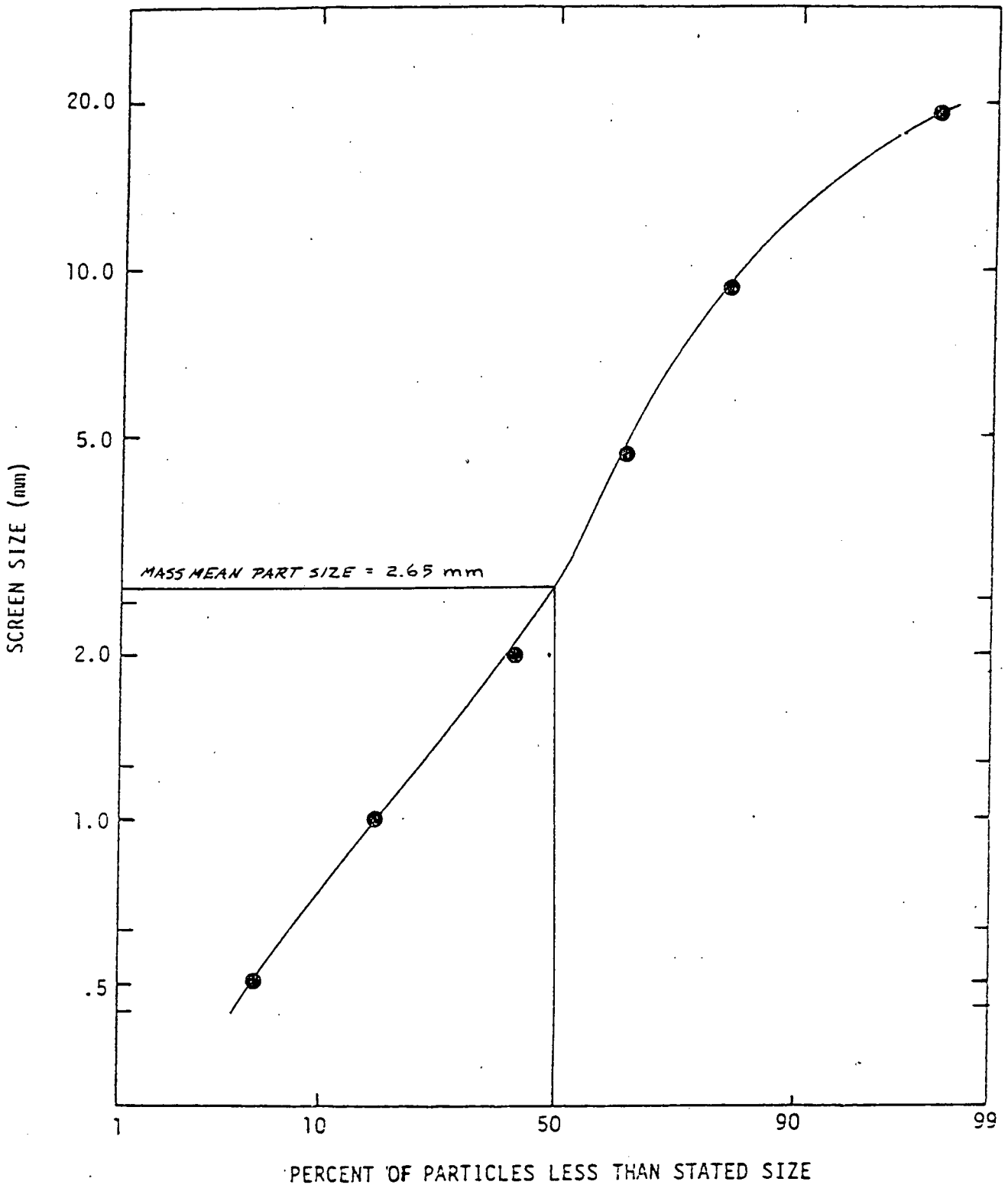


▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

PLOT OF PARTICLE SIZE DISTRIBUTION

DOUGLAS FIR PLANER SHAVINGS

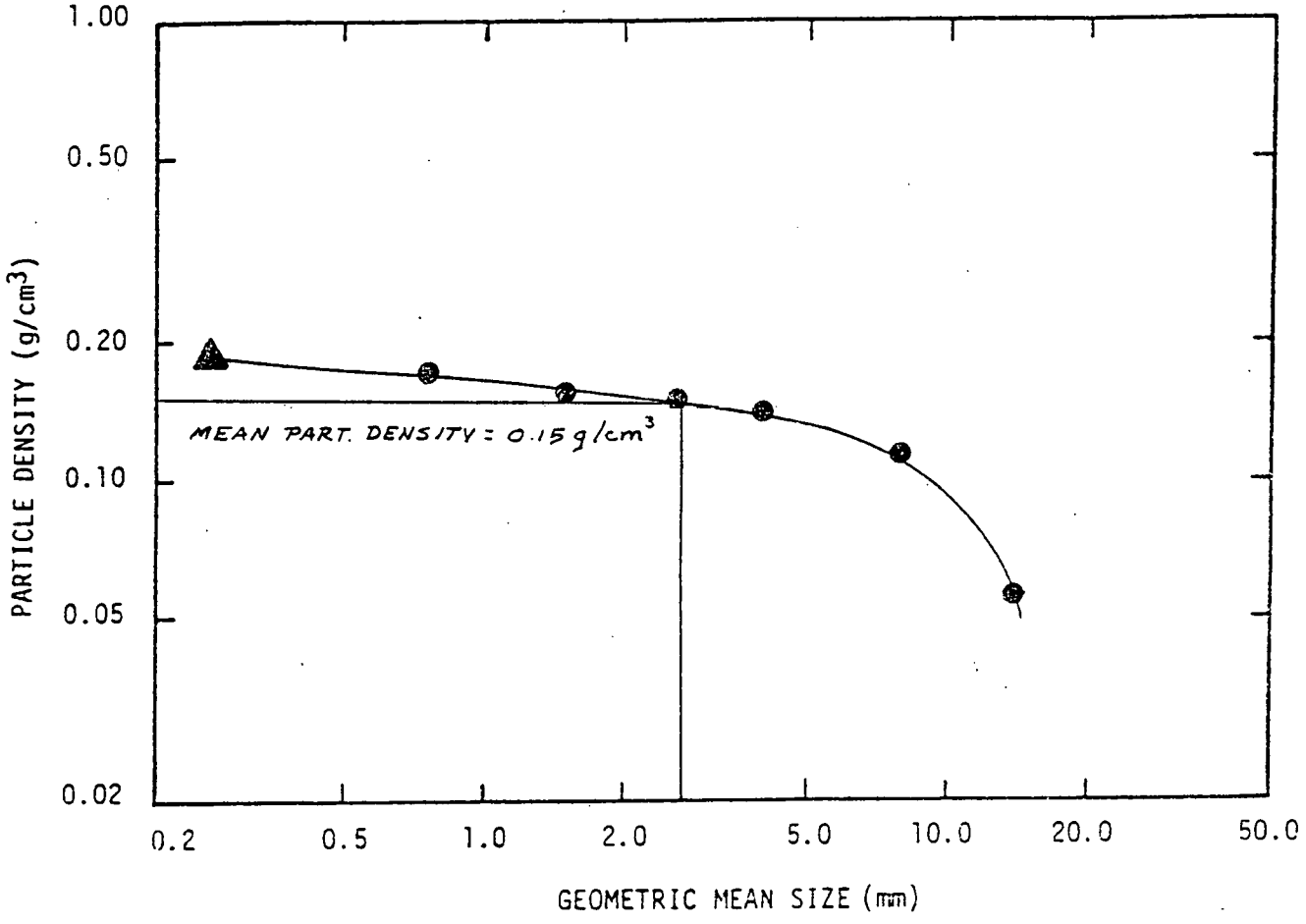
RUN NUMBER: 2



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 2

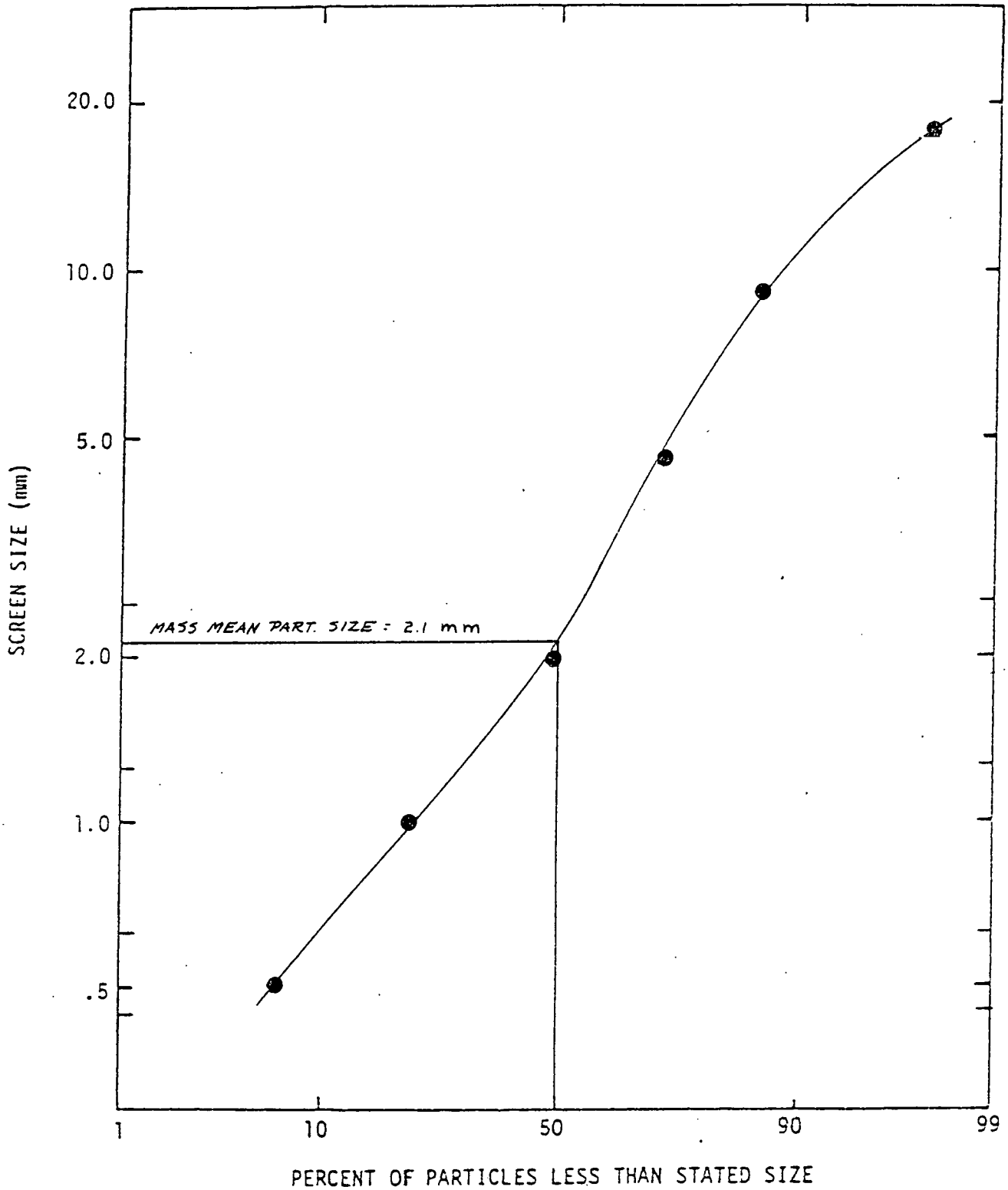


▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

PLOT OF PARTICLE SIZE DISTRIBUTION

DOUGLAS FIR PLANER SHAVINGS

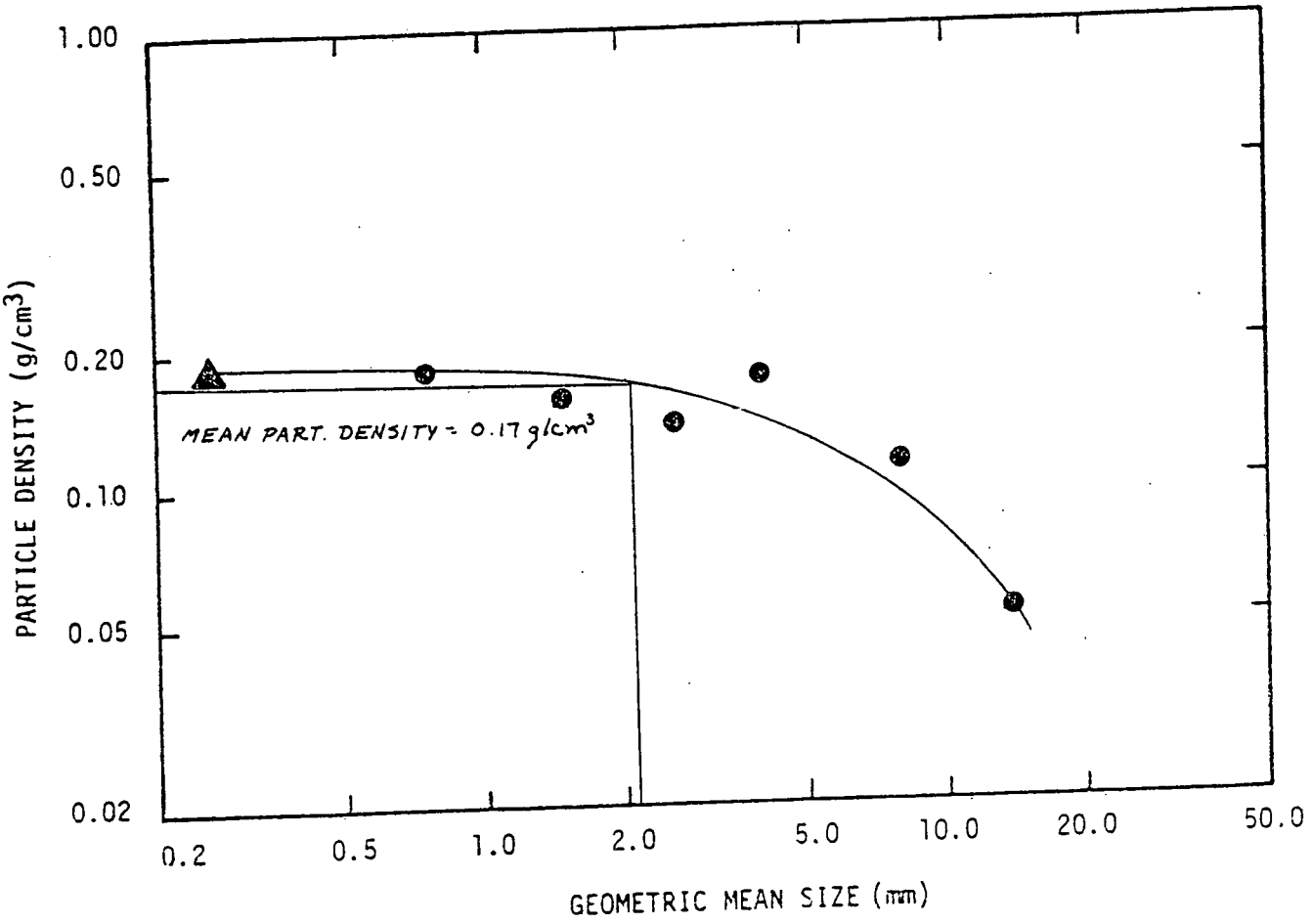
RUN NUMBER: *3*



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 3



▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

ASH ANALYSIS DATA AND GRAPHS

DATA FORM - WOOD ASH ANALYSES RUN NO: 14

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	32.36		27.51	
CRUCIBLE WT	(gm)	30.15		25.53	
SAMPLE WT	(gm)	2.21		1.98	
FINAL SAMPLE + CRUCIBLE WT	(gm)	30.37		25.72	
CRUCIBLE WT	(gm)	30.15		25.53	
ASH WT	(gm)	0.22	% 9.95	0.19	% 9.60
COMBUSTABLE CARBON WT	(gm)	1.99	% 90.05	1.79	% 90.40

AVERAGE % INORGANIC ASH: 9.78 AVERAGE % COMBUSTABLE CARBON: 90.23

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	21.30	17.24	4.06	66.64		63	0.064
1.000	34.59	17.24	17.35	62.58	93.91	242	0.072
.500	40.33	17.24	23.09	45.23	67.87	254	0.091
.250	26.03	17.24	8.79	22.14	33.22	65	0.135
.125	23.44	17.24	6.20	13.35	20.03	31	0.200
.063	20.61	17.24	3.37	7.15	10.73	13	0.259
.045	18.37	17.24	1.13	3.78	5.67	4	0.283
PAN	19.89	17.24	2.65	2.65	3.98	8	0.331

DATA FORM - WOOD ASH ANALYSES RUN NO: 15

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.76		32.09	
CRUCIBLE WT	(gm)	27.63		29.88	
SAMPLE WT	(gm)	2.13		2.21	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.82		30.07	
CRUCIBLE WT	(gm)	27.63		29.88	
ASH WT	(gm)	0.19	% 8.92	0.19	% 8.60
COMBUSTABLE CARBON WT	(gm)	1.94	% 91.08	2.02	% 91.40

AVERAGE % INORGANIC ASH: 9.76 AVERAGE % COMBUSTABLE CARBON: 91.24

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	21.16	17.23	3.93	64.56		58	0.068
1.000	35.09	17.24	17.85	60.63	93.91	237	0.075
.500	40.76	17.24	23.52	42.78	66.26	255	0.092
.250	25.80	17.25	8.55	19.26	29.32	61	0.140
.125	22.59	17.25	5.34	10.71	16.59	24	0.223
.063	19.88	17.25	2.63	5.37	8.32	10	0.263
.045	18.09	17.24	0.85	2.74	4.24	3	0.283
PAN	19.13	17.24	1.89	1.89	2.93	5	0.378

DATA FORM - WOOD ASH ANALYSES RUN NO: 16

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.39		28.72	
CRUCIBLE WT	(gm)	28.46		26.61	
SAMPLE WT	(gm)	1.93		2.11	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.61		26.77	
CRUCIBLE WT	(gm)	28.46		26.61	
ASH WT	(gm)	0.15	% 7.77	0.16	% 7.58
COMBUSTABLE CARBON WT	(gm)	1.78	% 92.23	1.95	% 92.42

AVERAGE % INORGANIC ASH: 7.68 AVERAGE % COMBUSTABLE CARBON: 92.33

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	21.88	17.19	3.89	62.87		73	0.053
1.000	33.82	17.19	16.63	58.98	93.81	230	0.072
.500	40.81	17.19	23.62	42.35	67.36	250	0.094
.250	26.32	17.19	9.13	18.73	29.79	65	0.140
.125	22.39	17.19	5.20	9.60	15.27	24	0.217
.063	19.56	17.19	2.37	4.40	7.00	9	0.263
.045	17.93	17.19	0.74	2.03	3.23	2	0.370
PAN	18.48	17.19	1.29	1.29	2.05	4	0.323

DATA FORM - WOOD ASH ANALYSES RUN NO: 17

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.20		30.64	
CRUCIBLE WT	(gm)	28.99		28.53	
SAMPLE WT	(gm)	2.21		2.11	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.13		28.67	
CRUCIBLE WT	(gm)	28.99		28.53	
ASH WT	(gm)	0.14	% 6.33	0.14	% 6.64
COMBUSTABLE CARBON WT	(gm)	2.07	% 93.67	1.97	% 93.36

AVERAGE % INORGANIC ASH: 64.9 AVERAGE % COMBUSTABLE CARBON: 93.52

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	23.48	17.24	6.24	65.70		95	0.066
1.000	35.42	17.24	18.18	59.46	90.50	260	0.070
.500	40.54	17.24	23.30	41.28	62.83	262	0.089
.250	26.62	17.24	9.38	17.98	27.37	68	0.138
.125	22.31	17.24	5.07	8.60	13.09	25	0.203
.063	19.22	17.24	1.98	3.53	5.37	8	0.248
.045	17.77	17.24	0.53	1.55	2.36	2	0.265
PAN	18.26	17.24	1.02	1.02	1.55	3	0.340

DATA FORM - WOOD ASH ANALYSES RUN NO: 19

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.55		30.24	
CRUCIBLE WT	(gm)	28.49		28.23	
SAMPLE WT	(gm)	2.06		2.01	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.64		28.37	
CRUCIBLE WT	(gm)	28.49		28.23	
ASH WT	(gm)	0.15	% 7.28	0.14	% 6.97
COMBUSTABLE CARBON WT	(gm)	1.91	% 92.72	1.87	% 93.03

AVERAGE % INORGANIC ASH: 7.13 AVERAGE % COMBUSTABLE CARBON: 92.88

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	23.94	17.24	6.7	62.83		98	0.068
1.000	34.36	17.24	17.12	56.13	89.34	238	0.072
.500	38.74	17.24	21.50	39.01	62.09	225	0.096
.250	25.98	17.24	8.74	17.51	27.87	60	0.146
.125	22.10	17.24	4.86	8.77	13.96	22	0.221
.063	19.38	17.24	2.14	3.91	6.22	9	0.238
.045	17.86	17.24	0.62	1.77	2.82	2	0.310
PAN	18.39	17.24	1.15	1.15	1.83	4	0.288

DATA FORM - WOOD ASH ANALYSES RUN NO: 21

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.00		31.02	
CRUCIBLE WT	(gm)	25.52		28.64	
SAMPLE WT	(gm)	2.48		2.38	
FINAL SAMPLE + CRUCIBLE WT	(gm)	25.71		28.83	
CRUCIBLE WT	(gm)	25.52		28.64	
ASH WT	(gm)	0.19	% 7.66	0.19	% 7.98
COMBUSTABLE CARBON WT	(gm)	2.29	% 92.34	2.19	% 92.02

AVERAGE % INORGANIC ASH: 7.82 AVERAGE % COMBUSTABLE CARBON: 92.18

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.36	17.24	0.12	73.16		2	0.060
2.000	24.42	17.24	7.18	73.04	99.84	95	0.076
1.000	35.44	17.24	18.20	65.86	90.02	225	0.081
.500	41.65	17.24	24.41	47.66	65.14	253	0.096
.250	27.46	17.24	10.22	23.25	31.78	72	0.142
.125	23.88	17.24	6.64	13.03	17.81	31	0.214
.063	20.49	17.24	3.25	6.39	8.73	13	0.250
.045	18.18	17.24	0.94	3.14	4.29	3	0.313
PAN	19.44	17.24	2.20	2.20	3.01	7	0.314

DATA FORM - WOOD ASH ANALYSES RUN NO: 26

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.77		27.74	
CRUCIBLE WT	(gm)	26.80		25.85	
SAMPLE WT	(gm)	1.97		1.89	
FINAL SAMPLE + CRUCIBLE WT	(gm)	26.94		25.99	
CRUCIBLE WT	(gm)	26.80		25.85	
ASH WT	(gm)	0.14	% 7.11	0.14	% 7.41
COMBUSTABLE CARBON WT	(gm)	1.83	% 92.89	1.75	% 92.59

AVERAGE % INORGANIC ASH: 7.26 AVERAGE % COMBUSTABLE CARBON: 92.74

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	21.31	17.24	4.07	58.62		72	0.057
1.000	30.92	17.24	13.68	54.55	93.06	211	0.065
.500	39.42	17.24	22.18	40.87	69.72	254	0.087
.250	2692	17.24	9.68	18.69	31.88	71	0.136
.125	22.50	17.24	5.26	9.01	15.37	26	0.202
.063	19.29	17.24	2.05	3.75	6.40	9	0.228
.045	17.85	17.24	0.61	1.70	2.90	2	0.305
PAN	18.33	17.24	1.09	1.09	1.86	4	0.273

DATA FORM - WOOD ASH ANALYSES RUN NO: 27

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	27.28		29.37	
CRUCIBLE WT	(gm)	25.28		27.44	
SAMPLE WT	(gm)	2.00		1.93	
FINAL SAMPLE + CRUCIBLE WT	(gm)	25.52		27.66	
CRUCIBLE WT	(gm)	25.28		27.44	
ASH WT	(gm)	0.24	%12.00	0.22	%11.40
COMBUSTABLE CARBON WT	(gm)	1.76	%88.00	1.71	%88.60

AVERAGE % INORGANIC ASH: 11.70 AVERAGE % COMBUSTABLE CARBON: 88.30

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	20.36	17.24	3.12	58.17		58	0.054
1.000	30.39	17.24	13.15	55.05	94.64	209	0.063
.500	37.12	17.24	19.88	41.90	72.03	240	0.083
.250	26.69	17.24	9.45	22.02	37.85	70	0.135
.125	23.65	17.24	6.41	12.57	21.61	32	0.200
.063	20.40	17.24	3.16	6.16	10.59	13	0.243
.045	18.16	17.24	0.92	3.00	5.16	3	0.307
PAN	19.32	17.24	2.08	2.08	3.58	6	0.347

DATA FORM - WOOD ASH ANALYSES RUN NO: 30

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.91		30.59	
CRUCIBLE WT	(gm)	28.82		28.36	
SAMPLE WT	(gm)	2.09		2.23	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.00		28.57	
CRUCIBLE WT	(gm)	28.82		28.36	
ASH WT	(gm)	0.18	% 8.61	0.21	% 9.42
COMBUSTABLE CARBON WT	(gm)	1.91	% 91.39	2.02	% 90.58

AVERAGE % INORGANIC ASH: 9.02 AVERAGE % COMBUSTABLE CARBON: 90.99

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	20.36	17.24	3.12	62.86		58	0.054
1.000	31.69	17.24	14.45	59.74	95.04	230	0.063
.500	41.10	17.24	23.86	45.29	72.49	275	0.087
.250	27.11	17.24	9.87	21.43	34.09	72	0.137
.125	23.16	17.24	5.92	11.56	18.39	30	0.197
.063	20.11	17.24	2.87	5.64	8.97	12	0.239
.045	18.14	17.24	0.90	2.77	4.41	4	0.225
PAN	19.11	17.24	1.87	1.87	2.97	6	0.312

DATA FORM - WOOD ASH ANALYSES RUN NO: 32

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.61		29.12	
CRUCIBLE WT	(gm)	27.91		26.51	
SAMPLE WT	(gm)	2.70		2.61	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.36		26.97	
CRUCIBLE WT	(gm)	27.91		26.51	
ASH WT	(gm)	0.45	%16.67	0.45	%17.24
COMBUSTABLE CARBON WT	(gm)	2.25	%83.33	2.16	%82.76

AVERAGE % INORGANIC ASH: 16.96 AVERAGE % COMBUSTABLE CARBON: 83.05

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	19.56	17.24	2.32	80.61		37	0.063
1.000	32.59	17.24	15.35	78.29	97.12	217	0.071
.500	43.95	17.24	26.71	62.94	78.08	292	0.091
.250	30.31	17.24	13.07	36.23	44.94	91	0.144
.125	27.82	17.24	10.58	23.16	28.73	48	0.220
.063	23.12	17.24	5.88	12.58	15.61	21	0.280
.045	19.08	17.24	1.84	6.70	8.31	6	0.307
PAN	22.10	17.24	4.86	4.86	6.03	12	0.405

DATA FORM - WOOD ASH ANALYSES RUN NO: 39

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.28		28.07	
CRUCIBLE WT	(gm)	28.63		25.60	
SAMPLE WT	(gm)	2.65		2.47	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.94		25.86	
CRUCIBLE WT	(gm)	28.63		25.60	
ASH WT	(gm)	0.31	% 11.70	0.26	% 10.53
COMBUSTABLE CARBON WT	(gm)	2.34	% 88.30	2.21	% 89.47

AVERAGE % INORGANIC ASH: 11.12 AVERAGE % COMBUSTABLE CARBON: 88.89

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	21.21	17.24	3.97	78.12		57	0.070
1.000	33.83	17.24	16.59	74.15	94.92	215	0.077
.500	44.68	17.24	27.44	57.56	73.68	273	0.101
.250	28.84	17.24	11.60	30.12	38.56	78	0.149
.125	26.48	17.24	9.24	18.52	23.71	41	0.225
.063	22.10	17.24	4.86	9.28	11.88	18	0.270
.045	18.72	17.24	1.48	4.42	5.66	5	0.296
PAN	20.18	17.24	2.94	2.94	3.76	9	0.327

DATA FORM - WOOD ASH ANALYSES RUN NO: 42

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.83		29.19	
CRUCIBLE WT	(gm)	29.60		26.92	
SAMPLE WT	(gm)	2.23		2.27	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.77		27.07	
CRUCIBLE WT	(gm)	29.60		26.92	
ASH WT	(gm)	0.17	% 7.62	0.15	% 6.61
COMBUSTABLE CARBON WT	(gm)	2.06	% 92.38	2.12	% 93.39

AVERAGE % INORGANIC ASH: 7.12 AVERAGE % COMBUSTABLE CARBON: 92.89

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	22.76	17.24	5.52	62.99		80	0.069
1.000	33.16	17.24	15.92	57.47	91.24	224	0.071
.500	40.97	17.24	23.73	41.55	65.96	244	0.097
.250	27.41	17.24	10.17	17.82	28.29	66	0.154
.125	22.07	17.24	4.83	7.65	12.14	21	0.230
.063	18.93	17.24	1.69	2.82	4.48	6	0.282
.045	17.70	17.24	0.46	1.13	1.79	1.6	0.288
PAN	17.91	17.24	0.67	0.67	1.06	2	0.335

DATA FORM - WOOD ASH ANALYSES RUN NO: 43

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	27.04		29.74	
CRUCIBLE WT	(gm)	25.58		28.22	
SAMPLE WT	(gm)	1.46		1.52	
FINAL SAMPLE + CRUCIBLE WT	(gm)	25.68		28.34	
CRUCIBLE WT	(gm)	25.58		28.22	
ASH WT	(gm)	0.10	% 6.85	0.12	% 7.89
COMBUSTABLE CARBON WT	(gm)	1.36	% 93.15	1.40	% 92.11

AVERAGE % INORGANIC ASH: 7.37 AVERAGE % COMBUSTABLE CARBON: 92.63

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SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000							
1.000	33.88	17.28	16.60	46.14		221	0.075
.500	34.20	17.28	16.92	29.54	64.02	176	0.096
.250	24.19	17.28	6.91	12.62	27.35	46	0.150
.125	20.58	17.28	3.56	5.71	12.38	16.8	0.212
.063	18.68	17.28	1.40	2.15	4.66	5.4	0.259
.045	17.62	17.28	0.34	0.75	1.63	1.2	0.283
PAN	17.69	17.28	0.41	0.41	0.89	1.1	0.373

DATA FORM - WOOD ASH ANALYSES RUN NO: 45

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.79		28.98	
CRUCIBLE WT	(gm)	27.28		27.43	
SAMPLE WT	(gm)	1.51		1.55	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.44		27.55	
CRUCIBLE WT	(gm)	27.28		27.43	
ASH WT	(gm)	0.16	%10.60	0.12	% 7.74
COMBUSTABLE CARBON WT	(gm)	1.35	%89.40	1.43	%92.26

AVERAGE % INORGANIC ASH: 9.17 AVERAGE % COMBUSTABLE CARBON: 90.83

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	22.11	17.33	4.78	47.53		61	0.078
1.000	30.12	17.33	12.79	42.75	89.94	152	0.084
.500	34.06	17.33	16.73	29.96	63.03	162	0.103
.250	24.15	17.33	6.82	13.23	27.84	44	0.155
.125	21.16	17.33	3.83	6.41	13.49	16	0.239
.063	18.97	17.33	1.64	2.58	5.43	6	0.273
.045	17.74	17.33	0.41	0.94	1.98	1.5	0.273
PAN	17.86	17.33	0.53	0.53	1.12	1.5	0.353

DATA FORM - WOOD ASH ANALYSES RUN NO: 47

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.56		30.26	
CRUCIBLE WT	(gm)	29.02		28.62	
SAMPLE WT	(gm)	1.54		1.64	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.19		28.80	
CRUCIBLE WT	(gm)	29.02		28.62	
ASH WT	(gm)	0.17	%11.04	0.18	%10.98
COMBUSTABLE CARBON WT	(gm)	1.37	%88.96	1.46	%89.02

AVERAGE % INORGANIC ASH: 11.01 AVERAGE % COMBUSTABLE CARBON: 88.99

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.66	17.33	0.33	49.56		6	0.055
2.000	22.71	17.33	5.38	49.23	99.33	71	0.076
1.000	29.02	17.33	11.69	43.85	88.48	150	0.078
.500	32.28	17.33	14.95	32.16	64.89	163	0.092
.250	24.02	17.33	6.69	17.21	34.73	47	0.143
.125	22.58	17.33	5.25	10.52	21.23	24	0.219
.063	20.24	17.33	2.91	5.27	10.63	11	0.264
.045	18.18	17.33	0.85	2.36	4.76	3	0.283
PAN	18.84	17.33	1.51	1.51	3.05	5	0.302

DATA FORM - WOOD ASH ANALYSES RUN NO: 49

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	33.25		29.87	
CRUCIBLE WT	(gm)	31.58		28.22	
SAMPLE WT	(gm)	1.67		1.65	
FINAL SAMPLE + CRUCIBLE WT	(gm)	31.68		28.32	
CRUCIBLE WT	(gm)	31.58		28.22	
ASH WT	(gm)	0.10	% 5.99	0.10	% 6.06
COMBUSTABLE CARBON WT	(gm)	1.57	% 94.01	1.55	% 93.94

AVERAGE % INORGANIC ASH: 6.03 AVERAGE % COMBUSTABLE CARBON: 93.98

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000							
1.000	35.07	17.28	17.79	48.81		254	0.070
.500	36.14	17.28	18.86	31.02	63.55	209	0.089
.250	24.45	17.28	7.17	12.16	24.91	48	0.149
.125	20.80	17.28	3.52	4.99	10.22	18	0.196
.063	18.35	17.28	1.07	1.47	3.01	5	0.214
.045	17.49	17.28	0.21	0.40	0.82	1	0.214
PAN	17.47	17.28	0.19	0.19	0.39	0.5	0.380

DATA FORM - WOOD ASH ANALYSES RUN NO: 52

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.79		30.65	
CRUCIBLE WT	(gm)	28.98		29.66	
SAMPLE WT	(gm)	0.81		0.79	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.02		29.90	
CRUCIBLE WT	(gm)	28.98		29.66	
ASH WT	(gm)	0.04	% 4.94	0.04	% 5.06
COMBUSTABLE CARBON WT	(gm)	0.77	% 95.06	0.75	% 94.94

AVERAGE % INORGANIC ASH: 5.0 AVERAGE % COMBUSTABLE CARBON: 95.0

* *

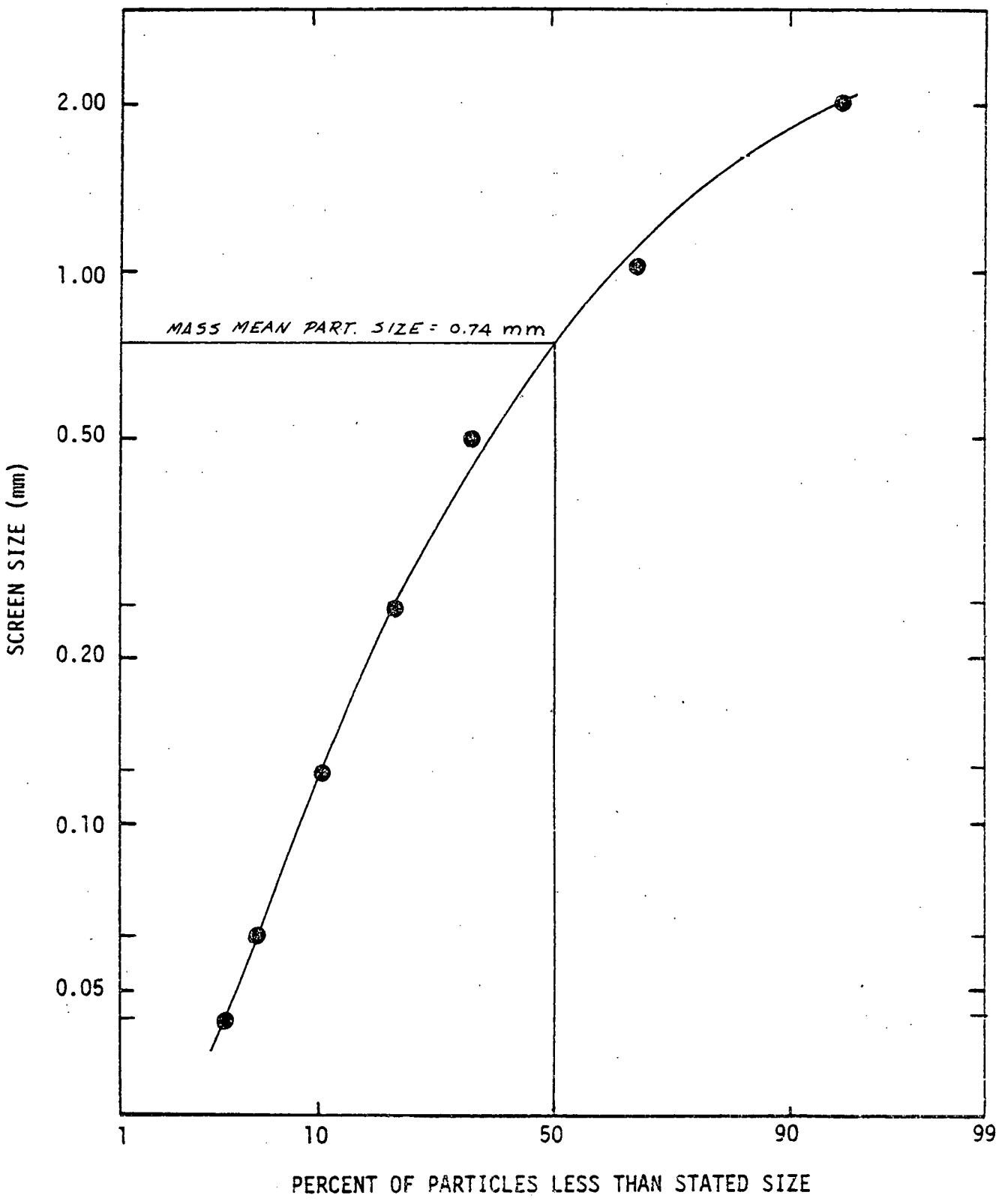
SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000							
1.000	33.44	17.28	16.16	48.53		257	0.063
.500	35.88	17.28	18.60	32.37	66.70	212	0.088
.250	24.98	17.28	7.70	13.77	28.37	56	0.138
.125	21.45	17.28	4.17	6.07	12.51	22	0.190
.063	18.60	17.28	1.32	1.90	3.92	5	0.264
.045	17.55	17.28	0.27	0.58	1.20	1.1	0.245
PAN	17.59	17.28	0.31	0.31	0.64	1.0	0.310

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

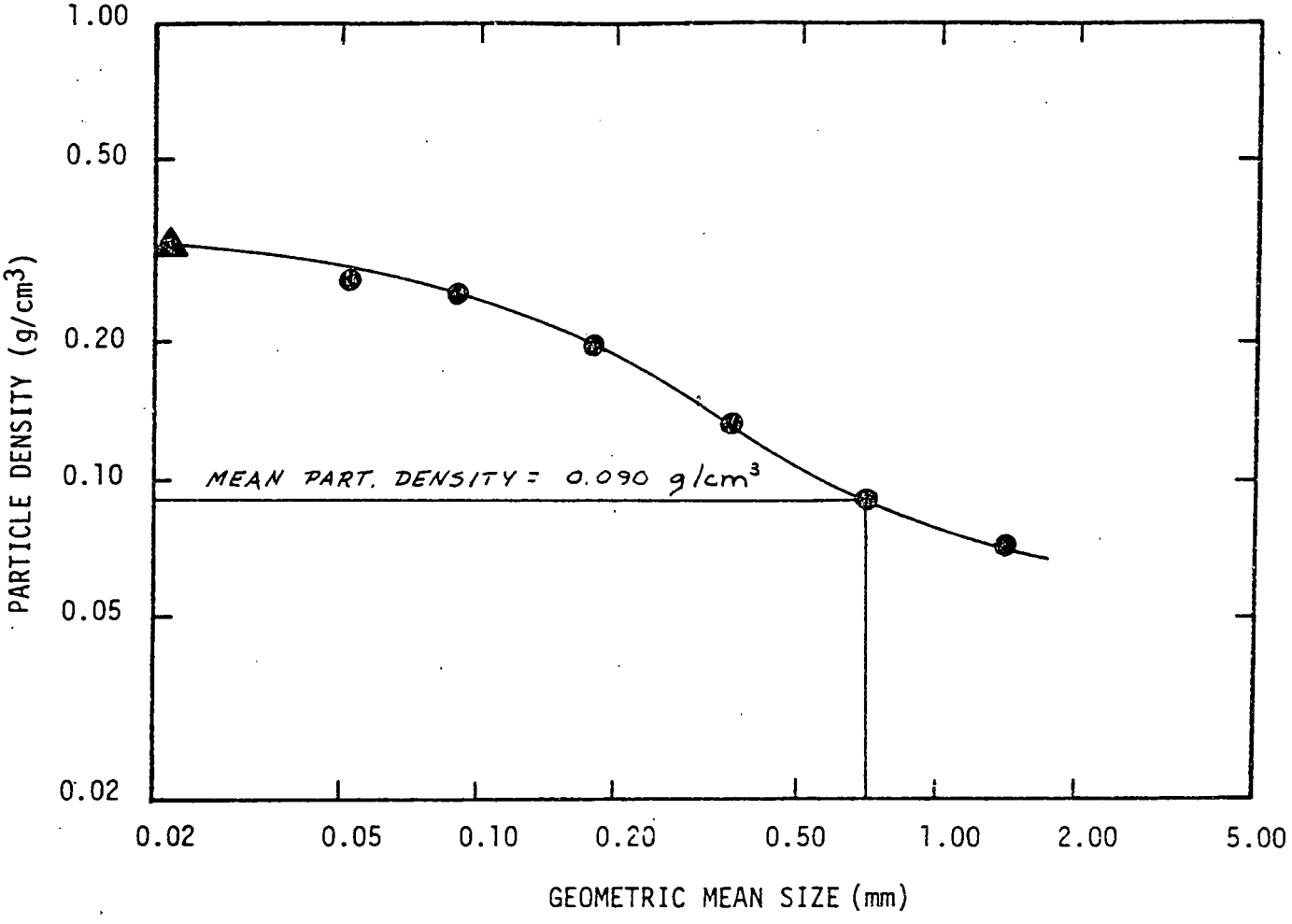
RUN NUMBER: *14*



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 14

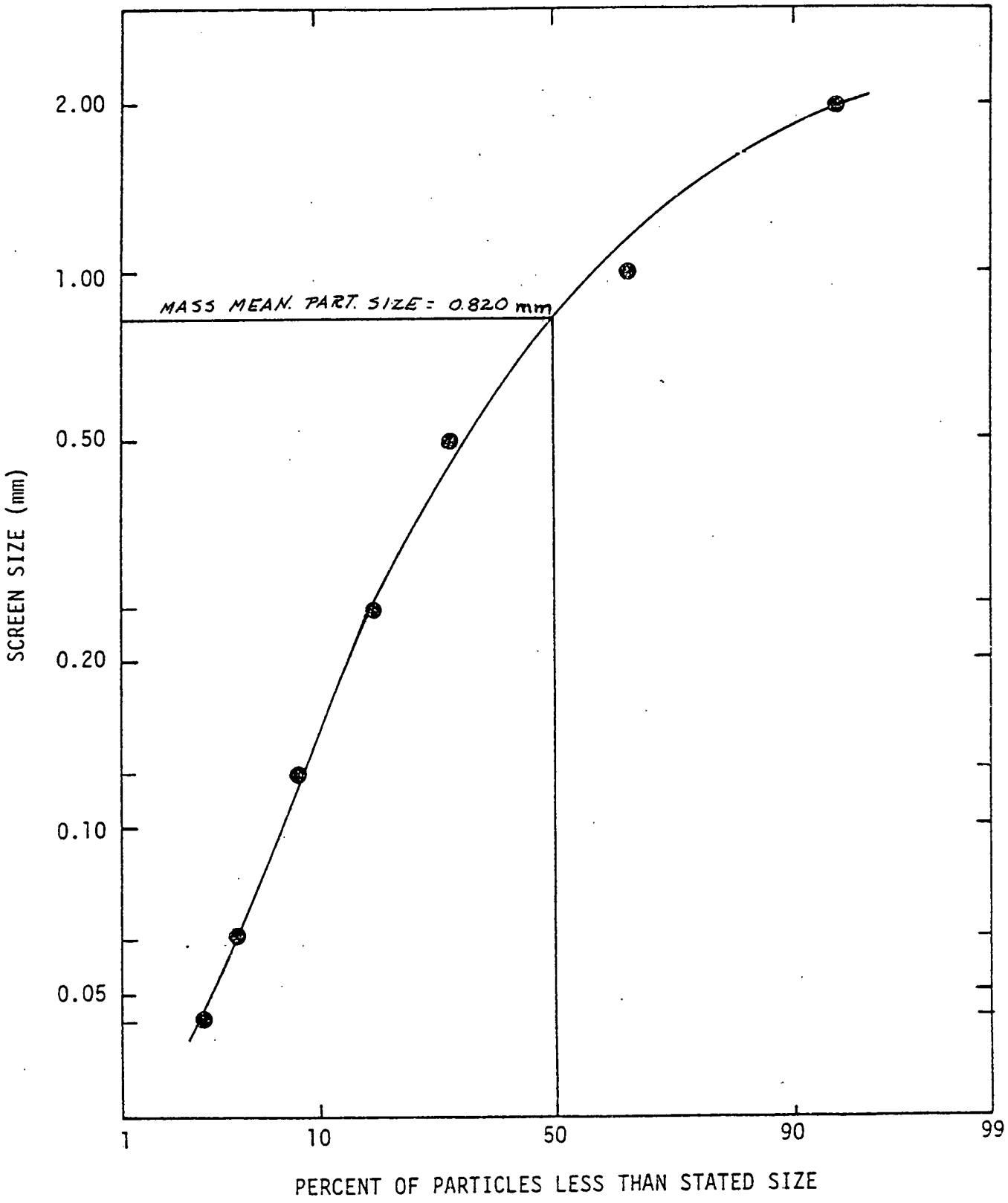


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

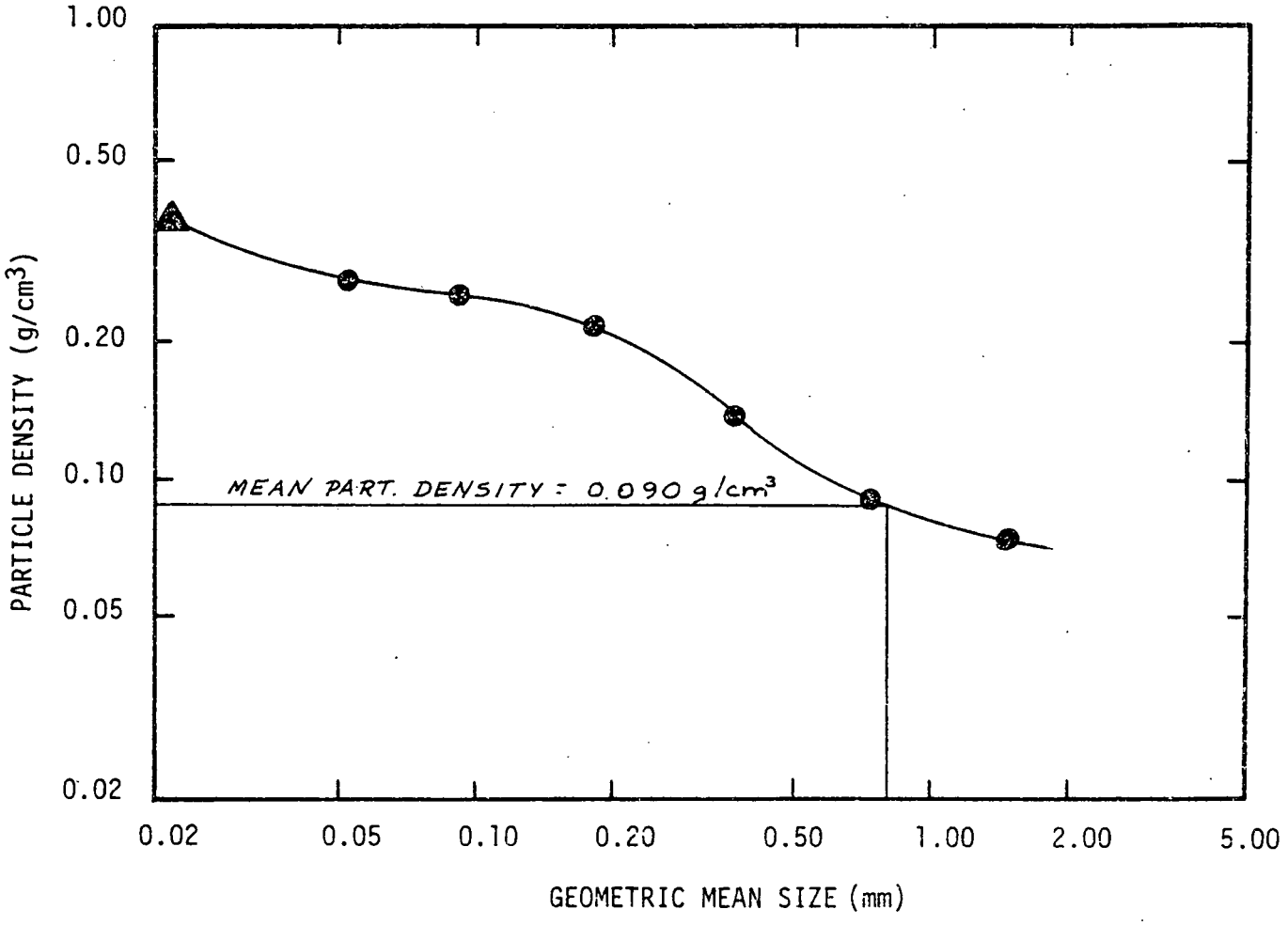
RUN NUMBER: 15



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 15

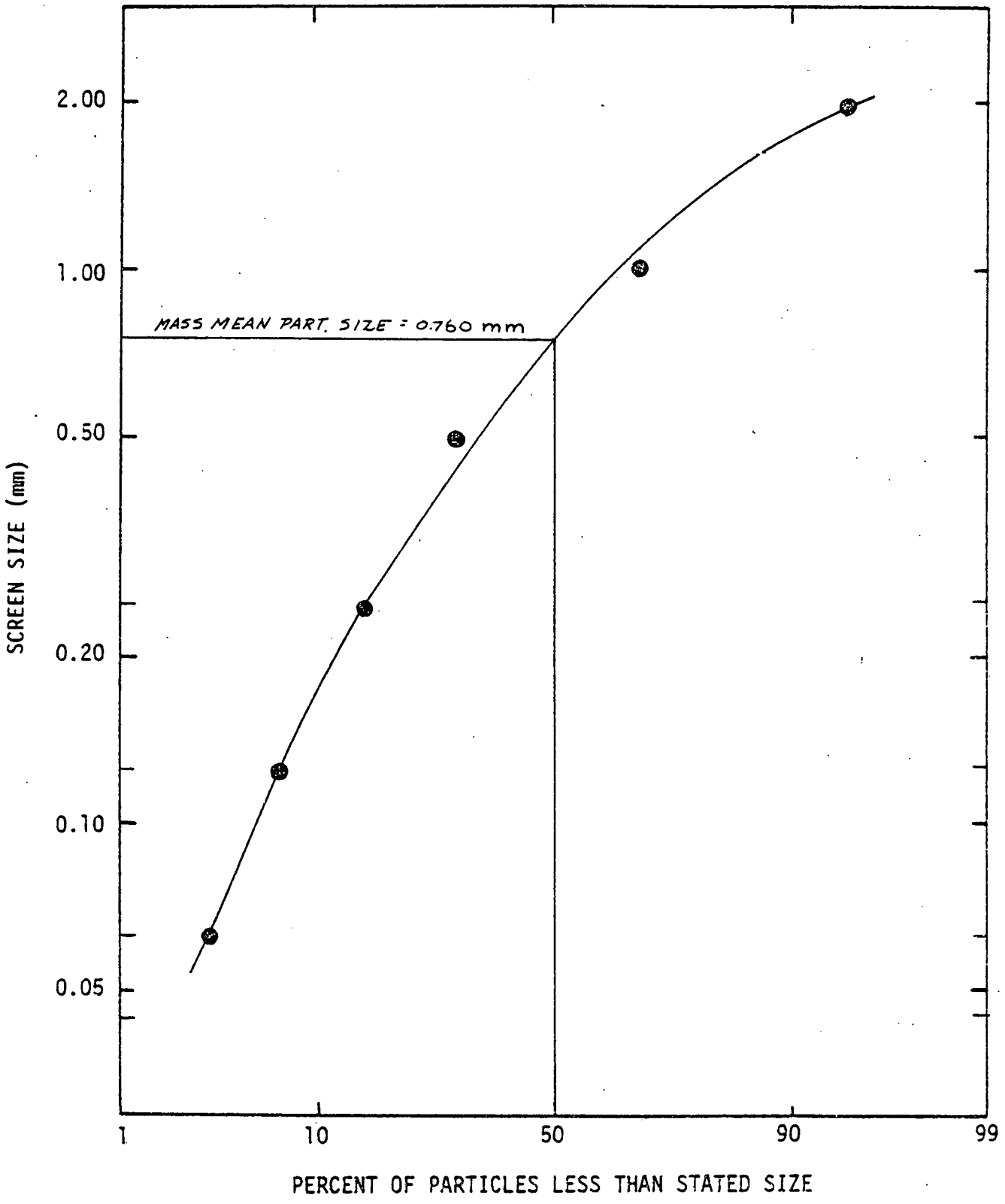


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

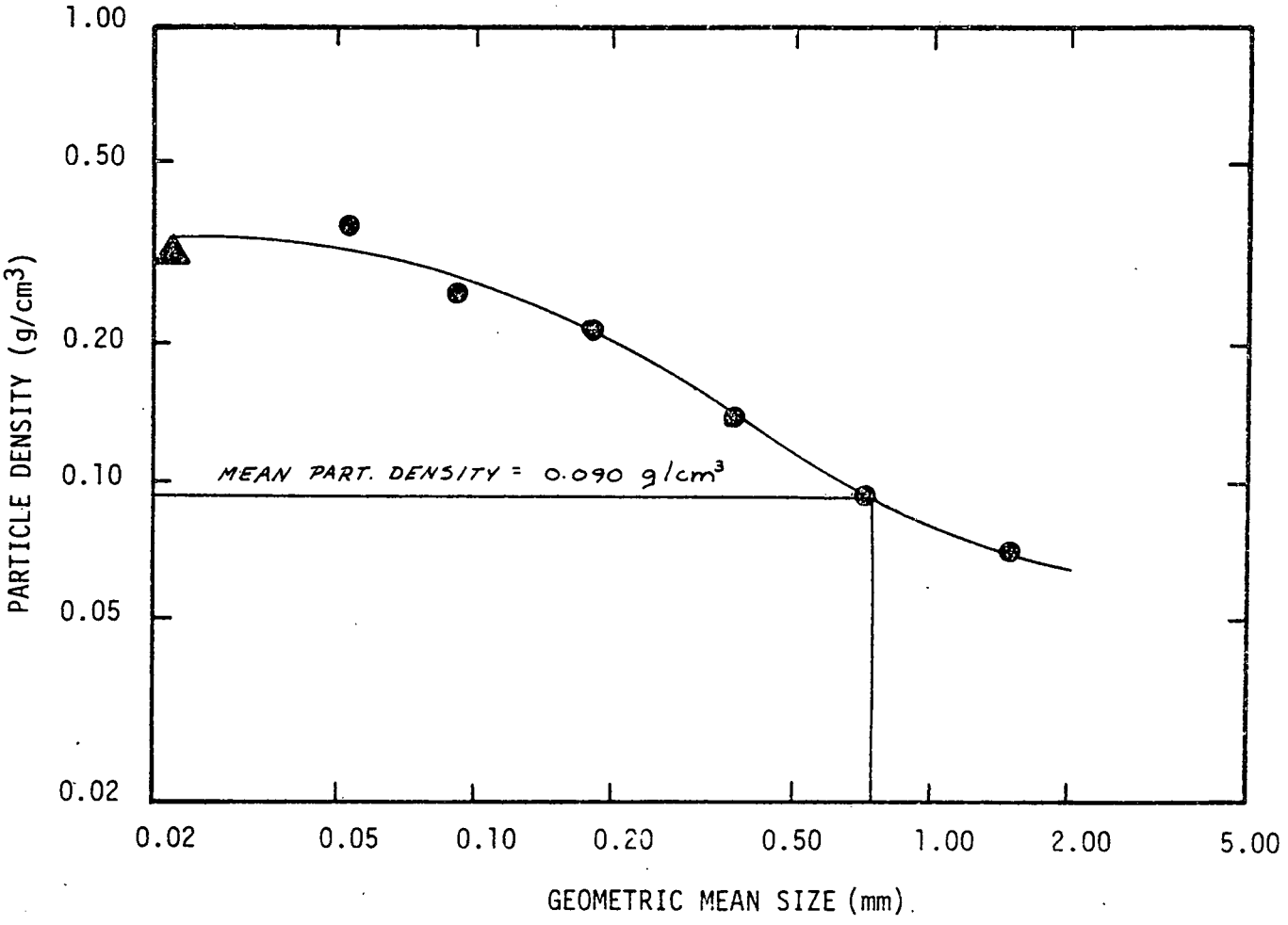
RUN NUMBER: 16



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 16

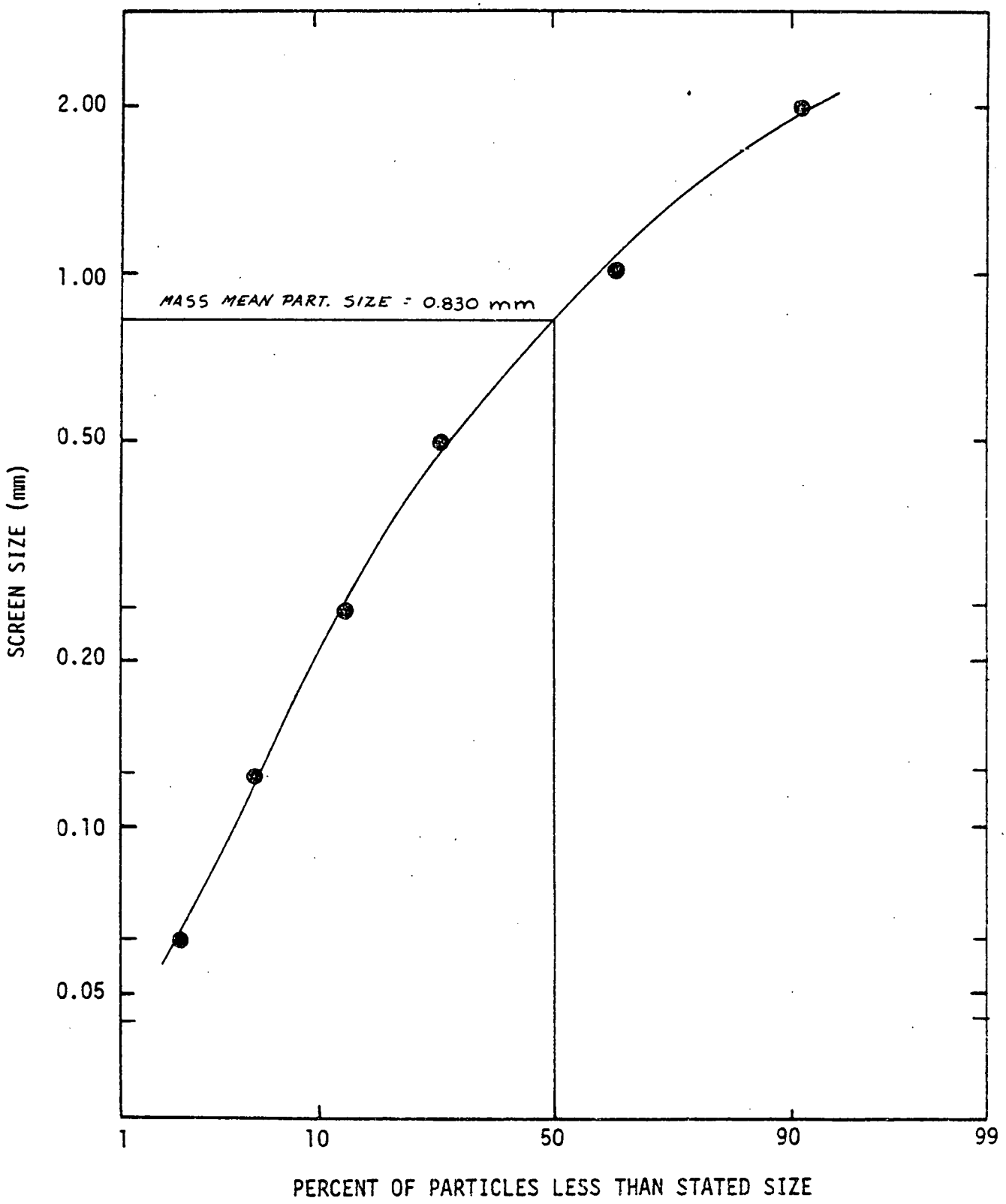


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

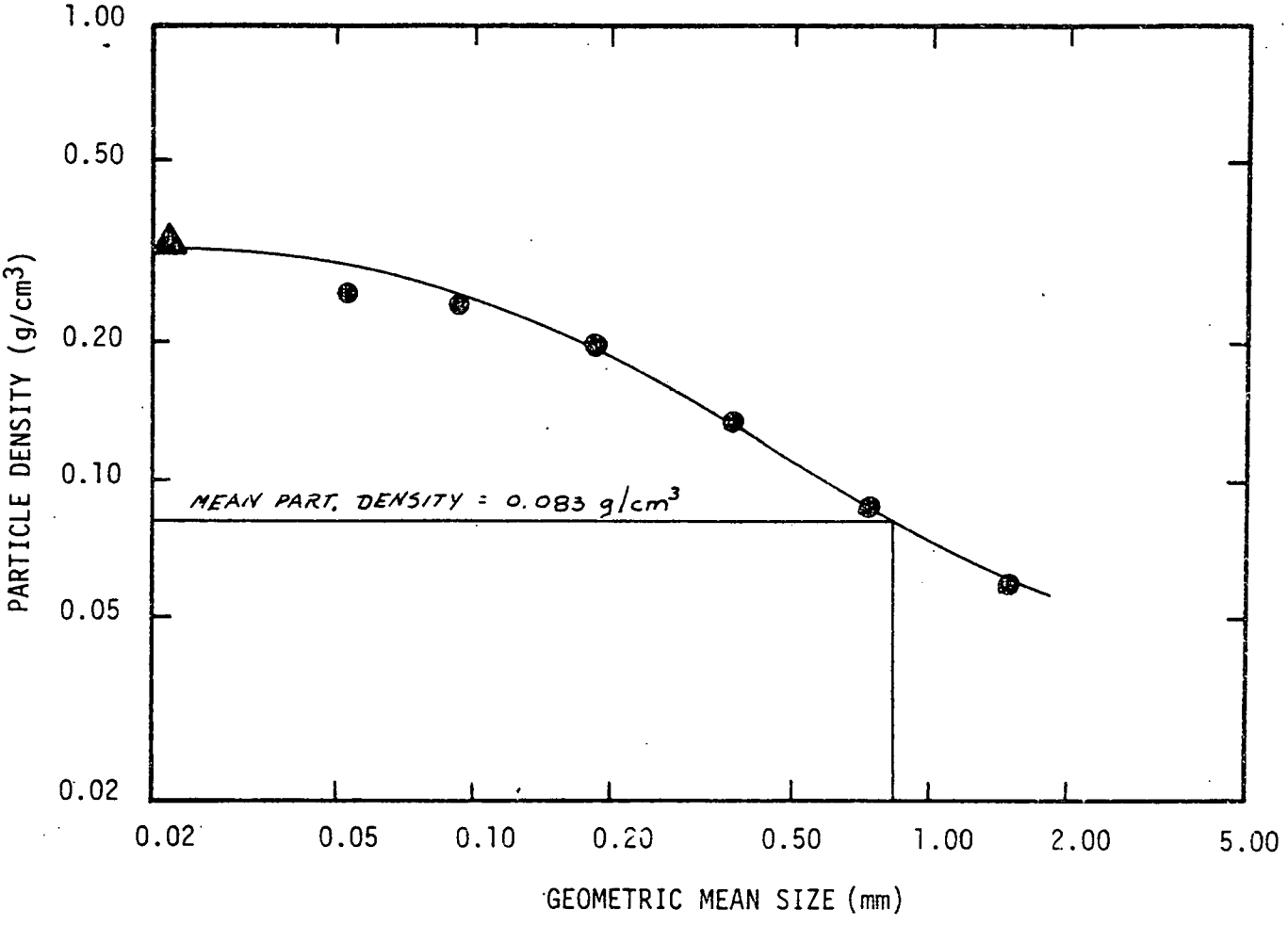
RUN NUMBER: 17



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: *17*

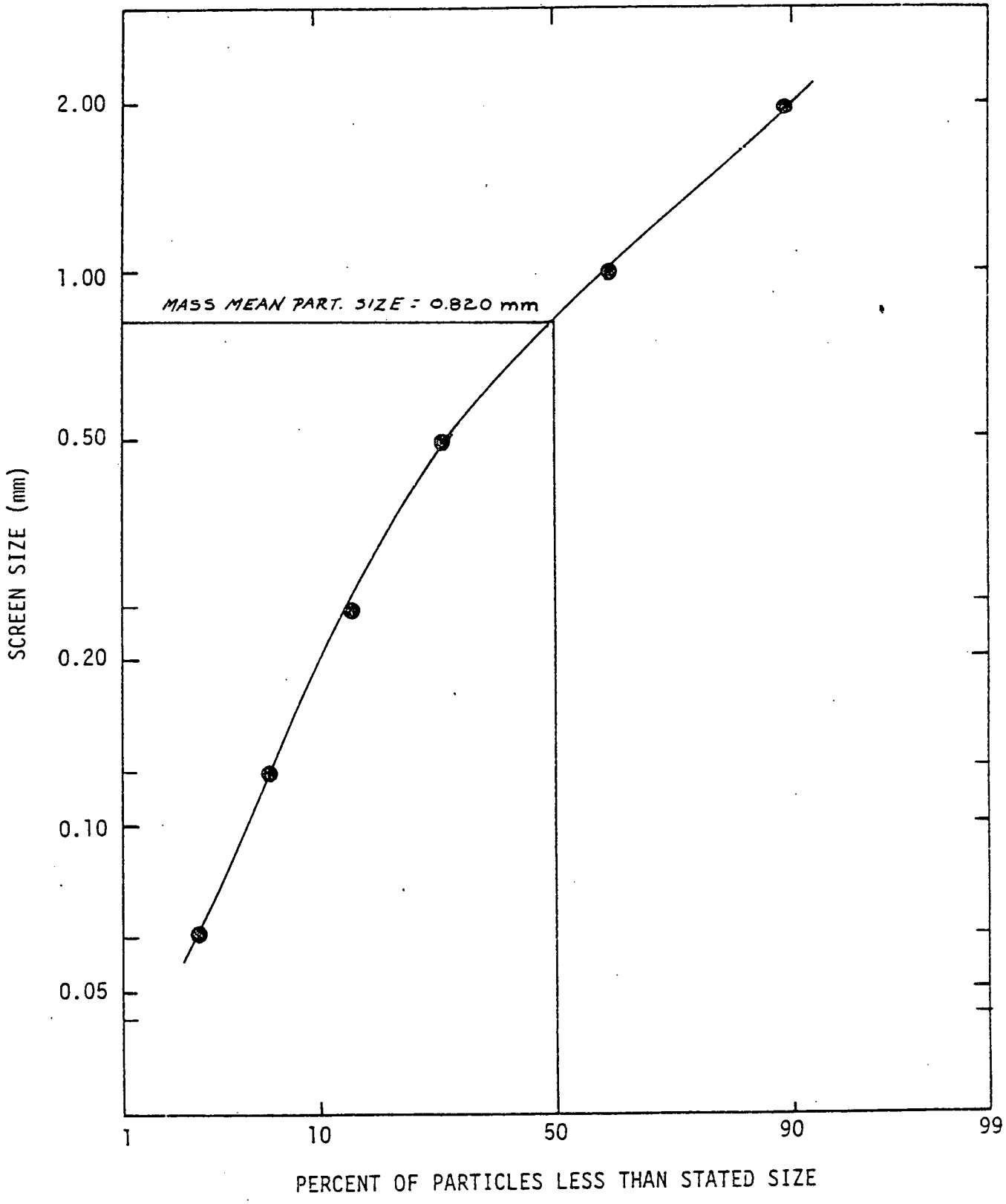


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

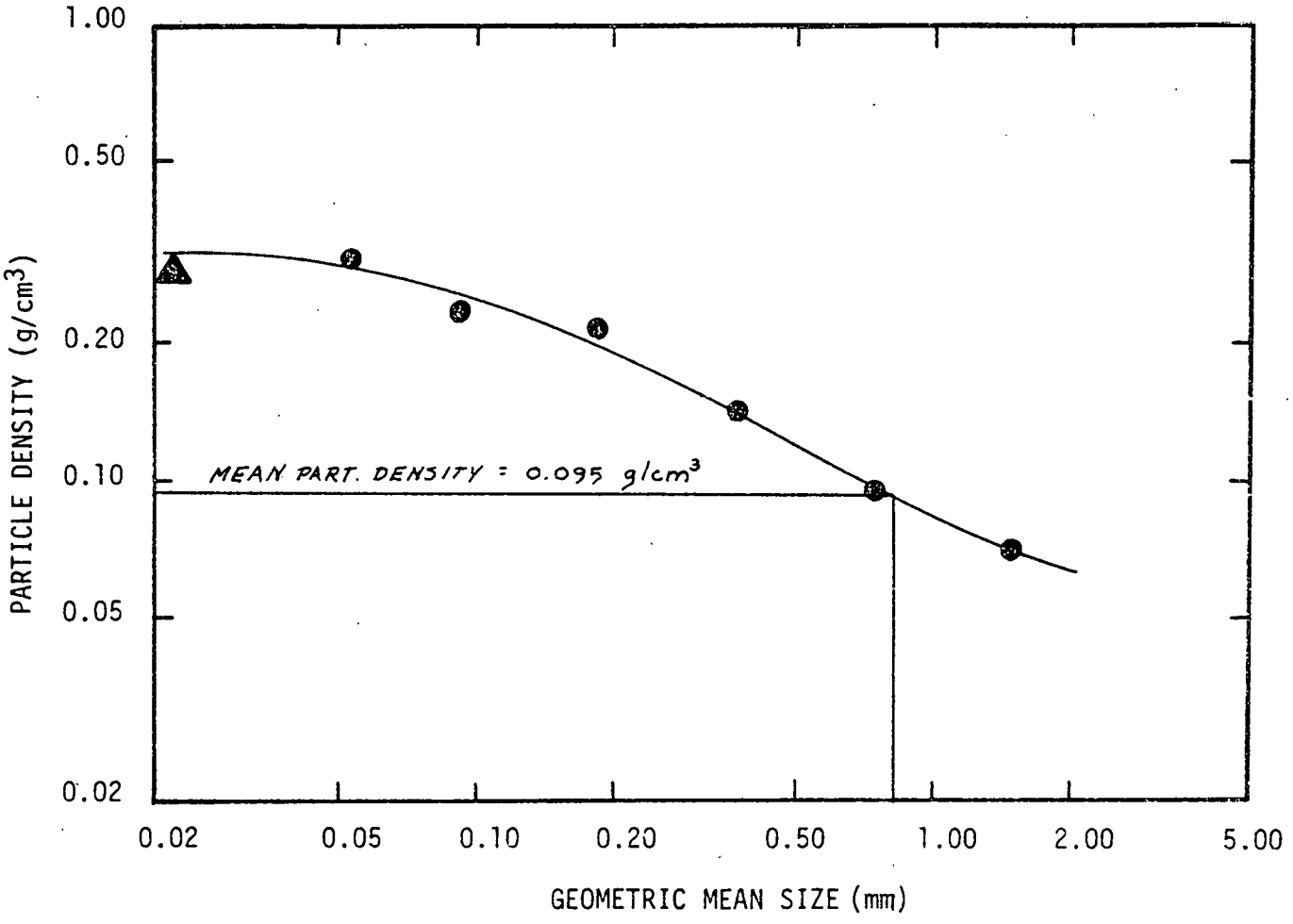
RUN NUMBER: 19



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 19

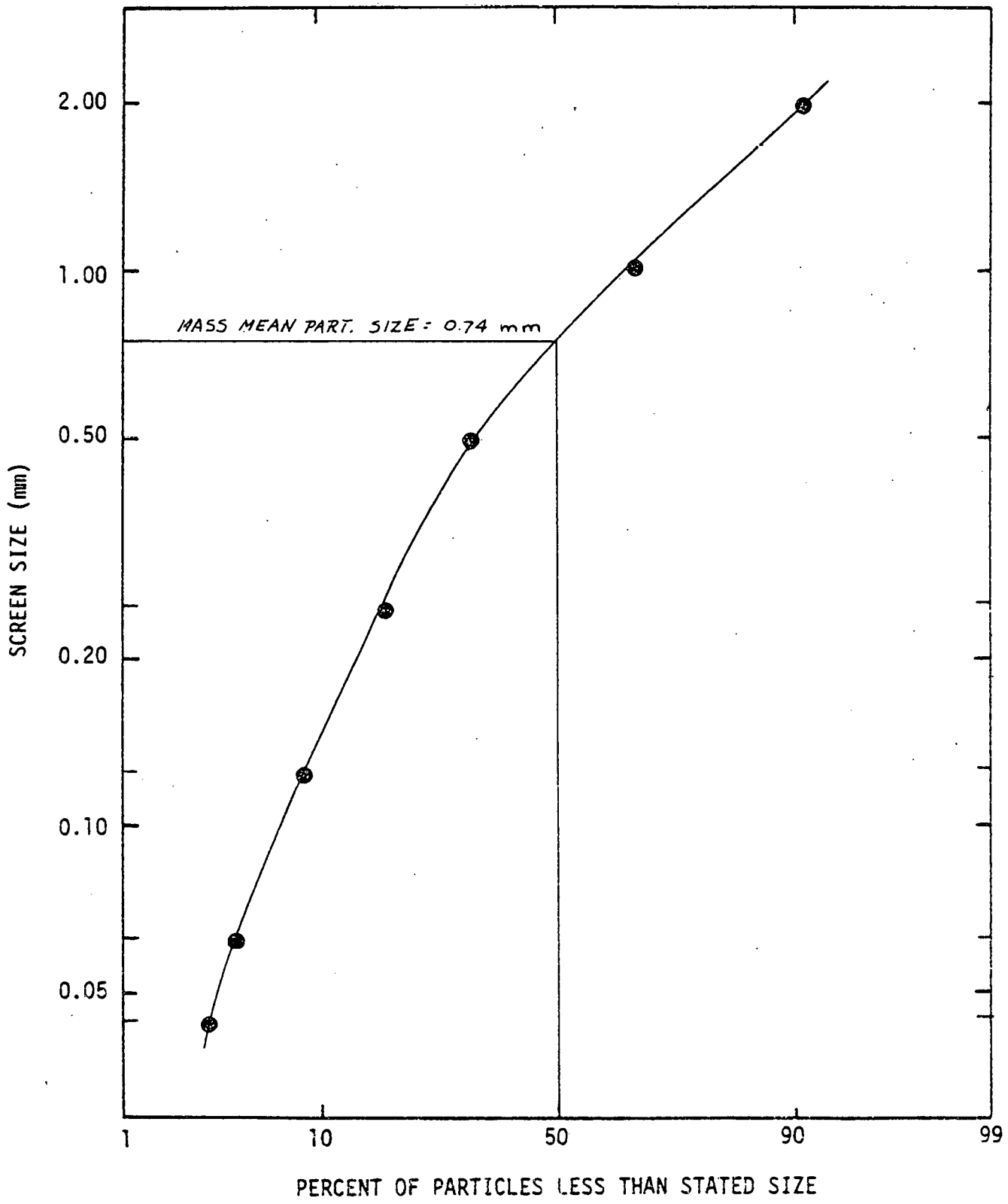


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

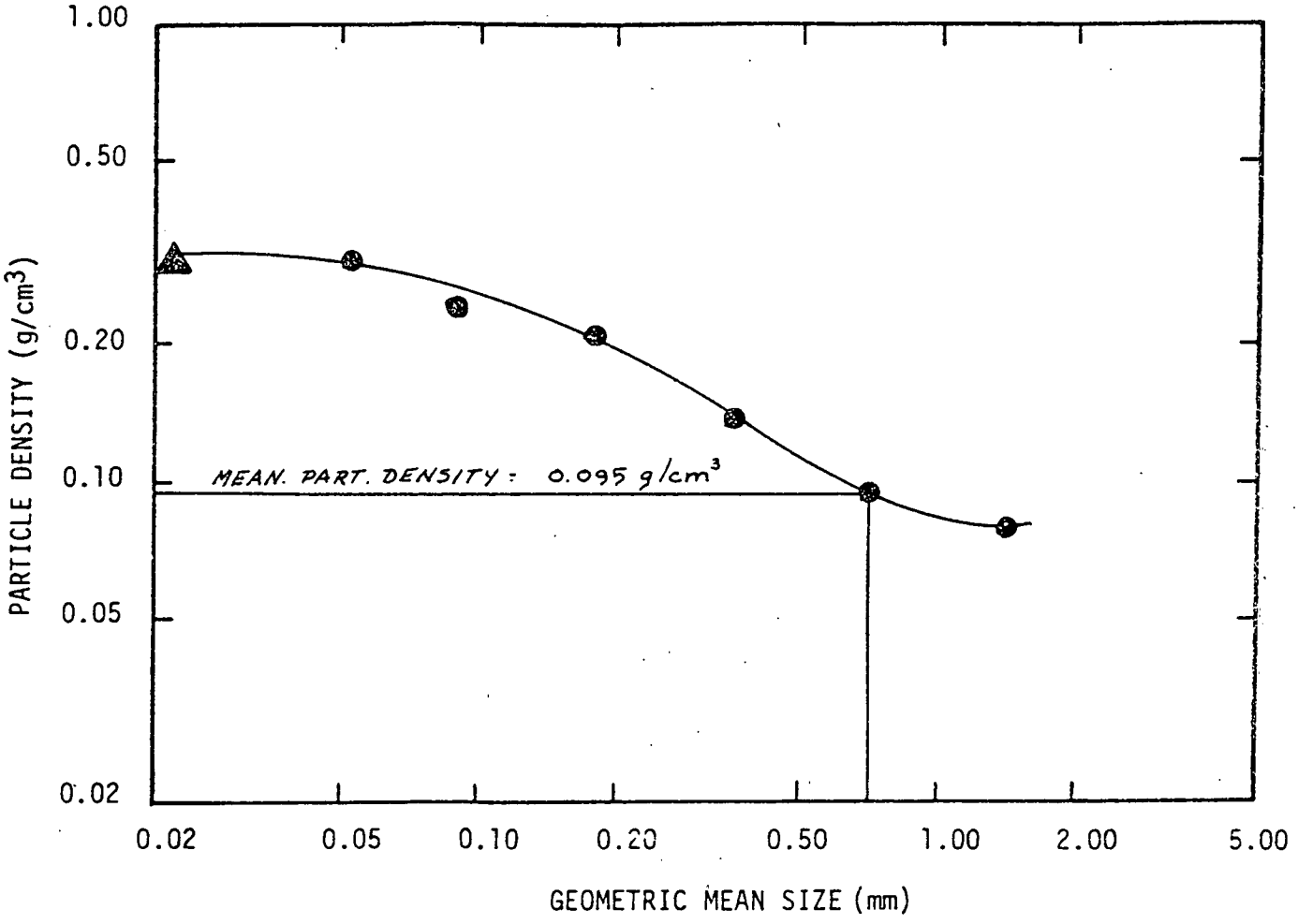
RUN NUMBER: 21



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 21

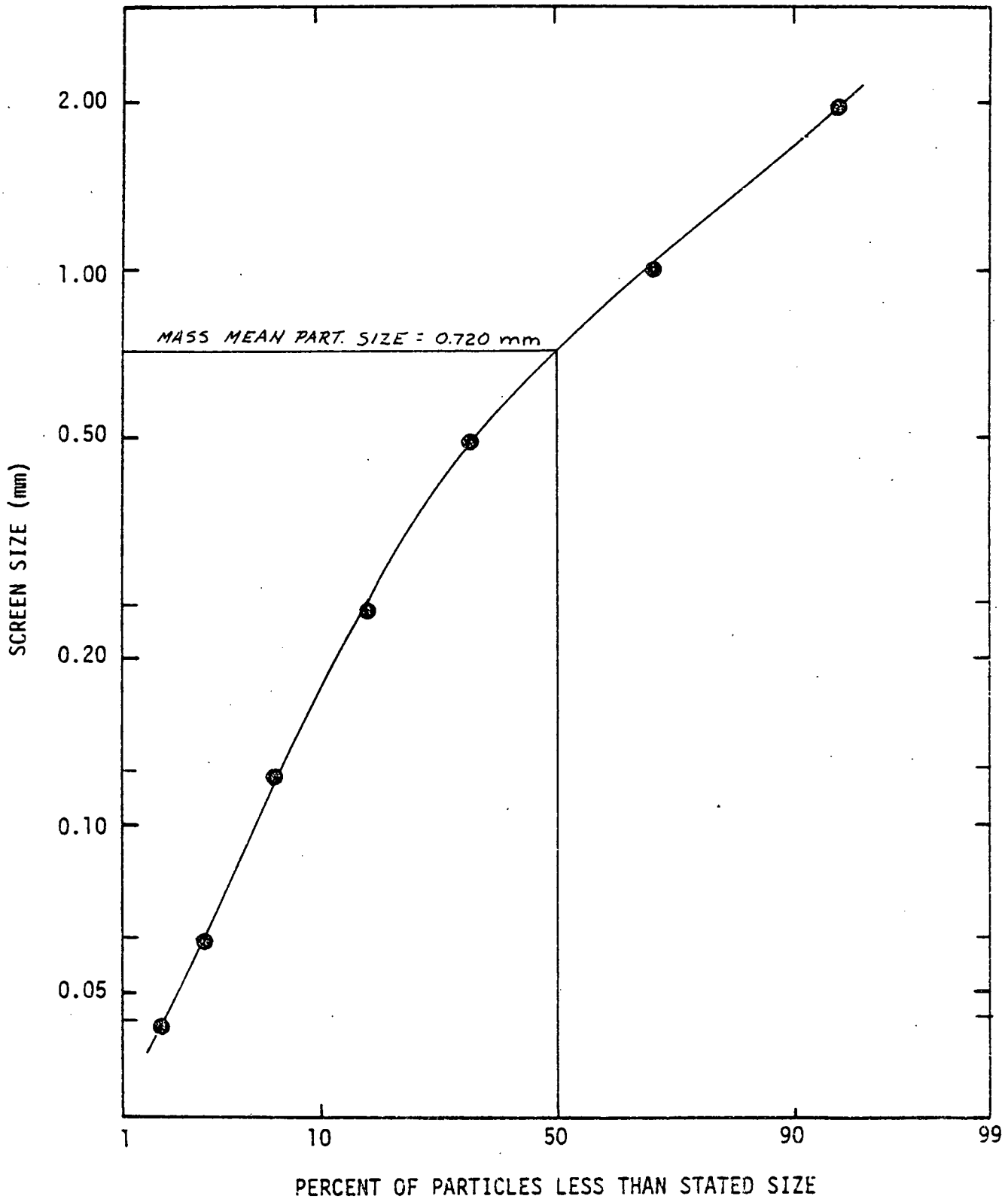


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

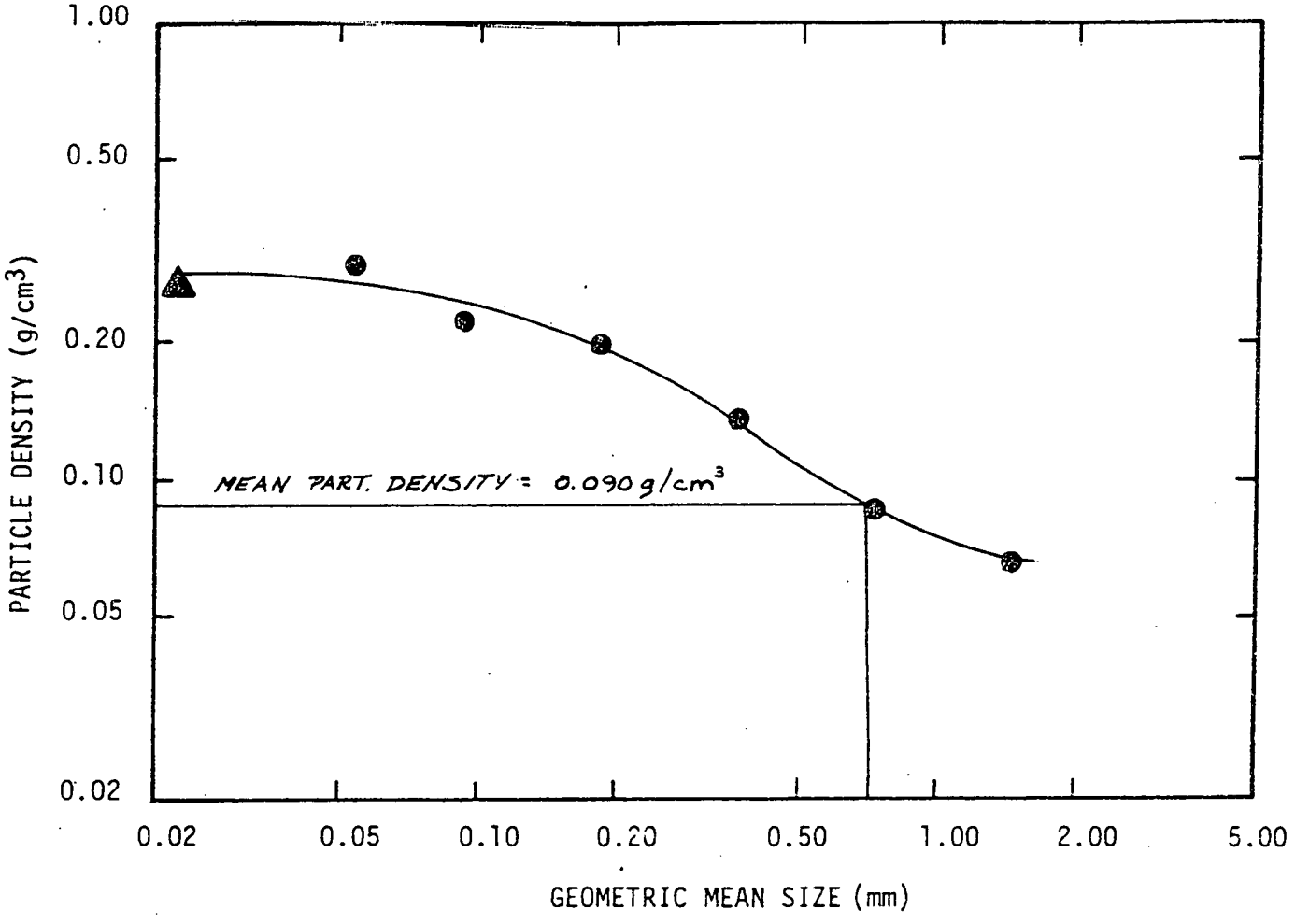
RUN NUMBER: 26



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 26

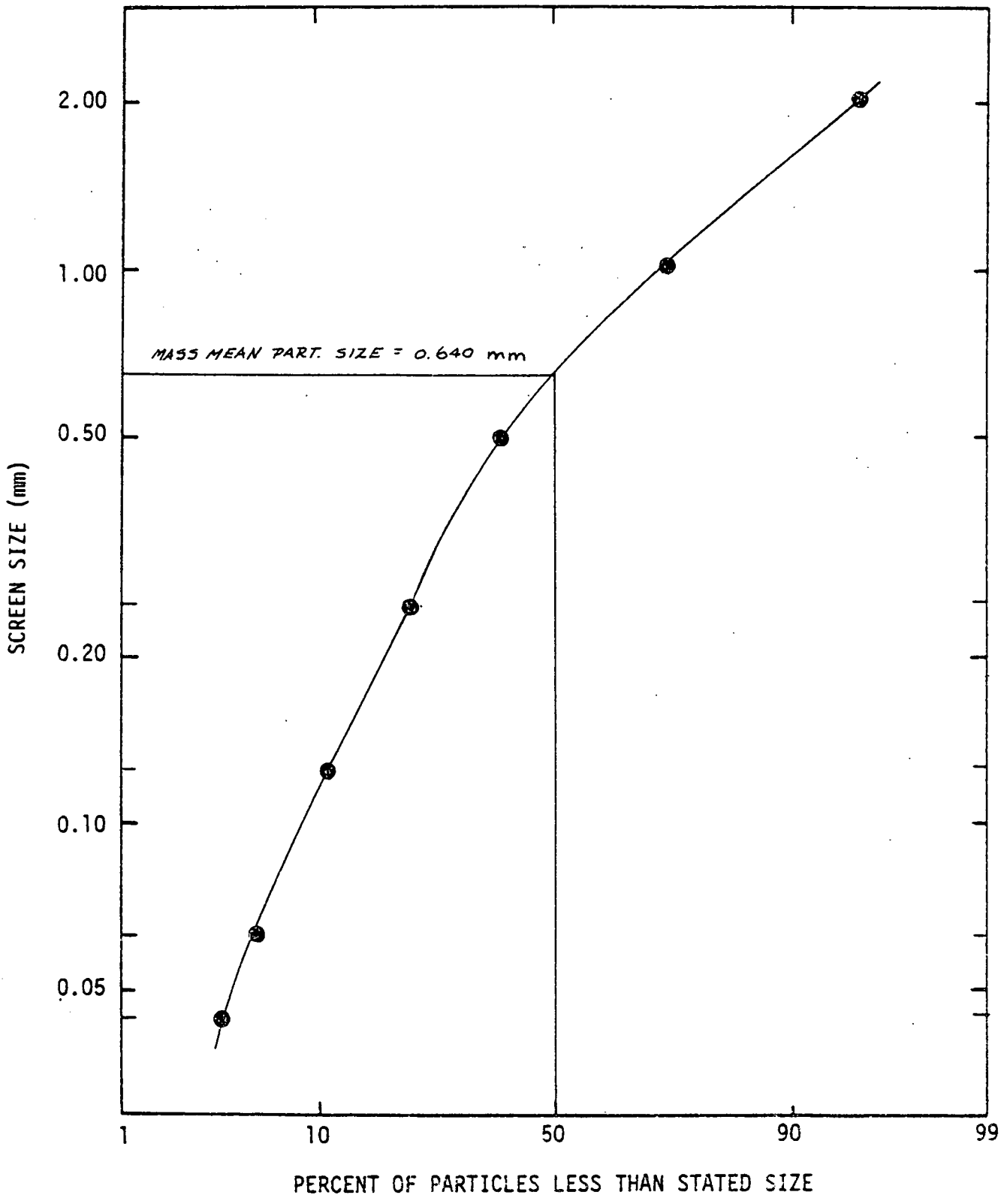


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

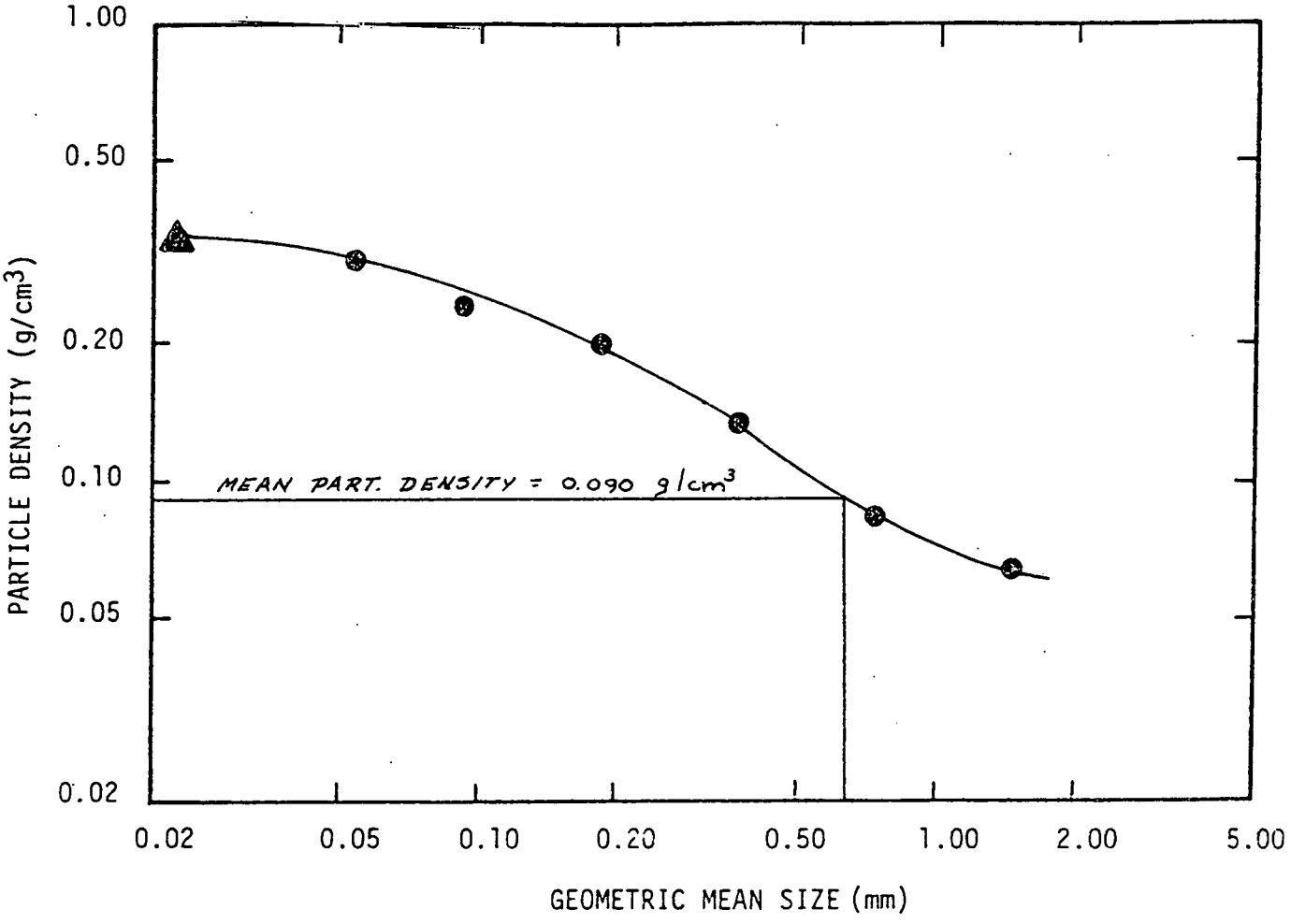
RUN NUMBER: 27



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 27

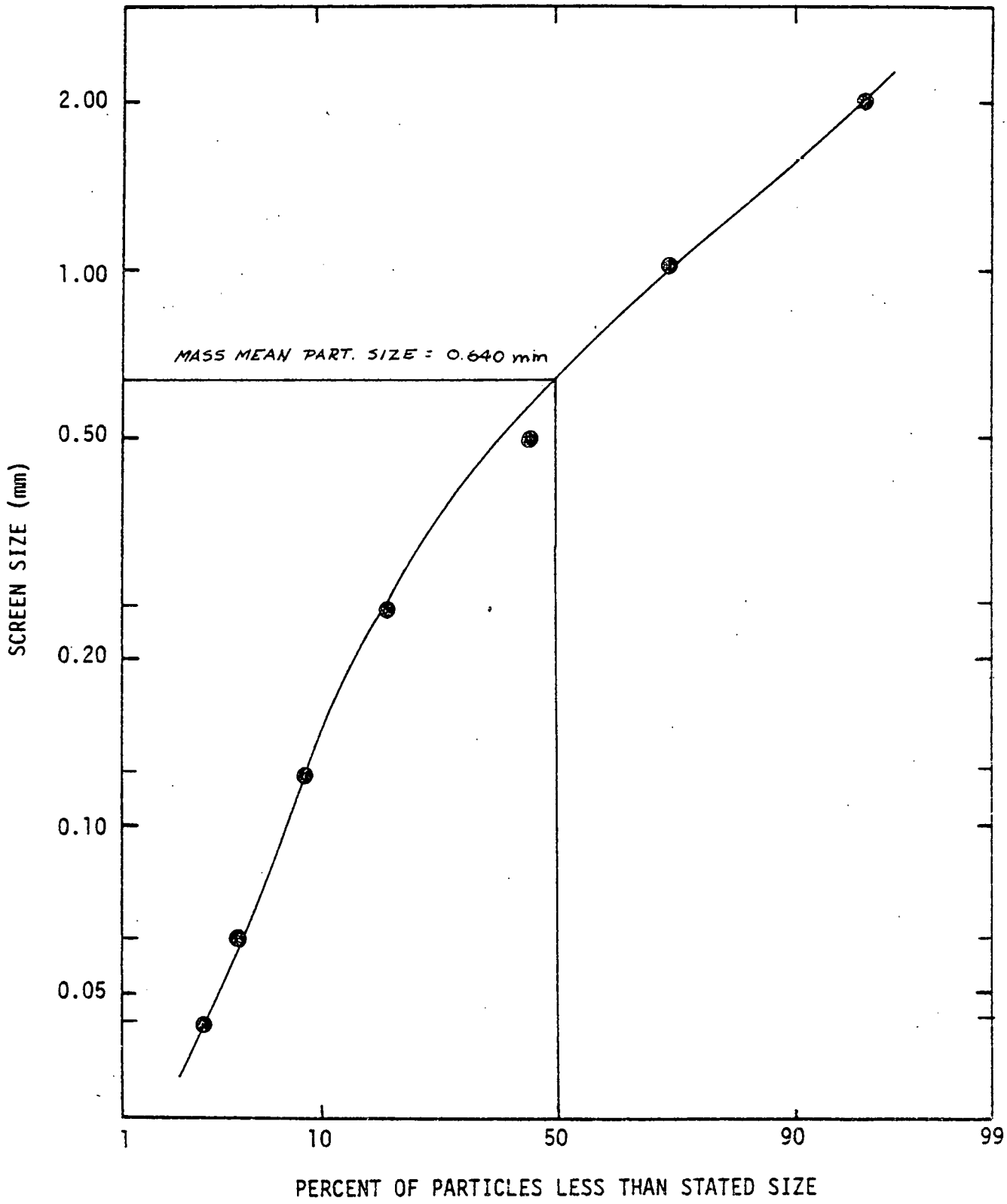


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

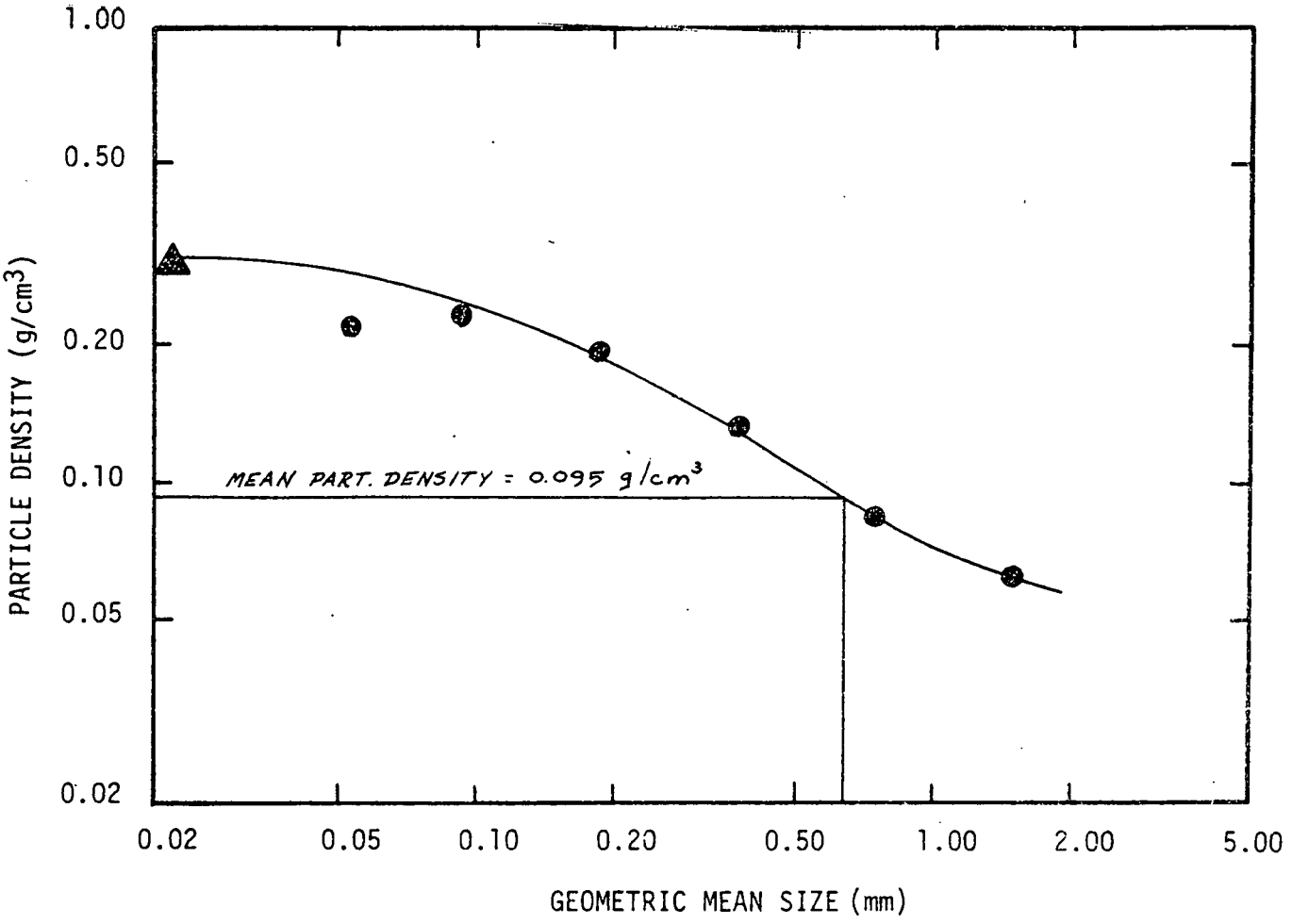
RUN NUMBER: 30



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: *30*

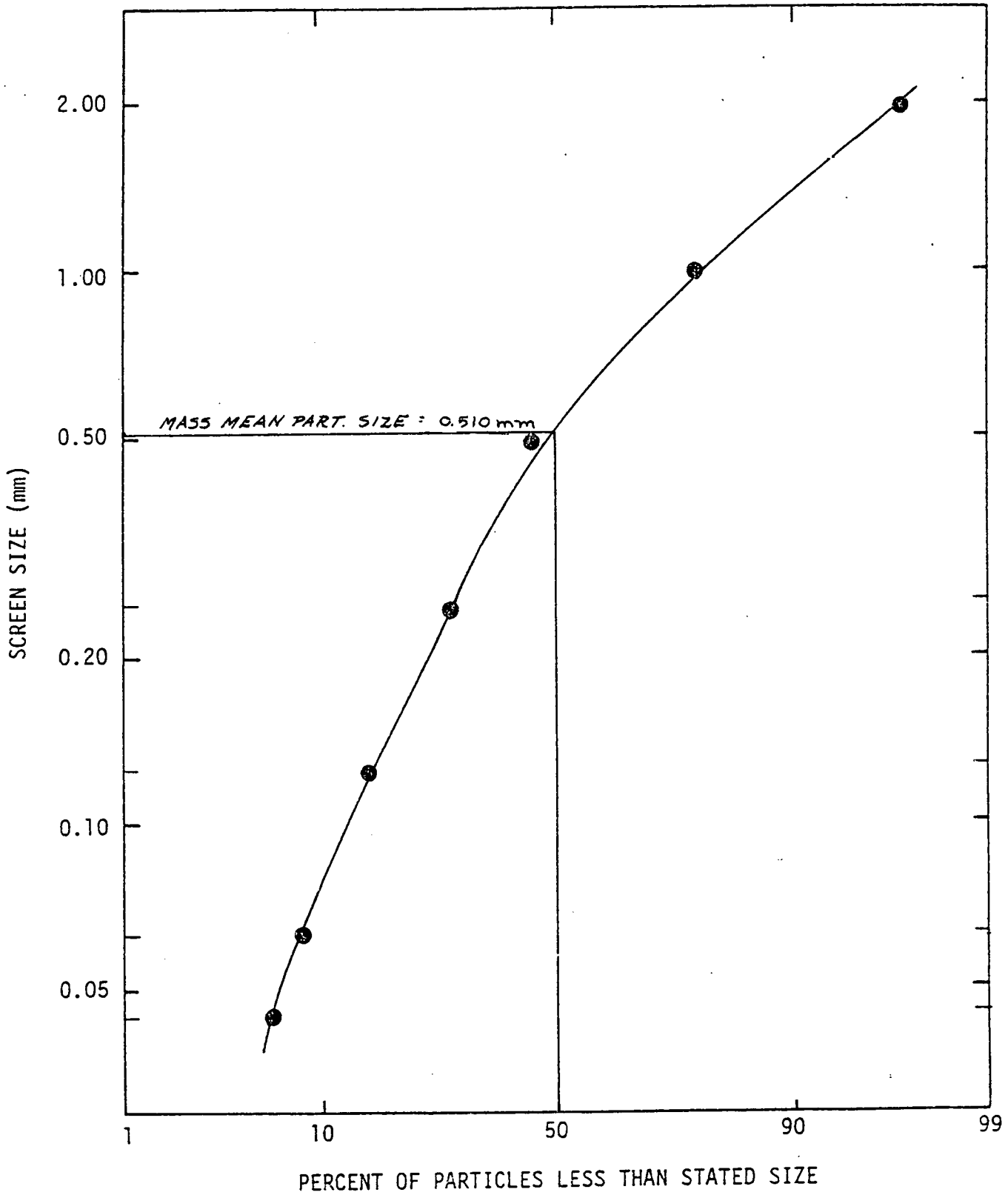


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

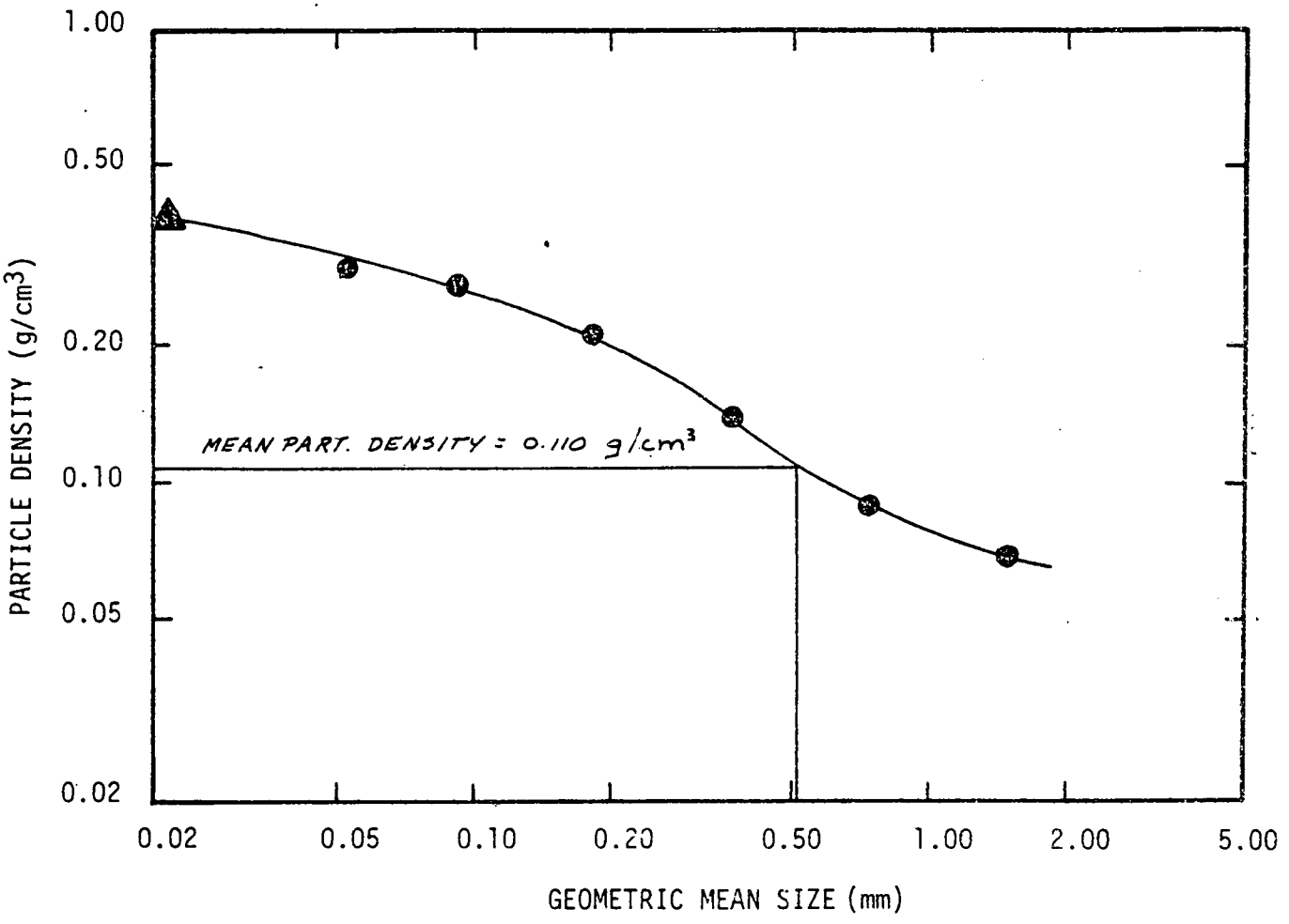
RUN NUMBER: 32



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 32

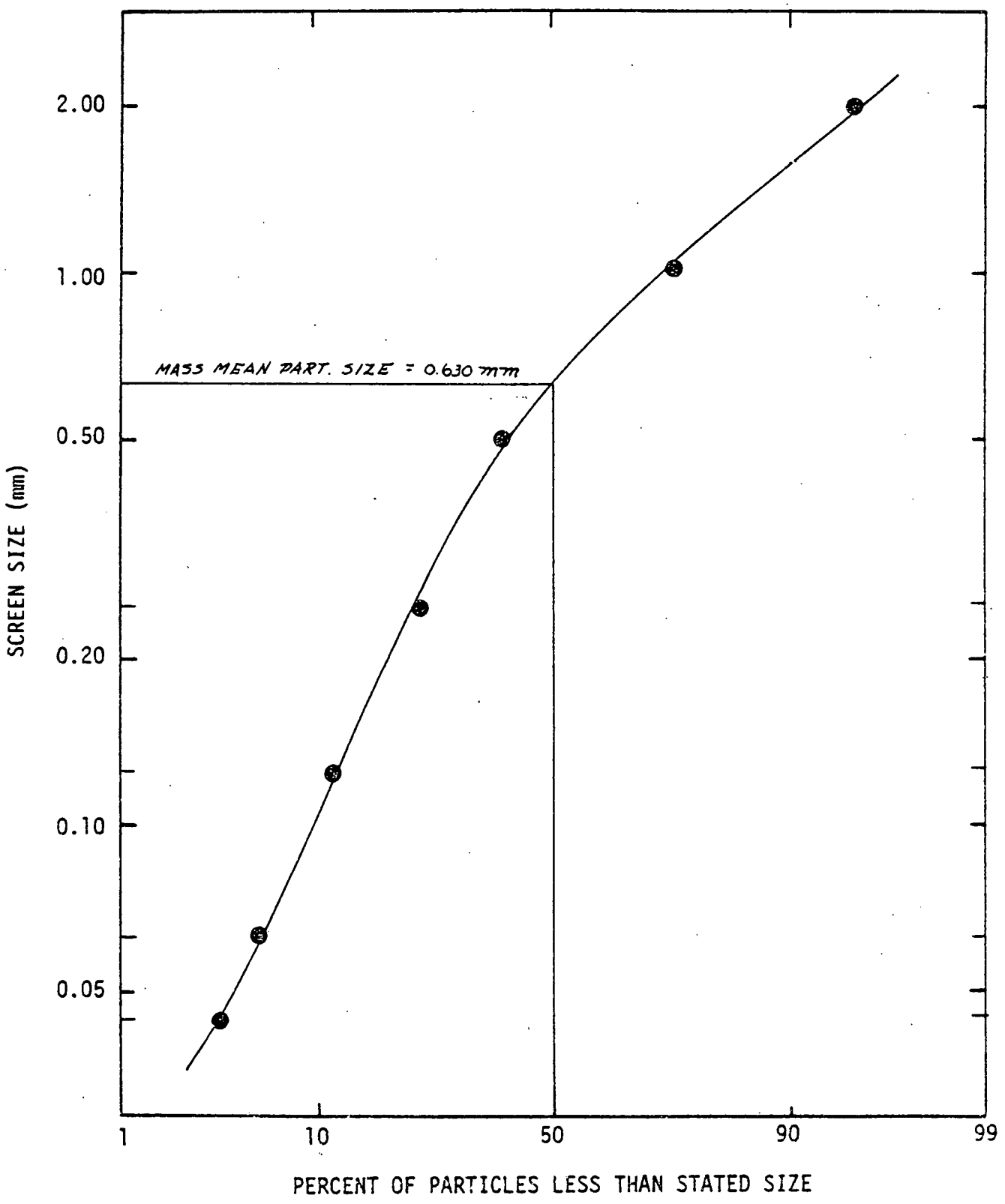


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

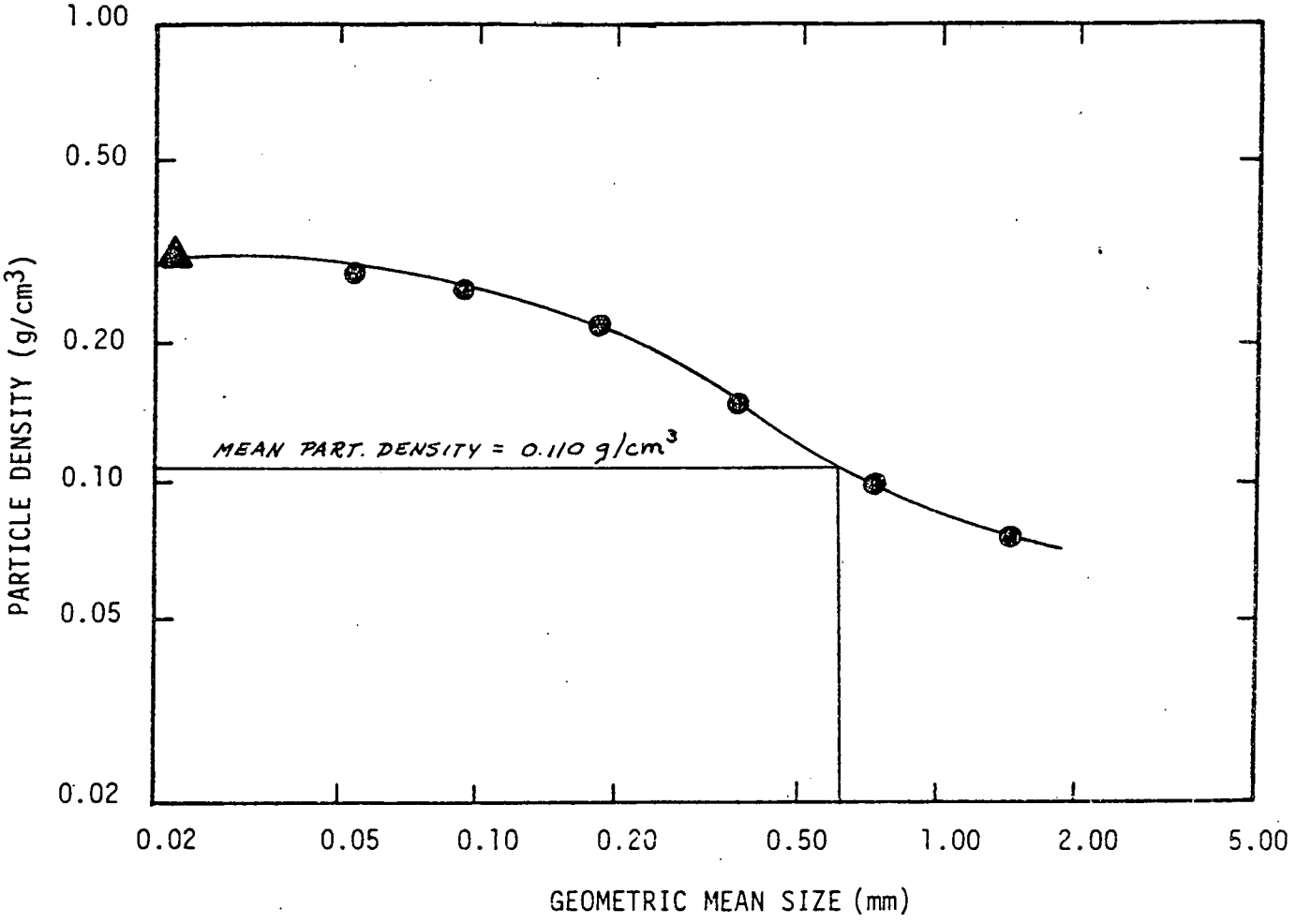
RUN NUMBER: 39



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 39

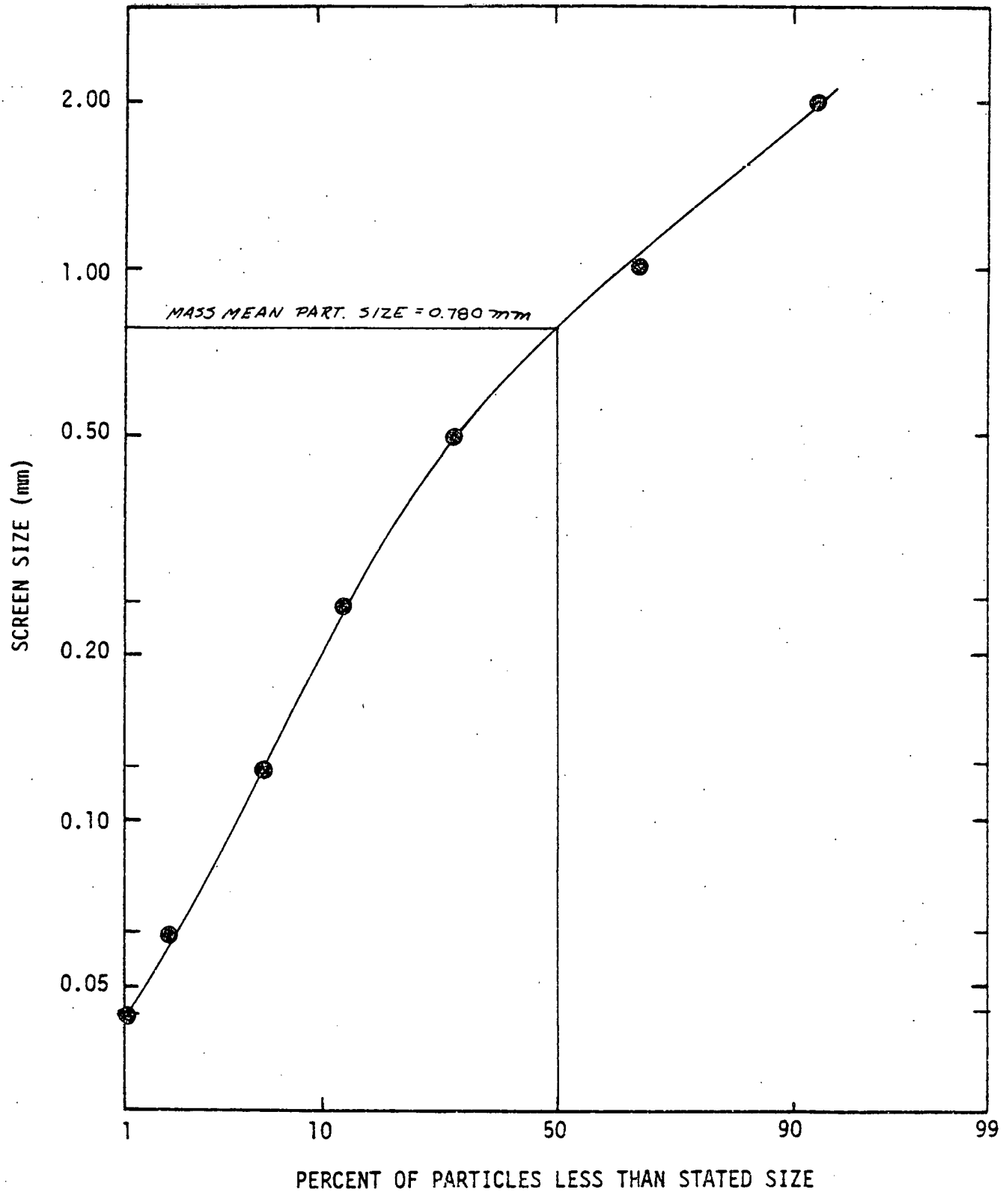


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

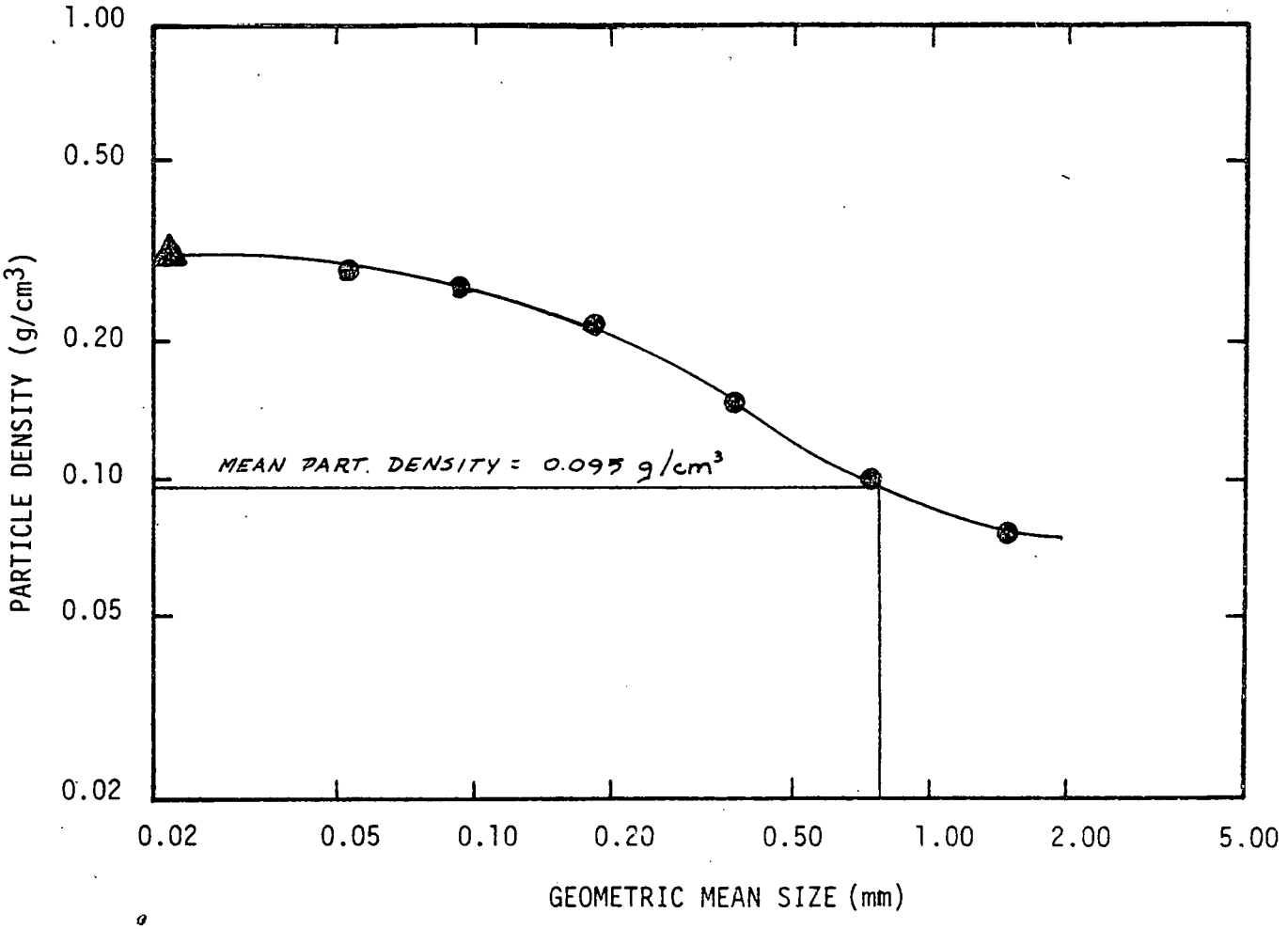
RUN NUMBER: 42



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 42

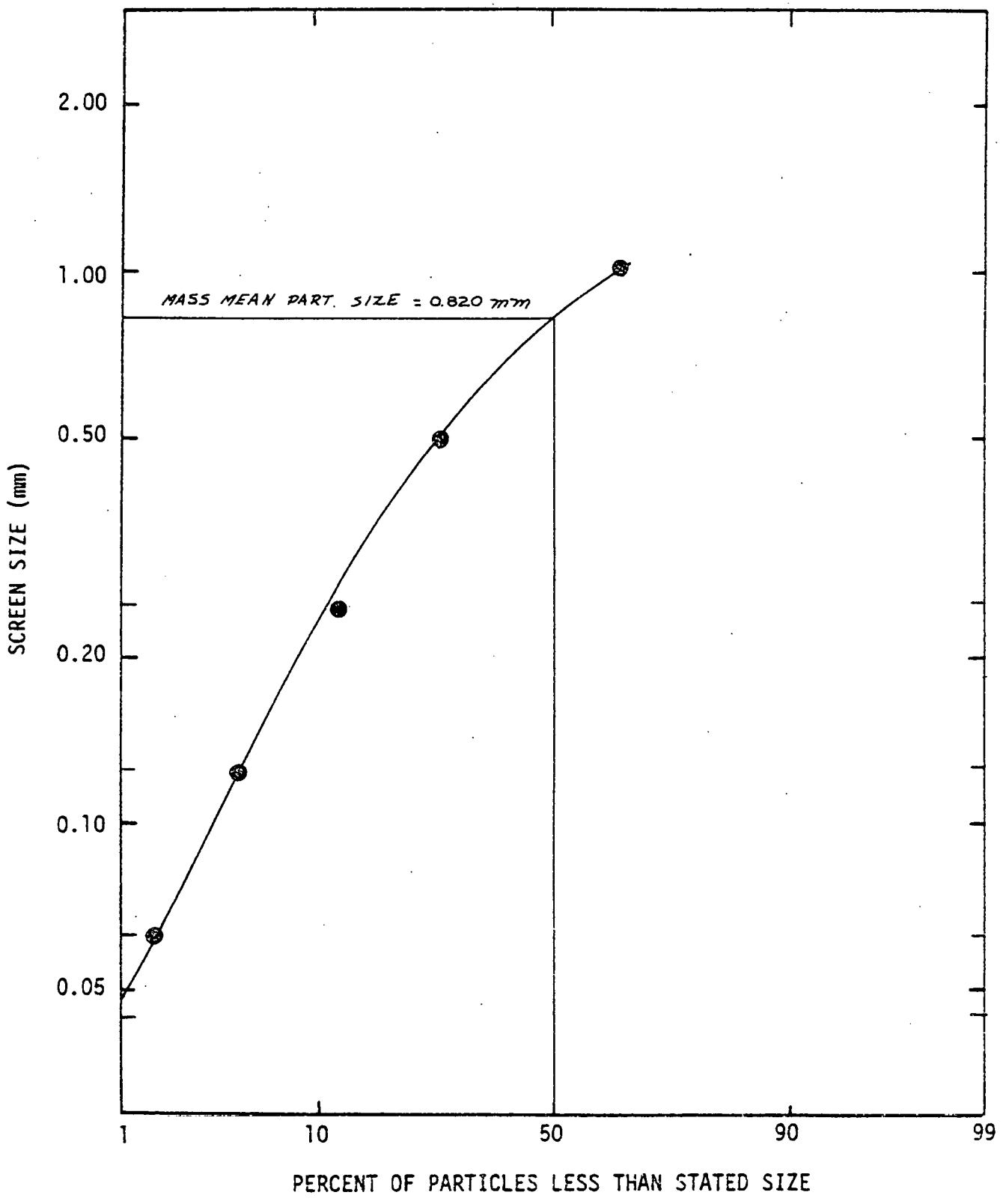


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

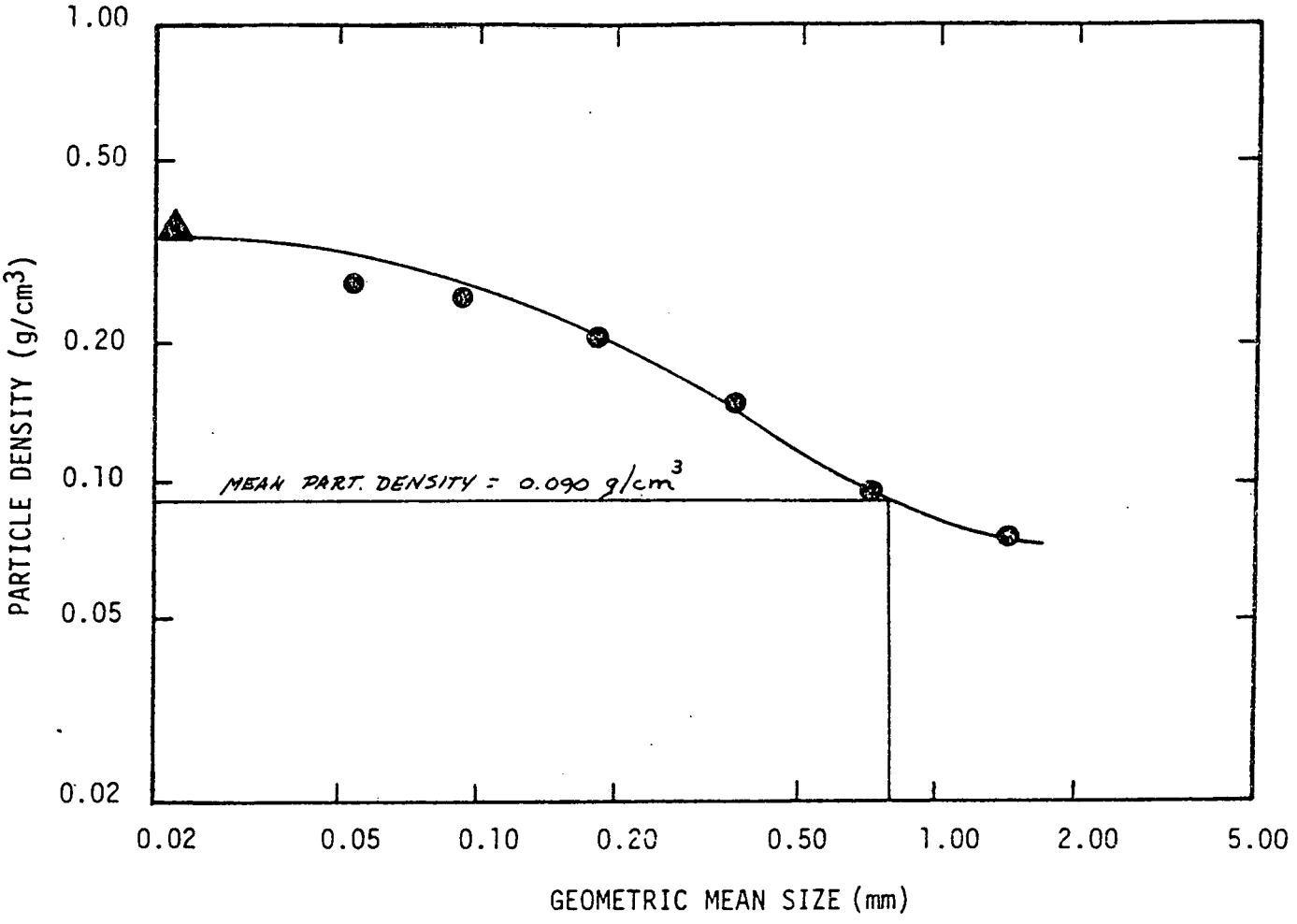
RUN NUMBER: *43*



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 43

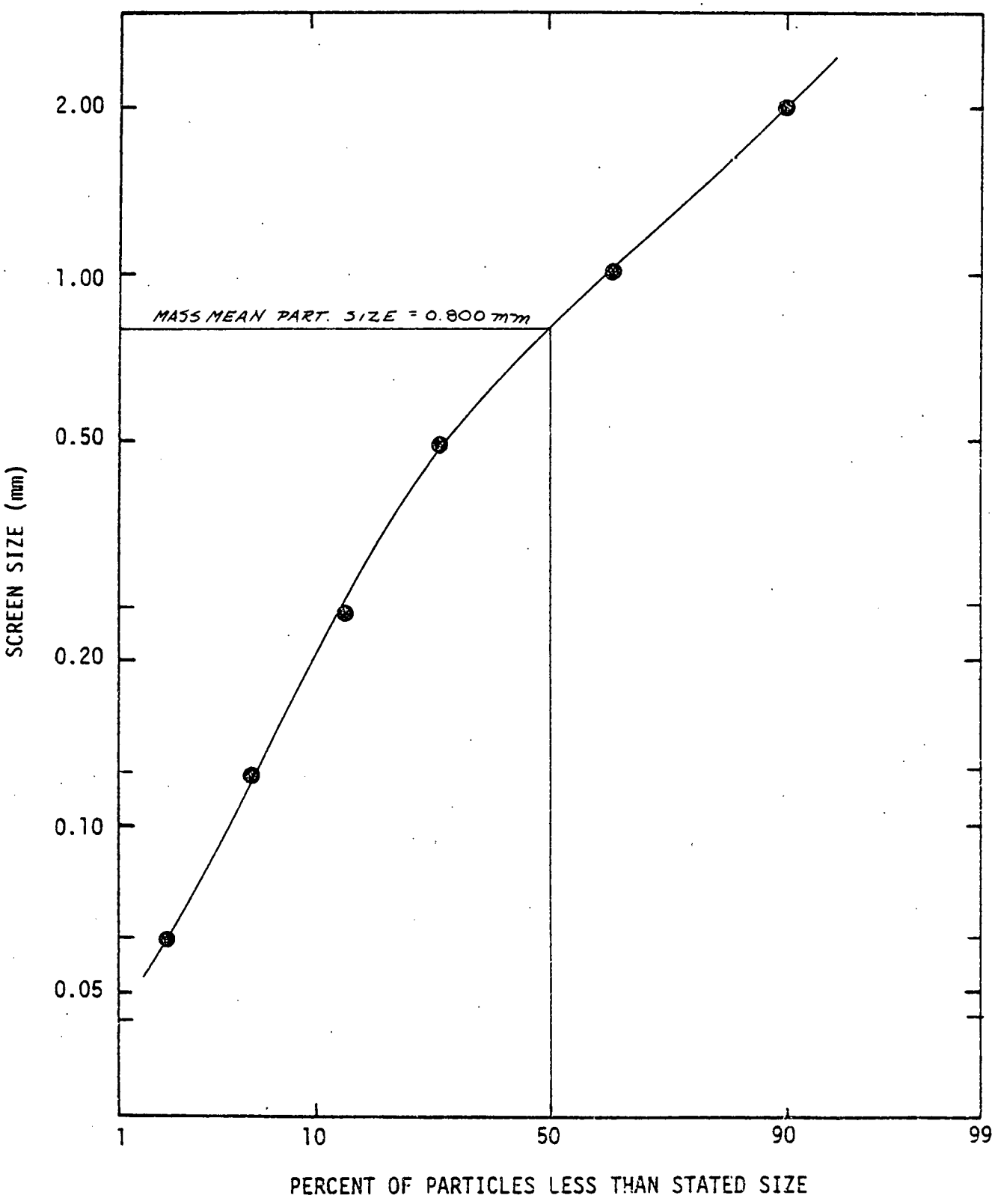


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

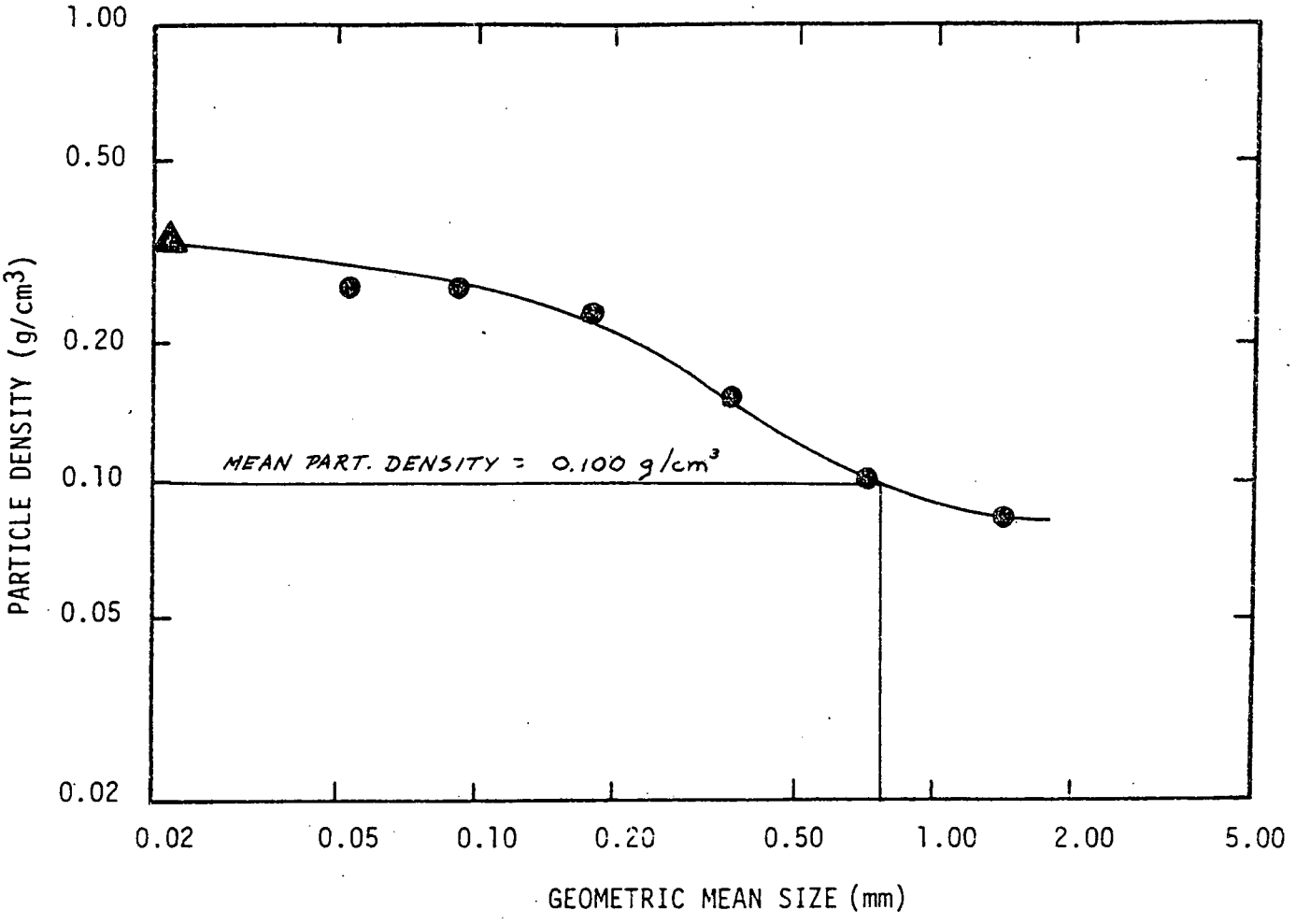
RUN NUMBER: 45



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 45

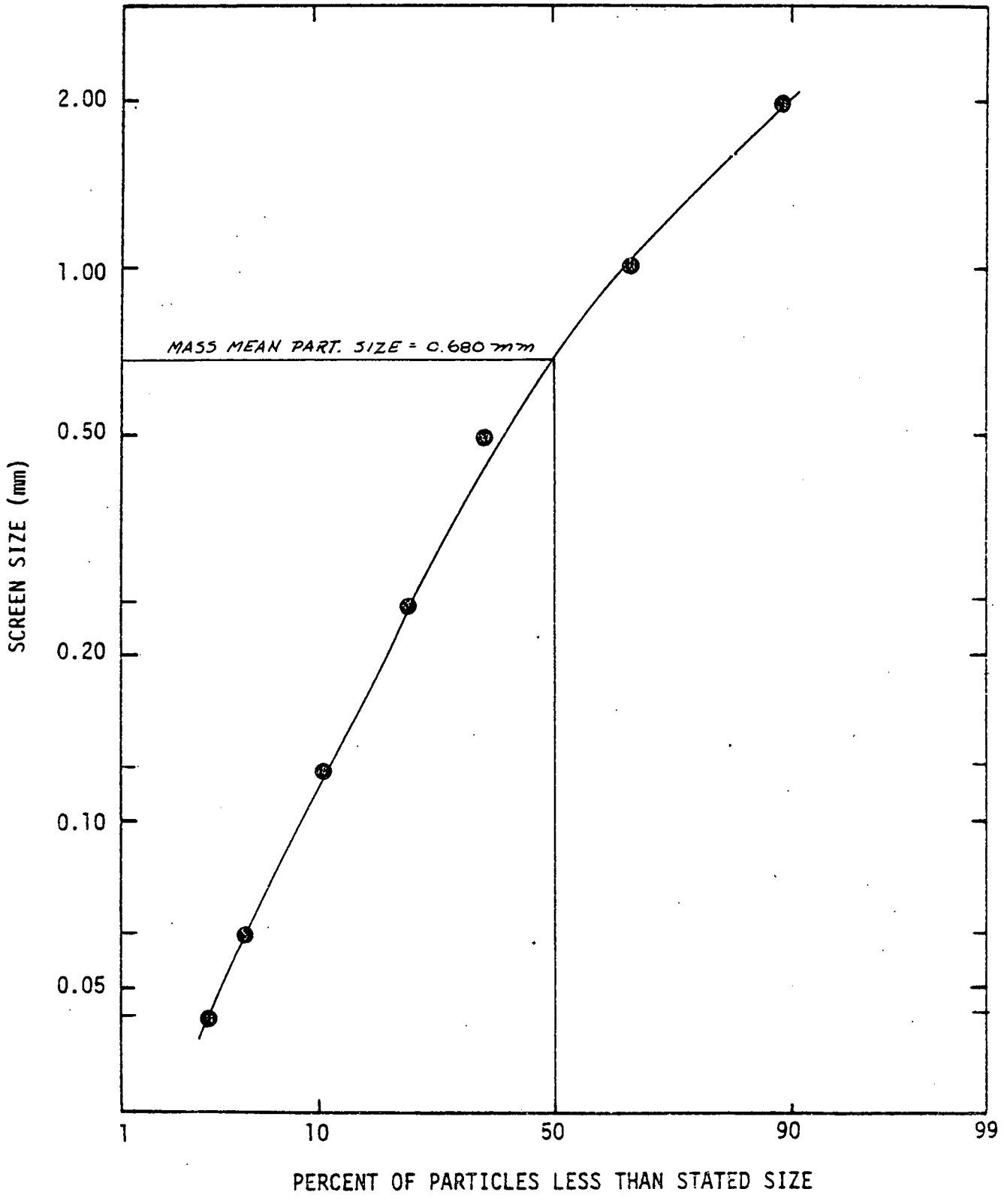


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

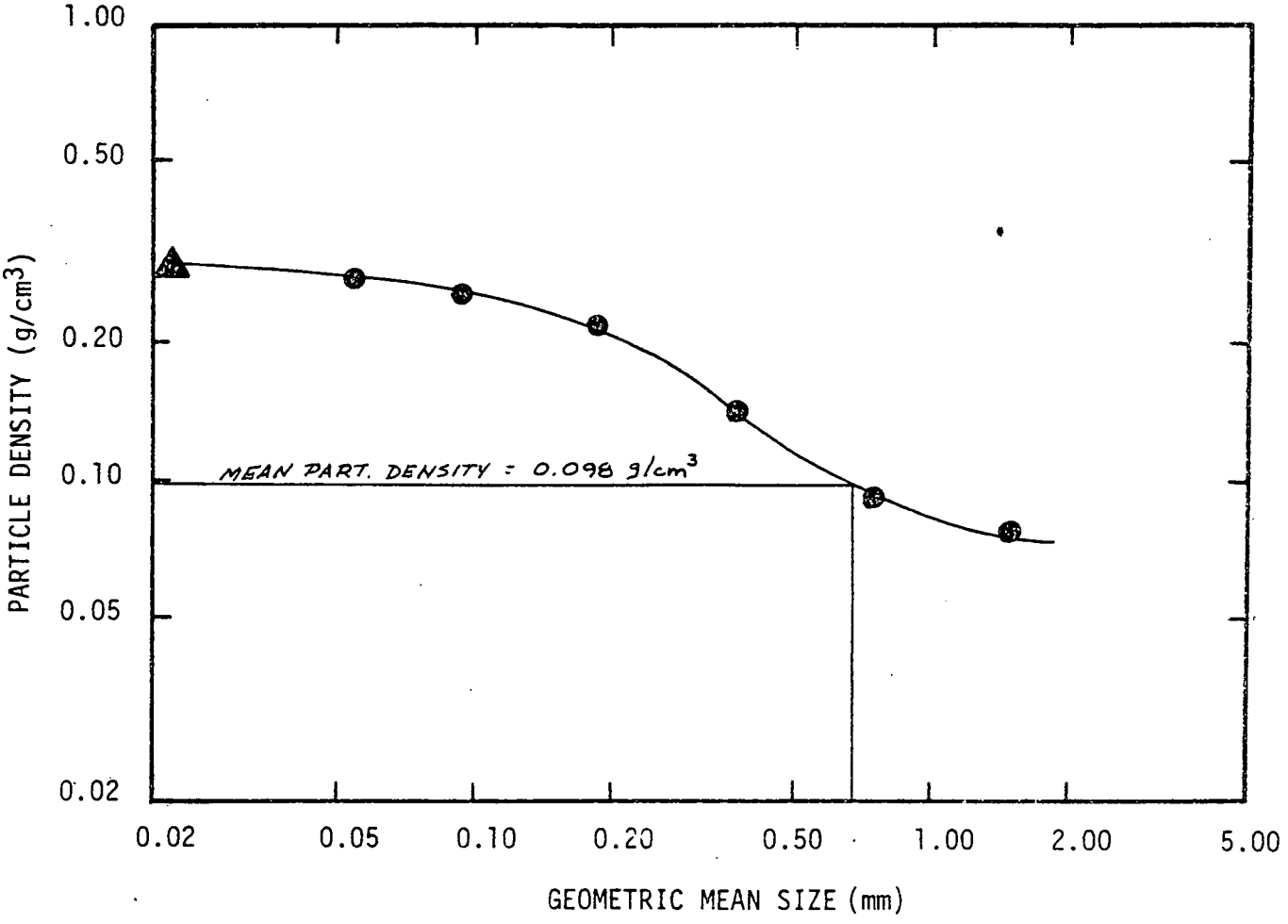
DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 47



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS
RUN NUMBER: 47

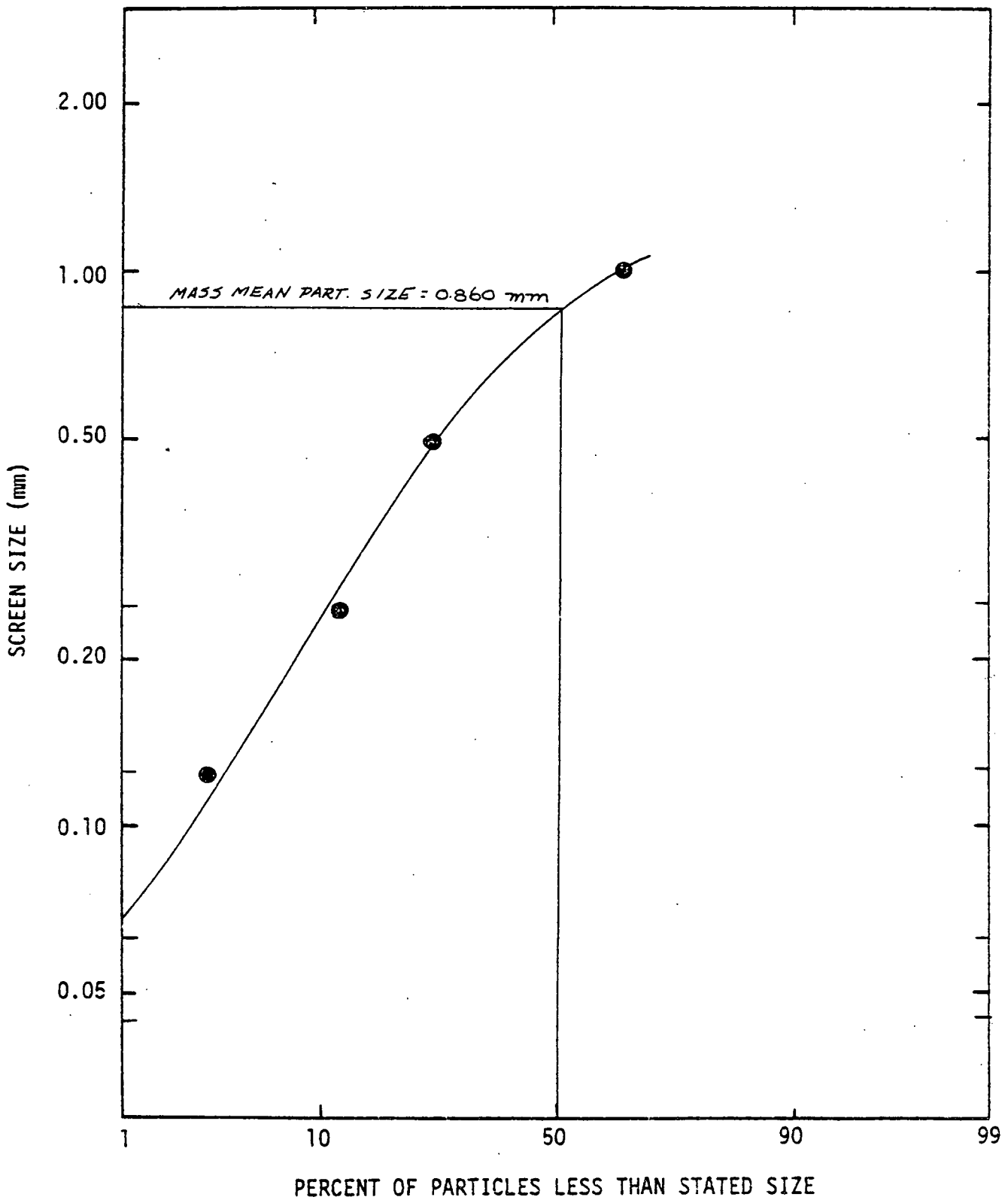


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

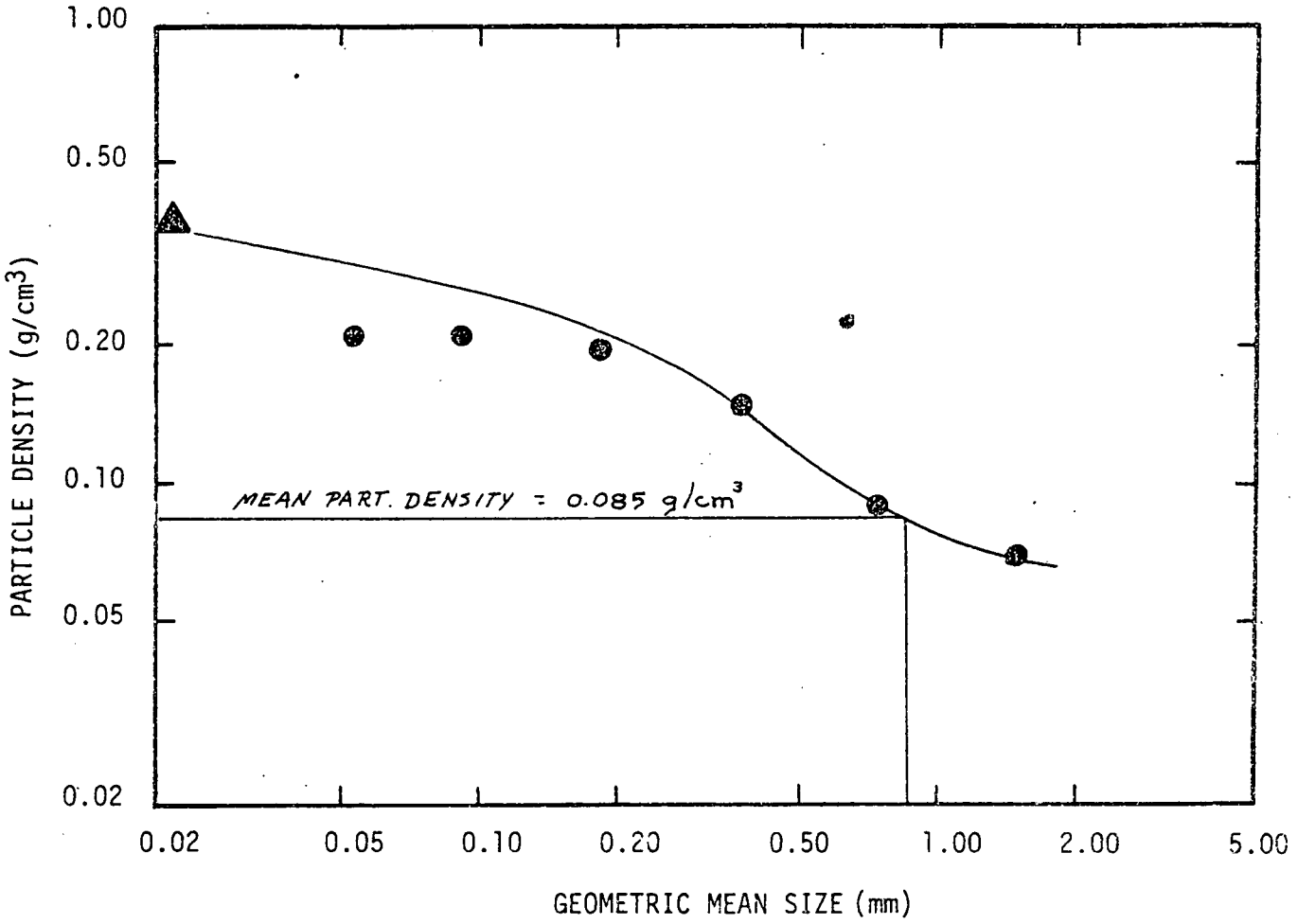
RUN NUMBER: 49



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 49

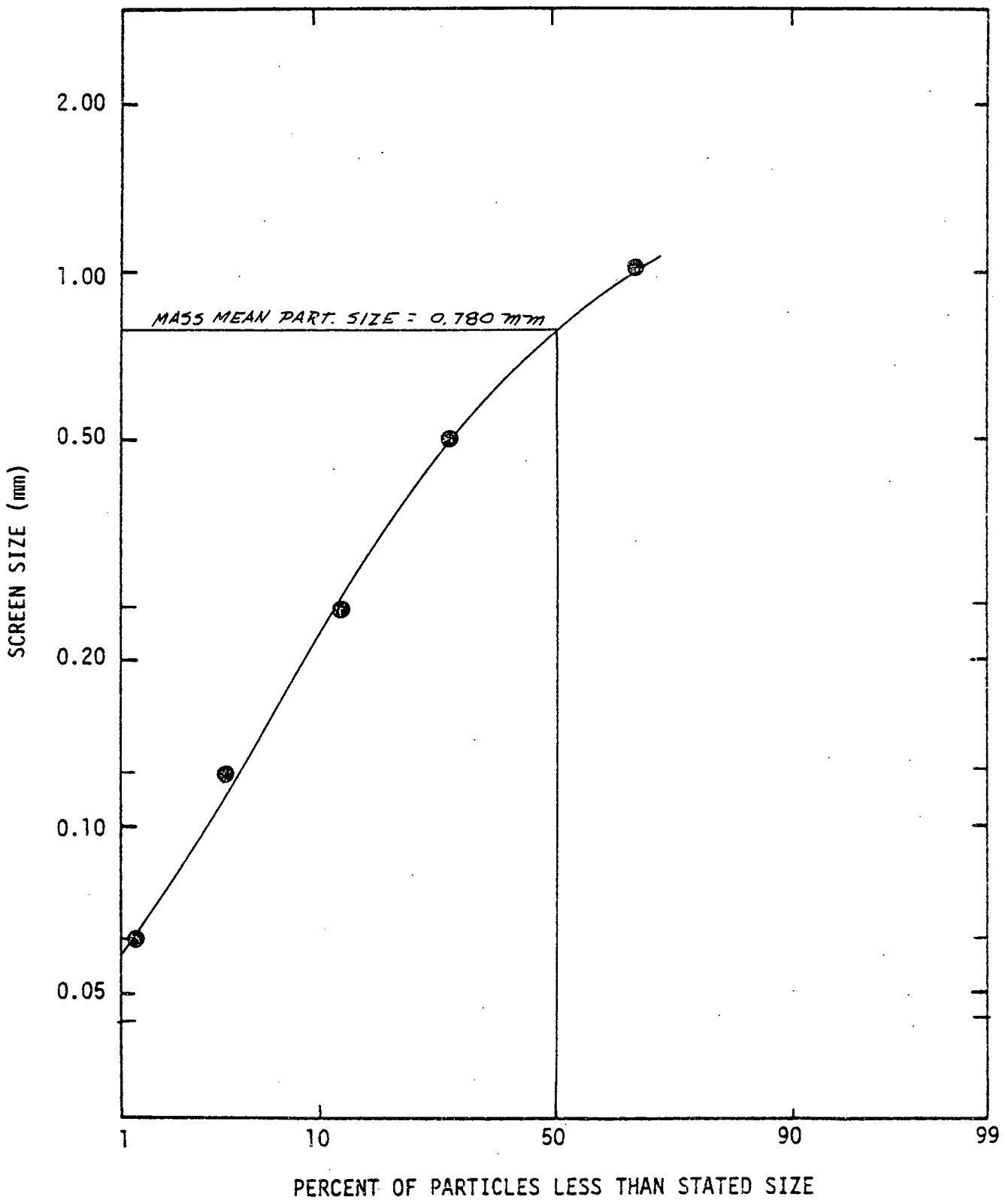


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR PLANER SHAVINGS

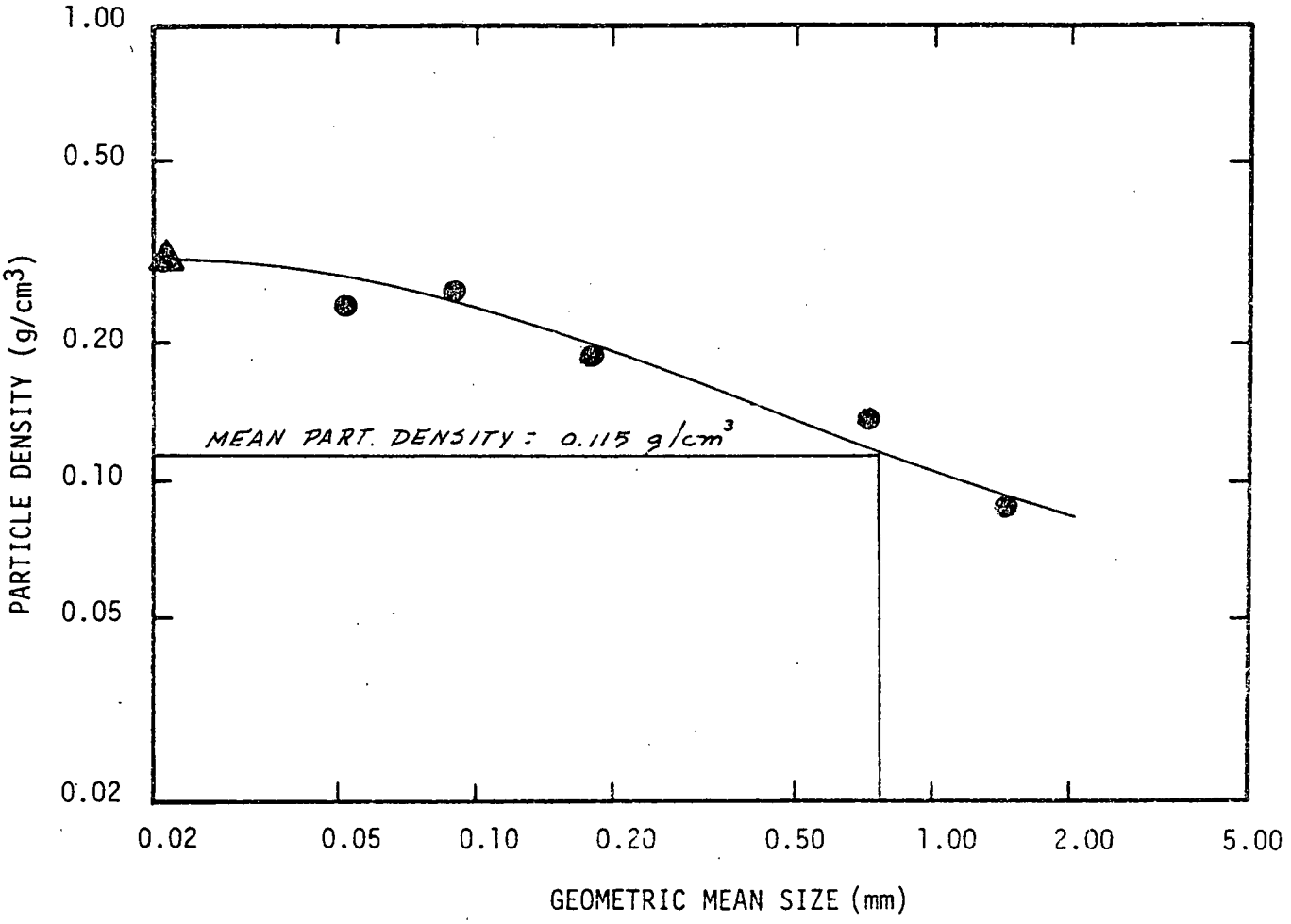
RUN NUMBER: 52



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR PLANER SHAVINGS

RUN NUMBER: 52



▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

COMBUSTIBLE CONTENT VS. SIZE OF ASH

DATA FORM - WOOD ASH ANALYSES

RUN NO: 27

DOUG. FIR PLANER SHAVINGS

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT	(gm)		
CRUCIBLE WT	(gm)		
SAMPLE WT	(gm)		
FINAL SAMPLE + CRUCIBLE WT	(gm)		
CRUCIBLE WT	(gm)		
ASH WT	(gm)	____ % ____	____ % ____
COMBUSTABLE CARBON WT	(gm)	____ % ____	____ % ____

AVERAGE % INORGANIC ASH: _____ AVERAGE % COMBUSTABLE CARBON: _____

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	19.93	17.12	2.81	57.53		50	0.056
1.000	30.16	17.12	13.04	54.72	95.12	207	0.063
.500	37.24	17.12	20.12	41.68	72.45	244	0.082
.250	26.68	17.12	9.56	21.56	37.48	70	0.137
.125	23.44	17.12	6.32	12.00	20.86	31	0.204
.063	20.22	17.12	3.10	5.68	9.87	11	0.282
.045	18.03	17.12	0.91	2.58	4.48	3	0.303
PAN	18.79	17.12	1.67	1.67	2.90	4	0.418

DATA FORM - WOOD ASH ANALYSES

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS

SIZE (mm) 2.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.78		27.63	
CRUCIBLE WT	(gm)	28.09		26.96	
SAMPLE WT	(gm)	0.69		0.67	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.10		26.97	
CRUCIBLE WT	(gm)	28.09		26.96	
ASH WT	(gm)	0.01	% 1.45	0.01	% 1.49
COMBUSTIBLE CARBON WT	(gm)	0.68	% 98.55	0.66	% 98.51

AVERAGE % INORGANIC ASH 1.47 AVERAGE % COMBUSTIBLE CARBON 98.53

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR. PLANER SHAVINGS

SIZE (mm) 1.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.54		28.48	
CRUCIBLE WT	(gm)	27.72		27.69	
SAMPLE WT	(gm)	0.82		0.79	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.73		27.70	
CRUCIBLE WT	(gm)	27.72		27.69	
ASH WT	(gm)	0.01	% 1.22	0.01	% 1.27
COMBUSTIBLE CARBON WT	(gm)	0.81	% 98.78	0.78	% 98.73

AVERAGE % INORGANIC ASH 1.25 AVERAGE % COMBUSTIBLE CARBON 98.78

DATA FORM - WOOD ASH ANALYSES

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS

SIZE (mm) 0.500

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.13		28.28	
CRUCIBLE WT	(gm)	27.79		27.01	
SAMPLE WT	(gm)	1.34		1.27	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.83		27.05	
CRUCIBLE WT	(gm)	27.79		27.01	
ASH WT	(gm)	0.04	% 2.99	0.04	% 3.15
COMBUSTIBLE CARBON WT	(gm)	1.30	% 97.01	1.23	% 96.85

AVERAGE % INORGANIC ASH 3.07 AVERAGE % COMBUSTIBLE CARBON 96.93

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER SHAVING

SIZE (mm) 0.250

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.11		27.49	
CRUCIBLE WT	(gm)	26.93		26.32	
SAMPLE WT	(gm)	1.18		1.17	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.08		26.48	
CRUCIBLE WT	(gm)	26.93		26.32	
ASH WT	(gm)	0.15	% 12.71	0.16	% 13.68
COMBUSTIBLE CARBON WT	(gm)	1.03	% 87.29	1.01	% 86.32

AVERAGE % INORGANIC ASH 13.20 AVERAGE % COMBUSTIBLE CARBON 86.81

DATA FORM - WOOD ASH ANALYSES

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS
SIZE (mm) 0.125

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.68		29.76	
CRUCIBLE WT	(gm)	26.53		26.63	
SAMPLE WT	(gm)	3.15		3.13	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.36		27.44	
CRUCIBLE WT	(gm)	26.53		26.63	
ASH WT	(gm)	0.83	% 26.35	0.81	% 25.88
COMBUSTIBLE CARBON WT	(gm)	2.32	% 73.65	2.32	% 74.12

AVERAGE % INORGANIC ASH 26.12 AVERAGE % COMBUSTIBLE CARBON 73.89

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS
SIZE (mm) 0.063

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.34		27.35	
CRUCIBLE WT	(gm)	26.86		25.84	
SAMPLE WT	(gm)	1.48		1.51	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.47		26.47	
CRUCIBLE WT	(gm)	26.86		25.84	
ASH WT	(gm)	0.61	% 41.22	0.63	% 41.72
COMBUSTIBLE CARBON WT	(gm)	0.87	% 58.78	0.88	% 58.28

AVERAGE % INORGANIC ASH 41.47 AVERAGE % COMBUSTIBLE CARBON 58.53

DATA FORM - WOOD ASH ANALYSES

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER SHAVINGS

SIZE (mm) 0.045

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	27.86		26.95	
CRUCIBLE WT	(gm)	27.46		26.47	
SAMPLE WT	(gm)	0.40		0.48	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.66		26.71	
CRUCIBLE WT	(gm)	27.46		26.47	
ASH WT	(gm)	0.20	% 50.00	0.24	% 50.00
COMBUSTIBLE CARBON WT	(gm)	0.20	% 50.00	0.24	% 50.00

AVERAGE % INORGANIC ASH 50.00 AVERAGE % COMBUSTIBLE CARBON 50.00

RUN NO. 27

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS

SIZE (mm) PAN

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	27.12		27.51	
CRUCIBLE WT	(gm)	26.33		26.72	
SAMPLE WT	(gm)	0.79		0.79	
FINAL SAMPLE + CRUCIBLE WT	(gm)	26.80		27.19	
CRUCIBLE WT	(gm)	26.33		26.72	
ASH WT	(gm)	0.47	% 59.49	0.47	% 59.49
COMBUSTIBLE CARBON WT	(gm)	0.32	% 40.51	0.32	% 40.51

AVERAGE % INORGANIC ASH 59.49 AVERAGE % COMBUSTIBLE CARBON 40.51

DATA FORM - WOOD ASH ANALYSES

RUN NO: 39

DOUG. FIR PLANER SHAVINGS

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT	(gm)		
CRUCIBLE WT	(gm)		
SAMPLE WT	(gm)		
FINAL SAMPLE + CRUCIBLE WT	(gm)		
CRUCIBLE WT	(gm)		
ASH WT	(gm)	____ %	____ %
COMBUSTABLE CARBON WT	(gm)	____ %	____ %

AVERAGE % INORGANIC ASH: _____ AVERAGE % COMBUSTABLE CARBON: _____

* *

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
2.000	20.34	17.12	3.22	77.35		45	0.072
1.000	33.36	17.12	16.24	74.13	95.84	199	0.082
.500	44.54	17.12	27.42	57.89	74.84	270	0.102
.250	29.25	17.12	12.13	30.47	39.39	80	0.152
.125	26.42	17.12	9.30	18.34	23.71	39	0.238
.063	21.98	17.12	4.86	9.04	11.69	17	0.286
.045	18.44	17.12	1.32	4.18	5.40	4	0.330
PAN	19.98	17.12	2.86	2.86	3.70	9	0.318

DATA FORM - WOOD ASH ANALYSES

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER SHAVINGS
SIZE (mm) 2.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	17.84		17.79	
CRUCIBLE WT	(gm)	17.05		17.00	
SAMPLE WT	(gm)	0.79		0.79	
FINAL SAMPLE + CRUCIBLE WT	(gm)	17.06		17.01	
CRUCIBLE WT	(gm)	17.05		17.00	
ASH WT	(gm)	0.01	% 1.27	0.01	% 1.27
COMBUSTIBLE CARBON WT	(gm)	0.78	% 98.73	0.78	% 98.73

AVERAGE % INORGANIC ASH 1.27 AVERAGE % COMBUSTIBLE CARBON 98.73

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER SHAVINGS
SIZE (mm) 1.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	19.30		17.82	
CRUCIBLE WT	(gm)	18.26		16.77	
SAMPLE WT	(gm)	1.04		1.05	
FINAL SAMPLE + CRUCIBLE WT	(gm)	18.27		16.78	
CRUCIBLE WT	(gm)	18.26		16.77	
ASH WT	(gm)	0.01	% 0.96	0.01	% 0.95
COMBUSTIBLE CARBON WT	(gm)	1.03	% 99.04	1.04	% 99.05

AVERAGE % INORGANIC ASH 0.96 AVERAGE % COMBUSTIBLE CARBON 99.05

DATA FORM - WOOD ASH ANALYSES

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVING
SIZE (mm) 0.500

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	17.57		17.93	
CRUCIBLE WT	(gm)	16.48		16.92	
SAMPLE WT	(gm)	1.09		1.01	
FINAL SAMPLE + CRUCIBLE WT	(gm)	16.51		16.95	
CRUCIBLE WT	(gm)	16.48		16.92	
ASH WT	(gm)	0.03	% 2.75	0.03	% 2.97
COMBUSTIBLE CARBON WT	(gm)	1.06	% 97.25	0.98	% 97.03

AVERAGE % INORGANIC ASH 2.86 AVERAGE % COMBUSTIBLE CARBON 97.14

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS
SIZE (mm) 0.250

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	18.24		18.48	
CRUCIBLE WT	(gm)	16.66		16.93	
SAMPLE WT	(gm)	1.58		1.55	
FINAL SAMPLE + CRUCIBLE WT	(gm)	16.90		17.16	
CRUCIBLE WT	(gm)	16.66		16.93	
ASH WT	(gm)	0.24	% 15.19	0.23	% 14.84
COMBUSTIBLE CARBON WT	(gm)	1.34	% 84.81	1.32	% 85.16

AVERAGE % INORGANIC ASH 15.02 AVERAGE % COMBUSTIBLE CARBON 84.99

DATA FORM - WOOD ASH ANALYSES

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS

SIZE (mm) 0.125

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	18.52		20.58	
CRUCIBLE WT	(gm)	16.20		18.25	
SAMPLE WT	(gm)	2.32		2.33	
FINAL SAMPLE + CRUCIBLE WT	(gm)	16.82		18.85	
CRUCIBLE WT	(gm)	16.20		18.25	
ASH WT	(gm)	0.62	% 26.72	0.60	% 25.75
COMBUSTIBLE CARBON WT	(gm)	1.70	% 73.28	1.73	% 74.25

AVERAGE % INORGANIC ASH 26.24 AVERAGE % COMBUSTIBLE CARBON 73.77

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR. PLANER SHAVING

SIZE (mm) 0.063

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	18.69		19.14	
CRUCIBLE WT	(gm)	16.51		16.78	
SAMPLE WT	(gm)	2.18		2.36	
FINAL SAMPLE + CRUCIBLE WT	(gm)	17.24		17.58	
CRUCIBLE WT	(gm)	16.51		16.78	
ASH WT	(gm)	0.73	% 33.49	0.80	% 33.90
COMBUSTIBLE CARBON WT	(gm)	1.45	% 66.51	1.56	% 66.10

AVERAGE % INORGANIC ASH 33.70 AVERAGE % COMBUSTIBLE CARBON 66.31

DATA FORM - WOOD ASH ANALYSES

RUN NO. 39

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS
SIZE (mm) 0.045

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	18.24		17.25	
CRUCIBLE WT	(gm)	17.82		16.59	
SAMPLE WT	(gm)	0.42		0.66	
FINAL SAMPLE + CRUCIBLE WT	(gm)	17.99		16.85	
CRUCIBLE WT	(gm)	17.82		16.59	
ASH WT	(gm)	0.17	%40.48	0.26	%39.39
COMBUSTIBLE CARBON WT	(gm)	0.25	%59.52	0.40	%60.61

AVERAGE % INORGANIC ASH 39.94 AVERAGE % COMBUSTIBLE CARBON 60.07

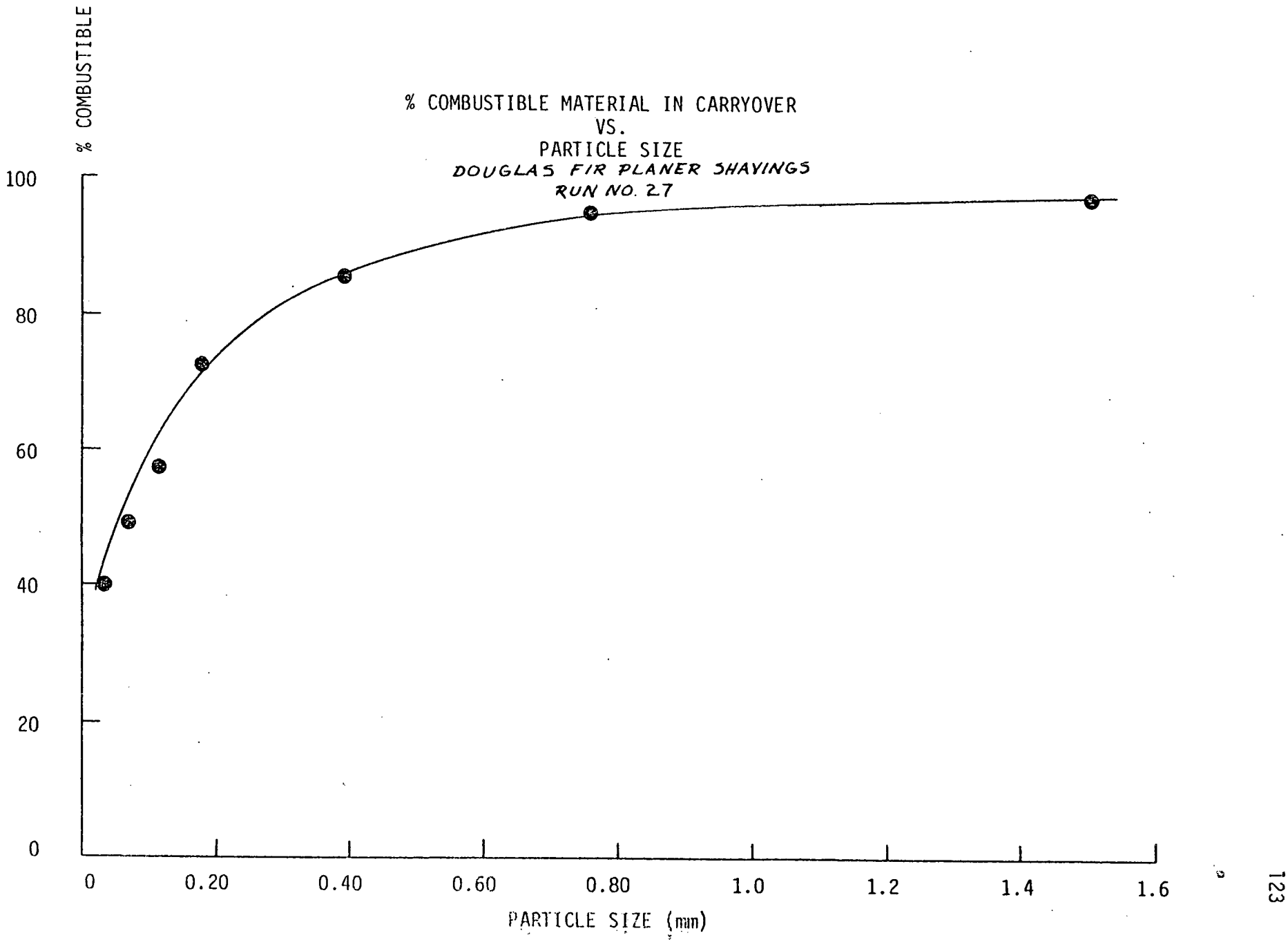
RUN NO. 39

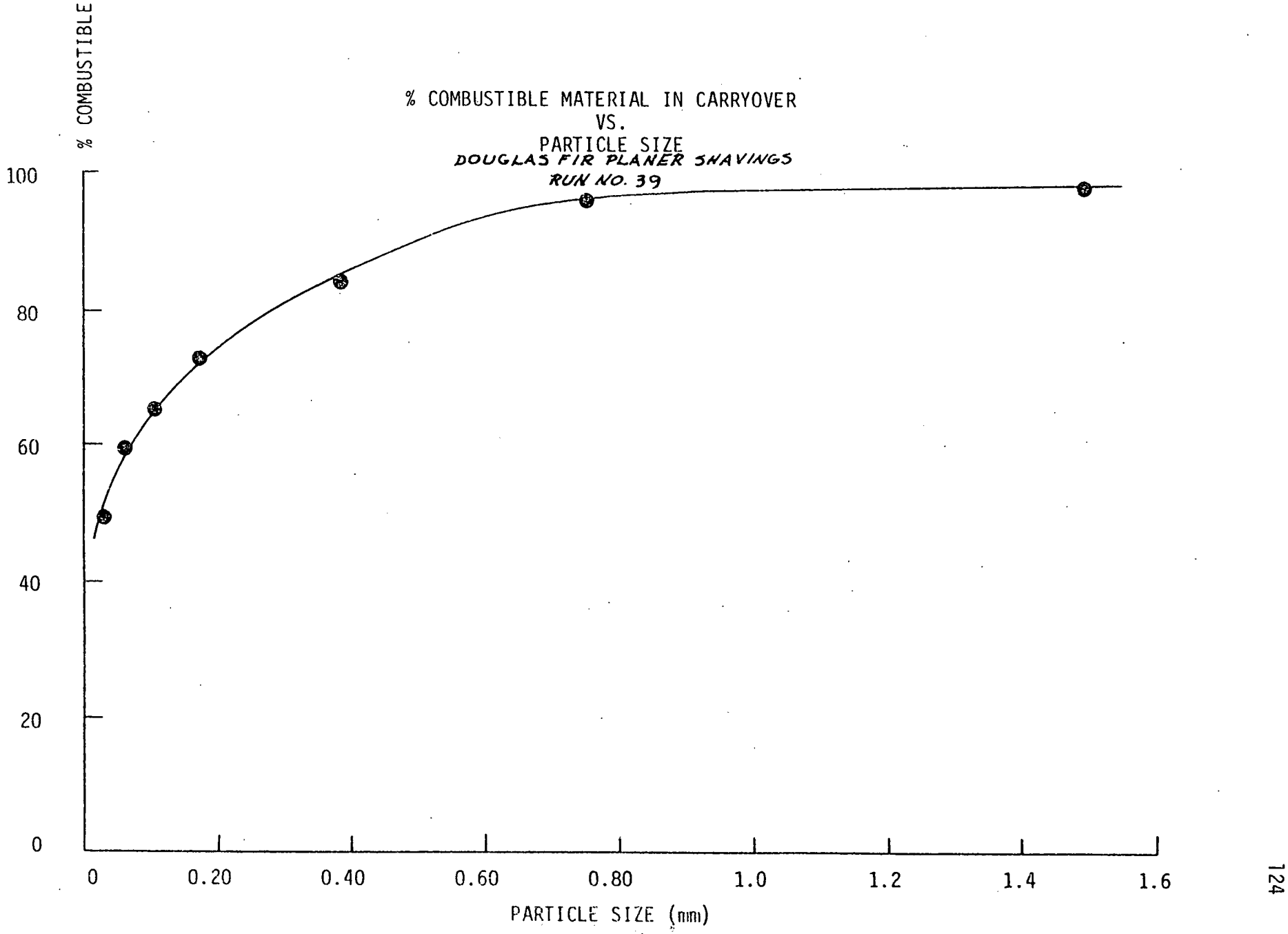
COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER SHAVINGS
SIZE (mm) PAN

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	19.34		18.52	
CRUCIBLE WT	(gm)	18.29		17.11	
SAMPLE WT	(gm)	1.05		1.41	
FINAL SAMPLE + CRUCIBLE WT	(gm)	18.81		17.81	
CRUCIBLE WT	(gm)	18.29		17.11	
ASH WT	(gm)	0.52	%49.52	0.70	%49.65
COMBUSTIBLE CARBON WT	(gm)	0.53	%50.48	0.71	%50.35

AVERAGE % INORGANIC ASH 49.59 AVERAGE % COMBUSTIBLE CARBON 50.42


% COMBUSTIBLE MATERIAL IN CARRYOVER
VS.
PARTICLE SIZE
DOUGLAS FIR PLANER SHAVINGS
RUN NO. 27
% COMBUSTIBLE
100
80
60
40
20
0
0
0.20
0.40
0.60
0.80
1.0
1.2
1.4
1.6
PARTICLE SIZE (mm)


% COMBUSTIBLE MATERIAL IN CARRYOVER
VS.
PARTICLE SIZE
DOUGLAS FIR PLANER SHAVINGS
RUN NO. 39
% COMBUSTIBLE
100
80
60
40
20
0
0
0.20
0.40
0.60
0.80
1.0
1.2
1.4
1.6
PARTICLE SIZE (mm)