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THE COMBUSTION CHARACTERISTICS OF EASTERN WHITE PINE BARK AND DOUGLAS FIR PLANER SHAVINGS

TECHNICAL PROGRESS REPORT NO. 5

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
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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 Eastern White Pine bark mixed with 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
Douglas Fir Planer Shavings
Red Alder Sawdust
Red Alder Bark
Ponderosa Pine Bark
Hemlock 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 air should be distributed approximately 40% undergrate and 60% overfire to achieve minimum air pollutant emissions and maximum combustion efficiency. Care must be taken to avoid burning out the grates with this combustion mode;
3) The temperature of the combustion air has a minor effect on combustion efficiency and air pollutant emissions. As the temperature increases, efficiency goes down slightly and air pollutant emissions increase slightly. Low temperature air results in emissions which are approximately 20% lower than air which is preheated to 387 ^{o}F. However, the use of low temperature inlet air reduces thermal efficiency of the boiler. Ideally, the undergrate air should be kept at ambient temperatures and the overfire air should be raised to maximum temperatures permitted by the air preheater.
4) The combustible content of the boiler emissions ranges over a wide spread (10.5% - 81.1%). In the optimal combustion modes, the mean combustible content of the ash is 35.2%. Approximately 1% of the total fuel input to the furnace will be carried out as ash. Therefore, approximately 1/3 of 1% will be carried out as combustible material. The potential heat recovery from this ash is relatively small and probably does not warrant attempts collect it. Therefore, I would recommend that the total ash be used for landfill if at all possible.

5) The mass mean size of the ash typically ranges from 0.06 mm to 0.71 mm. Under optimum combustion conditions, the mass mean size ranges from 0.06 to 0.22 mm.
6) The mass mean density of the ash typically ranges from 0.07 to 0.70 g/cm^3. Under optimum combustion conditions the mass mean density ranges from 0.25 to 0.70 g/cm^3.
7) Careful control of combustion conditions can reduce pollutant emissions by approximately 90%.

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.

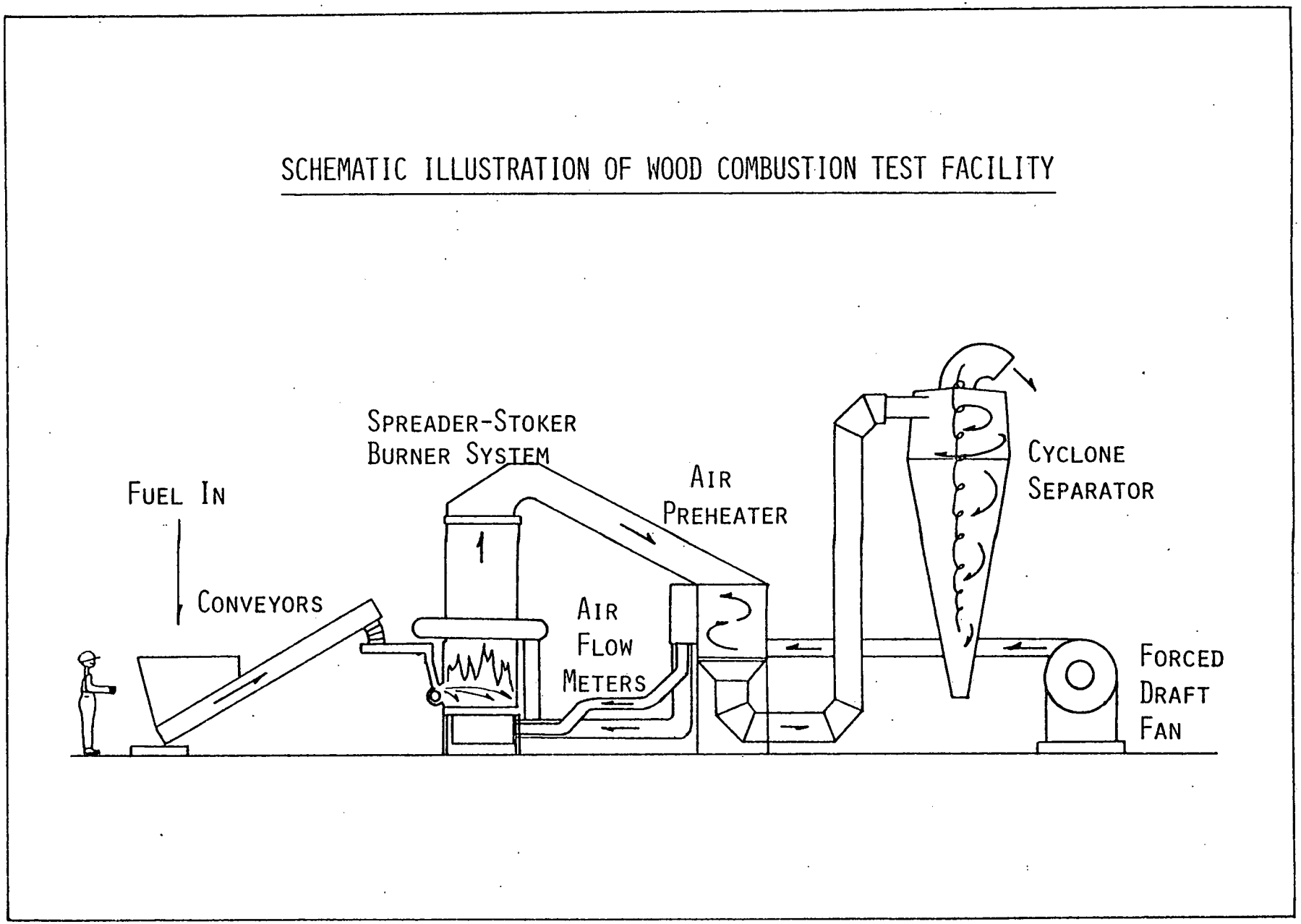


Figure 1: Wood Combustion Test Facility - Oregon State University

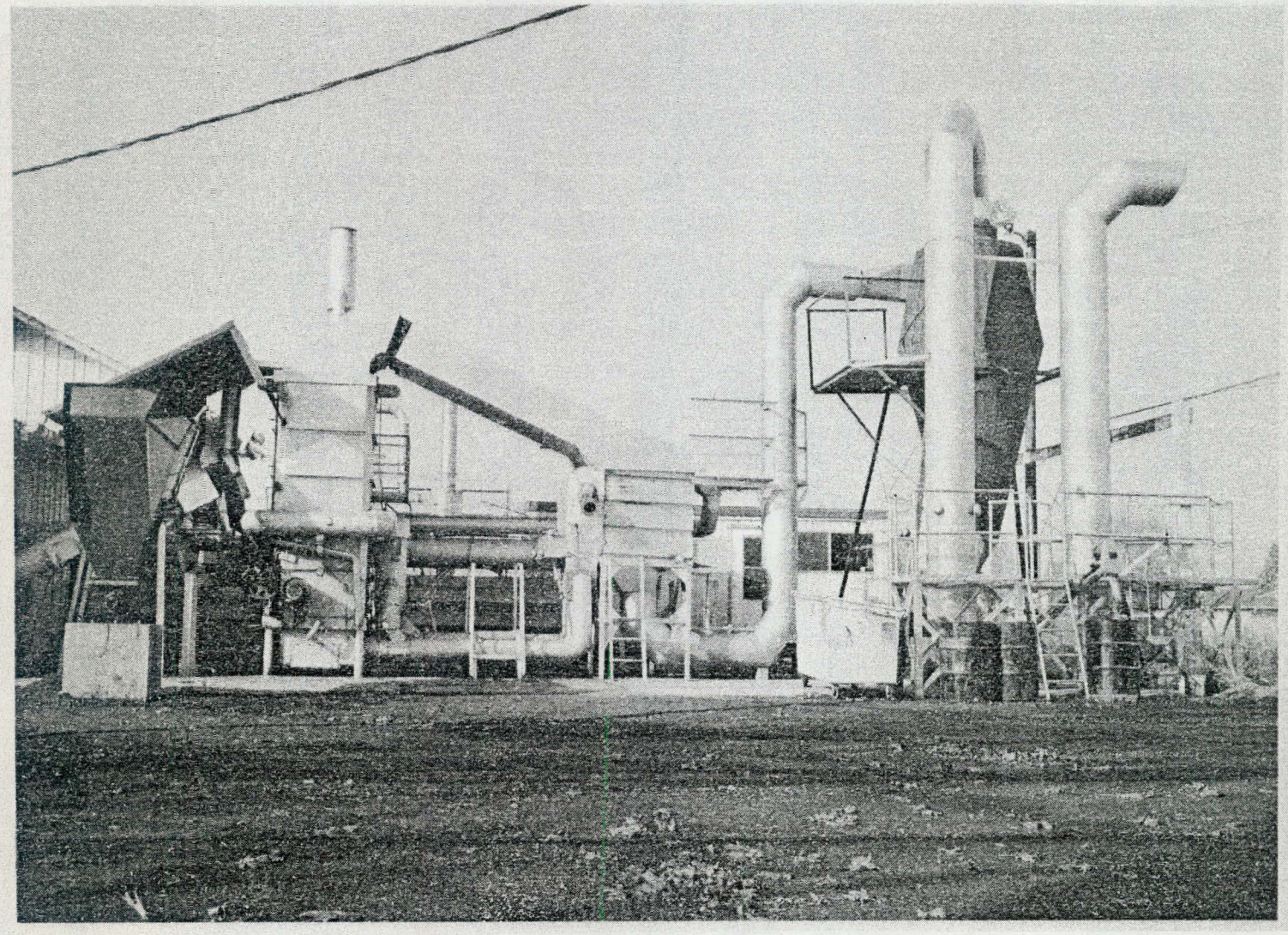


Figure 2: Photograph of the Experimental Test Facility - Oregon State University

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

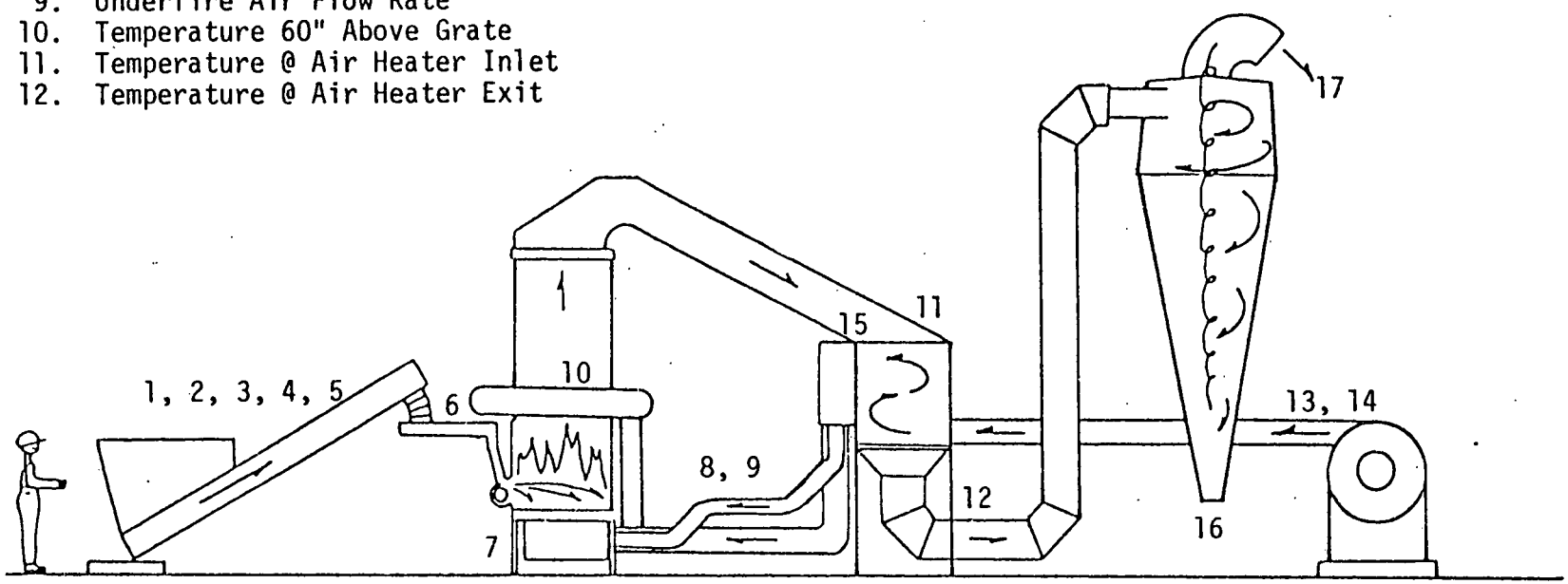


Figure 3: Schematic Illustration of Instrumentation Used With the Combustion Test Facility

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: E. White Pine bark and D. Fir 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:	56			
Test Run Numbers:	65	To	128	
Range - Fuel Size Used	1.0	To	20.0	(mm)
Range - Fuel Moisture Levels Used:	51	To	51	(%H_2O: "As-Is")
Range - Fuel Feed Rates Used:	523	To	738	(Dry Pounds/Hr)
Range - Levels of Excess Air:	25	To	165	(%)
Range - Levels of Inlet Air Temp:	130	To	415	(^oF)
Range - Levels of Air Distribution:	29	To	85	(% 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 37. 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 63.

The ash analyses results are noted in both tabular and graphic form beginning on page 72. The combustible content of the ash samples as a function of their size distribution is noted in tabular and graphic form beginning on page 145.

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): 523 to 738

   Effects statistically significant within the range studied:

   Yes XXX No _____
4. INLET AIR TEMPERATURE:

   Effects statistically significant within the range studied:

   Yes XXX No _____

   As air temperature increases, emissions increase XX decrease ___

   Reference: See pages 58 - 60.
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 61, 62.
6. DISTRIBUTION OF AIR ABOVE AND BELOW THE GRATE: Lb Air/Lb Dry Fuel

   Optimum rate of air flow through the grate: 3.0 - 4.2

   Range of air flow rates through the grate which were successfully tested: 2.68 to 11.09

   Overall optimum air distribution:

   Above the grate (overfire air): 55 (%) to 68 (%)

   Below the grate (underfire air): 32 (%) to 45 (%)

   Reference: See pages 49 - 57.

SUMMARY OF ASH CHARACTERISTICS

	All Tests (Range)	Optimum Combustion Conditions (Mean)	Optimum Combustion Conditions (Range)
1. Rate of Total Carryover (lbs/hr)	3.60 to 34.5	5.80	3.60 to 10.8
2. Concentration of Total Particulate (gr/SCF - not corrected to 12% CO_2)	0.31 to 2.30	0.50	0.31 to 0.95
3. Rate of Total Carryover (lb/lb dry fuel)	0.61 to 4.85	0.90	0.61 to 1.46
4. Rate of Combustible Carryover (lb/lb dry fuel)	0.08 to 3.12	0.26	0.08 to 0.64
5. Rate of Inorganic Carryover (lb/lb dry fuel)	0.24 to 2.05	0.57	0.38 to 0.82
6. Mass Mean Size (mm)	0.06 to 0.71	0.13	0.06 to 0.22
7. Mass Mean Density (g/cm^3)	0.07 to 0.70	0.44	0.25 to 0.70
8. Mean Combustible Content (%)	10.5 to 81.1	35.2	10.5 to 43.5

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

See pages 156-157.

EXPERIMENTAL DATA SUMMARY SHEETS

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 65 TO 128 FUEL SPECIES: E. WHITE PINE & DOUGLAS FIR SHAVING

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

MASS MEAN SIZE (mm): 5.1 SIZE RANGE (mm): 20.0 TO 1.0

MASS MEAN DENSITY (g/cm^3): 0.19 DENSITY RANGE (g/cm^3): 0.184 TO 0.253

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 97.79

= = = =

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 65 TO 128 FUEL SPECIES: E. WHITE PINE & DOUGLAS FIR PL. SHAVINGS

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

MASS MEAN SIZE (mm): 5.1 SIZE RANGE (mm): 1.0 TO 20.0

MASS MEAN DENSITY (g/cm^3): 0.19 DENSITY RANGE (g/cm^3): 0.184 TO 0.253

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 97.79

= = = =

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 65 TO 128 FUEL SPECIES: E. WHITE PINE & DOUGLAS FIR. PL. SHAVINGS.

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

MASS MEAN SIZE (mm): 5.1 SIZE RANGE (mm): 1.0 TO 20.0

MASS MEAN DENSITY (g/cm^3): 0.19 DENSITY RANGE (g/cm^3): 0.184 TO 0.253

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 97.79

= = = =

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 65 TO 128 FUEL SPECIES: E. WHITE PINE & DOUGLAS FIR PL. SHAVINGS

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

MASS MEAN SIZE (mm): 5.1 SIZE RANGE (mm): 1.0 TO 20.0

MASS MEAN DENSITY (g/cm^3): 0.19 DENSITY RANGE (g/cm^3): 0.184 TO 0.253

COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 97.79

= = = =

WOOD SPECIES: D. FIR & E.WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	650.	660.	670.	680.	690.
DATE:	3-6-78	3-6-78	3-6-78	3-6-78	3-6-78
CONVEYOR SETTING:	40.	40.	43.	43.	43.
FUEL FEED RATE: (DRY LBS/HR)	550.	550.	590.	590.	590.
HEAT INPUT RATE: (BTU/HR)	4951487.	4951487.	5314409.	5314409.	5314409.
HEAT RELEASE RATE: (BTU/HR-SQFT)	495149.	495149.	531441.	531441.	531441.
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:	53.	50.	25.	25.	50.
TEMPERATURES (DEGREES F)					
T2:	1365.	1415.	1263.	1245.	1300.
T3:	993.	1000.	1108.	1095.	1075.
T4:	683.	684.	758.	760.	778.
FAN OUTLET:	63.	64.	65.	64.	64.
UNDERGRATE:	395.	395.	410.	403.	392.
OVERFIRE:	330.	330.	302.	298.	308.
AIR HEATER:	463.	466.	500.	498.	447.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.1	.1	0.0	0.0	.1
6" VENTURI:	8.5	8.5	.2	.2	.6
12" VENTURI:	.8	.8	1.4	1.4	2.3
3" CONVEYOR:	3.0	3.0	2.9	3.0	3.0
ACROSS GRATE:	1.1	1.3	2.5	2.5	2.5
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	7.3	7.0	4.5	4.5	7.0
CARBON DIOXIDE:	12.3	12.3	15.1	15.1	12.0
CARBON MONOXIDE:	.35	.28	.43	.45	.50
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	677.	677.	0.	0.	743.
UNDERGRATE:	952.	953.	1511.	1510.	1819.
OVERFIRE:	1274.	1276.	271.	273.	377.
AIR FLOW RATES (SCFM)					
MAIN:	636.	636.	0.	0.	698.
UNDERGRATE:	507.	507.	774.	775.	987.
OVERFIRE:	679.	678.	139.	140.	204.
UNDER + OVER:	1186.	1184.	913.	915.	1191.
CALC. BASED ON : FUEL AND EX. AIR	1080.	1058.	947.	947.	1136.
PERCENT UG:OF	43.:57.	43.:57.	85.:15.	85.:15.	83.:17.
CARRY OVER DATA					
LBS/HR:	8.0	9.3	18.3	17.7	13.7
GR/SCF:	.865	1.025	2.255	2.131	1.409
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	21.	20.	20.	20.	21.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.178 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT):17.30

RUN NO:	70.	71.	72.	73.	74.
DATE:	3-6-78	3-7-78	3-7-78	3-7-78	3-7-78
CONVEYOR SETTING:	43.	43.	43.	43.	43.
FUEL FEED RATE: (DRY LBS/HR)	590.	590.	590.	590.	590.
HEAT INPUT RATE: (BTU/HR)	5314409.	5314409.	5314409.	5314409.	5314409.
HEAT RELEASE RATE: (BTU/HR-SQFT)	531441.	531441.	531441.	531441.	531441.
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:	55.	107.	93.	155.	165.
TEMPERATURES (DEGREES F)					
T2:	1320.	1326.	1316.	1345.	1333.
T3:	1048.	1030.	1027.	998.	1000.
T4:	772.	712.	727.	738.	740.
FAN OUTLET:	64.	60.	60.	61.	62.
UNDERGRATE:	383.	400.	403.	403.	395.
OVERFIRE:	304.	307.	308.	314.	311.
AIR HEATER:	432.	441.	441.	415.	408.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.1	.1	.1	.2	.2
6" VENTURI:	.6	1.0	1.0	1.5	1.5
12" VENTURI:	2.3	3.1	3.0	4.4	4.4
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	2.5	2.5	2.5	2.5	2.5
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	7.5	10.9	10.2	12.9	13.2
CARBON DIOXIDE:	11.5	9.6	10.2	7.4	7.1
CARBON MONOXIDE:	.50	.60	.62	.65	.67
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	804.	1147.	1105.	1512.	1512.
UNDERGRATE:	1804.	2063.	2034.	2364.	2354.
OVERFIRE:	375.	449.	449.	516.	514.
AIR FLOW RATES (SCFM)					
MAIN:	756.	1086.	1045.	1427.	1426.
UNDERGRATE:	995.	1126.	1110.	1329.	1335.
OVERFIRE:	207.	245.	245.	290.	291.
UNDER + OVER:	1202.	1372.	1356.	1619.	1626.
CALC. BASED ON : FUEL AND EX. AIR	1174.	1568.	1462.	1931.	2007.
PERCENT UG:OF	83.:17.	82.:18.	82.:18.	82.:18.	82.:18.
CARRY OVER DATA					
LBS/HR:	12.3	11.7	11.4	10.8	11.4
GR/SCF:	1.223	.871	.910	.652	.663
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	RAIN	RAIN	CLOUDY

SRU 1.470 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	75.	76.	77.	78.	79.
DATE:	3-7-78	3-7-78	3-7-78	3-7-78	3-7-78
CONVEYOR SETTING:	43.	43.	43.	43.	43.
FUEL FEED RATE: (DRY LBS/HR)	590.	590.	590.	590.	590.
HEAT INPUT RATE: (BTU/HR)	5314409.	5314409.	5314409.	5314409.	5314409.
HEAT RELEASE RATE: (BTU/HR-SQFT)	531441.	531441.	531441.	531441.	531441.
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:	48.	48.	90.	85.	98.
TEMPERATURES (DEGREES F)					
T2:	1335.	1387.	1443.	1420.	1428.
T3:	1042.	1033.	1020.	1025.	1011.
T4:	680.	680.	695.	697.	720.
FAN OUTLET:	60.	60.	60.	60.	60.
UNDERGRATE:	363.	3563.	388.	387.	388.
OVERFIRE:	422.	423.	415.	411.	412.
AIR HEATER:	486.	483.	478.	475.	469.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	0.0	0.0	.0	.0	.1
6" VENTURI:	5.1	5.1	9.0	9.1	12.6
12" VENTURI:	.5	.5	.8	.8	1.2
3" CONVEYOR:	3.0	3.0	2.9	3.0	3.0
ACROSS GRATE:	1.7	1.4	1.7	1.4	1.7
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	6.8	6.8	9.9	9.7	10.4
CARBON DIOXIDE:	13.5	13.8	11.0	11.2	10.5
CARBON MONOXIDE:	.70	.44	.10	.12	.17
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	0.	0.	604.	604.	1014.
UNDERGRATE:	962.	961.	1173.	1172.	1391.
OVERFIRE:	865.	864.	1094.	1099.	1262.
AIR FLOW RATES (SCFM)					
MAIN:	0.	0.	572.	571.	959.
UNDERGRATE:	500.	501.	615.	616.	737.
OVERFIRE:	450.	451.	574.	579.	668.
UNDER + OVER:	951.	952.	1189.	1195.	1405.
CALC. BASED ON : FUEL AND EX. AIR	1121.	1121.	1439.	1401.	1499.
PERCENT UG:OF	53.:47.	53.:47.	52.:48.	52.:48.	52.:48.
CARRY OVER DATA					
LBS/HR:	13.2	11.7	9.7	11.1	9.9
GR/SCF:	1.374	1.218	.783	.924	.770
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	23.	20.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	RAIN	RAIN	RAIN	RAIN	RAIN

SRU 1.188 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	80.	87.	88.	89.	90.
DATE:	3-7-78	3-9-78	3-9-78	3-9-78	3-9-78
CONVEYOR SETTING:	43.	43.	43.	43.	43.
FUEL FEED RATE: (DRY LBS/HR)	590.	590.	590.	590.	590.
HEAT INPUT RATE: (BTU/HR)	5314409.	5314409.	5314409.	5314409.	5314409.
HEAT RELEASE RATE: (BTU/HR-SQFT)	531441.	531441.	531441.	531441.	531441.
UNDERFIRE:	12.INCH	6.INCH	6.INCH	6.INCH	6.INCH
OVERFIRE:	6.INCH	12.INCH	12.INCH	12.INCH	12.INCH
PERCENT EX. AIR:	106.	82.	82.	90.	88.
TEMPERATURES (DEGREES F)					
T2:	1435.	1587.	1567.	1503.	1515.
T3:	985.	990.	987.	990.	997.
T4:	707.	660.	662.	698.	702.
FAN OUTLET:	60.	59.	59.	60.	60.
UNDERGRATE:	390.	393.	398.	398.	402.
OVERFIRE:	408.	382.	388.	377.	380.
AIR HEATER:	460.	410.	430.	414.	420.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.1	.1	.1	.2	.2
6" VENTURI:	12.8	5.8	5.8	7.7	7.8
12" VENTURI:	1.2	1.7	1.8	2.6	2.6
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.7	1.1	1.1	1.2	1.1
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.9	9.5	9.5	10.0	9.8
CARBON DIOXIDE:	10.0	11.5	11.5	10.7	10.5
CARBON MONOXIDE:	.14	.06	.05	.13	.08
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	1014.	1060.	1060.	1305.	1267.
UNDERGRATE:	1384.	770.	779.	884.	892.
OVERFIRE:	1265.	1674.	1731.	1993.	1999.
AIR FLOW RATES (SCFM)					
MAIN:	960.	1006.	1006.	1236.	1199.
UNDERGRATE:	740.	436.	431.	497.	499.
OVERFIRE:	676.	947.	957.	1122.	1118.
UNDER + OVER:	1417.	1382.	1388.	1619.	1617.
CALC. BASED ON : FUEL AND EX. AIR	1560.	1378.	1378.	1439.	1424.
PERCENT UG:OF	52.:48.	32.:68.	31.:69.	31.:69.	31.:69.
CARRY OVER DATA					
LBS/HR:	8.1	3.9	3.6	3.9	4.2
GR/SCF:	.606	.330	.305	.316	.344
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:	RAIN	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.529 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR PLANAR SHAV. & WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	91.	92.	93.	94.	95.
DATE:	3-1-78	3-13-78	3-13-78	3-13-78	3-13-78
CONVEYOR SETTING:	43.	43.	40.	40.	40.
FUEL FEED RATE: (DRY LBS/HR)	590.	590.	550.	550.	550.
HEAT INPUT RATE: (BTU/HR)	5314409.	5314409.	4951487.	4951487.	4951487.
HEAT RELEASE RATE: (BTU/HR-SQFT)	531441.	531441.	495149.	495149.	495149.
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:	25.	24.	50.	51.	65.
TEMPERATURES (DEGREES F)					
T2:	1342.	1350.	1323.	1320.	1287.
T3:	1062.	1060.	977.	980.	940.
T4:	718.	720.	683.	680.	687.
FAN OUTLET:	54.	55.	55.	56.	55.
UNDERGRATE:	152.	152.	157.	155.	170.
OVERFIRE:	152.	152.	157.	155.	170.
AIR HEATER:	167.	170.	173.	170.	190.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.1	.1	.2	.2	.3
6" VENTURI:	.8	.8	1.3	1.4	2.2
12" VENTURI:	.7	.7	.9	.8	1.5
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	2.0	1.4	2.0	2.0	2.5
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	4.4	4.3	7.0	7.1	8.3
CARBON DIOXIDE:	17.4	17.0	13.2	12.6	11.2
CARBON MONOXIDE:	.30	.32	.09	.18	.25
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0
AIR FLOW RATES (ACFM)					
MAIN:	1060.	1147.	1446.	1412.	1780.
UNDERGRATE:	906.	908.	1014.	962.	1281.
OVERFIRE:	365.	365.	432.	443.	530.
AIR FLOW RATES (SCFM)					
MAIN:	1014.	1096.	1382.	1347.	1702.
UNDERGRATE:	711.	709.	788.	751.	970.
OVERFIRE:	286.	285.	336.	346.	401.
UNDER + OVER:	997.	994.	1124.	1097.	1370.
CALC. BASED ON : FUEL AND EX. AIR	947.	939.	1058.	1065.	1164.
PERCENT UG:OF	71.:29.	71.:29.	70.:30.	68.:32.	71.:29.
CARRY OVER DATA					
LBS/HR:	17.7	18.0	10.2	9.3	11.1
GR/SCF:	2.181	2.236	1.124	1.018	1.117
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	21.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	CLOUDY	SUNNY	RAIN	CLOUDY	CLOUDY

SRU 1.517 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	96.	97.	98.	99.	100.
DATE:	3-13-78	3-13-78	3-13-78	3-14-78	3-13-78
CONVEYOR SETTING:	40.	40.	40.	40.	40.
FUEL FEED RATE: (DRY LBS/HR)	550.	550.	550.	550.	550.
HEAT INPUT RATE: (BTU/HR)	4951487.	4951487.	4951487.	4951487.	4951487.
HEAT RELEASE RATE: (BTU/HR-SQFT)	495149.	495149.	495149.	495149.	495149.
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:	73.	88.	91.	33.	34.
TEMPERATURES (DEGREES F)					
T2:	1302.	1317.	1333.	1400.	1402.
T3:	950.	933.	923.	983.	985.
T4:	687.	692.	698.	638.	645.
FAN OUTLET:	54.	57.	54.	52.	54.
UNDERGRATE:	172.	175.	172.	140.	143.
OVERFIRE:	172.	175.	172.	140.	143.
AIR HEATER:	187.	200.	199.	160.	163.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.3	.5	.5	.2	.2
6" VENTURI:	2.2	3.0	3.0	3.7	3.7
12" VENTURI:	1.5	2.1	2.1	.4	.4
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	2.5	2.1	2.5	1.3	1.4
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	8.8	9.8	10.0	5.4	5.5
CARBON DIOXIDE:	11.2	11.5	11.2	15.3	15.5
CARBON MONOXIDE:	.19	.25	.27	.28	.25
OXIDES OF NITROGEN:	.0	.0	.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	1808.	2134.	2157.	1377.	1377.
UNDERGRATE:	1278.	1492.	1491.	707.	709.
OVERFIRE:	529.	600.	600.	635.	636.
AIR FLOW RATES (SCFM)					
MAIN:	1729.	2032.	2067.	1324.	1318.
UNDERGRATE:	972.	1112.	1113.	561.	560.
OVERFIRE:	402.	447.	448.	504.	502.
UNDER + OVER:	1374.	1560.	1561.	1065.	1062.
CALC. BASED ON : FUEL AND EX. AIR	1221.	1327.	1348.	938.	945.
PERCENT UG:OF	71.:29.	71.:29.	71.:29.	53.:47.	53.:47.
CARRY OVER DATA					
LBS/HR:	10.5	10.5	9.9	8.7	8.4
GR/SCF:	1.004	.923	.857	1.082	1.037
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:	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY

SRU 1.554 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	101.	102.	103.	104.	105.
DATE:	3-14-78	3-14-78	3-14-78	3-14-78	3-14-78
CONVEYOR SETTING:	40.	40.	38.	40.	40.
FUEL FEED RATE: (DRY LBS/HR)	550.	550.	523.	550.	550.
HEAT INPUT RATE: (BTU/HR)	4951487.	4951487.	4709539.	4951487.	4951487.
HEAT RELEASE RATE: (BTU/HR-SQFT)	495149.	495149.	470954.	495149.	495149.
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:	44.	43.	76.	74.	105.
TEMPERATURES (DEGREES F)					
T2:	1403.	1433.	1320.	1325.	1300.
T3:	970.	992.	927.	930.	900.
T4:	657.	665.	643.	652.	652.
FAN OUTLET:	55.	56.	57.	58.	57.
UNDERGRATE:	160.	163.	163.	160.	175.
OVERFIRE:	160.	163.	163.	160.	175.
AIR HEATER:	180.	183.	183.	180.	195.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.3	.3	.4	.4	.5
6" VENTURI:	5.5	5.5	8.5	8.5	11.4
12" VENTURI:	.5	.5	.6	.6	.9
3" CONVEYOR:	3.0	2.9	3.0	3.0	3.0
ACROSS GRATE:	1.4	1.3	1.4	1.7	1.7
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	6.5	6.3	9.0	8.8	10.8
CARBON DIOXIDE:	13.5	14.6	11.2	11.0	10.2
CARBON MONOXIDE:	.19	.15	.23	.24	.25
OXIDES OF NITROGEN:	0.0	0.0	.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	1576.	1576.	1939.	1939.	2157.
UNDERGRATE:	791.	793.	858.	856.	1032.
OVERFIRE:	754.	754.	904.	902.	1032.
AIR FLOW RATES (SCFM)					
MAIN:	1505.	1501.	1846.	1844.	2052.
UNDERGRATE:	608.	607.	657.	658.	775.
OVERFIRE:	580.	577.	692.	694.	775.
UNDER + OVER:	1188.	1184.	1349.	1352.	1550.
CALC. BASED ON : FUEL AND EX. AIR	1016.	1009.	1181.	1228.	1446.
PERCENT UG:OF	51.:49.	51.:49.	49.:51.	49.:51.	50.:50.
CARRY OVER DATA					
LBS/HR:	8.4	8.1	6.9	7.5	6.3
GR/SCF:	.965	.937	.682	.713	.508
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:	SUNNY	CLOUDY	CLOUDY	CLOUDY	CLOUDY

SRU 1.595 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	106.	109.	110.	111.	112.
DATE:	3-14-78	3-15-78	3-15-78	3-15-78	3-15-78
CONVEYOR SETTING:	40.	45.	45.	45.	40.
FUEL FEED RATE: (DRY LBS/HR)	550.	617.	617.	617.	550.
HEAT INPUT RATE: (BTU/HR)	4951487.	5556357.	5556357.	5556357.	4951487.
HEAT RELEASE RATE: (BTU/HR-SQFT)	495149.	555636.	555636.	555636.	495149.
UNDERFIRE:	12.INCH	6.INCH	6.INCH	6.INCH	6.INCH
OVERFIRE:	6.INCH	12.INCH	12.INCH	12.INCH	12.INCH
PERCENT EX. AIR:	105.	24.	24.	65.	69.
TEMPERATURES (DEGREES F)					
T2:	1280.	1447.	1467.	1497.	1503.
T3:	908.	1030.	1025.	955.	967.
T4:	653.	658.	688.	667.	673.
FAN OUTLET:	57.	50.	52.	55.	56.
UNDERGRATE:	175.	145.	150.	151.	151.
OVERFIRE:	175.	145.	150.	151.	151.
AIR HEATER:	195.	165.	170.	171.	171.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.5	.3	.3	.4	.4
6" VENTURI:	11.3	2.5	2.5	3.8	3.7
12" VENTURI:	.9	.8	.8	1.1	1.2
3" CONVEYOR:	3.0	3.0	3.0	3.0	2.9
ACROSS GRATE:	1.7	1.1	1.1	1.3	1.3
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.8	4.3	4.3	8.6	8.5
CARBON DIOXIDE:	10.5	16.6	17.0	12.6	12.8
CARBON MONOXIDE:	.28	.07	.09	.16	.15
OXIDES OF NITROGEN:	.0	0.0	0.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	2134.	1666.	1695.	1914.	1914.
UNDERGRATE:	1032.	437.	439.	536.	530.
OVERFIRE:	1028.	1068.	1072.	1214.	1254.
AIR FLOW RATES (SCFM)					
MAIN:	2029.	1606.	1630.	1829.	1825.
UNDERGRATE:	775.	344.	343.	418.	413.
OVERFIRE:	772.	841.	837.	947.	978.
UNDER + OVER:	1547.	1185.	1180.	1365.	1391.
CALC. BASED ON : FUEL AND EX. AIR	1446.	982.	982.	1306.	1192.
PERCENT UG:OF	50.:50.	29.:71.	29.:71.	31.:69.	30.:70.
CARRY OVER DATA					
LBS/HR:	5.7	5.4	5.1	3.9	3.9
GR/SCF:	.460	.642	.606	.348	.382
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:	SUNNY	CLOUDY	CLOUDY	CLOUDY	SUNNY

SRU 1.153 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50-70
DENSITY (LBS/CU.FT): 17-30

RUN NO:	113.	114.	115.	116.	117.
DATE:	3-15-78	3-15-78	3-20-78	3-20-78	3-20-78
CONVEYOR SETTING:	40.	40.	54.	54.	54.
FUEL FEED RATE: (DRY LBS/HR)	550.	550.	738.	738.	738.
HEAT INPUT RATE: (BTU/HR)	4951487.	4951487.	6645122.	6645122.	6645122.
HEAT RELEASE RATE: (BTU/HR-SQFT)	495149.	495149.	664512.	664512.	664512.
UNDERFIRE:	6.INCH	6.INCH	12.INCH	12.INCH	6.INCH
OVERFIRE:	12.INCH	12.INCH	6.INCH	6.INCH	12.INCH
PERCENT EX. AIR:	97.	89.	63.	63.	56.
TEMPERATURES (DEGREES F)					
T2:	1443.	1445.	1370.	1400.	1520.
T3:	940.	967.	1115.	1133.	1102.
T4:	677.	682.	757.	805.	727.
FAN OUTLET:	58.	59.	69.	69.	70.
UNDERGRATE:	155.	155.	415.	372.	297.
OVERFIRE:	155.	155.	336.	330.	302.
AIR HEATER:	175.	175.	480.	448.	371.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.5	.5	.2	.4	.6
6" VENTURI:	5.0	5.1	1.5	1.4	7.2
12" VENTURI:	1.6	1.6	4.2	3.8	2.4
3" CONVEYOR:	3.0	3.0	2.9	2.9	3.0
ACROSS GRATE:	1.1	1.1	3.3	2.5	1.0
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	10.3	9.8	8.1	8.1	7.5
CARBON DIOXIDE:	9.9	10.3	12.9	12.6	12.9
CARBON MONOXIDE:	.37	.33	.27	.33	.17
OXIDES OF NITROGEN:	.0	.0	.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	2180.	2180.	1412.	1939.	2480.
UNDERGRATE:	613.	619.	2401.	2261.	834.
OVERFIRE:	1412.	1412.	529.	508.	1884.
AIR FLOW RATES (SCFM)					
MAIN:	2071.	2068.	1314.	1803.	2302.
UNDERGRATE:	475.	480.	1257.	1225.	494.
OVERFIRE:	1094.	1094.	277.	275.	1115.
UNDER + OVER:	1569.	1573.	1534.	1500.	1609.
CALC. BASED ON : FUEL AND EX. AIR	1390.	1334.	1543.	1543.	1477.
PERCENT UG:OF	30.:70.	30.:70.	82.:18.	82.:18.	31.:69.
CARRY OVER DATA					
LBS/HR:	4.2	4.9	18.3	16.8	9.8
GR/SCF:	.353	.429	1.383	1.270	.775
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	22.	20.	20.	22.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY

SRU 1.626 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	118.	119.	120.	121.	122.
DATE:	3-20-78	3-20-78	3-20-78	3-21-78	3-21-78
CONVEYOR SETTING:	54.	54.	54.	52.	52.
FUEL FEED RATE: (DRY LBS/HR)	738.	738.	738.	711.	711.
HEAT INPUT RATE: (BTU/HR)	6645122.	6645122.	6645122.	6403174.	6403174.
HEAT RELEASE RATE: (BTU/HR-SQFT)	664512.	664512.	664512.	640317.	640317.
UNDERFIRE:	6.INCH	12.INCH	12.INCH	12.INCH	12.INCH
OVERFIRE:	12.INCH	6.INCH	6.INCH	6.INCH	6.INCH
PERCENT EX. AIR:	40.	43.	34.	44.	40.
TEMPERATURES (DEGREES F)					
T2:	1568.	1280.	1290.	1423.	1387.
T3:	1130.	1113.	1157.	1117.	1123.
T4:	717.	770.	795.	777.	792.
FAN OUTLET:	71.	73.	73.	65.	66.
UNDERGRATE:	347.	157.	155.	145.	145.
OVERFIRE:	357.	157.	155.	145.	145.
AIR HEATER:	411.	177.	175.	165.	165.
PRESSURE DIFFERENTIALS (INCHES WATER)					
MAIN ORIFICE:	.4	.5	.5	.6	.5
6" VENTURI:	7.5	3.1	3.1	1.0	1.0
12" VENTURI:	2.5	2.0	2.0	2.4	2.3
3" CONVEYOR:	3.0	2.9	3.0	3.0	3.0
ACROSS GRATE:	1.0	1.9	1.7	2.0	2.0
EXHAUST GAS ANALYSIS (PERCENT)					
OXYGEN:	6.1	6.4	5.5	6.5	6.1
CARBON DIOXIDE:	14.8	13.8	15.1	13.8	14.6
CARBON MONOXIDE:	.08	.25	.19	.35	.31
OXIDES OF NITROGEN:	.0	.0	.0	.0	.0
AIR FLOW RATES (ACFM)					
MAIN:	2063.	2291.	2291.	2313.	2291.
UNDERGRATE:	871.	1436.	1433.	1538.	1510.
OVERFIRE:	1958.	597.	598.	393.	393.
AIR FLOW RATES (SCFM)					
MAIN:	1912.	2115.	2114.	2166.	2142.
UNDERGRATE:	492.	1109.	1111.	1211.	1189.
OVERFIRE:	1106.	461.	464.	309.	309.
UNDER + OVER:	1598.	1570.	1574.	1520.	1498.
CALC. BASED ON : FUEL AND EX. AIR	1326.	1354.	1269.	1314.	1277.
PERCENT UG:OF	31.:69.	71.:29.	71.:29.	80.:20.	79.:21.
CARRY OVER DATA					
LBS/HR:	10.8	17.7	20.7	22.5	24.3
GR/SCF:	.950	1.525	1.903	1.998	2.219
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	20.
OPACITY:	5.	5.	5.	5.	5.
WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY

SRU 1.568 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1 " MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	123.	124.	125.	126.	127.
DATE:	3-21-78	3-21-78	3-21-78	3-21-78	3-21-78
CONVEYOR SETTING:	52.	52.	49.	49.	50.
FUEL FEED RATE: (DRY LBS/HR)	711.	711.	671.	671.	685.
HEAT INPUT RATE: (BTU/HR)	6403174.	6403174.	6040252.	6040252.	6161226.
HEAT RELEASE RATE: (BTU/HR-SQFT)	640317.	640317.	604025.	604025.	616123.
UNDERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	6.INCH
OVERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	12.INCH
PERCENT EX. AIR:	92.	105.	60.	63.	50.

TEMPERATURES (DEGREES F)

T2:	1320.	1288.	1598.	1580.	1628.
T3:	1007.	977.	1015.	1015.	1087.
T4:	780.	767.	697.	712.	755.
FAN OUTLET:	67.	68.	68.	68.	69.
UNDERGRATE:	163.	165.	148.	150.	130.
OVERFIRE:	163.	165.	148.	150.	130.
AIR HEATER:	183.	185.	168.	170.	150.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.9	.9	.5	.5	.5
6" VENTURI:	2.3	2.3	10.7	10.8	4.5
12" VENTURI:	5.0	5.0	.8	.8	1.5
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	2.0	2.0	1.3	1.3	1.0

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	10.1	10.8	7.9	8.0	7.1
CARBON DIOXIDE:	9.5	9.1	13.8	12.9	13.2
CARBON MONOXIDE:	.50	.53	.11	.12	.04
OXIDES OF NITROGEN:	.0	.0	.0	.0	.0

AIR FLOW RATES (AGFM)

MAIN:	2960.	2977.	2291.	2269.	2269.
UNDERGRATE:	2141.	2145.	960.	962.	572.
OVERFIRE:	536.	537.	986.	991.	1351.

AIR FLOW RATES (SCFM)

MAIN:	2762.	2775.	2135.	2115.	2111.
UNDERGRATE:	1638.	1636.	752.	751.	461.
OVERFIRE:	410.	410.	772.	774.	1089.
UNDER + OVER:	2049.	2045.	1525.	1525.	1551.
CALC. BASED ON : FUEL AND EX. AIR	1752.	1871.	1377.	1403.	1317.
PERCENT UG:OF	80.:20.	80.:20.	49.:51.	49.:51.	30.:70.

CARRY OVER DATA

LBS/HR:	34.5	26.4	9.3	8.7	7.8
GR/SCF:	2.297	1.647	.788	.723	.691
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	20.	20.	20.	20.
OPACITY:	10.	10.	5.	5.	5.
WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY

SRU 1.644 UNTS.

RUN COMPLETE.

WOOD SPECIES: D. FIR & E. WHITE PINE
SIZE RANGE: 1" MINUS
MOISTURE (%): 50.70
DENSITY (LBS/CU.FT): 17.30

RUN NO:	128.	0.	0.	0.	0.
DATE:	3-21-78	::::::::	::::::::	::::::::	::::::::
CONVEYOR SETTING:	50.	0.	0.	0.	0.
FUEL FEED RATE: (DRY LBS/HR)	685.	0.	0.	0.	0.
HEAT INPUT RATE: (BTU/HR)	6161226.	0.	0.	0.	0.
HEAT RELEASE RATE: (BTU/HR-SQFT)	616123.	0.	0.	0.	0.
UNDERFIRE:	6.INCH	0.INCH	0.INCH	0.INCH	0.INCH
OVERFIRE:	12.INCH	0.INCH	0.INCH	0.INCH	0.INCH
PERCENT EX. AIR:	50.	0.	0.	0.	0.

TEMPERATURES (DEGREES F)

T2:	1597.	0.	0.	0.	0.
T3:	1100.	0.	0.	0.	0.
T4:	760.	0.	0.	0.	0.
FAN OUTLET:	70.	0.	0.	0.	0.
UNDERGRATE:	132.	0.	0.	0.	0.
OVERFIRE:	132.	0.	0.	0.	0.
AIR HEATER:	152.	0.	0.	0.	0.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.5	0.0	0.0	0.0	0.0
6" VENTURI:	4.4	0.0	0.0	0.0	0.0
12" VENTURI:	1.5	0.0	0.0	0.0	0.0
3" CONVEYOR:	3.0	0.0	0.0	0.0	0.0
ACROSS GRATE:	1.0	0.0	0.0	0.0	0.0

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	7.0	0.0	0.0	0.0	0.0
CARBON DIOXIDE:	13.8	0.0	0.0	0.0	0.0
CARBON MONOXIDE:	.03	0.00	0.00	0.00	0.00
OXIDES OF NITROGEN:	.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	2247.	0.	0.	0.	0.
UNDERGRATE:	566.	0.	0.	0.	0.
OVERFIRE:	1353.	0.	0.	0.	0.

AIR FLOW RATES (SCFM)

MAIN:	2087.	0.	0.	0.	0.
UNDERGRATE:	455.	0.	0.	0.	0.
OVERFIRE:	1088.	0.	0.	0.	0.
UNDER + OVER:	1543.	0.	0.	0.	0.
CALC. BASED ON : FUEL AND EX. AIR	1317.	0.	0.	0.	0.
PERCENT UG:OF	30.:70.	0.: 0.	0.: 0.	0.: 0.	0.: 0.

CARRY OVER DATA

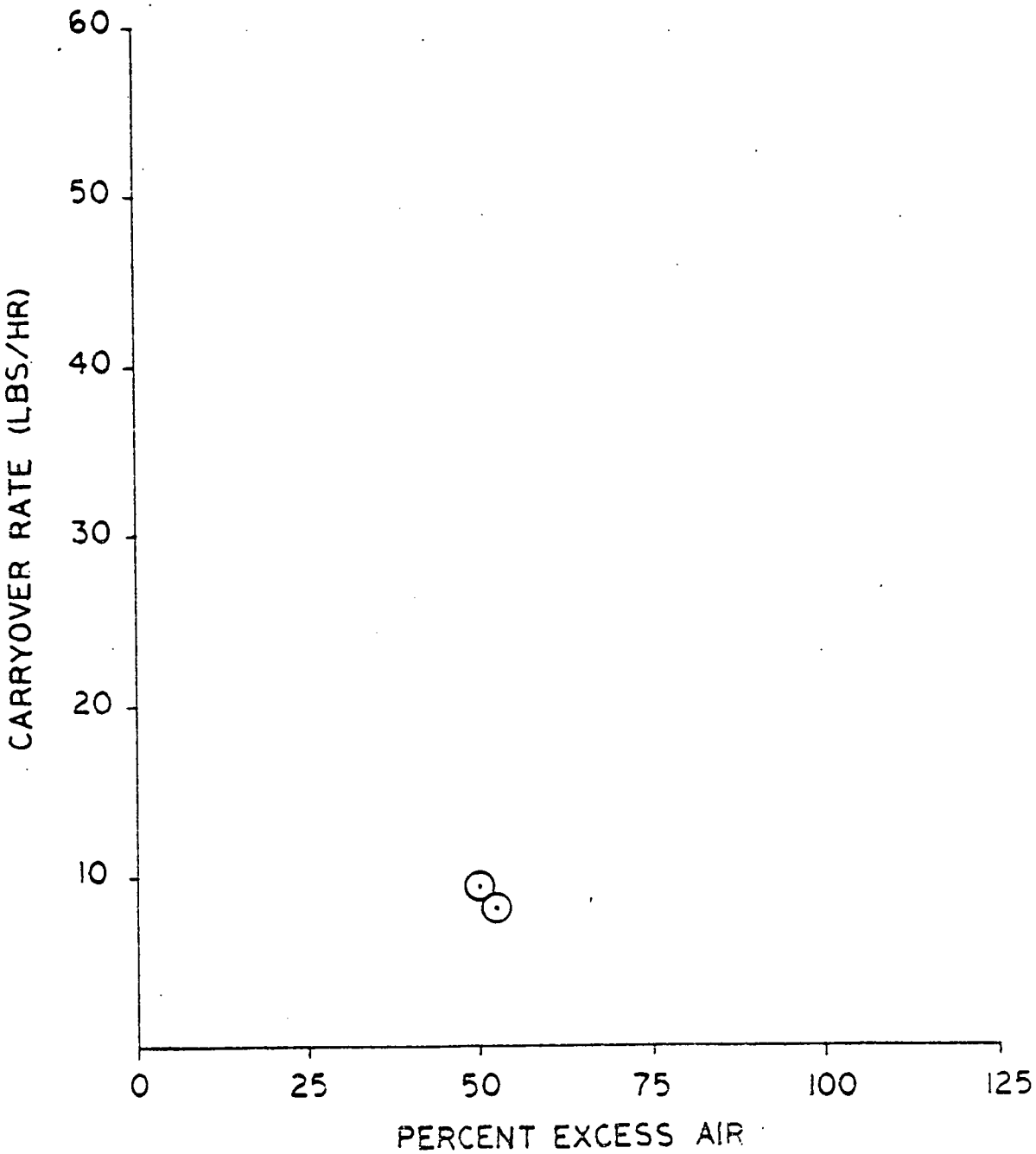
LBS/HR:	8.7	0.0	0.0	0.0	0.0
GR/SCF:	.771	0.000	0.000	0.000	0.000
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENTCOMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	20.	0.	0.	0.	0.
OPACITY:	5.	0.	0.	0.	0.

WEATHER: SUNNY

GRAPHS OF COLLECTED DATA

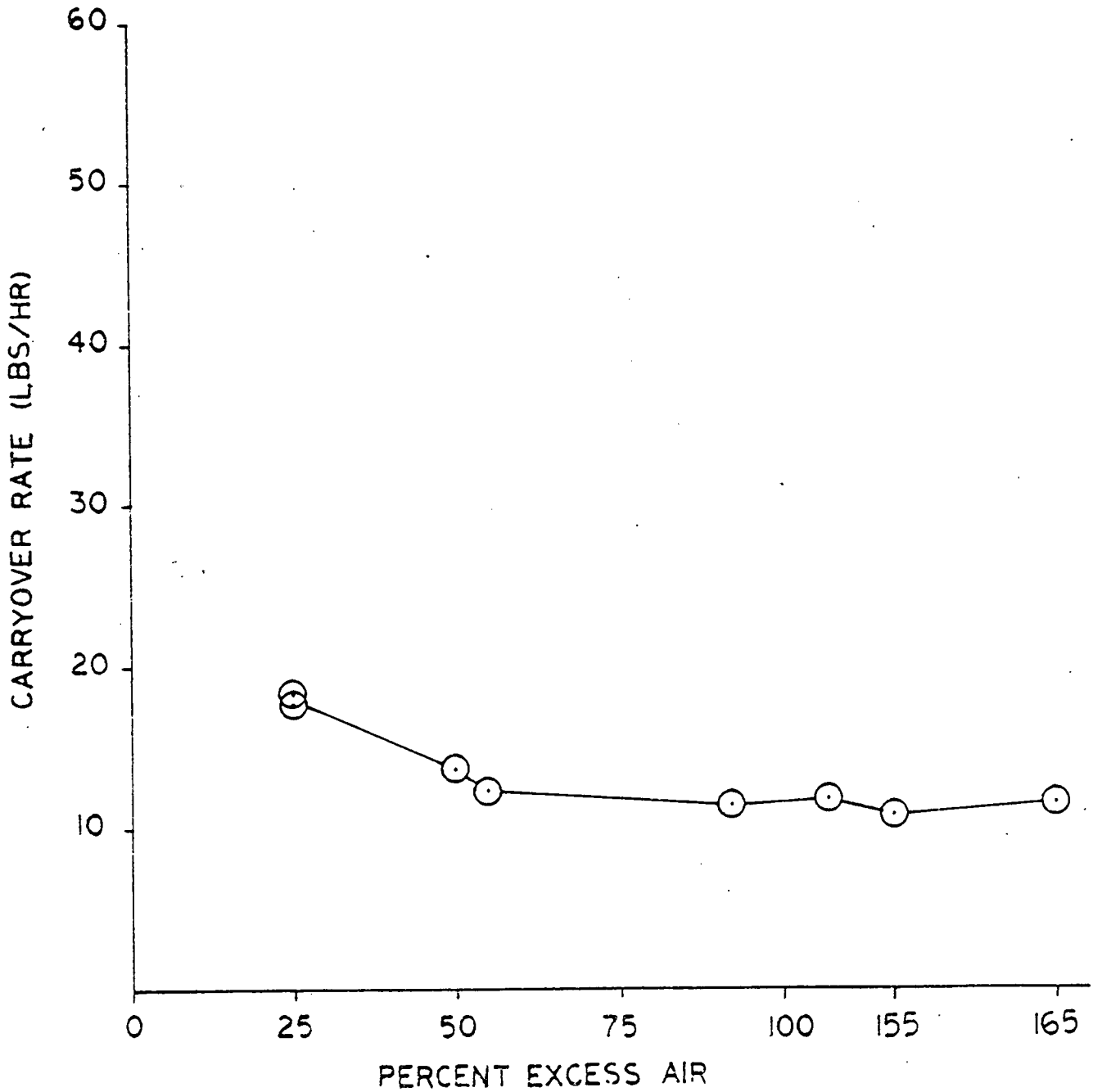
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	65 & 66	FUEL FEED RATE (DRY LBS/HR):	550
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	4.9×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	395
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	43



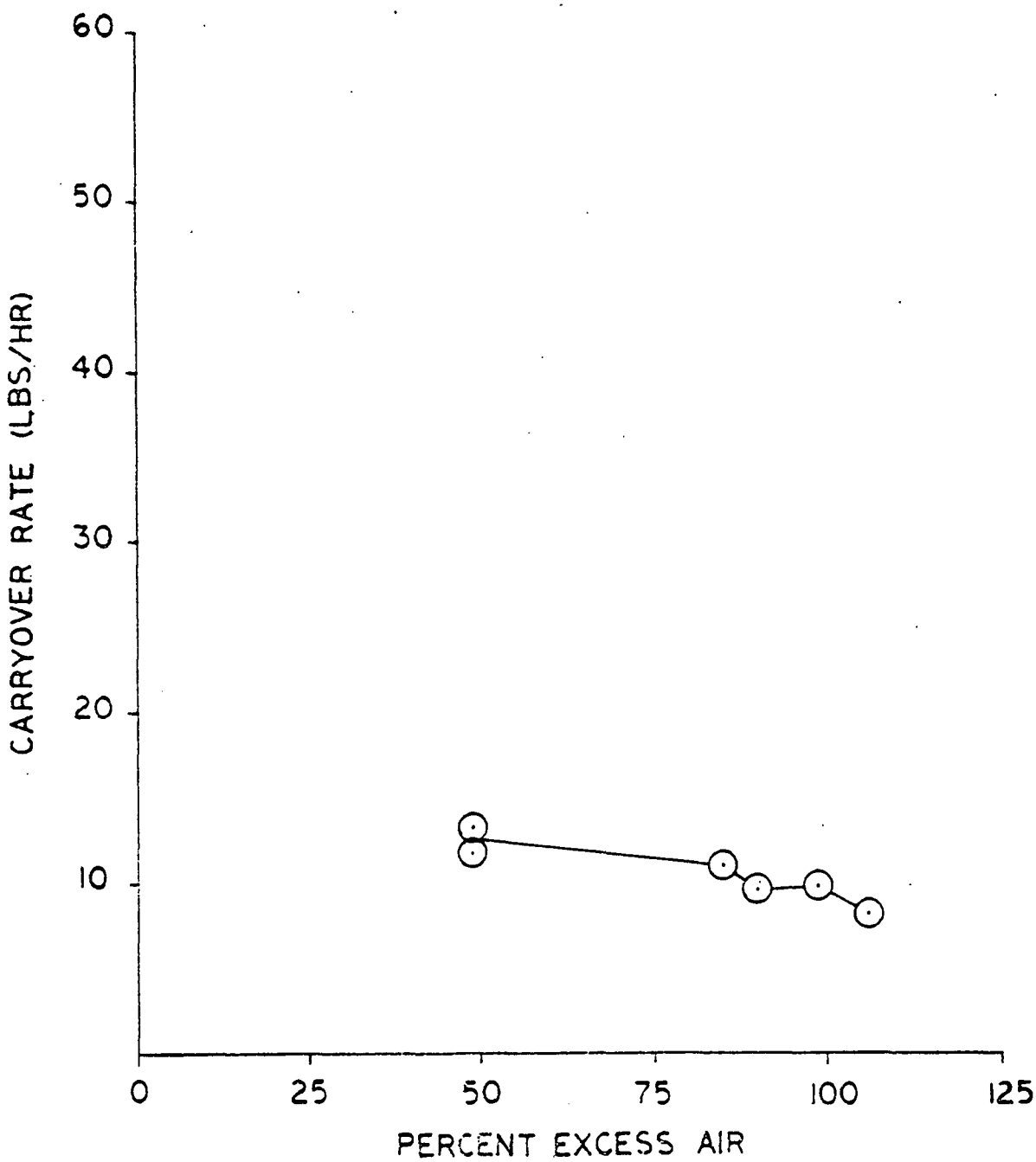
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	67-74	FUEL FEED RATE (DRY LBS/HR):	590
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.3×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	400
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	83



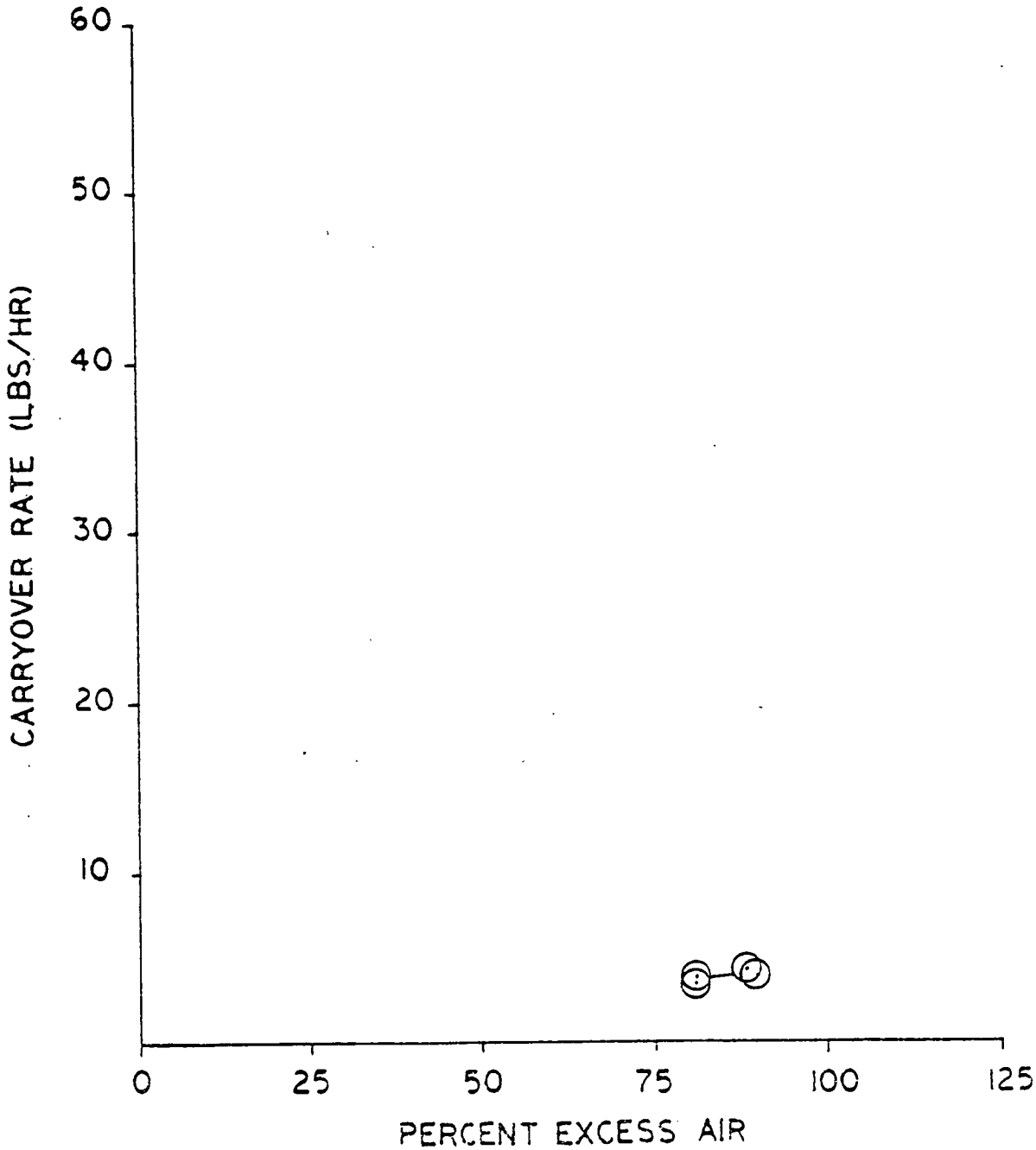
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	75-80	FUEL FEED RATE (DRY LBS/HR):	590
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.3×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	380
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	52



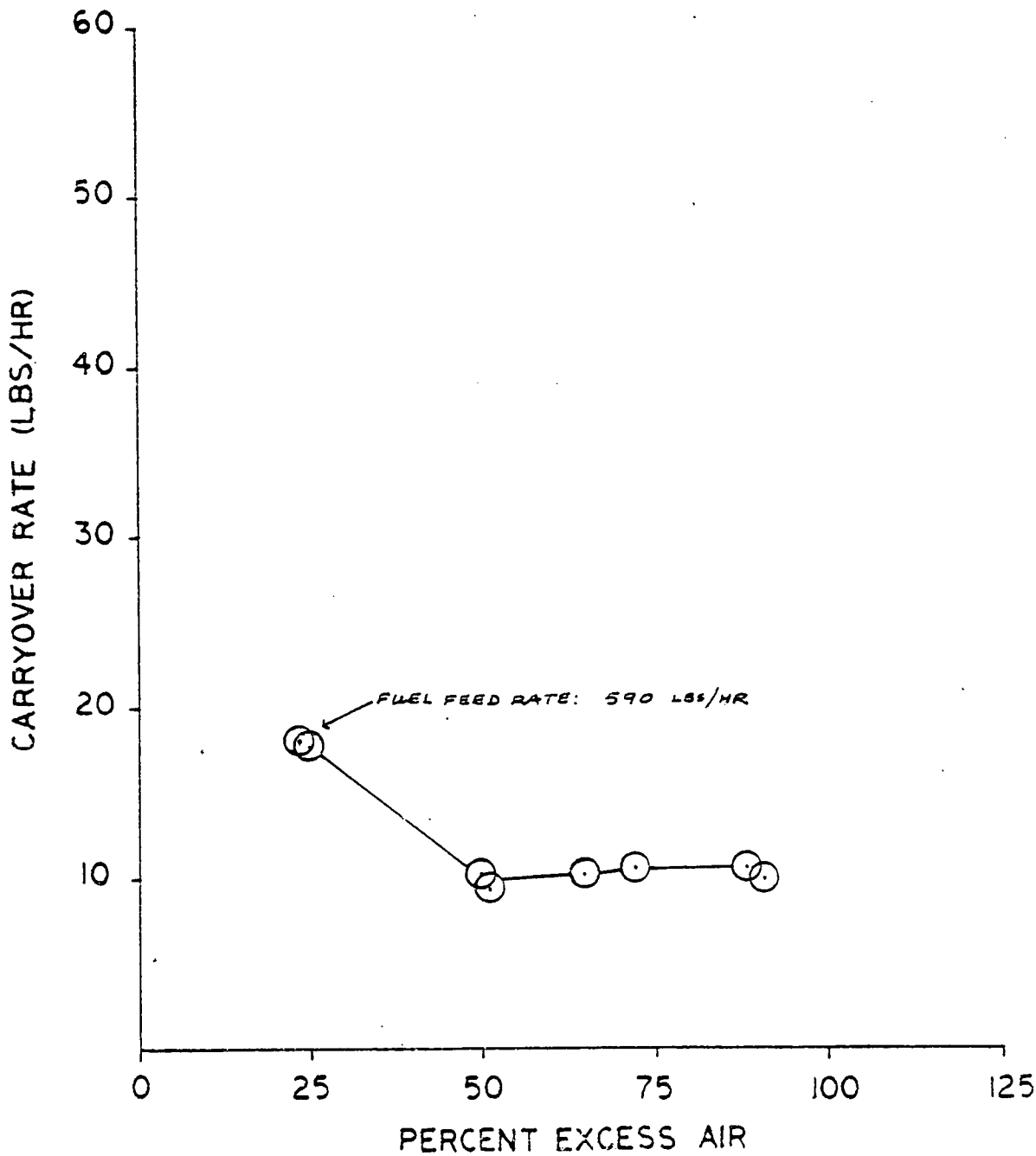
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	87-90	FUEL FEED RATE (DRY LBS/HR):	590
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.3×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	398
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	31



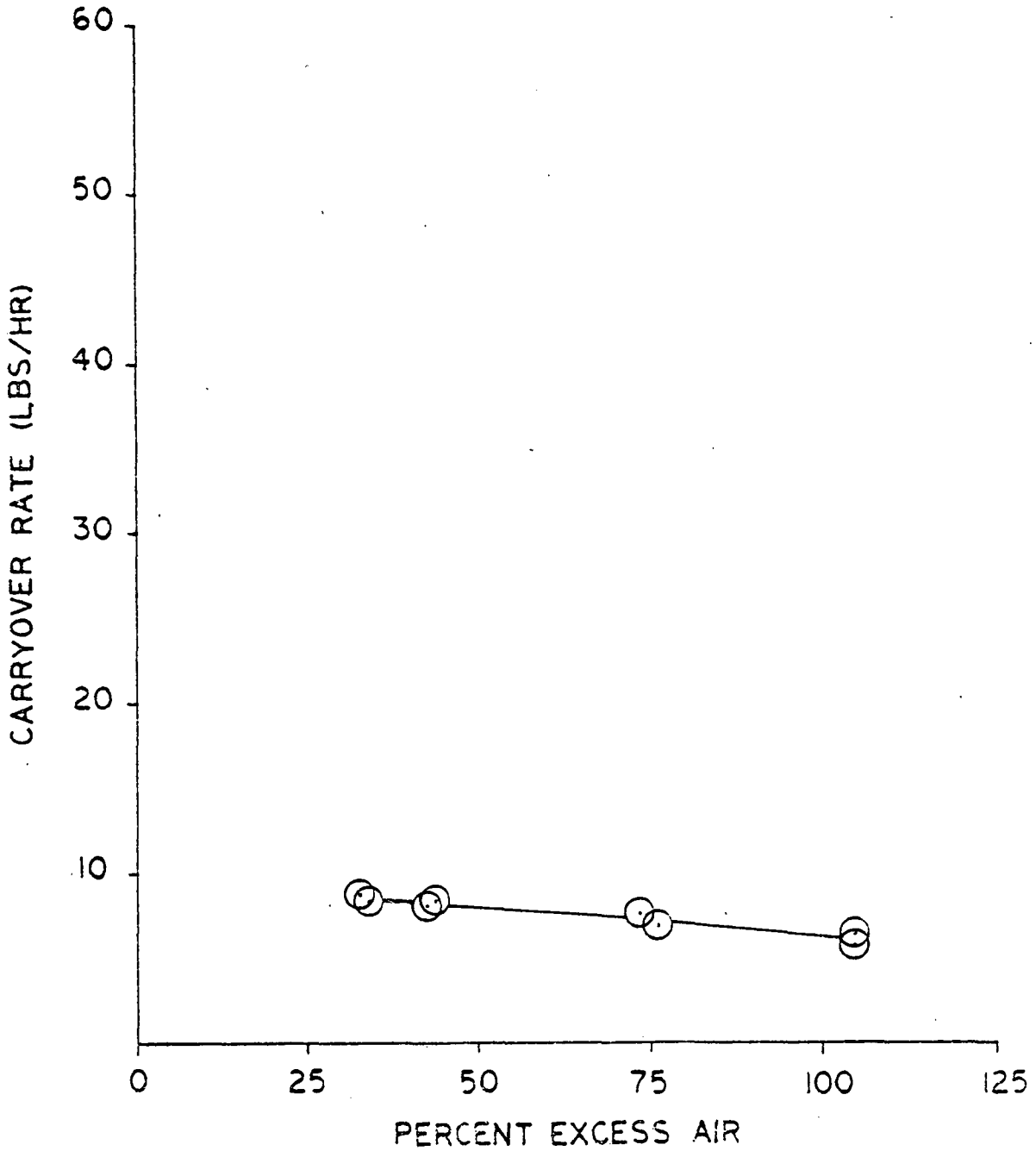
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	91-98	FUEL FEED RATE (DRY LBS/HR):	550
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.0×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	163
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	71



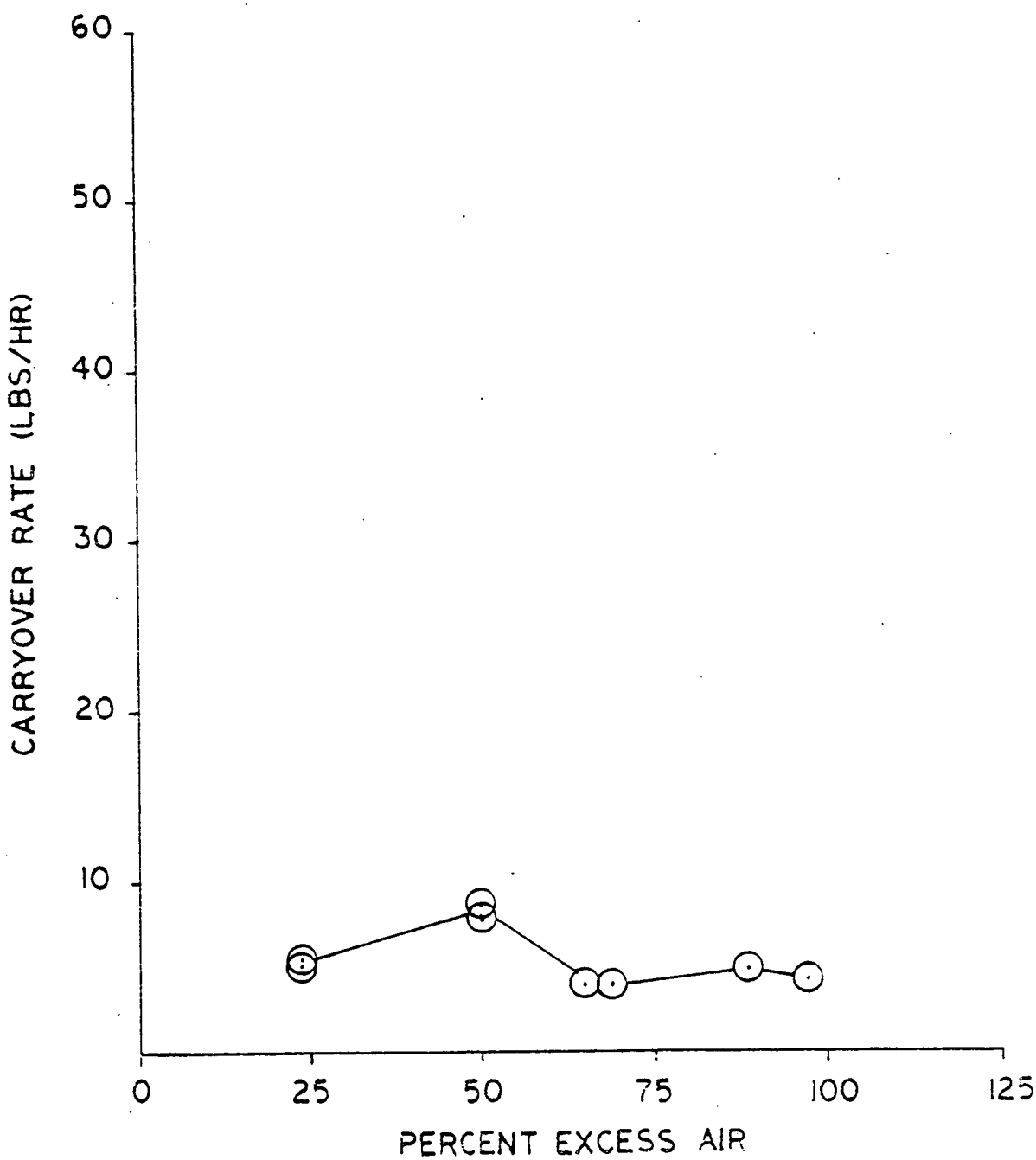
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	99-106	FUEL FEED RATE (DRY LBS/HR):	550
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.0×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	160
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	51



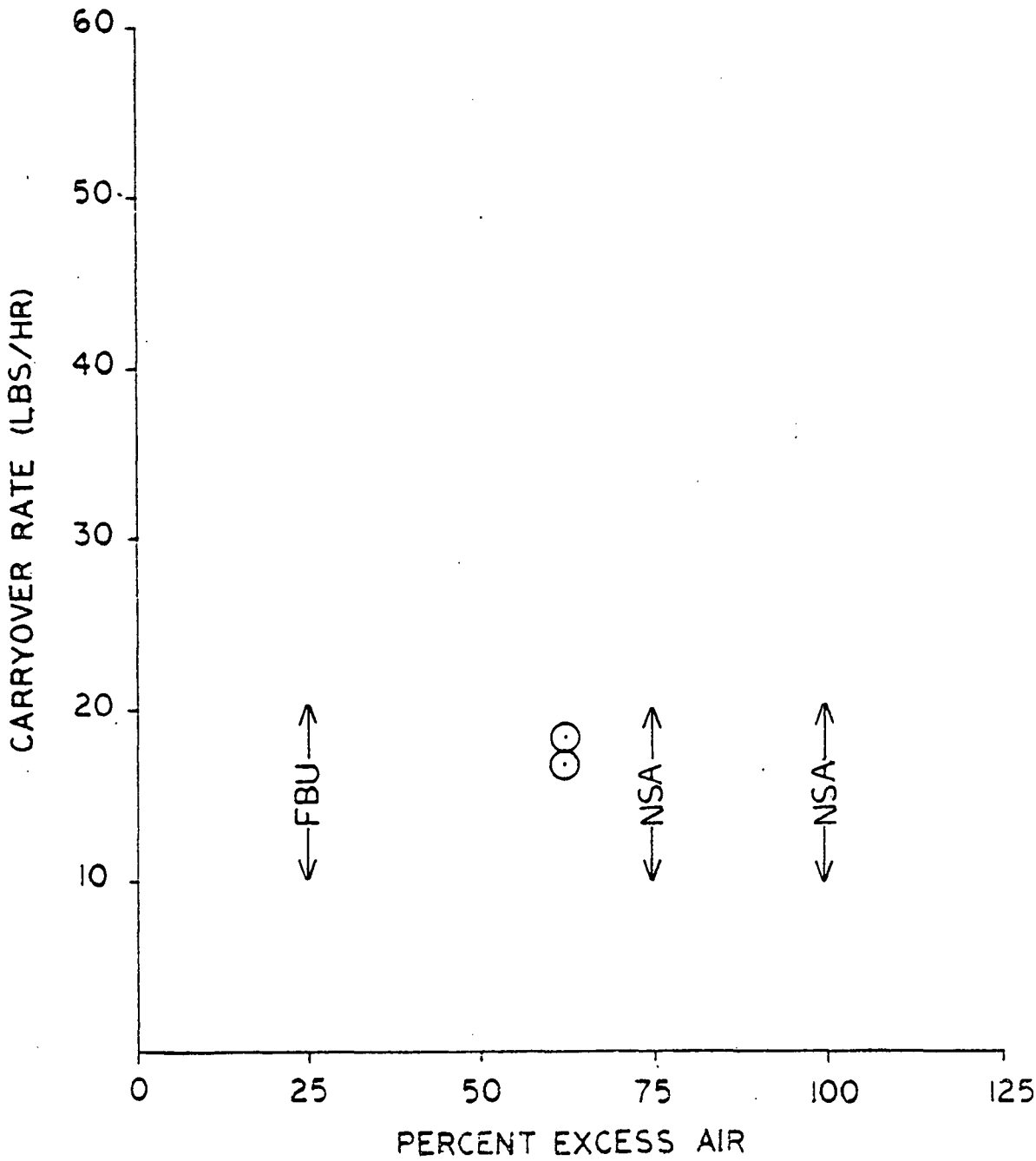
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	109-114 & 127-128	FUEL FEED RATE (DRY LBS/HR):	550
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	5.5×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	150
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	30



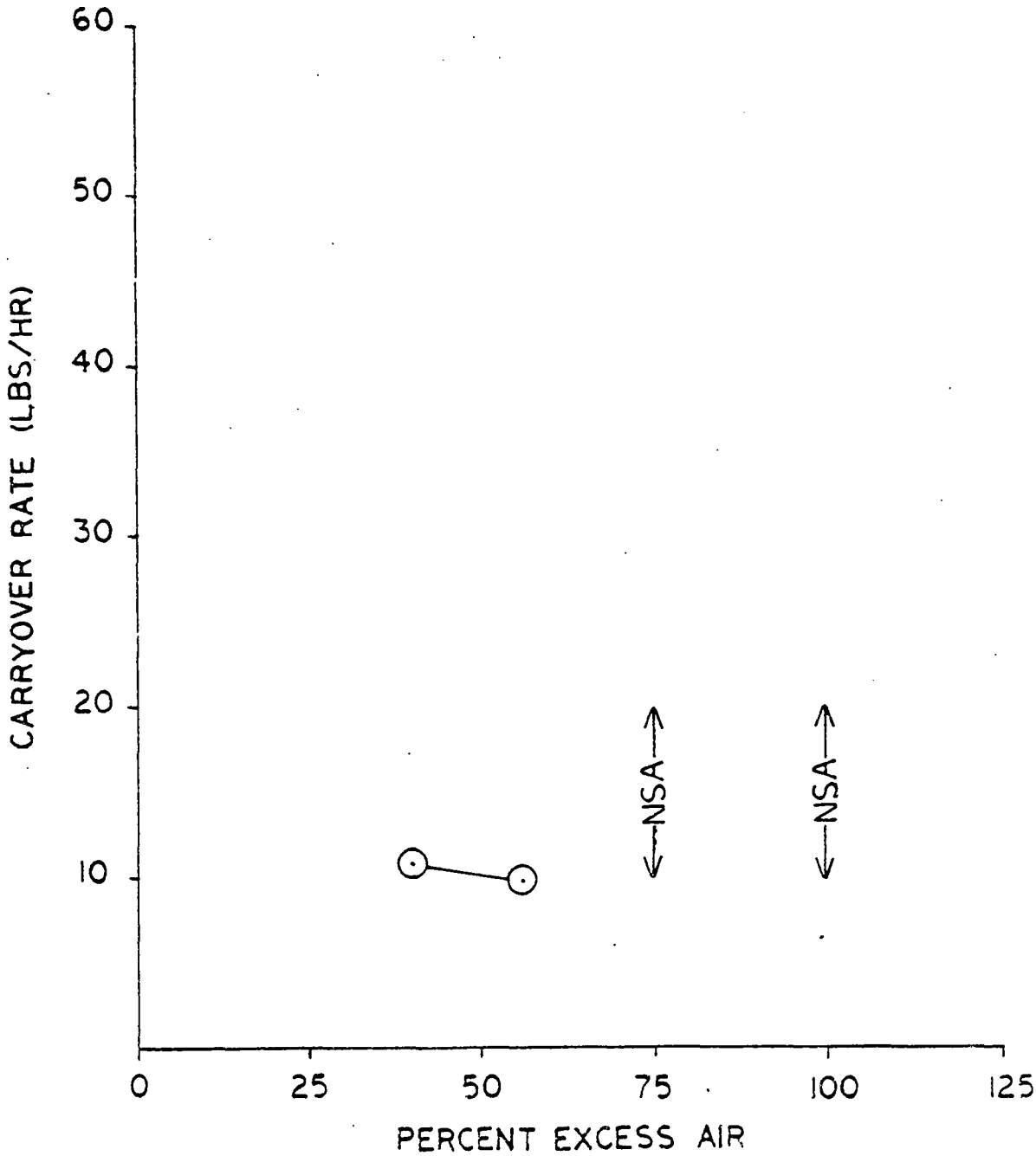
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	115 & 116	FUEL FEED RATE (DRY LBS/HR):	738
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	6.6×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	394
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	82



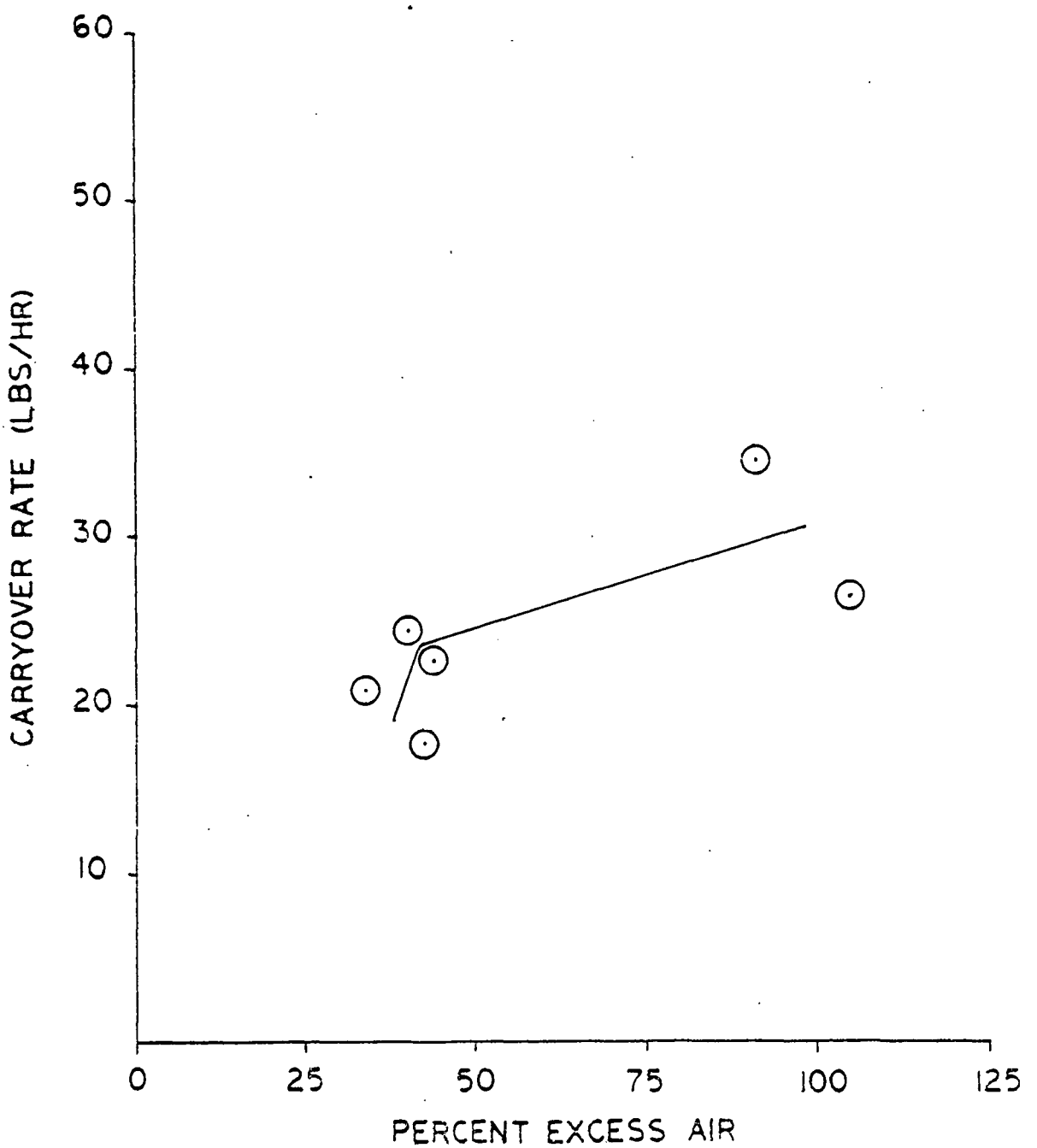
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	117 & 118	FUEL FEED RATE (DRY LBS/HR):	738
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	6.6×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	322
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	31



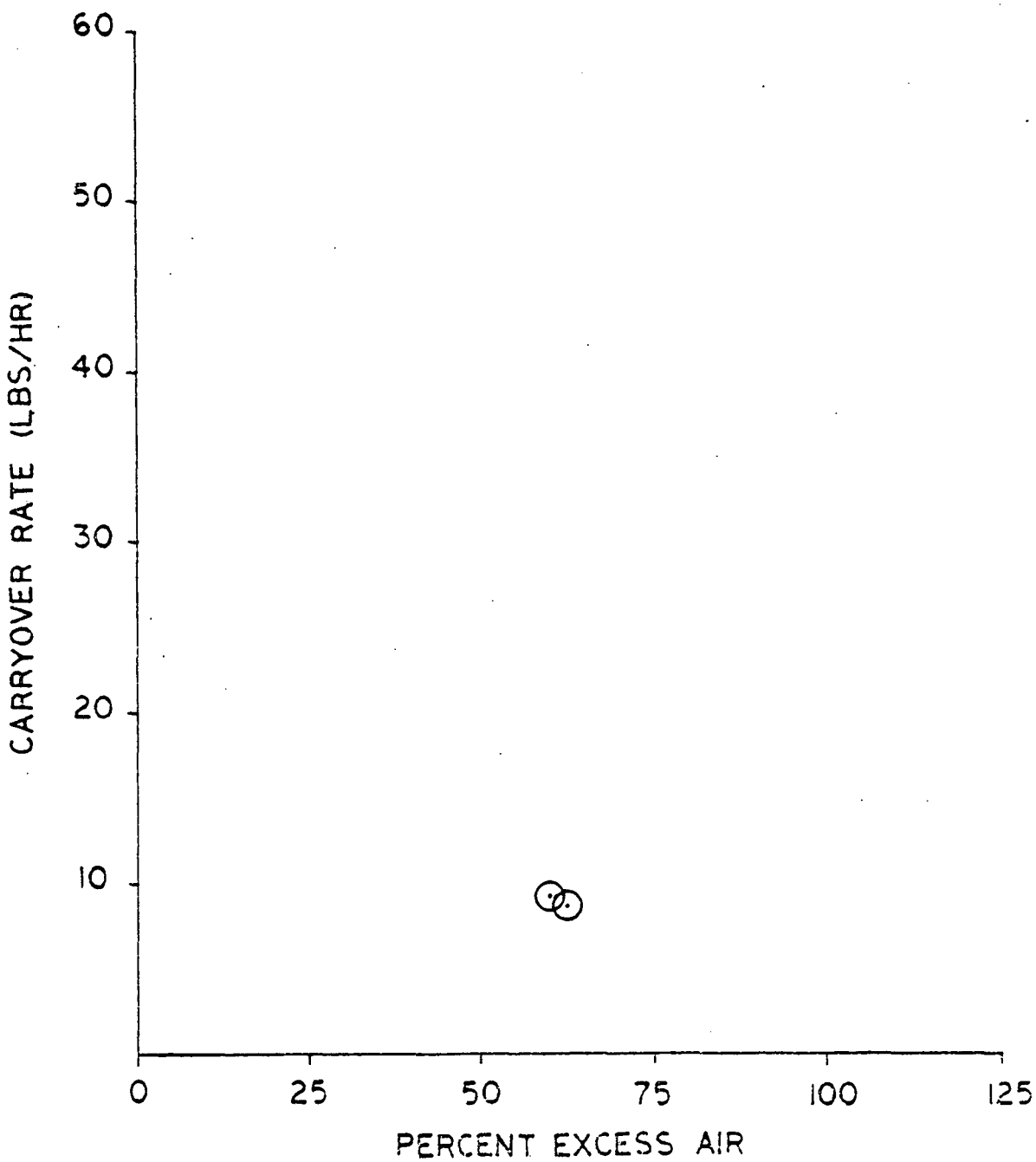
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

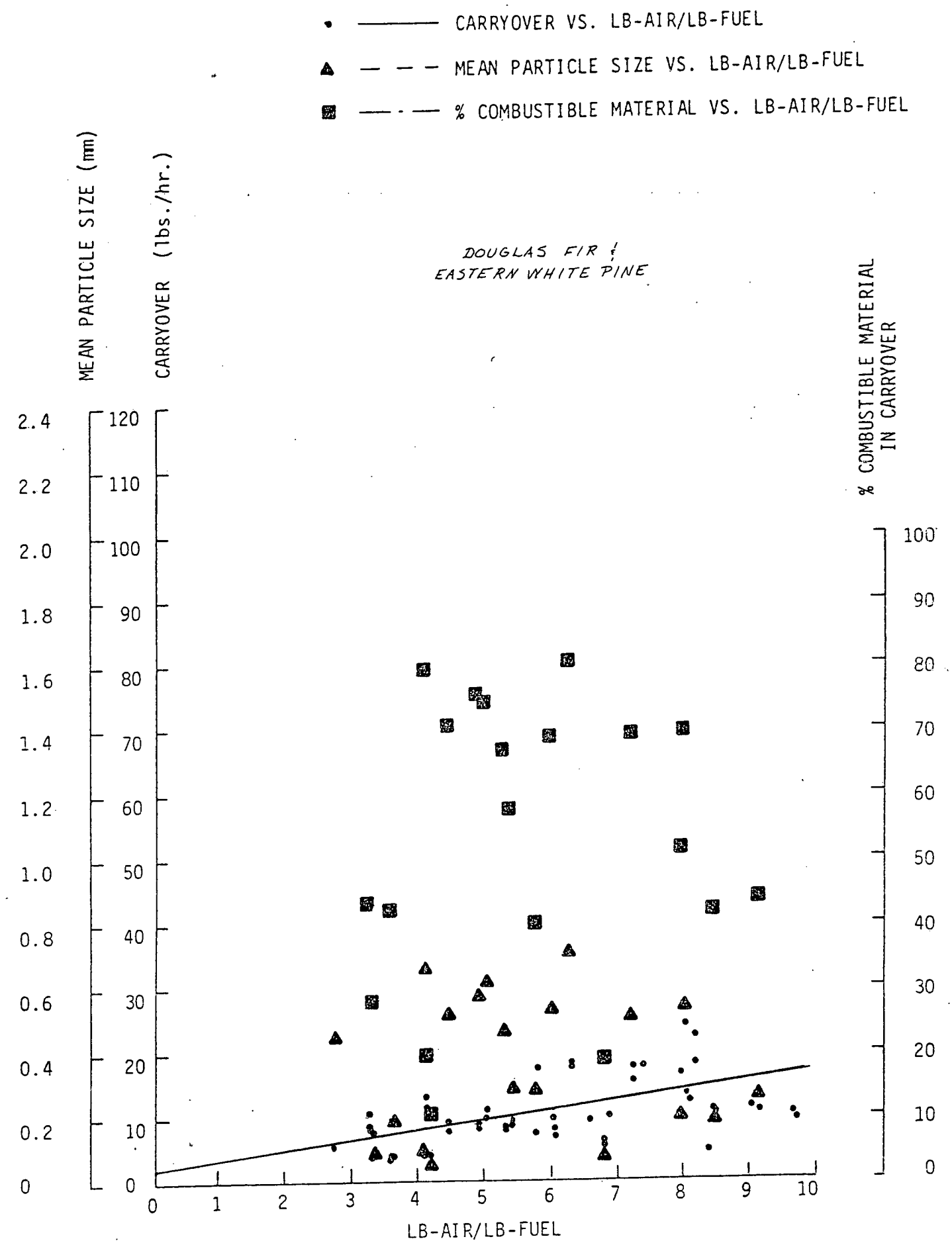
TEST NOS.:	119-124	FUEL FEED RATE (DRY LBS/HR):	725
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	6.5×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	156
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	71-80

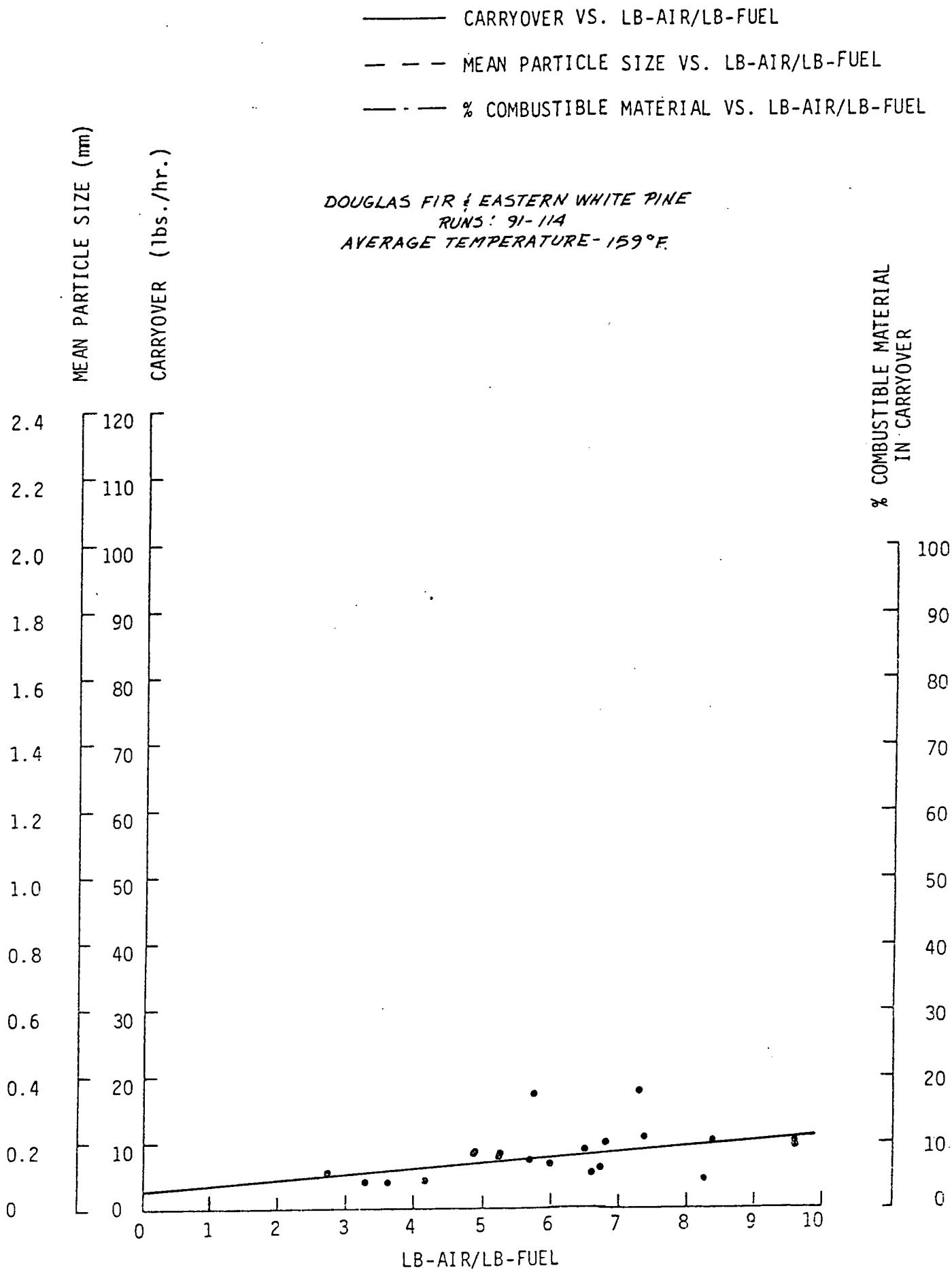


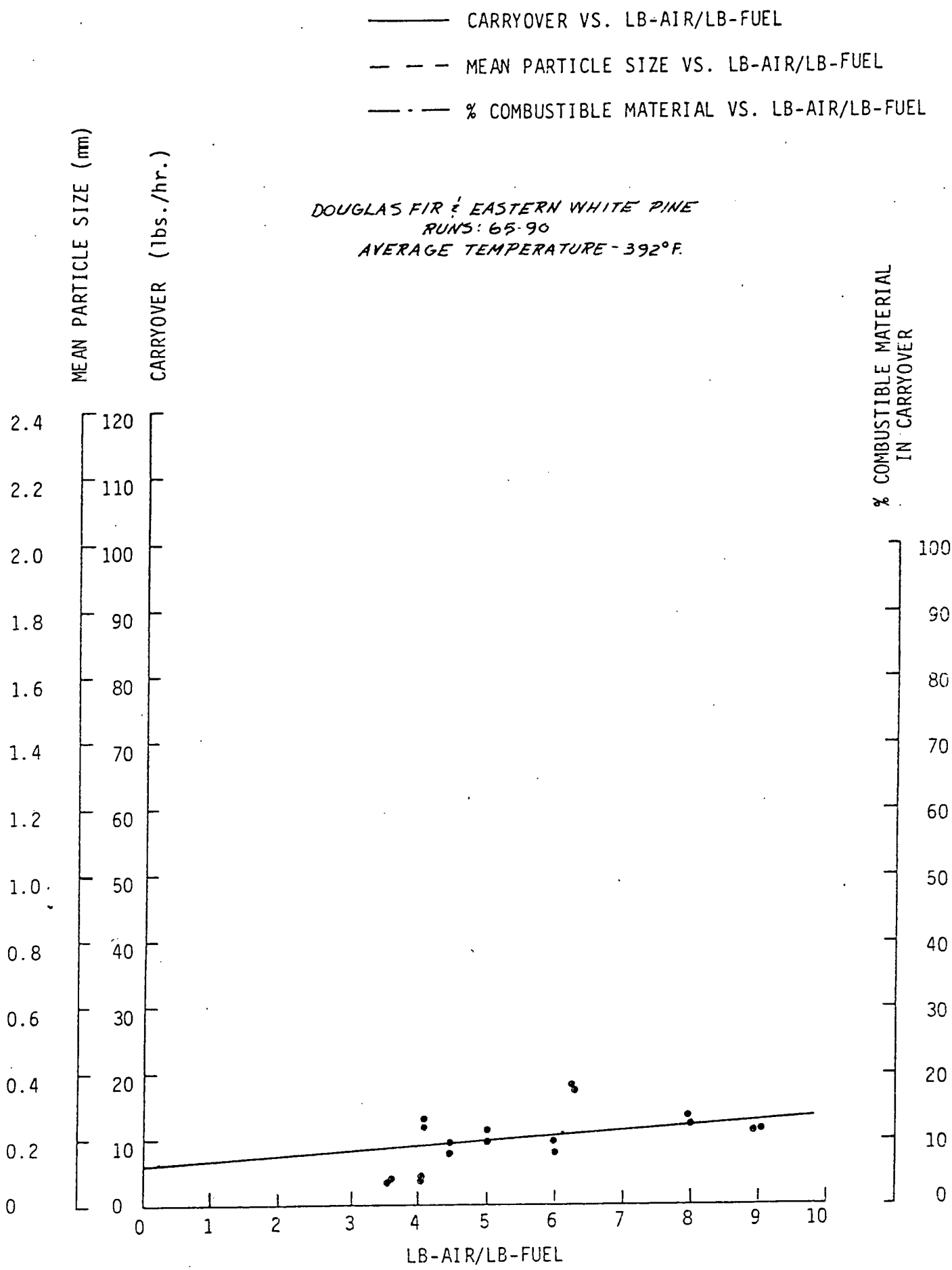
PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.:	125 & 126	FUEL FEED RATE (DRY LBS/HR):	671
SPECIES:	D. Fir & E. White Pine	HEAT RELEASE RATE (BTU/HR):	6.0×10^5
SIZE:	1" Minus	INLET AIR TEMPERATURE (°F):	149
MOISTURE:	51%	PERCENT UNDERGRATE AIR:	50



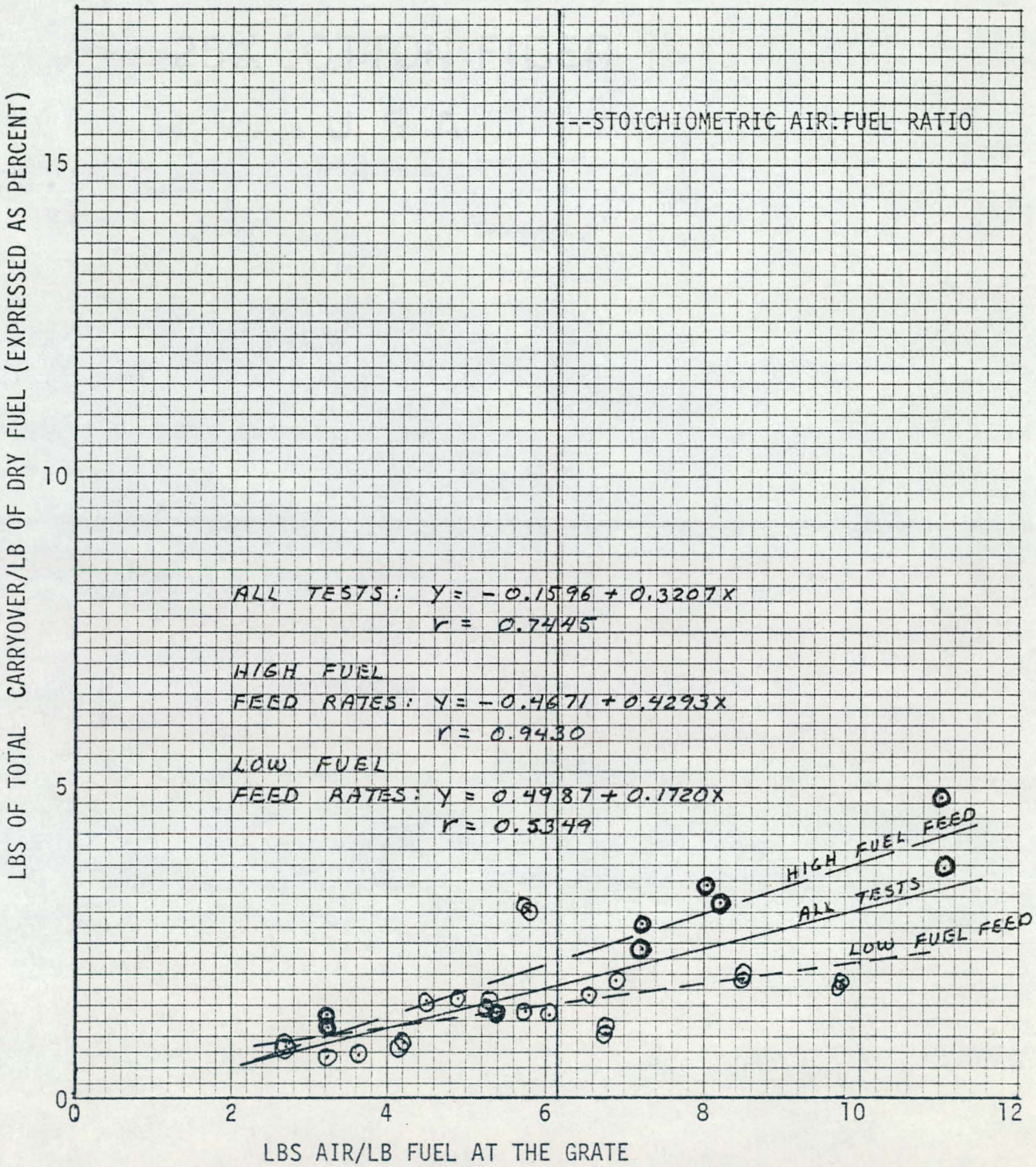

CARRYOVER VS. LB-AIR/LB-FUEL
MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
% COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL
MEAN PARTICLE SIZE (mm)
CARRYOVER (lbs./hr.)
% COMBUSTIBLE MATERIAL IN CARRYOVER
DOUGLAS FIR & EASTERN WHITE PINE
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
120
110
100
90
80
70
60
50
40
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 & EASTERN WHITE PINE
RUNS: 91-114
AVERAGE TEMPERATURE-159°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 & EASTERN WHITE PINE
RUNS: 65-90
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: E. WHITE PINE & D. FIR RUNS (91 TO 114) & 119 TO 128

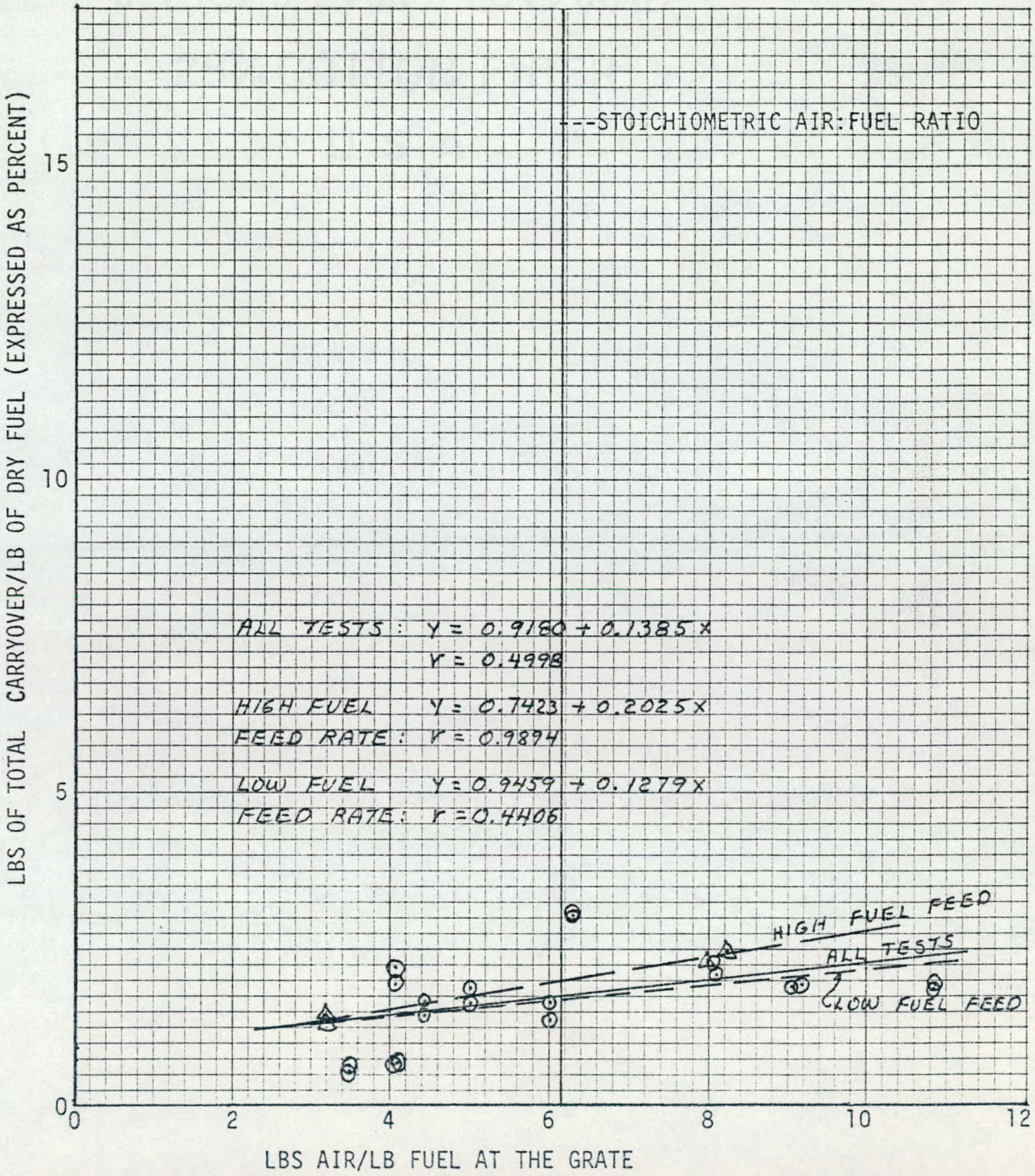
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 51%



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: E. WHITE PINE & D. FIR. RUNS 65 TO 90 & (115 TO 118)

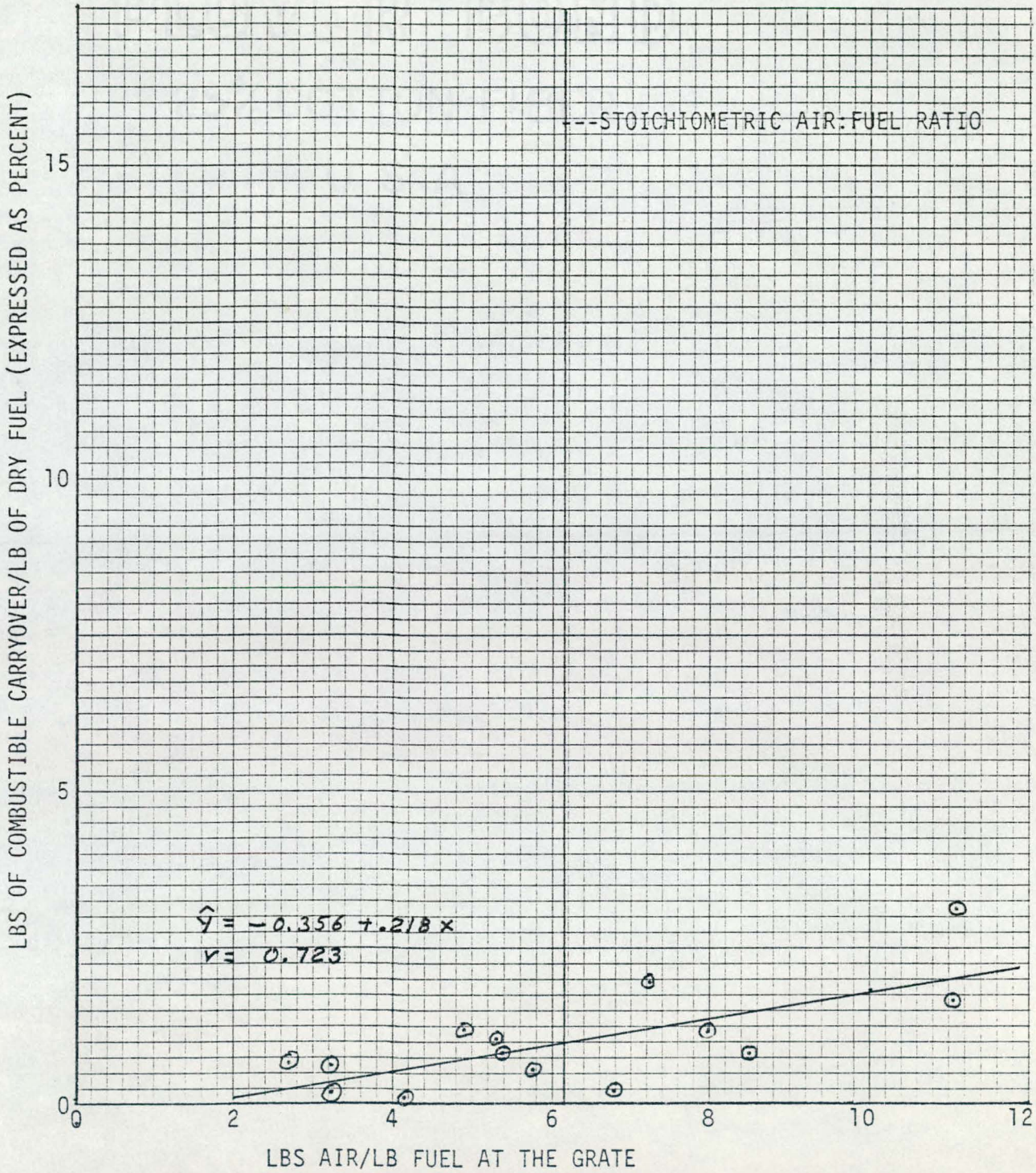
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 51 %



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: E. WHITE PINE + D. FIR PLAN. SHAV. RUNS 91 TO 128

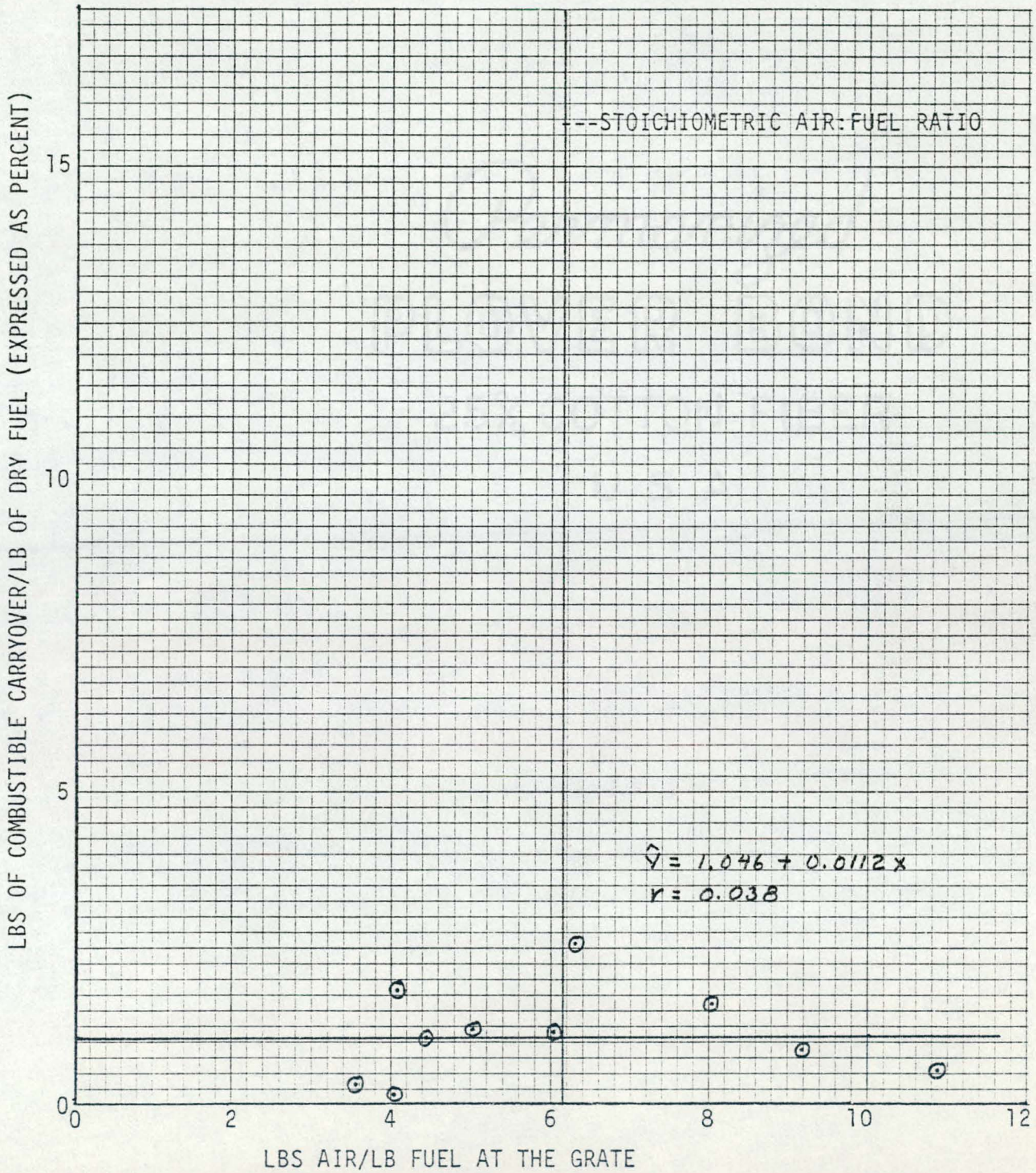
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 51 %



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: E. WHITE PINE & D. FIR PLAN. SHAV. RUNS 65 TO 90

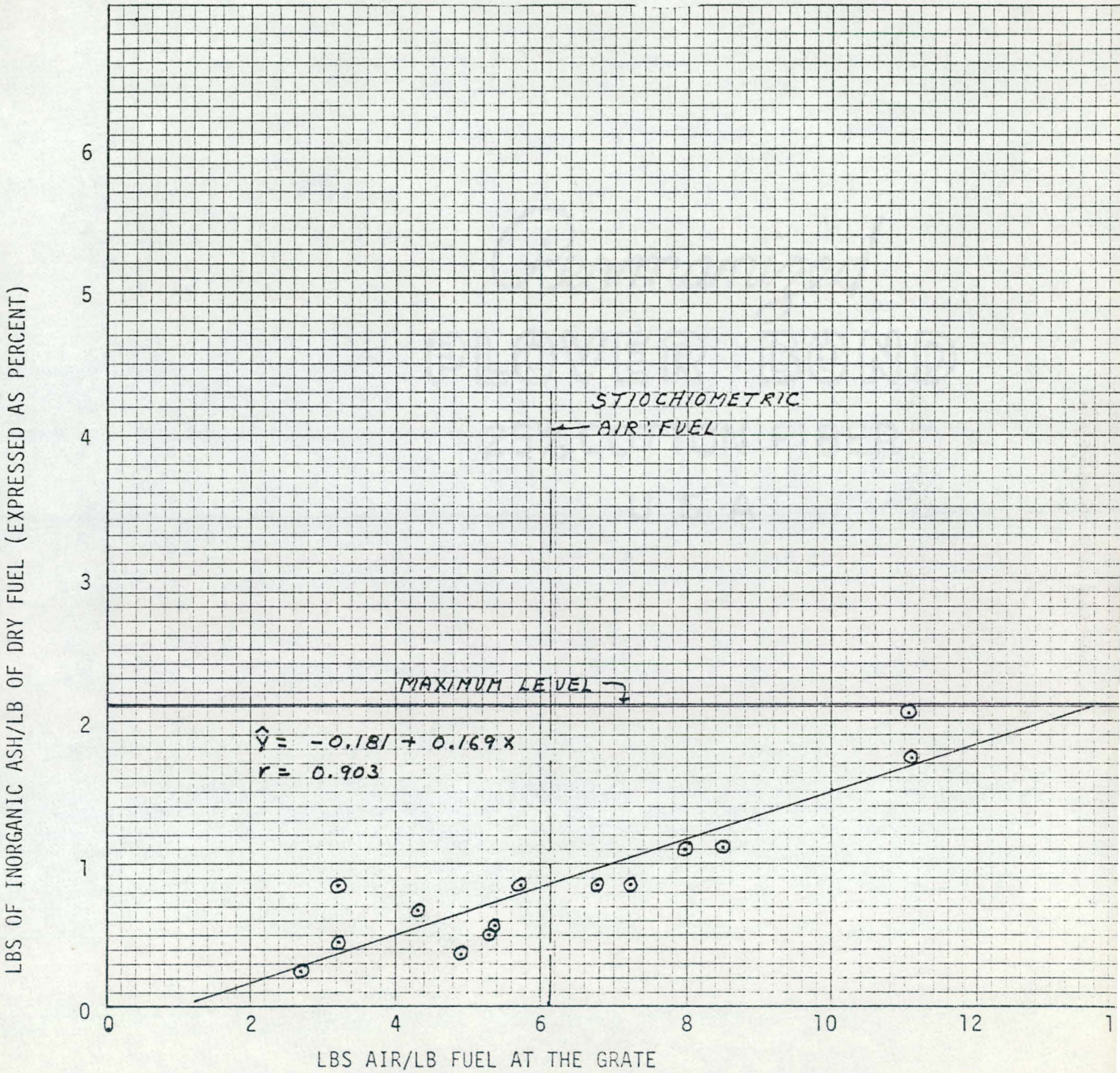
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 51 %



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: E. WHITE PINE & D. FIR PLAN. SHAV. RUNS: 91 TO 128

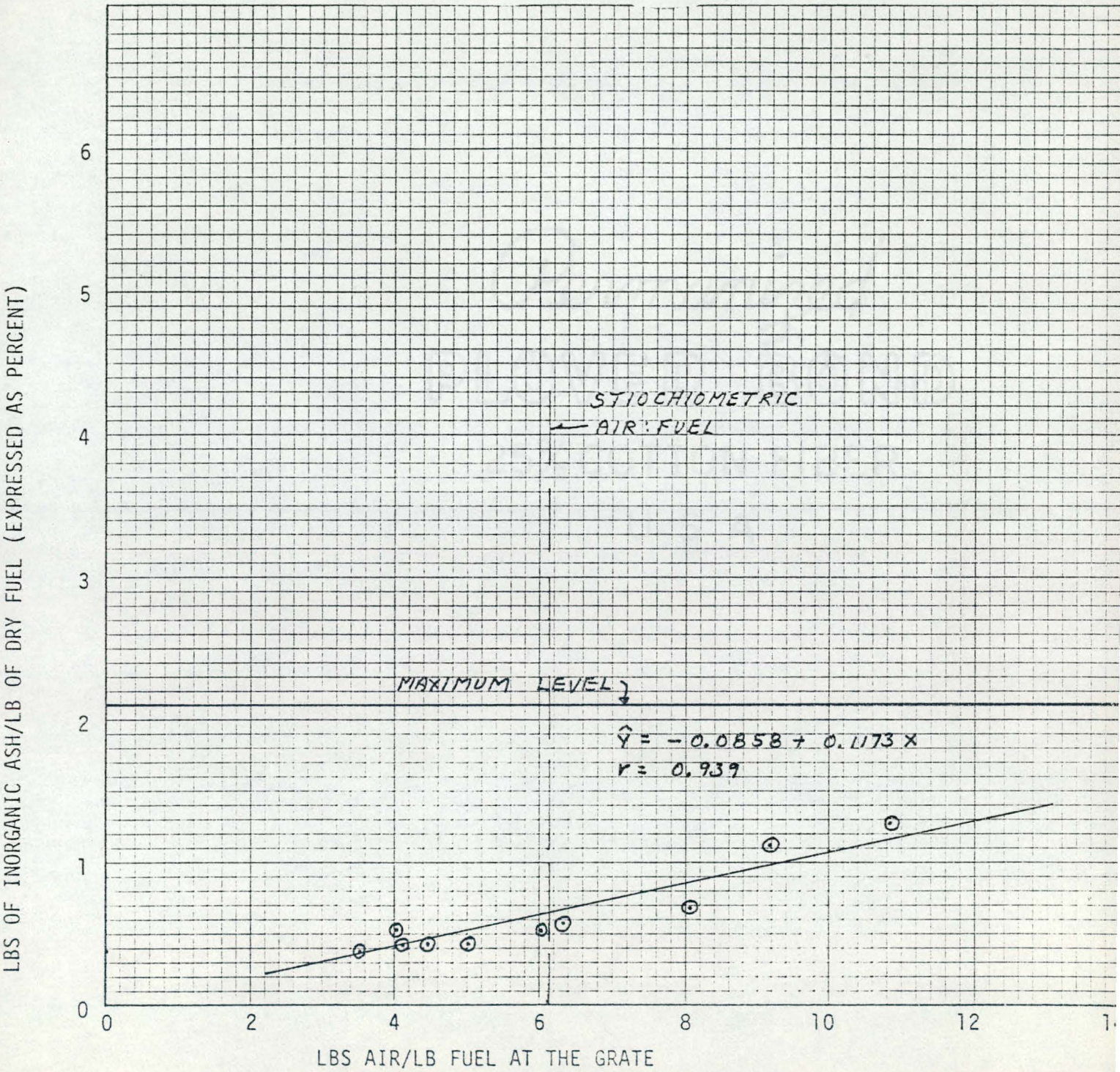
TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 51 (%)



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

SPECIES: E. WHITE PINE & D. FIR PLAN. SHAV. RUNS: 65 TO 90

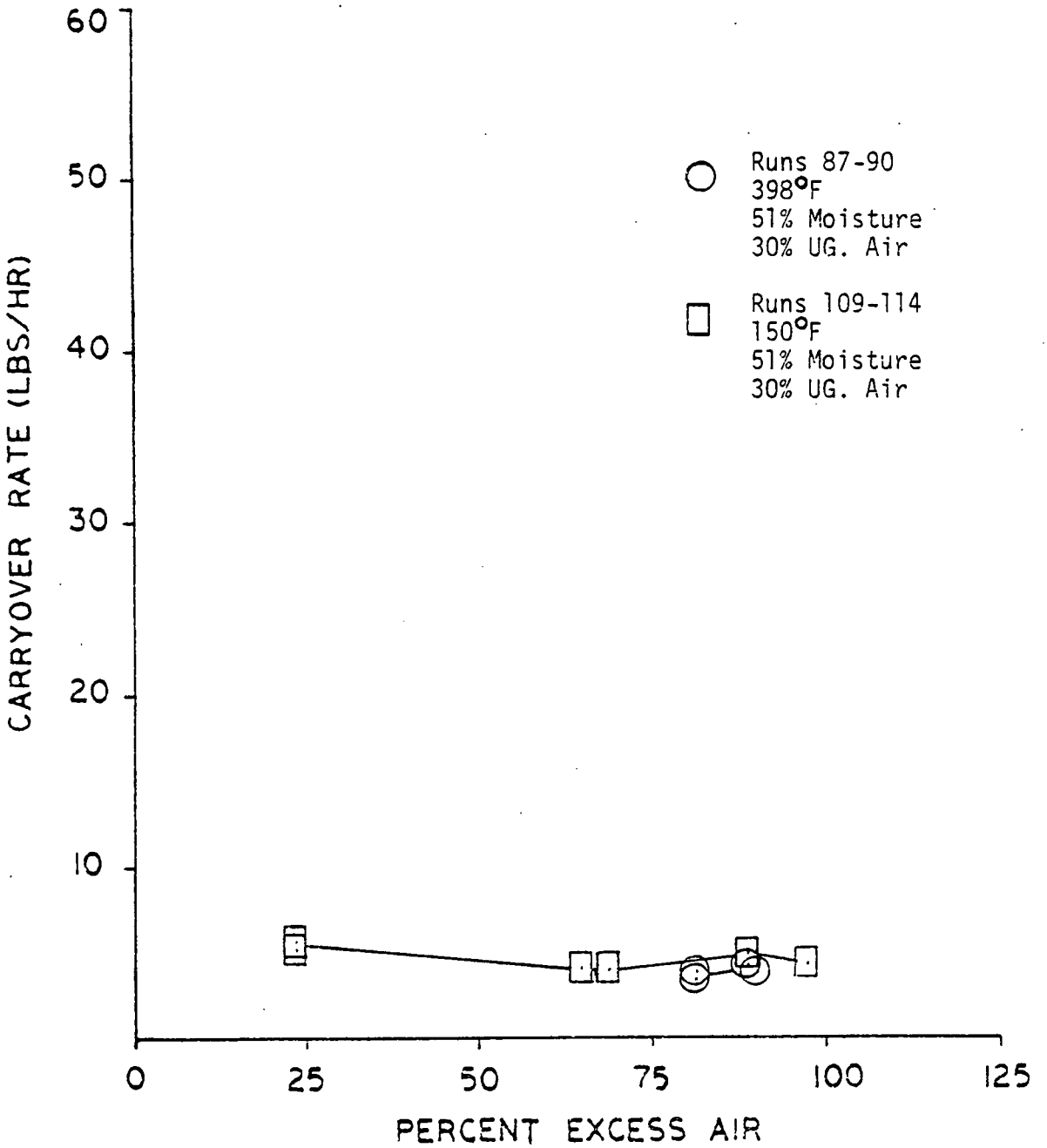
TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 51 (%)



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

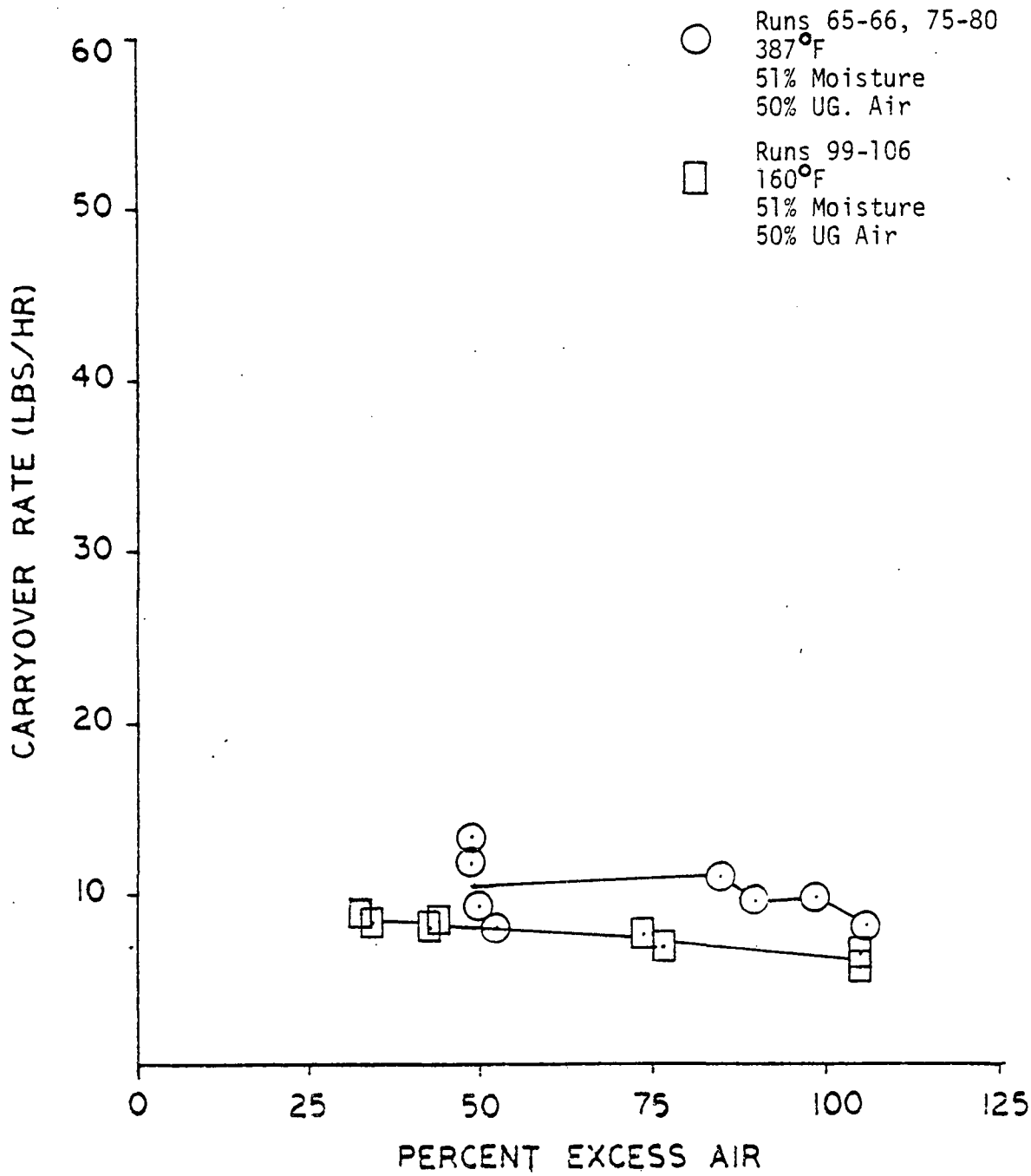
CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Doug. Fir & E. White Pine



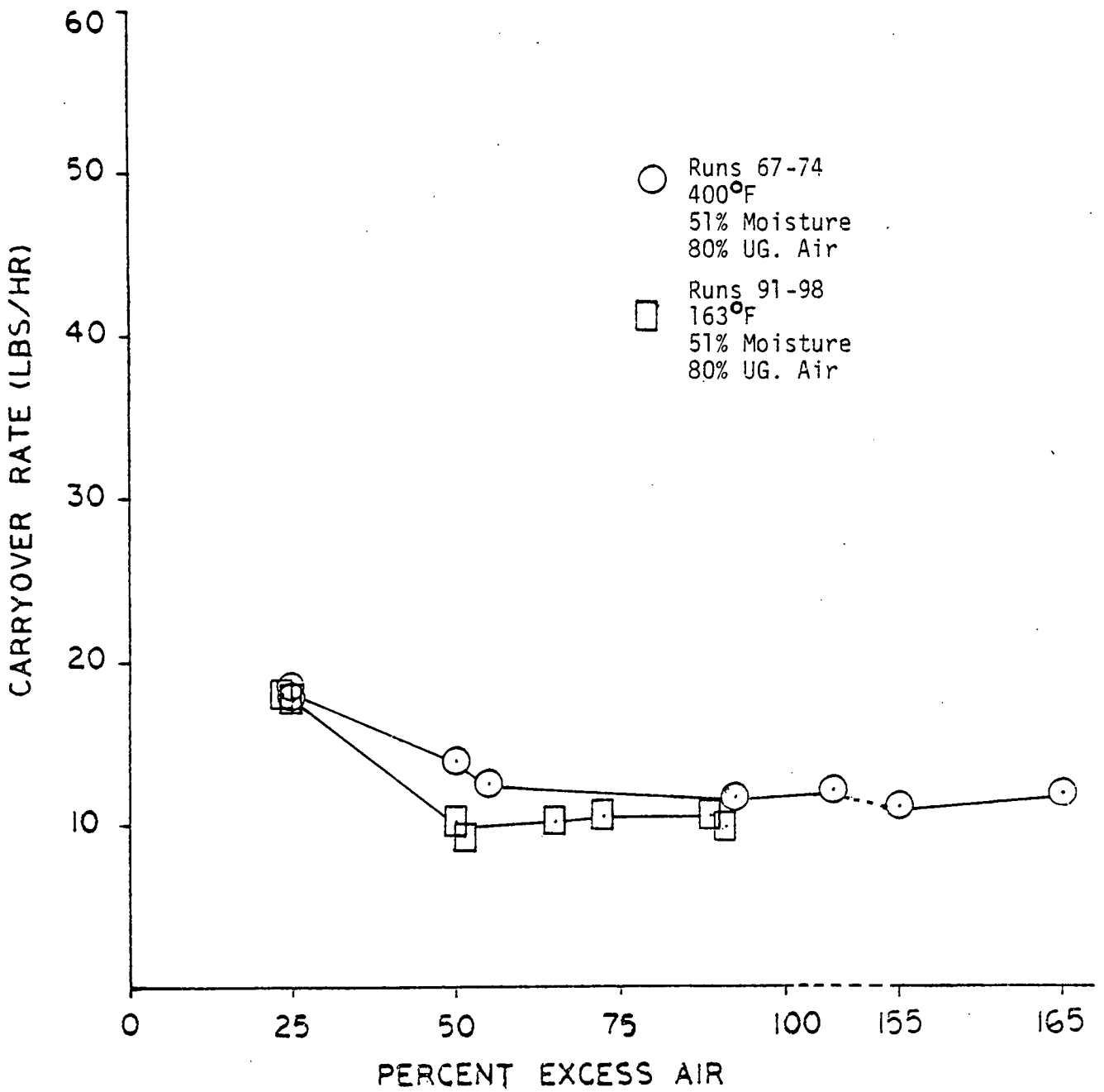
CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Doug. Fir & E. White Pine



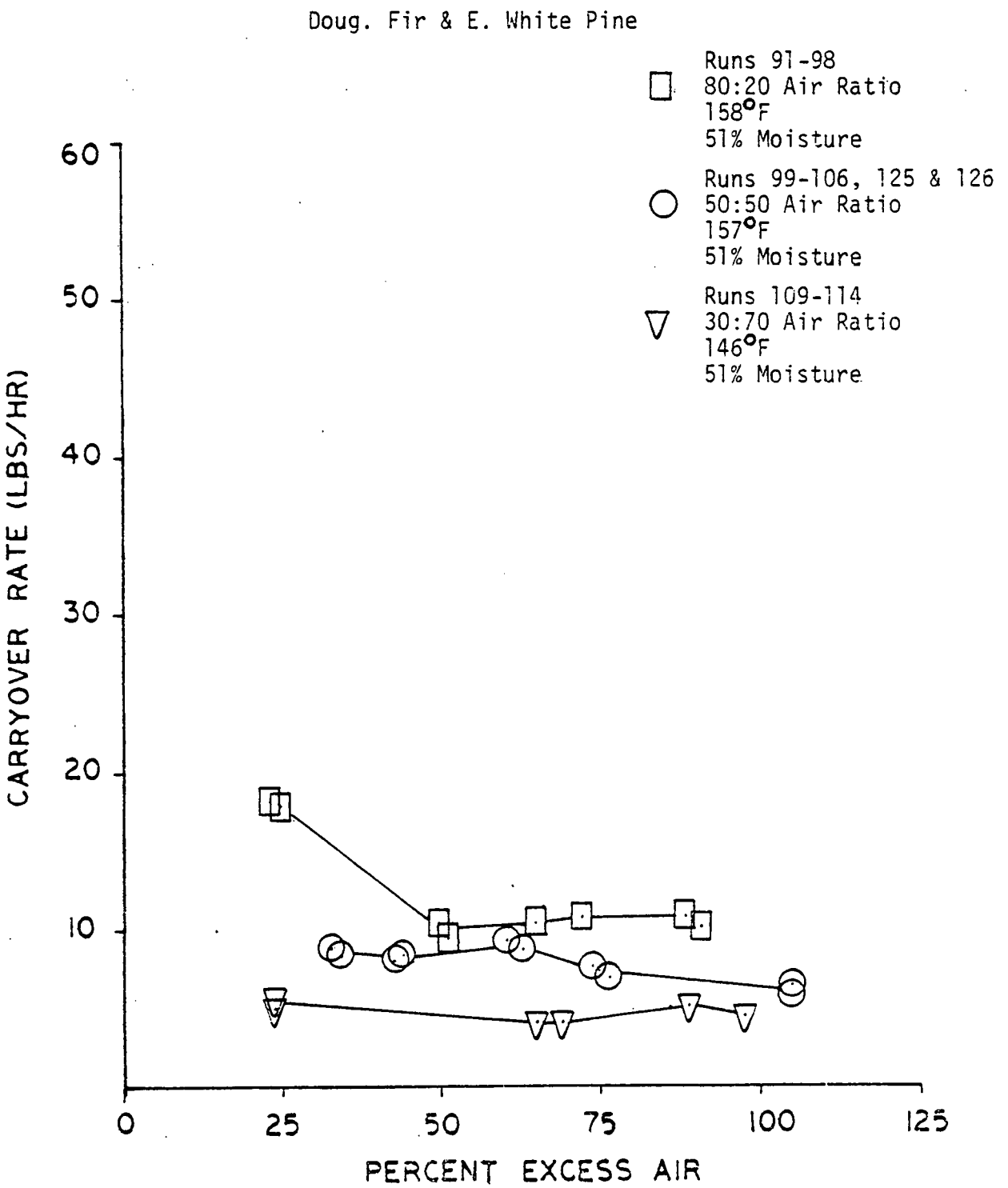
CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Doug. Fir & E. White Pine



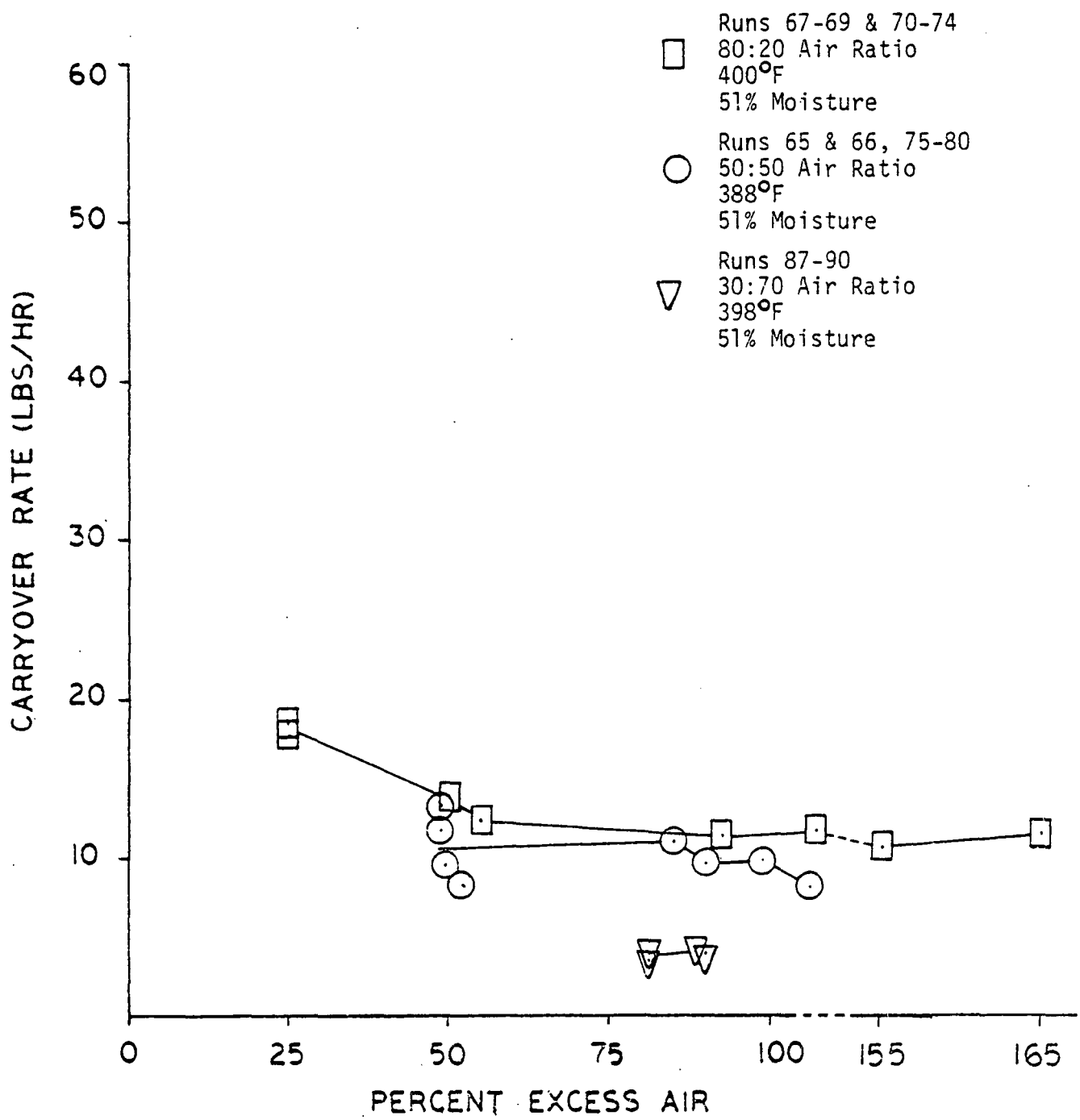
CARRYOVER RATE VS. EXCESS AIR

VARYING UNDERGRATE VS. OVERFIRE AIR RATIO



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

Doug. Fir & E. White Pine



FUEL ANALYSIS DATA AND GRAPHS

DATA FORM - RAW FUEL ANALYSES

FUEL: DOUG. FIR & EAST. WHITE PINE

COMBUSTIBLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2		SAMPLE NO. 3	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	32.66		32.31		31.78	
CRUCIBLE WT	(gm)	26.78		25.98		25.81	
SAMPLE WT	(gm)	5.88		6.33		5.97	
FINAL SAMPLE + CRUCIBLE WT	(gm)	26.87		26.08		26.02	
CRUCIBLE WT	(gm)	26.78		25.98		25.81	
ASH WT	(gm)	0.09	% 1.53	0.10	% 1.58	0.21	% 3.52
COMBUSTIBLE CARBON WT	(gm)	5.79	% 98.47	6.23	% 98.42	5.76	% 96.48

AVERAGE % INORGANIC ASH: 2.21

AVERAGE % COMBUSTIBLE CARBON: 97.79

* * * *

SIZE AND DENSITY ANALYSES

DOUG. FIR & EAST. WHITE PINE

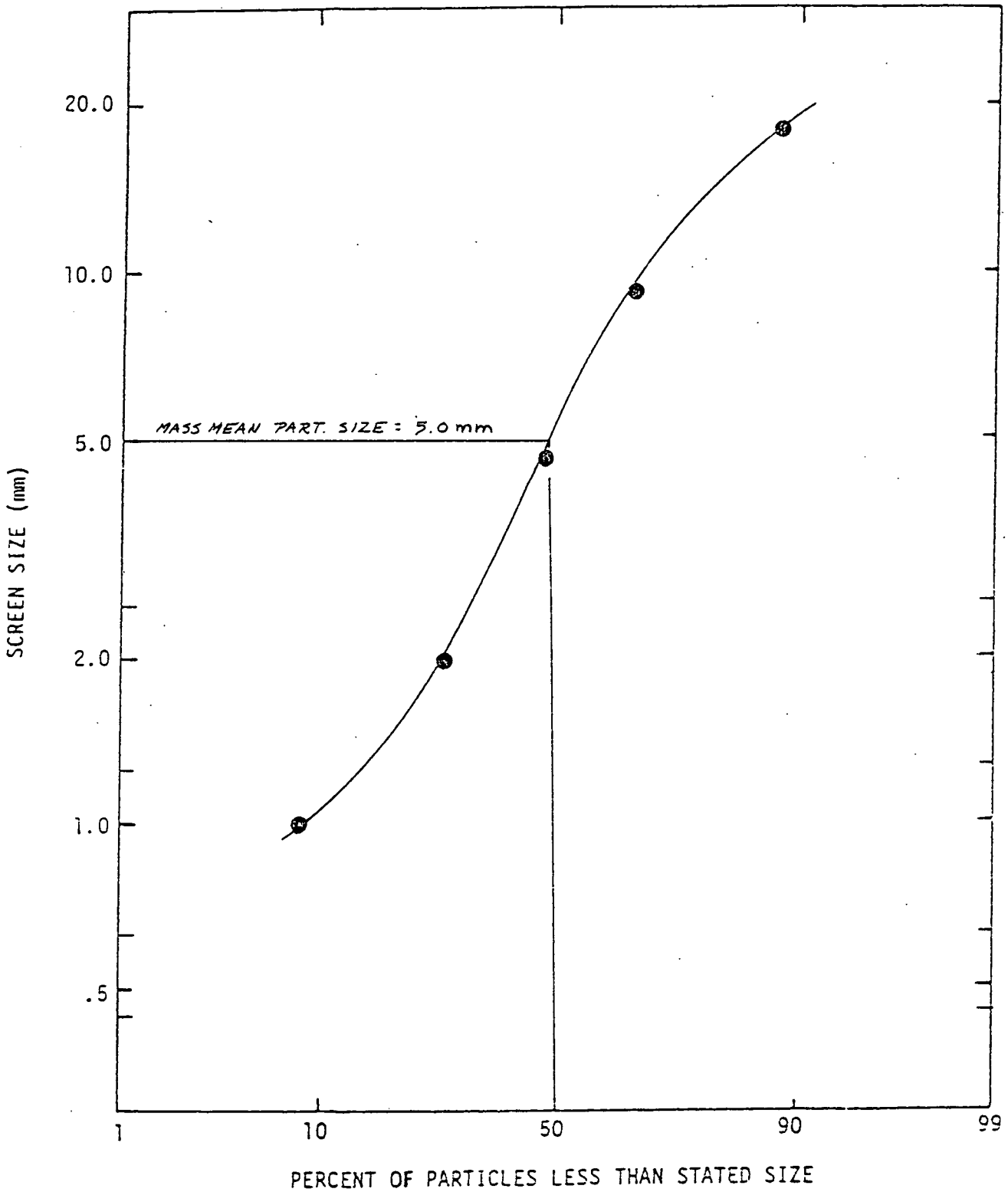
SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU-LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	31.23	17.12	14.11	132.40		65	0.217
4.760	49.13	17.12	32.01	118.29	89.34	155	0.207
3.327	41.76	17.12	24.64	86.28	65.17	130	0.190
2.000	43.34	17.12	26.22	61.64	46.56	130	0.202
1.000	41.80	17.12	24.68	35.42	26.75	125	0.187
0.500	26.85	17.12	9.73	10.74	8.11	45	0.216
PAN	18.13	17.12	1.01	1.01	0.76	4	0.253

SIZE AND DENSITY ANALYSES

DOUG. FIR & EAST. WHITE PINE

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	23.49	17.12	6.37	137.78		30	0.212
4.760	52.22	17.12	35.10	131.41	95.38	170	0.206
3.327	46.37	17.12	29.25	96.31	69.90	155	0.189
2.000	46.71	17.12	29.59	67.06	48.67	145	0.204
1.000	43.55	17.12	26.43	37.47	27.20	135	0.196
0.500	27.08	17.12	9.96	11.04	8.01	45	0.221
PAN	18.20	17.12	1.08	1.08	0.78	5	0.216

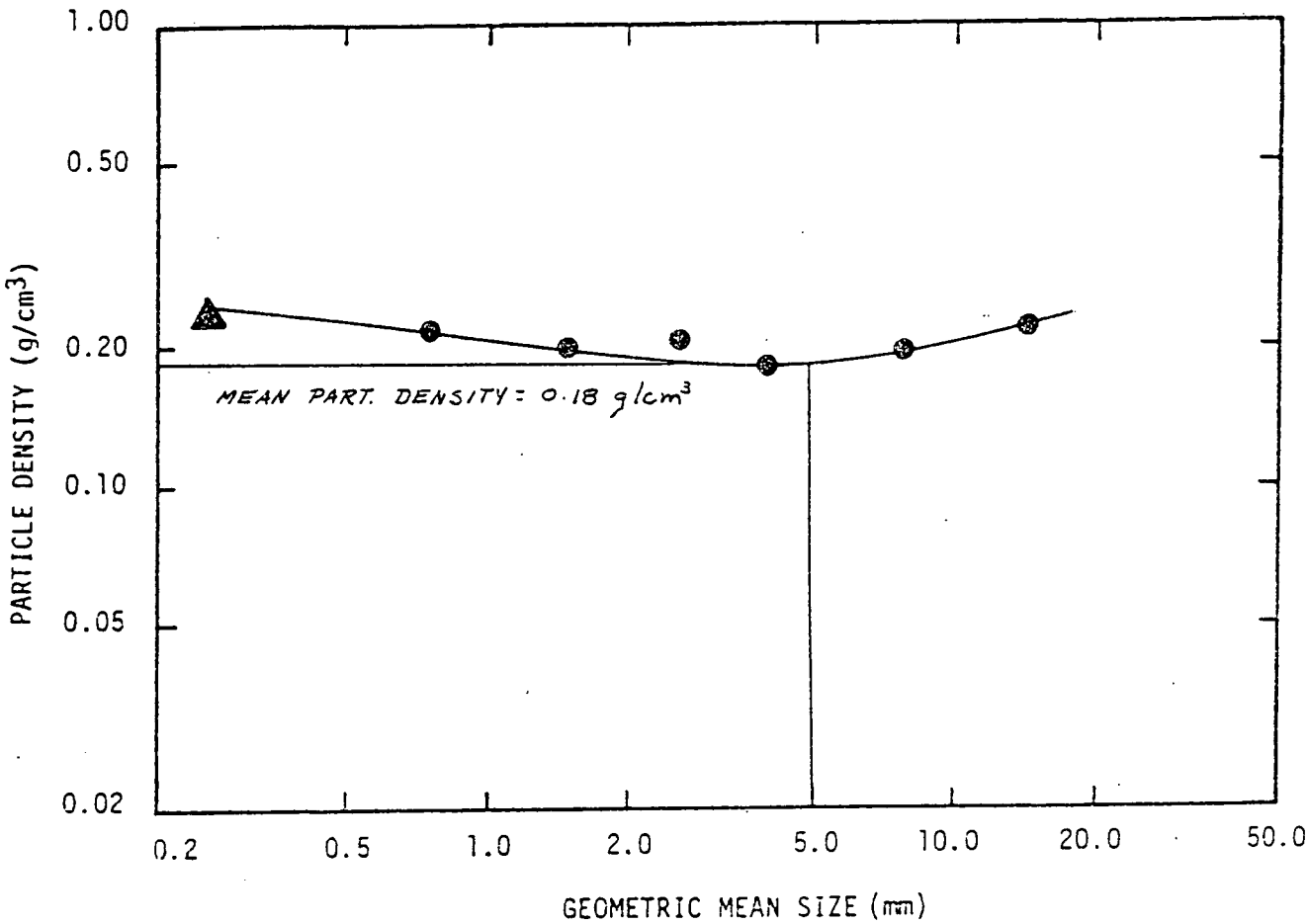
PLOT OF PARTICLE SIZE DISTRIBUTION
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 1



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

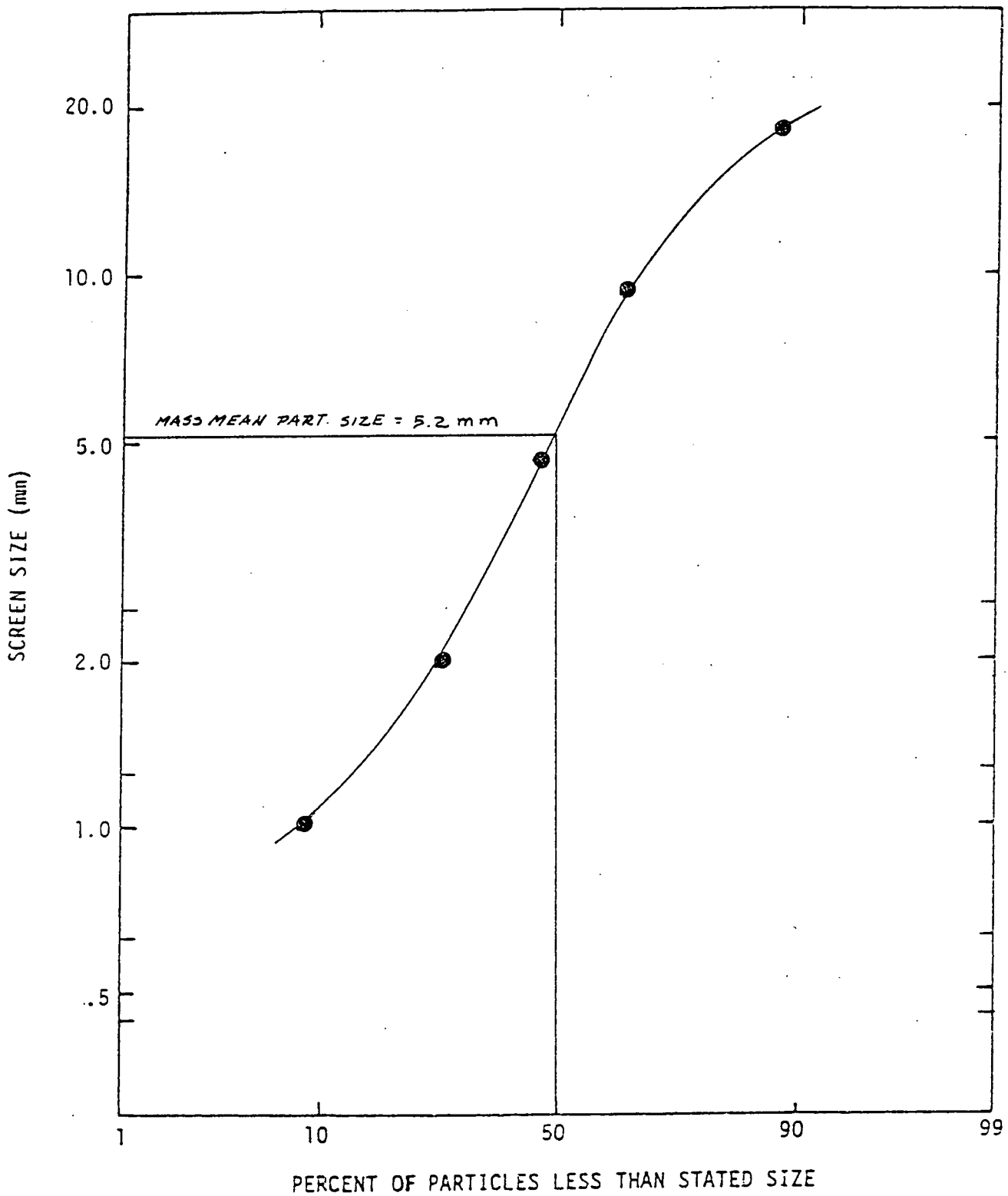
DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 1



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

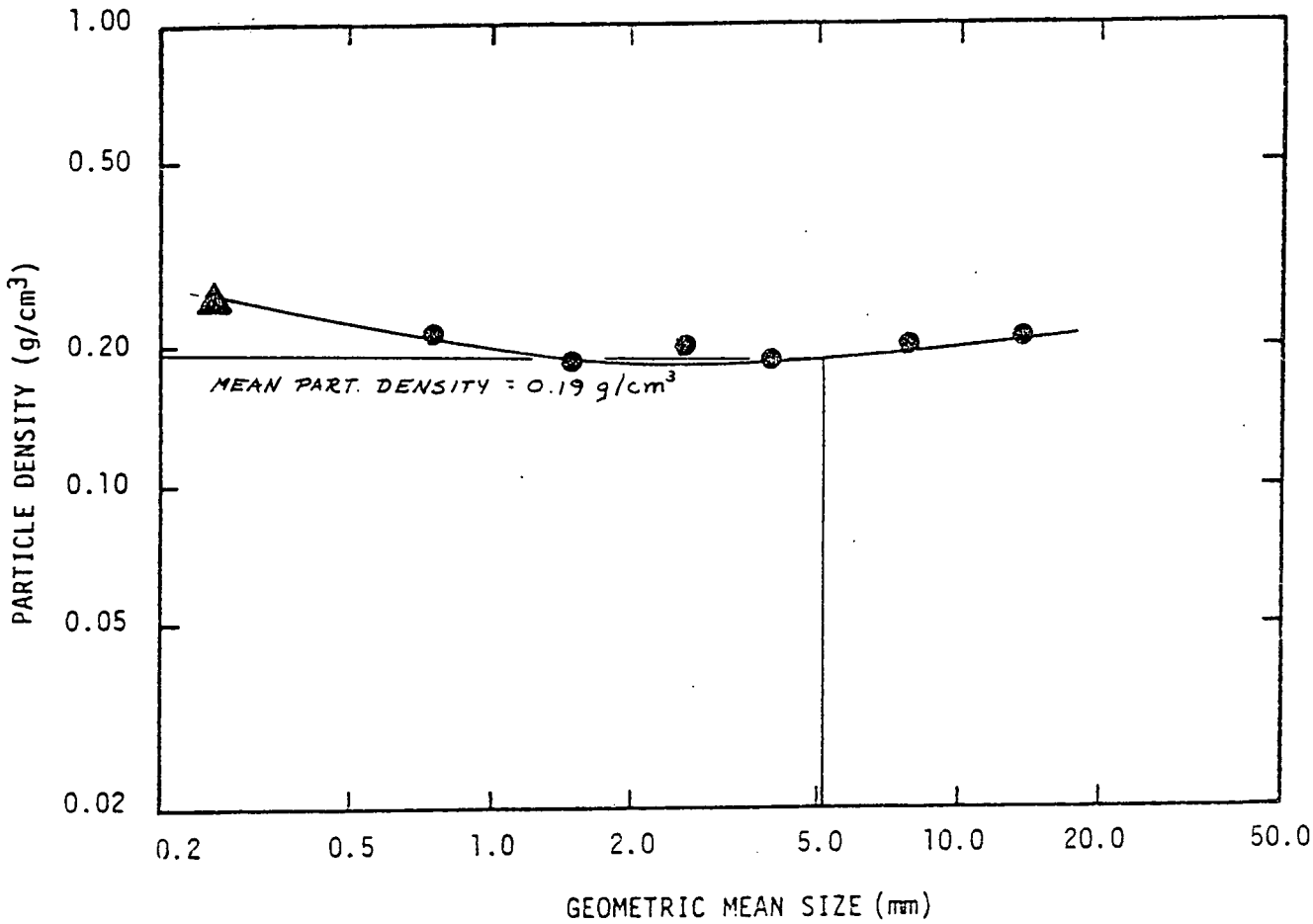
PLOT OF PARTICLE SIZE DISTRIBUTION
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 2



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

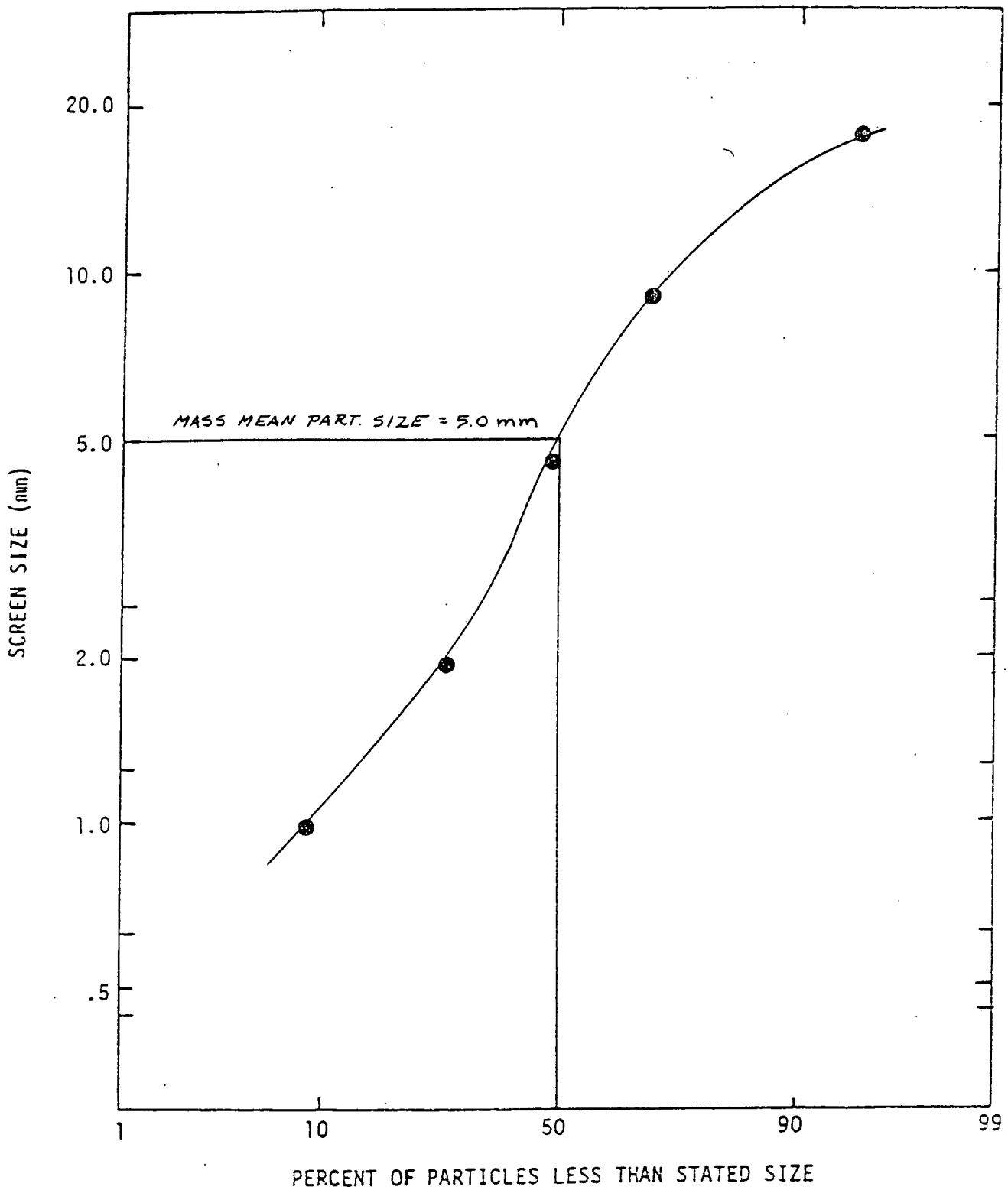
DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 2

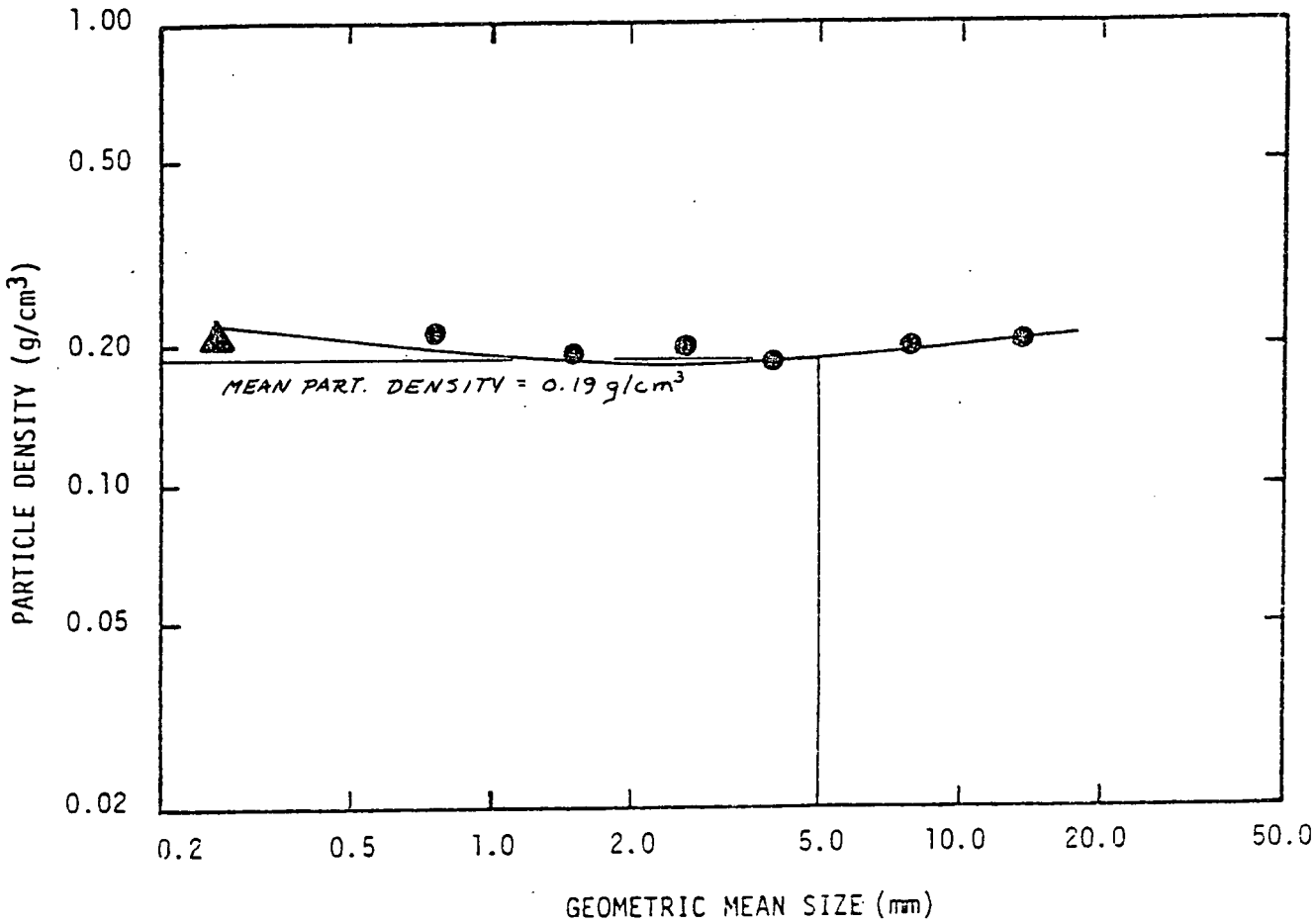


▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

PLOT OF PARTICLE SIZE DISTRIBUTION
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 3



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
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: 65

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	26.99		29.02	
CRUCIBLE WT	(gm)	25.58		27.55	
SAMPLE WT	(gm)	1.41		1.47	
FINAL SAMPLE + CRUCIBLE WT	(gm)	25.96		27.97	
CRUCIBLE WT	(gm)	25.58		27.55	
ASH WT	(gm)	0.38	% 26.95	0.42	% 28.57
COMBUSTABLE CARBON WT	(gm)	1.03	% 73.05	1.05	% 71.43

AVERAGE % INORGANIC ASH: 27.76 AVERAGE % COMBUSTABLE CARBON: 71.24

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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	25.86	17.28	8.58	47.88		145	0.059
.500	35.07	17.28	17.79	39.30	82.08	223	0.080
.250	24.12	17.28	6.84	21.51	44.92	59	0.116
.125	23.08	17.28	5.80	14.67	30.64	23	0.252
.063	20.86	17.28	3.58	8.87	18.53	15	0.239
.045	18.57	17.28	1.29	5.29	11.05	5.2	0.248
PAN	21.28	17.28	4.00	4.00	8.35	11.0	0.364

DATA FORM - WOOD ASH ANALYSES

RUN NO: 67

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.94		30.63	
CRUCIBLE WT	(gm)	29.36		28.89	
SAMPLE WT	(gm)	1.58		1.74	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.64		29.24	
CRUCIBLE WT	(gm)	29.36		28.89	
ASH WT	(gm)	0.28	% 17.72	0.35	% 20.11
COMBUSTABLE CARBON WT	(gm)	1.30	% 82.28	1.39	% 79.89

AVERAGE % INORGANIC ASH: 18.92 AVERAGE % COMBUSTABLE CARBON: 81.09

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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	29.46	17.28	12.18	49.99		176.0	0.069
.500	38.50	17.28	21.22	37.81	75.64	252.0	0.084
.250	24.21	17.28	6.93	16.59	33.19	62.0	0.112
.125	21.66	17.28	4.38	9.66	19.32	23.0	0.190
.063	19.77	17.28	2.49	5.28	10.56	10.2	0.244
.045	18.10	17.28	0.82	2.79	5.58	4.0	0.205
PAN	19.25	17.28	1.97	1.97	3.94	6.6	0.298

DATA FORM - WOOD ASH ANALYSES

RUN NO: 69

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.31		31.66	
CRUCIBLE WT	(gm)	26.73		30.07	
SAMPLE WT	(gm)	1.58		1.59	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.21		30.54	
CRUCIBLE WT	(gm)	26.73		30.07	
ASH WT	(gm)	0.48	% 30.38	0.47	% 29.56
COMBUSTABLE CARBON WT	(gm)	1.10	% 69.62	1.12	% 70.44

AVERAGE % INORGANIC ASH: 29.97 AVERAGE % COMBUSTABLE CARBON: 70.03

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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	18.44	17.28	1.16	45.28		26	0.045
1.000	25.06	17.28	7.78	44.12	97.44	130	0.060
.500	32.72	17.28	15.44	36.34	80.26	220	0.070
.250	23.83	17.28	6.55	20.90	46.16	64	0.102
.125	22.32	17.28	5.04	14.35	31.69	24	0.210
.063	20.84	17.28	3.56	9.31	20.56	13	0.274
.045	18.85	17.28	1.57	5.75	12.70	7	0.224
PAN	21.46	17.28	4.18	4.18	9.23	14	0.299

DATA FORM - WOOD ASH ANALYSES

RUN NO: 71

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.66		30.47	
CRUCIBLE WT	(gm)	26.48		27.43	
SAMPLE WT	(gm)	3.18		3.04	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.27		29.13	
CRUCIBLE WT	(gm)	26.48		27.43	
ASH WT	(gm)	1.79	% 56.29	1.70	% 55.92
COMBUSTABLE CARBON WT	(gm)	1.39	% 43.71	1.34	% 44.08

AVERAGE % INORGANIC ASH: 56.11 AVERAGE % COMBUSTABLE CARBON: 43.90

* *

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	26.21	17.28	8.93	99.48		137	0.065
.500	36.39	17.28	19.11	90.55	91.02	222	0.086
.250	35.51	17.28	18.23	71.44	71.81	91	0.200
.125	38.75	17.28	21.47	53.21	53.49	61	0.352
.063	29.49	17.28	12.21	31.74	31.91	37	0.330
.045	21.65	17.28	4.37	19.53	19.63	11	0.397
PAN	32.44	17.28	15.16	15.16	15.24	35	0.433

DATA FORM - WOOD ASH ANALYSES

RUN NO: 73

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	33.04		34.01	
CRUCIBLE WT	(gm)	27.85		28.52	
SAMPLE WT	(gm)	5.19		5.49	
FINAL SAMPLE + CRUCIBLE WT	(gm)	31.44		32.34	
CRUCIBLE WT	(gm)	27.85		28.52	
ASH WT	(gm)	3.59	% 69.17	3.82	% 69.58
COMBUSTABLE CARBON WT	(gm)	1.60	% 30.83	1.67	% 30.42

AVERAGE % INORGANIC ASH: 69.38 AVERAGE % COMBUSTABLE CARBON: 30.63

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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	25.16	17.33	7.83	157.80		114	0.069
.500	37.41	17.33	20.08	149.97	95.04	207	0.097
.250	48.83	17.33	31.50	129.89	82.31	119	0.265
.125	57.66	17.33	40.33	98.39	62.35	90	0.448
.063	38.43	17.33	21.10	58.06	36.79	56	0.377
.045	24.81	17.33	7.48	36.96	23.42	20	0.374
PAN	46.81	17.33	29.48	29.48	18.68	63	0.468

DATA FORM - WOOD ASH ANALYSES

RUN NO: 75

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.64		28.81	
CRUCIBLE WT	(gm)	29.01		27.17	
SAMPLE WT	(gm)	1.63		1.64	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.34		27.50	
CRUCIBLE WT	(gm)	29.01		27.17	
ASH WT	(gm)	0.33	% 20.25	0.33	% 20.12
COMBUSTABLE CARBON WT	(gm)	1.30	% 79.75	1.31	% 79.88

AVERAGE % INORGANIC ASH: 20.19 AVERAGE % COMBUSTABLE CARBON: 79.82

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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	28.42	17.23	11.19	53.63		168	0.067
.500	38.66	17.28	21.38	42.44	79.13	266	0.080
.250	25.89	17.28	8.61	21.06	39.27	80	0.108
.125	23.22	17.28	5.94	12.45	23.21	30	0.198
.063	20.63	17.28	3.35	6.51	12.14	14	0.239
.045	18.34	17.28	1.06	3.16	5.89	4	0.265
PAN	19.38	17.28	2.10	2.10	3.92	6	0.350

DATA FORM - WOOD ASH ANALYSES

RUN NO: 77

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.90		31.45	
CRUCIBLE WT	(gm)	28.47		30.03	
SAMPLE WT	(gm)	1.43		1.42	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.83		30.39	
CRUCIBLE WT	(gm)	28.47		30.03	
ASH WT	(gm)	0.36	%	0.36	% 25.35
COMBUSTABLE CARBON WT	(gm)	1.07	%	1.06	% 74.65

AVERAGE % INORGANIC ASH: 25.26 AVERAGE % COMBUSTABLE CARBON: 74.74

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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							
1.000	26.81	17.33	9.48	42.44		173	0.055
.500	32.34	17.33	15.01	32.96	77.66	217	0.069
.250	23.00	17.33	5.67	17.95	42.30	54	0.105
.125	22.15	17.33	4.82	12.28	28.93	22	0.219
.063	20.70	17.33	3.37	7.46	17.58	13	0.259
.045	18.53	17.33	1.20	4.09	9.64	5	0.240
PAN	20.22	17.33	2.89	2.89	6.81	7.5	0.385

DATA FORM - WOOD ASH ANALYSES

RUN NO: 79

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.07		31.78	
CRUCIBLE WT	(gm)	28.30		30.11	
SAMPLE WT	(gm)	1.77		1.67	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.88		30.61	
CRUCIBLE WT	(gm)	28.30		30.11	
ASH WT	(gm)	0.58	% 32.77	0.50	% 29.94
COMBUSTABLE CARBON WT	(gm)	1.19	% 67.23	1.17	% 70.06

AVERAGE % INORGANIC ASH: 31.34 AVERAGE % COMBUSTABLE CARBON: 68.85

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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	27.96	17.33	10.63	52.15		175.0	0.061
.500	34.46	17.33	17.13	41.52	79.62	242.0	0.071
.250	24.98	17.33	7.65	24.39	46.77	64.0	0.120
.125	24.16	17.33	6.85	16.74	32.10	27.0	0.254
.063	21.27	17.33	3.94	9.89	18.96	17.0	0.232
.045	18.87	17.33	1.54	5.95	11.41	6.2	0.248
PAN	21.74	17.33	4.41	4.41	8.46	12.5	0.353

DATA FORM - WOOD ASH ANALYSES RUN NO: 87

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.03		30.76	
CRUCIBLE WT	(gm)	28.47		28.22	
SAMPLE WT	(gm)	2.56		2.54	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.93		29.70	
CRUCIBLE WT	(gm)	28.47		28.22	
ASH WT	(gm)	1.46	% 57.03	1.48	% 58.27
COMBUSTABLE CARBON WT	(gm)	1.10	% 42.97	1.06	% 41.73

AVERAGE % INORGANIC ASH: 57.65 AVERAGE % COMBUSTABLE CARBON: 42.35

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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	26.71	17.22	3.49	76.06		70	0.050
.500	32.41	17.22	15.19	72.57	95.41	220	0.069
.250	27.52	17.22	10.30	57.38	75.44	90	0.114
.125	33.36	17.22	16.14	47.08	61.90	50	0.323
.063	30.31	17.22	13.09	30.94	40.68	35	0.374
.045	21.91	17.22	4.69	17.85	23.45	12	0.391
PAN	30.38	17.22	13.16	13.16	17.30	29	0.454

DATA FORM - WOOD ASH ANALYSES

RUN NO: 89

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	33.34		32.17	
CRUCIBLE WT	(gm)	28.98		27.56	
SAMPLE WT	(gm)	4.36		4.61	
FINAL SAMPLE + CRUCIBLE WT	(gm)	32.48		31.27	
CRUCIBLE WT	(gm)	28.98		27.56	
ASH WT	(gm)	3.50	% 80.28	3.71	% 80.48
COMBUSTABLE CARBON WT	(gm)	0.86	% 19.72	0.90	% 19.52

AVERAGE % INORGANIC ASH: 80.38 AVERAGE % COMBUSTABLE CARBON: 19.62

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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	18.72	17.22	1.50	129.57		30	0.050
.500	24.55	17.22	7.33	128.07	98.84	102	0.072
.250	28.03	17.22	10.81	120.74	93.19	67	0.161
.125	47.19	17.22	29.97	109.93	84.84	64	0.468
.063	45.55	17.22	28.33	79.96	61.71	59	0.480
.045	28.02	17.22	10.80	51.63	39.85	22	0.491
PAN	58.05	17.22	40.83	40.83	31.51	71	0.575

DATA FORM - WOOD ASH ANALYSES

RUN NO: 96

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.38		32.80	
CRUCIBLE WT	(gm)	26.73		30.07	
SAMPLE WT	(gm)	2.65		2.73	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.29		31.63	
CRUCIBLE WT	(gm)	26.73		30.07	
ASH WT	(gm)	1.56	% 58.87	1.56	% 57.14
COMBUSTABLE CARBON WT	(gm)	1.09	% 41.13	1.17	% 42.86

AVERAGE % INORGANIC ASH: 58.01 AVERAGE % COMBUSTABLE CARBON: 42.00

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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	23.54	17.33	6.21	83.46		101	0.061
.500	33.42	17.33	16.09	77.25	92.56	230	0.070
.250	28.16	17.33	10.83	61.16	73.28	80	0.135
.125	33.52	17.33	16.19	50.33	60.30	47	0.344
.063	29.77	17.33	12.44	34.14	40.91	33	0.377
.045	21.87	17.33	4.54	21.70	26.00	11	0.413
PAN	34.49	17.33	17.16	17.16	20.56	35	0.490

DATA FORM - WOOD ASH ANALYSES

RUN NO: 99

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.36		28.47	
CRUCIBLE WT	(gm)	27.84		26.91	
SAMPLE WT	(gm)	1.52		1.56	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.20		27.28	
CRUCIBLE WT	(gm)	27.84		26.91	
ASH WT	(gm)	0.36	% 23.68	0.37	% 23.72
COMBUSTABLE CARBON WT	(gm)	1.16	% 76.32	1.19	% 76.28

AVERAGE % INORGANIC ASH: 23.70 AVERAGE % COMBUSTABLE CARBON: 76.30

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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	17.77	17.23	0.54	45.19		14	0.039
1.000	27.57	17.22	10.35	44.65	98.81	197	0.053
.500	33.71	17.22	16.49	34.30	75.90	253	0.065
.250	23.14	17.22	5.92	17.81	39.41	73	0.081
.125	21.48	17.22	4.26	11.89	26.31	25	0.170
.063	20.30	17.22	3.08	7.63	16.88	12	0.257
.045	18.28	17.22	1.06	4.55	10.07	4	0.265
PAN	20.71	17.22	3.49	3.49	7.72	9	0.388

DATA FORM - WOOD ASH ANALYSES

RUN NO: 101

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.10		28.85	
CRUCIBLE WT	(gm)	29.60		27.18	
SAMPLE WT	(gm)	1.50		1.67	
FINAL SAMPLE + CRUCIBLE WT	(gm)	30.09		27.73	
CRUCIBLE WT	(gm)	29.60		27.18	
ASH WT	(gm)	0.49	% 32.67	0.55	% 32.93
COMBUSTABLE CARBON WT	(gm)	1.01	% 67.33	1.12	% 67.07

AVERAGE % INORGANIC ASH: 32.8 AVERAGE % COMBUSTABLE CARBON: 67.20

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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	23.26	17.33	5.93	47.72		118	0.050
.500	34.94	17.33	17.61	41.79	87.57	267	0.066
.250	24.42	17.33	7.09	24.18	50.67	79	0.090
.125	23.02	17.33	5.69	17.09	35.81	28	0.203
.063	21.09	17.33	3.76	11.40	23.89	18	0.209
.045	19.12	17.33	1.79	7.64	16.01	6	0.298
PAN	23.18	17.33	5.85	5.85	12.26	15	0.390

DATA FORM - WOOD ASH ANALYSES

RUN NO: 104

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.68		30.42	
CRUCIBLE WT	(gm)	27.55		27.84	
SAMPLE WT	(gm)	3.13		2.58	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.54		29.30	
CRUCIBLE WT	(gm)	27.55		27.84	
ASH WT	(gm)	1.99	% 63.58	1.46	% 56.59
COMBUSTABLE CARBON WT	(gm)	1.14	% 36.42	1.12	% 43.41

AVERAGE % INORGANIC ASH: 60.09 AVERAGE % COMBUSTABLE CARBON: 39.92

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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	20.94	17.23	3.71	89.22		74	0.050
.500	34.46	12.23	17.23	85.51	95.84	275	0.063
.250	28.31	17.23	11.08	68.28	76.53	108	0.103
.125	34.32	17.23	17.08	57.20	64.11	55	0.311
.063	31.77	17.23	14.54	40.12	44.97	36	0.404
.045	22.80	17.23	5.57	25.58	28.67	15	0.371
PAN	37.24	17.23	20.01	20.01	22.43	34	0.589

DATA FORM - WOOD ASH ANALYSES

RUN NO: 106

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	34.73		36.69	
CRUCIBLE WT	(gm)	27.85		30.30	
SAMPLE WT	(gm)	6.88		6.39	
FINAL SAMPLE + CRUCIBLE WT	(gm)	33.51		35.49	
CRUCIBLE WT	(gm)	27.85		30.30	
ASH WT	(gm)	5.66	% 82.27	5.19	% 81.22
COMBUSTABLE CARBON WT	(gm)	1.22	% 17.73	1.20	% 18.78

AVERAGE % INORGANIC ASH: 81.75 AVERAGE % COMBUSTABLE CARBON: 18.26

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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	18.93	17.32	1.61	201.14		33	0.049
.500	28.75	17.32	11.43	199.53	99.20	174	0.066
.250	33.43	17.32	16.11	188.10	93.52	106	0.152
.125	61.58	17.32	44.26	171.99	85.51	92	0.481
.063	60.52	17.32	43.20	127.73	63.50	85	0.508
.045	34.83	17.32	17.51	84.53	42.03	33	0.531
PAN	84.34	17.32	67.02	67.02	33.32	129	0.520

DATA FORM - WOOD ASH ANALYSES

RUN NO: 109

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.53		30.09	
CRUCIBLE WT	(gm)	26.73		28.22	
SAMPLE WT	(gm)	1.80		1.87	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.22		28.75	
CRUCIBLE WT	(gm)	26.73		28.22	
ASH WT	(gm)	0.49	% 27.22	0.53	% 28.34
COMBUSTABLE CARBON WT	(gm)	1.31	% 72.78	1.34	% 71.66

AVERAGE % INORGANIC ASH: 27.78 AVERAGE % COMBUSTABLE CARBON: 72.22

* * * *

DATA FORM - WOOD ASH ANALYSES RUN NO: 111

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	34.13		33.53	
CRUCIBLE WT	(gm)	28.31		27.66	
SAMPLE WT	(gm)	5.82		5.87	
FINAL SAMPLE + CRUCIBLE WT	(gm)	32.53		31.87	
CRUCIBLE WT	(gm)	28.31		27.66	
ASH WT	(gm)	4.22	% 72.51	4.21	% 71.72
COMBUSTABLE CARBON WT	(gm)	1.60	% 27.49	1.66	% 28.28

AVERAGE % INORGANIC ASH: 72.12 AVERAGE % COMBUSTABLE CARBON: 27.89

* *

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	19.48	17.22	2.26	178.59		45	0.050
.500	36.05	17.22	18.83	176.33	98.73	282	0.067
.250	33.46	17.22	16.24	157.50	88.19	152	0.107
.125	48.66	17.22	31.44	141.26	79.10	95	0.331
.063	53.52	17.22	36.30	109.82	61.49	86	0.422
.045	33.95	17.22	16.73	73.52	41.17	36	0.465
PAN	74.01	17.22	56.79	56.79	31.80	100	0.568

DATA FORM - WOOD ASH ANALYSES

RUN NO: 113

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	36.77		38.68	
CRUCIBLE WT	(gm)	26.48		28.62	
SAMPLE WT	(gm)	10.29		10.06	
FINAL SAMPLE + CRUCIBLE WT	(gm)	35.71		37.60	
CRUCIBLE WT	(gm)	26.48		28.62	
ASH WT	(gm)	9.23	% 89.70	8.98	% 89.26
COMBUSTABLE CARBON WT	(gm)	1.06	% 10.30	1.08	% 10.74

AVERAGE % INORGANIC ASH: 89.48 AVERAGE % COMBUSTABLE CARBON: 10.52

* * * *

DATA FORM - WOOD ASH ANALYSES

RUN NO: 116

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.15		30.31	
CRUCIBLE WT	(gm)	25.59		27.05	
SAMPLE WT	(gm)	3.56		3.26	
FINAL SAMPLE + CRUCIBLE WT	(gm)	27.33		28.61	
CRUCIBLE WT	(gm)	25.59		27.05	
ASH WT	(gm)	1.74	%48.88	1.56	%47.85
COMBUSTABLE CARBON WT	(gm)	1.82	%51.12	1.70	%52.15

AVERAGE % INORGANIC ASH: 48.37 AVERAGE % COMBUSTABLE CARBON: 51.64

* *

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	19.74	17.18	2.56	104.21		38	0.067
1.000	29.59	17.18	12.41	101.65	97.54	175	0.071
.500	40.74	17.18	23.56	89.24	85.63	290	0.081
.250	33.72	17.19	16.53	65.68	63.03	98	0.169
.125	35.20	17.19	18.01	49.15	47.16	51	0.353
.063	29.47	17.19	12.28	31.14	29.88	30	0.409
.045	21.80	17.19	4.61	18.86	18.10	12	0.384
PAN	31.44	17.19	14.25	14.25	13.67	30	0.475

DATA FORM - WOOD ASH ANALYSES

RUN NO: 118

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.03		33.68	
CRUCIBLE WT	(gm)	27.28		29.87	
SAMPLE WT	(gm)	3.75		3.81	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.40		32.02	
CRUCIBLE WT	(gm)	27.28		29.87	
ASH WT	(gm)	2.12	% 56.53	2.15	% 56.43
COMBUSTABLE CARBON WT	(gm)	1.63	% 43.47	1.66	% 43.57

AVERAGE % INORGANIC ASH: 56.48 AVERAGE % COMBUSTABLE CARBON: 43.52

* *

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	18.03	17.23	0.80	104.69		16	0.050
1.000	24.44	17.23	7.21	103.89	99.24	109	0.066
.500	41.28	17.23	24.05	96.68	92.35	175	0.137
.250	34.33	17.23	17.10	72.63	69.38	109	0.157
.125	39.94	17.23	22.71	55.53	53.04	56	0.406
.063	34.27	17.23	17.04	32.82	31.35	40	0.426
.045	23.10	17.23	5.87	15.78	15.07	12	0.489
PAN	27.14	17.23	9.91	9.91	9.47	42	0.236

DATA FORM - WOOD ASH ANALYSES

RUN NO: 120

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	31.16		27.67	
CRUCIBLE WT	(gm)	28.30		24.87	
SAMPLE WT	(gm)	2.86		2.80	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.17		25.72	
CRUCIBLE WT	(gm)	28.30		24.87	
ASH WT	(gm)	0.87	% 30.42	0.85	% 30.36
COMBUSTABLE CARBON WT	(gm)	1.99	% 69.58	1.95	% 69.64

AVERAGE % INORGANIC ASH: 30.39 AVERAGE % COMBUSTABLE CARBON: 69.61

* *

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	21.66	17.33	4.33	89.64		69	0.063
1.000	34.65	17.33	17.32	85.31	95.17	232	0.075
.500	44.49	17.33	27.16	67.99	75.85	315	0.086
.250	28.81	17.33	11.48	40.83	45.55	81	0.142
.125	28.66	17.33	11.33	29.35	32.74	34	0.333
.063	24.88	17.33	7.55	18.02	20.10	22	0.343
.045	20.04	17.33	2.71	10.47	11.68	9	0.301
PAN	25.09	17.33	7.76	7.76	8.66	19	0.408

DATA FORM - WOOD ASH ANALYSES

RUN NO: 123

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	28.46		30.02	
CRUCIBLE WT	(gm)	26.02		27.43	
SAMPLE WT	(gm)	2.44		2.59	
FINAL SAMPLE + CRUCIBLE WT	(gm)	26.87		28.37	
CRUCIBLE WT	(gm)	26.02		27.43	
ASH WT	(gm)	0.85	%34.84	0.94	%36.29
COMBUSTABLE CARBON WT	(gm)	1.59	%65.16	1.65	%63.71

AVERAGE % INORGANIC ASH: 35.57 AVERAGE % COMBUSTABLE CARBON: 64.44

* *

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	18.98	17.33	1.65	76.06		30	0.055
1.000	28.32	17.33	10.99	74.41	97.83	160	0.069
.500	37.73	17.33	20.40	63.42	83.38	266	0.077
.250	26.95	17.33	9.65	43.02	56.56	82	0.118
.125	26.34	17.33	9.01	33.37	43.87	42	0.215
.063	26.14	17.33	8.81	24.36	32.03	28	0.315
.045	21.00	17.33	3.67	15.55	20.44	10	0.367
PAN	29.21	17.33	11.88	11.88	15.62	24	0.495

DATA FORM - WOOD ASH ANALYSES

RUN NO: 124

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	33.16		32.60	
CRUCIBLE WT	(gm)	28.48		27.56	
SAMPLE WT	(gm)	4.68		5.04	
FINAL SAMPLE + CRUCIBLE WT	(gm)	31.01		30.41	
CRUCIBLE WT	(gm)	28.48		27.56	
ASH WT	(gm)	2.53	% 54.06	2.85	% 56.55
COMBUSTABLE CARBON WT	(gm)	2.15	% 45.94	2.19	% 43.45

AVERAGE % INORGANIC ASH: 55.31 AVERAGE % COMBUSTABLE CARBON: 44.70

* *

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	17.43	17.22	0.21	138.65		3	0.070
2.000	21.19	17.22	3.97	138.44	99.85	47	0.084
1.000	32.52	17.22	15.30	134.47	96.99	150	0.102
.500	48.33	17.22	31.11	119.17	85.95	258	0.121
.250	38.76	17.24	21.52	88.06	63.51	79	0.272
.125	46.77	17.24	29.53	66.54	47.99	58	0.509
.063	35.26	17.24	18.02	37.01	26.69	30	0.601
.045	22.61	17.24	5.37	18.99	13.70	8	0.671
PAN	30.86	17.24	13.62	13.62	9.82	20	0.681

DATA FORM - WOOD ASH ANALYSES

RUN NO: 125

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.33		32.49	
CRUCIBLE WT	(gm)	27.62		29.87	
SAMPLE WT	(gm)	2.71		2.62	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.77		30.96	
CRUCIBLE WT	(gm)	27.62		29.87	
ASH WT	(gm)	1.15	% 42.44	1.09	% 41.60
COMBUSTABLE CARBON WT	(gm)	1.56	% 57.56	1.53	% 58.40

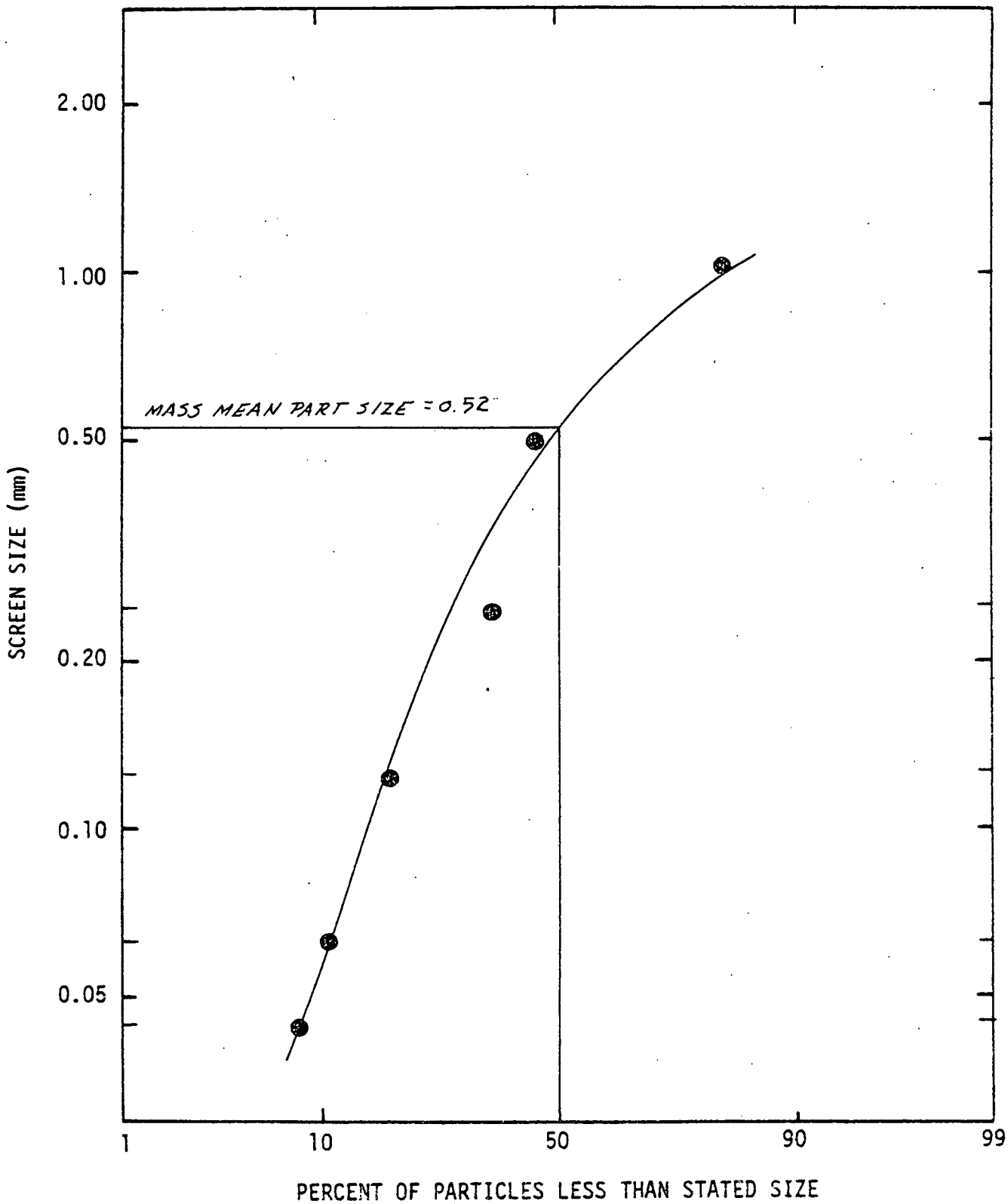
AVERAGE % INORGANIC ASH: 42.02 AVERAGE % COMBUSTABLE CARBON: 57.98

* *

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	26.92	17.33	9.59	76.11		177	0.054
.500	37.56	17.33	20.23	66.52	87.40	300	0.067
.250	27.76	17.33	10.43	46.29	60.82	89	0.117
.125	27.46	17.33	10.13	35.86	47.12	46	0.220
.063	26.97	17.33	9.64	25.73	33.81	46	0.210
.045	21.55	17.33	4.22	16.09	21.14	17	0.248
PAN	29.20	17.33	11.87	11.87	15.60	27	0.440

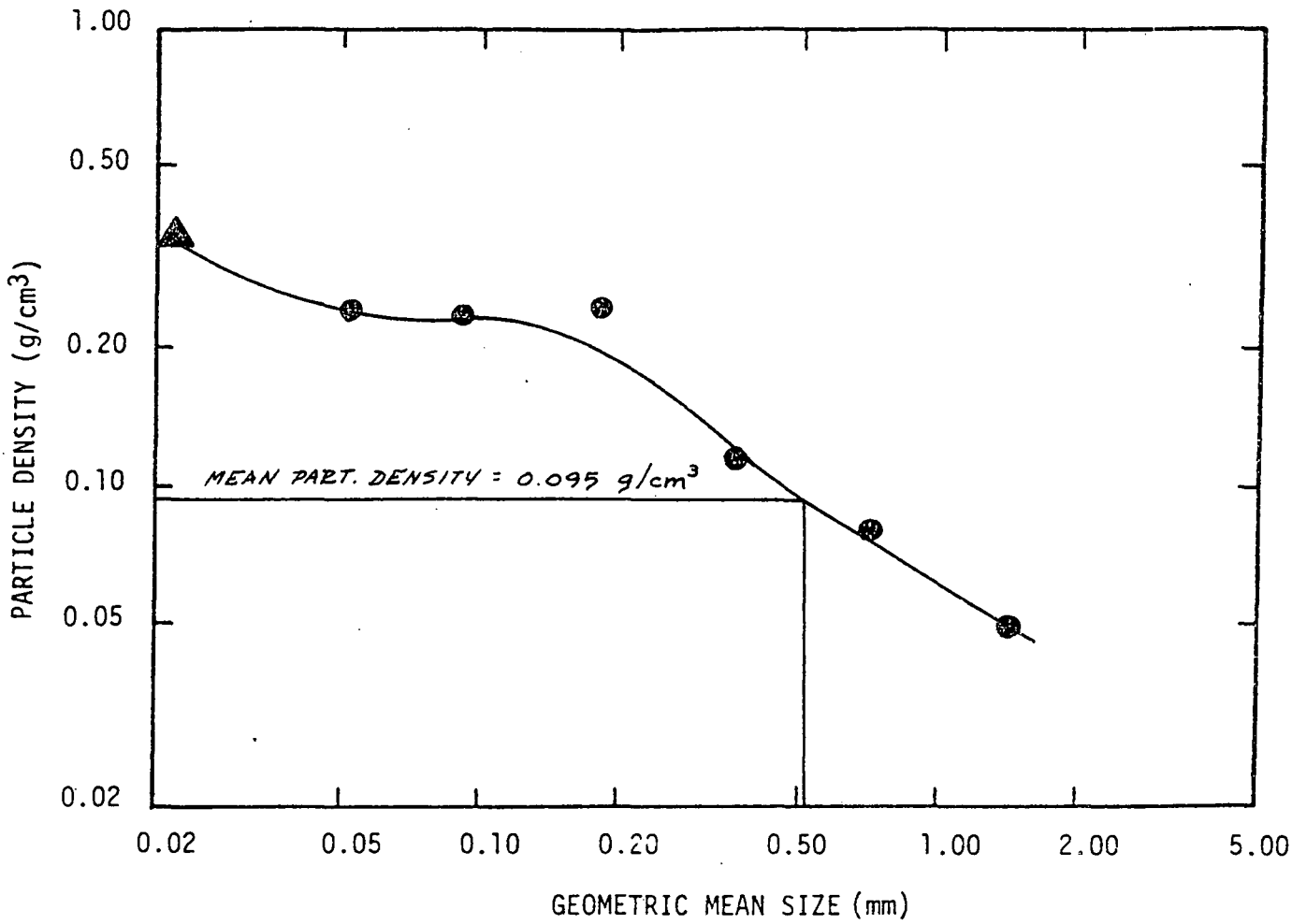
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 65



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 65

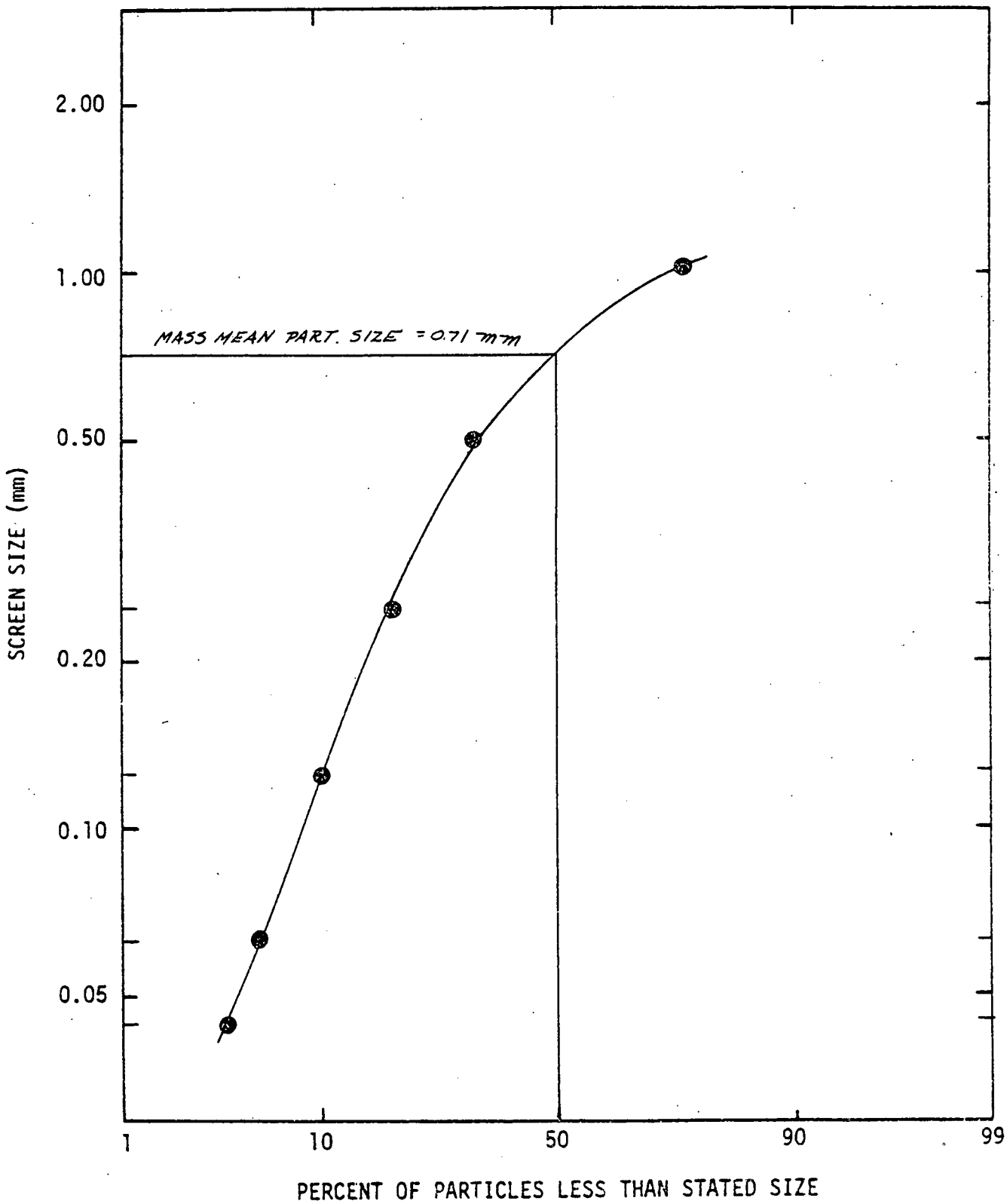


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

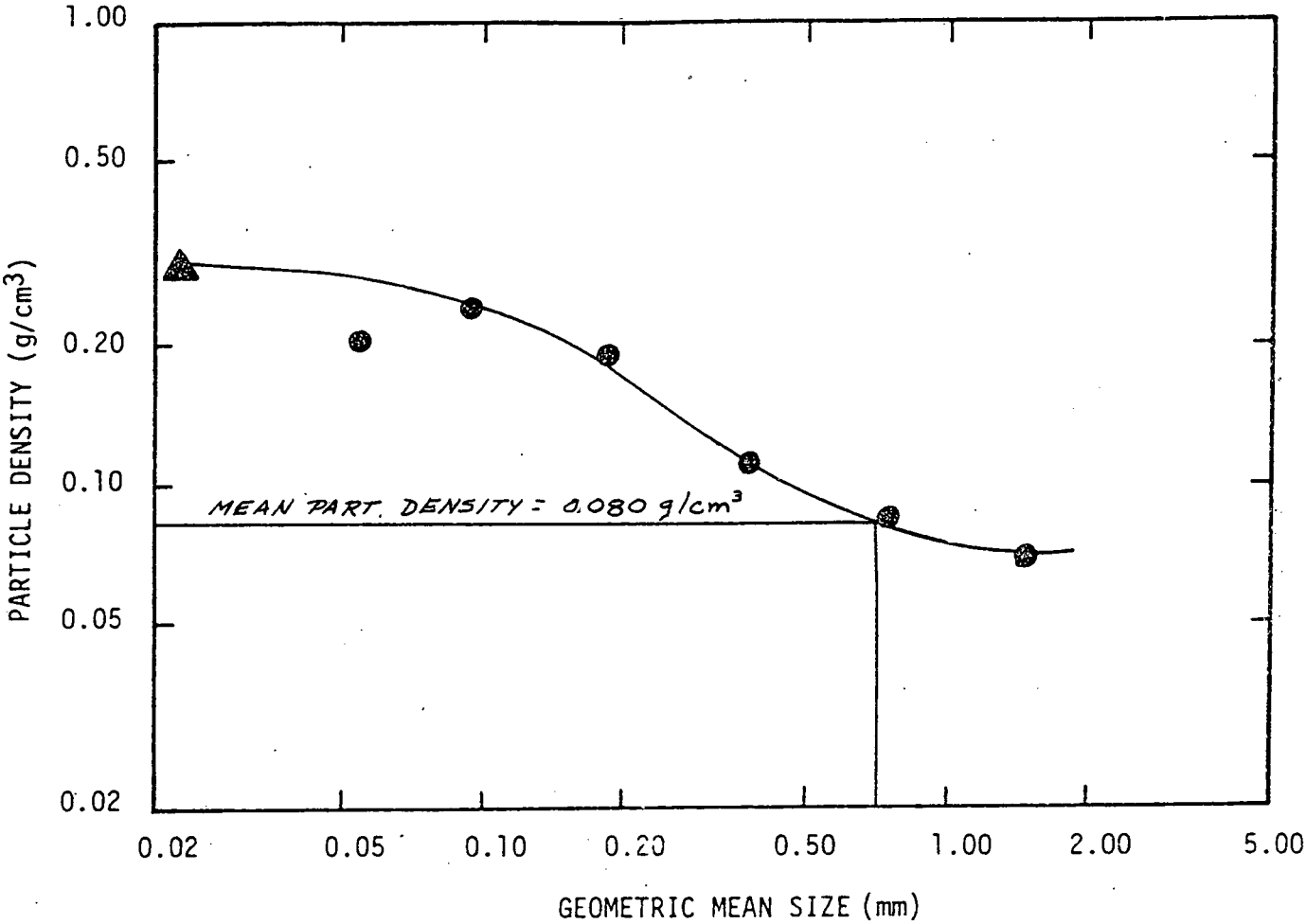
RUN NUMBER: 67



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 67

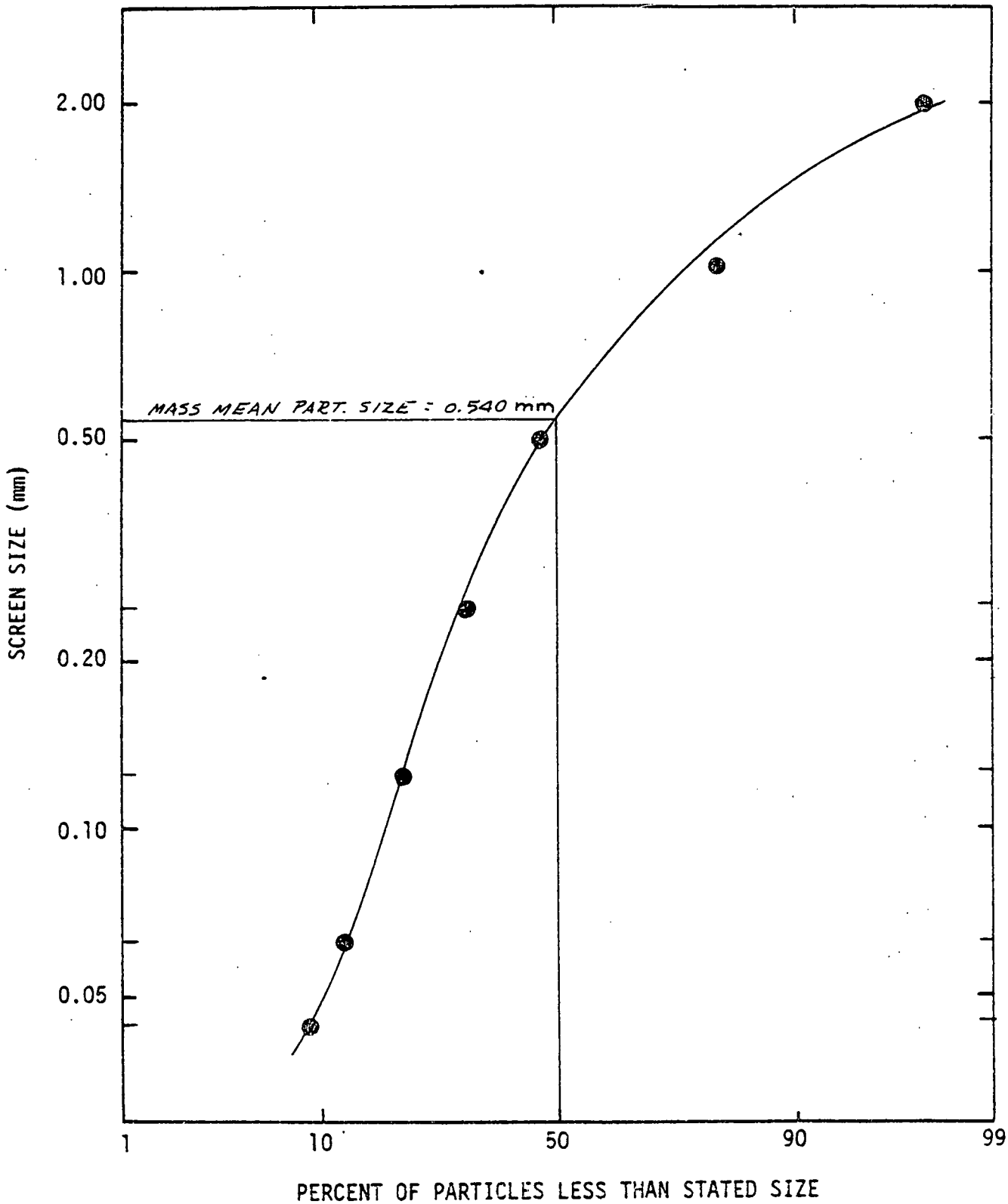


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

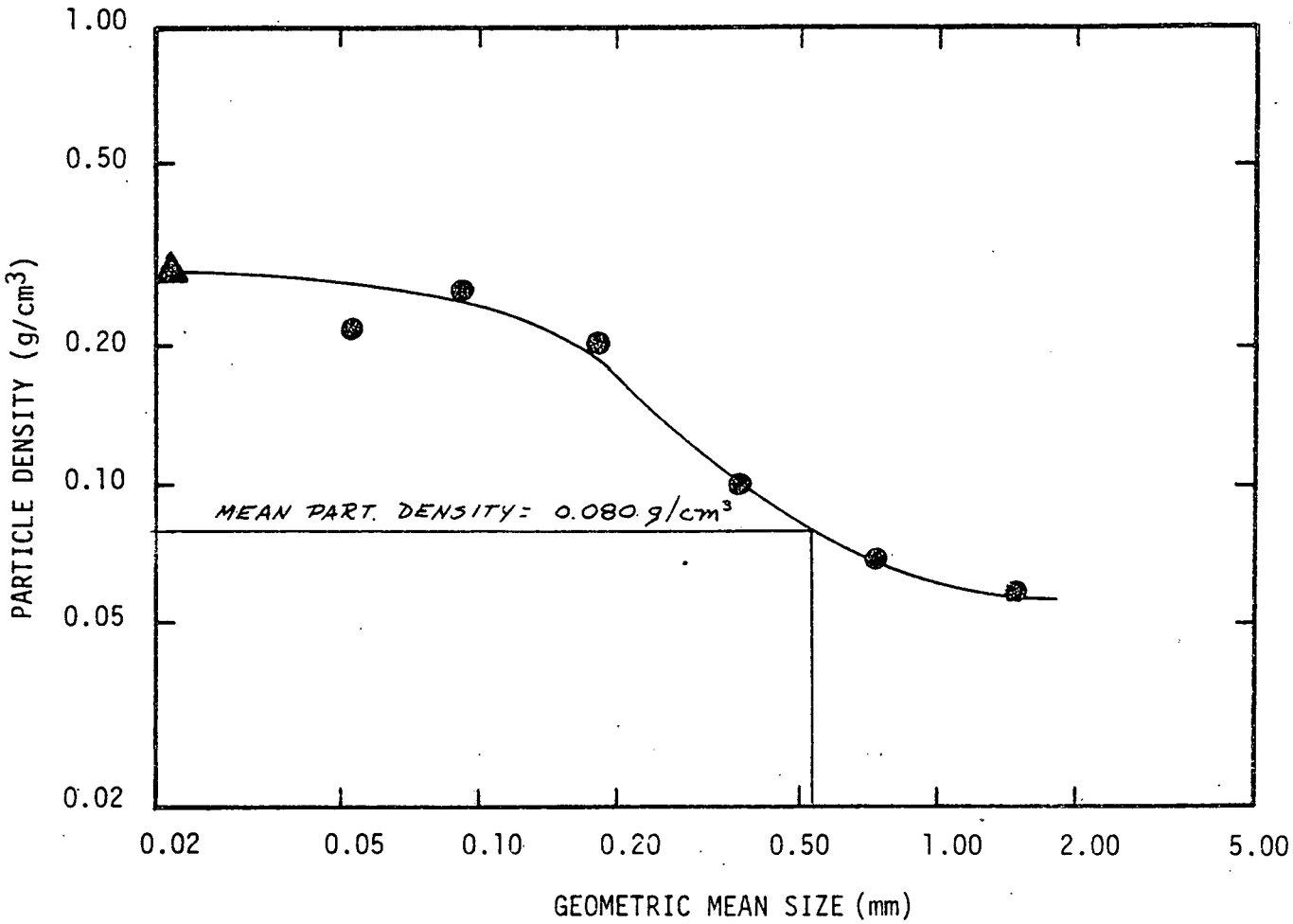
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 69



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NUMBER: 69

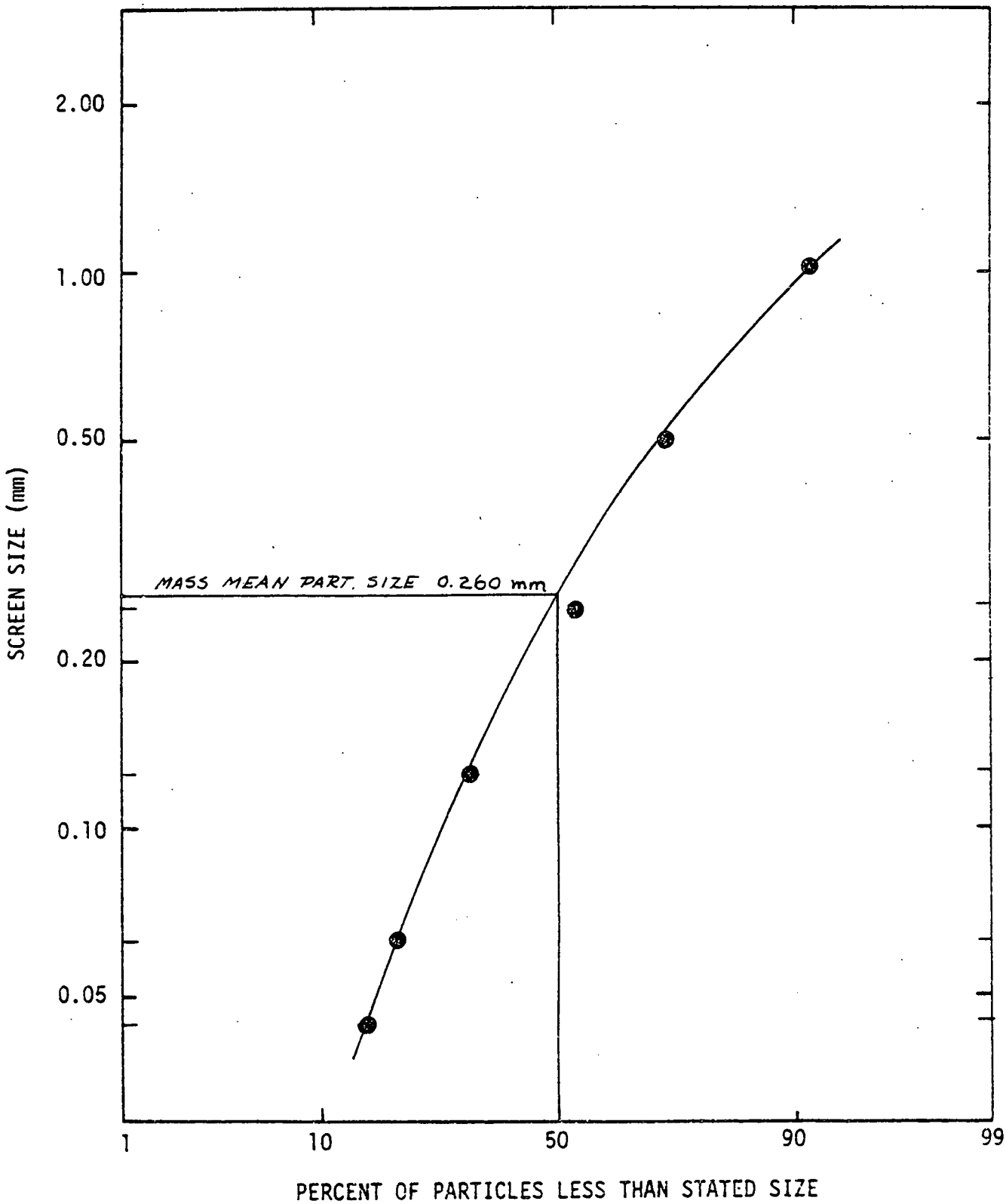


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

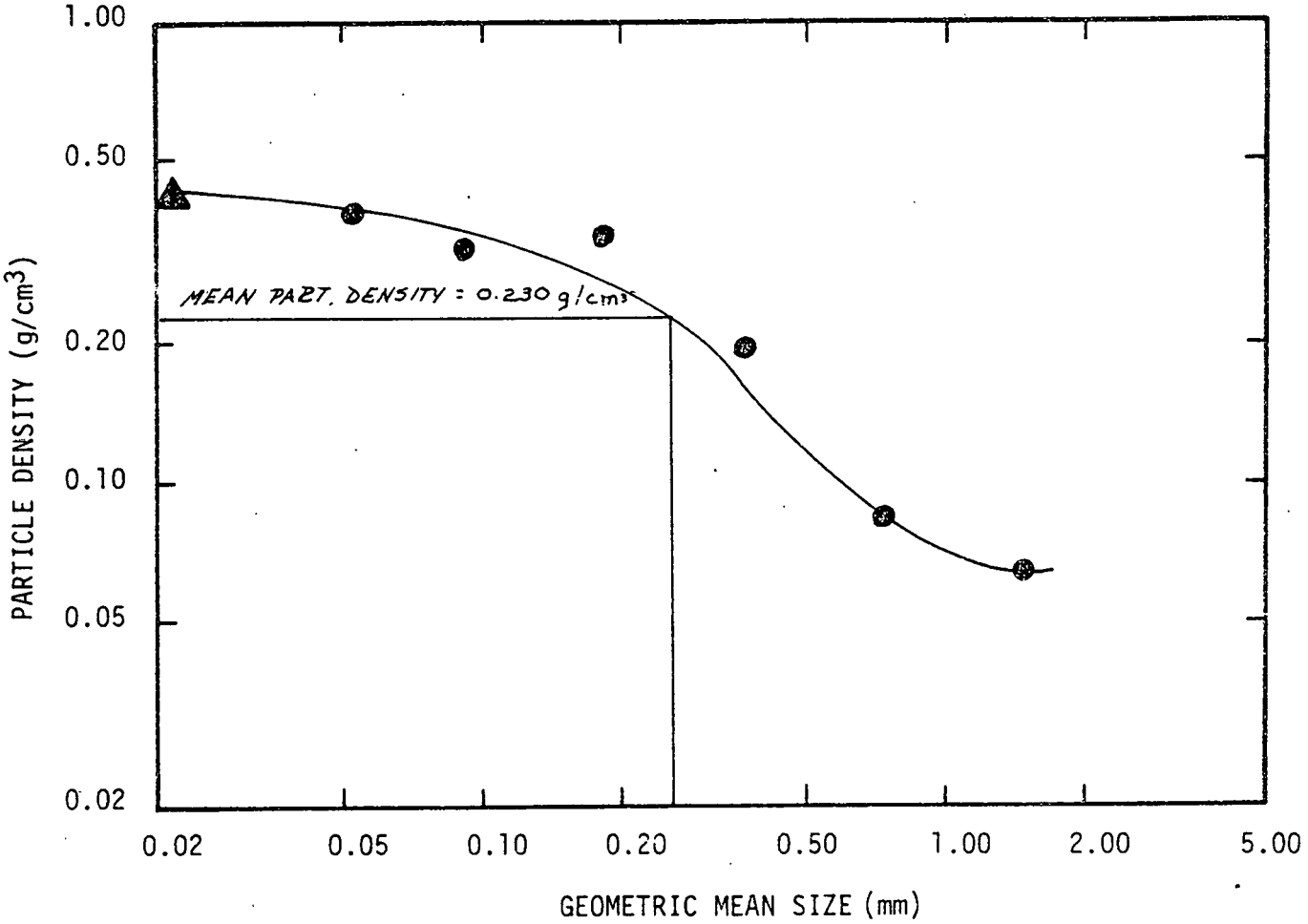
RUN NUMBER: 71



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 71

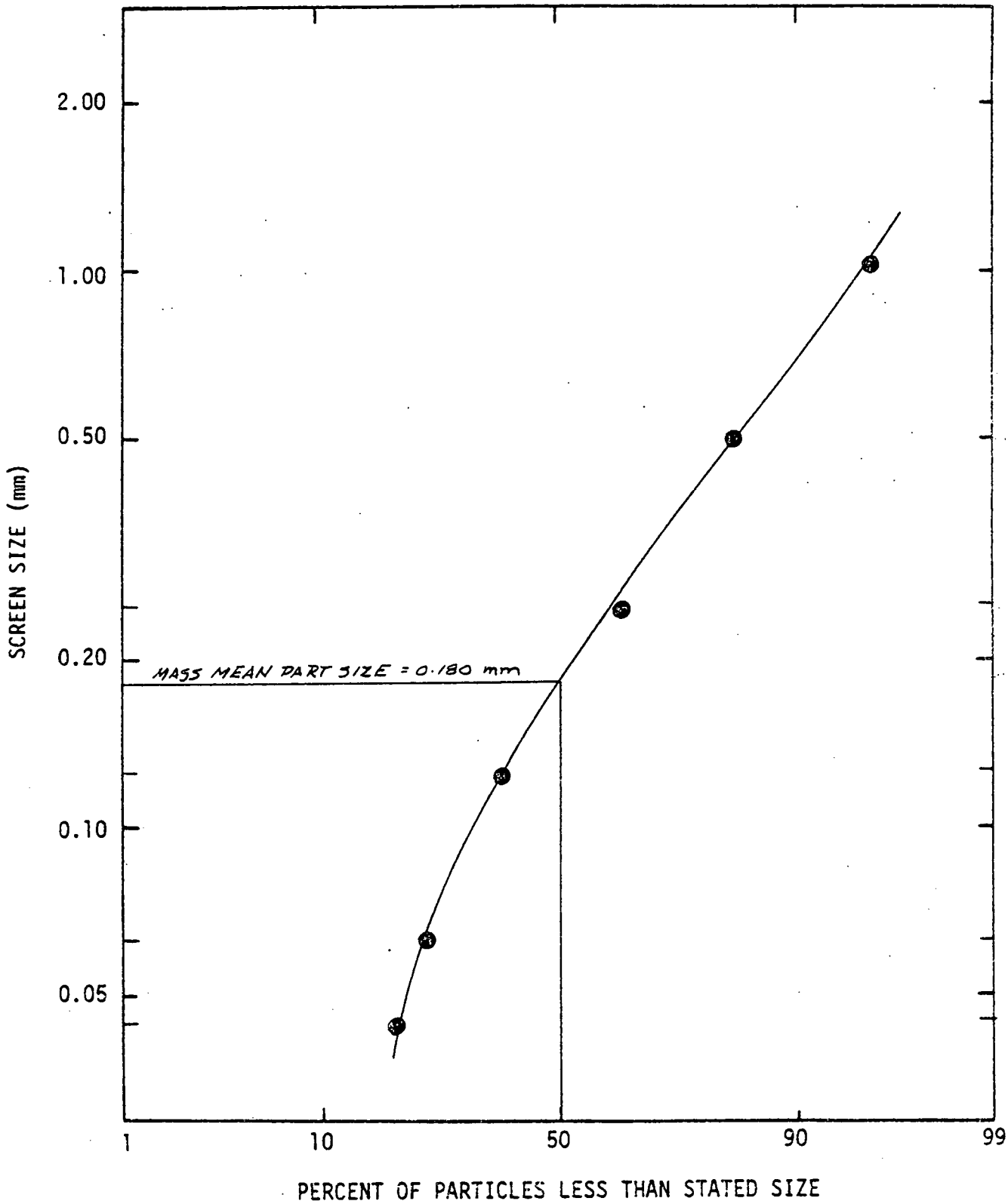


▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

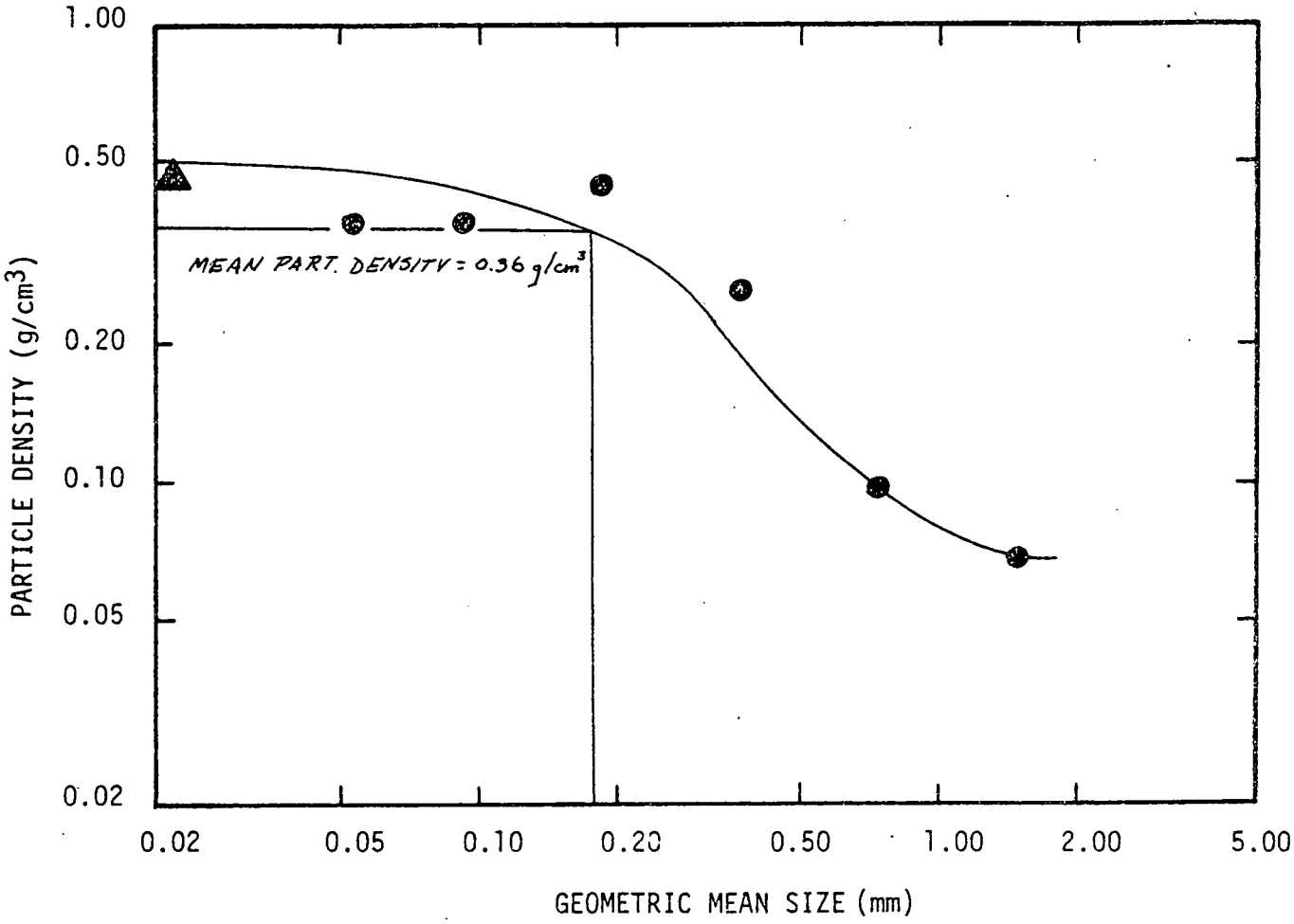
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 73



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 73

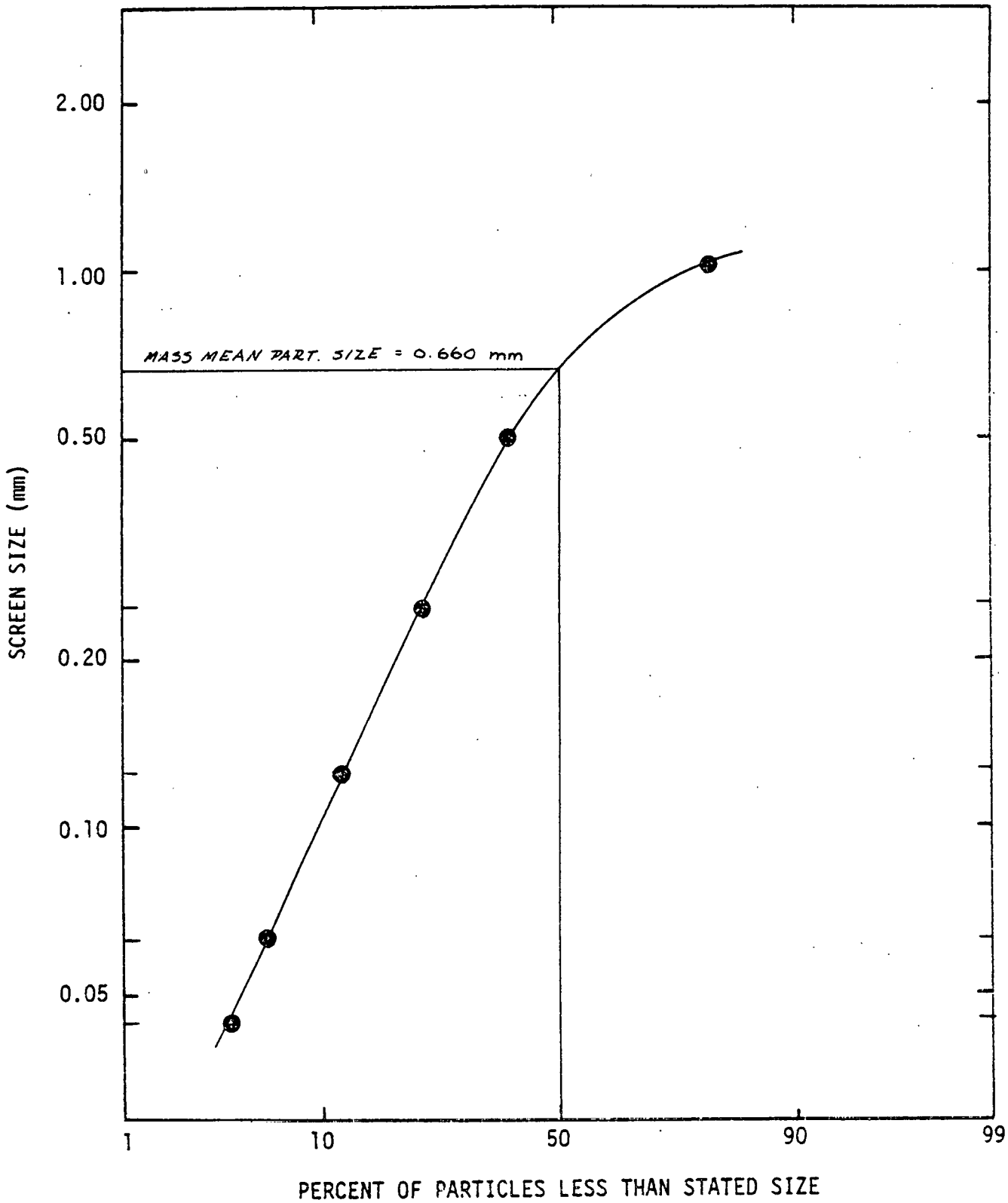


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

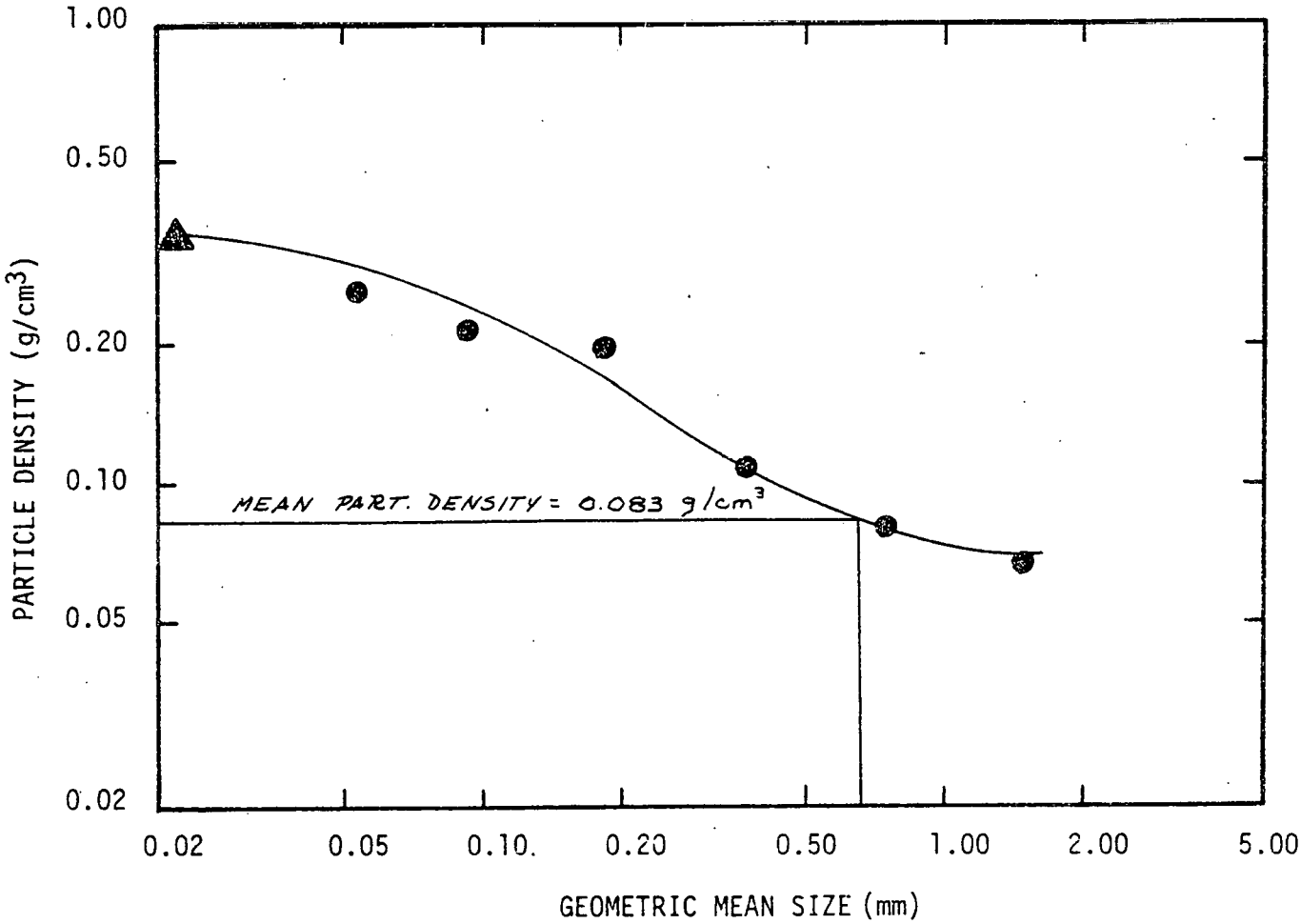
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 75



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 75

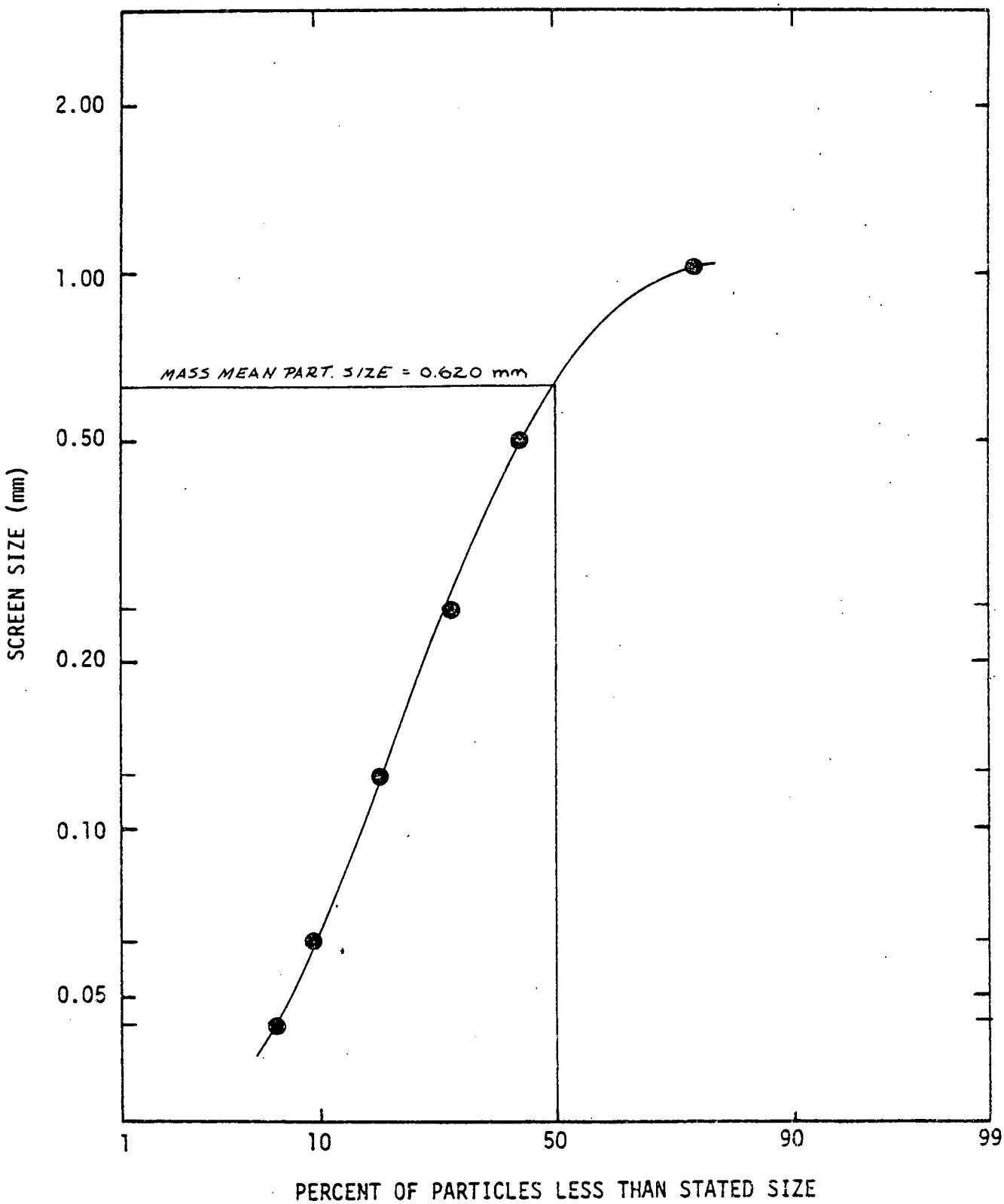


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

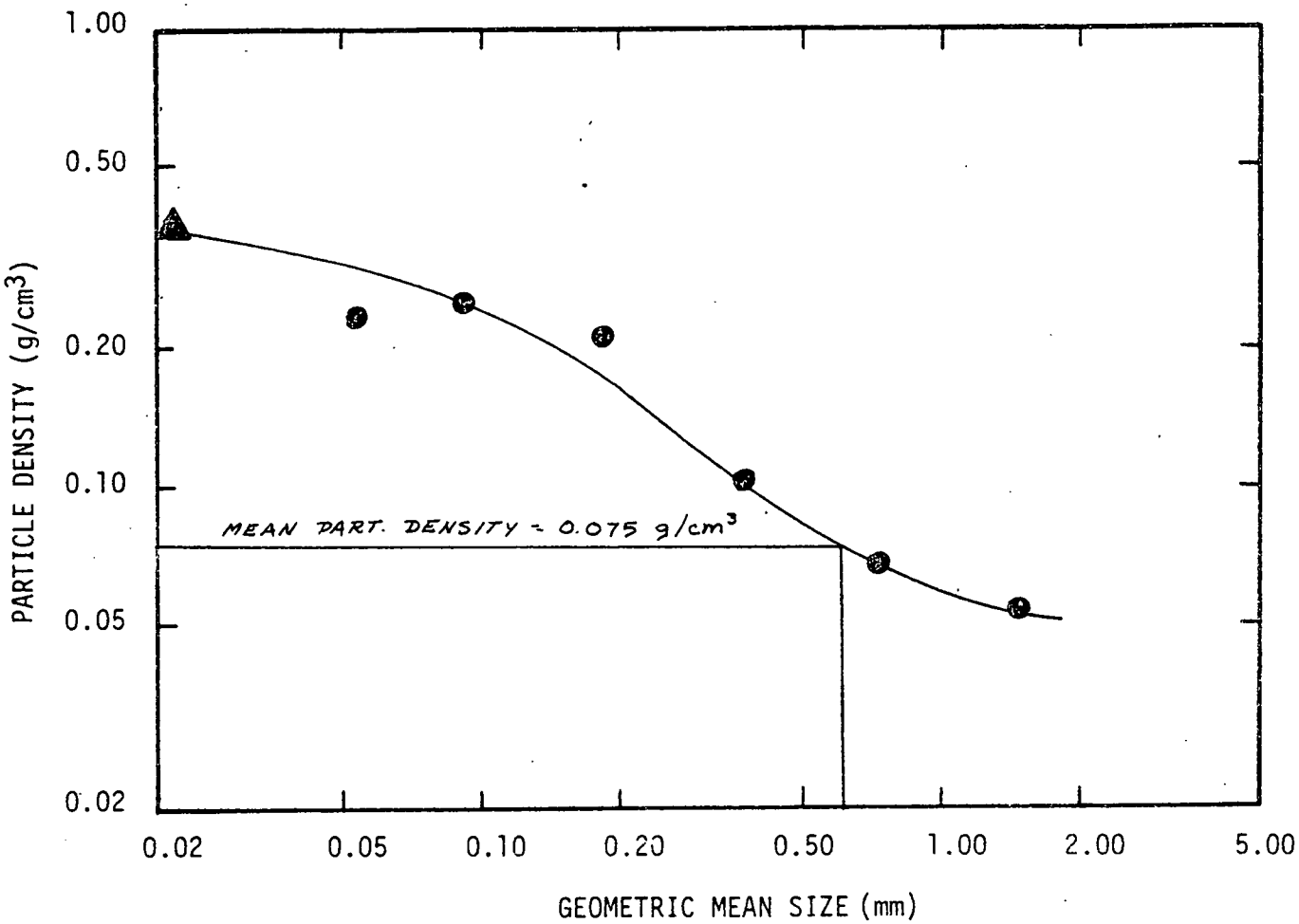
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 77



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 77

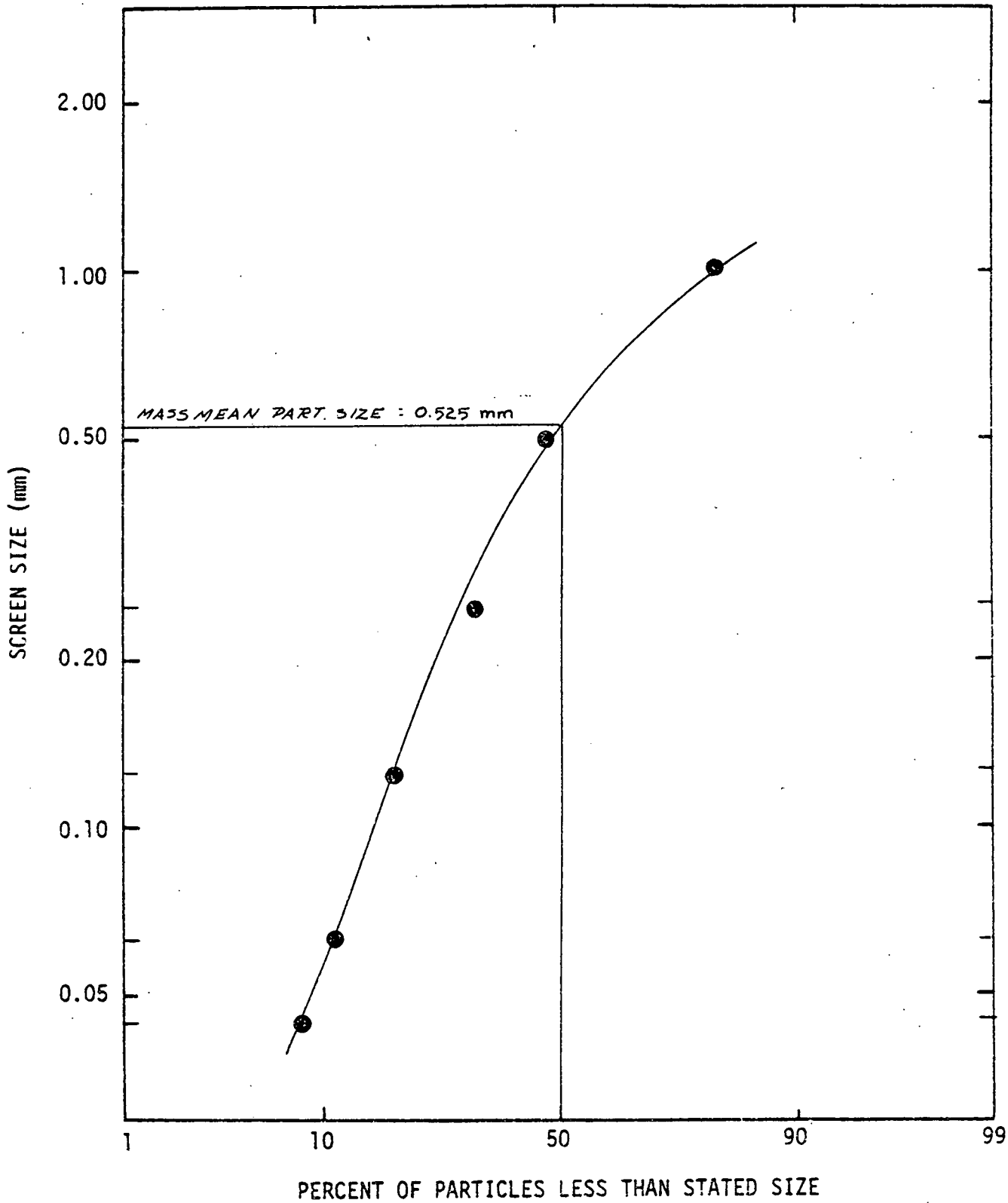


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

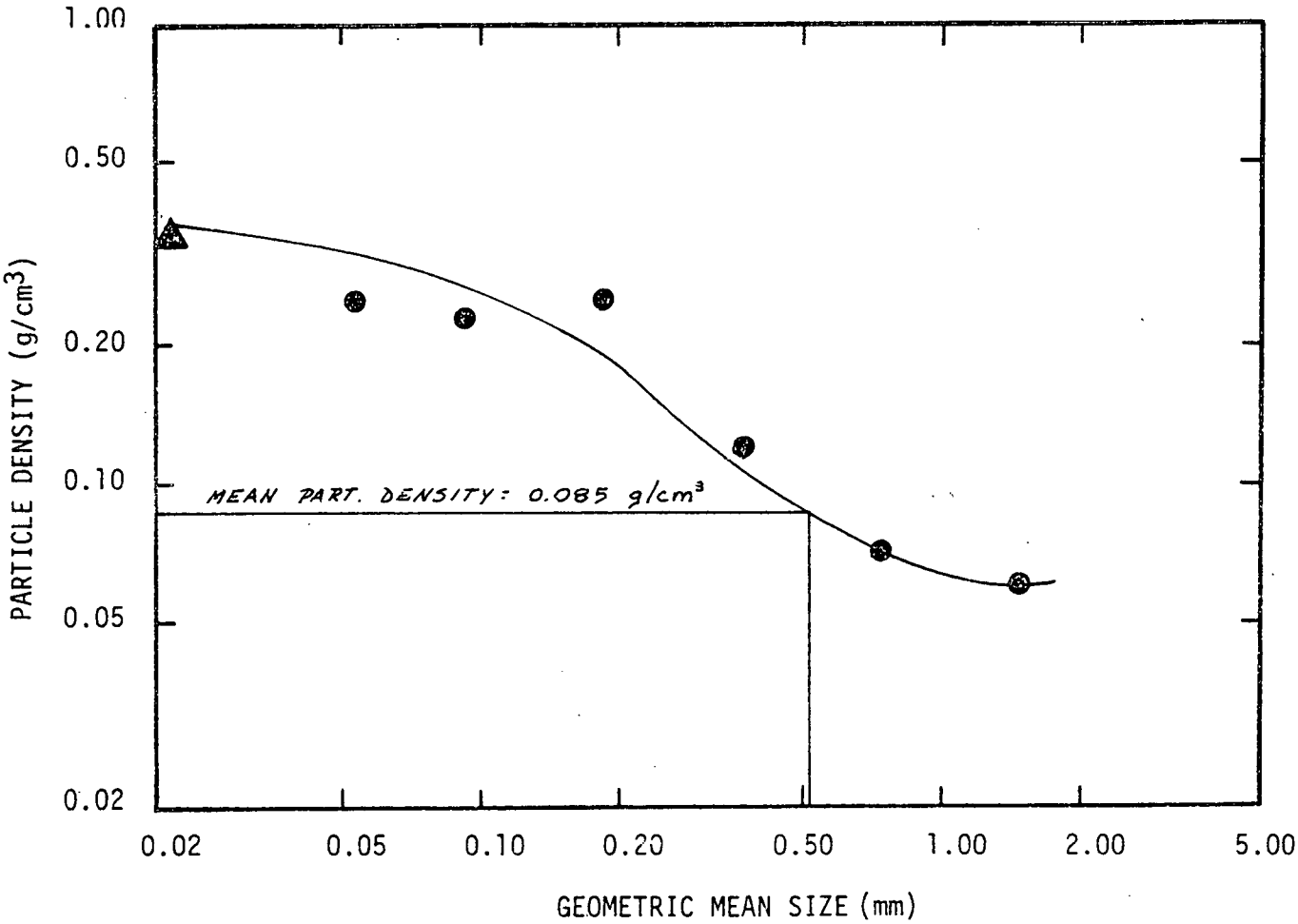
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 79



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NUMBER: 79

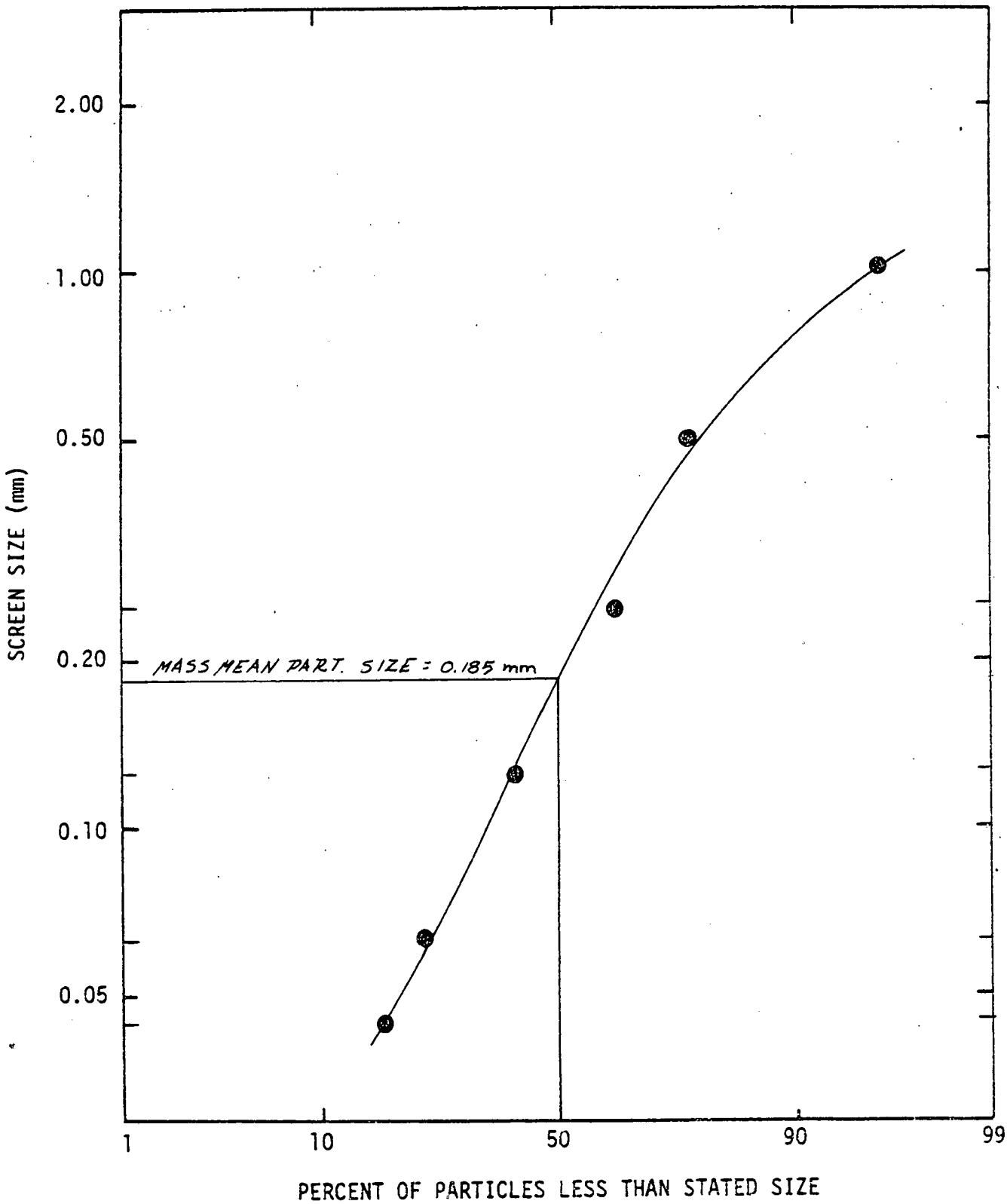


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

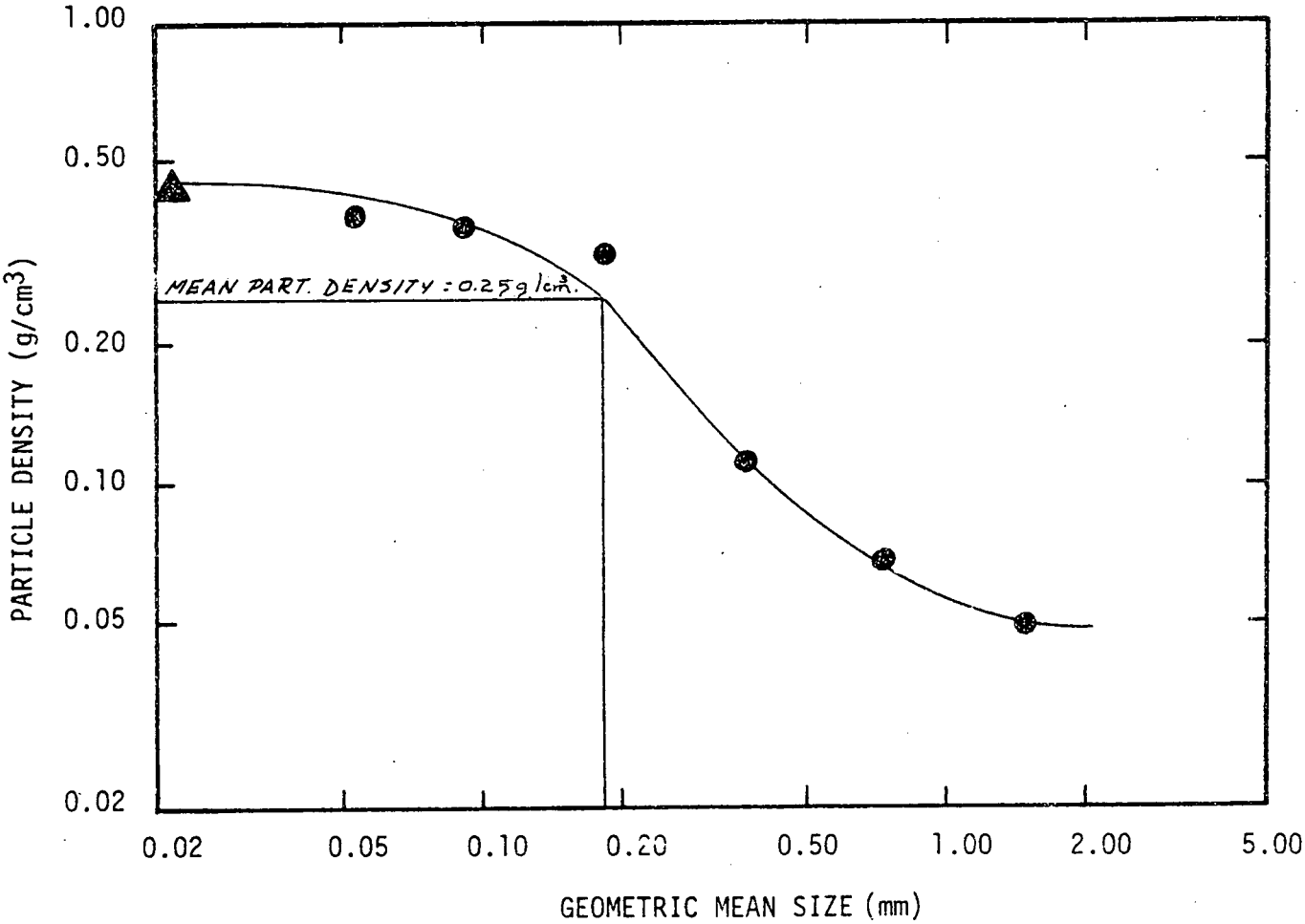
RUN NUMBER: 87



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 87

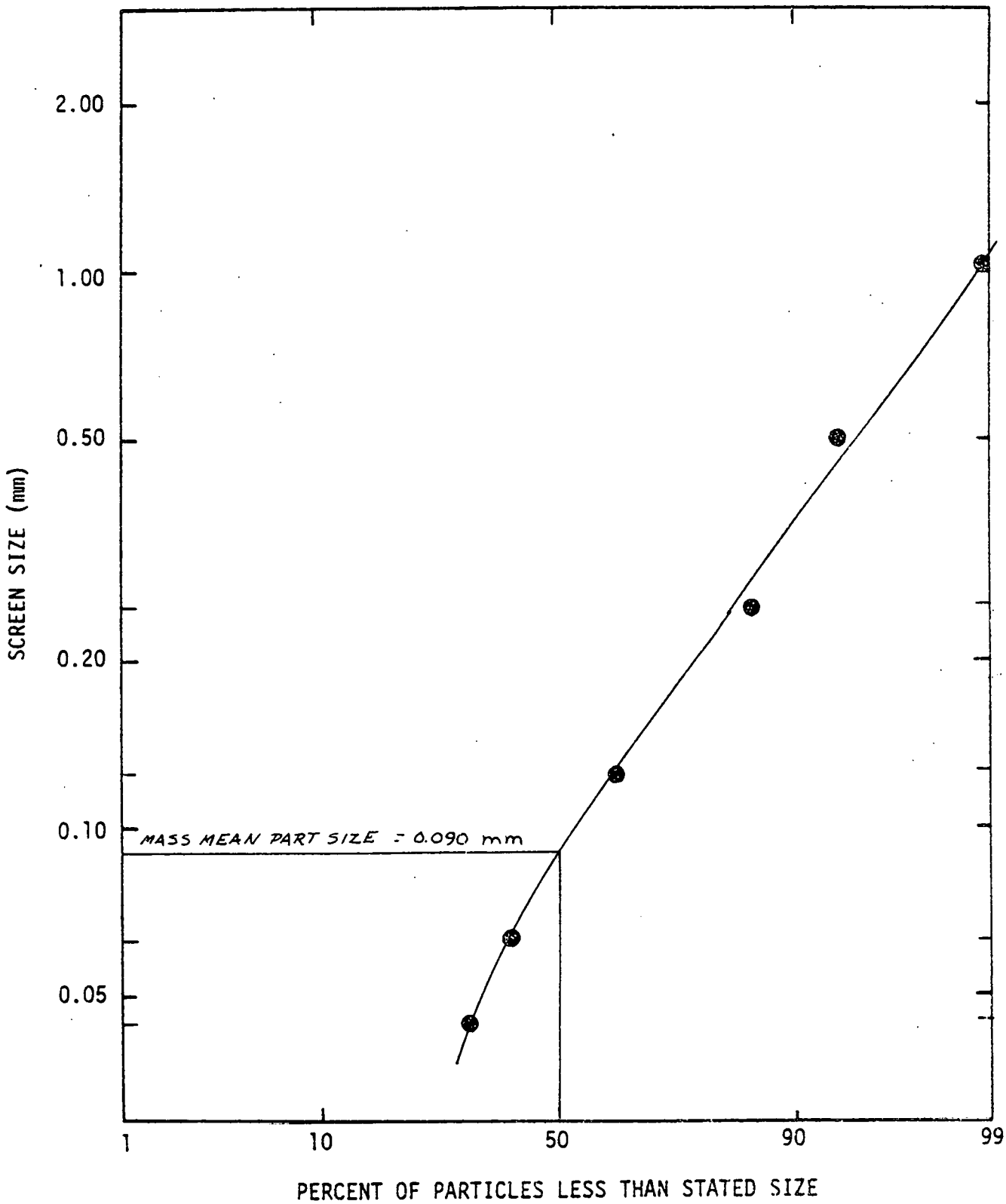


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

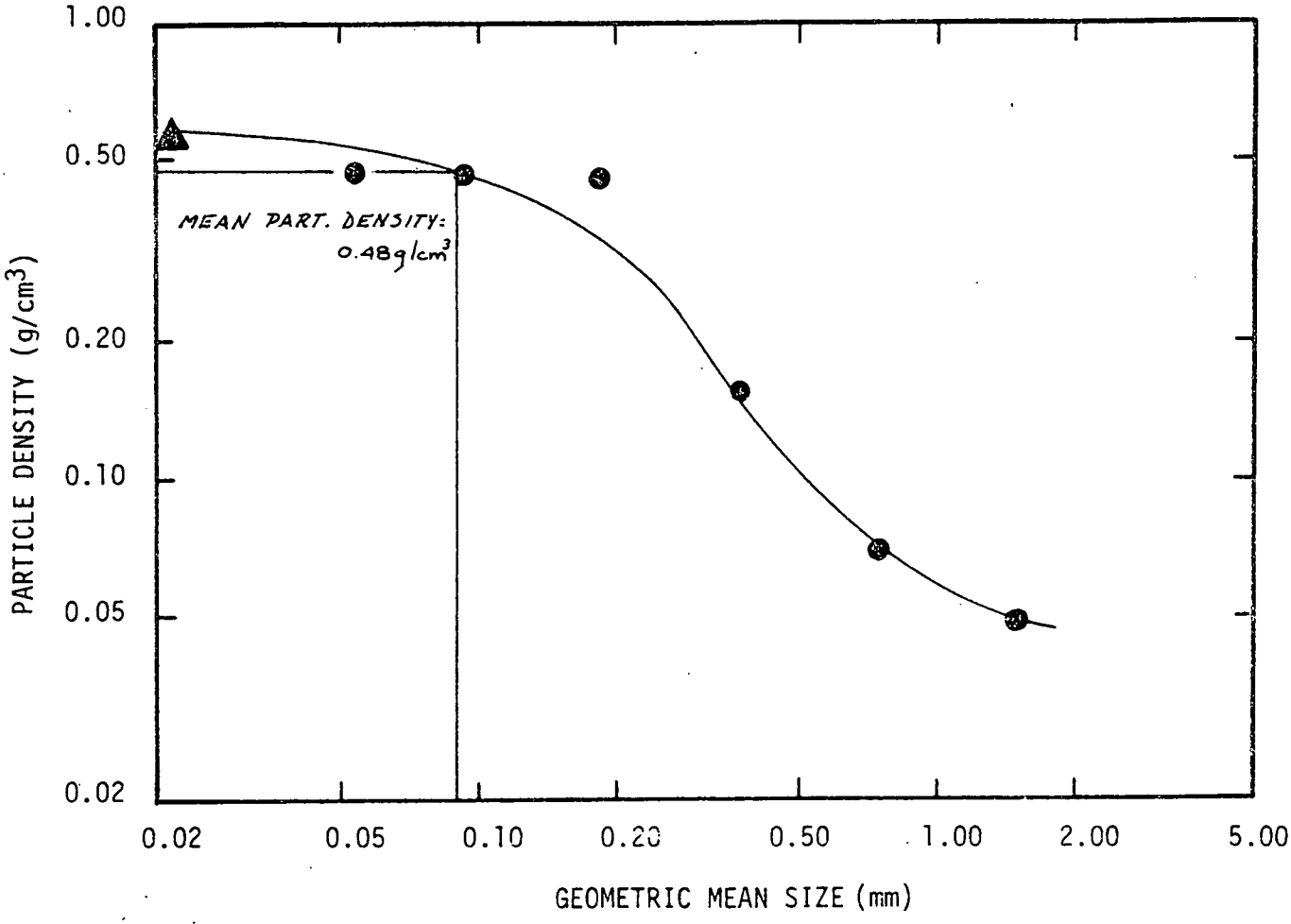
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 89



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 89

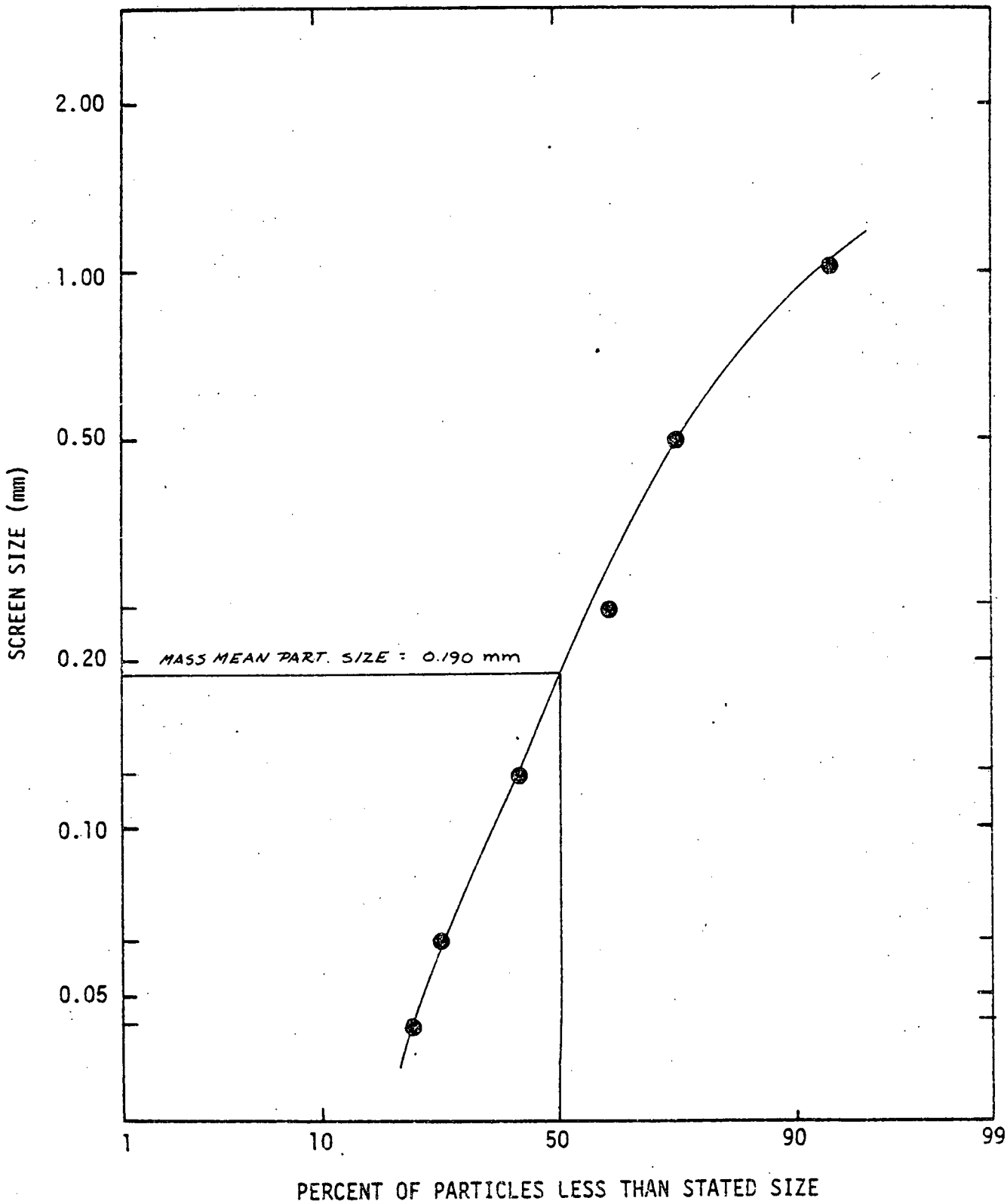


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

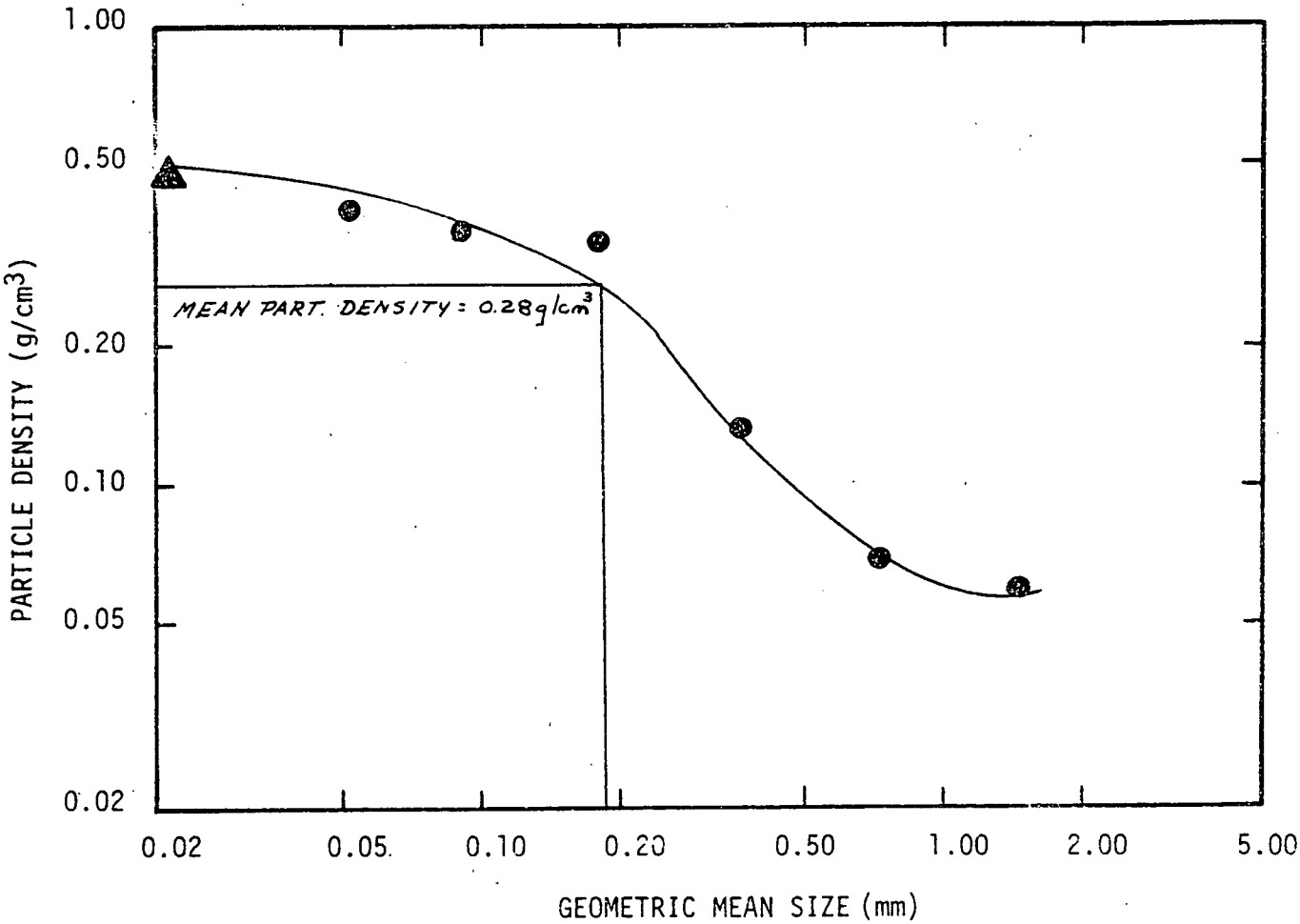
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 96



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 96

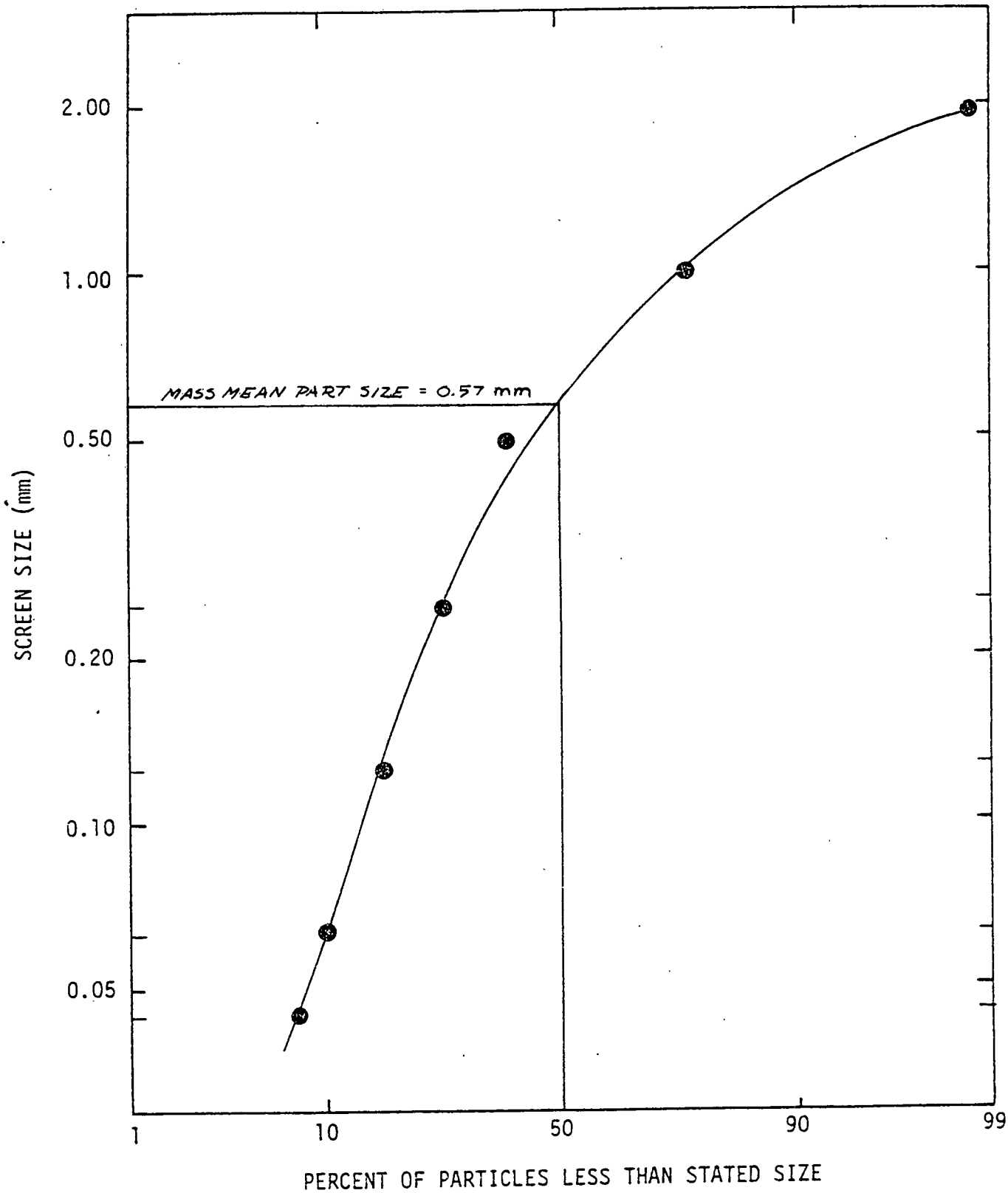


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

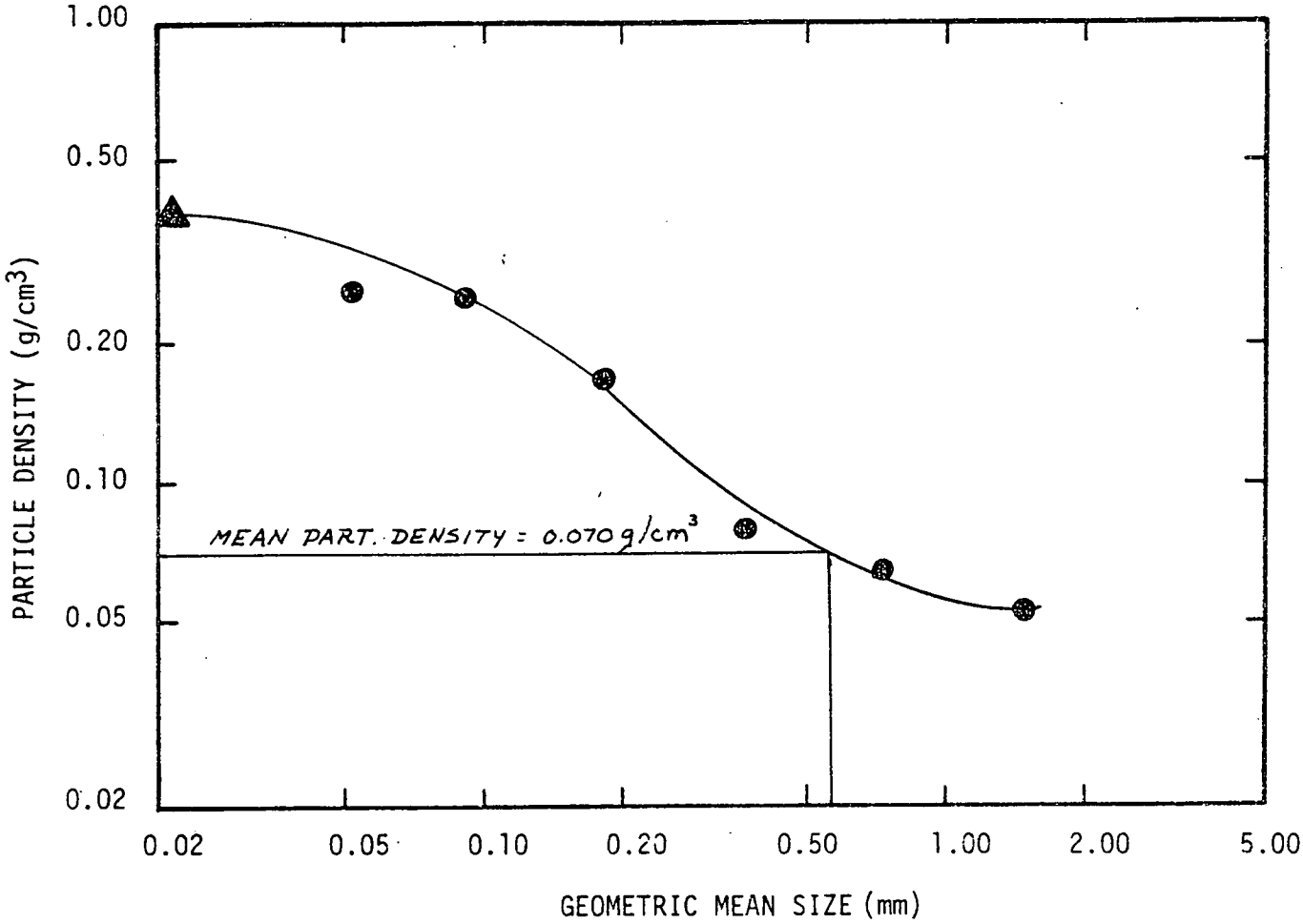
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 99



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NUMBER: 99

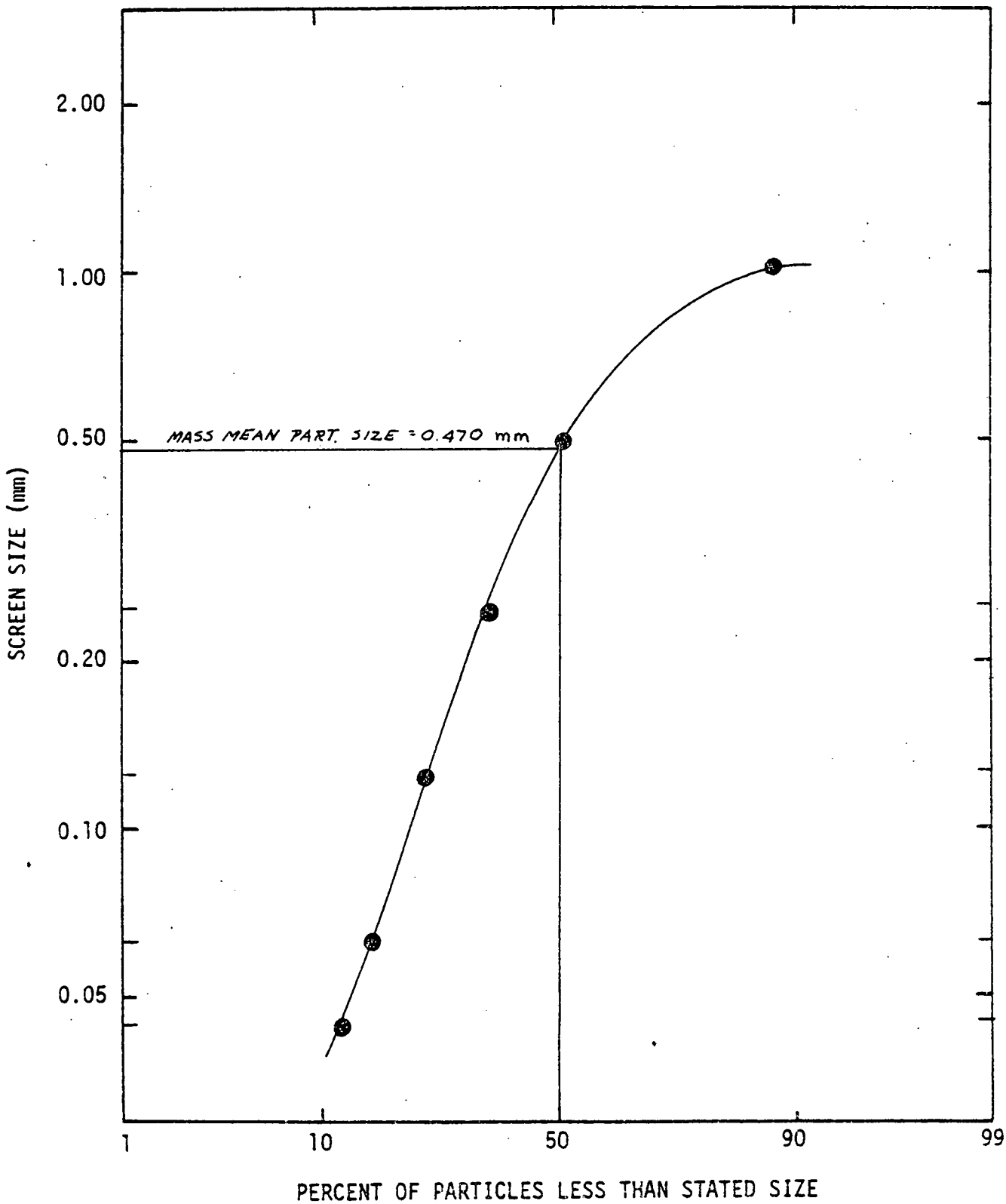


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

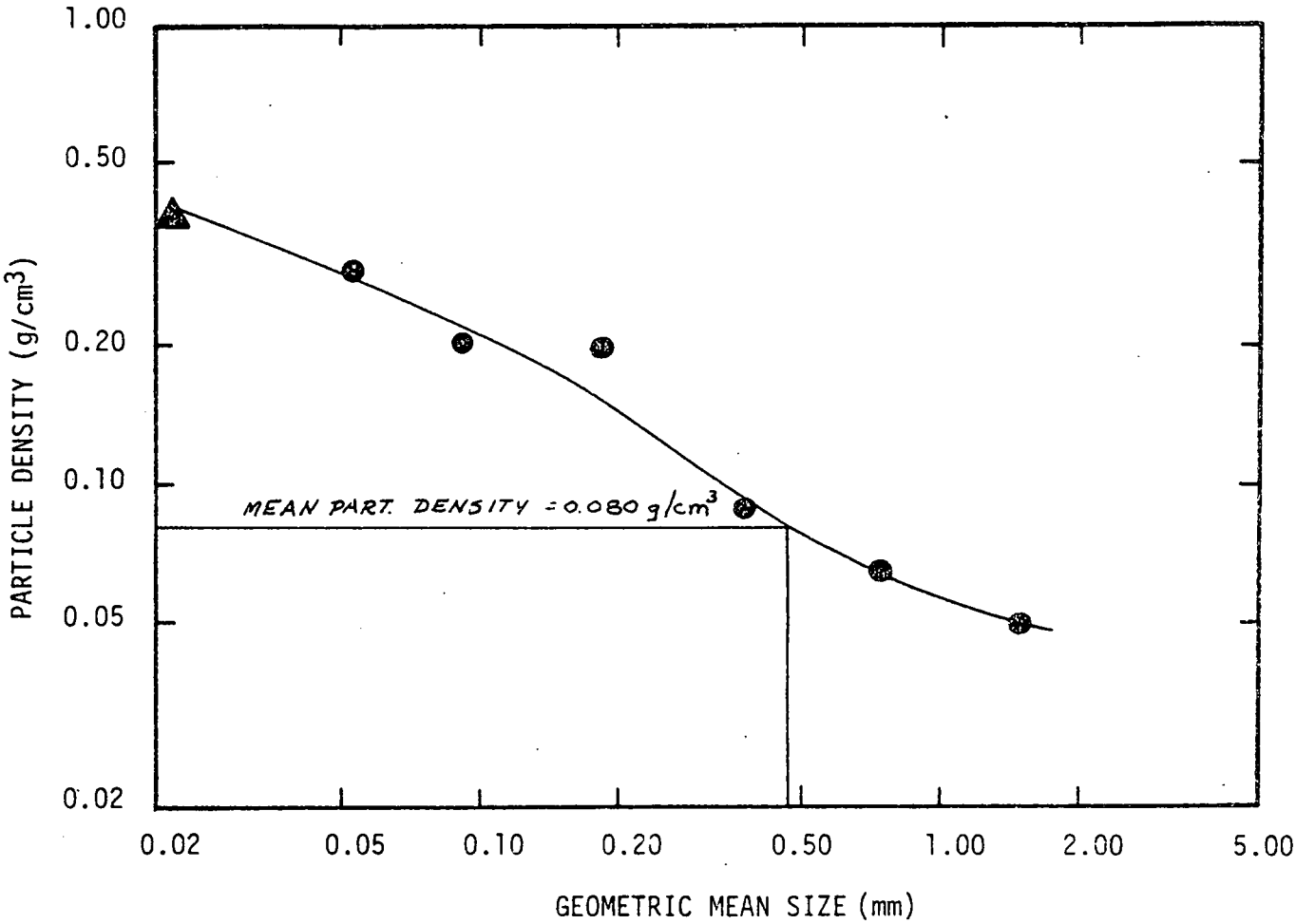
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 101



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 101

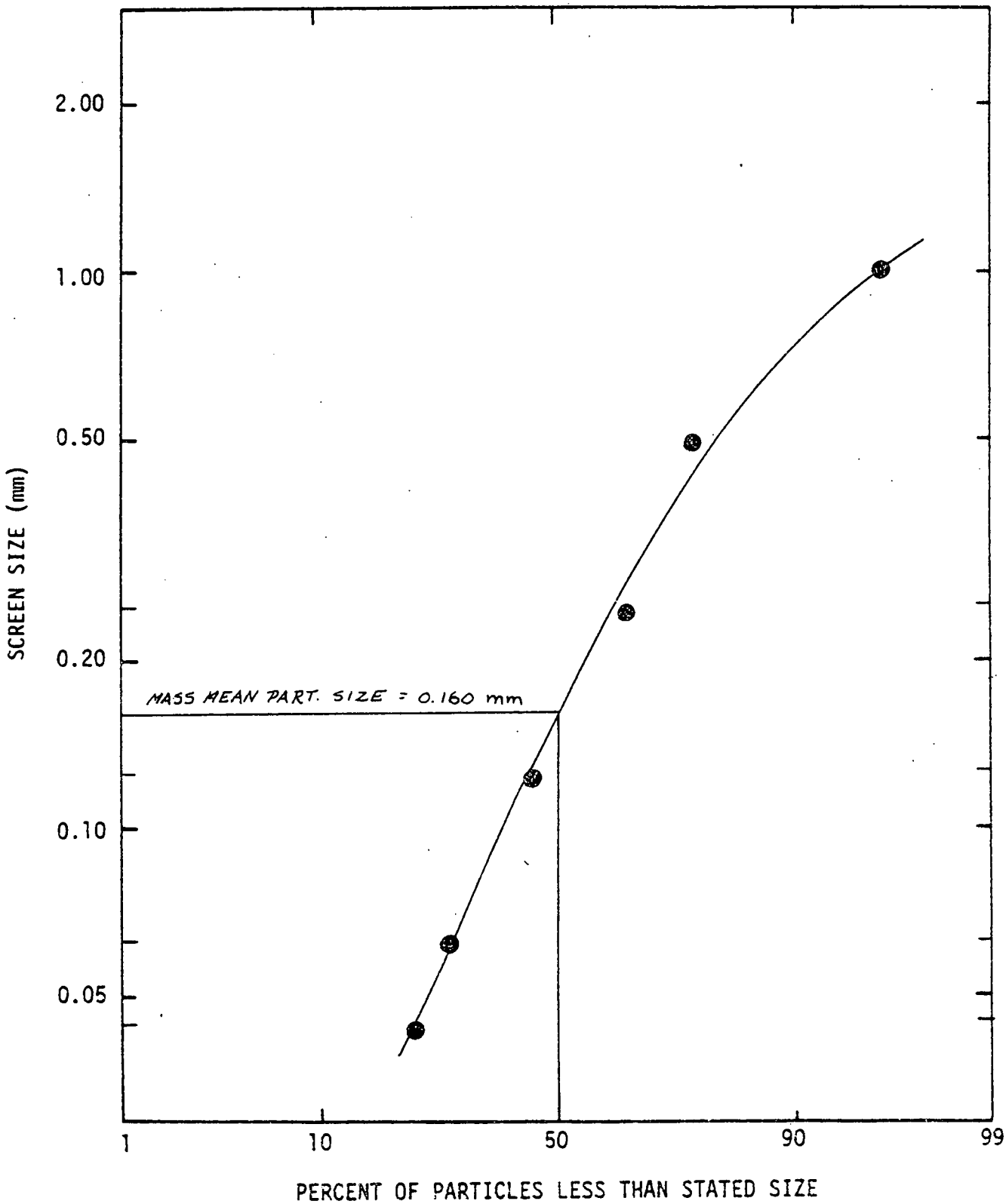


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

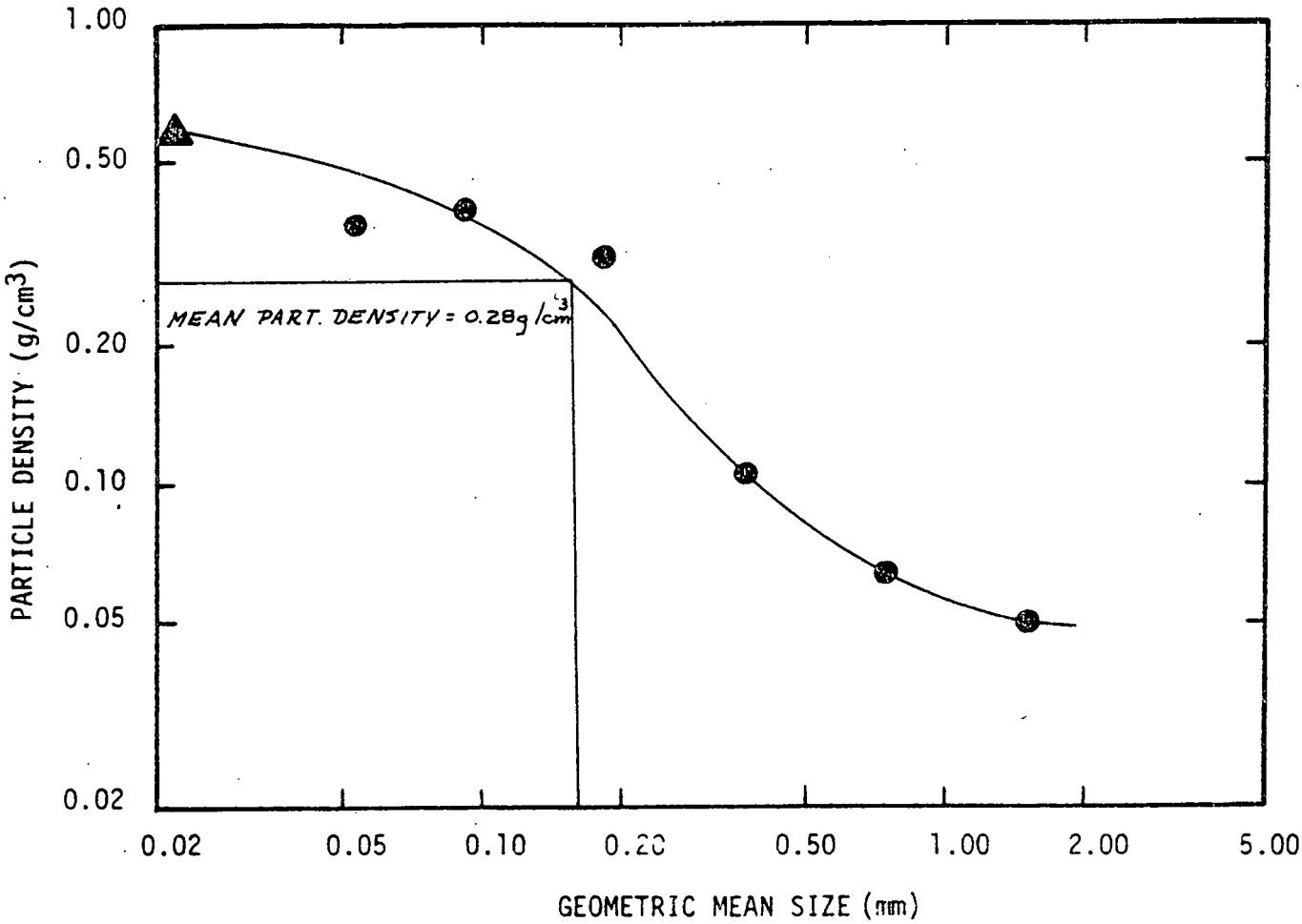
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 104



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 104

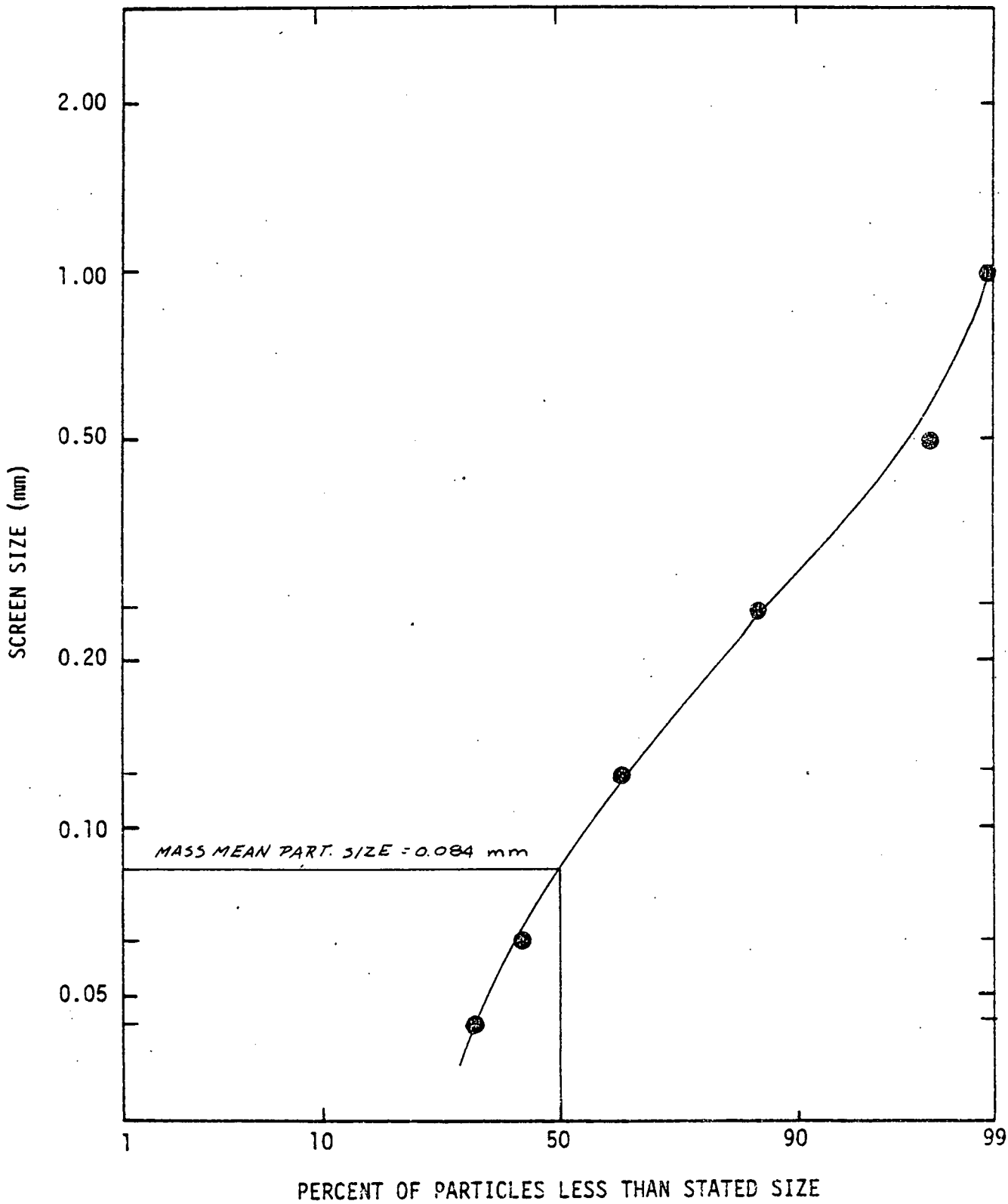


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

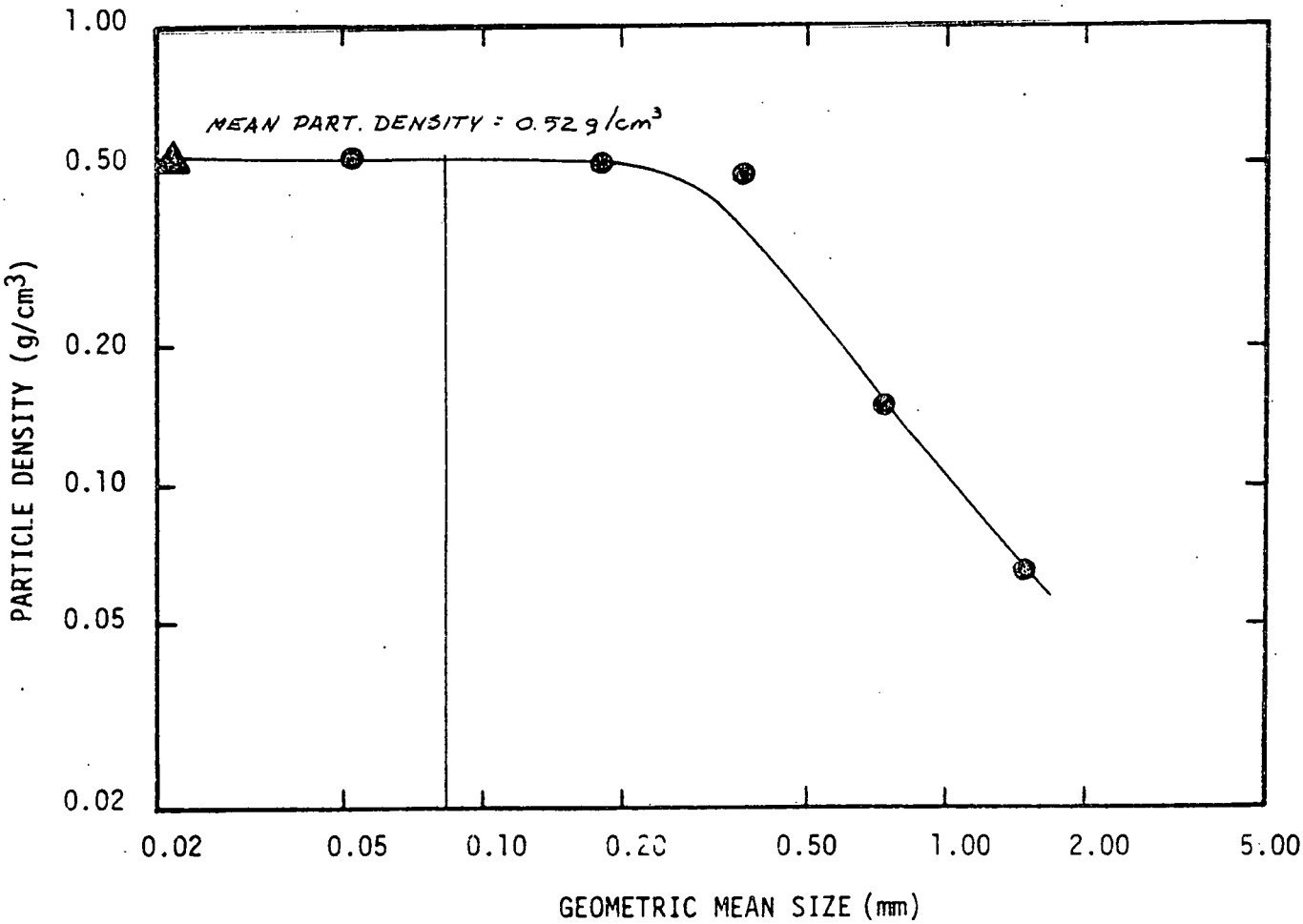
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 106



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 106

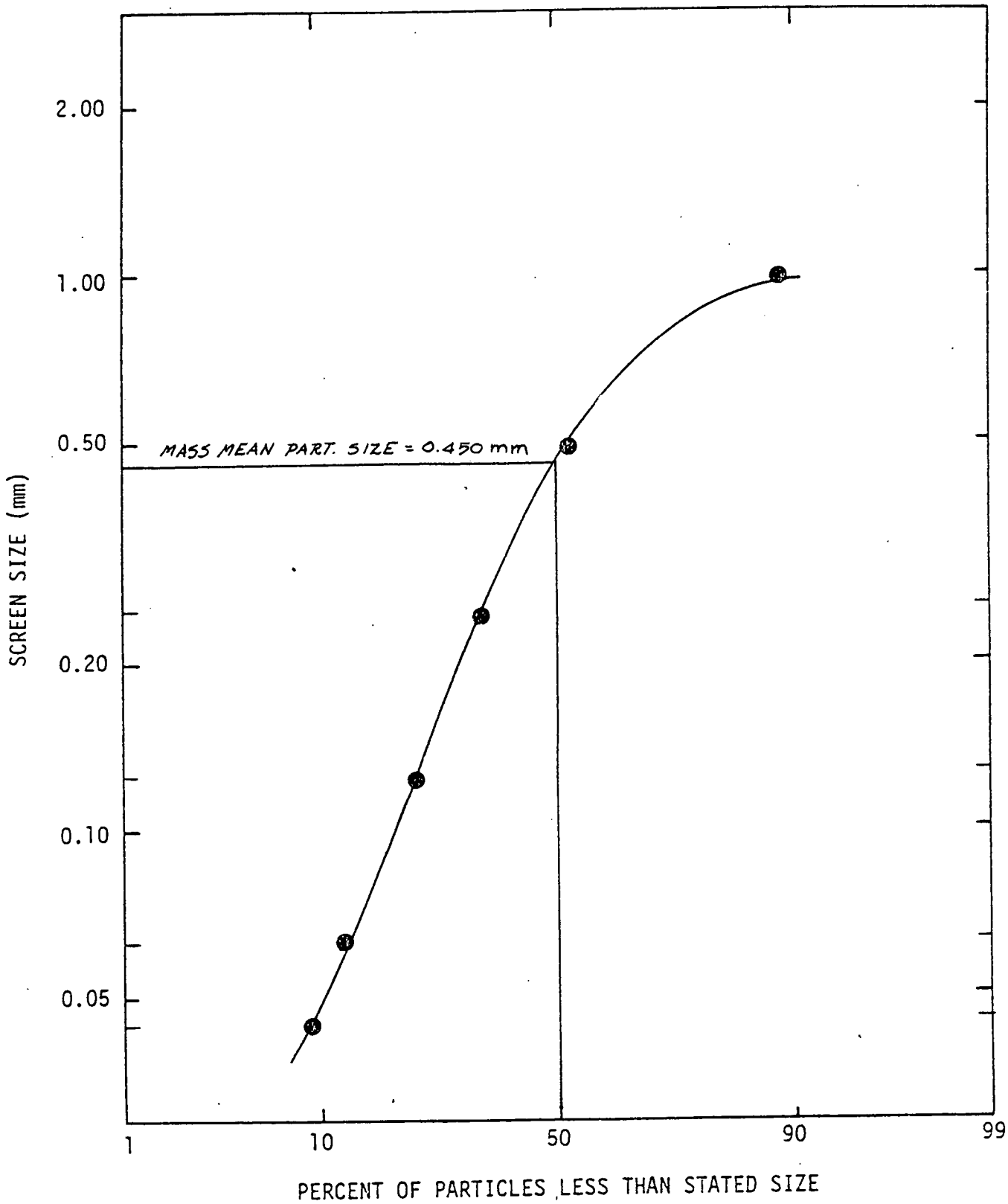


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

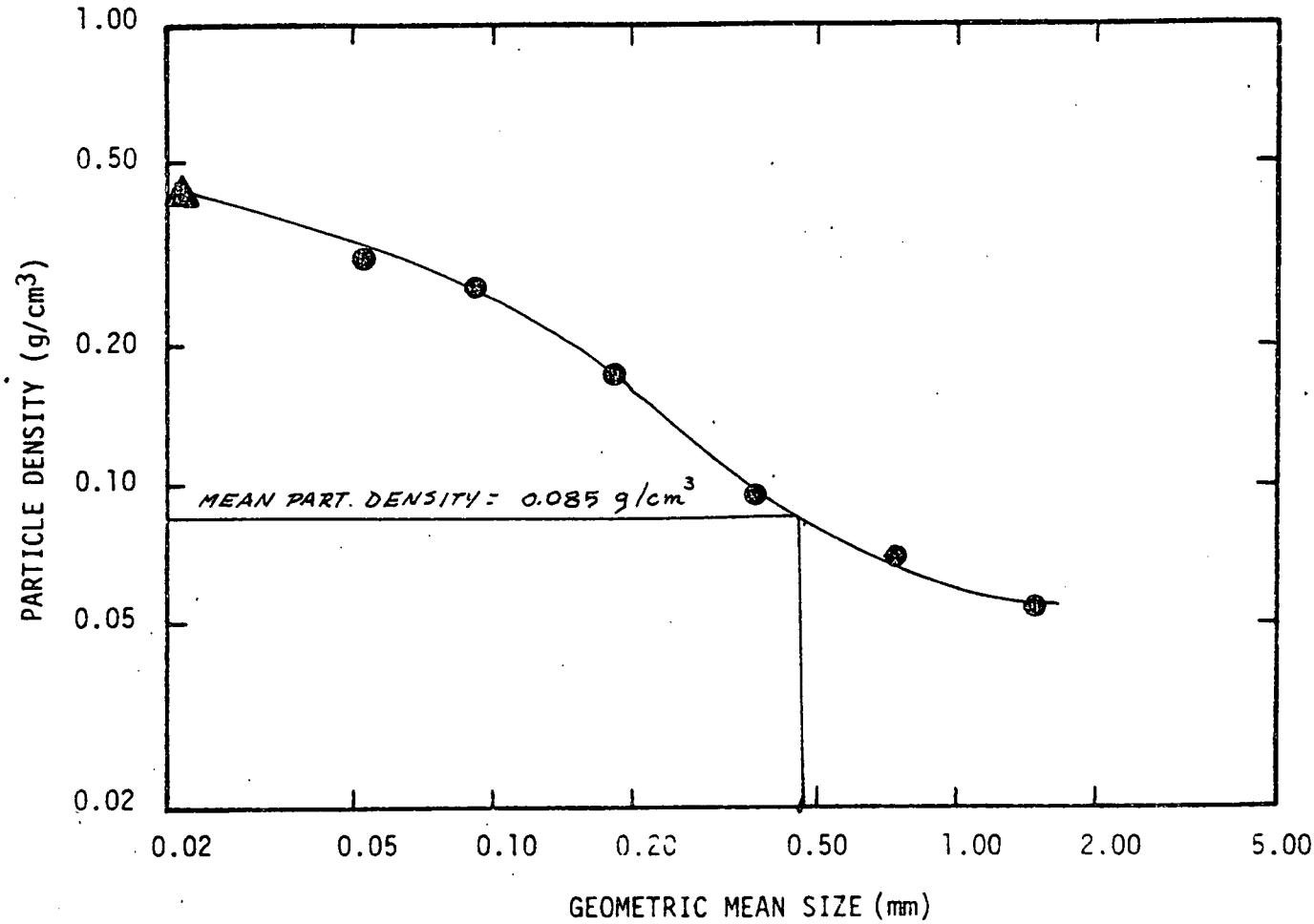
DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 109



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 109

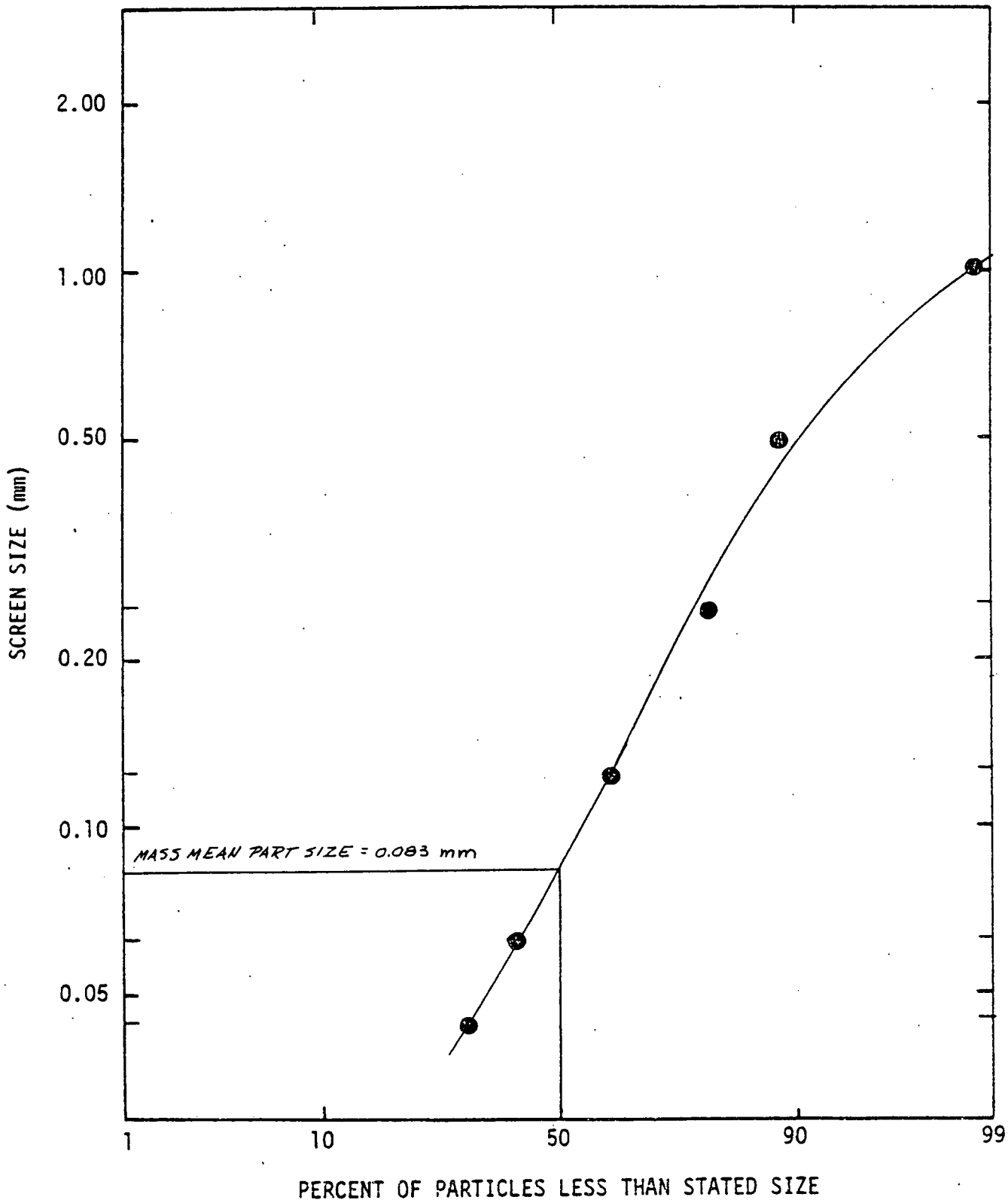


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

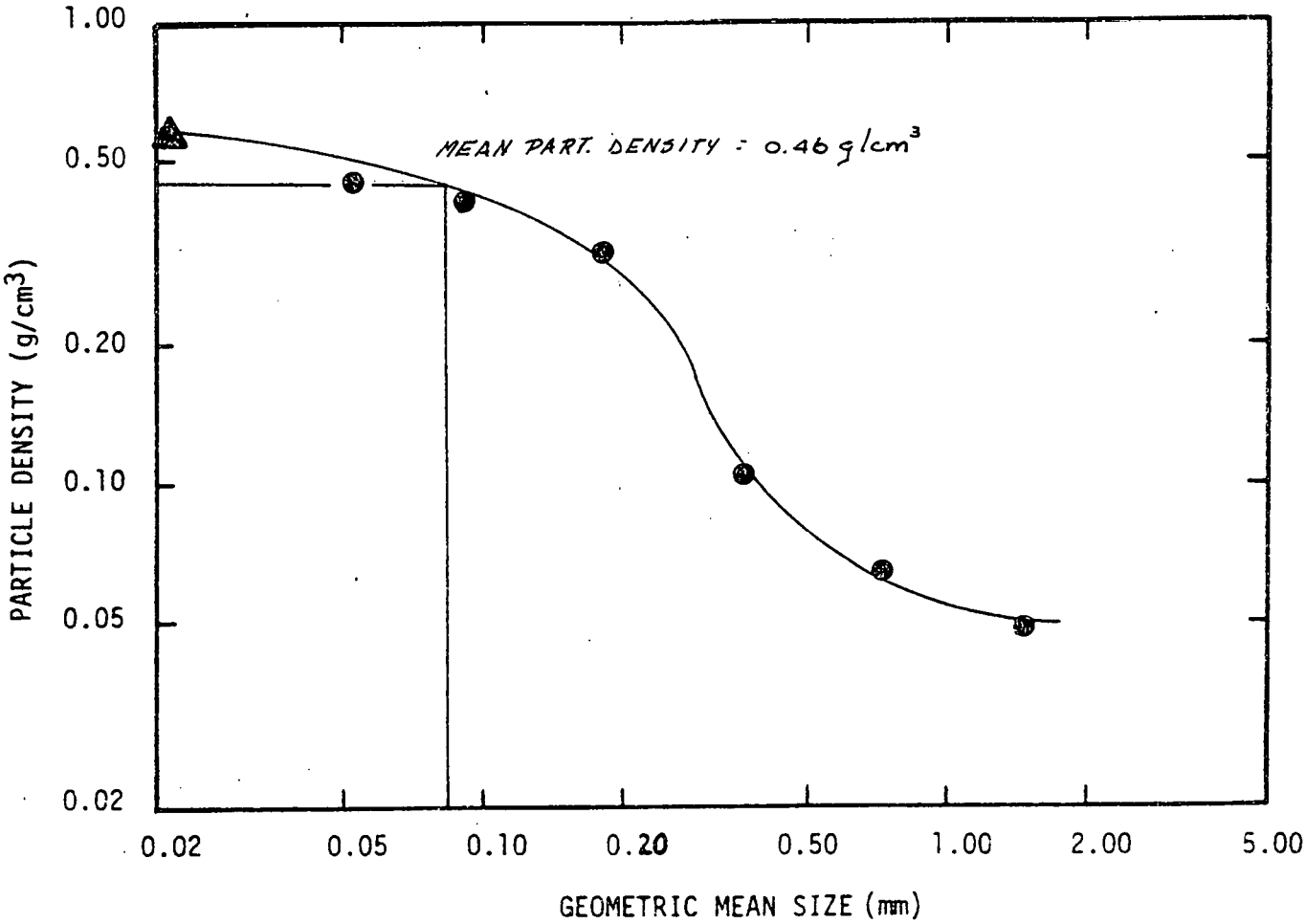
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 111



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NUMBER: 111

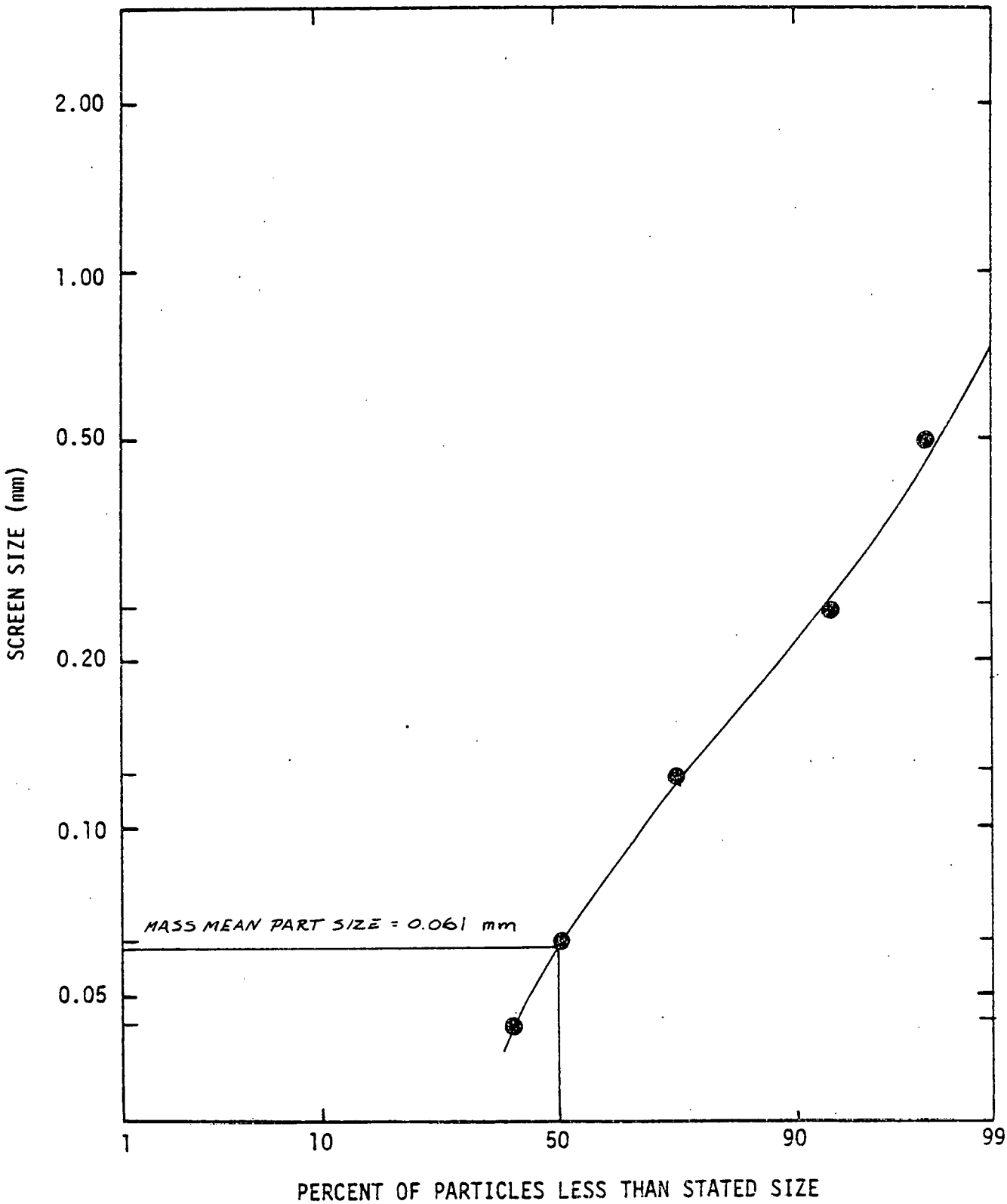


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

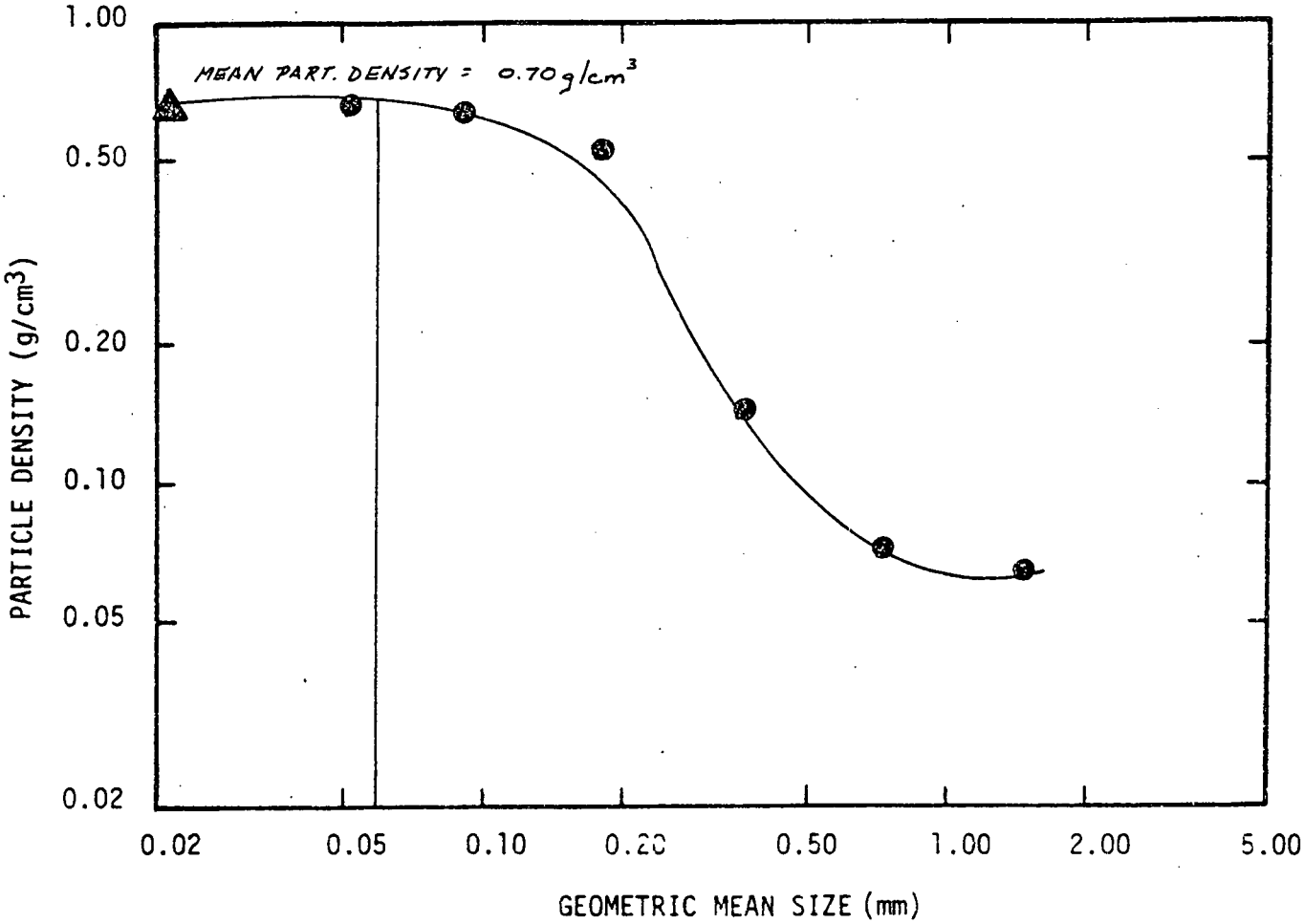
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 113



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 113

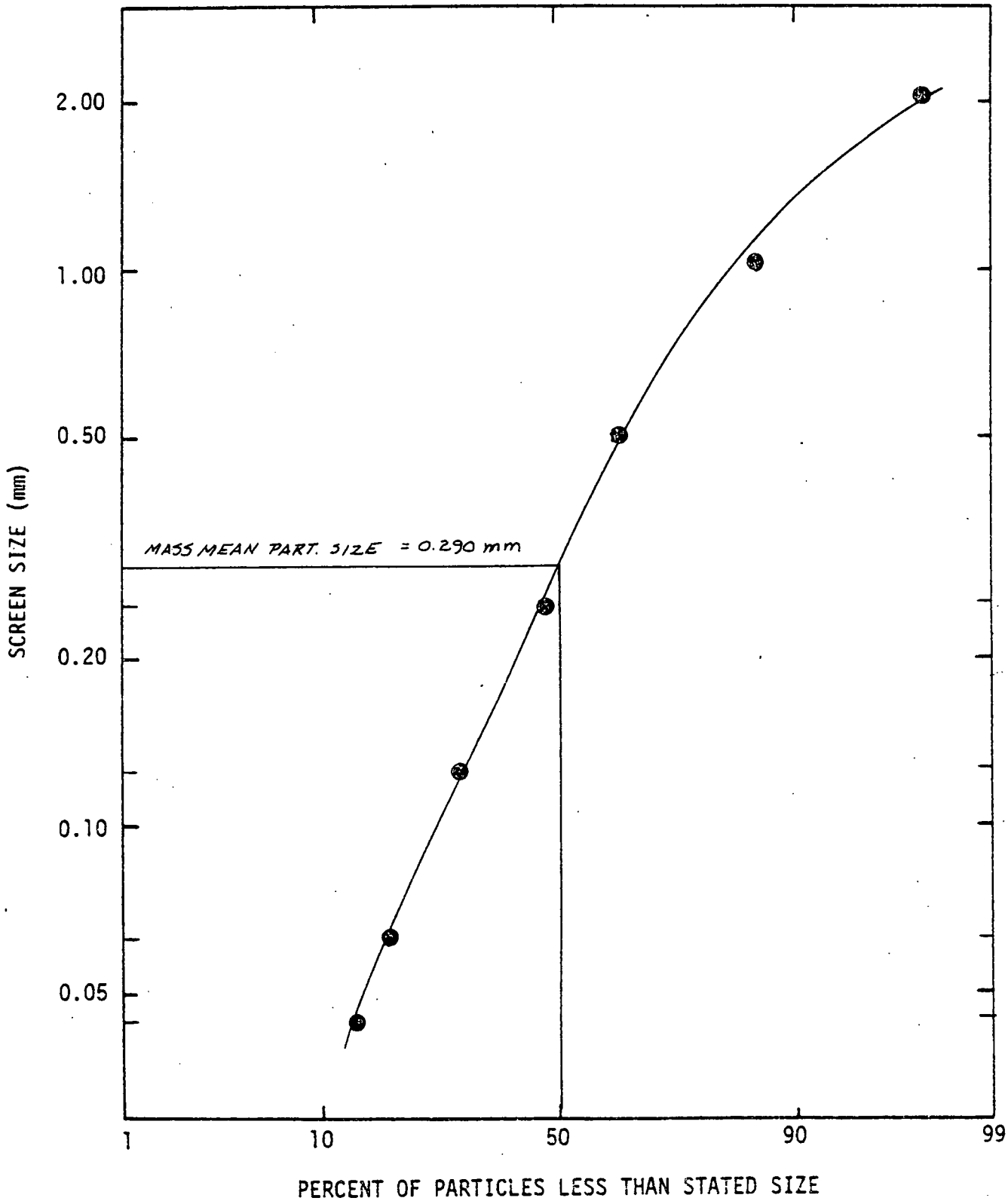


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

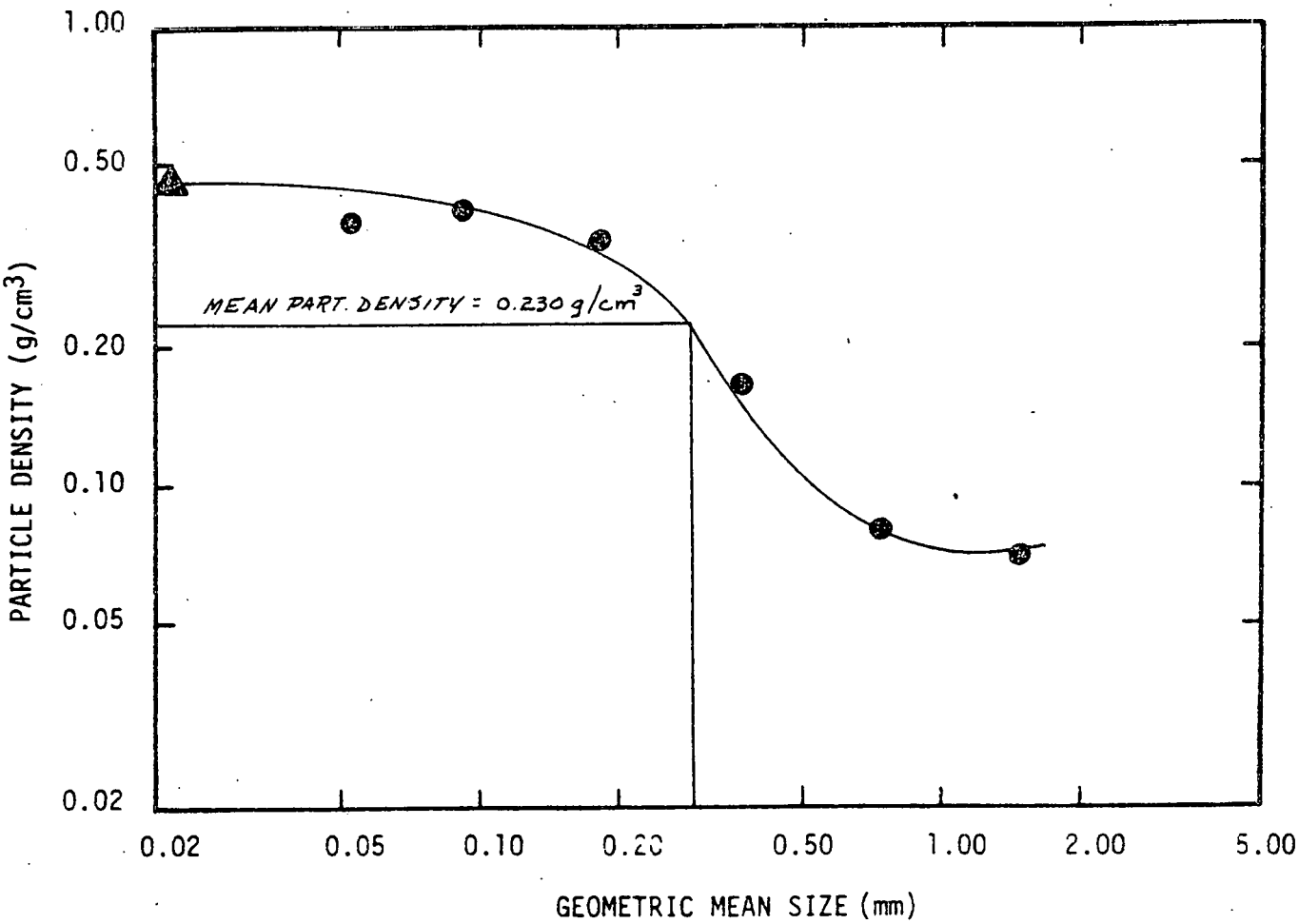
RUN NUMBER: 116



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 116

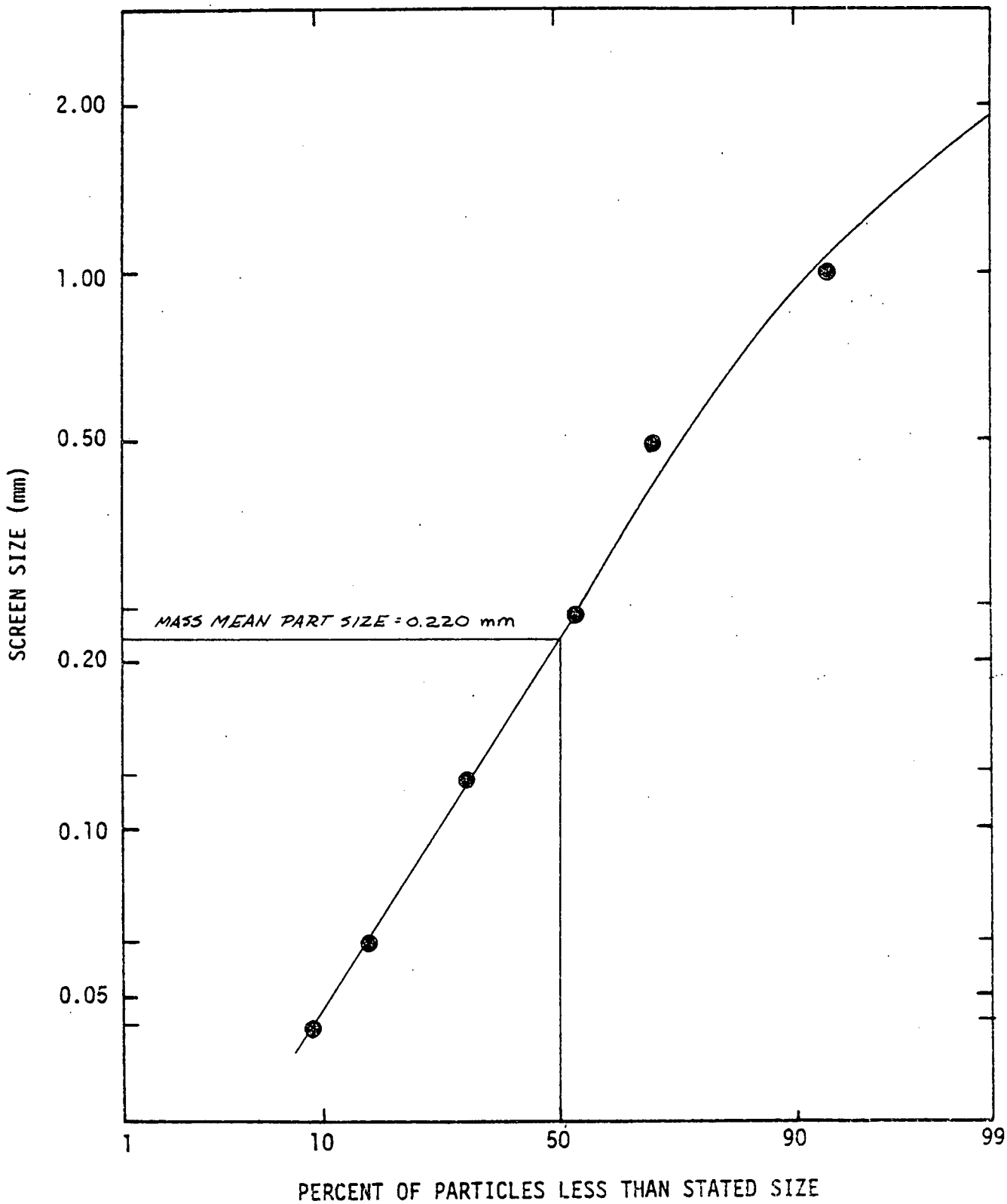


▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

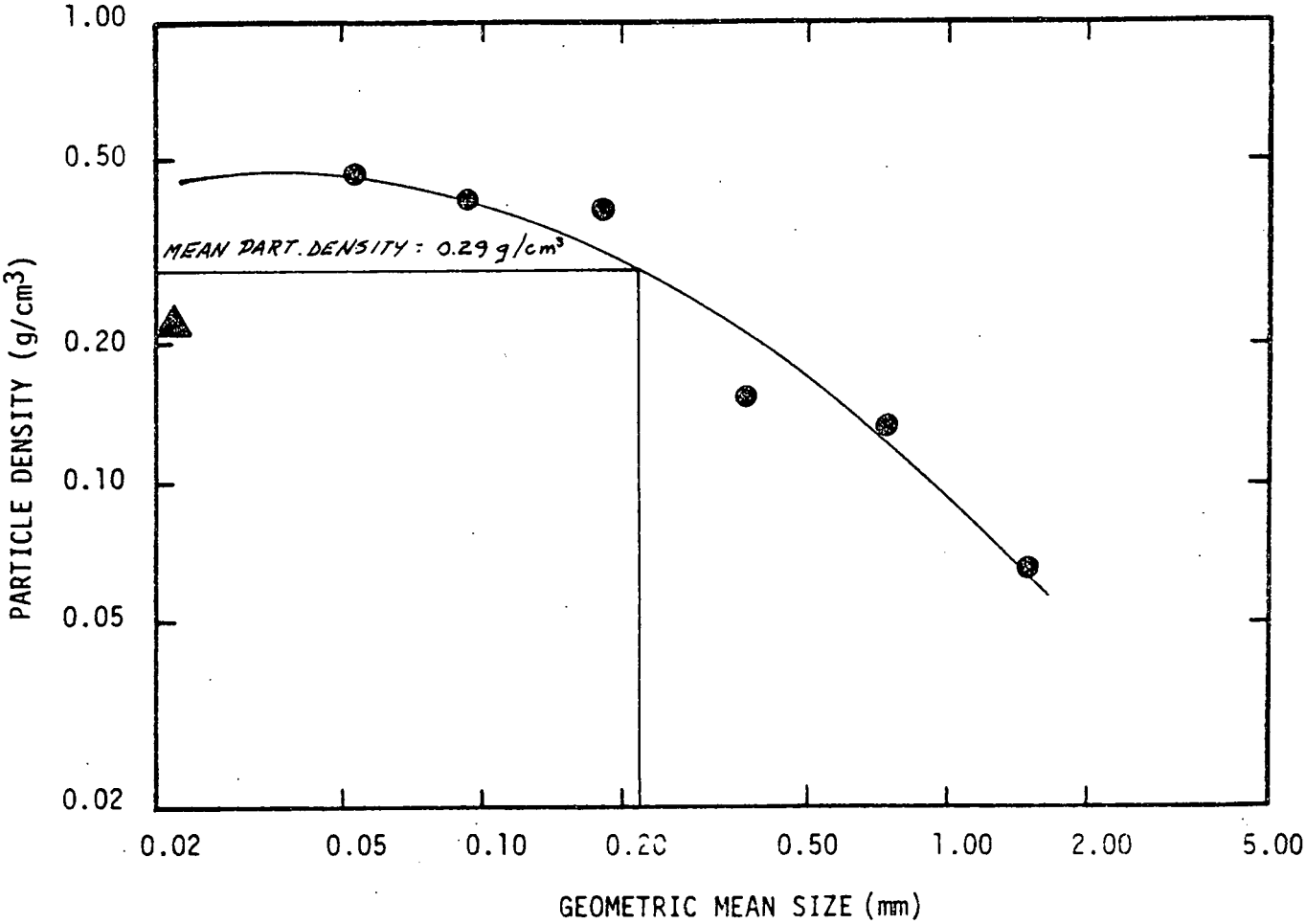
RUN NUMBER: 118



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 118

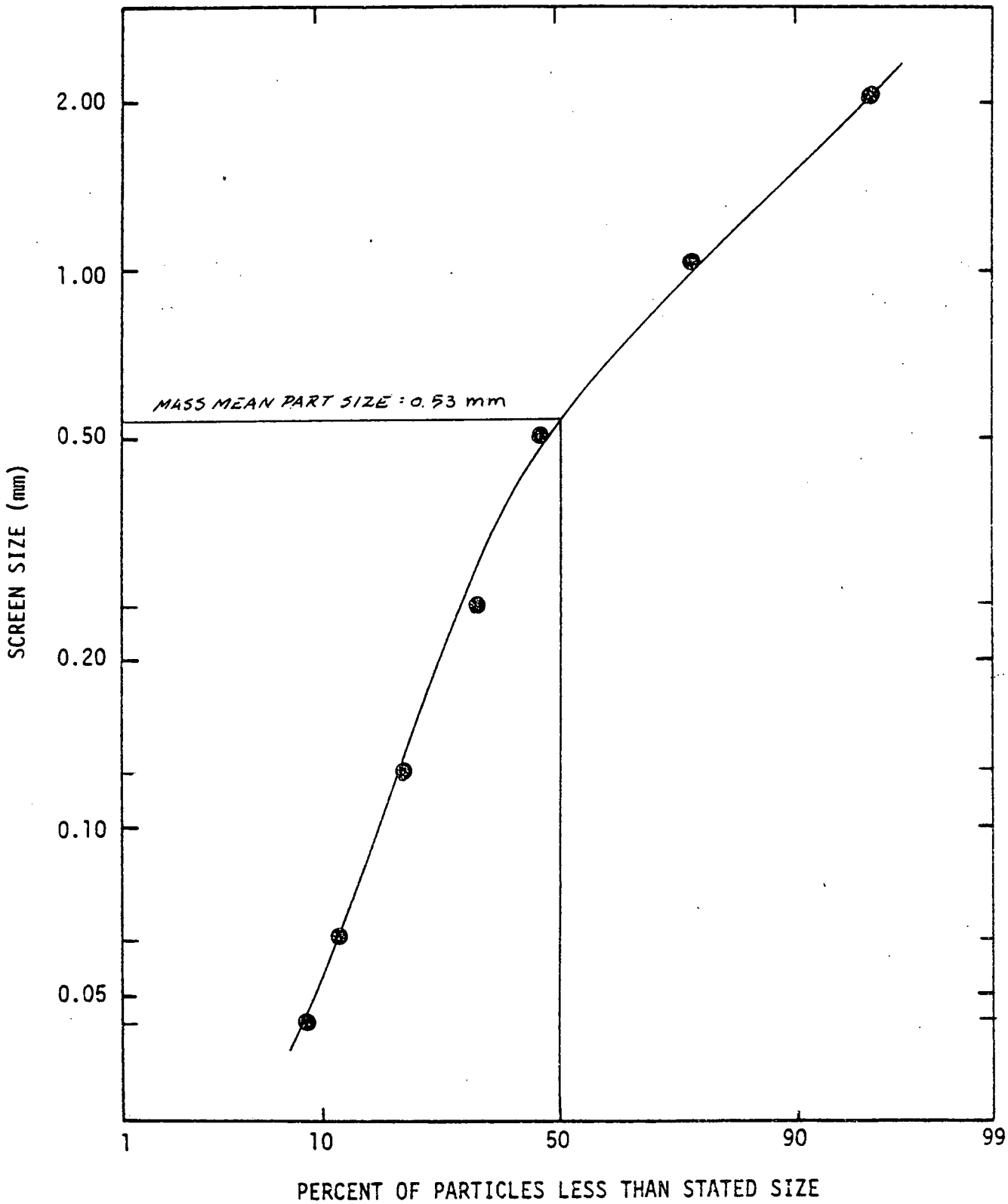


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

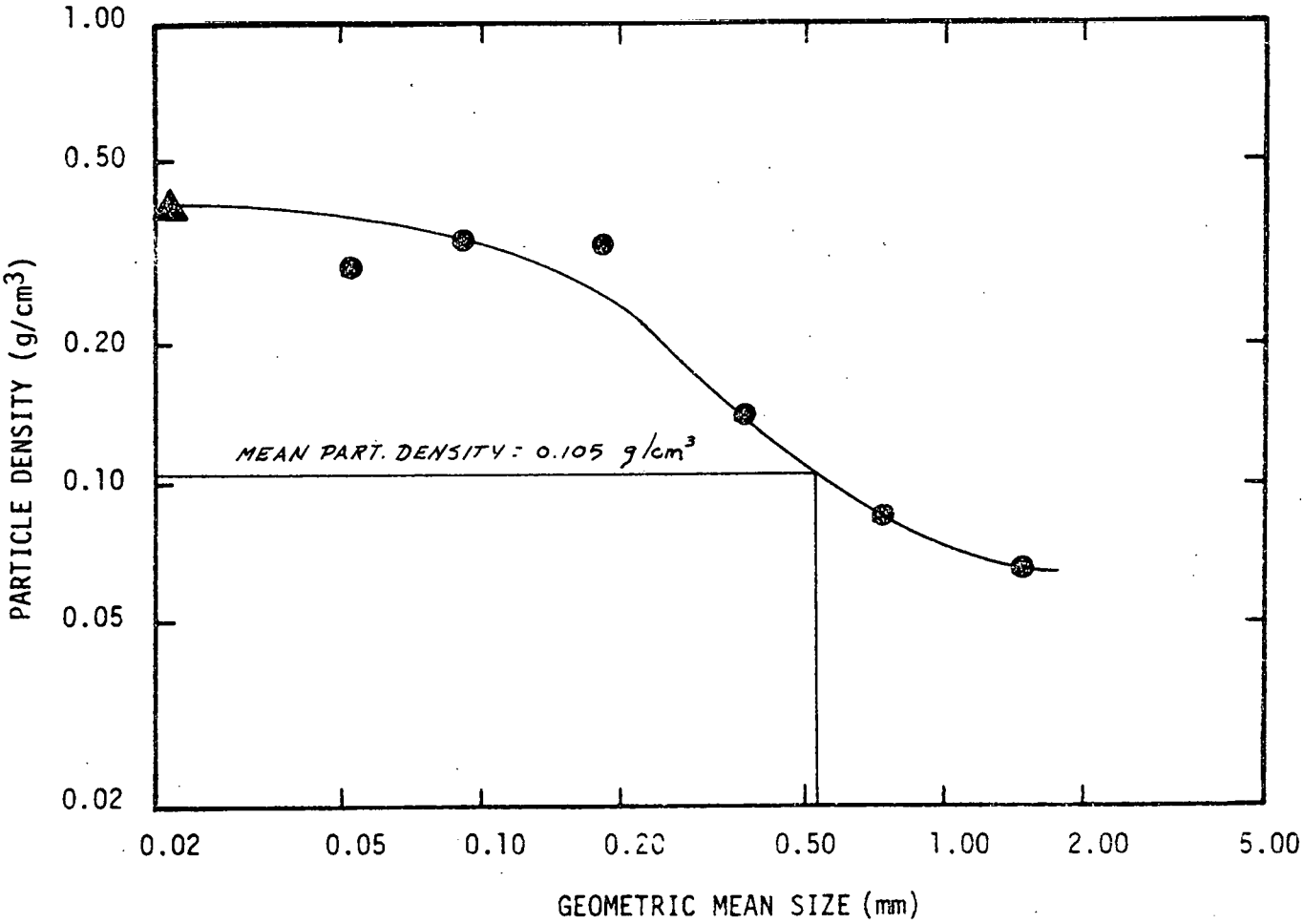
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 120



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NUMBER: 120

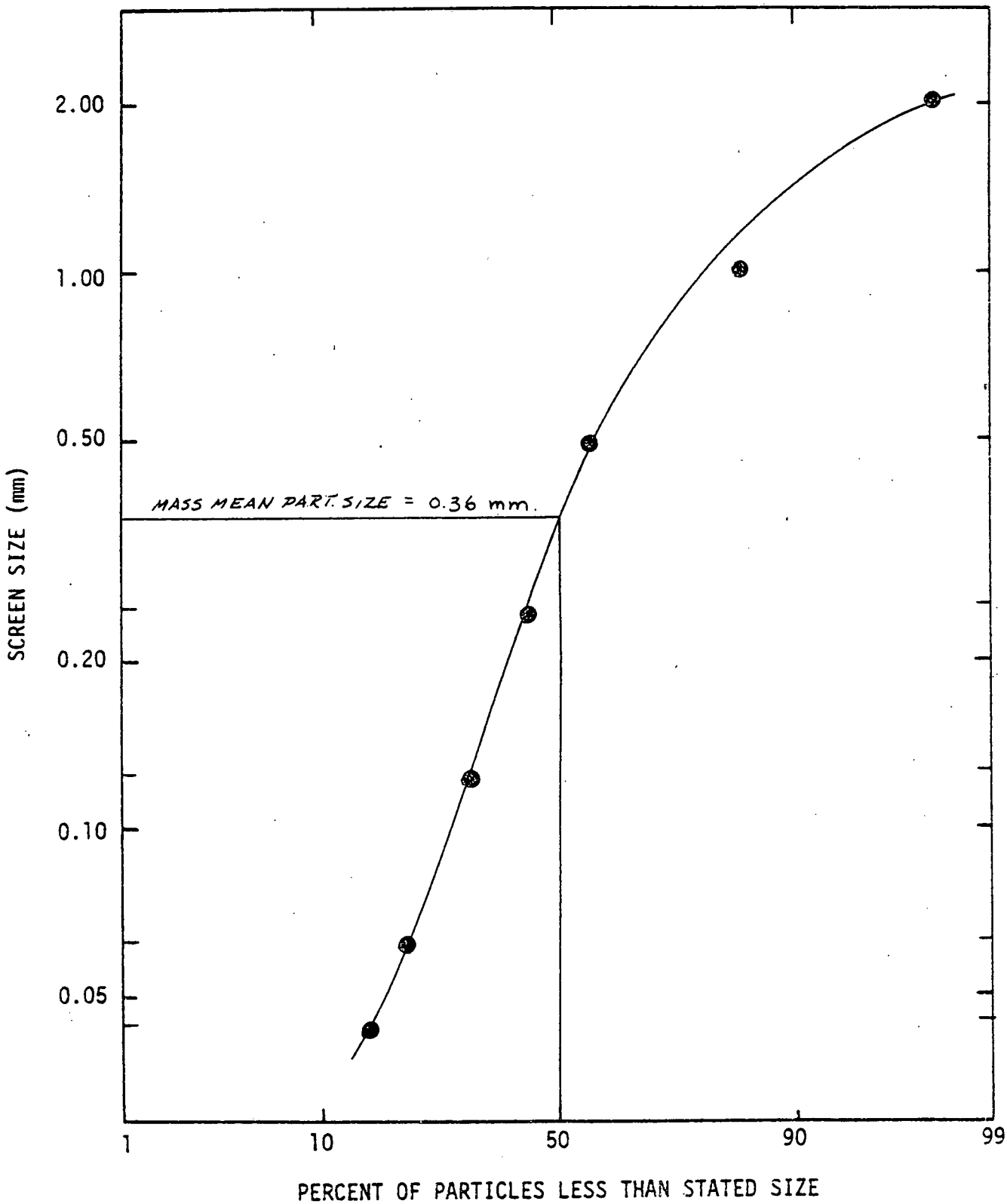


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

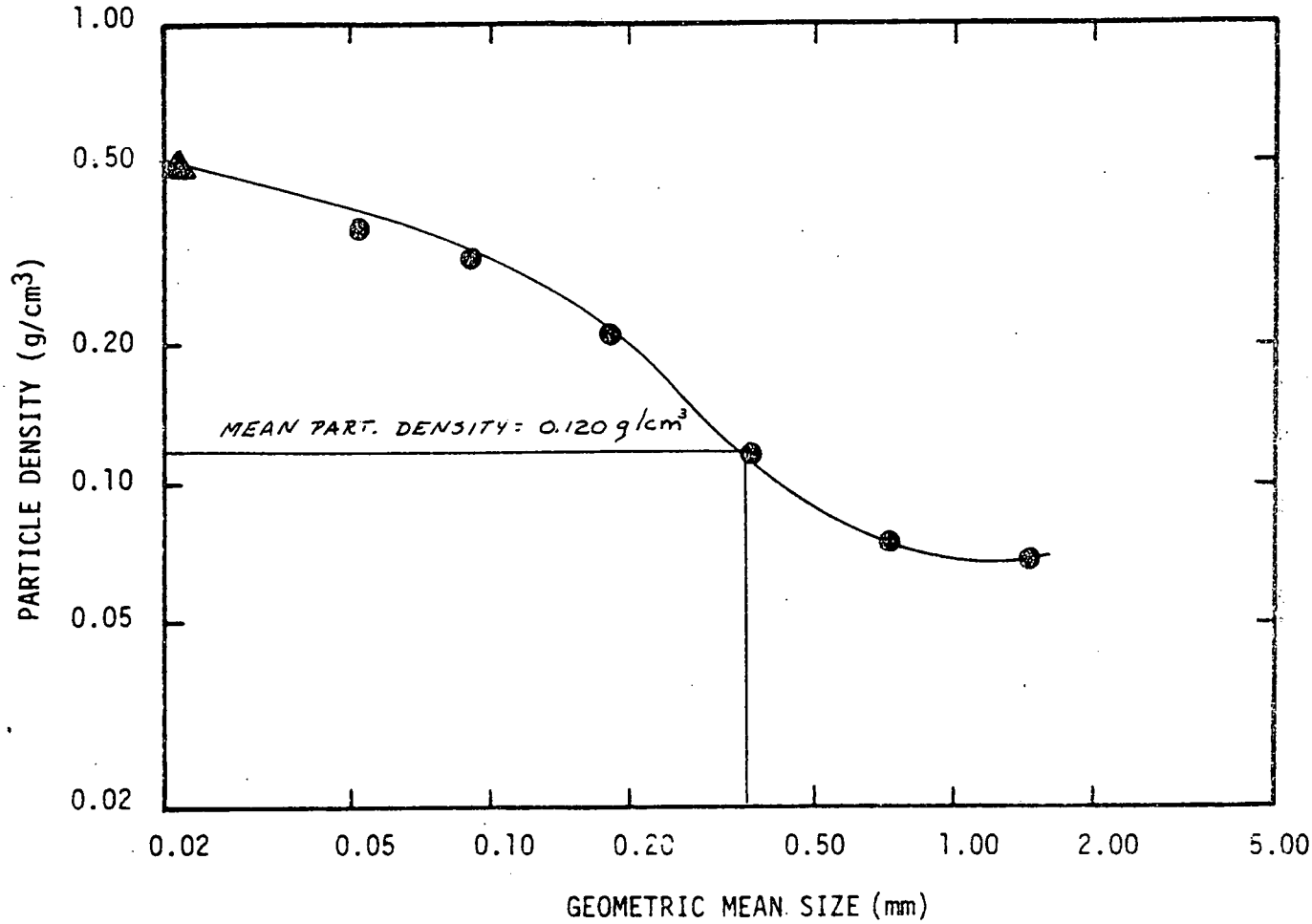
RUN NUMBER: 123



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 123

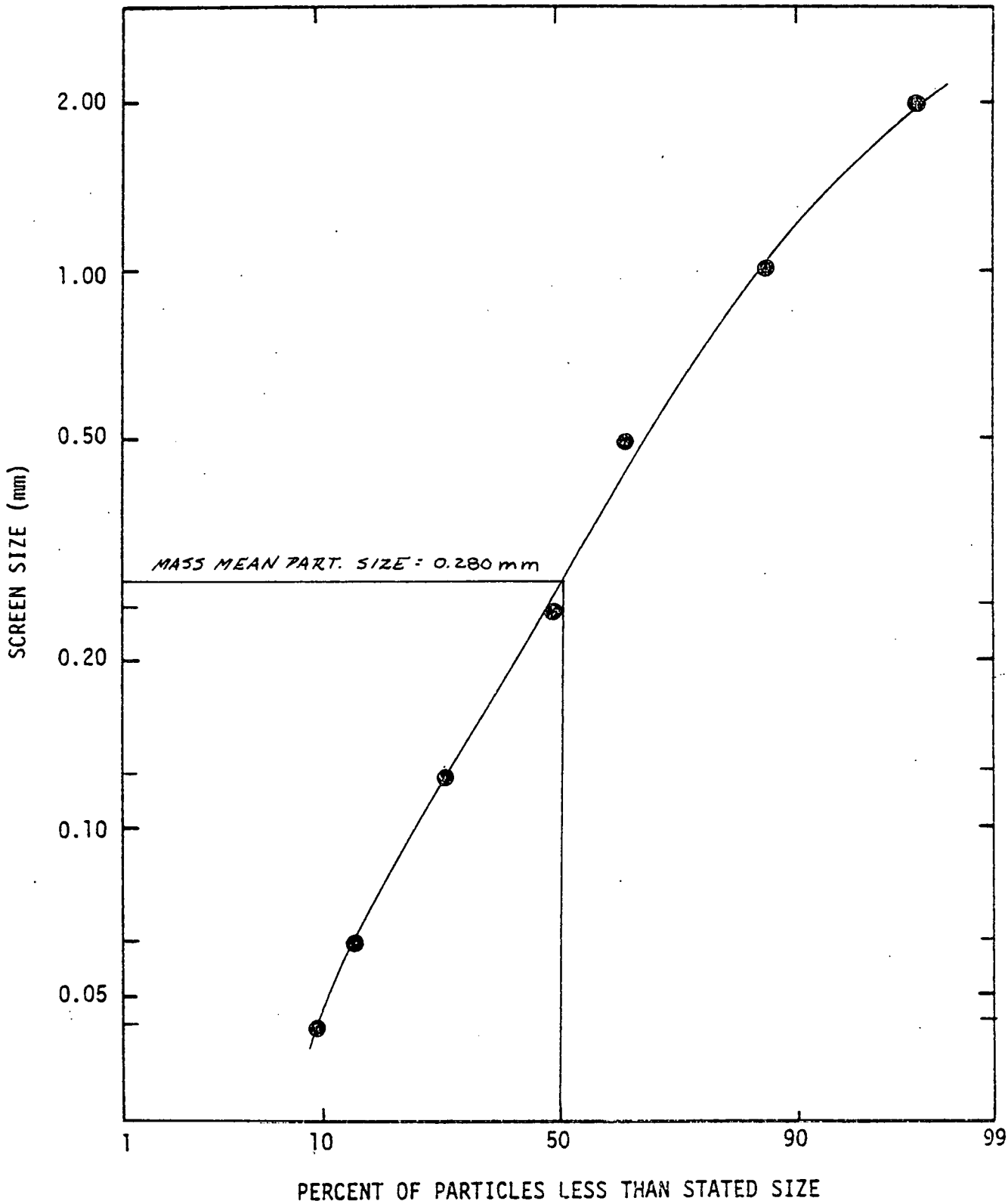


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

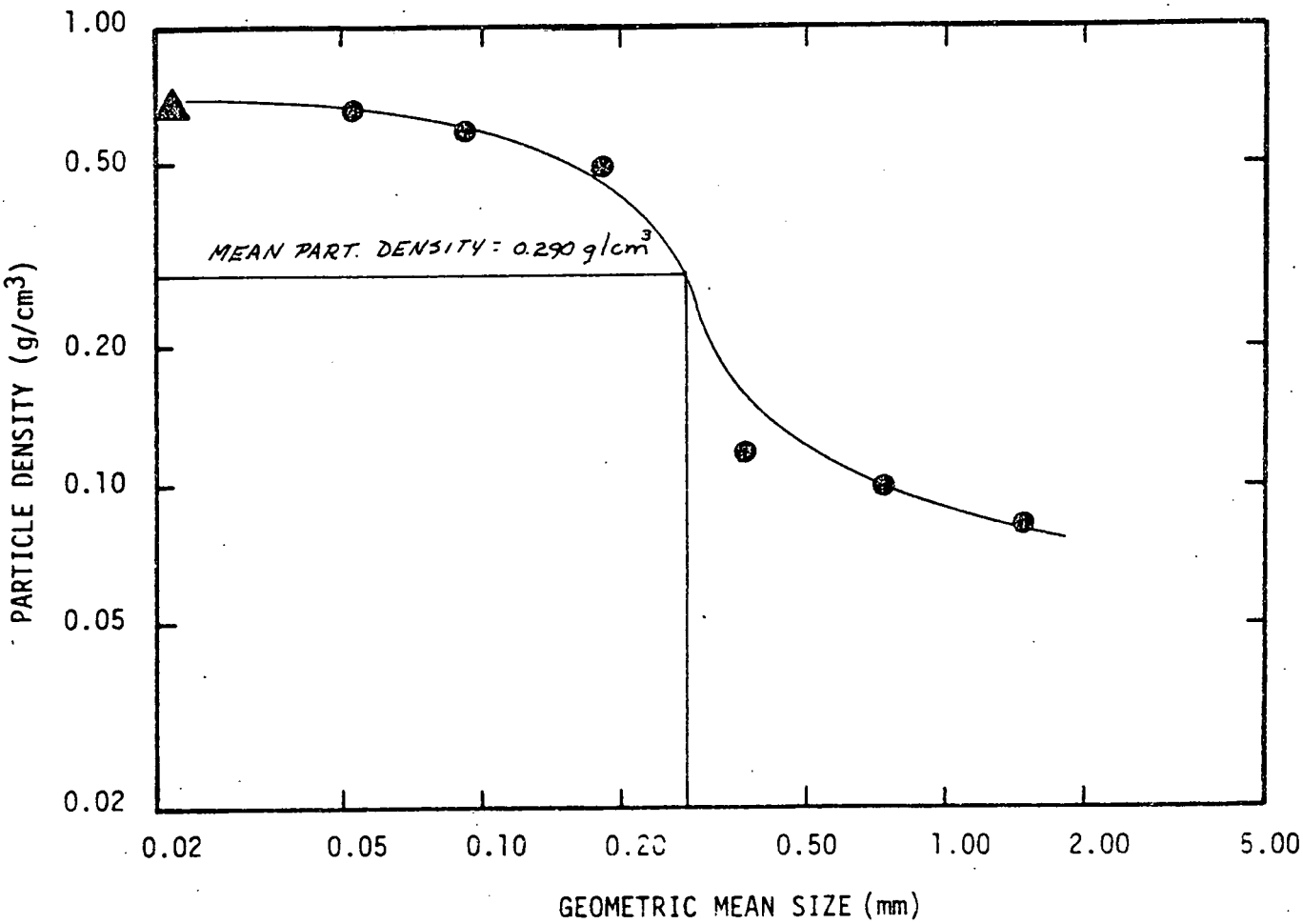
PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

RUN NUMBER: 124



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE
DOUGLAS FIR &
EASTERN WHITE PINE
RUN NUMBER: 124

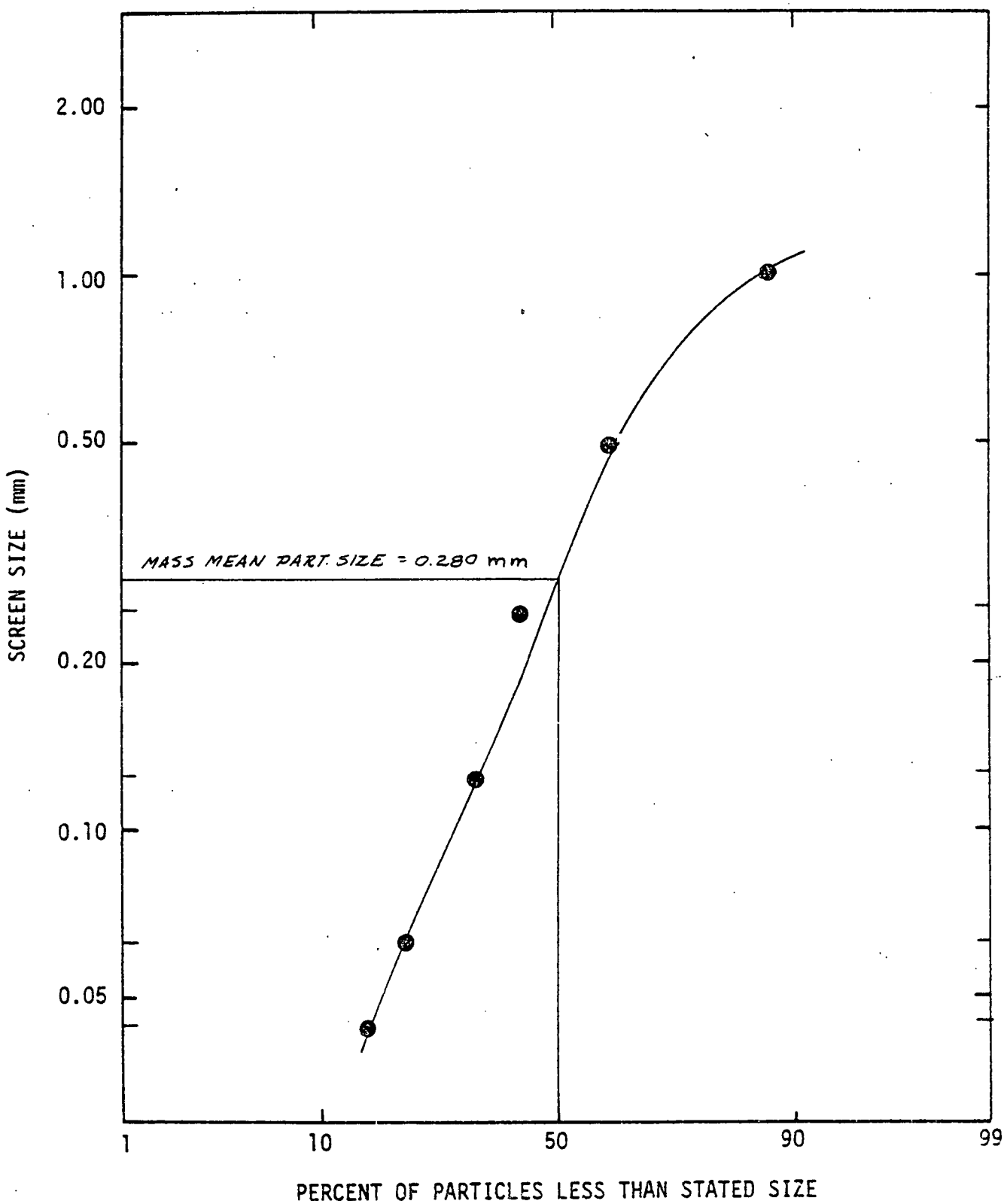


▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

DOUGLAS FIR &
EASTERN WHITE PINE

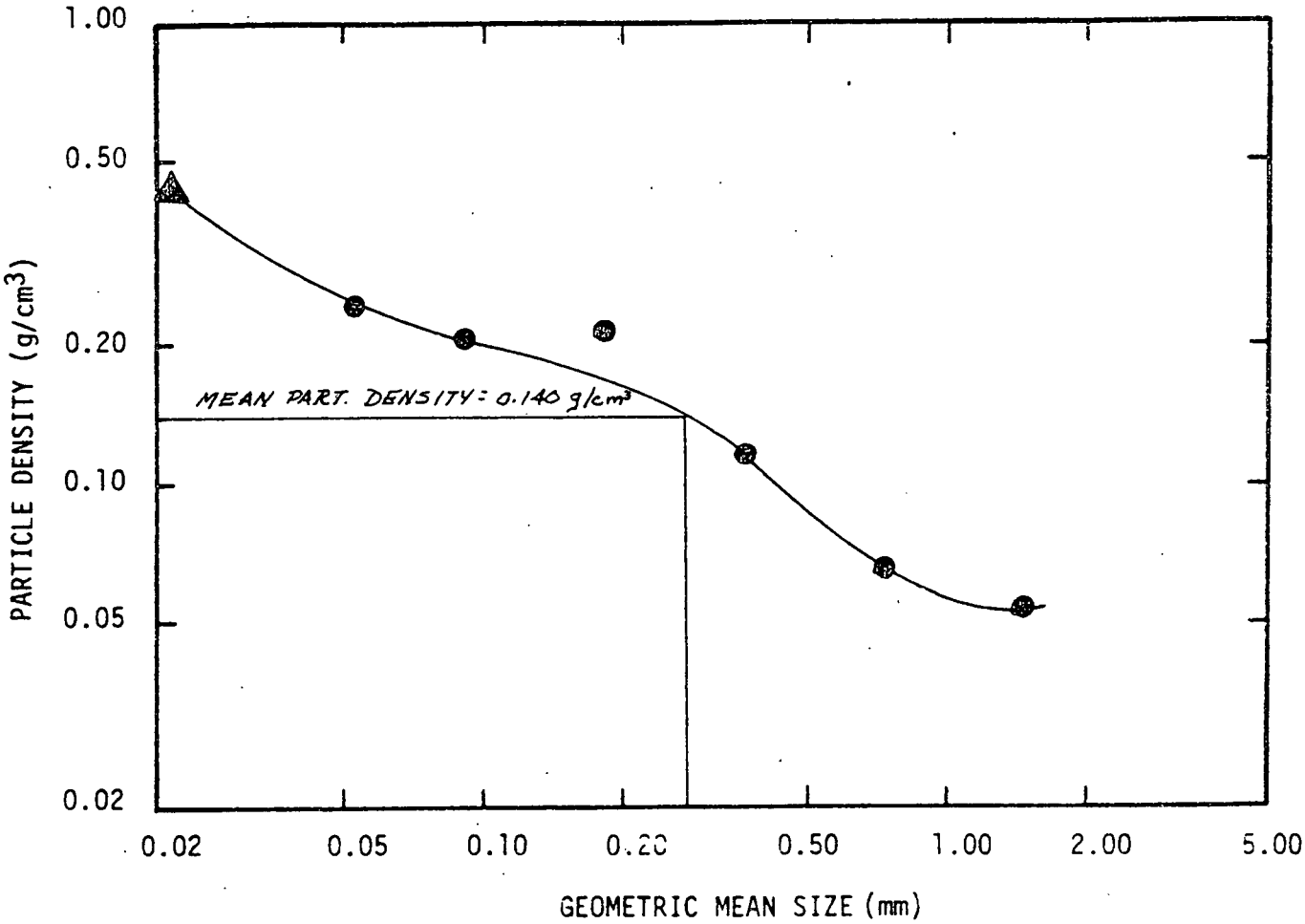
RUN NUMBER: 125



PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DOUGLAS FIR & EASTERN WHITE PINE

RUN NUMBER: 125



▲ = 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: 89

DOUG FIR PLANER SHAVINGS & E. WHT. PINE

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: _____

* * * *

DATA FORM - WOOD ASH ANALYSES

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER'S EAST. WHITE PINE'
SIZE (mm) 2.000

		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)		%		%
COMBUSTIBLE CARBON WT	(gm)		%		%

AVERAGE % INORGANIC ASH _____ AVERAGE % COMBUSTIBLE CARBON _____

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR & EAST. WHITE PINE
SIZE (mm) 1.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	17.42		17.29	
CRUCIBLE WT	(gm)	16.73		16.60	
SAMPLE WT	(gm)	0.69		0.69	
FINAL SAMPLE + CRUCIBLE WT	(gm)	16.79		16.65	
CRUCIBLE WT	(gm)	16.73		16.60	
ASH WT	(gm)	0.06	% 8.70	0.05	% 7.25
COMBUSTIBLE CARBON WT	(gm)	0.63	% 91.30	0.64	% 92.75

AVERAGE % INORGANIC ASH 7.98 AVERAGE % COMBUSTIBLE CARBON 92.03

DATA FORM - WOOD ASH ANALYSES

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.500

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	17.66		17.84	
CRUCIBLE WT	(gm)	16.76		16.91	
SAMPLE WT	(gm)	0.90		0.93	
FINAL SAMPLE + CRUCIBLE WT	(gm)	16.84		16.99	
CRUCIBLE WT	(gm)	16.76		16.81	
ASH WT	(gm)	0.08	% 8.89	0.08	% 8.60
COMBUSTIBLE CARBON WT	(gm)	0.82	% 91.11	0.85	% 91.40

AVERAGE % INORGANIC ASH 8.75 AVERAGE % COMBUSTIBLE CARBON 91.26

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.250

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	18.22		18.67	
CRUCIBLE WT	(gm)	16.88		17.33	
SAMPLE WT	(gm)	1.34		1.34	
FINAL SAMPLE + CRUCIBLE WT	(gm)	17.53		17.98	
CRUCIBLE WT	(gm)	16.88		17.33	
ASH WT	(gm)	0.65	% 48.51	0.65	% 48.51
COMBUSTIBLE CARBON WT	(gm)	0.69	% 51.49	0.69	% 51.49

AVERAGE % INORGANIC ASH 48.51 AVERAGE % COMBUSTIBLE CARBON 51.49

DATA FORM - WOOD ASH ANALYSES

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST WHITE PINE
SIZE (mm) 0.125

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	24.00		23.92	
CRUCIBLE WT	(gm)	16.61		16.43	
SAMPLE WT	(gm)	7.39		7.49	
FINAL SAMPLE + CRUCIBLE WT	(gm)	22.95		22.83	
CRUCIBLE WT	(gm)	16.61		16.43	
ASH WT	(gm)	6.34	% 85.79	6.40	% 85.45
COMBUSTIBLE CARBON WT	(gm)	1.05	% 14.21	1.09	% 14.55

AVERAGE % INORGANIC ASH 85.62 AVERAGE % COMBUSTIBLE CARBON 14.38

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.063

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	20.31		19.95	
CRUCIBLE WT	(gm)	16.70		16.57	
SAMPLE WT	(gm)	3.61		3.38	
FINAL SAMPLE + CRUCIBLE WT	(gm)	19.87		19.51	
CRUCIBLE WT	(gm)	16.70		16.57	
ASH WT	(gm)	3.17	% 87.81	2.94	% 86.98
COMBUSTIBLE CARBON WT	(gm)	0.44	% 12.19	0.44	% 13.02

AVERAGE % INORGANIC ASH 87.40 AVERAGE % COMBUSTIBLE CARBON 12.61

DATA FORM - WOOD ASH ANALYSES

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST WHITE PINE
SIZE (mm) 0.045

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	19.53		19.46	
CRUCIBLE WT	(gm)	16.85		16.78	
SAMPLE WT	(gm)	2.68		2.68	
FINAL SAMPLE + CRUCIBLE WT	(gm)	19.22		19.14	
CRUCIBLE WT	(gm)	16.85		16.78	
ASH WT	(gm)	2.37	% 88.43	2.36	% 88.06
COMBUSTIBLE CARBON WT	(gm)	0.31	% 11.57	0.32	% 11.94

AVERAGE % INORGANIC ASH 88.25 AVERAGE % COMBUSTIBLE CARBON 11.75

RUN NO. 89

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST WHITE PINE
SIZE (mm) PAN

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	21.81		22.05	
CRUCIBLE WT	(gm)	16.60		16.88	
SAMPLE WT	(gm)	5.21		5.17	
FINAL SAMPLE + CRUCIBLE WT	(gm)	21.49		21.74	
CRUCIBLE WT	(gm)	18.60		16.88	
ASH WT	(gm)	4.89	% 93.86	4.86	% 94.00
COMBUSTIBLE CARBON WT	(gm)	0.32	% 6.14	0.31	% 6.00

AVERAGE % INORGANIC ASH 93.93 AVERAGE % COMBUSTIBLE CARBON 6.07

DATA FORM - WOOD ASH ANALYSES

RUN NO: 106

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: _____

* * * *

DATA FORM - WOOD ASH ANALYSES

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST. WHITE PINE
SIZE (mm) 2.000

		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)		%		%
COMBUSTIBLE CARBON WT	(gm)		%		%

AVERAGE % INORGANIC ASH _____ AVERAGE % COMBUSTIBLE CARBON _____

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST. WHITE PINE
SIZE (mm) 1.000

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	26.00		29.09	
CRUCIBLE WT	(gm)	25.28		28.37	
SAMPLE WT	(gm)	0.72		0.72	
FINAL SAMPLE + CRUCIBLE WT	(gm)	25.35		28.46	
CRUCIBLE WT	(gm)	25.28		28.37	
ASH WT	(gm)	0.07	% 9.72	0.09	% 12.50
COMBUSTIBLE CARBON WT	(gm)	0.65	% 90.28	0.63	% 87.50

AVERAGE % INORGANIC ASH 11.11 AVERAGE % COMBUSTIBLE CARBON 88.89

DATA FORM - WOOD ASH ANALYSES

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.500

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	29.25		27.21	
CRUCIBLE WT	(gm)	27.92		25.85	
SAMPLE WT	(gm)	1.33		1.36	
FINAL SAMPLE + CRUCIBLE WT	(gm)	28.02		25.98	
CRUCIBLE WT	(gm)	27.92		25.85	
ASH WT	(gm)	0.10	% 7.52	0.13	% 9.56
COMBUSTIBLE CARBON WT	(gm)	1.23	% 92.48	1.23	% 90.44

AVERAGE % INORGANIC ASH 8.54 AVERAGE % COMBUSTIBLE CARBON 91.46

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST WHITE PINE
SIZE (mm) 0.250

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.74		29.15	
CRUCIBLE WT	(gm)	28.82		27.16	
SAMPLE WT	(gm)	1.92		1.99	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.75		28.16	
CRUCIBLE WT	(gm)	28.82		27.16	
ASH WT	(gm)	0.93	% 48.44	1.06	% 50.25
COMBUSTIBLE CARBON WT	(gm)	0.99	% 51.56	0.99	% 49.75

AVERAGE % INORGANIC ASH 49.35 AVERAGE % COMBUSTIBLE CARBON 50.66

DATA FORM - WOOD ASH ANALYSES

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.125

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	32.38		34.26	
CRUCIBLE WT	(gm)	26.71		28.64	
SAMPLE WT	(gm)	5.67		5.62	
FINAL SAMPLE + CRUCIBLE WT	(gm)	31.70		33.58	
CRUCIBLE WT	(gm)	26.71			
ASH WT	(gm)	4.99	% 88.01	4.94	% 87.90
COMBUSTIBLE CARBON WT	(gm)	0.68	% 11.99	0.68	% 12.10

AVERAGE % INORGANIC ASH 87.96 AVERAGE % COMBUSTIBLE CARBON 12.05

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.063

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	32.55		32.68	
CRUCIBLE WT	(gm)	27.25		27.44	
SAMPLE WT	(gm)	5.30		5.24	
FINAL SAMPLE + CRUCIBLE WT	(gm)	32.00		32.13	
CRUCIBLE WT	(gm)	27.25		27.44	
ASH WT	(gm)	4.75	% 89.62	4.69	% 89.50
COMBUSTIBLE CARBON WT	(gm)	0.55	% 10.38	0.55	% 10.50

AVERAGE % INORGANIC ASH 89.56 AVERAGE % COMBUSTIBLE CARBON 10.44

DATA FORM - WOOD ASH ANALYSES

RUN NO. 106

COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG. FIR PLANER & EAST. WHITE PINE
SIZE (mm) 0.045

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	30.00		31.99	
CRUCIBLE WT	(gm)	25.52		27.56	
SAMPLE WT	(gm)	4.48		4.43	
FINAL SAMPLE + CRUCIBLE WT	(gm)	29.55		31.54	
CRUCIBLE WT	(gm)	25.52		27.56	
ASH WT	(gm)	4.03	% 89.96	3.98	% 89.84
COMBUSTIBLE CARBON WT	(gm)	0.45	% 10.04	0.45	% 10.16

AVERAGE % INORGANIC ASH 89.90 AVERAGE % COMBUSTIBLE CARBON 10.10

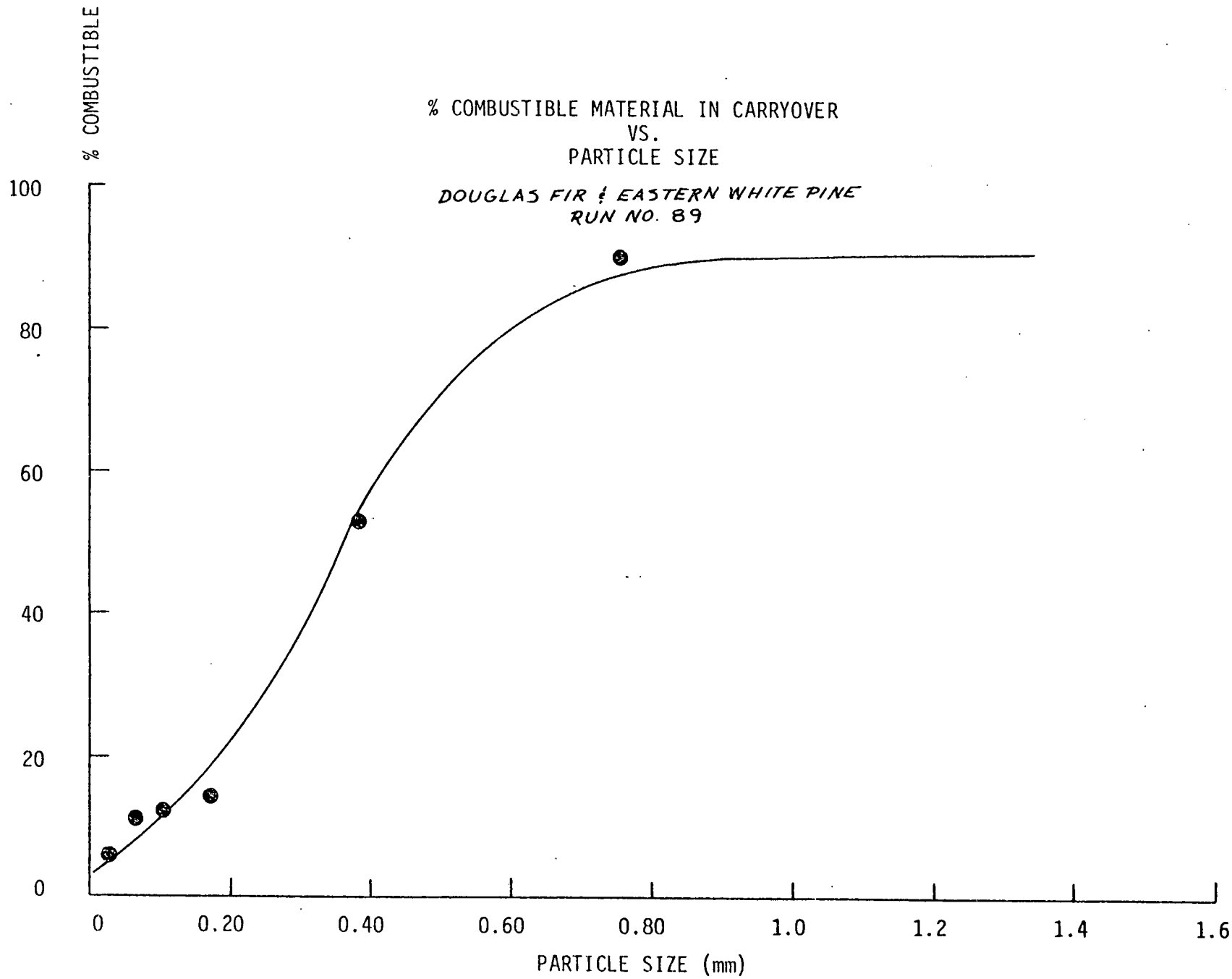
RUN NO. 106

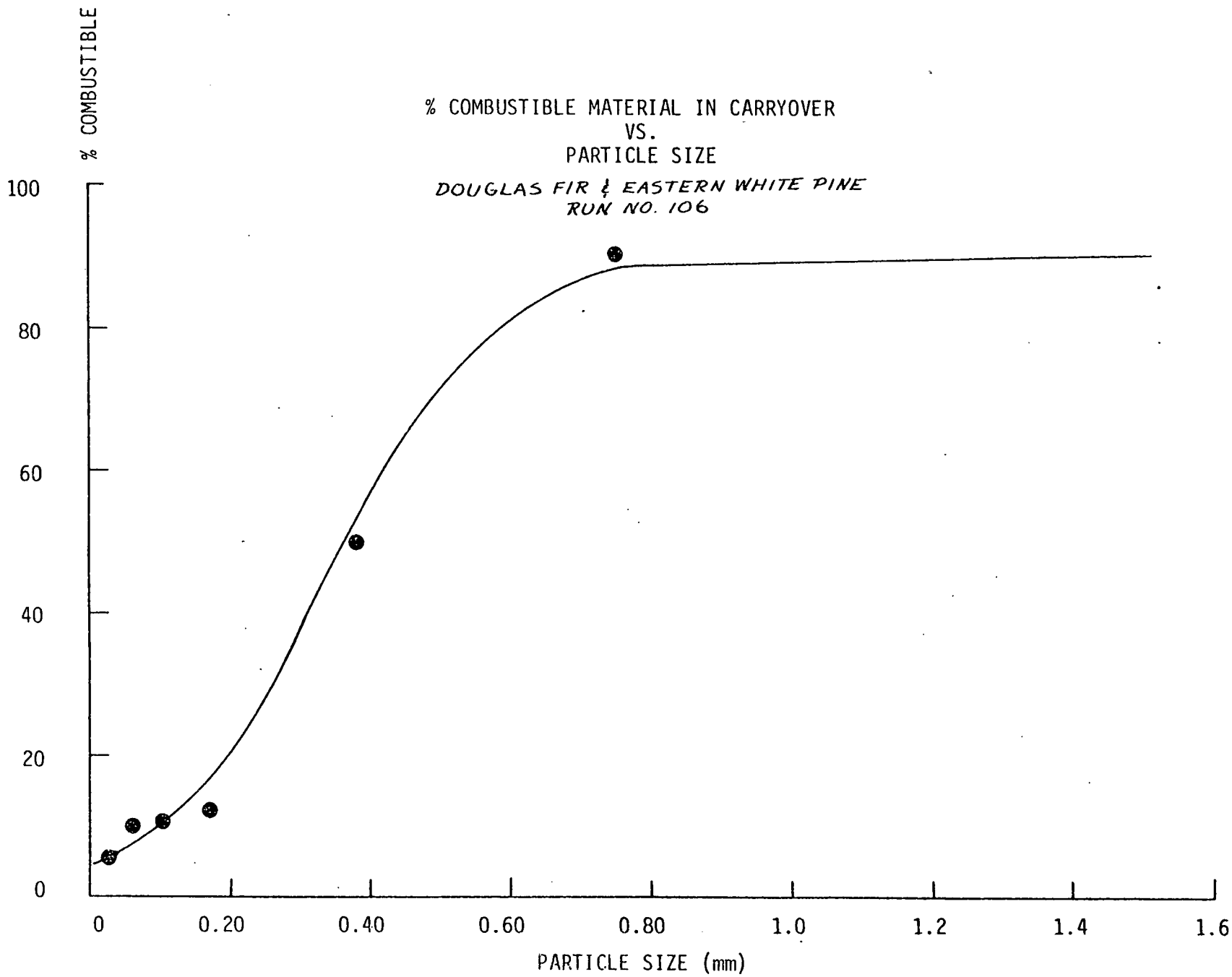
COMBUSTIBLE CONTENT ANALYSES

FUEL DOUG FIR PLANER & EAST. WHITE PINE
SIZE (mm) PAN

		SAMPLE NO. 1		SAMPLE NO. 2	
INITIAL SAMPLE + CRUCIBLE WT	(gm)	33.86		34.93	
CRUCIBLE WT	(gm)	25.54		26.52	
SAMPLE WT	(gm)	8.32		8.41	
FINAL SAMPLE + CRUCIBLE WT	(gm)	33.49		34.38	
CRUCIBLE WT	(gm)	25.54		26.52	
ASH WT	(gm)	7.95	% 95.55	7.86	% 93.46
COMBUSTIBLE CARBON WT	(gm)	0.37	% 4.45	0.55	% 6.54

AVERAGE % INORGANIC ASH 94.51 AVERAGE % COMBUSTIBLE CARBON 5.50


% COMBUSTIBLE MATERIAL IN CARRYOVER
VS.
PARTICLE SIZE
DOUGLAS FIR & EASTERN WHITE PINE
RUN NO. 89
% 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 & EASTERN WHITE PINE
RUN NO. 106
% 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)