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Preliminary Report on the Geotechnical Properties of the Fort Union Formation at Sheridan, Wyoming

By

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Preliminary Report on the Geotechnical Properties of the Fort Union Formation at Sheridan, Wyoming

by Richard A. Farrow[1]

Introduction

This report summarizes the geotechnical properties and lithology obtained from tests run on core holes at Sheridan, Wyo. (fig. 1). The study, which is part of the Energy Lands Program, helps define geotechnical and lithologic characteristics of the lower Tertiary Fort Union Formation in the northwest part of the Powder River Basin, Wyo. and Mont. The study provides information that is helpful in predicting the effects of mining coal in the formation and to define the characteristics of the broken rocks when they comprise spoil banks on reclaimed land. The study also provides civil engineering data used for site construction of highways, bridges, coal silos, buildings, pipelines, canals, and other related projects.

Tube samples or core were taken from four holes that were spaced within 10 m of each other and on the northeast side of Sheridan City and in the NW1/4SE1/4, sec. 23, T. 56 N., R. 84 W., Sheridan County, Wyo. The collar elevation of the site was about 1134 m (3,720 ft) and the core holes penetrated the uppermost 136.7 m (488 ft) of soil and rocks. The uppermost 5.6 m (18.3 ft) of sampling was done with a Shelby tube and the remainder was done with wireline coring apparatus. All the holes were plugged with bentonite slurry and Portland cement after the study was completed. The composite tube-sample-and-core-hole is herein called S-2 core hole.

The data is reported in either metric or English-system units--depending upon what units were calibrated into the individual testing devices. Appendix A has conversion factors for the different units of pressure and length.

[1]Deceased, November 25, 1980.

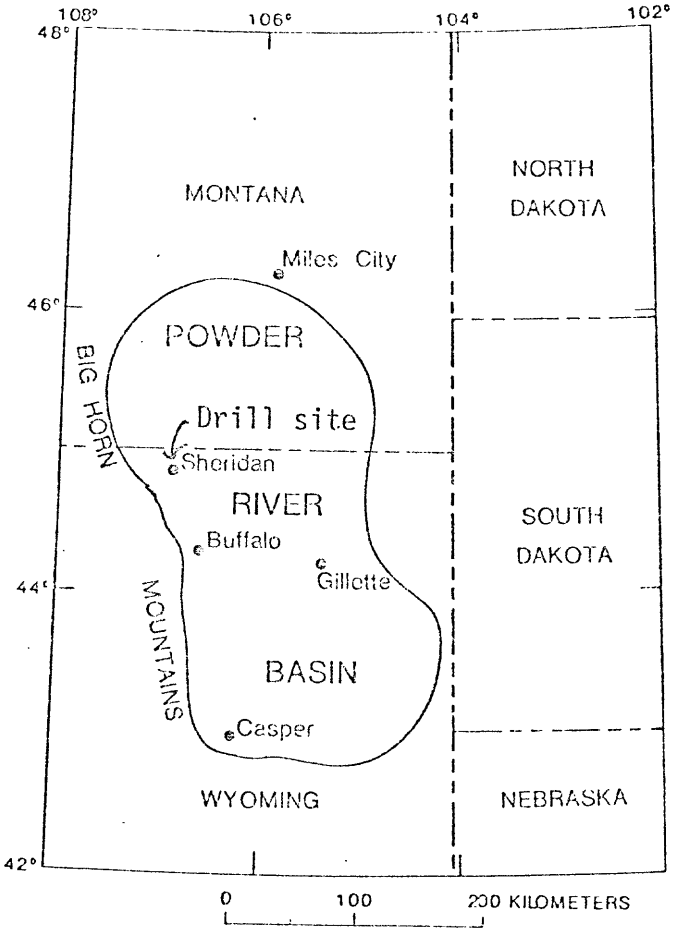

Figure 1.--Index map showing the drill-site locality, Powder River Basin, Sheridan, Wyo.

Field tests and procedures

Upon recovery, each core was wiped, scraped, or washed and described for lithology and general consistency. Detailed lithologic descriptions are summarized in Appendix B. Many cores were subjected to point-load and Schmidt hammer tests and then were sealed in glass jars at the drill site in order to preserve natural moisture. Commercial geophysical logs, three-dimensional sonic velocity, electric (spontaneous potential and resistivity), caliper, density, and nuclear (gamma-ray and neutron) logs were run in the S-2 hole before it was cased. Compressional-wave velocity is calculated from the sonic logs, as are the point-load and Schmidt hammer test data, which with the lithologic and core-recovery logs are presented in the geotechnical properties log of Appendix C.

The point-load test described in Aufmuth (1974) consists of diametrically compressing a segment of core between two rounded points until failure occurs in tension. The value of the index is calculated from P/d, where P is the force at failure and d is the diameter of the core. Some authors multiply this by the factor $4/\pi$, which then results in the force per unit area on the broken surface; this report does not.

The Schmidt hammer test is a device that propels a spring-loaded hammer against the sample and measures the rebound. The rebound numbers (R) are empirically related to the amount of rebound against a calibrated spring. The test is a nondestructive index of relative compressive strength for elastic materials (Hall and others, 1974). Most of the rocks and soils in this borehole are near the lower limits of sensitivity of the test, however, and relative strengths can only be determined in a qualitative sense. The test requires a coherent segment of core whose length exceeds its diameter. If the core failed under impact, the data from that depth were discarded. The plot on the geotechnical properties log shows the arithmetic mean of three Schmidt type-L hammer tests for each depth reported.

Laboratory test program and procedures

Subsequent tests in the laboratory were performed to determine properties of both soils and rocks and the results are summarized in Appendix B. The less-competent materials were tested for grain-size distribution, Atterberg limits, water content, and densities. For the most part, only minimal effort was required to disaggregate the materials so tested. More competent layers were subjected to tests normally associated with rocks. The tests included those for static elastic moduli, unconfined compressive strength, and dynamic elastic properties. Preparation of suitable specimens was difficult because of the friable or fissile nature of the material; therefore, only limited numbers of the rock tests were performed.

Preparation of soil samples was performed in accordance with the standard method for dry preparation of soil samples for particle-size analysis and determination of soil constants (ASTM standard D421-58, reapproved 1972). Particle-size analysis of soils (ASTM standard D422-63, reapproved 1972) was used in the subject determinations with the exception that disaggregation was accomplished by rubber pestle and hand-held mortar. The results are presented as computer-generated graphs. The ASTM standard methods were used for the determination of liquid limit, plastic limit, and plasticity index of soils (ASTM standards D423-66 and D424-59, reapproved 1971). The water pycnometer method described in the standard method of test for specific gravity of soils (ASTM D854-58, reapproved 1972) was used for determination of grain densities. Bulk densities were determined according to the method described by Chleborad and others (1975). Static elastic moduli were determined on the same specimens as were subsequently tested for unconfined compressive strength. Stress-strain curves were drawn by two X-Y plotters from signals originating from a load cell and from a specimen-mounted deformation jacket containing both radial and longitudinal linear variable differential transformers. The curves, along with specimen dimensions, tolerances, and modes of failure, are shown in Appendix D (Laboratory Test Results). Also shown are the results of ultrasonic pulse velocity tests. Wherever sample numbers are given in this report, they refer to the core hole and to depths in meters.

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APPENDIX A

Conversion factors for pressure and length

Table 1.--Conversion factors for pressure

X Factor =	atmosphere	bar	psi ($lb/in.^2$)	psf (lb/ft^2)	dynes/cm^2	g/cm^2	N/m^2 (newton per metre squared)	Pa (Pascal)
atmosphere	1	1.0133	1.4696×10^{1}	2.1162×10^{3}	1.01325×10^{6}	1.0332×10^{3}	1.01325×10^{5}	1.01325×10^{5}
bar	9.8692×10^{-1}	1	1.4504×10^{1}	2.088×10^{3}	1.000×10^{6}	1.01971×10^{3}	1.000×10^{5}	1.000×10^{5}
psi ($lb/in.^2$)	6.8046×10^{-2}	6.8947×10^{-2}	1	6.9445×10^{-3}	6.8947×10^{4}	7.0307×10^{1}	6.8947×10^{3}	6.8947×10^{3}
psf (lb/ft^2)	4.7245×10^{-4}	4.7880×10^{-4}	1.44×10^{2}	1	4.7880×10^{2}	4.8824×10^{-1}	4.7880×10^{1}	4.7880×10^{1}
dynes/cm^2	9.8692×10^{-7}	1.000×10^{6}	1.4504×10^{-5}	2.0886×10^{-3}	1	1.01971×10^{-3}	1.000×10^{-1}	1.000×10^{-1}
g/cm^2	9.6784×10^{-4}	9.8061×10^{-4}	1.4223×10^{-2}	2.0482	9.80665×10^{2}	1	9.80665×10^{4}	9.80665×10^{4}
N/m^2 (newtons per metre squared)	9.8692×10^{-6}	1.000×10^{-5}	1.4504×10^{-4}	2.0886×10^{-2}	1.000×10^{1}	1.01971×10^{-2}	1	1
Pa (Pascal)	9.8692×10^{-6}	1.000×10^{-5}	1.4504×10^{-4}	2.0886×10^{-2}	1.000×10^{1}	1.01971×10^{-2}	1	1

Table 2.--Conversion factors for length

From \ To	inch (in.)	feet (ft)	millimeter (mm)	centimeter (cm)	meter (m)
inch (in.)	1	0.08333	25.400	2.5400	2.5400×10^{-2}
feet (ft)	12.0	1	304.8	30.48	3.048×10^{-1}
millimeter (mm)	3.937×10^{-2}	3.281×10^{-3}	1	10^{-1}	10^{-3}
centimeter (cm)	3.937×10^{-1}	3.281×10^{-2}	10^{1}	1	10^{-2}
meter (m)	39.37	3.281	10^{3}	10^{2}	1

APPENDIX B

Lithologic description of Shelby tube samples and core samples

Lithology of Shelby-tube samples

Depth (meters)	Description
0-0.45	Plant debris and coal fragments
0.45-0.70	Clay, moderate yellowish-brown, sandy, stiff, plastic
0.70-0.80	Clay, dusky yellowish-brown, silty, soft, plastic
0.80-2.00	Clays, moderate to dark yellowish-brown, silty, stiff, plastic
2.00-3.00	Clay, as above, sandy with occasional gravel to 1 cm, white calcareous lines, lenses, and stringers below 2.75 m
3.00-4.00	Clay, dark yellowish-brown, silty, plastic, stiff
4.00-5.15	As above with 2-3 cm sand layer at 4.85 m
5.15-5.75	Clay, mottled reddish-yellow-brown with reddish-brown spots in light olive-gray overall color, soft, plastic; contains fragments of relatively unweathered claystone; grades downward to moderate brown
5.75-6.00	Gravel, loose, wet, fragments about 2-3 mm in moderate brown clay matrix, end of Shelby-tube samples

Lithology of core samples

Depth (meters)	Description
0-4.88	Surface pipe rotated in; no sample
4.88-5.03	Sand, light yellowish-brown with light gray stringers, very fine to fine-grained, clay binder, soft, zones of iron oxide
5.03-5.18	----do----------
5.18-5.33	Clay, yellowish-brown, silty to very fine sandy zones
5.33-5.49	----do----------
5.49-5.64	Clay, yellow-brown, darker brown mottlings
5.64-5.79	Clay, yellow-brown, silty to very fine sandy zones
5.79-5.87	Sand, light brown, silty, soft
5.87-7.16	Pebbles to 5 cm, very fine to fine gravel
7.16-7.32	----do----------
7.32-7.41	Claystone, medium gray with irregular zones of light gray siltier zones
7.41-7.54	Claystone, as above, less sandy
7.54-7.80	Mudstone, very fine bedding, thinly interlaminated carbonaceous sands and silts
7.80-8.40	Mudstone, medium gray with light gray silty zones
8.40-8.55	Mudstone, as above, with iron oxide zones
8.55-8.70	Mudstone, as above, silty, more uniform
8.70-8.90	Claystone, medium gray, slightly silty
8.90-9.10	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
9.10- 9.20	Mudstone, medium gray, silty
9.20- 9.40	----do----------
9.40- 9.50	----do----------
9.50- 9.70	Mudstone, medium gray-brownish gray, silty
9.70- 9.85	----do----------
9.85-10.15	Mudstone, medium gray-brownish gray, silty, becoming hard enough to produce conchoidal fractures
10.15-10.30	Mudstone, medium dark gray, silty zones
10.30-10.45	Mudstone, medium gray, silty zones increasingly silty downward
10.45-10.60	Mudstone, medium gray, very fine sand at bottom
10.60-10.75	Mudstone, medium gray, very fine sandy, friable
10.75-10.90	Mudstone, medium gray, brownish gray zones, alternating sandy and very clayey zones
10.90-11.00	Mudstone, as above, black carbonaceous inclusions
11.00-11.10	Mudstone, medium dark gray, silty, carbonaceous zones
11.10-11.25	----do----------
11.25-11.40	Mudstone, as above, coal (11.35)?
11.40-11.53	Mudstone, medium dark gray, silty, carbonaceous zones
11.53-11.70	Mudstone, medium dark gray, silty, coaly zones, hairline fractures subhorizontal
11.70-12.30	Mudstone, medium dark gray, silty, coal stringers 2 mm thick

Lithology of core samples--Continued

Depth (meters)	Description
12.30-12.40	Mudstone, dark gray, carbonaceous, finely laminated clay, dark gray carbonaceous at base, high angle parting along compositional boundary
12.40-12.60	Mudstone, dark gray to black, very carbonaceous, fine laminations mostly of clay
12.60-12.75	Coal
12.75-12.90	Mudstone, dark gray to dark brownish gray, mostly clay, 10 cm; some coal
12.90-13.03	Mudstone, dark brownish gray, clayey
13.03-13.20	----do----------
13.20-14.00	Shale, dark gray to black, very carbonaceous to coaly, bottom 10 cm mudstone, dark gray to black, silty
14.00-14.15	Mudstone, medium dark gray
14.15-14.45	Mudstone, medium dark gray, spiral slickensides from drilling, coaly zones
14.45-15.00	Coal and shale, black
15.00-15.15	Mudstone, medium dark gray, silty
15.15-15.30	----do----------
15.30-15.45	Mudstone, dark gray to black, silty and coaly zones
15.45-15.60	----do----------
15.60-15.75	Shale, dark gray, coaly and silty zones; grades into mudstone, brownish gray, clayey
15.75-15.90	Mudstone, dark gray, silty

Lithology of core samples--Continued

Depth (meters)	Description
15.90-16.05	Mudstone, dark gray, silty
16.05-16.20	Mudstone, dark gray, clayey
16.20-16.35	Shale, black, very carbonaceous, bottom 3 cm are coal, shaley
16.35-16.50	Coal 3 cm, shale, black, coaly
16.50-16.65	Shale, black, carbonaceous
16.65-16.80	----do----------
16.80-16.90	Shale, black, 3 cm coal, lignitic
16.90-17.05	----do----------
17.05-17.20	Mudstone, medium dark gray to medium brownish gray, silty zones, 1 mm thick coal stringers
17.20-17.35	----do----------
17.35-17.50	----do----------
17.50-17.65	----do----------
17.65-17.80	Mudstone, medium dark gray to medium brownish gray, silty zones, 5 mm thick coal stringers
17.80-18.00	Mudstone, medium dark gray to medium brownish gray, silty zones distinctively eroded by drilling fluid
18.00-18.15	----do----------
18.15-18.30	----do----------
18.30-18.45	Mudstone, as above
18.45-18.60	Mudstone, medium brownish gray, silty
18.60-18.75	----do----------
18.75-18.90	Mudstone, medium brownish gray, silty, carbonaceous
18.90-19.05	Mudstone, medium gray, grading to light gray, silty

Lithology of core samples--Continued

Depth (meters)	Description
19.05-19.20	Mudstone, medium dark gray, silty to sandy (very fine-grained), carbonaceous zones
19.20-19.35	Mudstone, medium dark gray with brownish gray, silty zones
19.35-19.50	Mudstone-siltstone, light olive gray to light gray, hard, concretionary
19.50-19.65	Mudstone, medium olive gray, sandy (very fine-grained), carbonaceous zones
19.65-20.00	Mudstone, medium gray, silty to sandy (very fine-grained), carbonaceous zones, silty zones are brownish gray
20.00-20.15	----do----------
20.15-20.30	----do----------
20.30-20.45	----do----------
20.45-20.60	Mudstone, brownish olive gray, clayey, grades to shale, dark brown, very carbonaceous-lignitic 6 cm
20.60-20.75	Shale, dark gray to black, carbonaceous, fissile
20.75-20.90	Shale, as above, pyrite flecks
20.90-21.05	Mudstone, medium dark gray, clayey, carbonaceous zones
21.05-21.20	----do----------
21.20-21.25	Mudstone, dark gray, clayey zones with interlaminated sparce silty zones, brownish gray, occasional carbonaceous layers
21.25-21.40	Mudstone, dark gray, some fissility, occasional silty zones

Lithology of core samples--Continued

Depth (meters)	Description
21.40-21.55	Shale, dark gray to black, very carbonaceous to coaly
21.55-21.70	Mudstone, medium gray, clayey
21.70-21.85	Mudstone, medium gray, clayey, grades to shale, black, carbonaceous
21.85-22.00	Shale, brown, lignitic-coaly stringers, mudstone, clayey 7 cm
22.00-22.05	Mudstone, clayey at top, grades to shale, coaly
22.05-22.15	Mudstone, clayey, medium olive gray, 5 cm shale, black, carbonaceous
22.15-22.30	----do----------
22.30-22.45	Coal, 10 cm, shale, black, carbonaceous
22.45-22.60	Shale, black, carbonaceous grades to claystone, dark gray carbonaceous
22.60-22.75	Claystone, dark gray, rosin spot
22.75-23.25	Claystone, as above
23.25-23.40	Shale, dark gray, carbonaceous
23.40-23.55	----do----------
23.55-23.70	----do----------
23.70-23.85	Shale, 10 cm, as above, 5 cm coal, black
23.85-24.00	Coal, black
24.00-24.15	Shale, black with interbedded coal stringers
24.15-24.30	Claystone, dark olive gray, silty zones
24.30-24.50	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
24.50-24.65	Claystone, dark olive gray, silty zones
24.65-24.80	----do----------
24.80-24.90	Mudstone, dark olive gray, clayey
24.90-25.10	Shale, dark gray to black, carbonaceous
25.10-25.25	----do----------
25.25-25.40	Mudstone, dark olive gray
25.40-25.55	----do----------
25.55-25.70	Mudstone, dark gray to black, with coal stringers and coaly shale, grades to claystone, black, carbonaceous
25.70-25.85	Claystone, dark gray, carbonaceous
25.85-26.00	Coal, 10 cm, shale, black, carbonaceous, silty
26.00-26.10	Mudstone, dark olive gray, silty zones, washed by drilling fluid
26.10-26.20	----do----------
26.20-26.35	----do----------
26.35-26.50	Mudstone, dark olive gray, silty zones, spiral fractures from drilling
26.50-26.65	Mudstone, dark gray with lighter silty zones
26.65-26.80	----do----------
26.80-26.95	----do----------
26.95-27.10	----do----------
27.10-27.25	Mudstone, medium olive gray, silty
27.25-27.40	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
27.40-27.55	Mudstone, medium olive gray, with dark gray zones, silty
27.55-27.65	Mudstone, medium olive gray, silty, hard
27.65-27.85	Mudstone, medium olive gray, less silty, hard
27.85-27.95	Mudstone, medium olive gray, less silty
27.95-28.05	----do----------
28.05-28.65	----do----------
28.65-28.80	Claystone, shale, dark olive gray to black, carbonaceous
28.80-28.95	Shale, black, carbonaceous, grades to mudstone, dark gray to dark olive gray, carbonaceous
28.95-29.05	Claystone, dark olive
29.05-29.50	Mudstone, dark olive, silty
29.50-29.65	Mudstone, dark olive to medium brownish gray, silty
29.65-29.95	Mudstone, dark gray, silty
29.95-30.10	Mudstone, medium gray to olive brown, 5 cm silty zone
30.10-30.25	Mudstone, dark to medium olive gray, carbonaceous, silty
30.25-30.40	Mudstone, dark gray 5 cm, medium gray 10 cm
30.40-30.55	Mudstone, medium gray, silty, light yellow brown zones
30.55-30.70	Mudstone, medium olive gray
30.70-30.85	Mudstone, medium olive gray, yellow brown zones
30.85-31.95	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
31.95-32.10	Mudstone, medium olive gray, yellow brown zones
32.10-32.25	Mudstone, medium olive gray, very silty
32.25-32.40	Mudstone, medium olive gray, sandy (very fine-grained)
32.40-32.55	Mudstone, medium olive gray, silty
32.55-32.70	Mudstone, medium olive gray, silty, finely interlaminated carbonaceous silts bottom 3 cm
32.70-32.85	Siltstone-mudstone, dark gray, carbonaceous
32.85-33.85	Core missing
33.85-33.95	Sandstone, medium gray, very fine-grained, speckled, ~20 percent feldspar, subrounded to rounded, very friable--sample lost above is presumed to be more of the sandstone, carbonaceous stringers and coaly zones approximately 1 mm thick
33.95-34.10	----do----------
34.10-34.50	Sandstone, as above, more carbonaceous zones, laminated
34.50-34.65	----do----------
34.65-34.80	Sandstone, as above, becomes increasingly silty
34.80-34.95	Siltstone, light medium gray, very hard, partings along fossil leaves, becomes dark gray
34.95-35.10	Siltstone, as above, light medium gray, not as hard, becomes sandy at base
35.10-35.20	Shale, black, coaly, soft
35.20-35.35	Mudstone, medium dark olive gray, silty
35.35-35.50	Mudstone, as above, clayey with partings in coal

Lithology of core samples--Continued

Depth (meters)	Description
35.50-35.80	Mudstone, as above
35.80-35.95	Mudstone, dark gray to black, clayey
35.95-36.10	----do----------
36.10-36.25	Shale, dark olive gray, carbonaceous, silty
36.25-36.35	Shale, dark olive gray, dark dusky brown, carbonaceous zones
36.35-36.50	Shale, dark olive gray, silty zones
36.50-36.65	Mudstone, dark olive gray, silty zones
36.65-36.80	Mudstone, as above, carbonaceous zones
36.80-36.95	Mudstone, dark olive gray, silty zones
36.95-37.25	Mudstone, as above, sandy (very fine-grained) at base, carbonaceous
37.25-37.35	Shale, gray to black, carbonaceous
37.35-37.50	Shale, black, carbonaceous, very fine laminations
37.50-37.65	----do----------
37.65-37.80	Coal with black shale
37.80-38.00	----do----------
38.00-38.05	Siltstone, dark brownish gray, sandy (very fine-grained) carbonaceous stringers, very friable
38.05-38.20	----do----------
38.20-38.35	Siltstone, dark olive gray
38.35-38.50	Mudstone, dark olive gray, silty zones, soft clayey zones
38.50-38.65	Mudstone, as above, increasing clay content
38.65-38.80	Mudstone, as above, becomes silty at base

Lithology of core samples--Continued

Depth (meters)	Description
38.80-38.95	Mudstone, dark olive gray, few lighter colored silty zones
38.95-39.10	Mudstone, as above
39.10-39.25	----do----------
39.25-39.40	----do----------
39.40-39.55	----do----------
39.55-39.70	----do----------
39.70-39.85	----do----------
39.85-40.00	----do----------
40.00-40.15	----do----------
40.15-40.30	Mudstone, dark olive gray, increasing silt to sandy (very fine-grained)
40.30-40.45	Siltstone, olive gray, sandy (very fine-grained)
40.45-40.60	----do----------
40.60-40.75	----do----------
40.75-40.85	Siltstone, as above, harder
40.85-41.00	----do----------
41.00-41.15	Mudstone, olive gray, silty and clayey zones
41.15-41.30	----do----------
41.30-41.45	Mudstone, olive gray, becomes lighter olive and siltier downward
41.45-41.60	Mudstone, as above, with tan-brown concretions
41.60-41.75	Mudstone, grades downward to siltstone, olive gray, sandy (very fine-grained)

Lithology of core samples--Continued

Depth (meters)	Description
41.75-41.90	Siltstone, light olive gray, sandy (very fine-grained), vertical fractures
41.90-42.00	----do----------
42.00-42.15	Mudstone, dark olive gray, clayey zones, with light olive gray silty and sandy (very fine-grained) zones
42.15-42.25	Siltstone, light olive gray
42.25-42.40	Siltstone, olive gray
42.40-42.55	Siltstone, light olive gray, sandy (very fine-grained) hard
42.55-42.70	----do----------
42.70-42.85	Mudstone, olive gray, silty
42.85-43.15	Mudstone, olive gray, less silty
43.15-43.20	Siltstone, light olive gray
43.20-43.30	Sandstone, light olive gray, very fine to fine-grained, silty, clayey zones, friable
43.30-43.40	----do----------
43.40-43.50	Mudstone, olive gray, sandy at top
43.50-43.65	Mudstone, olive gray, sandy at base
43.65-43.80	Sandstone, light olive gray, very fine grained to silty, grades downward to siltstone then mudstone
43.80-43.90	Mudstone, olive gray, silty zones
43.90-44.05	Mudstone, olive gray, silty to sandy (very fine-grained)
44.05-44.20	Siltstone, light olive gray with brownish hard zones

Lithology of core samples--Continued

Depth (meters)	Description
44.20-44.35	Siltstone, as above, grades to claystone, olive gray
44.35-44.65	30 cm lost, probably clay
44.65-44.80	Claystone-mudstone, olive gray, silty zones
44.80-44.95	Claystone, olive gray, not as silty
44.95-45.10	Mudstone, olive gray, silty zones
45.10-45.30	Core lost
45.30-45.45	Sandstone, olive gray, very fine-grained to silty, friable, grades downward to shale, black, carbonaceous
45.45-45.55	Sandstone, olive gray, very fine-grained, carbonaceous stringers
45.55-45.70	----do----------
45.70-45.85	Shale, black, carbonaceous
45.85-46.00	Coal, black, shale partings
46.00-46.15	Coal, mudstone, brownish olive gray, silty
46.15-46.35	Mudstone, olive gray, carbonaceous zones, silty
46.35-46.45	Mudstone, olive gray, no carbonaceous zones
46.45-46.60	----do----------
46.60-46.85	Claystone, olive gray
46.85-47.00	Mudstone, olive gray, more silty
47.00-47.15	----do----------
47.15-47.35	----do----------
47.35-47.45	----do----------
47.45-47.60	Sandstone, light olive gray, 5 cm, mudstone, olive gray, silty

Lithology of core samples--Continued

Depth (meters)	Description
47.60-47.65	Sandstone, light olive gray, 5 cm, mudstone, olive gray silty
47.65-47.80	Mudstone, olive gray, silty to sandy
47.80-47.95	Siltstone, light olive gray, sandy
47.95-48.10	Siltstone, as above, grades to sandstone, sandy (very fine-grained), olive brown
48.10-48.25	Sandstone, light olive gray, very fine-grained to silty, hard
48.25-48.40	Siltstone, olive gray, grades downward to claystone
48.40-48.50	Mudstone, olive gray with lighter colored silty zones
48.50-48.65	----do----------
48.65-48.80	----do----------
48.80-48.90	----do----------
48.90-49.05	----do----------
49.05-49.15	Mudstone, olive gray, silty
49.15-49.30	----do----------
49.30-49.45	----do----------
49.45-49.55	----do----------
49.55-49.70	----do----------
49.70-49.85	Mudstone, olive gray, sandy at top
49.85-50.05	Mudstone, olive gray
50.05-50.20	----do----------
50.20-50.35	----do----------
50.35-50.50	Mudstone, olive gray, sandy at bottom
50.50-50.65	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
50.65-50.75	Shale, dark olive gray, some fissility to very fine bedding
50.75-50.90	Mudstone, olive gray, silty
50.90-51.05	----do----------
51.05-51.50	----do----------
51.50-51.65	Sandstone, olive gray, very fine-grained, friable with brownish zones
51.65-51.80	----do----------
51.80-51.95	Mudstone, olive gray, silty to sandy (very fine-grained)
51.95-52.10	----do----------
52.10-52.20	Mudstone, olive gray, silty
52.20-52.35	Mudstone, olive gray, silty with brownish zones
52.35-52.50	Mudstone, olive gray, silty with brownish zones, at 52.50 meters bottom section of surface casing rotated off and was lost in the hole. Drill rig moved approximately 1 m east and rock-bit hole started
51.35-51.50	Mudstone, dark olive gray, silty with very fine sandy zones
51.50-51.65	Sandstone, olive gray, very fine-grained, silty
51.65-51.80	----do----------
51.80-51.95	Mudstone, olive gray, silty to sandy (very fine-grained)

Lithology of core samples--Continued

Depth (meters)	Description
51.95-52.10	Mudstone, olive gray, silty
52.10-52.25	----do----------
52.25-52.40	Mudstone, light olive gray, silty
52.40-52.50	----do----------
52.50-52.60	Sandstone, very fine-grained, dark olive gray, silty
52.60-52.75	Mudstone, dark olive gray, silty to sandy (very fine-grained)
52.75-52.85	----do----------
52.85-53.00	Mudstone, dark olive gray, silty
53.00-53.15	Mudstone, dark olive gray, lighter silty zones.
53.15-53.30	----do----------
53.30-53.45	----do----------
53.45-53.60	----do----------
53.60-53.75	----do----------
53.75-53.80	Mudstone, becomes very clayey with lighter brown mottling
53.80-53.95	Mudstone, dark olive gray
53.95-54.10	Mudstone, as above, grades downward to dark brownish olive clay
54.10-54.25	Shale, dark brown to black, carbonaceous, pockets and 3 mm coal stringers
54.25-54.35	----do----------
54.35-54.80	Same soft shale drilled and not cored
54.80-54.95	Mudstone, dark brownish olive gray, grades downward to dark olive gray

Lithology of core samples--Continued

Depth (meters)	Description
54.95-55.10	Mudstone, dark olive gray, silty zones
55.10-55.15	----do----------
55.15-55.30	----do----------
55.30-55.45	Mudstone, dark olive gray, silty
55.45-55.60	Mudstone, as above, olive gray, silty
55.60-55.75	Mudstone, as above, carbonaceous zones
55.75-56.00	Sandstone, very fine-grained to silty, clayey zones, friable, mottled with mudstone, as above
56.00-56.15	Sandstone, as above
56.15-56.30	Shale, dark olive gray, sandy at top
56.30-56.40	Shale, as above
56.40-56.50	Shale, as above, hard
56.50-56.60	Shale, as above, becomes brownish, carbonaceous
56.60-56.75	Shale, brownish to black, carbonaceous to coaly zones, silty
56.75-56.85	----do----------
56.85-57.00	Shale, becomes darker olive gray, fractures at 40° separates coal 3 cm
57.00-57.15	Shale, black, coaly
57.15-57.30	----do----------
57.30-57.35	Mudstone, dark olive gray, clayey
57.35-57.60	Mudstone, as above, coaly stringers
57.60-57.75	----do----------
57.75-57.90	----do----------
57.90-58.05	----do----------
58.05-58.20	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
58.20-58.35	Sandstone, olive gray, very fine grained to silty, very clayey
58.35-58.50	Sandstone, as above, grades downward to interbedded mudstone, as above
58.50-58.60	Sandstone, as above, carbonaceous, lignitic
58.60-58.75	Mudstone, olive black
58.75-58.80	Mudstone, olive black, clayey
58.80-58.90	Mudstone, as above, becomes very silty with carbonaceous stringers
58.90-59.05	Mudstone, olive gray, silty to sandy (very fine grained) zones, argillaceous
59.05-59.20	----do----------
59.20-59.35	----do----------
59.35-59.45	Mudstone, olive gray, grades to siltstone, olive gray, hard
59.45-59.55	Siltstone, olive gray, sandy (very fine grained) hard, becomes softer, clayey, grades to mudstone
59.55-59.70	Mudstone, grades to siltstone, olive brown, grades to mudstone, dark olive gray
59.70-59.85	Mudstone, olive gray to greenish gray
59.85-60.00	----do----------
60.00-60.15	Mudstone, dark greenish gray
60.15-60.25	Mudstone, as above, becomes silty and hard
60.25-60.40	Mudstone, as above, silty and softer

Lithology of core samples--Continued

Depth (meters)	Description
60.40-60.50	Siltstone, olive gray
60.50-60.65	Mudstone, olive gray, hard, silty at top
60.65-60.80	Mudstone, as above, sandy, abrupt change to sandstone-siltstone, medium olive gray, very hard
60.80-60.90	----do----------
60.90-61.05	----do----------
61.05-61.20	----do----------
61.20-61.35	----do----------
61.35-61.55	Sandstone, medium gray, carbonaceous stringers, silty, hard
61.55-61.85	----do----------
61.85-62.00	Sandstone, light olive gray, very fine grained to silty, very calcareous, hard
62.00-62.15	----do----------
62.15-62.25	Sandstone, as above, with very fine friable layers of yellow color
62.25-62.35	----do----------
62.35-62.45	Sandstone, as above, brownish yellow, concretions, becomes mudstone, olive gray with friable sandy zones, silty zones, clay seams
62.45-62.60	Sandstone, light olive gray, very fine grained to silty friable
62.60-63.30	Sandstone, as above, with clay-rich zones

Lithology of core samples--Continued

Depth (meters)	Description
63.30-63.35	Mudstone, olive gray, very sandy with clayey zones
63.35-63.50	Mudstone, very sandy
63.50-63.65	Sandstone, very argillaceous zones, friable
63.65-63.80	Sandstone, light olive gray, very argillaceous, silty, friable
63.80-63.95	Sandstone, as above, dark yellow orange zone 63.90
63.95-64.05	Sandstone, dark yellow-brown with lighter yellow clay-rich zones, medium hard, very hard non-calcareous zones
64.05-64.70	Sandstone, medium olive gray, friable, argillaceous
64.70-64.75	Sandstone, as above, carbonaceous laminations
64.75-65.05	Sandstone, as above, friable, less than 5 percent feldspar, subrounded
65.05-65.20	Sandstone, medium olive gray, very argillaceous, carbonaceous zones
65.20-65.25	Mudstone, dark olive brown, very friable sandy zones, clay-rich brown zones, carbonaceous
65.25-65.40	Sandstone, olive gray, carbonaceous stringers, friable, bright yellow mottling
65.40-66.60	Sandstone, as above, few medium-grain zones, carbonaceous, friable
66.00-66.15	Claystone, medium olive gray, silty, hard
66.15-66.25	Siltstone, dark yellow brown, sandy (very fine-grained), claystone, medium olive gray, silty, hard

Lithology of core samples--Continued

Depth (meters)	Description
66.25-66.40	Claystone, medium olive gray, silty
66.40-66.50	Sandstone, light olive gray, very fine grained, to silty, argillaceous, friable, carbonaceous stringers
66.50-66.60	Claystone, medium olive gray, silty
66.60-66.85	Claystone, as above, waxy
66.85-67.00	Claystone, as above, dark yellow zones, fractures and slickensides at 45°
67.00-67.20	Mudstone, medium olive gray, finely laminated (1/2 cm), silty layers
67.20-67.35	----do----------
67.35-67.50	Mudstone, claystone, very argillaceous
67.50-67.65	Claystone, medium dark olive gray, waxy, silty
67.65-68.10	----do----------
68.10- 68.15	----do----------
68.15-68.30	Coal, brownish black, argillaceous
68.30-68.45	Coal, vertical fractures
68.45-68.55	Coal
68.55-68.60	Mudstone, dark olive gray, silty
68.60-68.75	Mudstone, as above, sandy (very fine grained)
68.75-68.90	Mudstone, as above, carbonaceous stringers
68.90-69.05	Siltstone, dark olive gray, silty, argillaceous
69.05-69.20	Mudstone, silty
69.20-69.30	Mudstone, dark olive gray, with brownish yellow mottled zones

Lithology of core samples--Continued

Depth (meters)	Description
69.30-69.40	Mudstone, as above, stringers of very fine sand
69.40-69.55	Mudstone, as above, 45° fractures
69.55-69.70	Mudstone, as above, dark olive gray, silty to sandy (very fine grained)
69.70-69.85	Mudstone, as above, very silty
69.85-69.95	Mudstone, as above, argillaceous, 2 mm coal
69.95-70.45	Claystone, dark olive gray, coal at 70.05, brown, argillaceous
70.45-70.60	Claystone, dark olive gray, silty
70.60-70.75	Claystone, as above, waxy
70.75-70.90	----do----------
70.90-71.10	Claystone, as above, waxy slickensides
71.10-71.25	Claystone, as above, silty laminations
71.25-71.35	Claystone, dusky yellow brown, fracture 60°, waxy
71.35-71.40	----do----------
71.40-71.50	Claystone, olive gray
71.50-71.65	Claystone, olive gray, carbonaceous fractures at 30°
71.65-71.75	Claystone, olive gray, sandy concretions approximately 10 cm diameter, brownish yellow, hard
71.75-71.90	Claystone, dark olive gray
71.90-72.05	Claystone, dark olive gray, waxy
72.05-72.10	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
72.10-72.25	Claystone, dusky yellow brown, silty, slickensides
72.25-72.40	Claystone, as above, slickenside, carbonaceous
72.40-72.55	----do----------
72.55-72.85	----do----------
72.85-73.10	Claystone, olive gray, dark yellow mottling, soft
73.10-73.25	Shale, dark brown to dusky brown
73.25-73.30	Coal, black, soft
73.30-73.40	Coal, black, hard, vitreous luster
73.40-73.55	Coal, black, dull luster
73.55-73.70	Coal, black
73.70-73.75	----do----------
73.75-73.90	Coal, 3 cm, claystone, dark dusky brown, 10 cm, claystone, dusky yellow brown, fractures 30°, waxy
73.90-74.05	Shale, dusky brown, carbonaceous, soft
74.05-74.15	Shale, as above, thin coal seams 2 cm thick
74.15-74.25	Shale, as above
74.25-74.30	----do----------
74.30-74.40	----do----------
74.40-74.55	----do----------
74.55-74.70	Shale, dusky brown, grades to claystone, 74.60, olive gray, waxy, fractures 60°
74.70-74.75	Claystone, as above, increasingly silty
74.75-74.95	Claystone, as above, very silty

Lithology of core samples--Continued

Depth (meters)	Description
74.95-75.10	Claystone, as above, carbonaceous flecks, 20° fractures
75.10-75.20	Claystone, olive black, carbonaceous, 60° fractures, slickensides
75.20-75.30	----do----------
75.30-75.50	Claystone, as above, carbonaceous
75.50-75.60	Claystone, olive black, carbonaceous, increasingly silty
75.60-75.75	Siltstone, dark gray to black, carbonaceous, sandy (very fine-grained)
75.75-75.80	Siltstone, as above
75.80-75.90	Coal, black
75.90-76.05	----do----------
76.05-76.20	----do----------
76.20-76.35	Coal, black, 76.25, sandstone, very light gray, friable, argillaceous, carbonaceous flecks
76.35-76.40	----do----------
76.40-76.60	----do----------
76.60-76.75	Sandstone, very light gray, very fine-grained and silty layers, calcareous
76.75-76.90	Sandstone, as above, fine-grained and silty layers, calcareous
76.90-77.05	----do----------
77.05-77.40	Sandstone, as above, with 1 cm laminations, greenish gray claystone layers, carbonaceous and coaly flecks and stringers, calcareous

Lithology of core samples--Continued

Depth (meters)	Description
77.40-77.55	Siltstone, gray green, interlaminated with claystone, gray green, carbonaceous flecks and stringers, calcareous
77.55-77.70	Siltstone, claystone, as above, calcareous to limey
77.70-77.85	Siltstone-claystone, as above, hard
77.85-78.00	----do----------
78.00-78.15	Siltstone-claystone, as above, some yellow spots, crossbedding and contorted beds, calcareous to limey
78.15-78.30	Siltstone, as above, fossiliferous
78.30-78.45	----do----------
78.45-78.65	Siltstone, very light to light gray, sandy (very fine grained), friable, argillaceous, very calcareous
78.65-78.80	Siltstone, as above, carbonaceous layers interlaminated claystones, sandy, calcareous, H_2S
78.80-78.90	----do----------
78.90-79.05	----do----------
79.05-79.20	----do----------
79.20-79.50	Siltstone, as above, oil slick in bottle
79.50-79.65	Siltstone, as above, becomes very sandy

Lithology of core samples--Continued

Depth (meters)	Description
79.65-79.75	Sandstone, light gray, very fine to fine-grained, silty, interlaminated with claystone, light gray to dark gray, carbonaceous stringers, calcareous
79.75-79.85	Sandstone-claystone, as above
79.85-80.05	Sandstone, very light to light gray, very fine grained to silty, argillaceous, carbonaceous flecks, calcareous
80.05-80.15	----do----------
80.15-80.30	Siltstone, as above, calcareous
80.30-80.40	Sandstone, light gray, very fine grained to silty, argillaceous, calcareous, interlaminated siltstone and claystone, light gray, carbonaceous flecks and streaks
80.40-80.45	Siltstone, light gray, carbonaceous flecks and streaks becomes very silaceous
80.45-80.65	Siltstone, medium gray, calcareous to limey, hard
80.65-80.80	Sandstone, medium dark gray, silty to sandy (very fine-grained) very calcareous to limey, hard
80.80-80.95	----do----------
80.95-81.10	Sandstone, as above, limey
81.10-81.25	Sandstone, as above, becomes silty, very argillaceous, calcareous, friable at base

Lithology of core samples--Continued

Depth (meters)	Description
81.25-81.60	Siltstone, medium gray, calcareous, carbonaceous stringers, argillaceous
81.60-81.65	----do----------
81.65-81.80	Siltstone, as above, sandy (very fine grained) zones
81.80-81.95	Siltstone, medium gray, very argillaceous, calcareous
81.95-82.10	Claystone, medium gray, calcareous to limey, silty, carbonaceous stringers
82.10-82.25	----do----------
82.25-82.35	----do----------
82.35-82.45	Claystone, as above, silty, limey, hard
82.45-82.60	----do----------
82.60-82.65	Claystone, as above, carbonaceous partings
82.65-82.70	Claystone, as above, becomes increasingly interlaminated with noncalcareous clay zones, less silty, softer, 3 mm coal seam
82.70-82.80	Claystone, as above
82.80-82.90	Claystone, as above, silty to sandy (very fine-grained) layers
82.90-83.00	Siltstone, medium gray, argillaceous, silty, scattered yellow gray spots, calcareous
83.00-83.15	----do----------
83.15-83.30	----do----------
83.30-83.45	Siltstone, as above, noncalcareous, hard

Lithology of core samples--Continued

Depth (meters)	Description
83.45-83.60	Siltstone, as above, noncalcareous
83.60-83.80	----do----------
83.80-83.90	Siltstone, medium gray, argillaceous, noncalcareous, hard
83.90-84.00	----do----------
84.00-84.05	----do----------
84.05-84.20	----do----------
84.20-84.35	Siltstone, as above, becomes lighter olive gray, interlaminated with very fine sand
84.35-84.50	----do----------
84.50-84.65	Siltstone, light olive gray, sandy (very fine grained), carbonaceous partings
84.65-84.75	Siltstone, light olive gray, sandy (very fine grained)
84.75-84.90	Sandstone, light olive gray, very silty, argillaceous, noncalcareous
84.90-85.05	----do----------
85.05-85.20	Sandstone, light olive gray, interlaminated with very carbonaceous silty zones
85.20-85.35	Sandstone, medium gray, very fine grained, silty, argillaceous, carbonaceous stringers
85.35-85.45	----do----------
85.45-85.60	Sandstone, as above, silty, very argillaceous
85.60-85.75	Sandstone, as above, with 2 cm layers fine- to medium-grained sandstone

Lithology of core samples--Continued

Depth (meters)	Description
85.75-85.90	Sandstone, fine- to medium-grained, subrounded, light olive gray, carbonaceous flecks and stringers, friable, noncalcareous
85.90-86.05	----do----------
86.05-86.20	Sandstone, as above, becomes very fine to fine-grained at base
86.20-86.35	Sandstone, as above, carbonaceous stringers
86.35-86.45	Sandstone, as above, argillaceous
86.45-86.55	Sandstone, as above, silty stringers
86.55-86.70	----do----------
86.70-86.85	Sandstone, as above, carbonaceous stringers
86.85-86.95	----do----------
86.95-87.10	Sandstone, medium to very fine grained, silty, subrounded, noncalcareous, carbonaceous flecks, friable
87.10-87.25	----do----------
87.25-87.35	Sandstone, as above, slightly calcareous
87.35-87.40	Sandstone, as above, calcareous
87.40-87.55	Siltstone, medium gray, argillaceous, very calcareous to limey, hard, interlaminated with claystone, olive gray, silty, waxy
87.55-87.65	Claystone, medium dark gray, carbonaceous, fractures 10° to 60°
87.65-87.75	Coal, black, hard, argillaceous

Lithology of core samples--Continued

Depth (meters)	Description
87.75-87.90	Coal, brownish black
87.90-88.05	----do----------
88.05-88.20	----do----------
88.20-88.35	----do----------
88.35-88.40	----do----------
88.40-88.55	Coal, becomes very argillaceous
88.55-88.70	Coal, brownish black, shaley
88.70-88.85	Coal
88.85-88.95	Coal, black to brownish black, very shaley
88.95-89.15	Claystone, olive gray, waxy, with silty zones
89.15-89.30	Sandstone, light olive gray, very silty, argillaceous, carbonaceous stringers
89.30-89.45	Siltstone, light olive gray, sandy (very fine-grained), very argillaceous
89.45-89.60	Sandstone, light olive gray, silty, very argillaceous
89.60-89.75	Sandstone, as above, noncalcareous
89.75-89.90	Sandstone, as above, very silty, very argillaceous, noncalcareous
89.90-89.95	----do----------
89.95-90.10	----do----------
90.10-90.20	----do----------
90.20-90.35	----do----------
90.35-90.50	----do----------
90.50-90.60	Sandstone, very fine grained, siltstone, light olive gray, very argillaceous

Lithology of core samples--Continued

Depth (meters)	Description
90.60-90.75	Siltstone, sandy (very fine grained), light olive gray, calcareous, carbonaceous stringers
90.75-90.90	Siltstone, as above
90.90-91.00	Siltstone, as above, sandy (very fine grained)
91.00-91.90	Siltstone, as above, sandy
91.90-92.05	Sandstone, brownish gray, very fine grained to silty, very argillaceous, carbonaceous stringers, calcareous
92.05-92.20	----do----------
92.20-92.30	Sandstone, olive gray, very fine to fine-grained, carbonaceous stringers, friable
92.30-92.45	Sandstone, becomes very argillaceous to silty
92.45-92.60	Sandstone, as above, carbonaceous, fractures at 45°
92.60-92.70	----do----------
92.70-92.85	Sandstone, olive gray, fine-grained to silty, argillaceous zones, friable
92.85-93.00	Sandstone, becomes medium gray, black carbonaceous sandy layers, yellow brown spots at base
93.00-93.15	----do----------
93.15-93.40	----do----------
93.40-93.50	Sandstone, as above, sandy (very fine grained) to silty

Lithology of core samples--Continued

Depth (meters)	Description
93.50-93.90	Claystone, light gray, interlaminated siltstone, medium dark gray
93.90-93.95	Claystone, dark gray, silty
93.95-94.05	Claystone, dark gray to dark olive gray, silty, waxy slickensides on fractures at 80°
94.05-94.15	Claystone, as above
94.15-94.30	Claystone, as above, fractures at 50°
94.30-94.40	Claystone, olive gray, silty, fractures at 15°, sandy layers
94.40-94.55	----do----------
94.55-94.70	Claystone, dark olive gray, silty, waxy slickensides on fracture at 45°
94.70-94.85	Coal, dark brownish black, argillaceous
94.85-95.00	Coal, black
95.00-95.45	Coal, dark brownish black, shaley
95.45-95.60	Shale, olive gray, interlaminated lignitic claystone, olive gray, waxy slickensides on fractures at 45° and 60°
95.60-95.75	Claystone, as above, fractures at 75°
95.75-95.90	----do----------
95.90-95.95	----do----------
95.95-96.10	Claystone, as above, fractures at 15°
96.10-96.25	Claystone, as above, silty, contorted carbonaceous zones

Lithology of core samples--Continued

Depth (meters)	Description
96.25-96.40	Siltstone, olive gray, argillaceous, calcareous
96.40-96.55	----do----------
96.55-96.65	Siltstone, olive gray, very argillaceous, calcareous
96.65-96.75	Siltstone, dark olive gray, shaley, carbonaceous flecks
96.75-96.90	Siltstone, as above
96.90-97.00	----do----------
97.00-97.15	----do----------
97.15-97.30	----do----------
97.30-98.50	Siltstone, medium dark gray, argillaceous
98.50-99.00	Siltstone, as above, some core lost due to jammed core barrel
99.00-99.10	Siltstone, as above
99.10-99.20	----do----------
99.20-99.55	Coal, black, hard
99.55-99.70	Claystone, olive gray, sandy (fine) zones, very silty, noncalcareous
99.70-99.80	Siltstone, dark olive gray
99.80-99.95	Claystone, olive gray, sandy and silty zones
99.95-100.05	Claystone, dark olive gray, sandy (fine-grained) lenses
100.05-100.20	Claystone, as above, silty

Lithology of core samples--Continued

Depth (meters)	Description
100.20-100.30	Claystone, as above, carbonaceous
100.30-100.45	Siltstone, olive gray, carbonaceous flecks
100.45-100.60	Siltstone, as above, noncalcareous
100.60-100.75	Siltstone, light olive gray, argillaceous
100.75-100.85	Siltstone, as above, highly fractured
100.85-101.05	----do----------
101.05-101.20	----do----------
101.20-101.35	----do----------
101.35-101.50	----do----------
101.50-101.65	----do----------
101.65-101.80	----do----------
101.80-101.95	----do----------
101.95-102.05	Siltstone, olive gray, irregularly interbedded with sandstone, light olive gray, very fine grained to silty, carbonaceous stringers, argillaceous
102.05-102.20	----do----------
102.20-102.35	Siltstone, as above, light olive gray, sandy (very fine-grained) argillaceous
102.35-102.50	Siltstone, as above, 1 mm coal seams
102.50-102.65	----do----------
102.65-102.80	Siltstone, as above, slightly calcareous with hard brown calcareous concretions near base

Lithology of core samples--Continued

Depth (meters)	Description
102.80-102.90	Siltstone, mottled light olive brown and dark olive gray, carbonaceous stringers, sandy (very fine grained) zones
102.90-103.00	----do----------
103.00-103.15	Siltstone, olive gray, limey, argillaceous
103.15-103.20	Siltstone, as above, sandy (very fine grained) zones
103.20-103.35	Sandstone, very fine to fine-grained, olive gray, very argillaceous, silty
103.35-103.40	----do----------
103.40-103.55	Sandstone, as above, becomes very silty
103.55-103.80	Sandstone, olive gray, very fine grained, grades to siltstone, calcareous
103.80-103.85	Siltstone, olive gray, sandy (very fine grained) carbonaceous partings, calcareous
103.85-104.00	----do----------
104.00-104.10	----do----------
104.10-104.25	----do----------
104.25-104.40	----do----------
104.40-104.55	Siltstone, as above, increasingly sandy (very fine grained)
104.55-104.70	Siltstone, as above, sandy (very fine to fine-grained)
104.70-104.85	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
104.85-105.00	Siltstone, as above, sandy (very fine to fine-grained)
105.00-105.15	----do----------
105.15-105.30	Siltstone, as above, carbonaceous partings
105.30-105.35	----do----------
105.35-105.50	----do----------
105.50-105.60	Siltstone, olive gray, very argillaceous, carbonaceous parting, hard, calcareous
105.60-105.70	Siltstone, olive gray to dark gray, carbonaceous, limey, hard
105.70-105.85	----do----------
105.85-106.00	----do----------
106.00-106.10	Siltstone, dark gray, carbonaceous, slightly calcareous
106.10-106.25	Siltstone, as above, fractures at 60°
106.25-106.35	Siltstone, brownish olive gray, slightly calcareous, fractures at 45°
106.35-106.50	Siltstone, olive gray
106.50-106.75	Siltstone, olive gray, carbonaceous partings
106.75-106.90	Siltstone, olive gray
106.90-107.05	----do----------
107.05-107.20	----do----------
107.20-107.35	----do----------
107.35-107.50	Claystone, olive gray, very silty, fractures at 45°

Lithology of core samples--Continued

Depth (meters)	Description
107.50-107.65	Claystone, as above, waxy slickensides on fractures
107.65-107.80	----do----------
107.80-107.95	----do----------
107.95-108.10	----do----------
108.10-108.20	Claystone, as above, fractures at 60°
108.20-108.35	----do----------
108.35-108.65	Claystone, olive gray, very silty, no fractures, brownish gray mottling
108.65-108.75	----do----------
108.75-109.00	----do----------
109.00-109.20	Claystone, as above, fractures at 10°
109.20-109.50	----do----------
109.50-109.65	Claystone, as above, fractures at 60°
109.65-109.75	Claystone, grades to brownish clay, lignitic
109.75-109.95	Claystone-coal, dark olive gray
109.95-110.10	Coal-sandstone, very fine grained, grades to siltstone, dark gray to brownish olive gray, carbonaceous
110.10-110.25	Siltstone, 5 cm, coal, black
110.25-110.30	Coal
110.30-110.45	Shale, black, very carbonaceous to coaly, silty zones
110.45-110.60	Shale, brownish black, carbonaceous to coaly
110.60-110.75	Claystone, as above, brownish, carbonaceous to coaly

Lithology of core samples--Continued

Depth (meters)	Description
110.75-110.95	Siltstone, dark gray, sandy (very fine grained) carbonaceous, grades to claystone, olive gray, silty to sandy (very fine-grained) very carbonaceous
110.95-111.10	Claystone, olive gray, sandy (very fine grained) lense
111.10-111.20	Siltstone, dark gray to dark olive gray, sandy (very fine grained)
111.20-111.30	Siltstone, dark olive gray, slightly sandy (very fine grained)
111.30-111.45	Claystone, dark olive gray, carbonaceous layers
111.45-111.55	Claystone, as above
111.55-111.65	Claystone, dark gray, carbonaceous
111.65-111.75	----do----------
111.75-111.85	Claystone, as above, waxy slickensides
111.85-112.00	Claystone, as above, coal, 12 cm
112.00-112.10	Claystone, lighter olive green
112.10-112.25	Claystone, as above, waxy partings
112.25-112.35	Claystone, as above, carbonaceous inclusions
112.35-112.45	----do----------
112.45-112.55	Claystone, as above, coal seams, black, hard
112.55-112.70	----do----------
112.70-112.80	----do----------
112.80-112.90	Siltstone, dark olive gray, carbonaceous flecks and partings, very argillaceous

Lithology of core samples--Continued

Depth (meters)	Description
112.90-113.05	Siltstone, as above
113.05-113.20	----do----------
113.20-113.30	----do----------
113.30-113.45	----do----------
113.45-113.60	Siltstone, dark olive gray, becomes sandy (very fine grained)
113.60-113.75	----do----------
113.75-114.40	----do----------
114.40-114.55	----do----------
114.55-114.70	Siltstone, light olive gray, sandy (very fine grained), finely interlaminated darker gray zones
114.70-114.85	Sandstone, medium olive gray, very fine grained, argillaceous, carbonaceous flecks and stringers, friable
114.85-115.00	Sandstone, as above
115.00-115.20	----do----------
115.20-115.35	Sandstone, medium olive gray, very fine grained, slightly argillaceous, carbonaceous flecks and partings, friable
115.35-115.50	----do----------
115.50-115.60	----do----------
115.60-115.75	Sandstone, as above, becomes very finely laminated with dark gray carbonaceous sandstone, very fine grained

Lithology of core samples--Continued

Depth (meters)	Description
115.75-115.90	Sandstone, as above, very finely laminated
115.90-116.05	Coal, black, hard
116.05-116.30	Coal, black, hard, vertical fractures
116.30-116.45	Siltstone, dark gray, carbonaceous, sandy (very fine grained)
116.45-116.70	Siltstone, dark olive gray, carbonaceous, sandy (very fine grained)
116.70-116.85	Siltstone, as above, becomes increasingly sandy
116.85-117.00	----do----------
117.00-117.15	----do----------
117.15-117.30	Siltstone, as above, claystone, silty
117.30-117.40	Claystone, dark olive gray, silty
117.40-117.55	Claystone, as above
117.55-117.70	Siltstone, dark olive gray, sandy (very fine grained) layers
117.70-117.75	Siltstone, dark olive gray, sandy (very fine grained)
117.75-117.85	Siltstone, as above, fractures at 45°
117.85-118.00	Claystone, dark grayish black, very carbonaceous, waxy, fractures at 10°
118.00-118.15	Claystone, as above
118.15-118.20	----do----------
118.20-118.25	Claystone, as above, waxy slickensides
118.25-118.45	Claystone, as above, becomes darker olive gray

Lithology of core samples--Continued

Depth (meters)	Description
118.45-118.55	Claystone, as above, becomes silty
118.55-118.80	Claystone, as above, silty at base, waxy slickensides
118.80-118.90	Claystone, dark grayish black
118.90-119.05	----do----------
119.05-119.20	Claystone, dark olive gray, silty zones, waxy slickensides
119.20-119.35	----do----------
119.35-119.45	----do----------
119.45-119.60	----do----------
119.60-119.70	Siltstone, olive gray, sandy (very fine-grained) argillaceous
119.70-119.85	----do----------
119.85-120.00	Siltstone, as above, hard
120.00-120.10	----do----------
120.10-120.25	----do----------
120.25-120.40	----do----------
120.40-120.55	Claystone, olive gray, silty, hard
120.55-120.65	Claystone, olive gray, silty, carbonaceous flecks, leaf impressions, hard
120.65-120.80	----do----------
120.80-120.95	----do----------
120.95-121.05	Siltstone, olive gray, sandy (very fine grained) argillaceous, hard
121.05-121.20	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
121.20-121.35	Siltstone, as above, becomes brownish gray, very sandy
121.35-121.50	Sandstone, brownish olive gray, sandy, very argillaceous
121.50-121.60	----do----------
121.60-121.75	----do----------
121.75-121.80	----do----------
121.80-121.95	Sandstone, brownish olive gray, becomes very fine to fine-grained, friable, argillaceous
121.95-122.20	Sandstone, olive gray, very fine to fine-grained, silty, 1 cm laminations claystone, dark olive gray
122.20-122.35	Sandstone, as above, crossbedding
122.35-122.45	Sandstone, as above, interlaminated with claystone, dark olive gray
122.45-122.55	Claystone, dark olive gray
122.55-122.70	Claystone, as above, sandy (very fine to fine-grained) pockets
122.70-122.85	Sandstone, olive gray, very fine to fine-grained, silty
122.85-123.00	Claystone, dark olive gray, interlaminated sandstone, as above
123.00-123.15	Claystone, as above
123.15-123.30	----do----------
123.30-123.50	Claystone, as above, becomes dark gray, carbonaceous

Lithology of core samples--Continued

Depth (meters)	Description
123.50-123.65	Claystone, as above, becomes dark gray, carbonaceous
123.65-123.80	Claystone, dark olive gray, waxy slickensides on partings
123.80-123.90	----do----------
123.90-124.05	----do----------
124.05-124.15	----do----------
124.15-124.20	Sandstone, light olive gray, very fine grained to silty
124.20-124.25	Sandstone, as above, claystone layers
124.25-124.40	Sandstone, light olive gray, very fine to fine-grained, claystone layers
124.40-124.50	Sandstone, brownish olive gray
124.50-124.55	----do----------
124.55-124.60	----do----------
124.60-124.75	----do----------
124.75-124.90	Sandstone, brownish olive gray, becomes finely interlaminated with dark gray siltstone, carbonaceous brown streaks
124.90-125.05	----do----------
125.05-125.20	Claystone, olive gray, very sandy (very fine grained)
125.20-125.30	----do----------
125.30-125.40	Claystone, olive gray to dark gray, silty
125.40-125.55	----do----------
125.55-125.70	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
125.70-125.85	Claystone, as above, becomes very dark olive gray
125.85-125.95	Coal, black, hard
125.95-126.05	----do----------
126.05-126.20	Claystone, olive gray, waxy slickensides
126.20-126.35	----do----------
126.35-126.45	----do----------
126.45-126.60	Claystone, dark brownish black, carbonaceous to coaly
126.60-126.75	Claystone, dark olive gray, silty
126.75-126.85	Claystone, olive gray, silty
126.85-127.00	Claystone, as above, waxy slickensides at 20°
127.00-127.15	Siltstone, olive gray, sandy (very fine grained) carbonaceous partings and stringers
127.15-127.30	Sandstone, olive brownish gray, very fine grained to silty, argillaceous
127.30-127.90	----do----------
127.90-127.95	----do----------
127.95-128.10	Claystone, dark olive gray, silty zones
128.10-128.25	----do----------
128.25-128.35	----do----------
128.35-128.45	Claystone, as above, grades to sandstone, olive brownish gray, very fine grained to silty, argillaceous

Lithology of core samples--Continued

Depth (meters)	Description
128.45-128.60	Sandstone, as above
218.60-128.75	----do----------
128.75-128.80	Claystone, dark olive gray
128.80-128.90	Claystone, as above, interlaminated fine-grained sand
128.90-129.05	----do----------
129.05-129.20	----do----------
129.20-129.30	Sandstone, olive gray, very fine-grained to silty, argillaceous, friable
129.30-129.45	Claystone, as above
129.45-129.60	Sandstone, as above
129.60-129.75	Claystone, as above
129.75-129.85	----do----------
129.85-130.00	Sandstone, olive gray, very fine grained to silty, argillaceous, friable
130.00-130.15	----do----------
130.15-130.30	----do----------
130.30-130.45	----do----------
130.45-130.55	----do----------
130.55-130.70	----do----------
130.70-130.85	Siltstone
130.85-130.90	Sandstone, as above
130.90-131.05	Claystone
131.05-131.20	Sandstone, light olive gray, very fine to fine-grained, silty, argillaceous

Lithology of core samples--Continued

Depth (meters)	Description
131.20-131.35	Sandstone, light olive gray, very fine to fine-grained, silty, argillaceous
131.35-132.25	----do----------
132.25-132.35	----do----------
132.35-132.45	----do----------
132.45-132.60	----do----------
132.60-132.85	----do----------
132.85-133.00	----do----------
133.00-133.10	----do----------
133.10-133.20	----do----------
133.20-133.30	Sandstone, light olive gray, very fine grained to silty, argillaceous, friable
133.30-133.40	----do----------
133.40-133.55	Claystone-siltstone
133.55-133.70	Siltstone
133.70-133.75	Claystone
133.75-133.90	Siltstone
133.90-134.05	Claystone-carbonaceous partings
134.05-134.20	Sandstone
134.20-134.30	Siltstone
134.30-134.40	Siltstone, 1 cm claystone layers
134.40-134.50	----do----------
134.50-134.65	Sandstone, very fine grained to silty
134.65-134.80	----do----------
134.80-134.95	----do----------

Lithology of core samples--Continued

Depth (meters)	Description
134.95-135.10	Claystone
135.10-135.25	Sandstone, as above, with 2 cm claystone layers
135.25-135.40	----do----------
135.40-135.48	Claystone
135.48-135.85	Sandstone, as above, with 2 cm claystone layers
135.85-136.00	----do----------
136.00-136.15	Claystone
136.15-136.30	Sandstone
136.30-136.45	----do----------
136.45-136.60	Claystone, interbedded sandstone layers
136.60-136.70	Sandstone, becomes brownish, hard
	Total Depth 136.70

APPENDIX C

Geotechnical properties logs: core recovery, lithologic, Schmidt hammer, point load, and compressional- (P) wave velocity

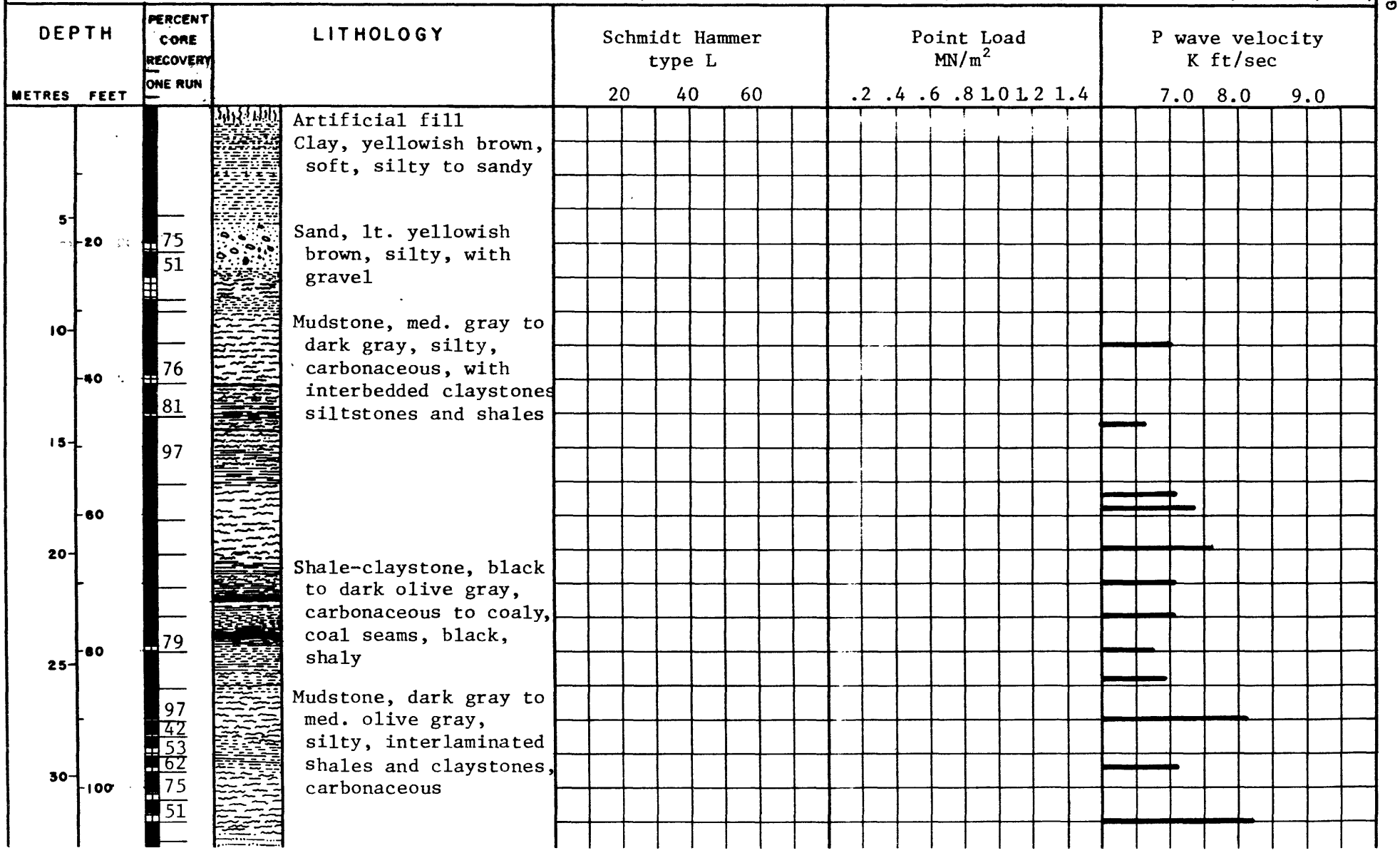
GEOTECHNICAL PROPERTIES LOG

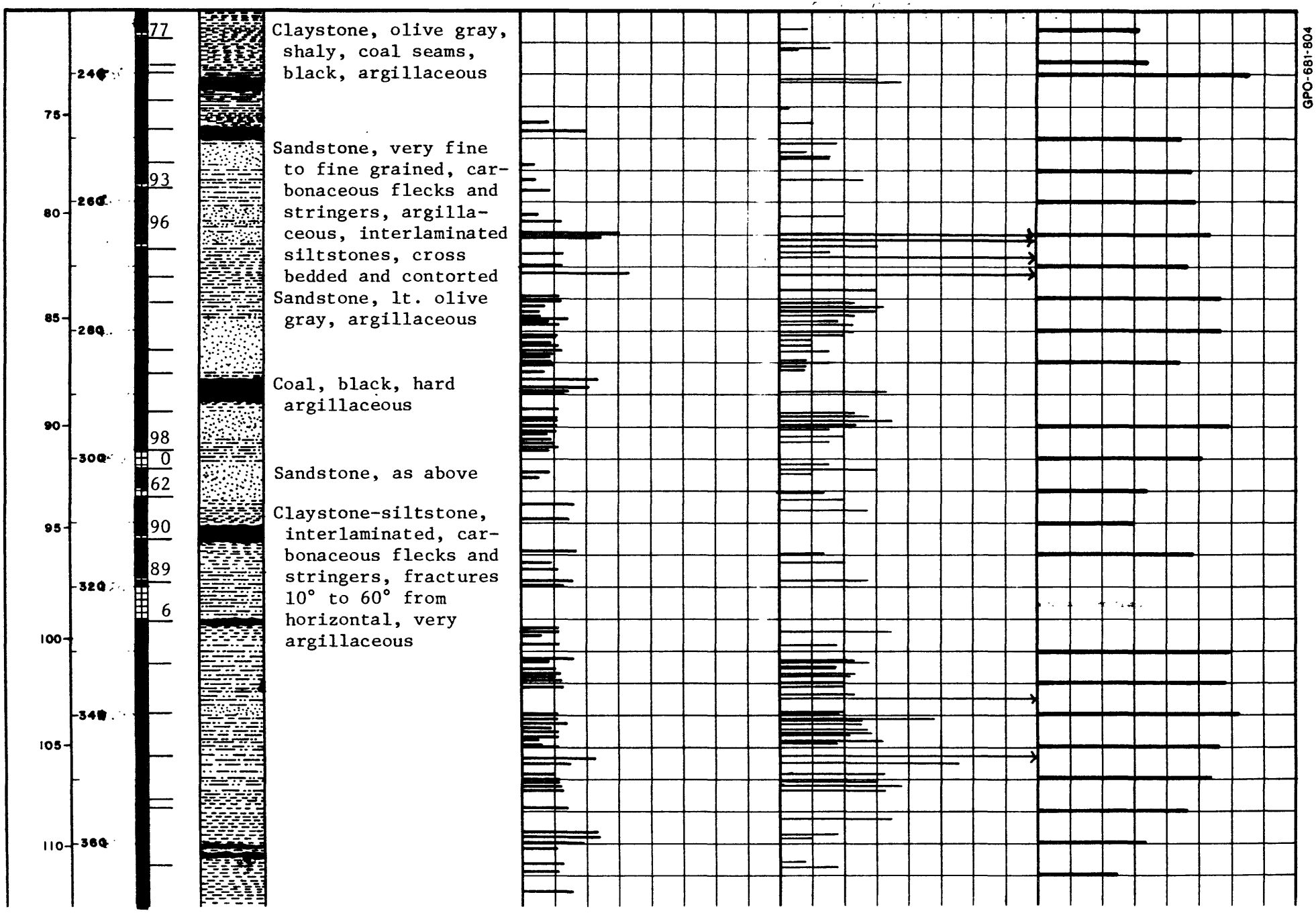
U.S. GEOLOGICAL SURVEY
ENGINEERING GEOLOGY BRANCH

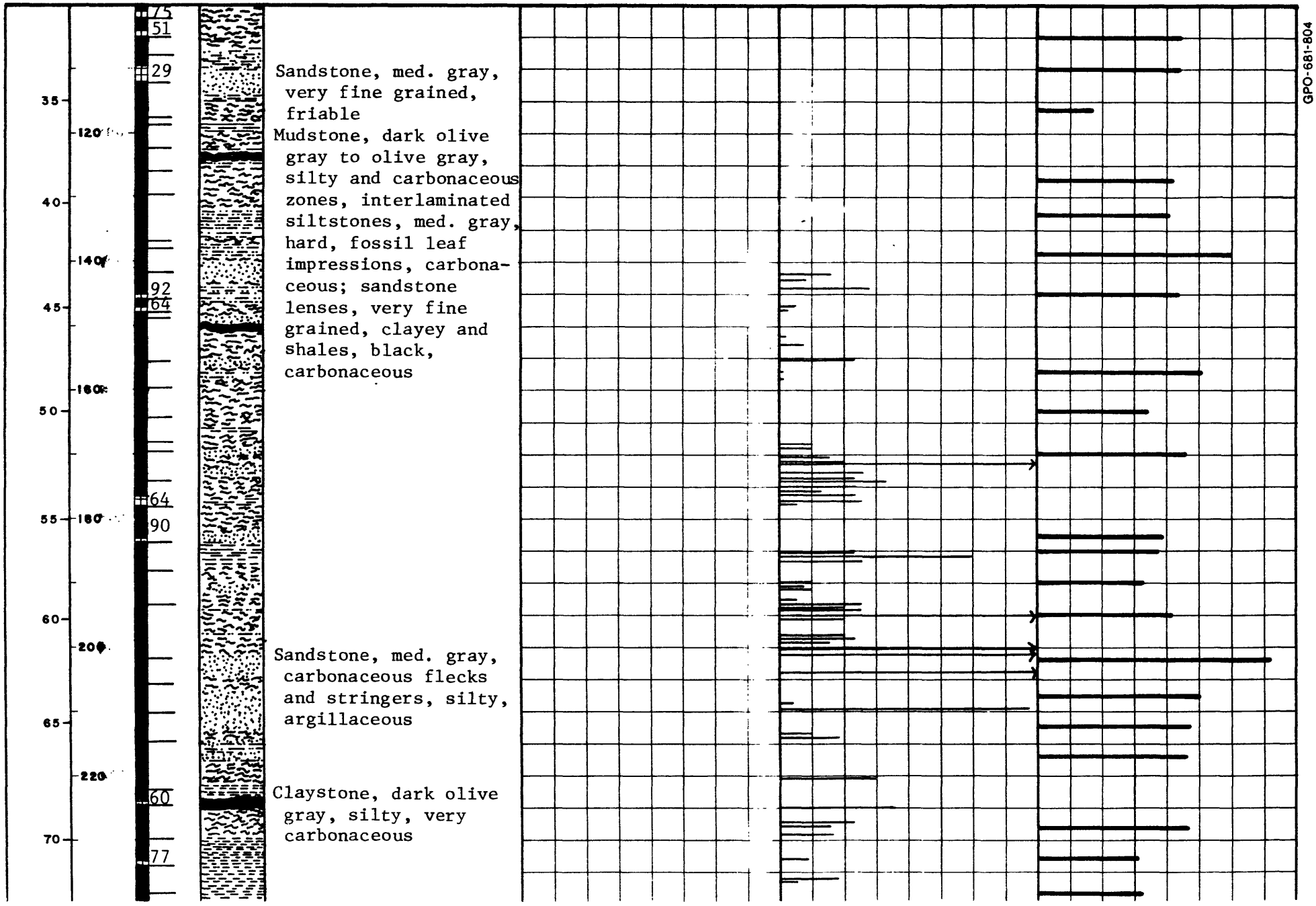
DRILL HOLE Composite S-1, S-2, S-2a

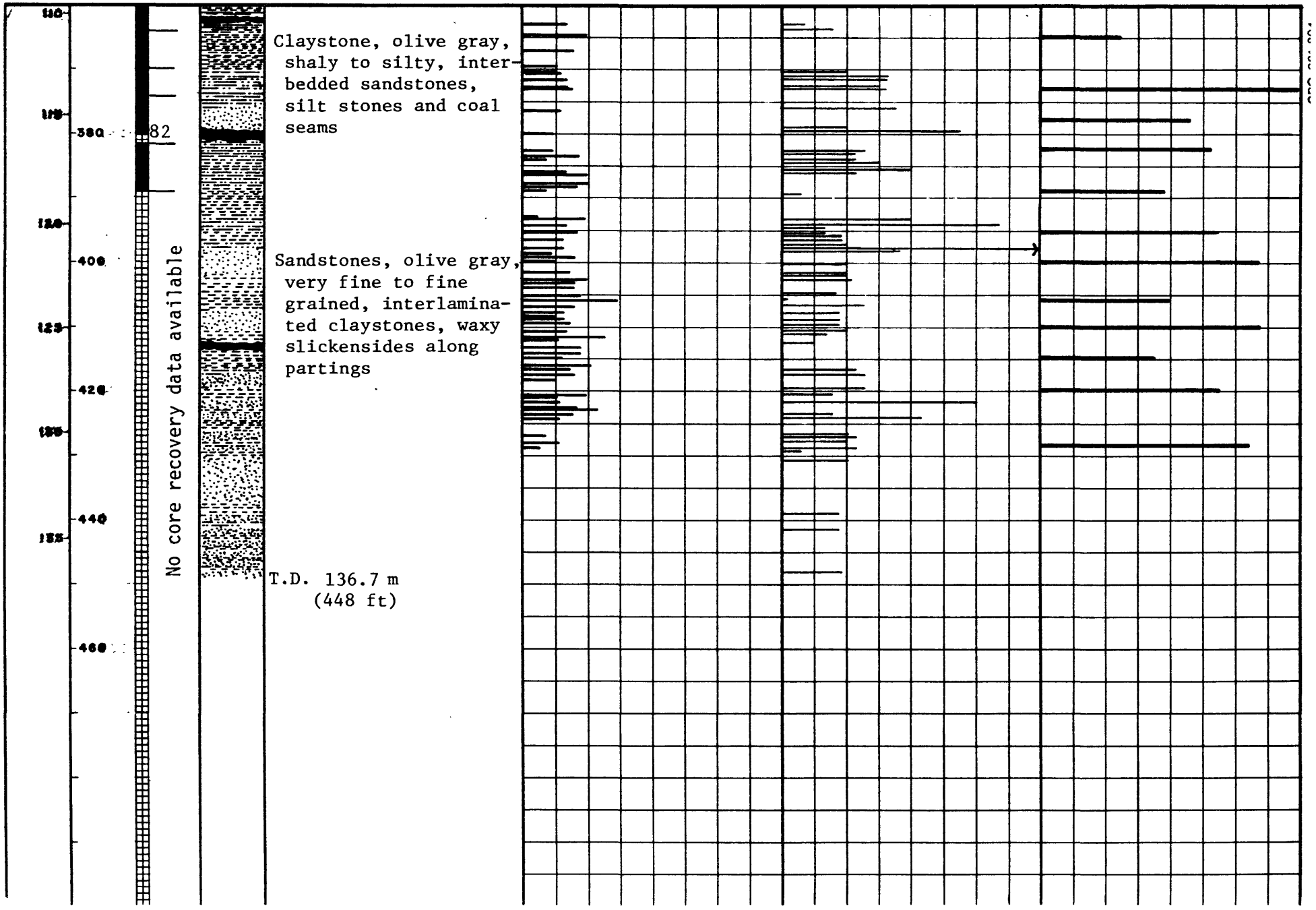
COUNTY Sheridan STATE Wyoming ELEVATION 1,137 m
LOCATION NW 1/4, SE 1/4, sec. 23, T. 56 N., R. 84 W. 3,730 ft(est.)

GPO-681-804




77
93
96
98
0
62
90
89
6
Claystone, olive gray, shaly, coal seams, black, argillaceous
Sandstone, very fine to fine grained, carbonaceous flecks and stringers, argillaceous, interlaminated siltstones, cross bedded and contorted
Sandstone, lt. olive gray, argillaceous
Coal, black, hard argillaceous
Sandstone, as above
Claystone-siltstone, interlaminated, carbonaceous flecks and stringers, fractures 10° to 60° from horizontal, very argillaceous
GPO-681-804

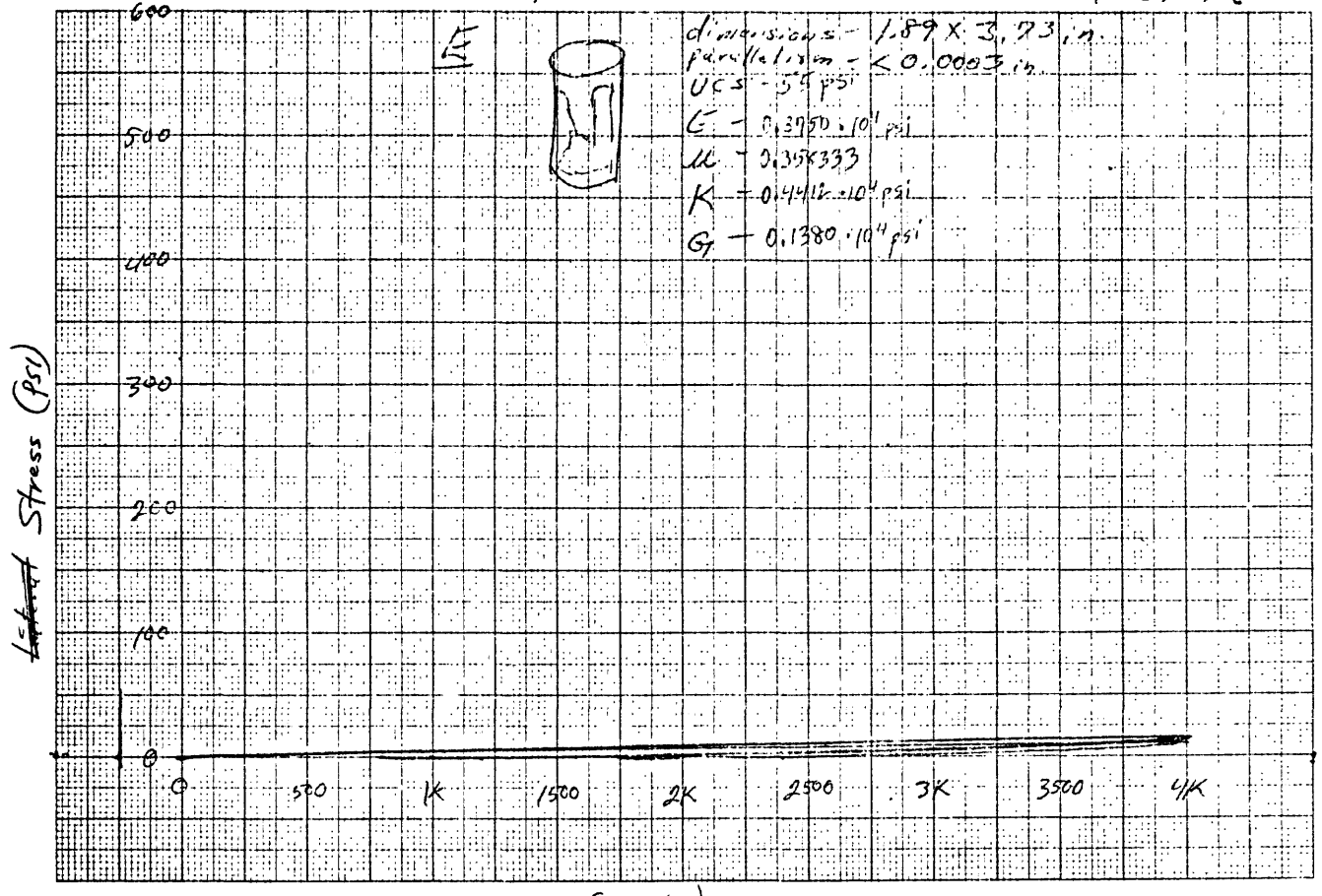

75
51
29
35
120
40
140
92
64
45
160
50
64
55
180
90
60
200
65
220
60
70
77
Sandstone, med. gray, very fine grained, friable
Mudstone, dark olive gray to olive gray, silty and carbonaceous zones, interlaminated siltstones, med. gray, hard, fossil leaf impressions, carbonaceous; sandstone lenses, very fine grained, clayey and shales, black, carbonaceous
Sandstone, med. gray, carbonaceous flecks and stringers, silty, argillaceous
Claystone, dark olive gray, silty, very carbonaceous
GPO-681-804


Claystone, olive gray, shaly to silty, interbedded sandstones, silt stones and coal seams
Sandstones, olive gray, very fine to fine grained, interlaminated claystones, waxy slickensides along partings
T.D. 136.7 m
(448 ft)
No core recovery data available
82

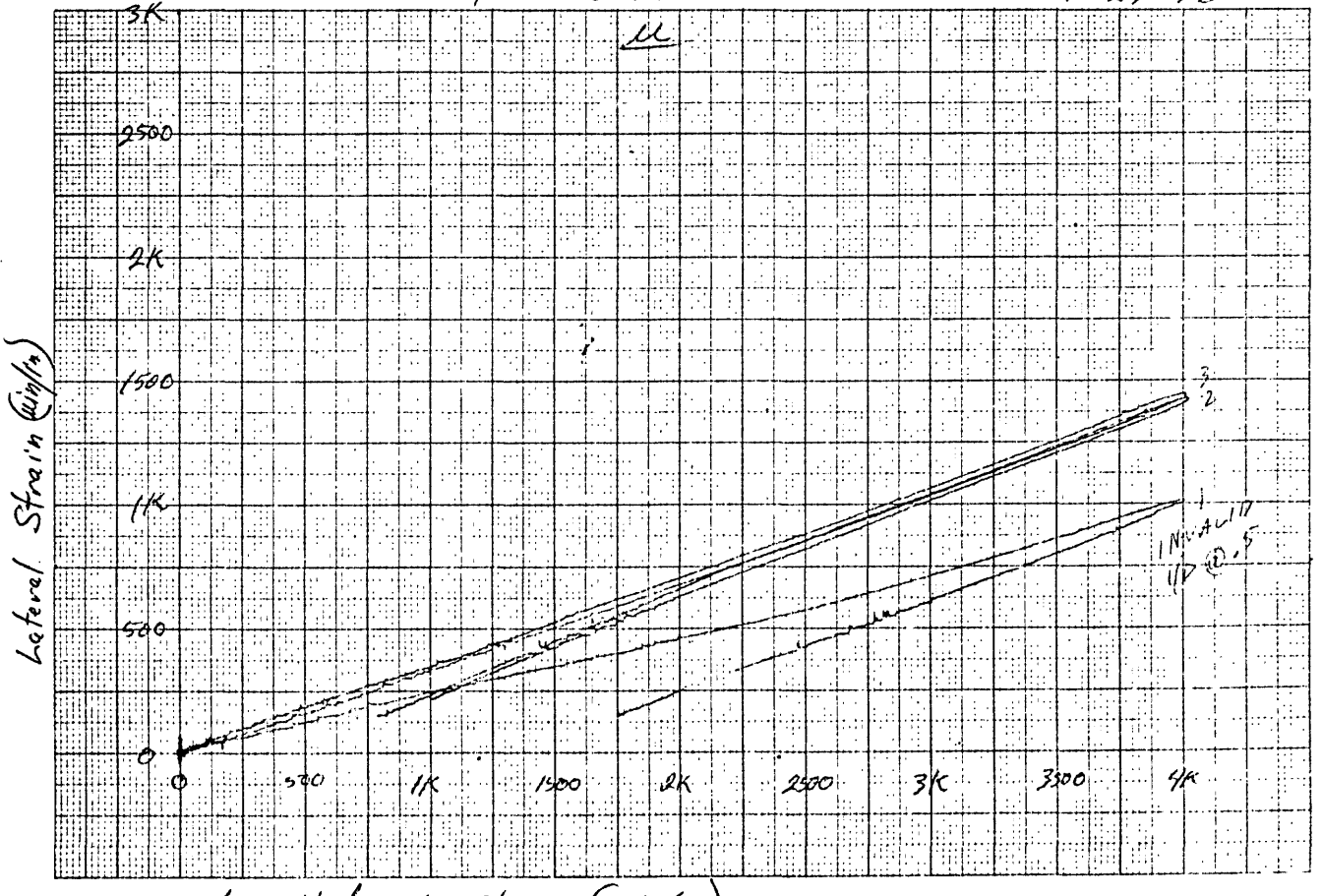
APPENDIX D

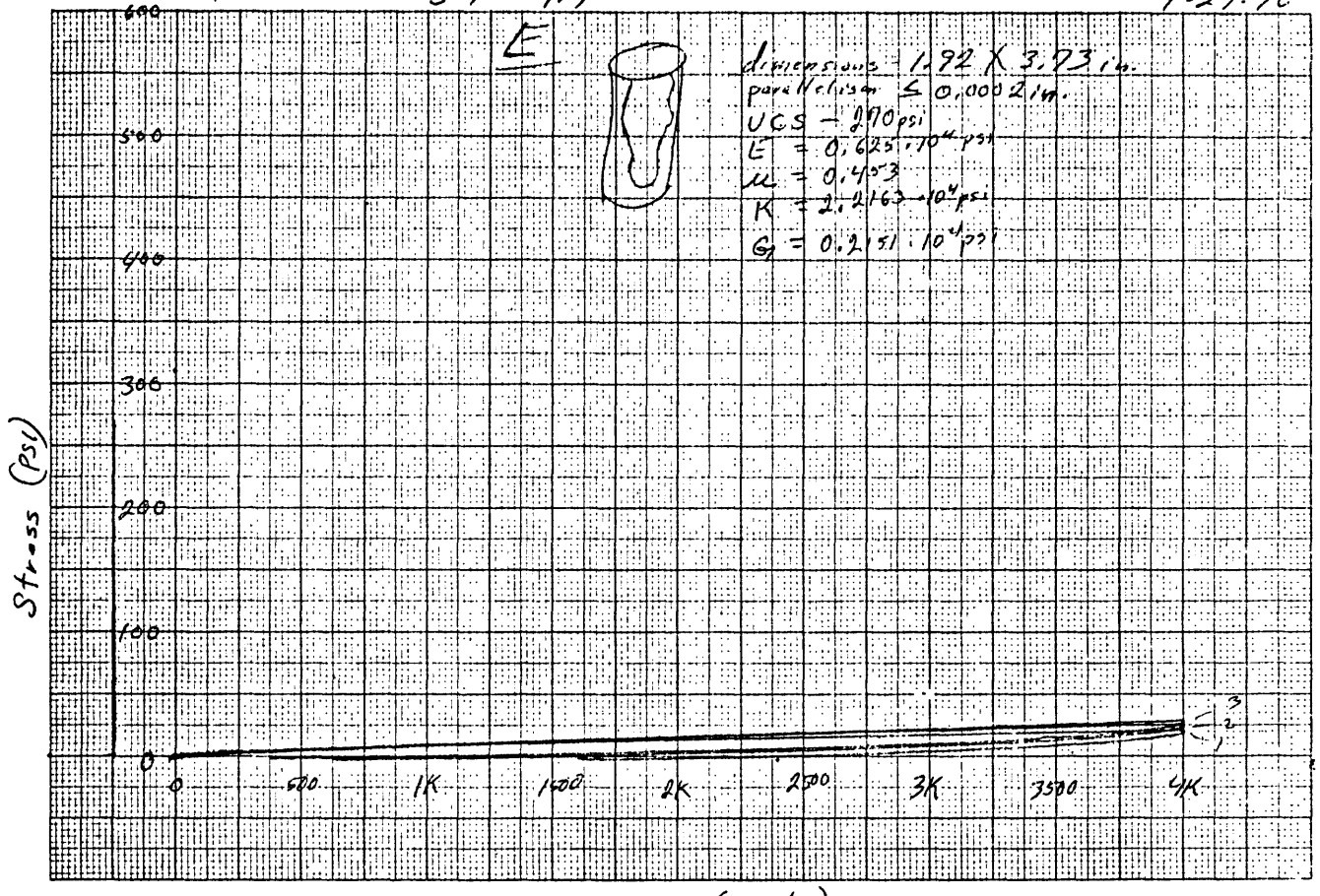
Laboratory test results: size analysis, Atterberg limits, moisture density, particle-size curves, summary of static test results, stress-strain curves, and ultrasonic test results

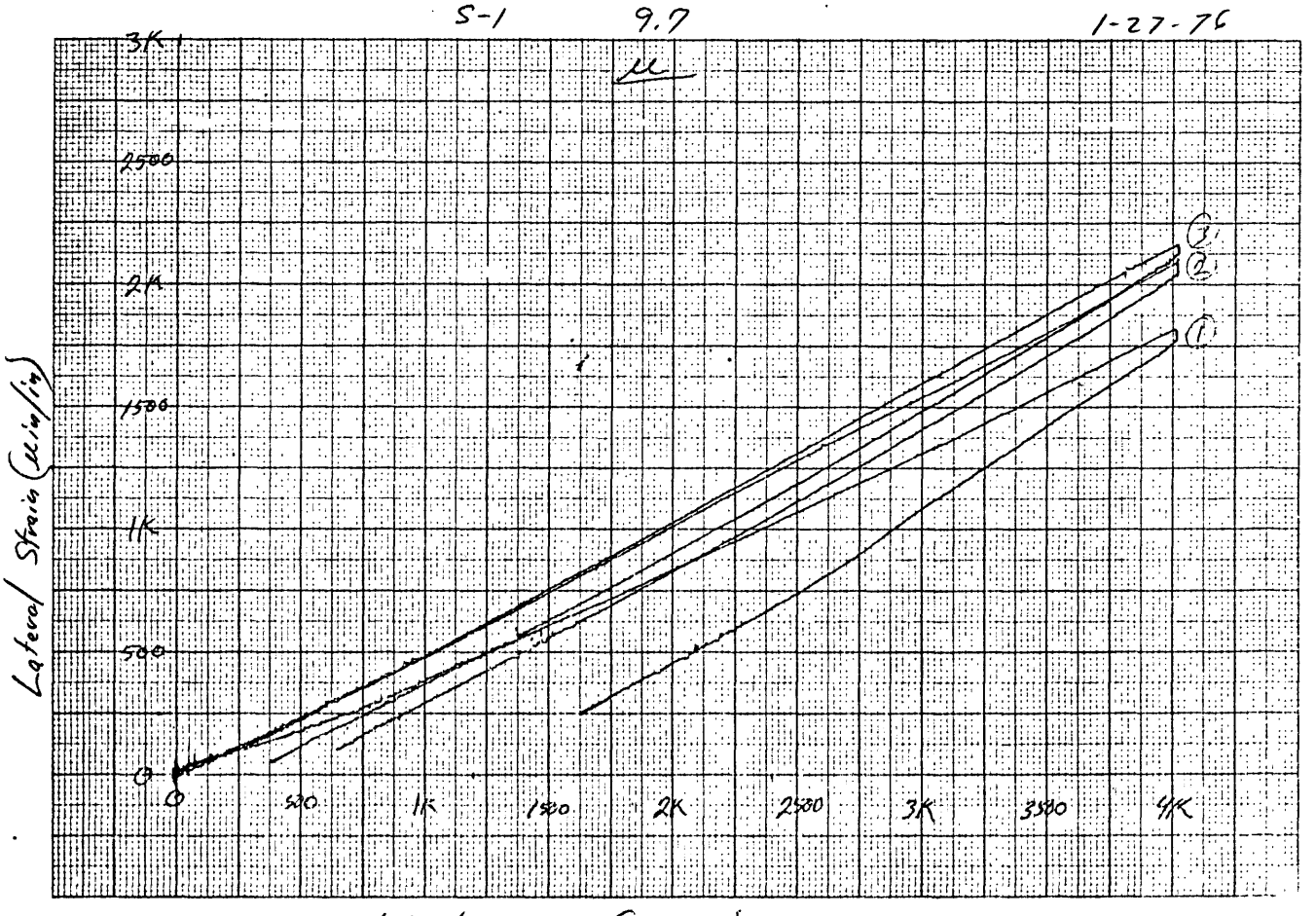
S-1 8.90 1-27-76

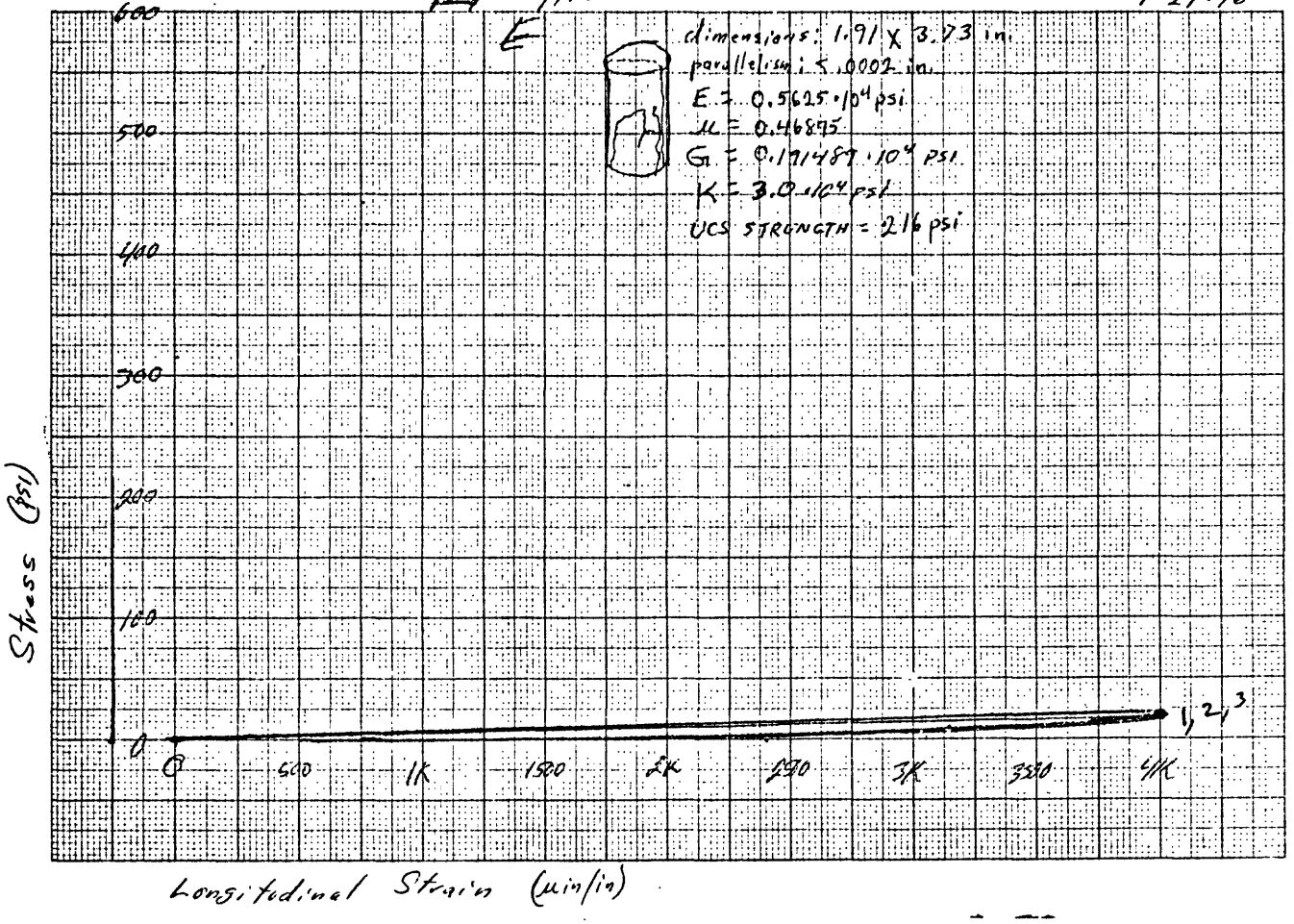


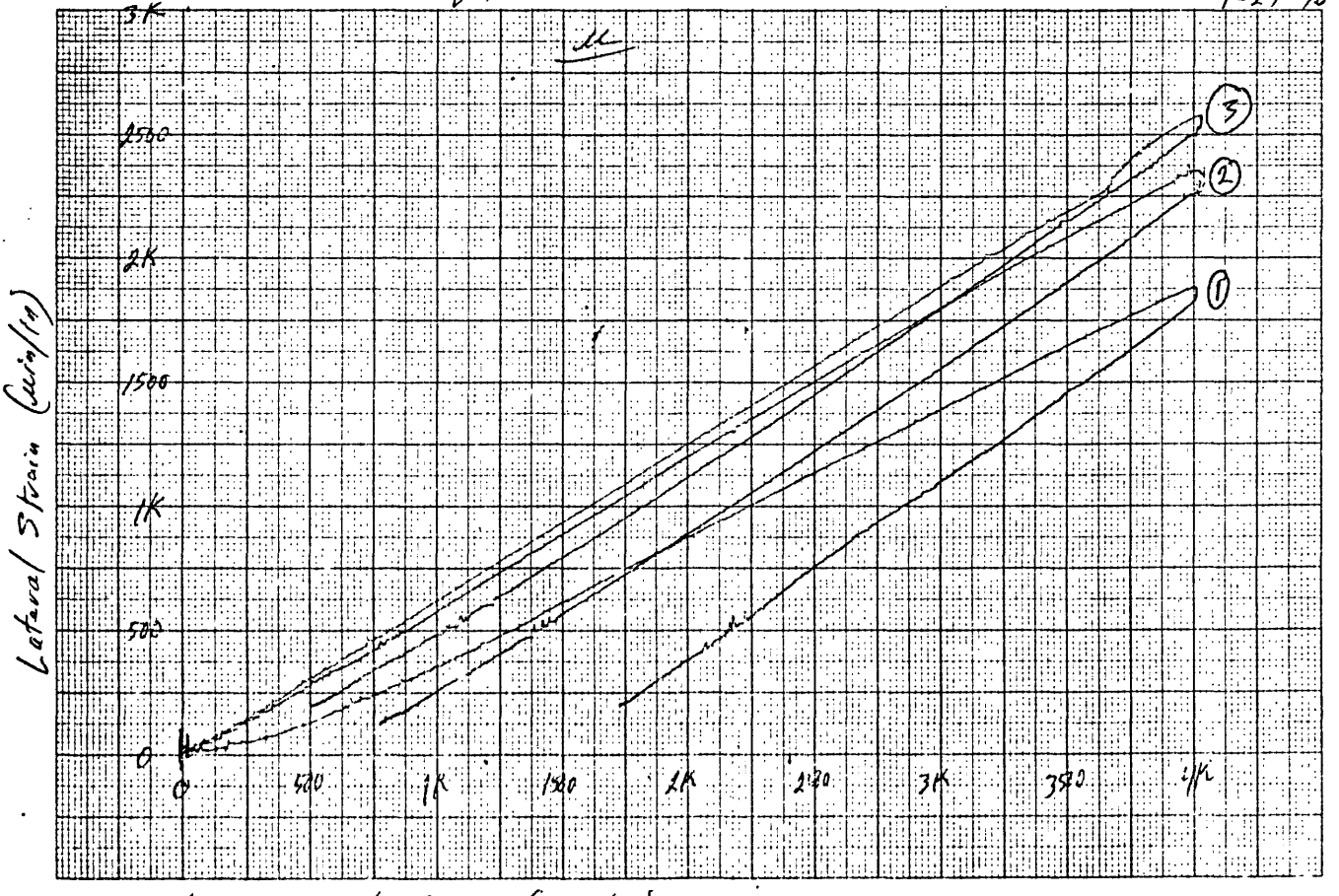
S-1 8.90 1-27-76




E
dimensions: 1.92 X 3.93 in.
parallelism ≤ 0.0002 in.
UCS = 2170 psi
E = 0.625 · 10^4 psi
μ = 0.453
K = 2.2163 · 10^4 psi
G = 0.2151 · 10^4 psi
Stress (psi)
600
500
400
300
200
100
0
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin/in.)


S-1 9.7 1-27-76
μ
Lateral Strain (μin/in)
3K
2500
2K
1500
1K
500
0
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin/in)


dimensions: 1.91 X 3.73 in.
parallelism ≤ .0002 in.
E = 0.5625 · 10⁴ psi
μ = 0.46875
G = 0.191487 · 10⁴ psi
K = 3.0 · 10⁴ psi
UCS STRENGTH = 216 psi
Stress (psi)
600
500
400
300
200
100
0
0
500
1K
1500
2K
2500
3K
3500
4K
1, 2, 3
Longitudinal Strain (μin/in)


μ
Lateral Strain (μin/in)
3K
2500
2K
1500
1K
500
0
0
500
1K
1500
2K
2500
3K
3500
4K
3
2
1
Longitudinal Strain (μin/in)

S-1 11.10 1-28-76

E

Dimensions - 1.91 X 3.72 in.
Parallel. sm - < 0.01 in.
UCS - 50 psi
E - $0.3125 \cdot 10^4$ psi
μ - 0.40
K - $0.5208 \cdot 10^4$ psi
G - $0.1116 \cdot 10^4$ psi

Stress (psi)

600
500
400
300
200
100
0

3,3

0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in)

S-1 11.10 1-28-76

4

Lateral Strain (μin/in.)

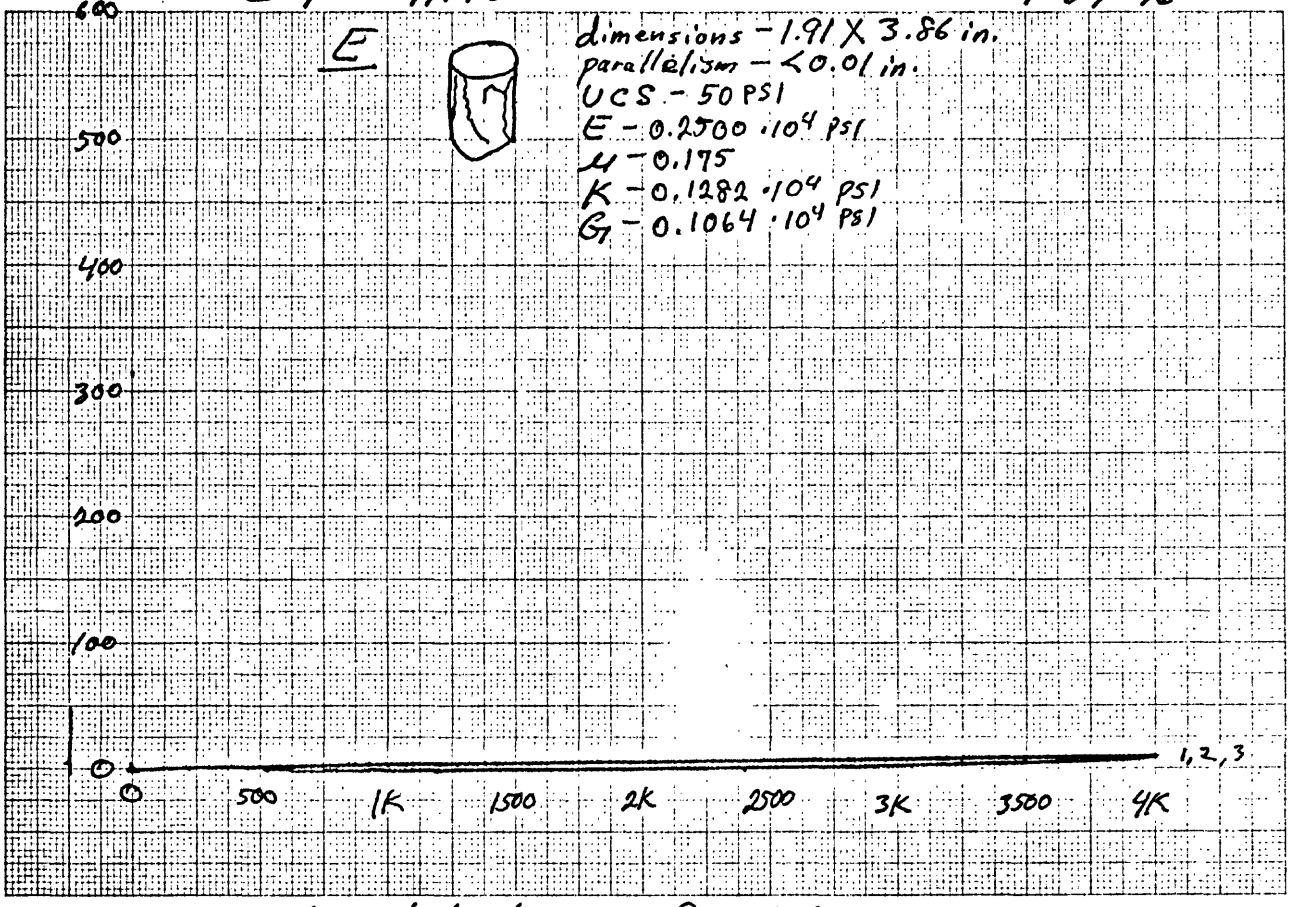
3K
2500
2K
1500
1K
500
0

1
2
3

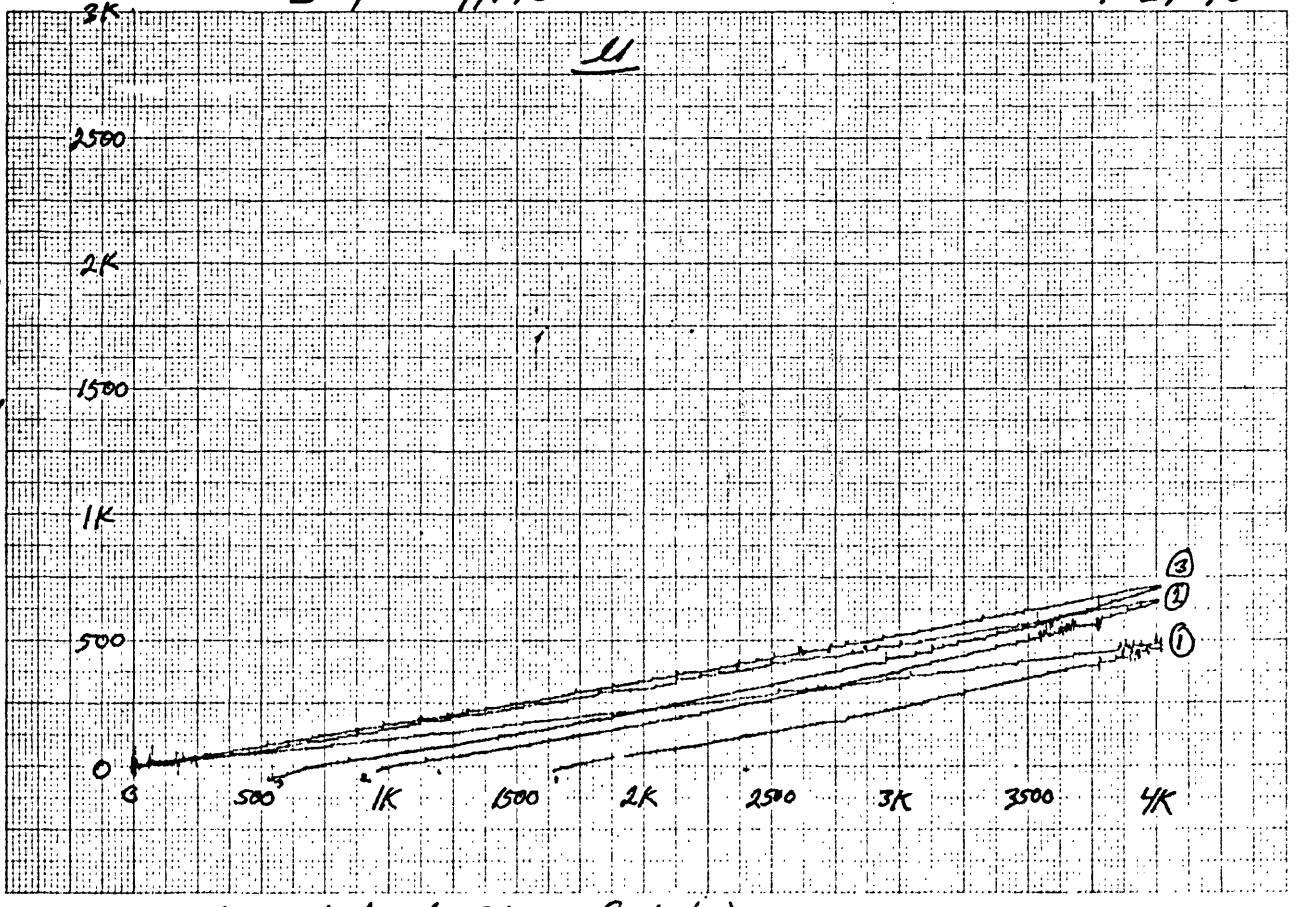
0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in.)

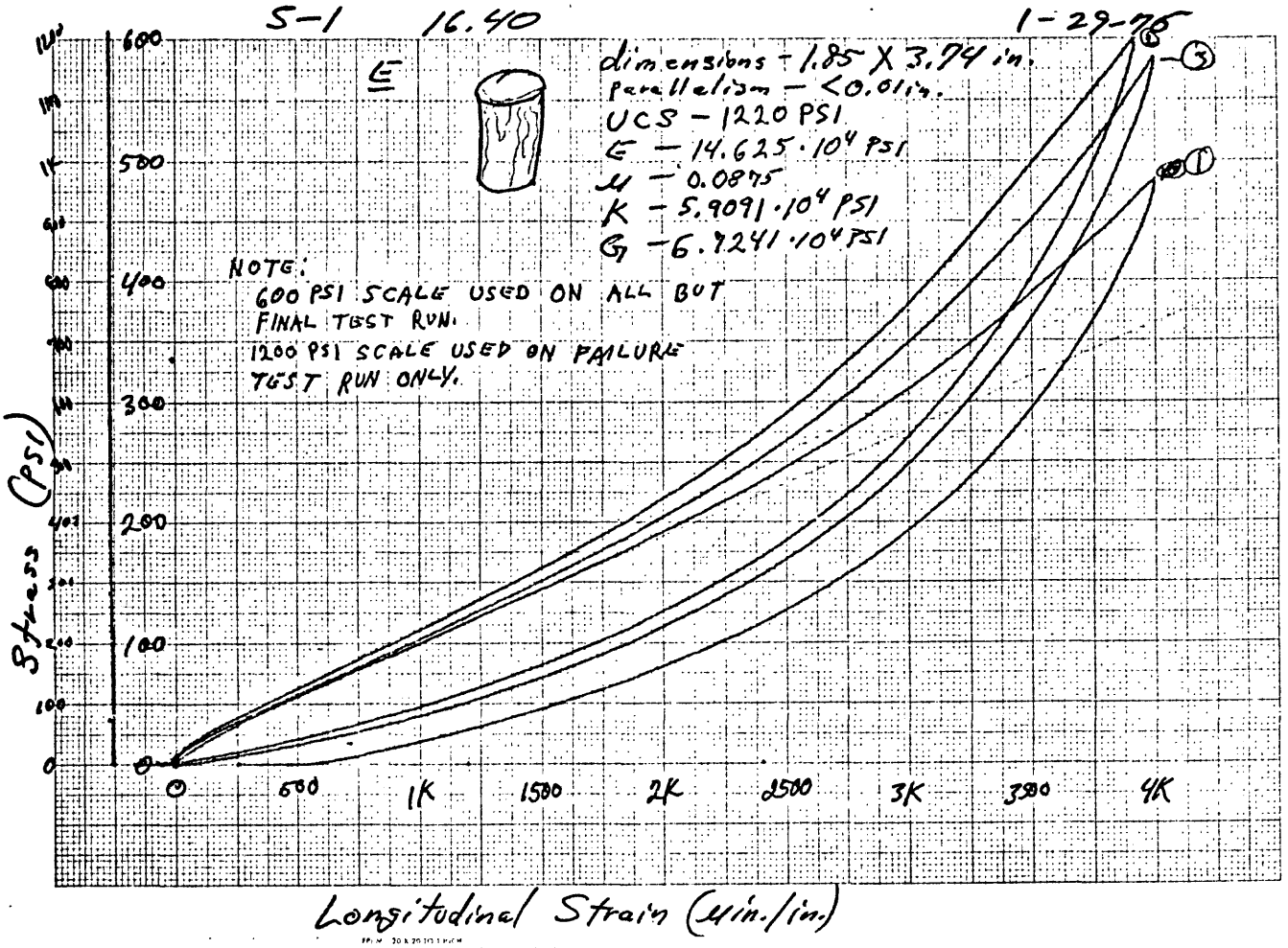
S-1 11.40 1-29-76



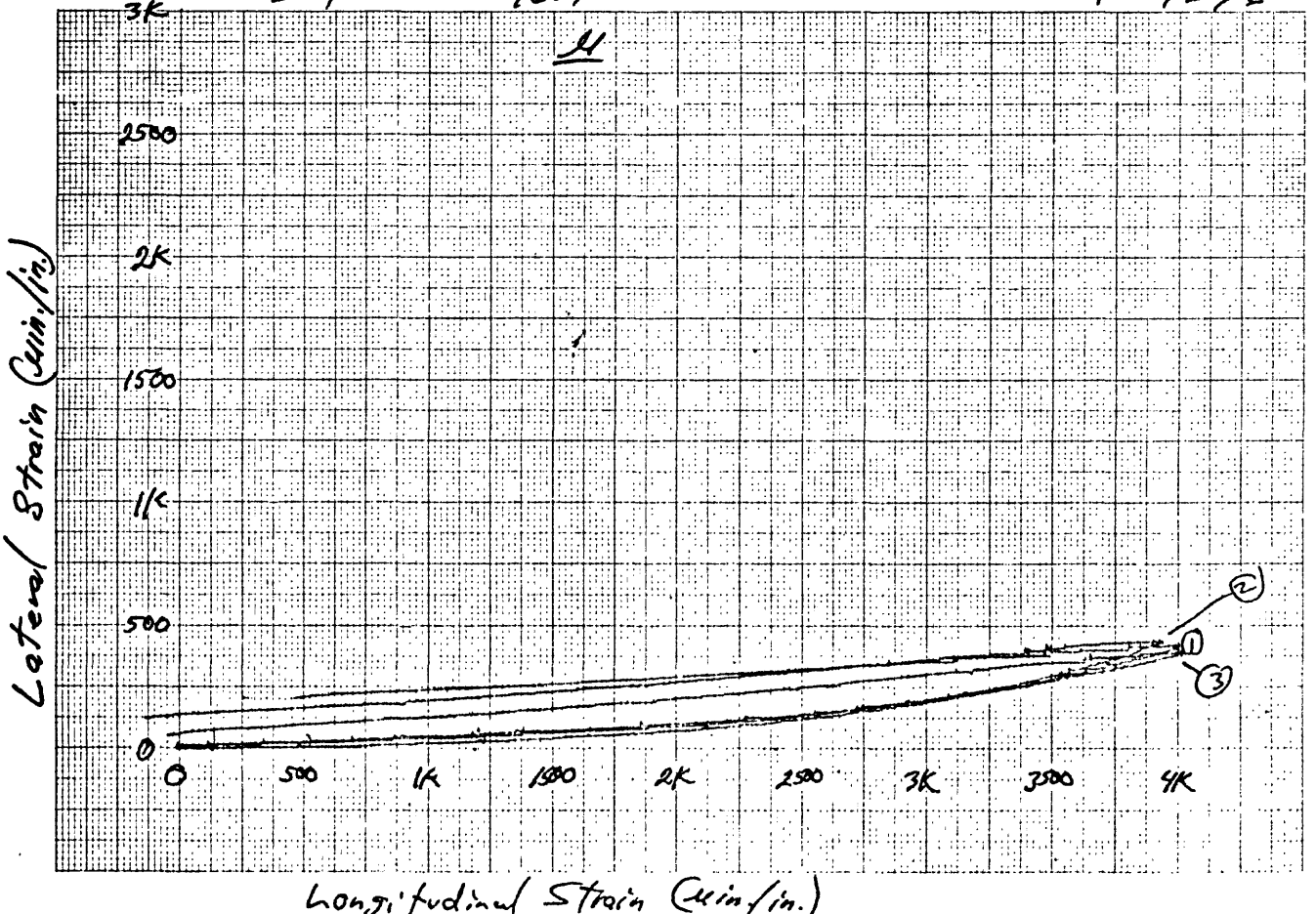
S-1 11.40 1-29-76



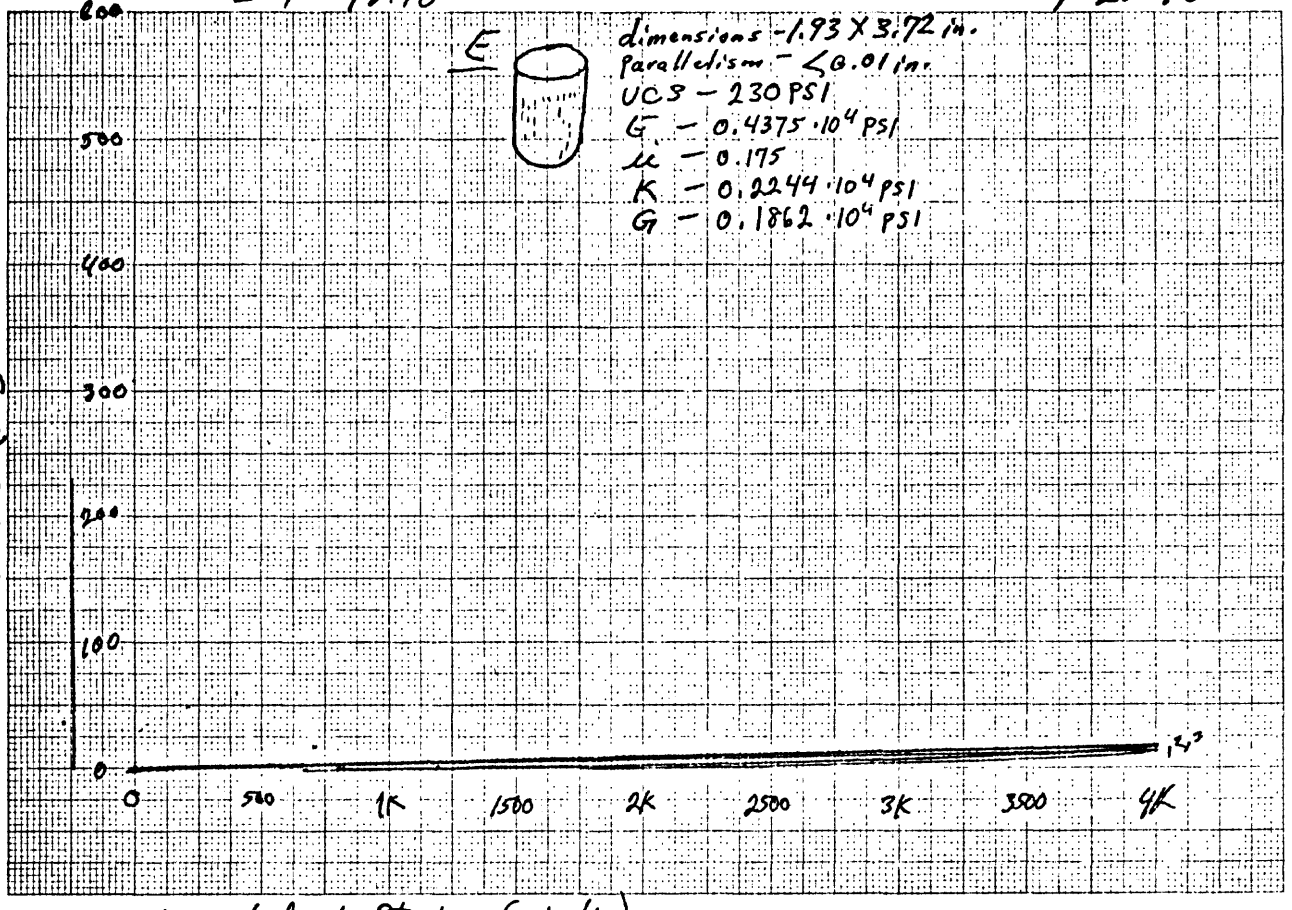
S-1 16.40 1-29-75



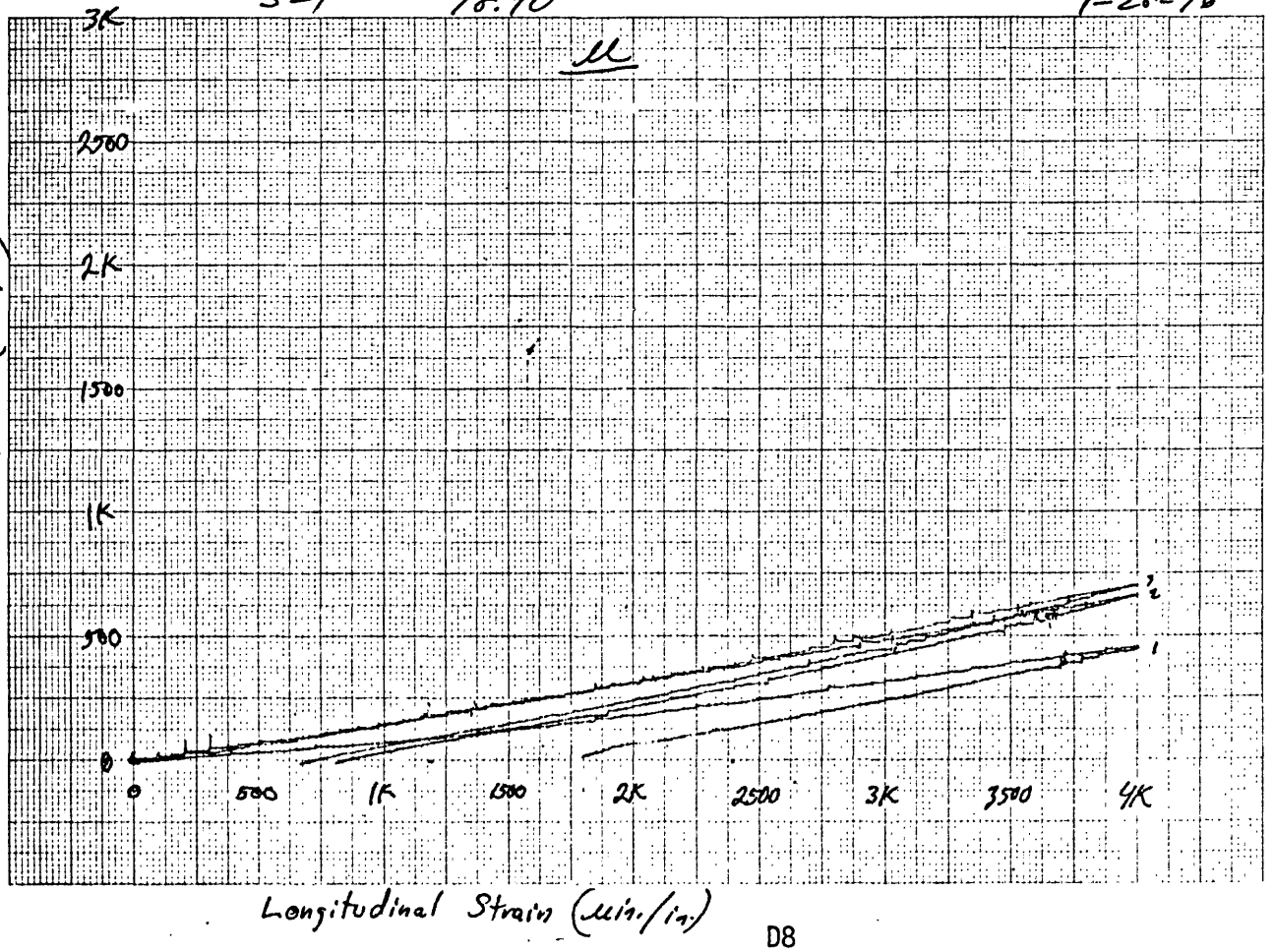
S-1 16.40 1-29-75



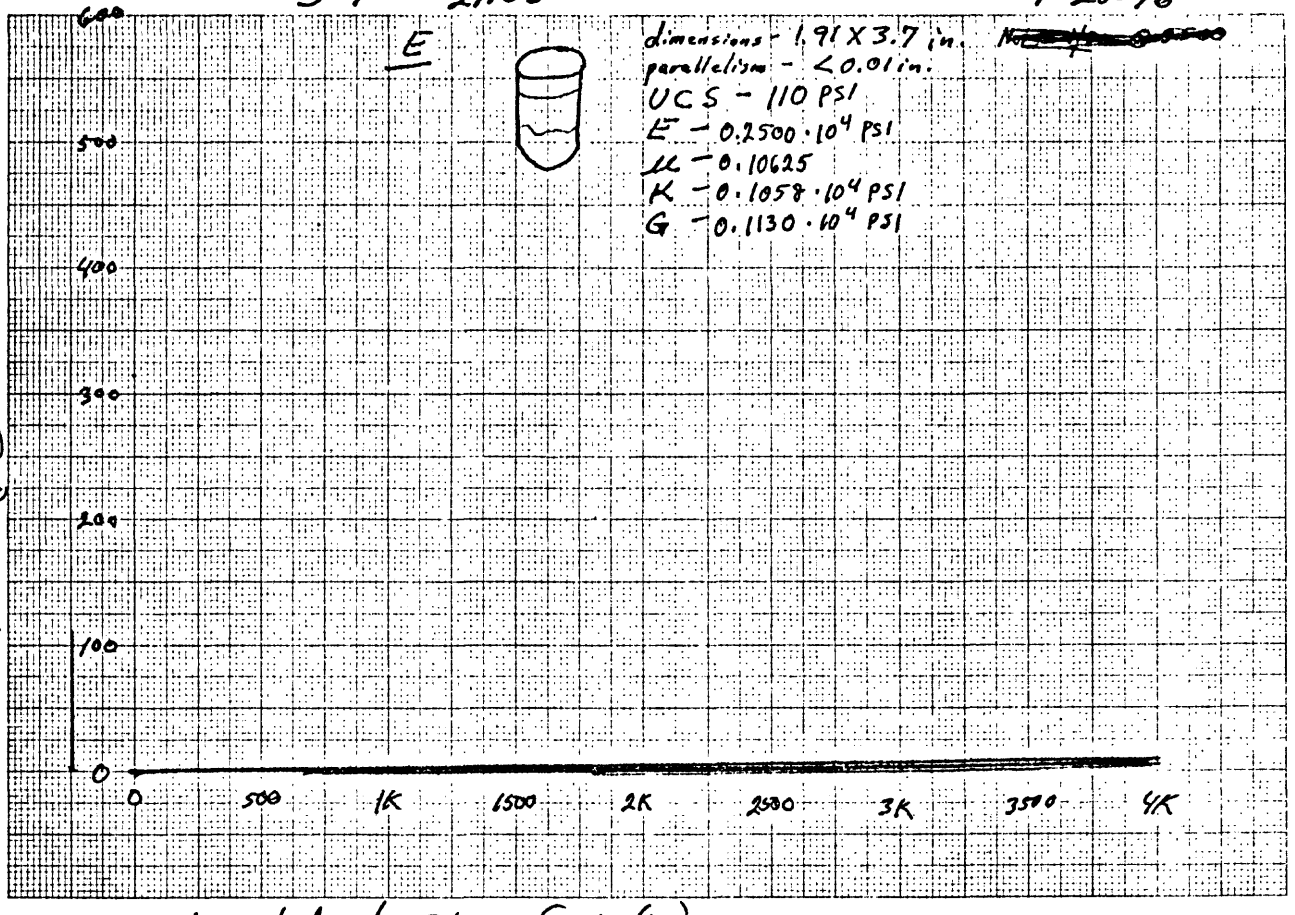
S-1 18.90 1-28-76



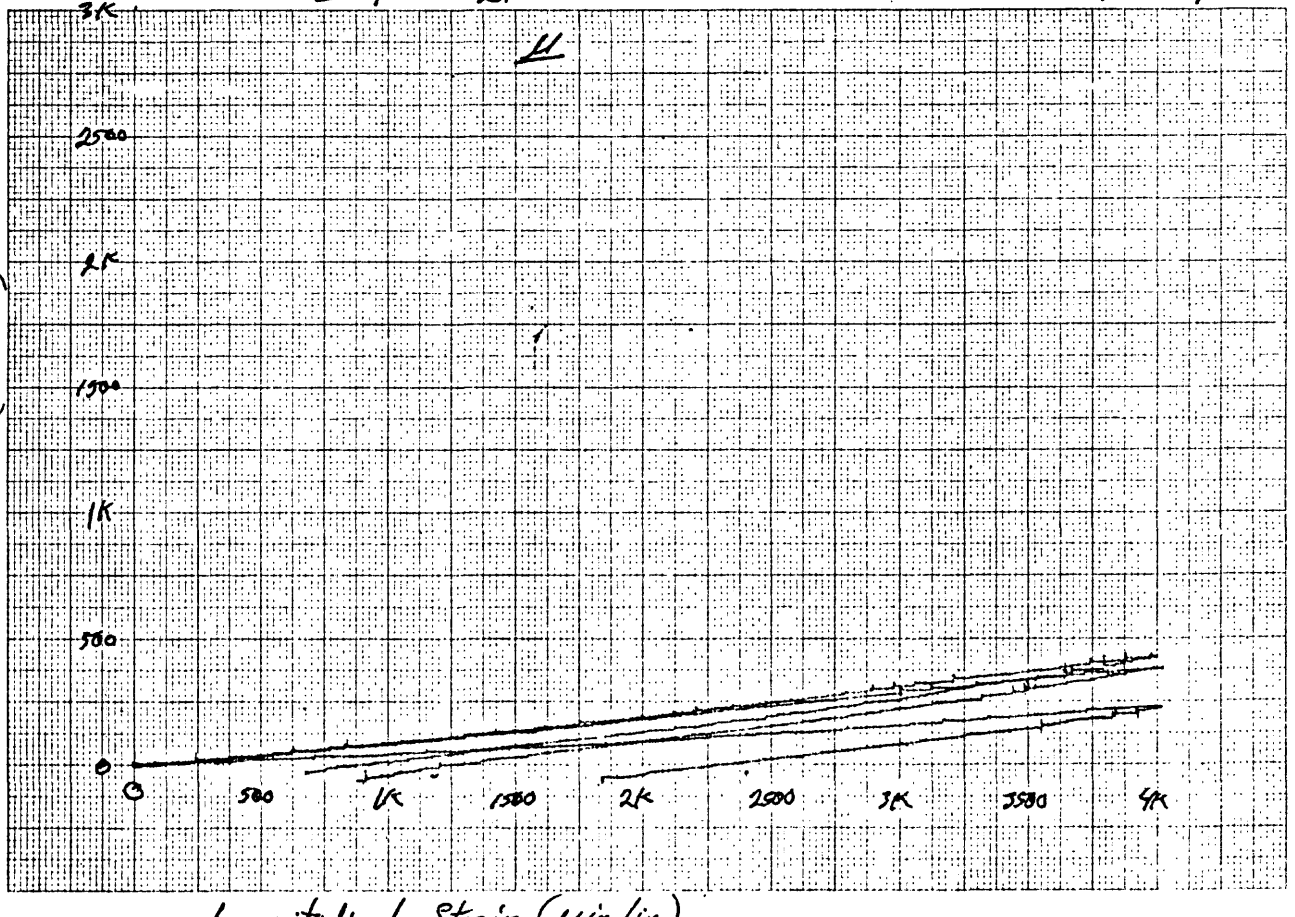
S-1 18.90 1-28-76

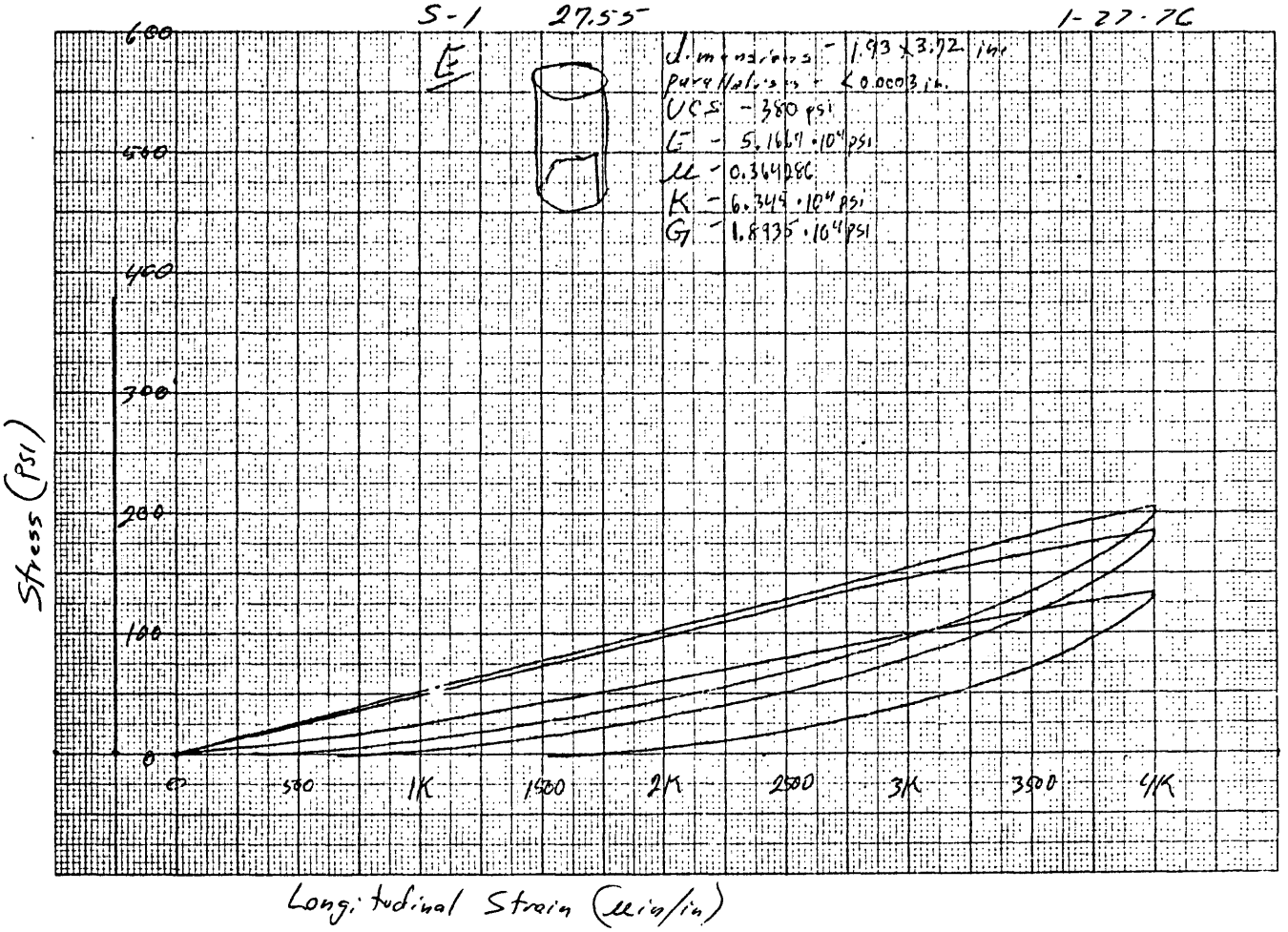


S-1 21.05" 1-28-76

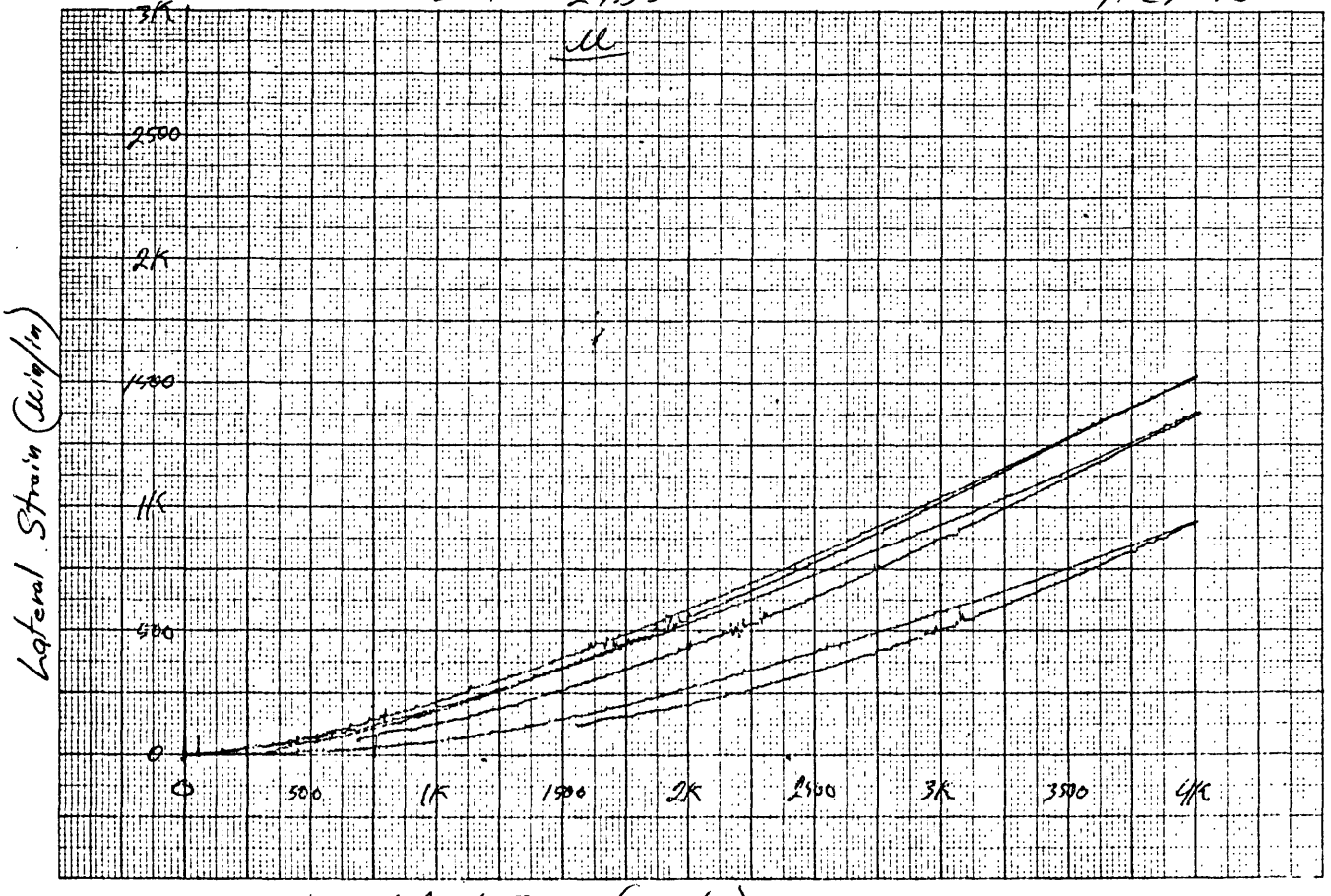


S-1 21.05" 1-28-76

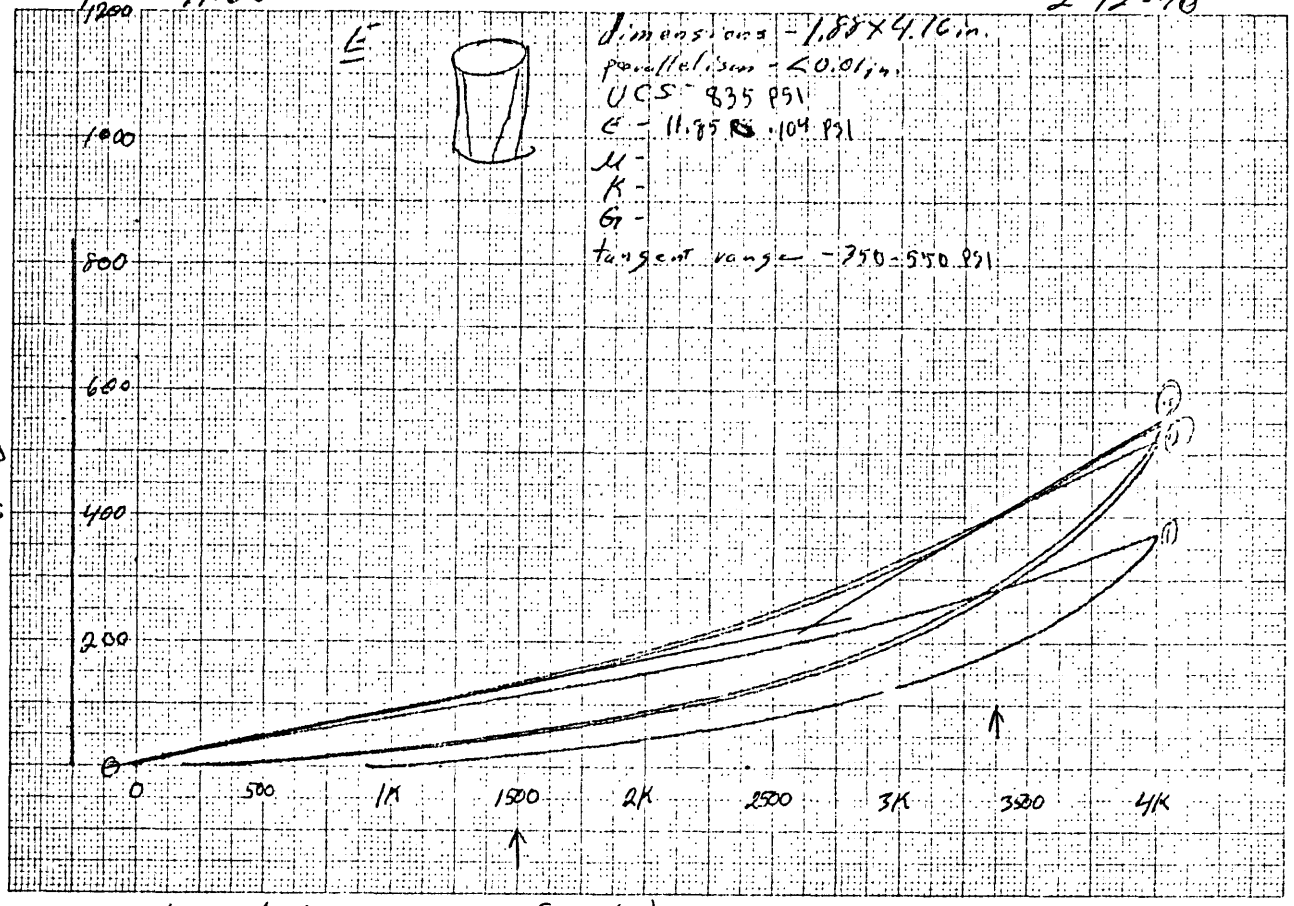




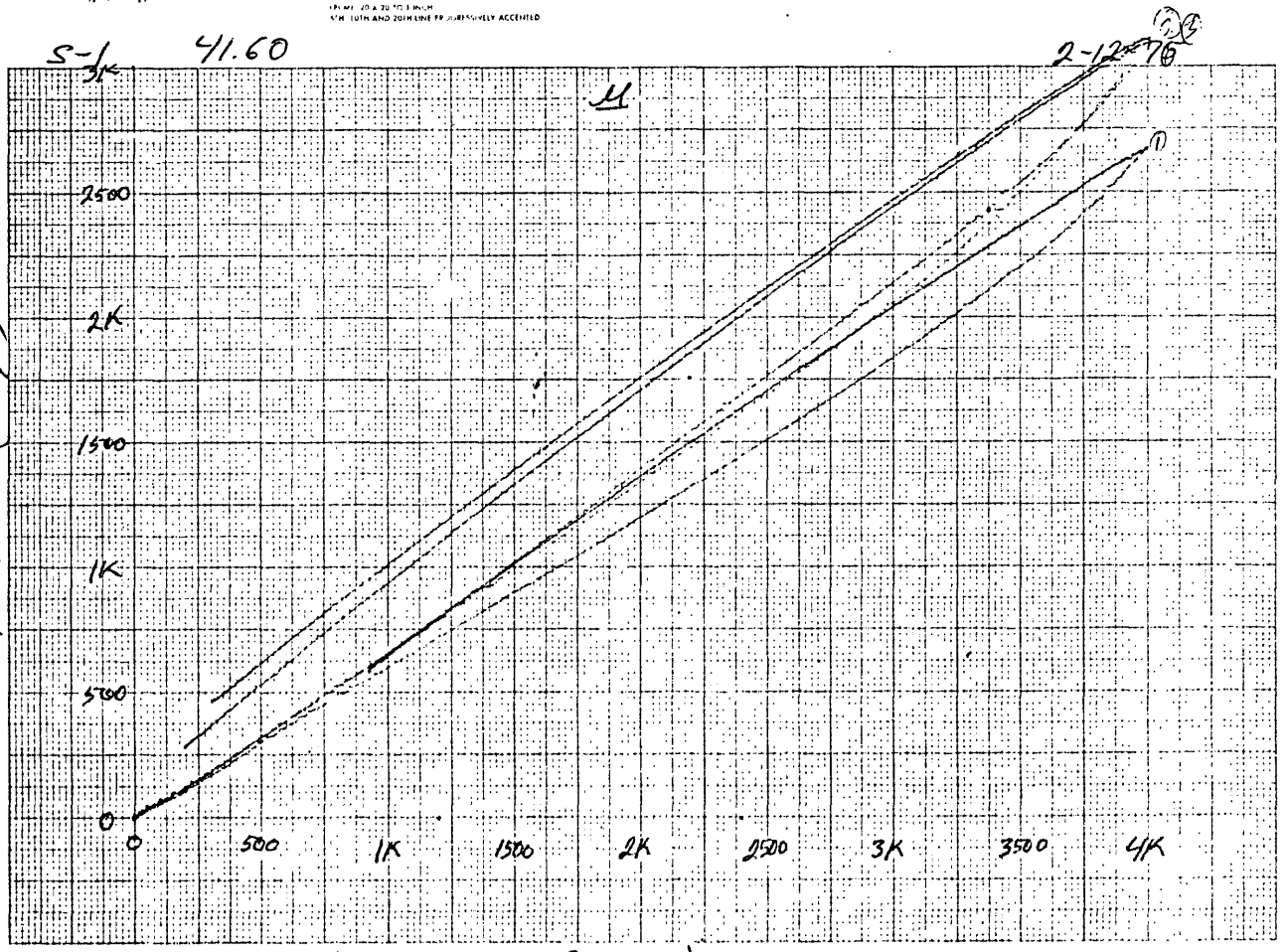
S-1 27.55 1-27-76

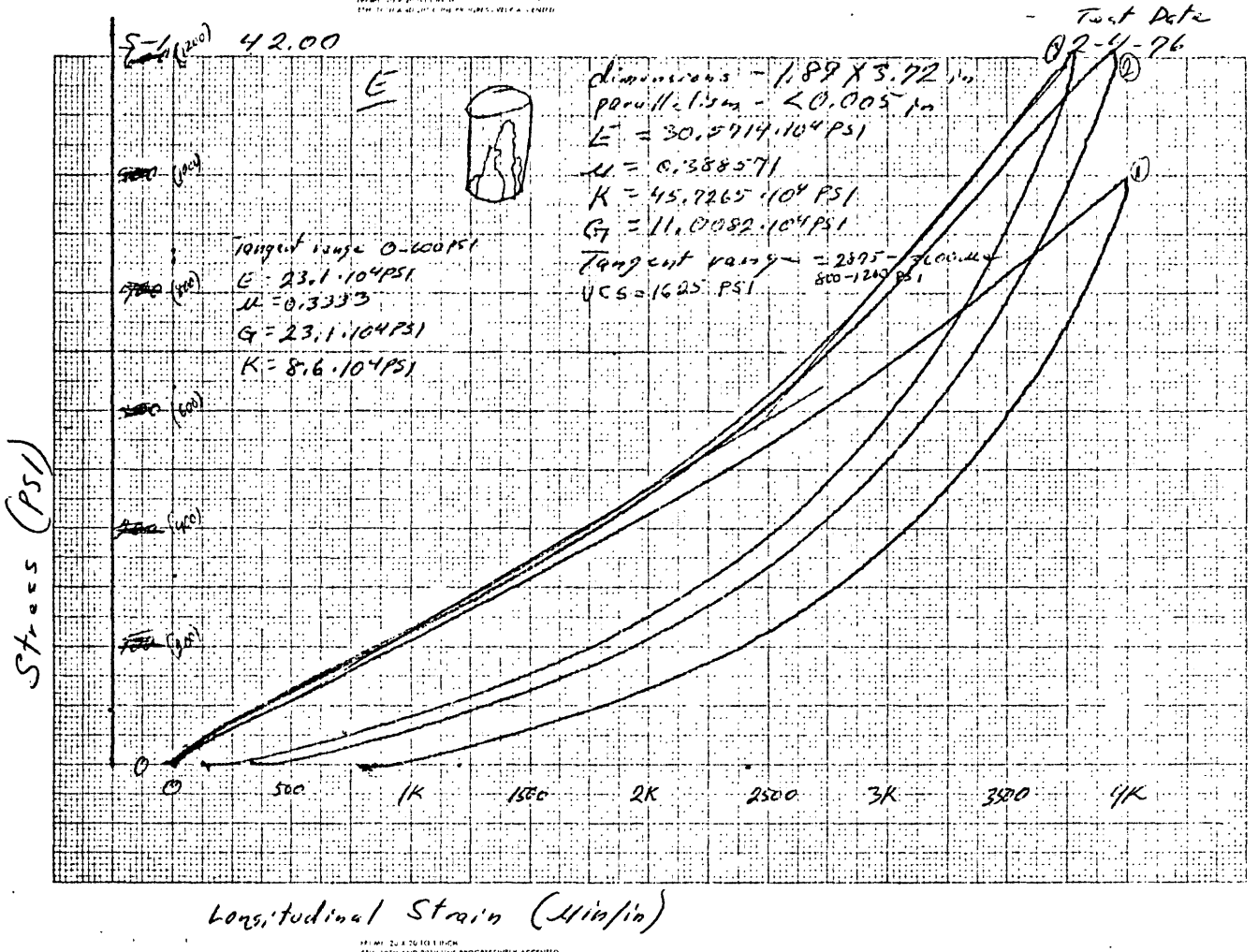


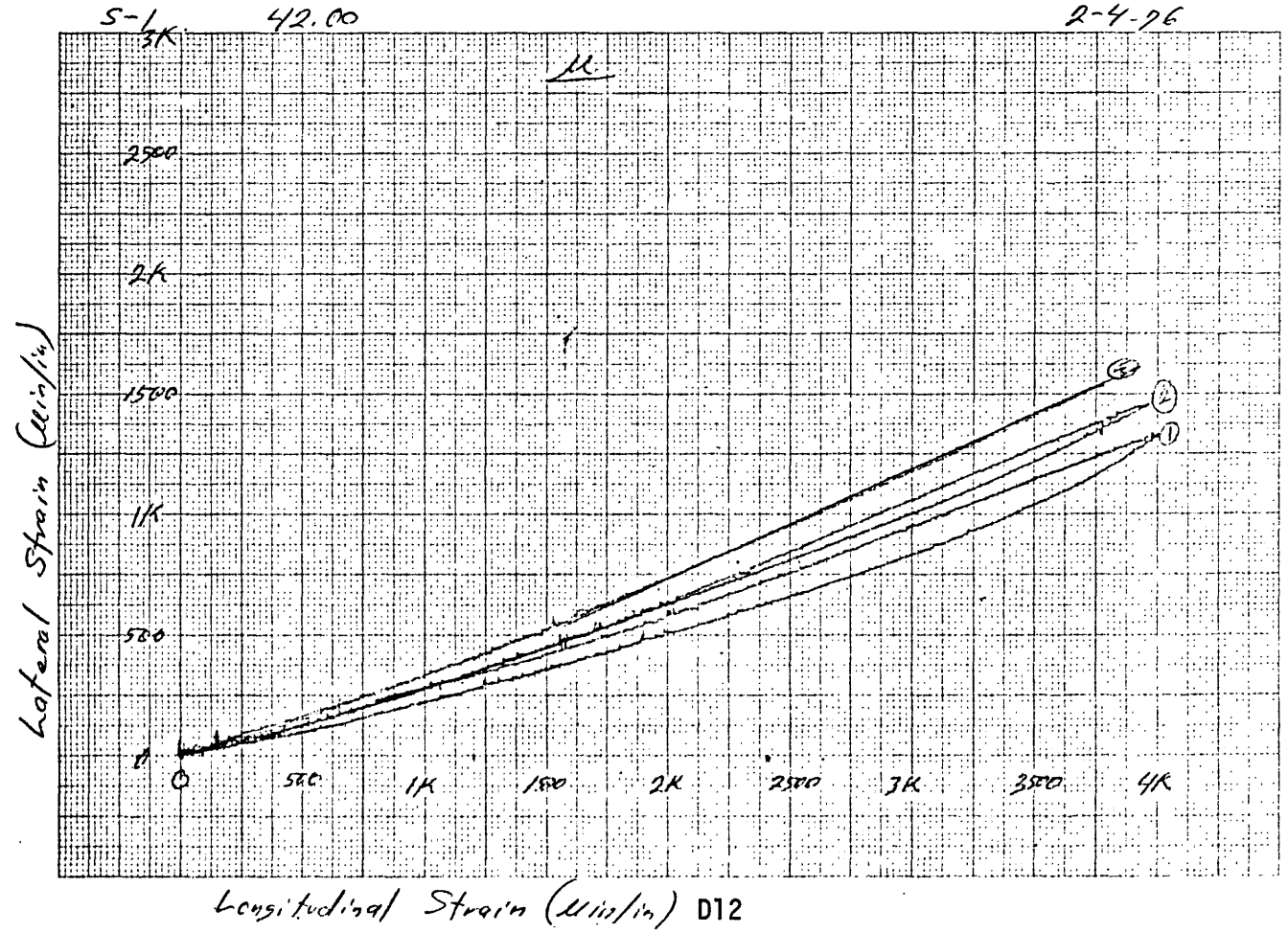
S-1 41.60 2-12-76



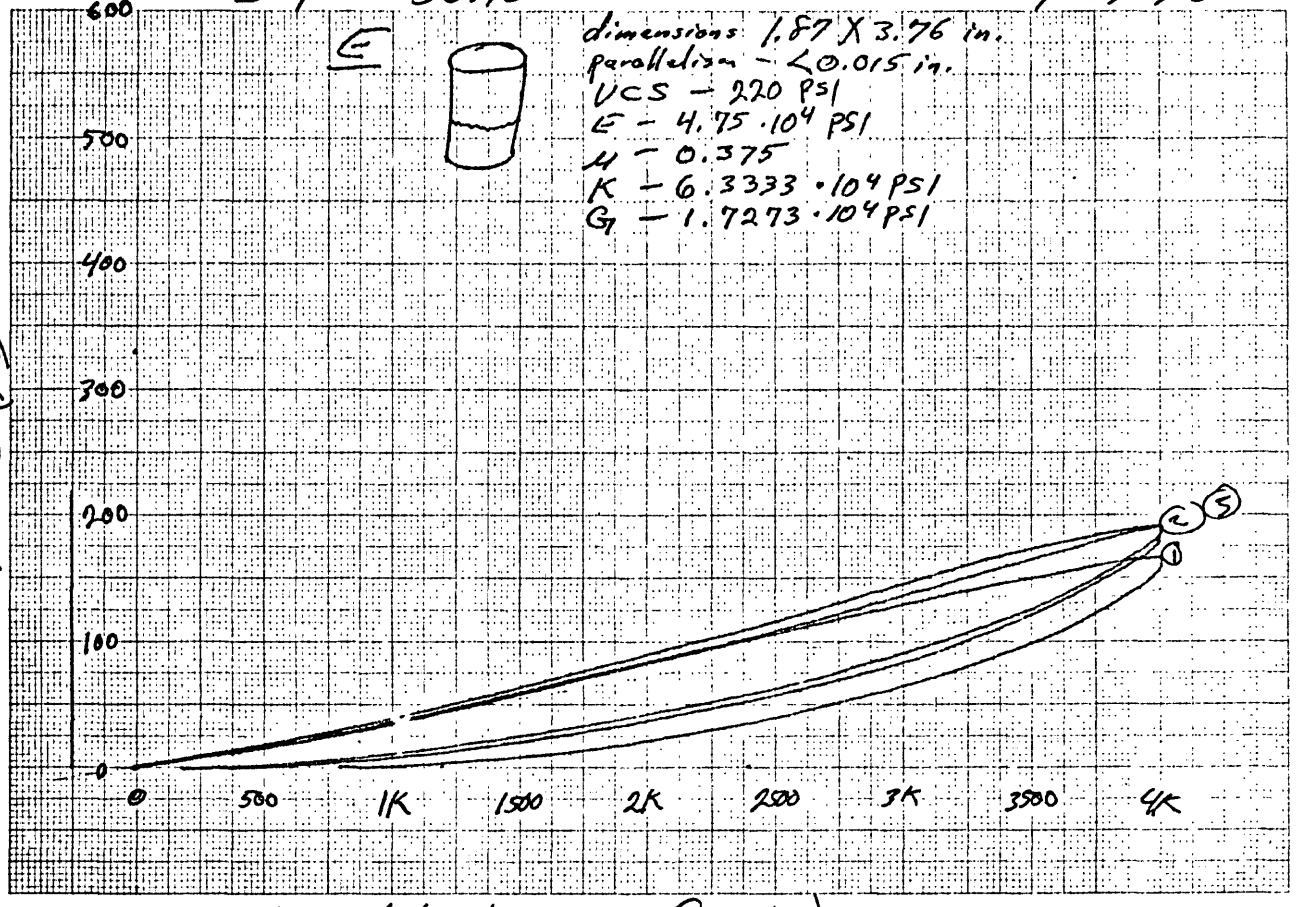
S-1 41.60 2-12-76



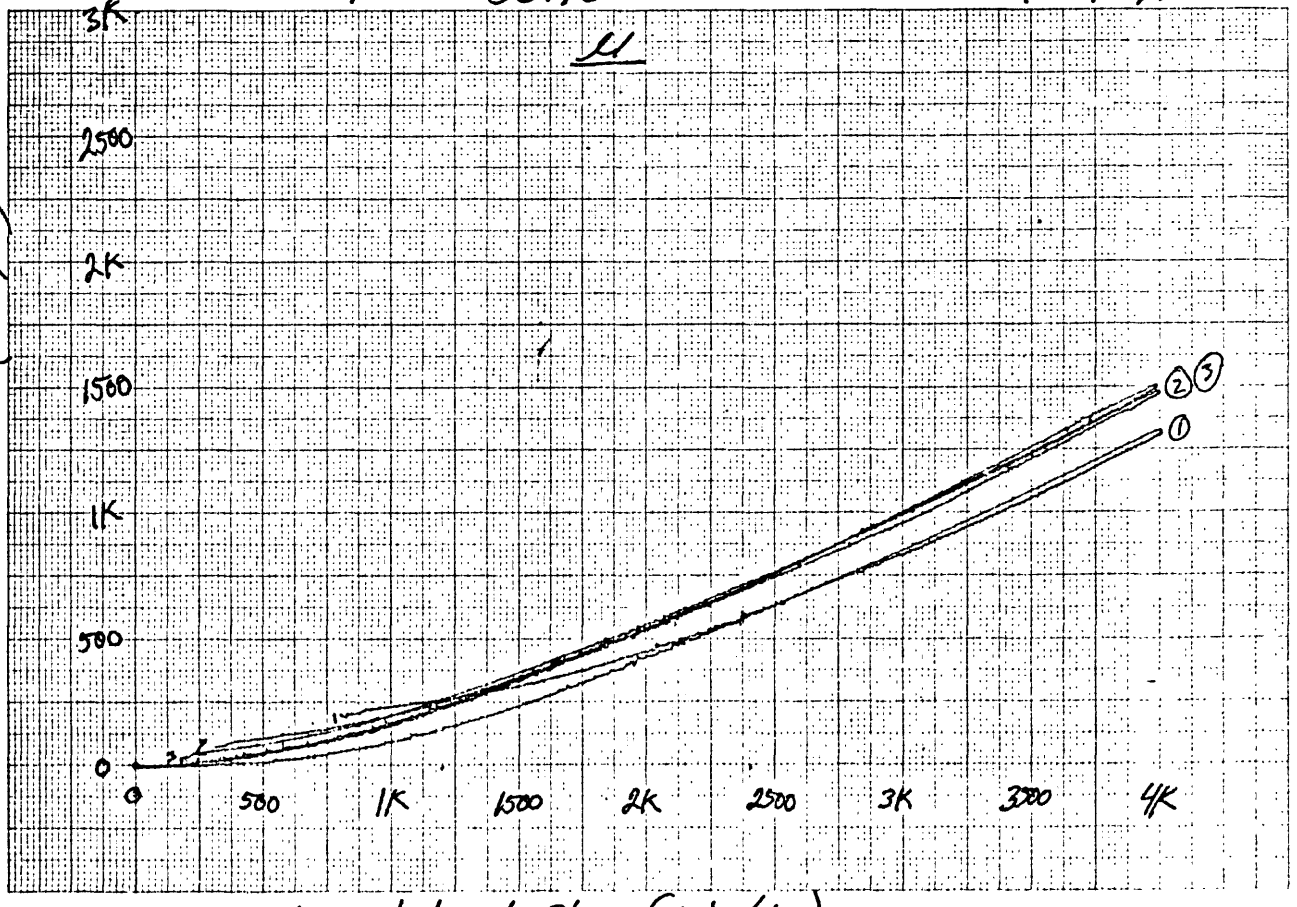

Test Data
2-4-96
S-1
42.00
E
dimensions - 1.89 X 3.72 in
parallelism - < 0.005 in
E = 30.5714.10⁴ PSI
μ = 0.388571
K = 45.7265.10⁴ PSI
G = 11.0082.10⁴ PSI
Tangent range = 2895 - 3600 με
800 - 1200 PSI
UCS = 1625 PSI
Tangent range 0-600 PSI
E = 23.1.10⁴PSI
μ = 0.3333
G = 23.1.10⁴PSI
K = 8.6.10⁴PSI
Stress (PSI)
Longitudinal Strain (μin/in)
0
500
1K
1500
2K
2500
3K
3500
4K


S-1
42.00
2-4-96
μ
Lateral Strain (μin/in)
Longitudinal Strain (μin/in)
0
500
1K
1500
2K
2500
3K
3500
4K

S-1 50.90 1-29-76

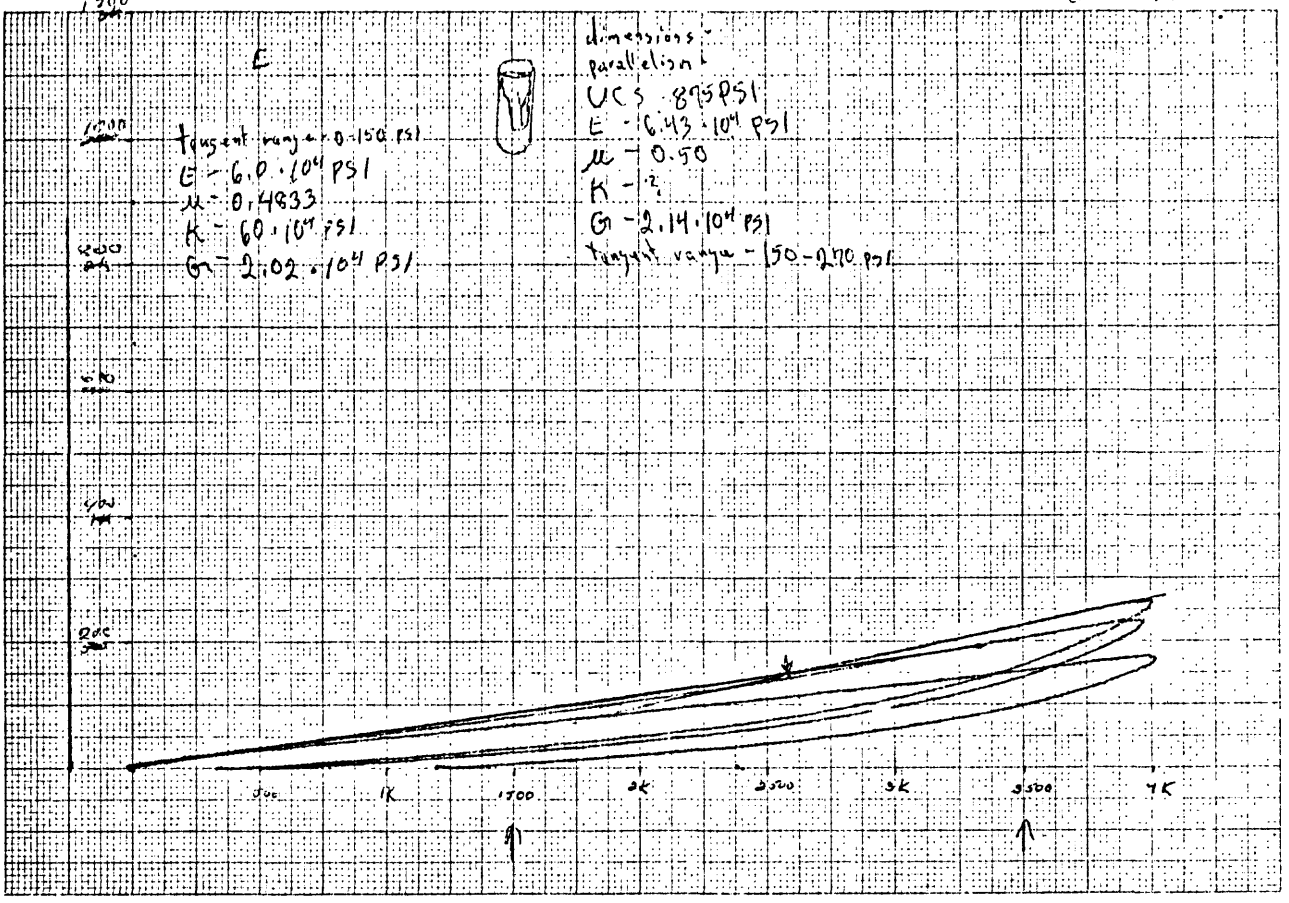


S-1 50.90 1-29-76



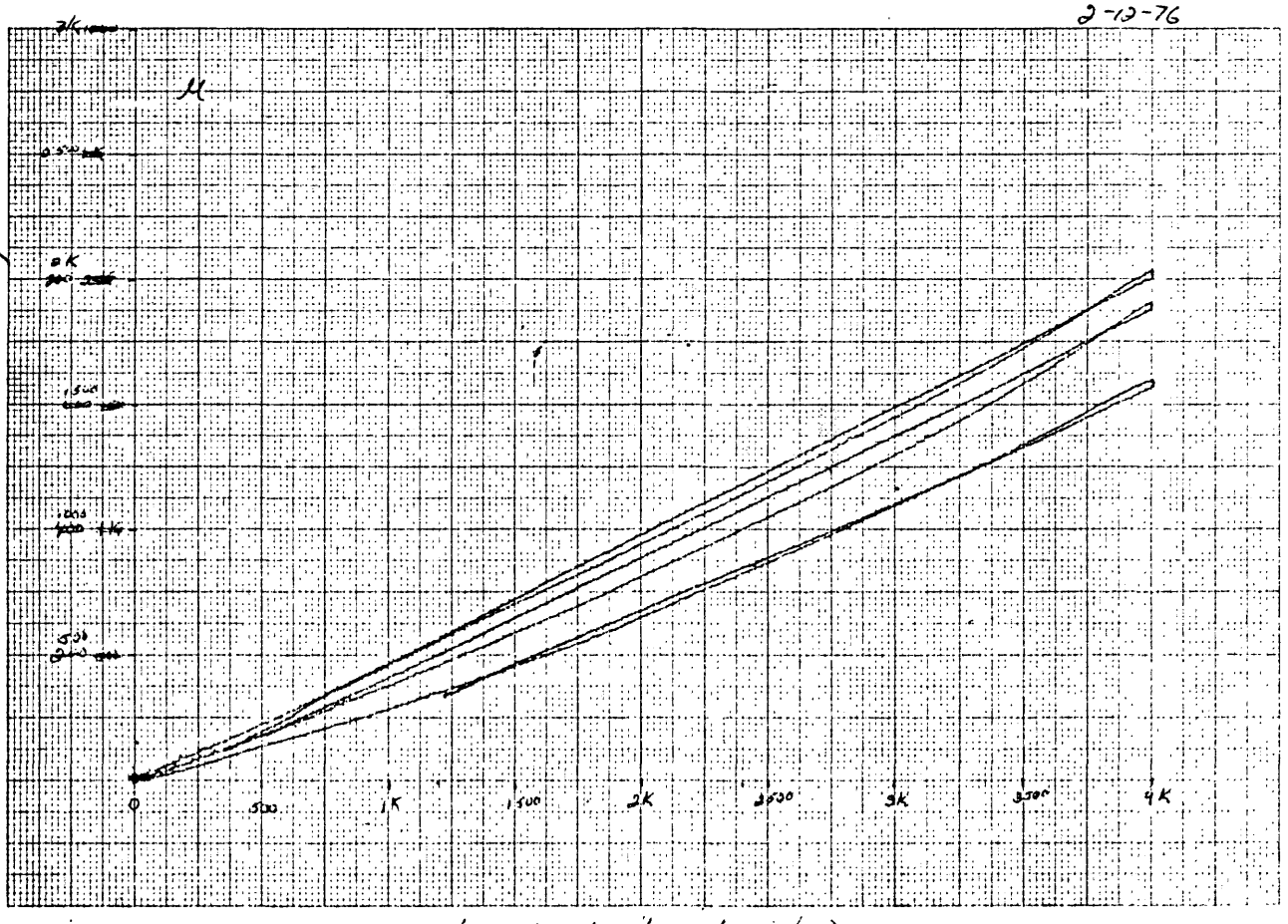
S-1 51.65

2-12-76



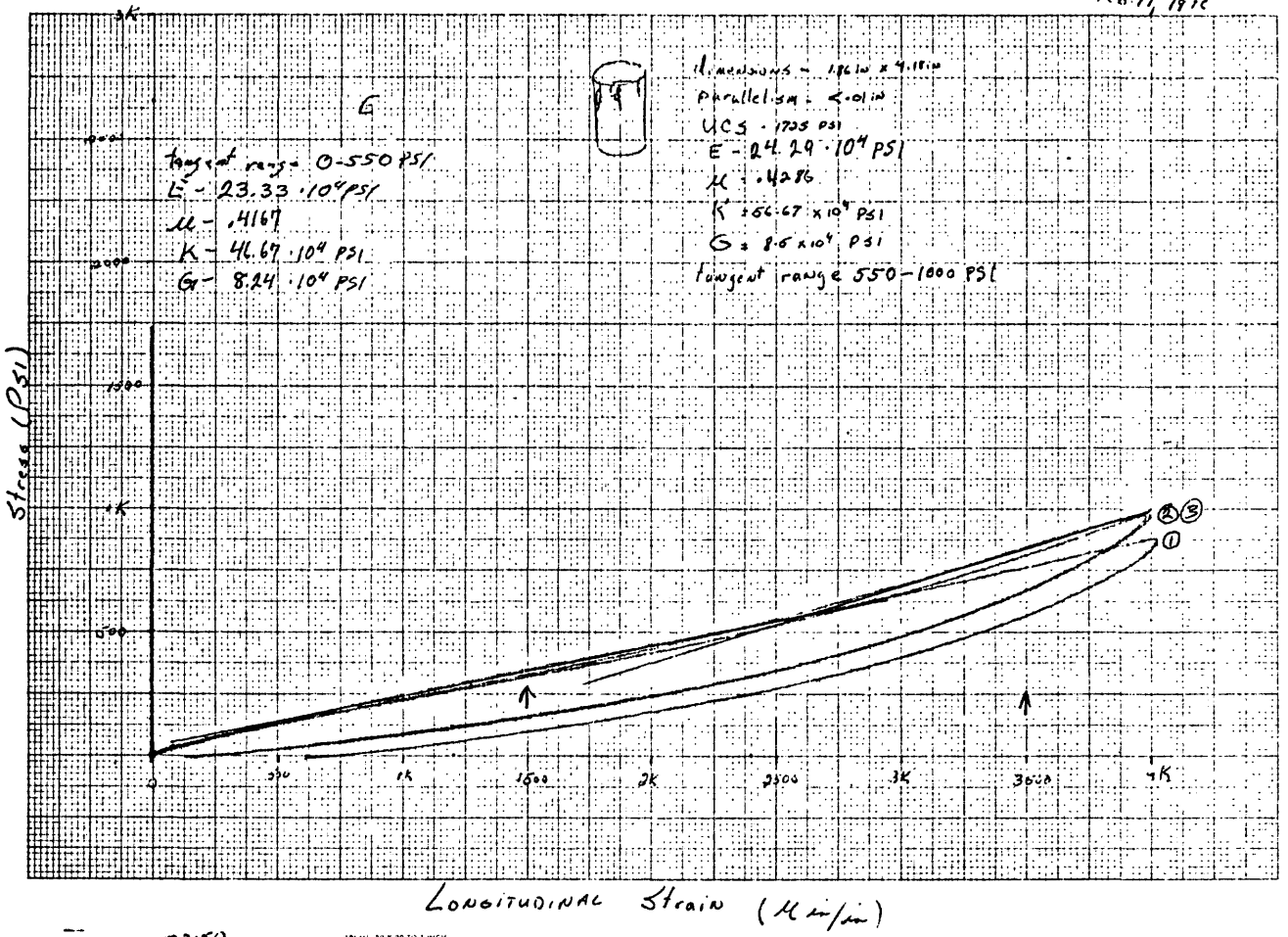
S-1 51.65

2-12-76



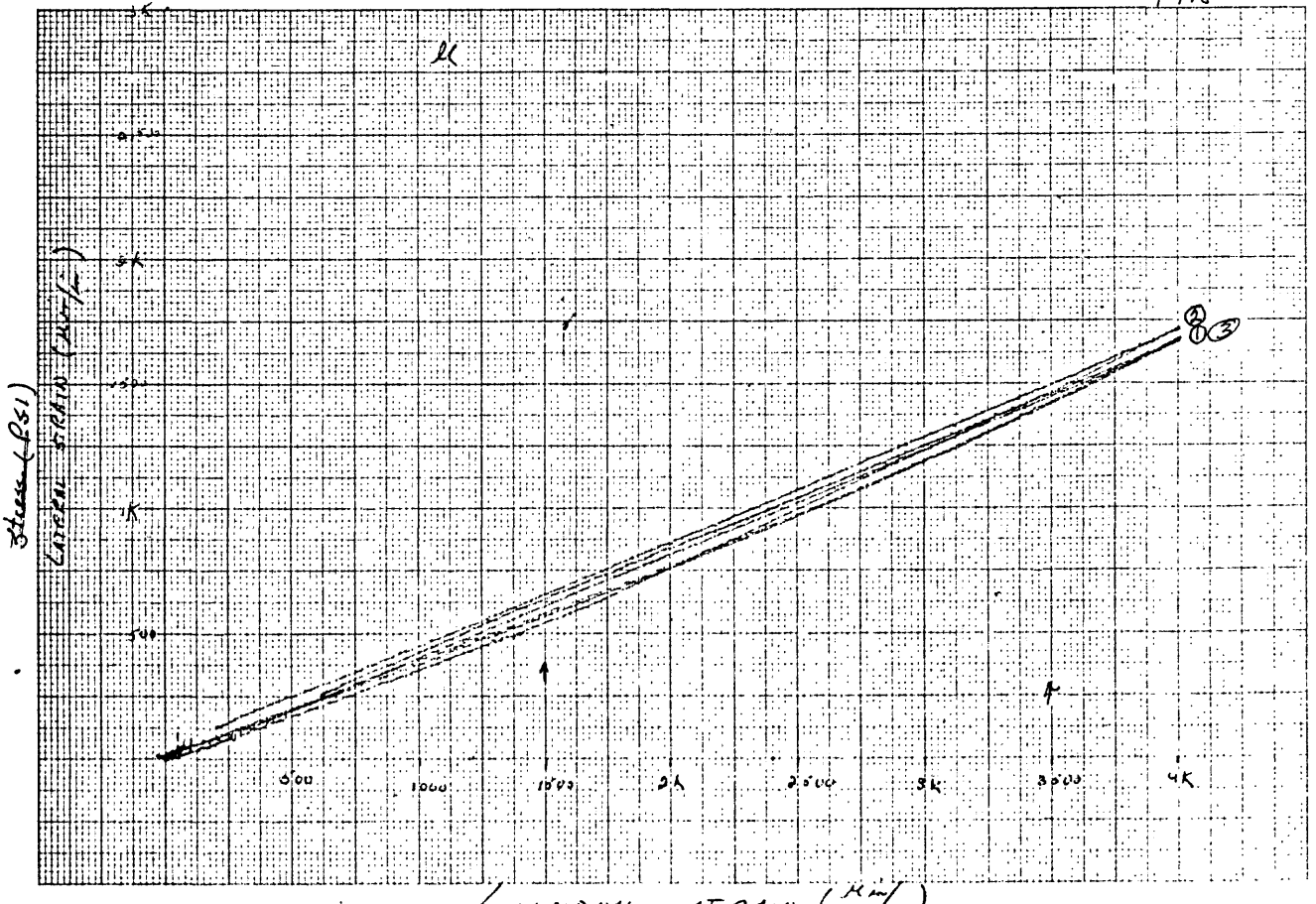
5-1 . 52.50

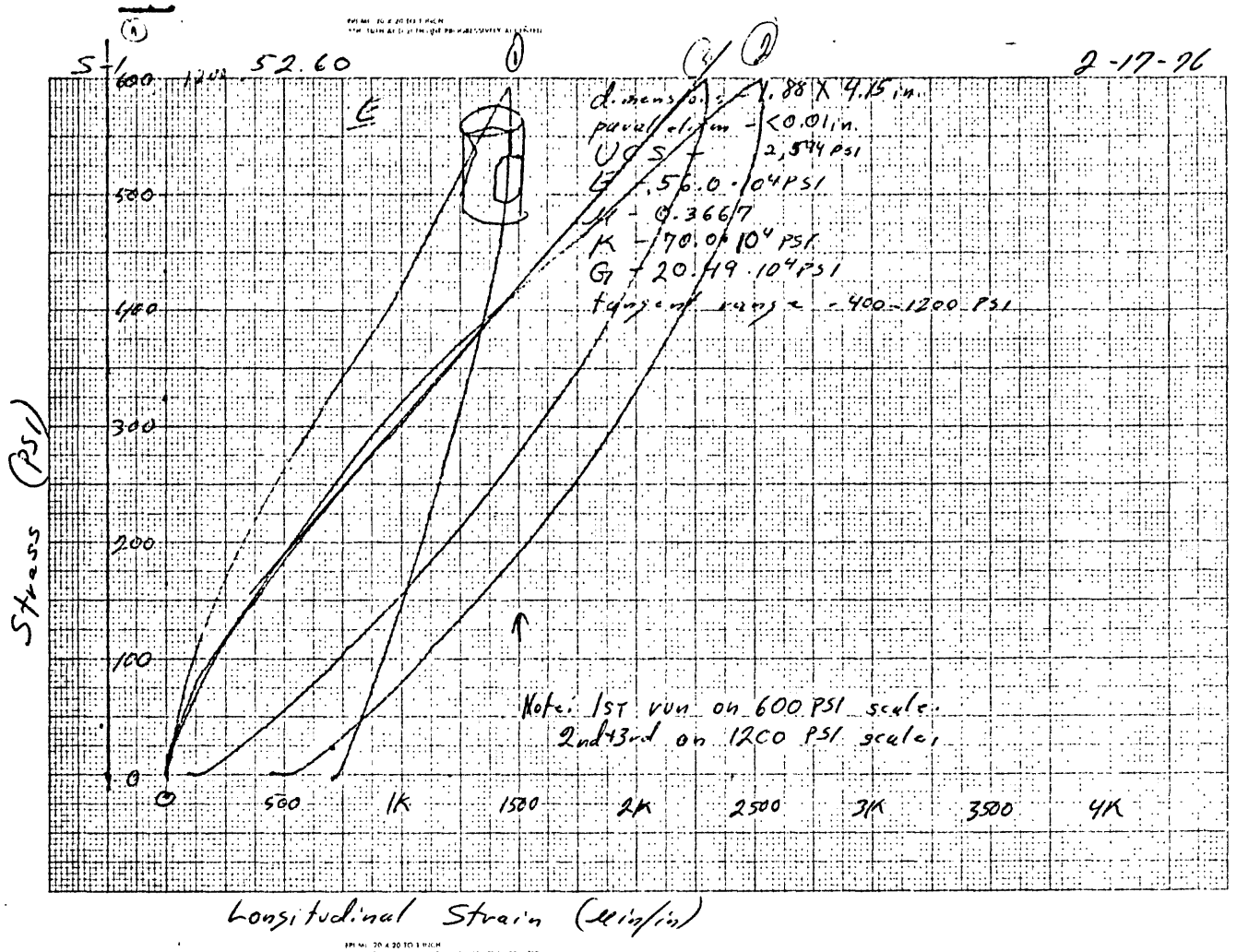
Feb. 17, 1976

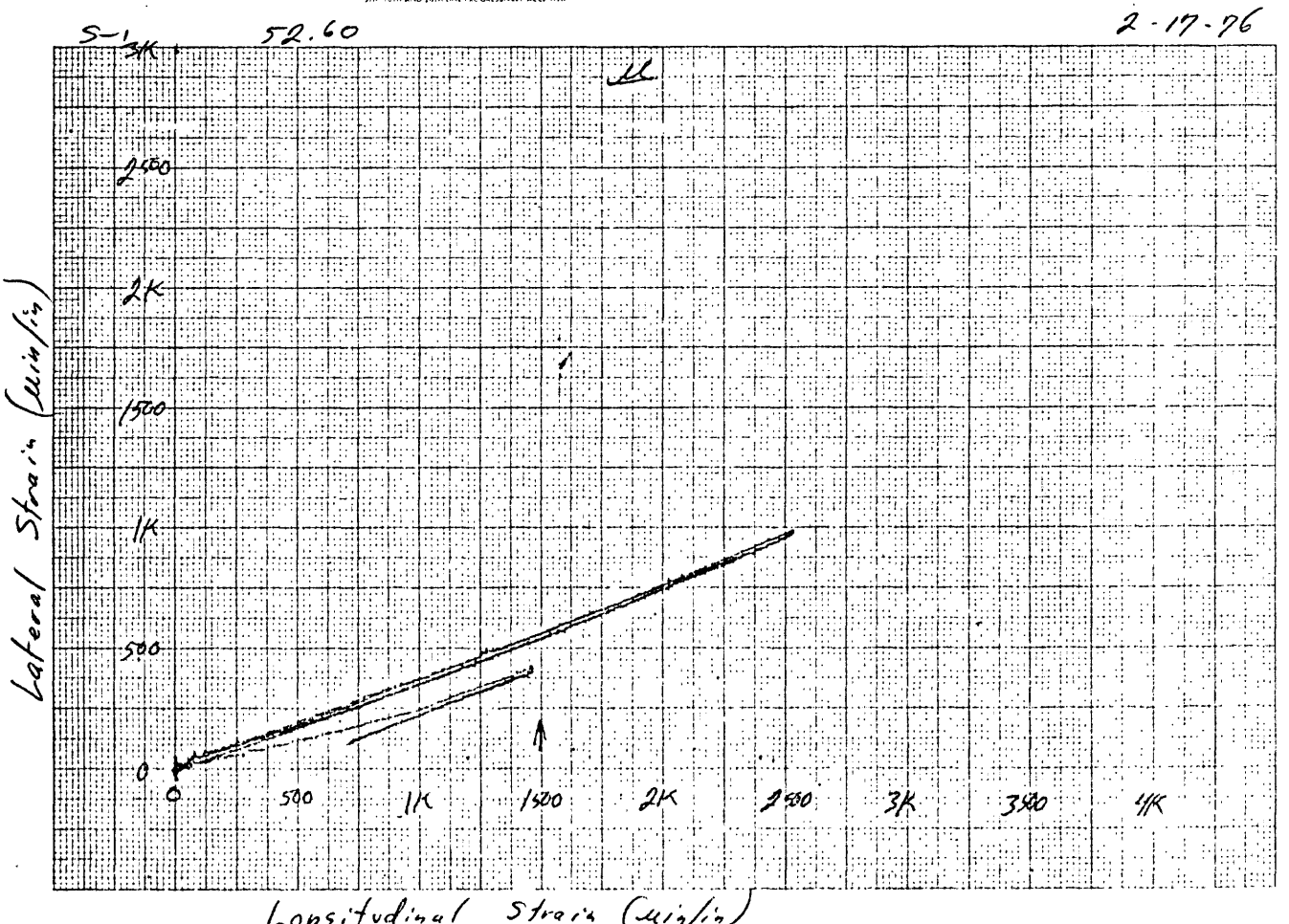


5-1 52.50

Feb. 17, 1976




S-1
52.60
2-17-76
dimensions = 1.88 X 4.15 in.
parallelism = <0.01 in.
UCS = 2,544 psi
E = 56.0 · 10⁴ PSI
μ = 0.366/7
K = 70.0 · 10⁴ PSI
G = 20.49 · 10⁴ PSI
tangent range = 400-1200 PSI
Note: 1ST run on 600 PSI scale.
2nd & 3rd on 1200 PSI scale.
Stress (PSI)
Longitudinal Strain (μin/in)


S-1
52.60
2-17-76
Lateral Strain (μin/in)
Longitudinal Strain (μin/in)

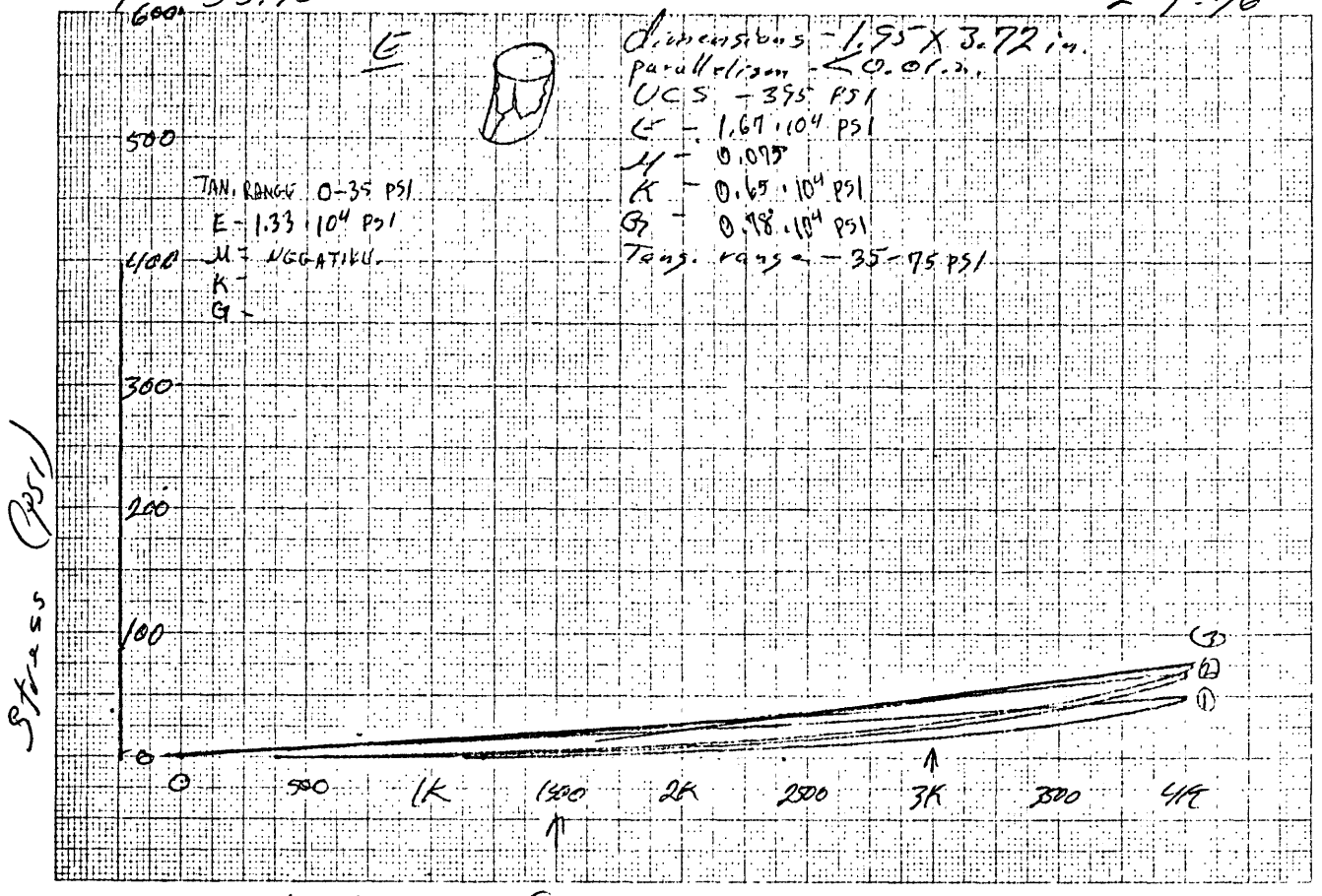
S-1 53.45

2-9-76

E

Dimensions - 1.95 X 3.72 in.
Parallelism - < 0.01 in.
UCS - 395 PSI
E - $1.67 \cdot 10^4$ PSI
μ - 0.095
K - $0.65 \cdot 10^4$ PSI
G - $0.98 \cdot 10^4$ PSI
Tens. range - 35-75 PSI

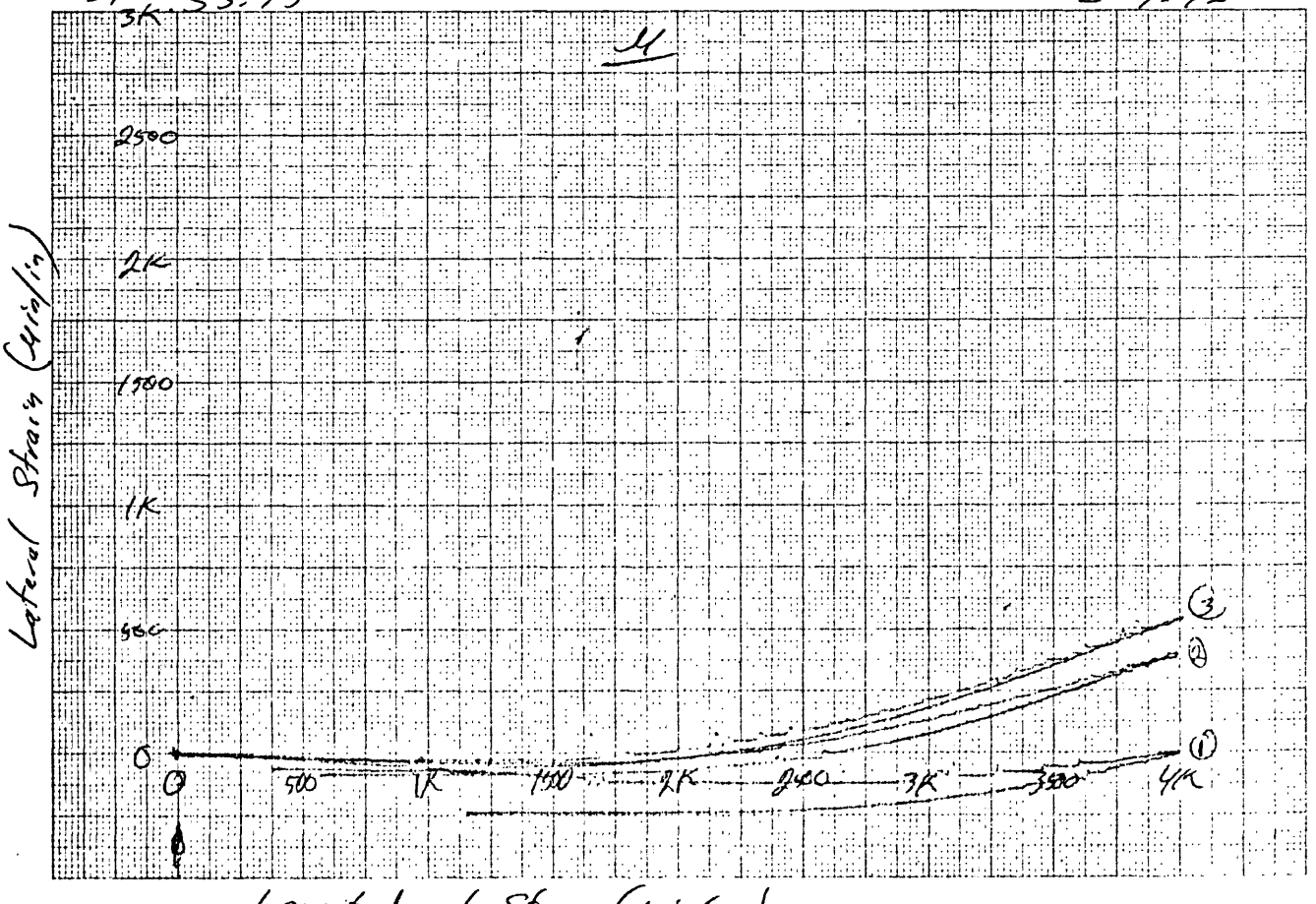
TAN. RANGE 0-35 PSI
E - $1.33 \cdot 10^4$ PSI
μ - NEGATIVE
K -
G -



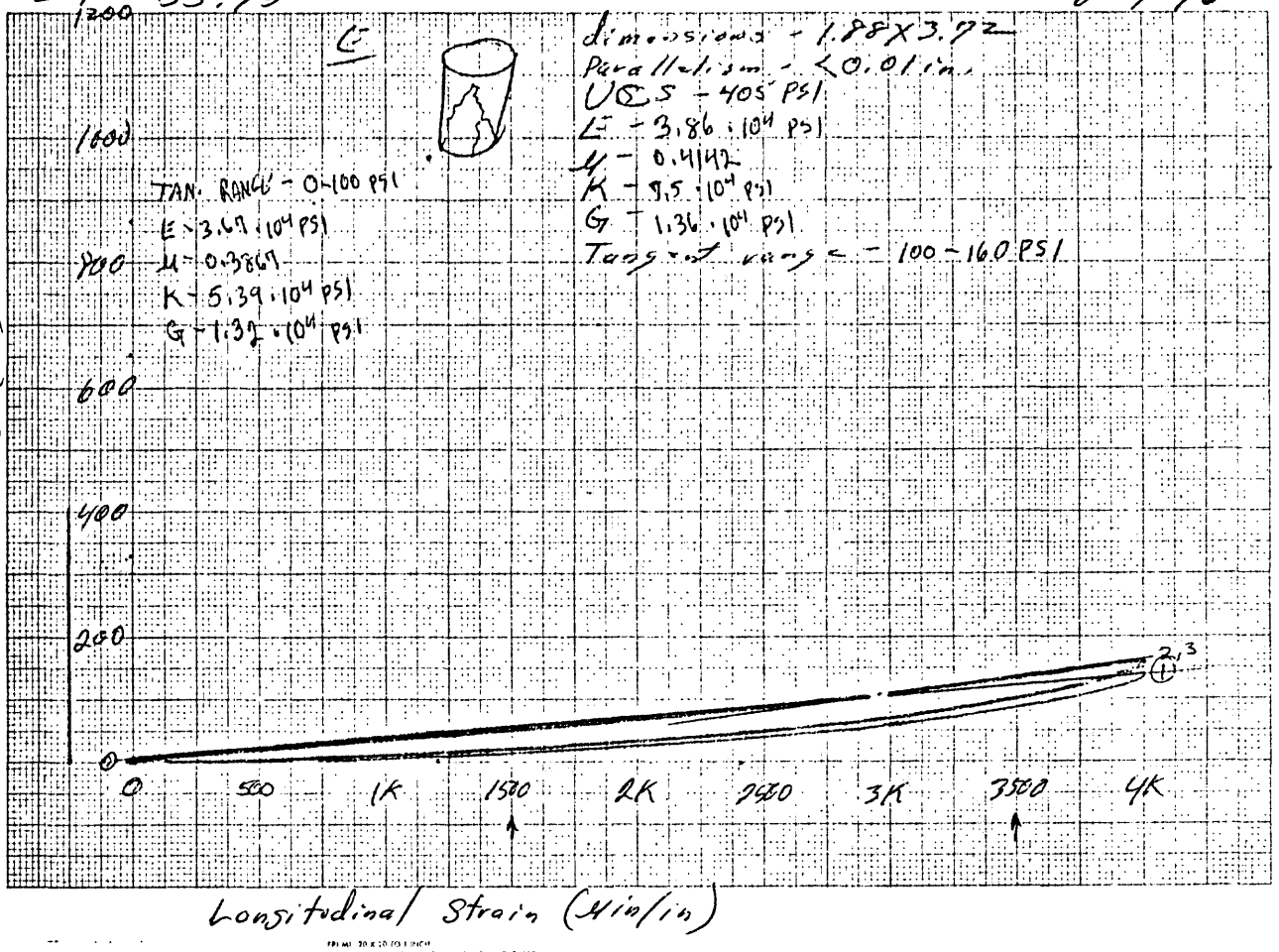
S1 53.45

2-9-76

μ



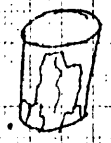
S-1 55.75 2-9-76



S-1 55.75 2-9-76

S-1 66.25 2-9-76

E

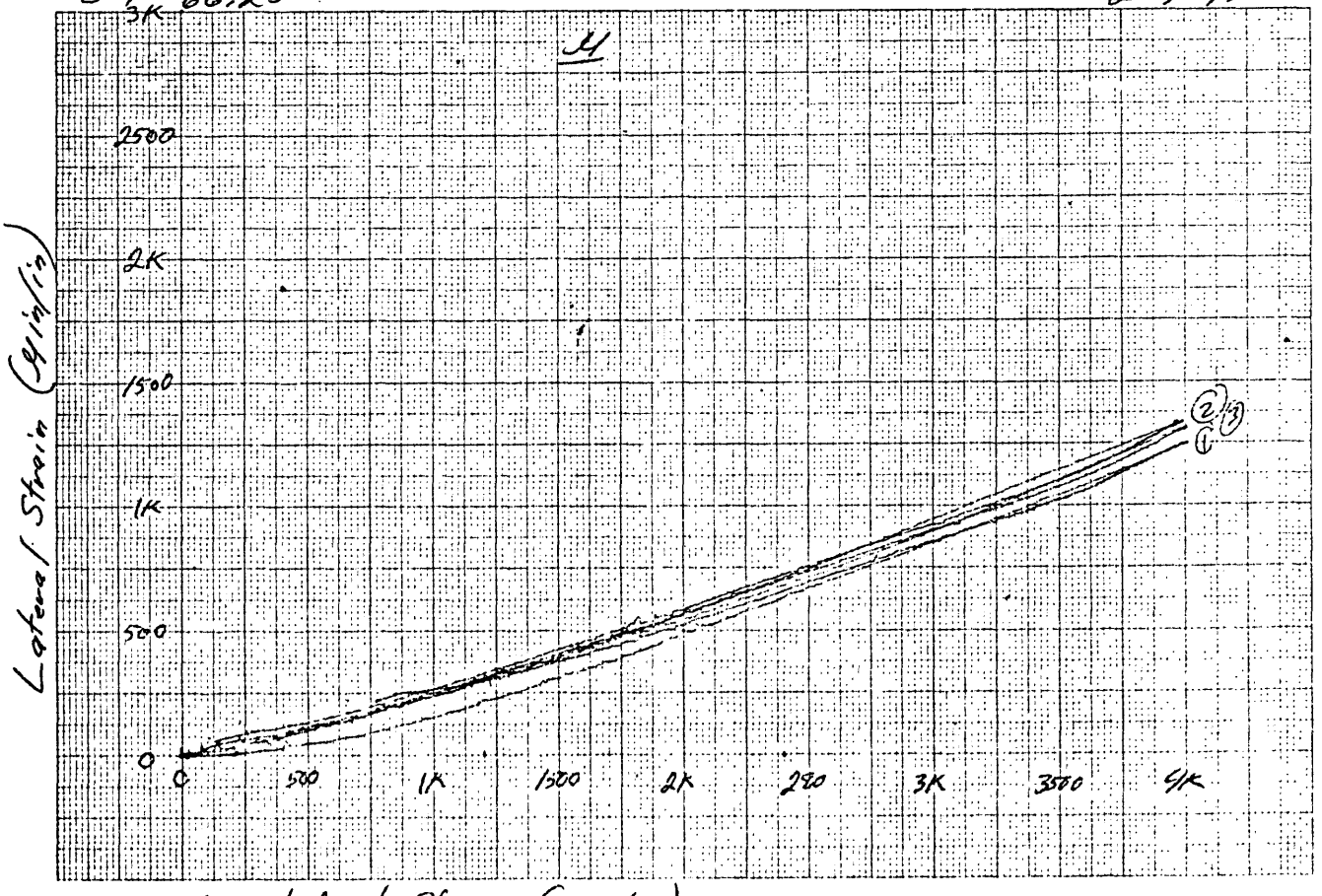


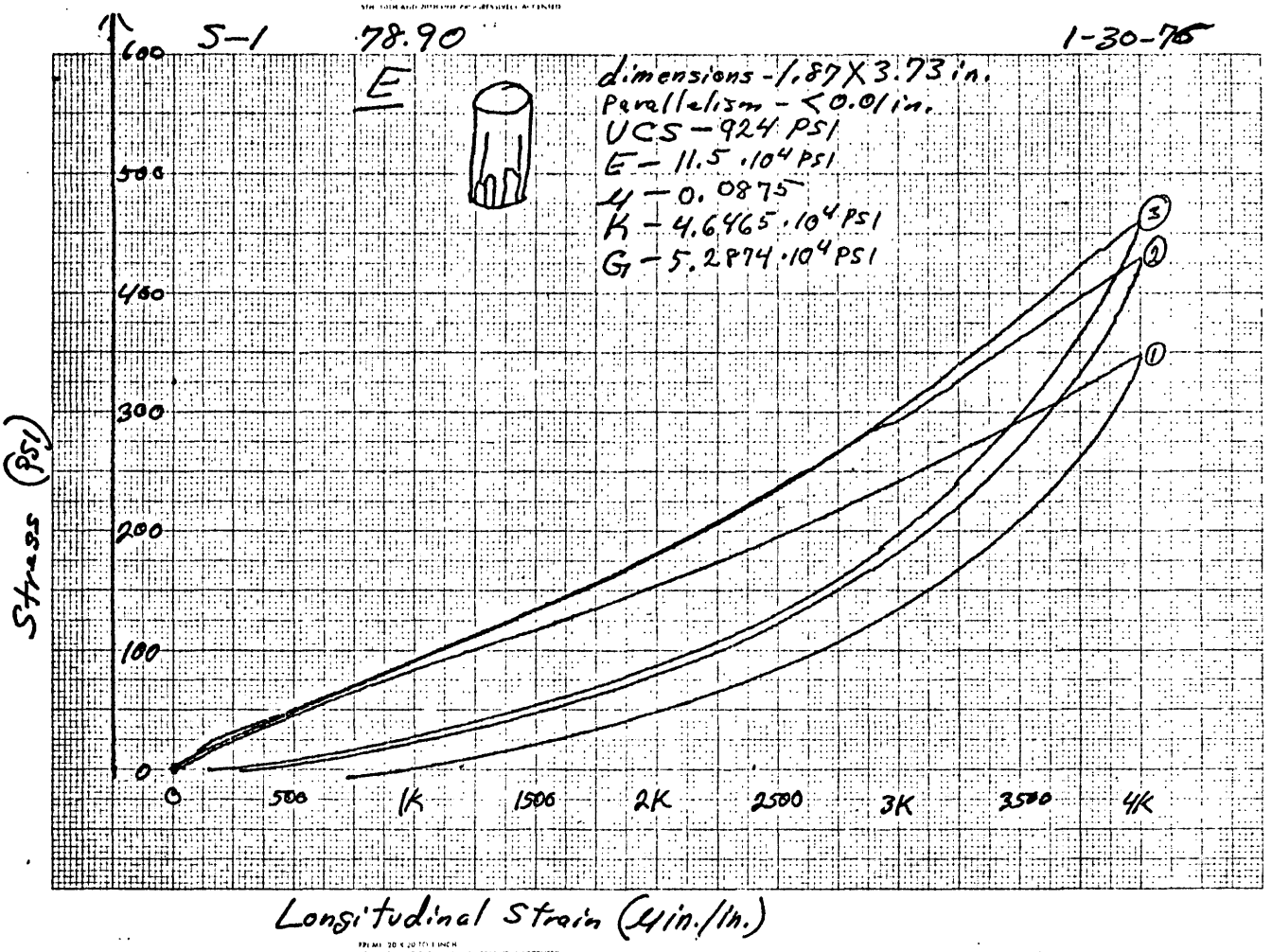
dimensions - 1.83 X 3.89 in
Parallelism - ±0.01 in
UCS - 1383 PSI
E - 13.28 · 10^4 PSI
μ - 0.31429
K - 11.92 · 10^4 PSI
G - 5.05 · 10^4 PSI
Tangent range - 540-300 PSI

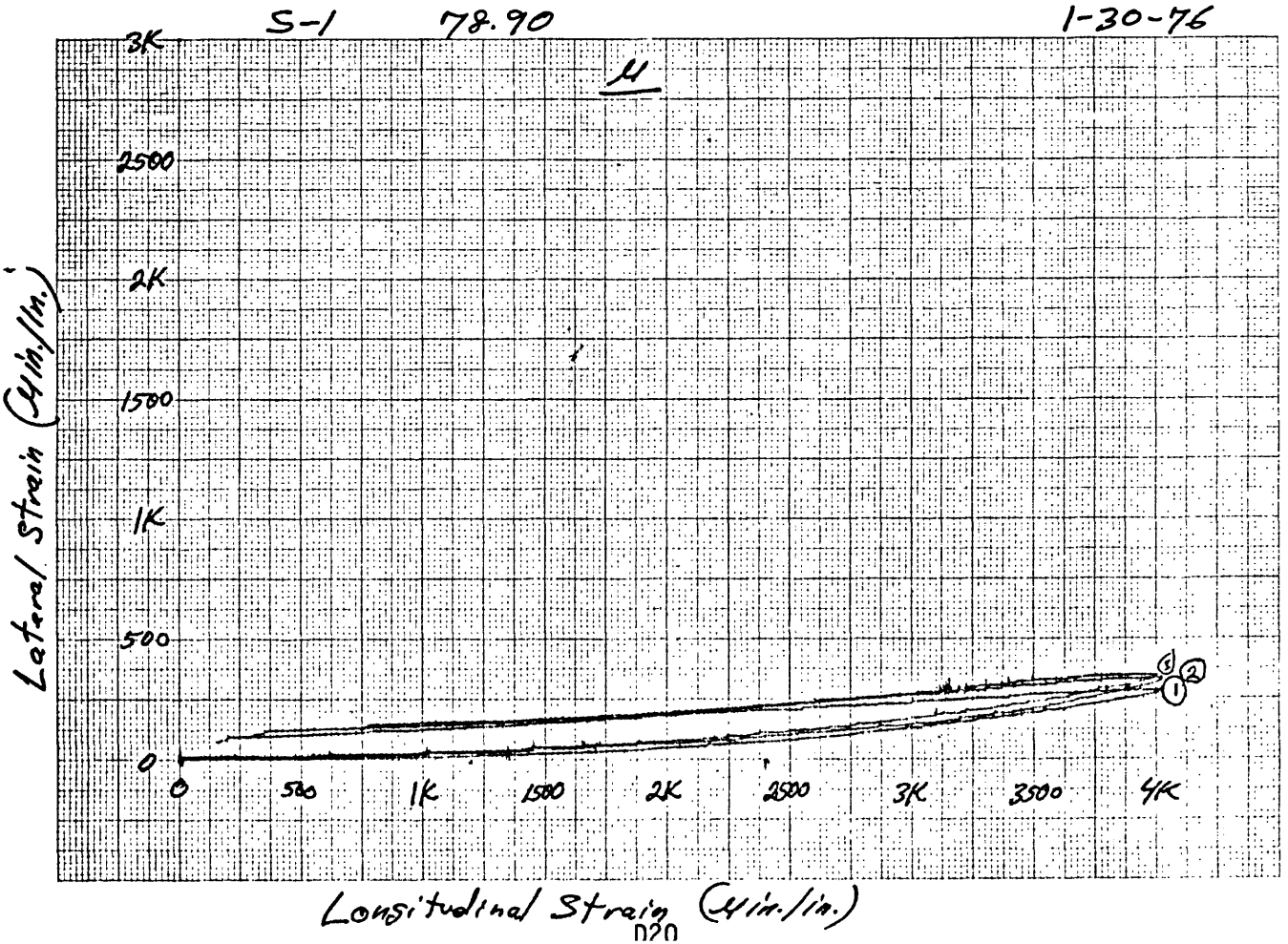
Tan - 150 - 300 PSI
E - 14.0 · 10^4 PSI
μ - 0.2333
K - 8.75 · 10^4 PSI
G - 5.68 · 10^4 PSI

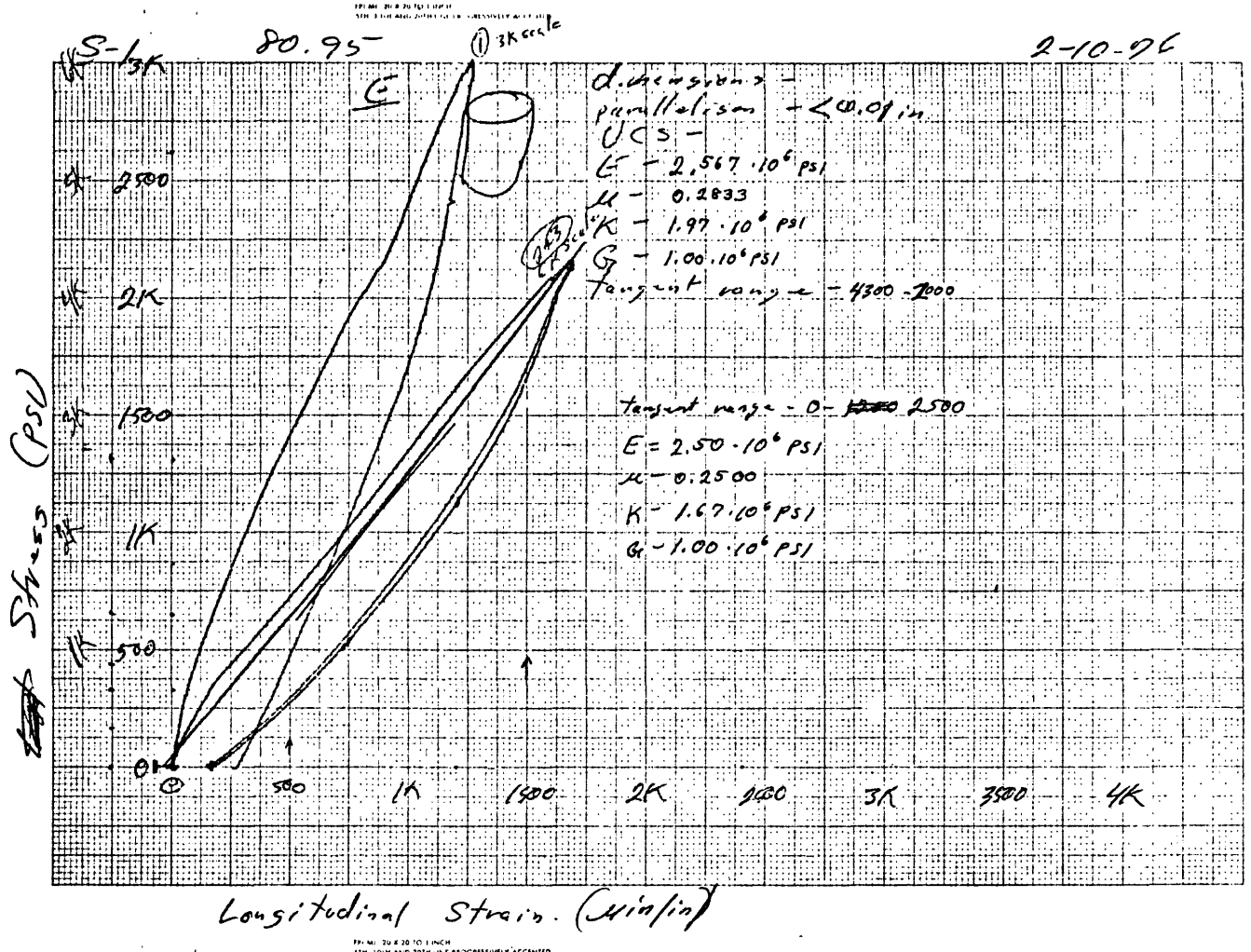
S-1 66.25 2-9-76

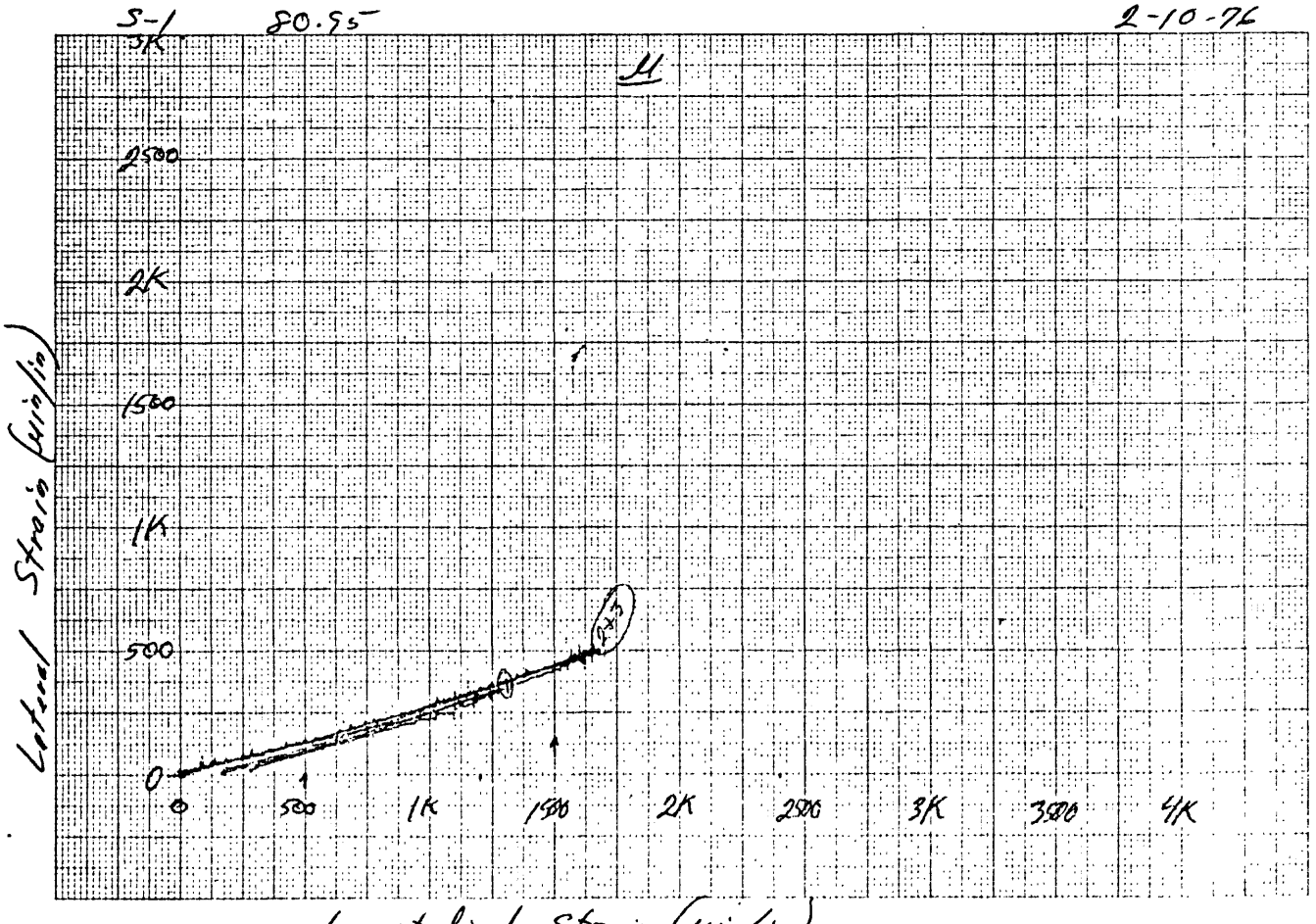
μ




S-1
78.90
1-30-76
E
dimensions - 1.87 X 3.73 in.
Parallelism - < 0.01 in.
UCS - 924 PSI
E - 11.5 · 10⁴ PSI
μ - 0.0875
K - 4.6465 · 10⁴ PSI
G - 5.2874 · 10⁴ PSI
Stress (PSI)
600
500
400
300
200
100
0
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin./in.)


S-1
78.90
1-30-76
μ
Lateral Strain (μin./in.)
3K
2500
2K
1500
1K
500
0
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin./in.)


S-1
80.95
2-10-76
C
(1) 3K cycle
dimensions -
parallelism - < 0.01 in.
UCS -
G = 2.567 · 10⁶ PSI
μ = 0.2833
K = 1.97 · 10⁶ PSI
G = 1.00 · 10⁶ PSI
Tangent range - 4300 - 2000
tangent range - 0 - 2500
E = 2.50 · 10⁶ PSI
μ = 0.2500
K = 1.67 · 10⁶ PSI
G = 1.00 · 10⁶ PSI
3K
2500
2K
1500
1K
500
0
500
1K
1500
2K
2500
3K
3500
4K
Lateral Stress (PSI)
Longitudinal Strain. (μin/in)


S-1
80.95
2-10-76
U
3K
2500
2K
1500
1K
500
0
500
1K
1500
2K
2500
3K
3500
4K
Lateral Strain (μin/in)
Longitudinal Strain (μin/in)

S-1200 84.05 2-12-76

E

dimensions - 1.8 X 4.16 in.
parallelism - < 0.01 in.
UCS - 1621 PSI
E - ~~11.0~~ $\cdot 10^4$ PSI 9.75 $\cdot 10^4$ PSI
μ - 0.468750
K - 52.0 $\cdot 10^4$ PSI
G - 3.319 $\cdot 10^4$ PSI
test cut range - 100 - 400 PSI

Stress (PSI)

1000
800
600
400
200
0

0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in)

S-13K 84.05 2-12-76

μ

Lateral Strain (μin/in)

2500
2K
1500
1K
500
0

0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in)

S-1 85.90 2-11-96

E

dimensions - 1.8 x 3.99 in
parallel sides - <0.01 in.
UCS - 340 PSI
E - 5.0 · 10^4 PSI
μ - 0.3419
K - 5.96 · 10^4 PSI
G - 1.86 · 10^4 PSI
tangent range - 175 - 270 PSI

tangent range - 0 - 50 PSI
E - 3.33 · 10^4 PSI
μ - 0.3669
K - 4.11 · 10^4 PSI
G - 1.22 · 10^4 PSI

Stress (PSI)

1200
1000
800
600
400
200
0

0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in)

S-1 85.90 2-11-96

μ

Lateral Strain (μin/in)

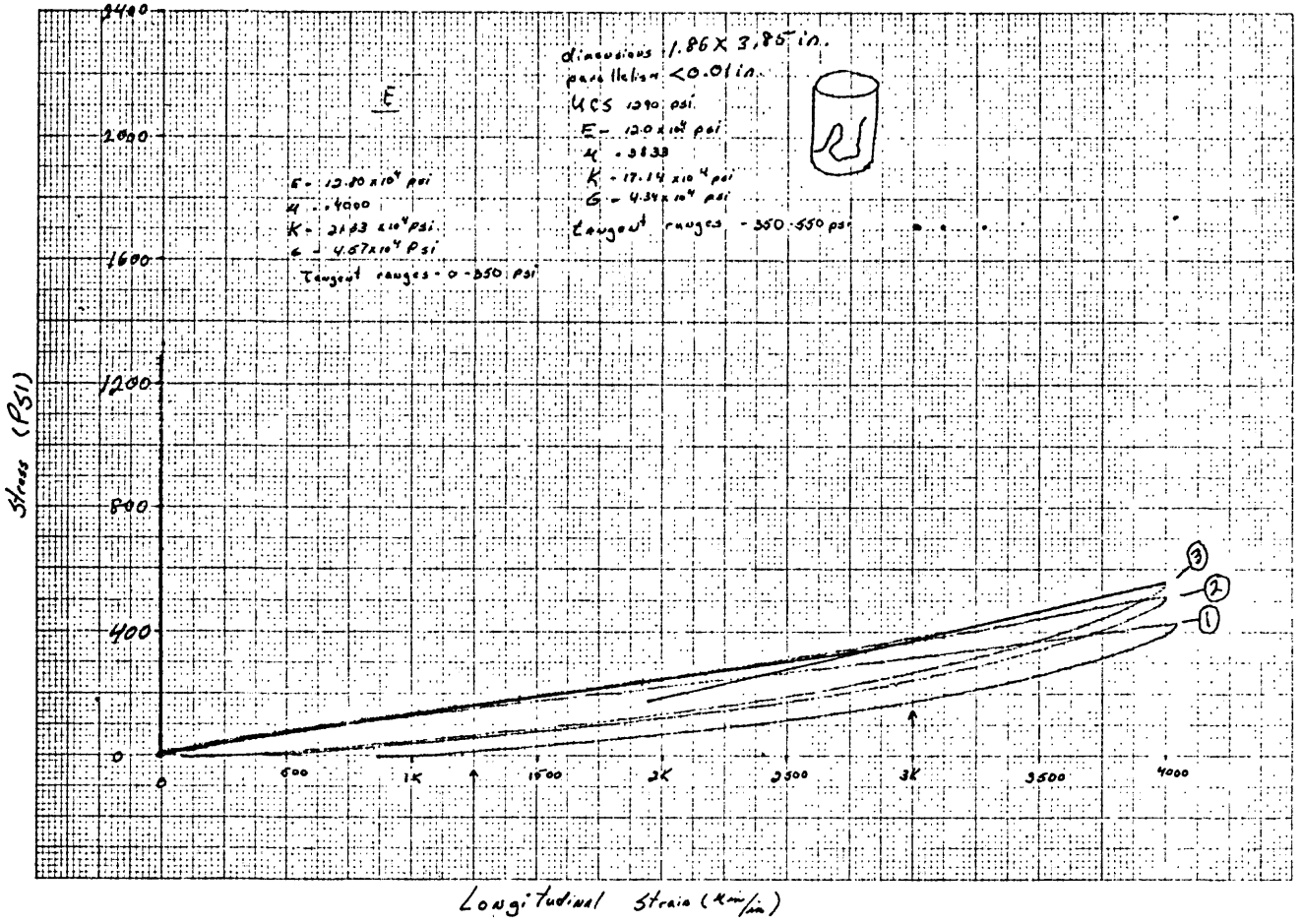
3K
2500
2K
1500
1K
500
0

0 500 1K 1500 2K 2500 3K 3500 4K

Longitudinal Strain (μin/in)

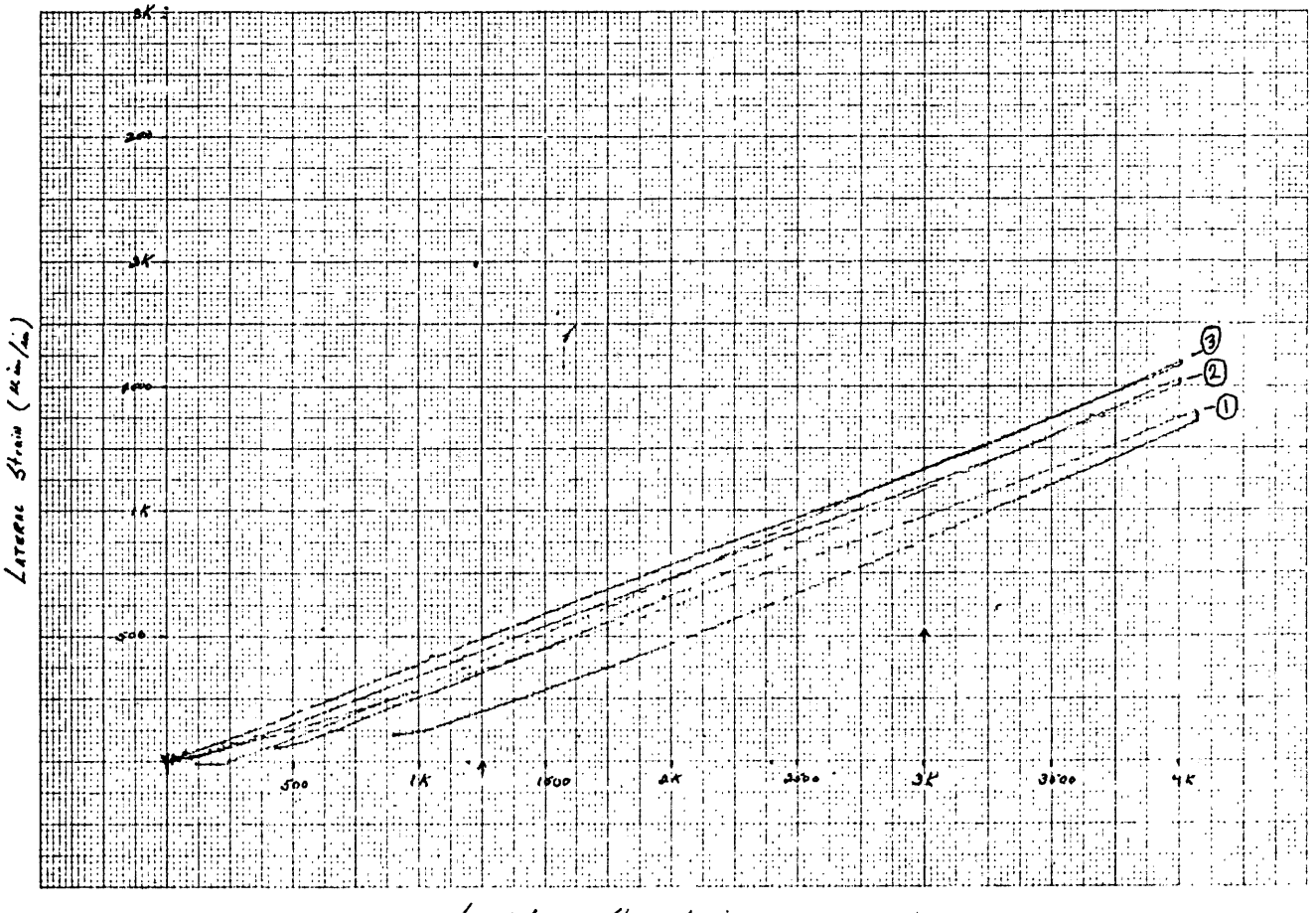
S-1 89.60

Feb. 17, 1976



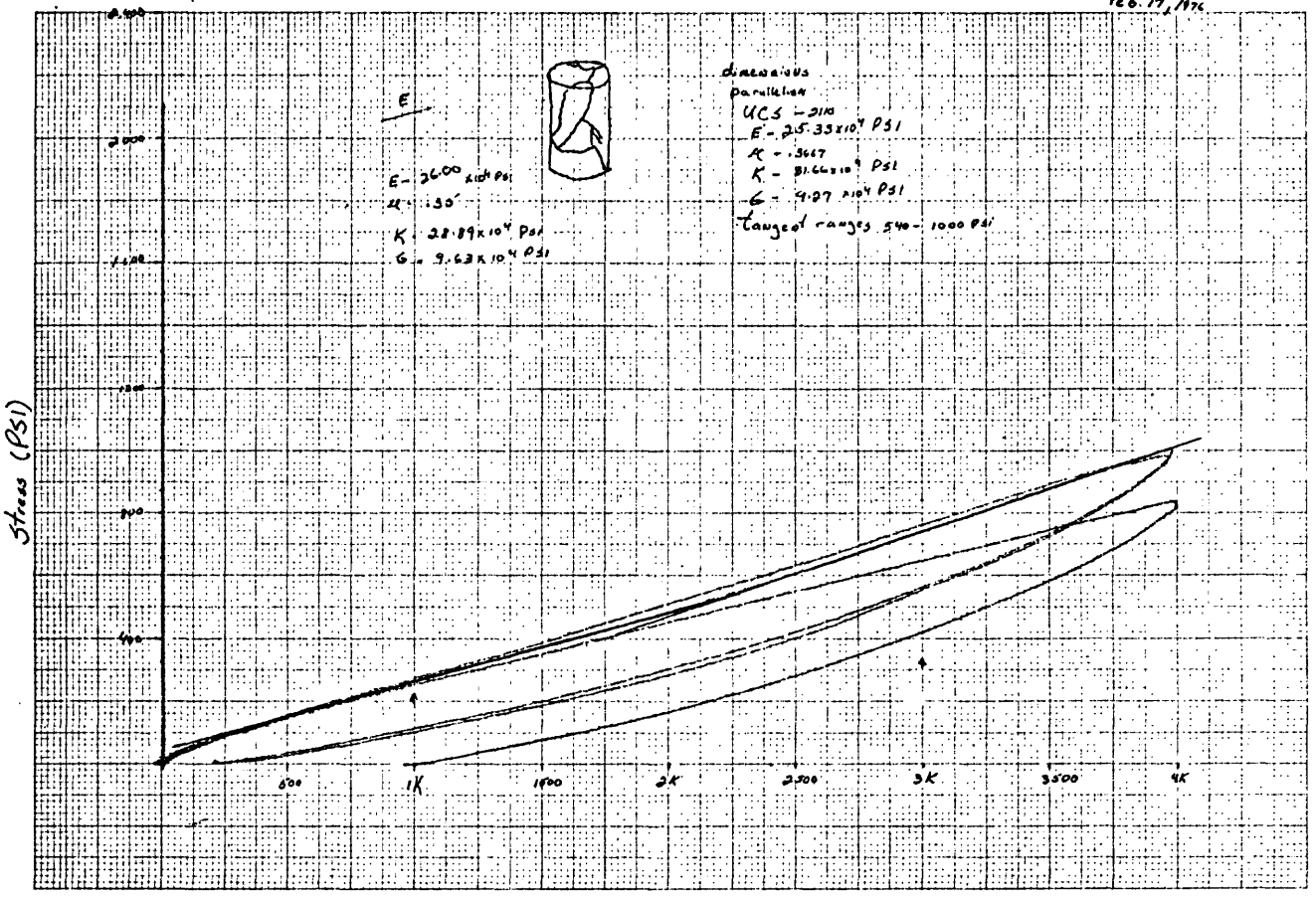
S-1 89.60

Feb. 17, 1976



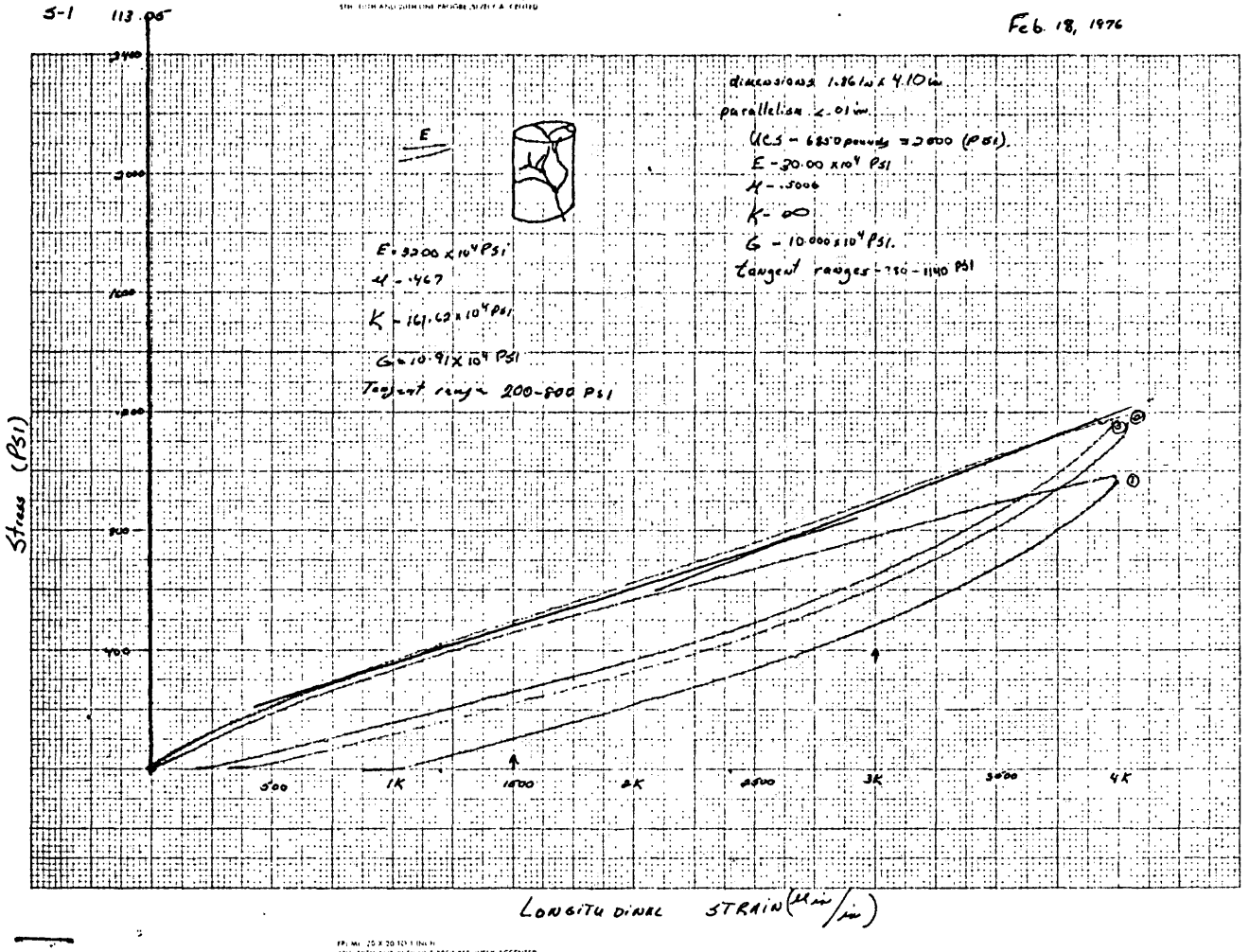
3-1 101.05

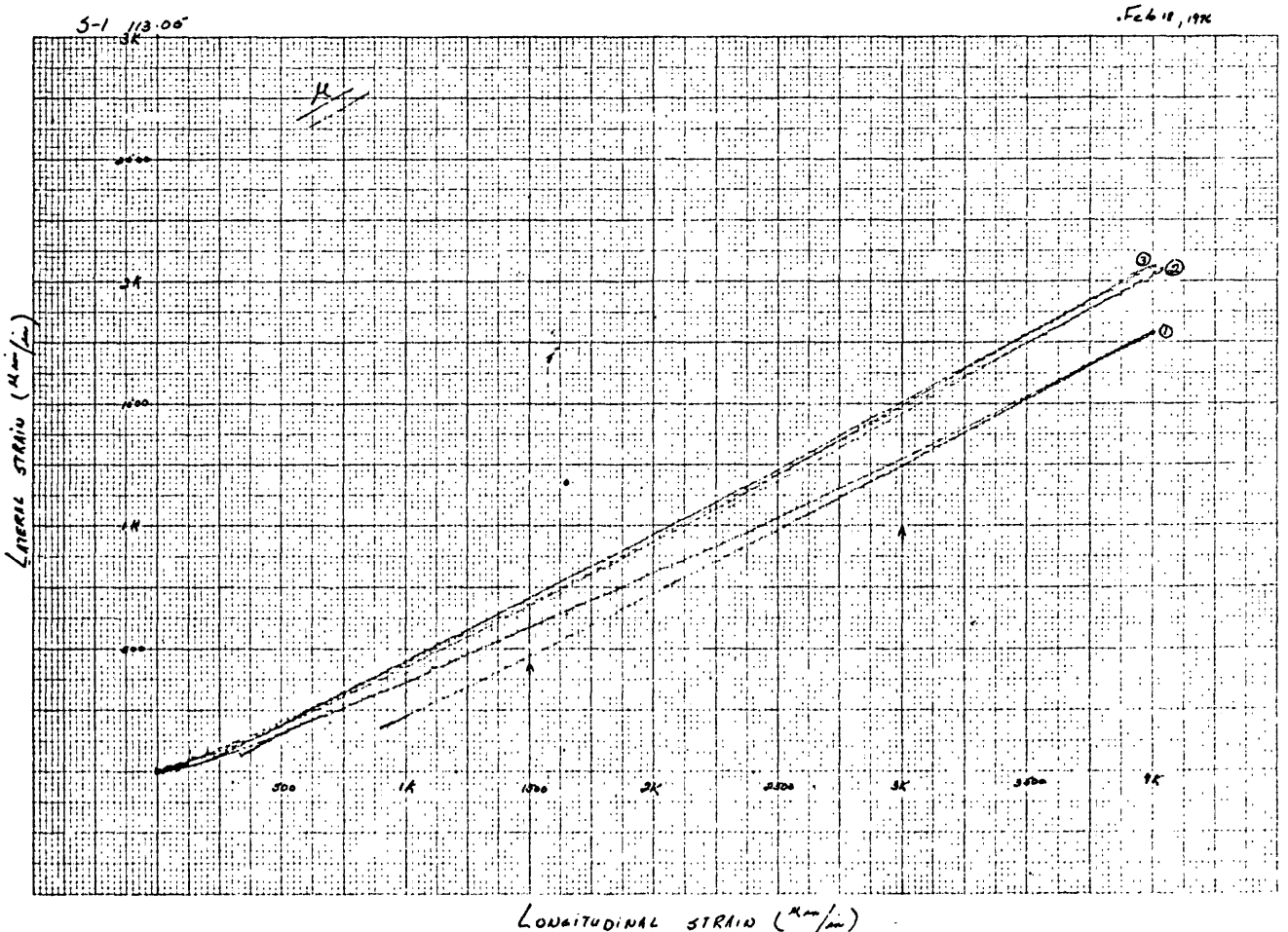
Feb. 17, 1976



3-1 101.06

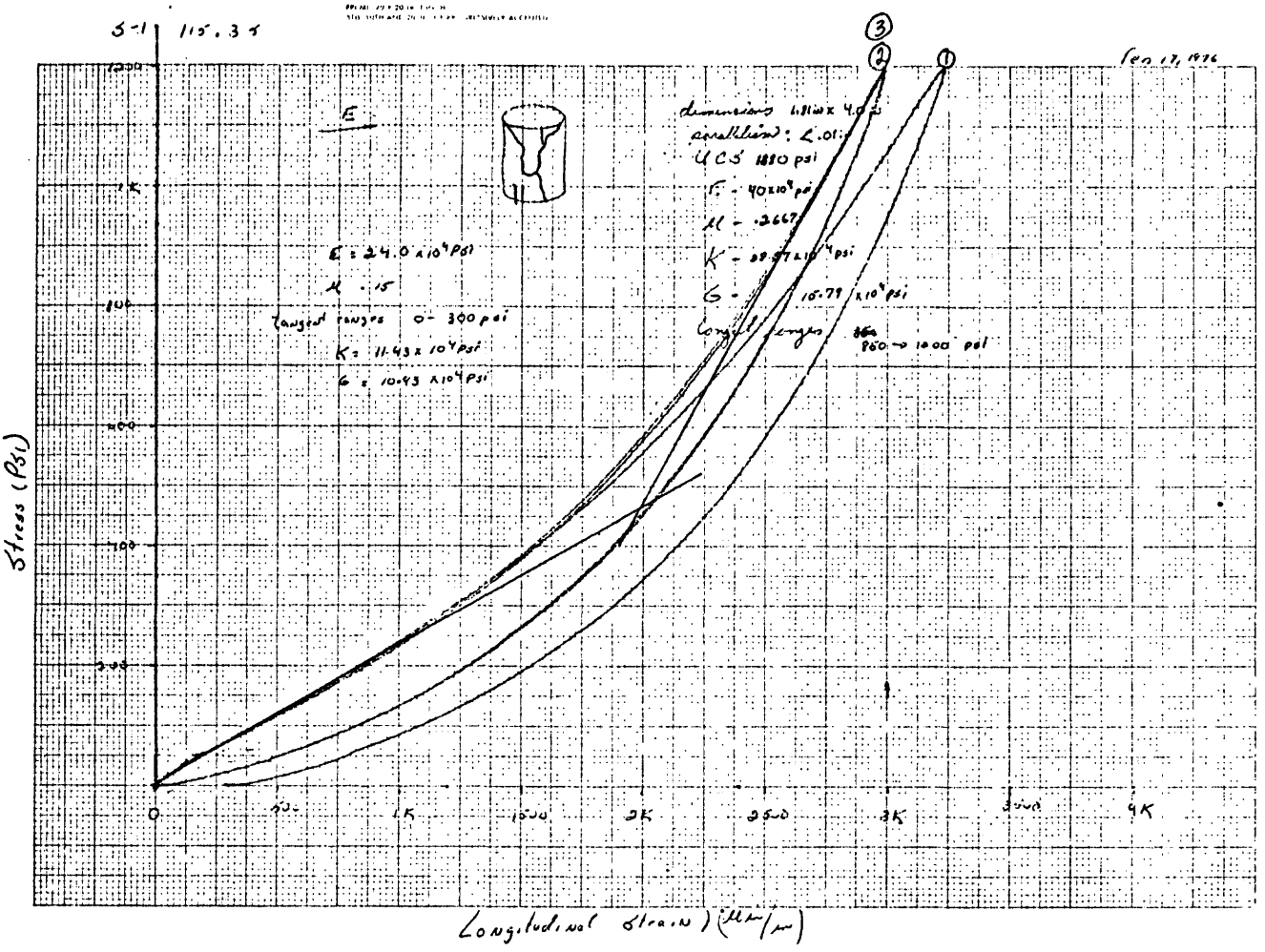
Feb 17, 1976


5-1 113.05
Feb. 18, 1976
dimensions 1.961in x 4.10in
parallelism <.01in
UCS - 6850pounds = 2000 (PSI).
E - 30.00 x10⁶ PSI
μ - .3006
K - ∞
G - 10.000x10⁶ PSI.
Tangent ranges - 750 - 1140 PSI
E
E = 9200 x10⁶ PSI
μ - .467
K - 161.62 x10⁶ PSI
G = 10.91 X 10⁶ PSI
Tangent range = 200-500 PSI
Stress (PSI)
500
1K
1500
2K
2500
3K
3500
4K
LONGITUDINAL STRAIN (μin/in)


5-1 113.00
Feb 18, 1976
μ
LATERAL STRAIN (μin/in)
500
1K
1500
2K
2500
3K
3500
4K
LONGITUDINAL STRAIN (μin/in)

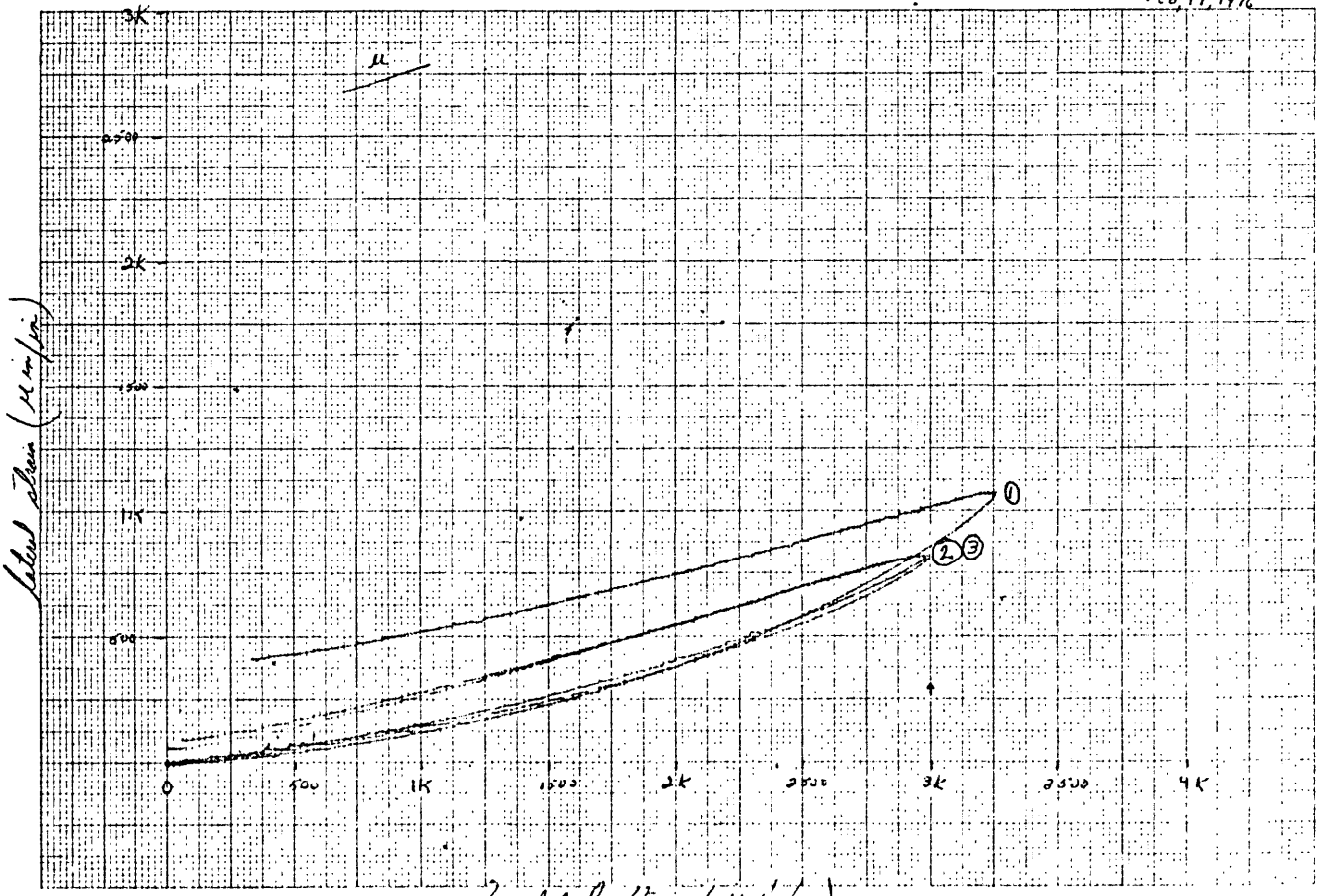
S-1 115.3 s

Feb. 17, 1976



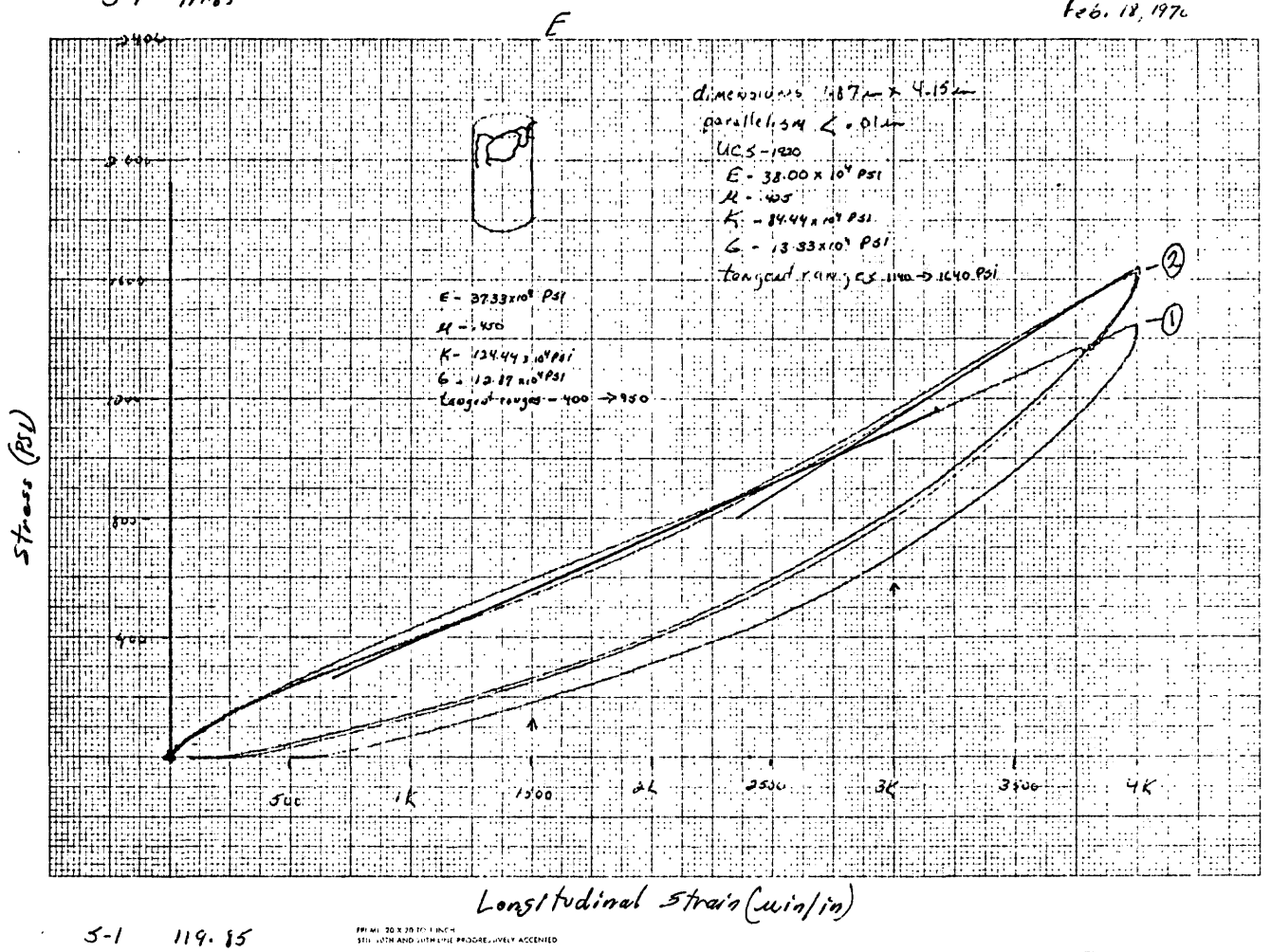
S-1 115.3 s

Feb, 17, 1976



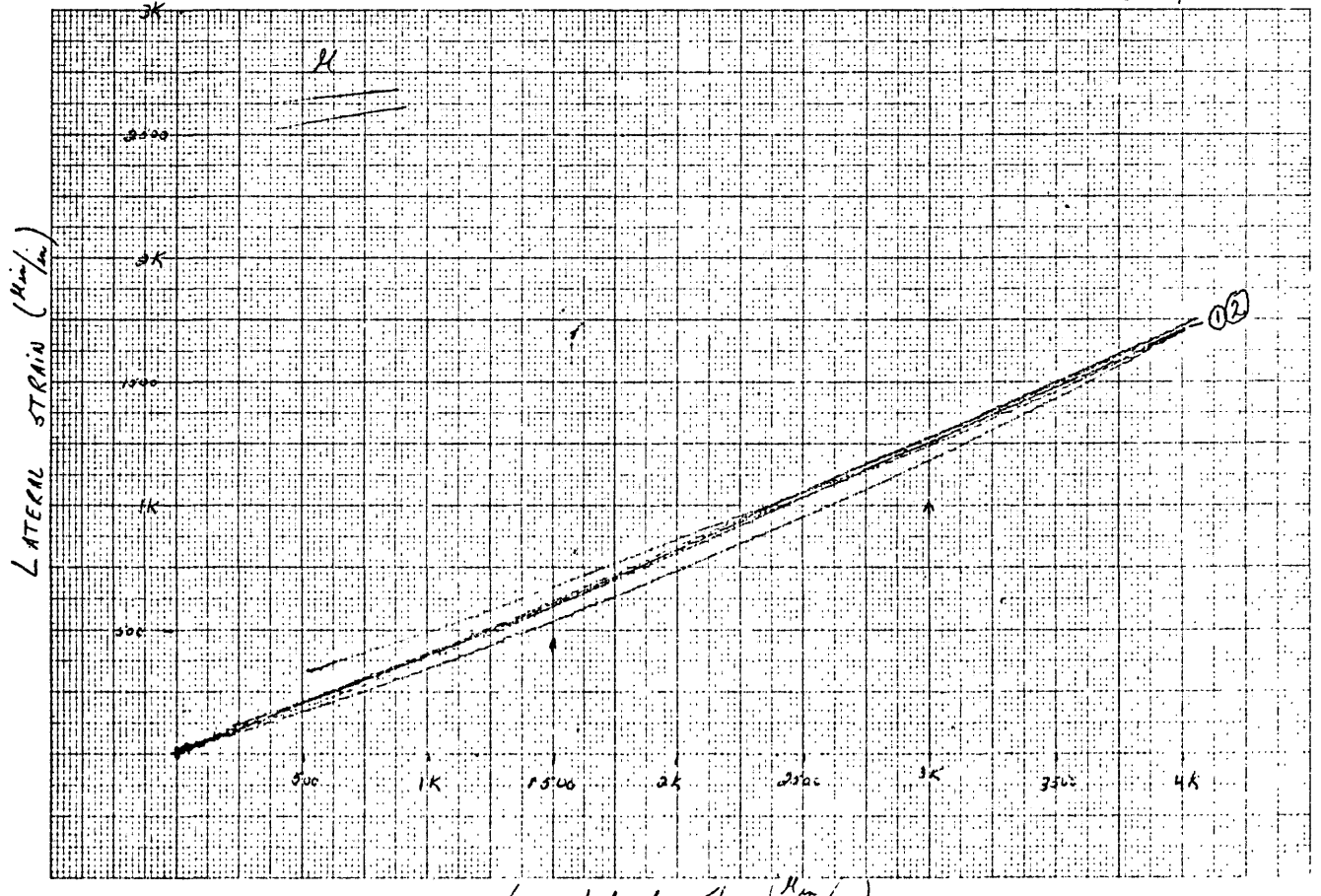
S-1 119.85

Feb. 18, 1976



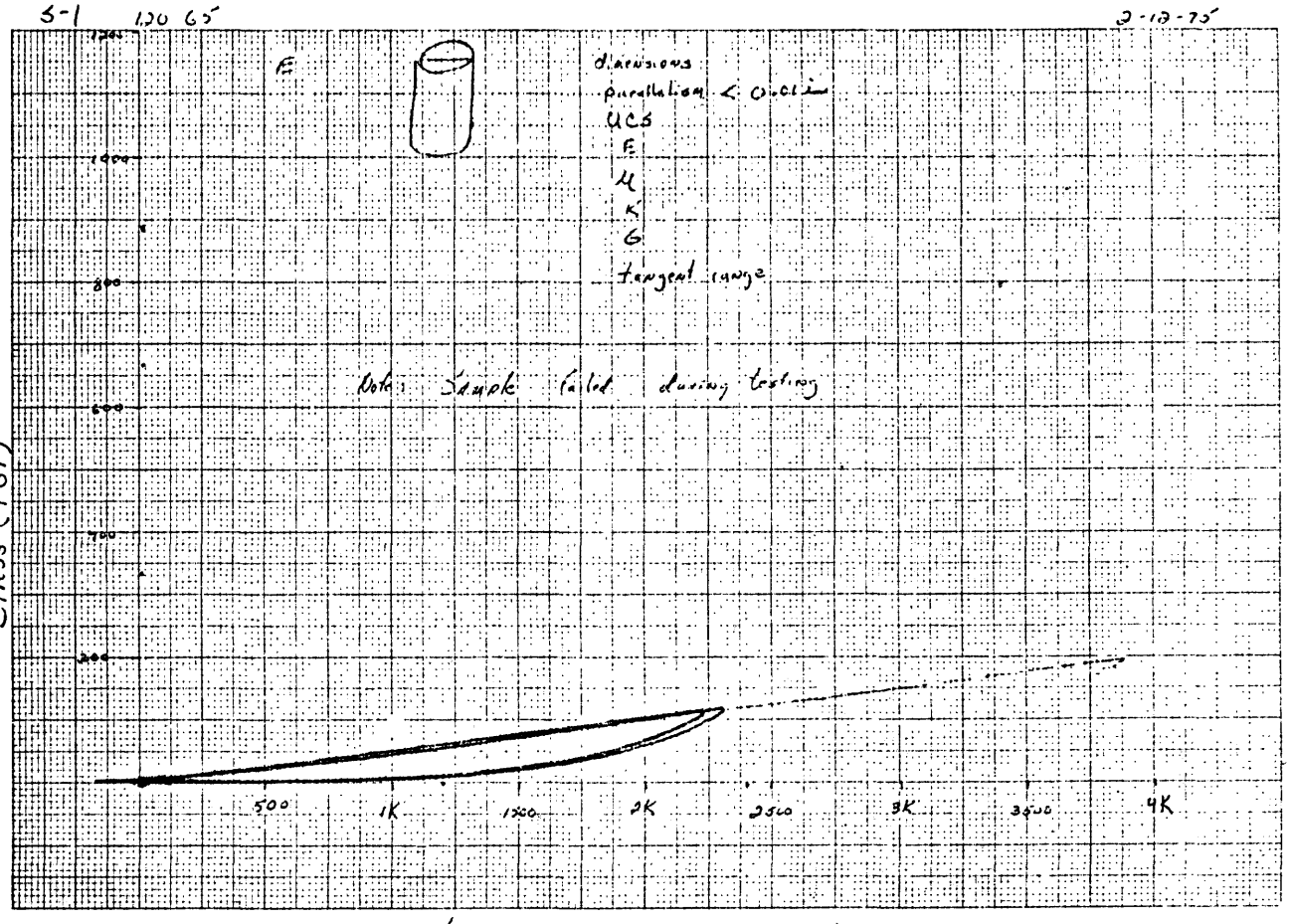
S-1 119.85

Feb 18, 1976

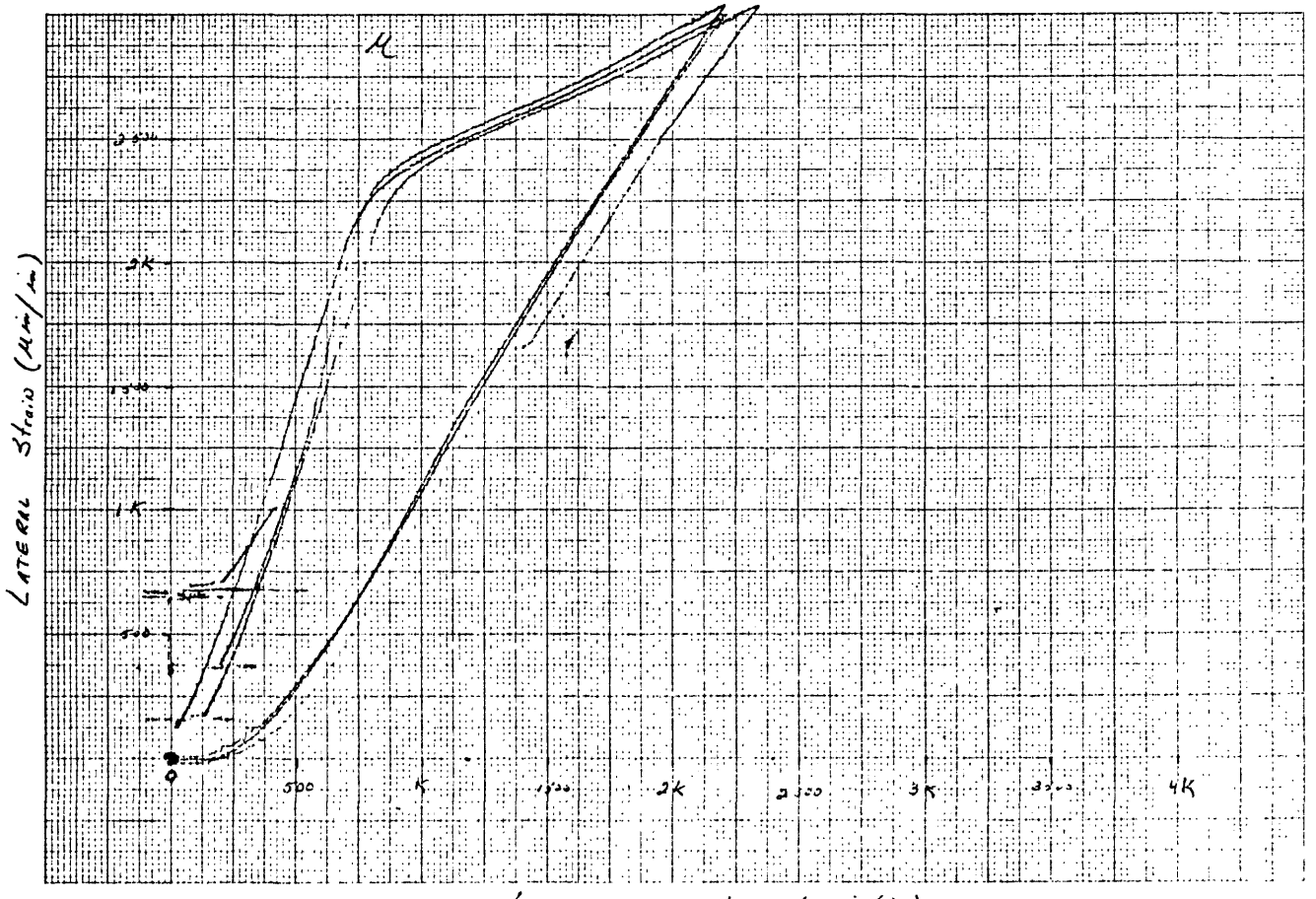


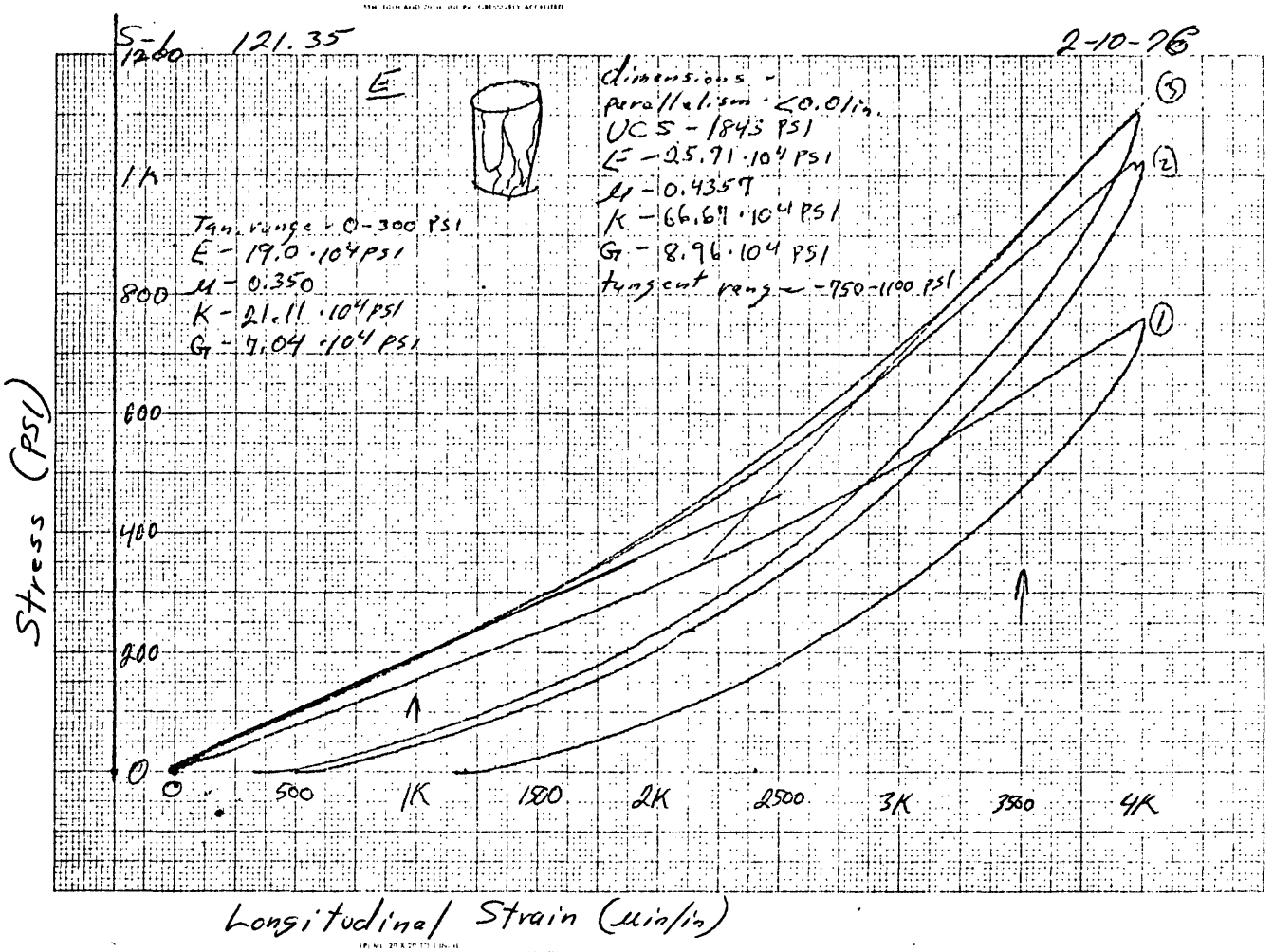
S-1 120 65

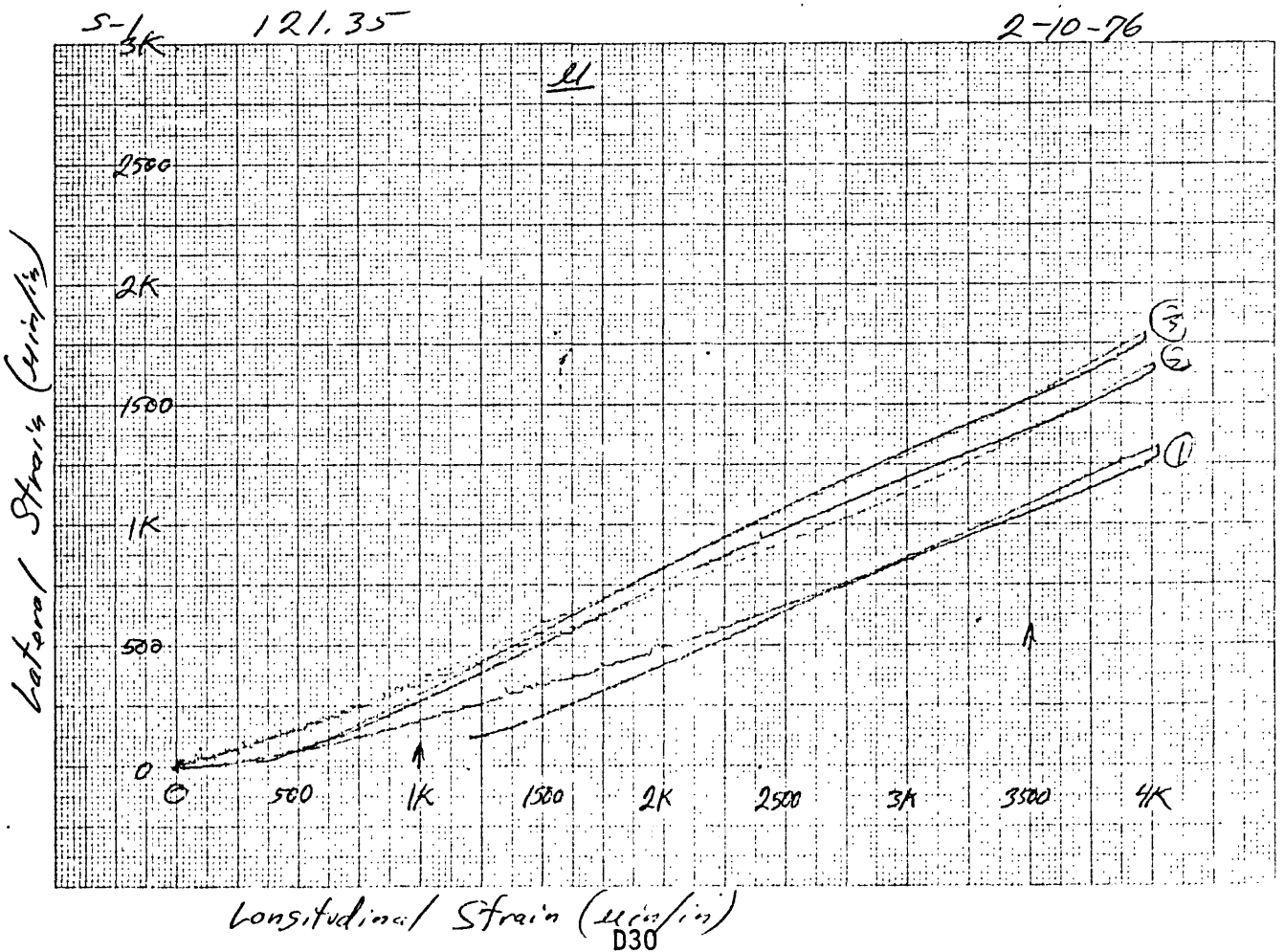
2-13-75



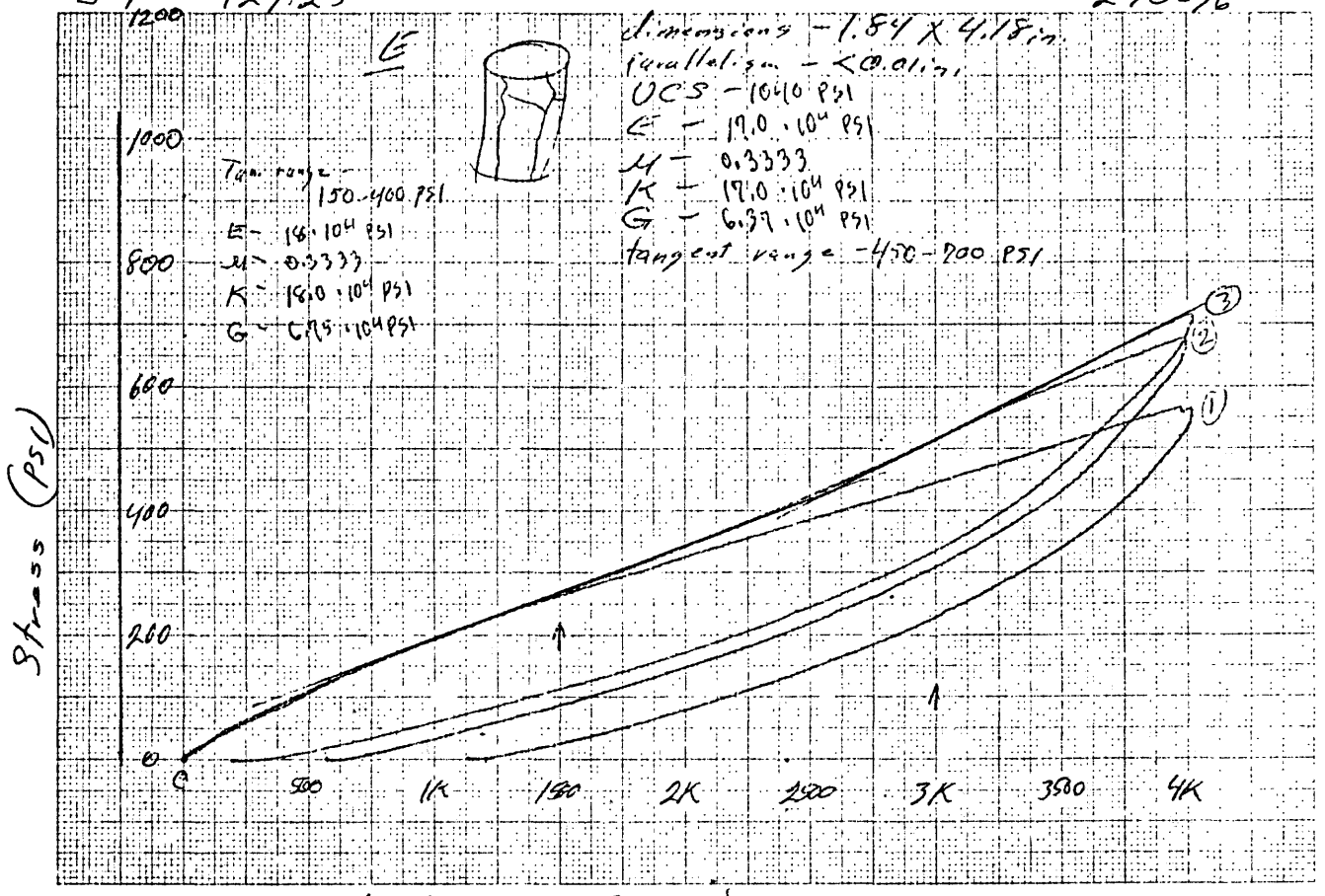
S-1 120.65



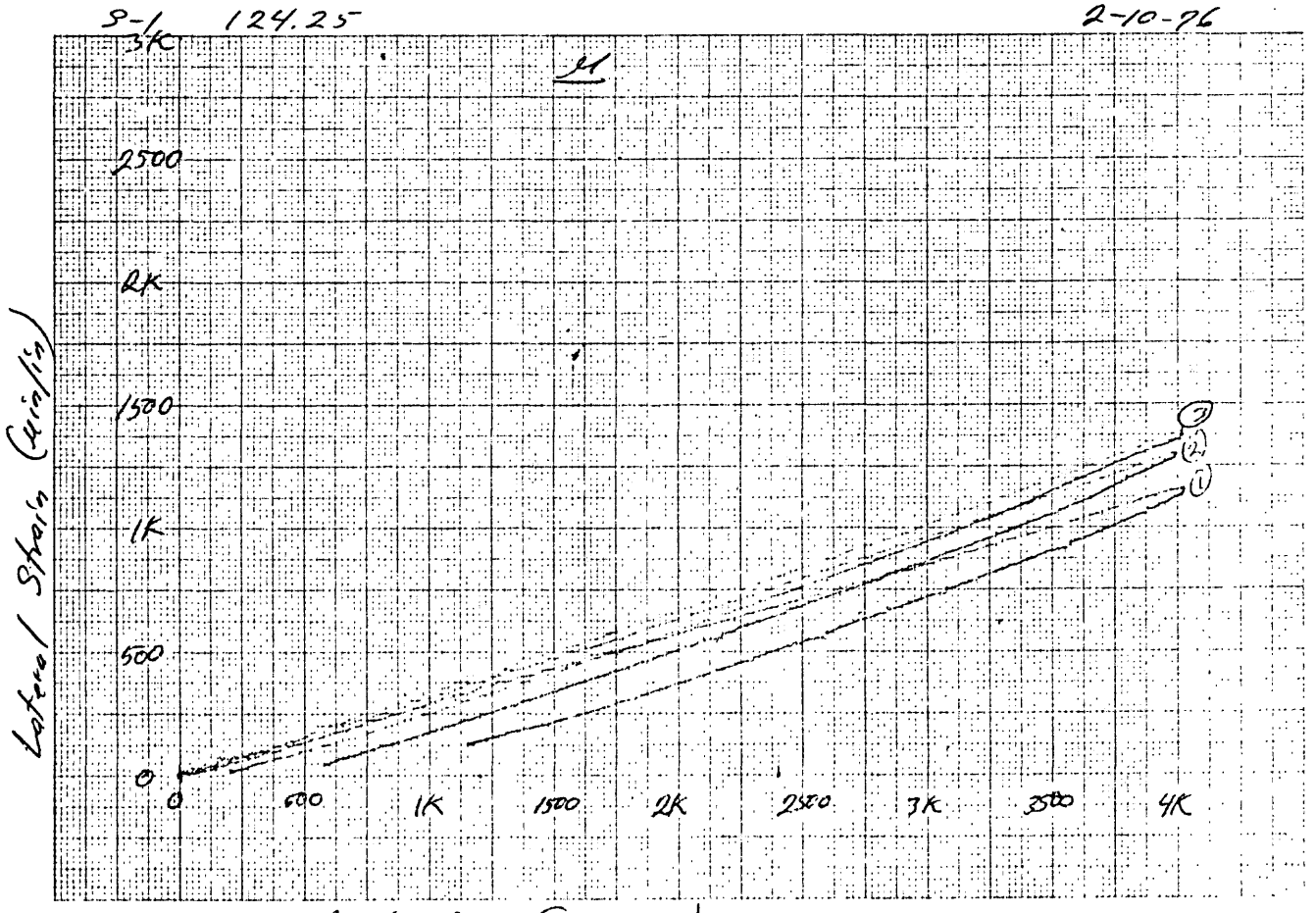

S-1
121.35
2-10-76
E
dimensions -
parallelism < 0.01 in.
UCS - 1845 PSI
E - 25.71 · 10⁴ PSI
μ - 0.4359
K - 66.67 · 10⁴ PSI
G - 8.96 · 10⁴ PSI
tangent rang - 750-1100 PSI
Tan. range - 0-300 PSI
E - 19.0 · 10⁴ PSI
μ - 0.350
K - 21.11 · 10⁴ PSI
G - 7.04 · 10⁴ PSI
1200
1K
800
600
400
200
0
Stress (PSI)
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin/in)


S-1
121.35
2-10-76
μ
3K
2500
2K
1500
1K
500
0
Lateral Strain (μin/in)
0
500
1K
1500
2K
2500
3K
3500
4K
Longitudinal Strain (μin/in)

S-1 124.25" 2-10-76



S-1 124.25" 2-10-76



Submitter: R. A. Farrow

Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75

Analyst: Eric Smirnow

Reviewed by:

	SAMPLE NUMBER				
	S-1-7.80	S-1-8.40	S-1-8.40a	S-1-8.90	S-1-9.20
Gravel: 76 - 4.76 mm (% by weight)		0			0
Sand: 4.76 - 0.075 mm (% by weight)		0			0
Silt: 0.075 - 0.005 mm (% by weight)		52			37
Clay: <0.005 mm (% by weight)		48			63
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)		41			50
Plastic limit [PL] (% of dry soil weight)		19			19
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)		22			31
Unified soil classification		CL			CL-CH
As received water content [w] (% of dry soil weight)	19.6	13.6	14.7	14.8	15.1
Activity: A = PI ÷ % finer than 0.002 mm		0.56			0.62
Liquidity index: $I_L = (w - PL) \div PI$		-0.3			-0.1
$CaCO_3$		- *			-

REMARKS: * - No reaction
S-1-8.40 - Top of core variable in color; therefore, two water content tests.
and
S-1-8.40a Two hard claystone aggregates approximately 1 cm in diameter present in core, and removed prior to testing.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H.W.Olser

	SAMPLE NUMBER				
	S-1-9.70	S-1-9.85	S-1-10.60	S-1-11.00	S-1-11.40
Gravel: 76 - 4.76 mm (% by weight)		0	0	0	
Sand: 4.76 - 0.075 mm (% by weight)		6	32	0	
Silt: 0.075 - 0.005 mm (% by weight)		60	46	46	
Clay: <0.005 mm (% by weight)		34	22	54	
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)		34	27	41	
Plastic limit [PL] (% of dry soil weight)		17	22	19	
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)		17	5	22	
Unified soil classification		CL	CL-ML	CL	
As received water content [w] (% of dry soil weight)	11.4	12.4	11.0	18.2	16.3
Activity: A = PI ÷ % finer than 0.002 mm		0.63	0.29	0.52	
Liquidity index: $I_L = (w - PL) \div PI$		- 0.3	- 2.2	0	
$CaCO_3$		+*	TR **	+	

REMARKS: * + - strong reaction
** TR - weak reaction

Submitter: R. A. Farrow
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ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H.W.Olsen

	SAMPLE NUMBER				
	S-1-11.53	S-1-15.30	S-1-15.45	S-1-17.05	S-1-17.20
Gravel: 76 - 4.76 mm (% by weight)		0	0	0	
Sand: 4.76 - 0.075 mm (% by weight)		6.5	1.5	1.5	
Silt: 0.075 - 0.005 mm (% by weight)		9	5.5	72.5	
Clay: <0.005 mm (% by weight)		84.5	93	26	
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)		62	69	30	
Plastic limit [PL] (% of dry soil weight)		30	27	18	
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)		32	42	12	
Unified soil classification		CH	CH	CL	
As received water content [w] (% of dry soil weight)	15.1				14.0
Activity: A = PI ÷ % finer than 0.002 mm		0.43	0.49	0.57	
Liquidity index: $I_L = (w - PL) \div PI$					
$CaCO_3$		-	-	-	

REMARKS: S-1-15.30 - Coal fragments up to 1 cm diameter present in core; larger fragments removed prior to testing. Wood fragments up to several mm in length present in core; not removed prior to testing.
S-1-15.45 - Wood fragments up to several mm in length present in core; not removed prior to testing.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H.W.Olsen

	SAMPLE NUMBER				
	S-1-17.50	S-1-17.80	S-1-18.15	S-1-18.90	S-1-19.05
Gravel: 76 - 4.76 mm (% by weight)			0		0
Sand: 4.76 - 0.075 mm (% by weight)			0.5		19
Silt: 0.075 - 0.005 mm (% by weight)			38		71
Clay: <0.005 mm (% by weight)			61.5		10
Coefficient of uniformity: C_u = D60 ÷ D10					13.0
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					6.0
Liquid limit [LL] (% of dry soil weight)			47		26
Plastic limit [PL] (% of dry soil weight)			18		18
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)			29		8
Unified soil classification			CL		CL
As received water content [w] (% of dry soil weight)	11.0	11.0	14.6	10.5	13.7
Activity: A = PI ÷ % finer than 0.002 mm			0.59		0.94
Liquidity index: I_L = (w - PL) ÷ PI			-0.1		-0.5
$CaCO_3$			-		TR

REMARKS:

S-1-18.90 - Water content test from top of core, Bottom of core dissimilar (harder).

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SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H.W.Olsen

	SAMPLE NUMBER				
	S-1-20.90	S-1-22.00	S-1-22.00a	S-1-23.25	S-1-25.25
Gravel: 76 - 4.76 mm (% by weight)	0			0	0
Sand: 4.76 - 0.075 mm (% by weight)	5			6.5	2
Silt: 0.075 - 0.005 mm (% by weight)	29			10	15.5
Clay: <0.005 mm (% by weight)	66			83.5	82.5
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	55			67	62
Plastic limit [PL] (% of dry soil weight)	23			26	13
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	32			41	49
Unified soil classification	CH			CH	CH
As received water content [w] (% of dry soil weight)	17.9	15.0	26.3	25.3	15.7
Activity: A = PI ÷ % finer than 0.002 mm	0.59			0.58	0.73
Liquidity index: $I_L = (w - PL) \div PI$	-0.2			0	0.1
$CaCO_3$	-			-	-

REMARKS:
S-1-20.90 - Top of core more friable than bottom. Coal present in hydrometer sieve analysis.
S-1-22.00 - Coal and wood fragments from several mm to 1 cm present within core; larger fragments removed prior to testing. Variable texture and color within core; therefore, two water content tests.
and
S-1-22.00a - Particle size distribution and Atterberg Limits tests not performed due to water content variation within core.
S-1-23.25 - Coal and wood fragments up to several mm in length present within core; not removed prior to testing. Variable moisture and texture within core.
S-1-25.25 - Coal and wood fragments up to several mm in length present within core. Variable texture and plasticity within core. Fragments not removed prior to testing.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H.W.Olser

	SAMPLE NUMBER				
	S-1-26.00	S-1-27.10	S-1-27.65	S-1-30.25	S-1-32.55
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	0
Sand: 4.76 - 0.075 mm (% by weight)	1	4.5	0.5	8.5	33
Silt: 0.075 - 0.005 mm (% by weight)	50.5	47.5	40.5	44	42.5
Clay: <0.005 mm (% by weight)	48.5	48	59	47.5	24.5
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	41	39	47	36	28
Plastic limit [PL] (% of dry soil weight)	15	15	19	15	16
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	26	24	28	21	12
Unified soil classification	CL	CL	CL	CL	CL
As received water content [w] (% of dry soil weight)	9.7	7.6	4.2		5.2
Activity: A = PI ÷ % finer than 0.002 mm	0.67	0.62	0.59	0.54	0.63
Liquidity index: $I_L = (w - PL) \div PI$	-0.2	-0.3	-0.5		-0.9
$CaCO_3$	-	-	-	-	-

REMARKS: S-1-30.25 - Variable color and slightly variable hardness within core.

S-1-32.55 - Variable color and plasticity within core. Tests performed on the most uniform portion of sample.

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Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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	SAMPLE NUMBER				
	S-1-33.85	S-1-35.50	S-1-36.50	S-1-36.80	S-1-40.30
Gravel: 76 - 4.76 mm (% by weight)	0	0		0	0
Sand: 4.76 - 0.075 mm (% by weight)	84	3.5		3	0.5
Silt: 0.075 - 0.005 mm (% by weight)	11	15		30	66.5
Clay: <0.005 mm (% by weight)	5	81.5		67	33
Coefficient of uniformity: C_u = D60 ÷ D10	4.9				
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$	3.0				
Liquid limit [LL] (% of dry soil weight)	NP*	59		51	29
Plastic limit [PL] (% of dry soil weight)	NP	26		19	16
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	NP	33		32	13
Unified soil classification	SM	CH		CH	CL
As received water content [w] (% of dry soil weight)		14.8	11.9	12.1	8.0
Activity: A = PI ÷ % finer than 0.002 mm		0.53		0.59	0.49
Liquidity index: $I_L = (w - PL) \div PI$		-0.3		-0.2	-0.6
$CaCO_3$	-	-		-	-

REMARKS: * Non-plastic
S-1-35.50 - Lignitic composition. Small wood fragments up to several mm in length present within core; not removed prior to testing. Coal present in hydrometer sieve analysis.

S-1-36.80 - Coaly lenses up to 1 cm in thickness containing coal fragments < 1 mm in diameter present within core; aforementioned areas removed from test material.

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SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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	SAMPLE NUMBER				
	S-1-41.00	S-1-41.30	S-1-41.75	S-1-43.65	S-1-44.20
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	0
Sand: 4.76 - 0.075 mm (% by weight)	1.5	9.5	59.5	17.5	2
Silt: 0.075 - 0.005 mm (% by weight)	56	55.5	27	57.5	57.5
Clay: <0.005 mm (% by weight)	42.5	35	13.5	25	40.5
Coefficient of uniformity: C_u = D60 ÷ D10			205.9		
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$			2.3		
Liquid limit [LL] (% of dry soil weight)	37	31	NP	26	35
Plastic limit [PL] (% of dry soil weight)	17	16	NP	18	17
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	20	15	NP	8	22
Unified soil classification	CL	CL	SM	CL	CL
As received water content [w] (% of dry soil weight)			8.1	10.0	
Activity: A = PI ÷ % finer than 0.002 mm	0.57	0.55		0.40	0.71
Liquidity index: $I_L = (w - PL) \div PI$				-1.0	
$CaCO_3$	-	-	-	TR	TR

REMARKS: S-1-41.30 - Bottom of core more friable, coarser, and lighter in color than top. Both portions used in testing.

S-1-44.20 - Distinct boundary between two different materials within core which separated when handled; therefore, two test suites. Small hard brownish silty aggregates up to 5 mm in diameter present within core; largest aggregates removed prior to testing.

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ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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Reviewed by: H.W.Olsen

	SAMPLE NUMBER				
	S-1-44.20a	S-1-45.45	S-1-47.15	S-1-48.65	S-1-51.80
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	0
Sand: 4.76 - 0.075 mm (% by weight)	0.5	32.5	1.5	0	4.5
Silt: 0.075 - 0.005 mm (% by weight)	40.5	43	32	42.5	55.5
Clay: <0.005 mm (% by weight)	59	24.5	66.5	57.5	40
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	46	27	50	49	34
Plastic limit [PL] (% of dry soil weight)	20	16	21	20	17
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	26	11	29	29	17
Unified soil classification	CL	CL	CL-CH	CL	CL
As received water content [w] (% of dry soil weight)			15.0	11.5	
Activity: A = PI ÷ % finer than 0.002 mm	0.58	0.55	0.54	0.61	0.55
Liquidity index: $I_L = (w - PL) \div PI$			-0.2	-0.3	
$CaCO_3$	-	-	-	-	-

REMARKS: S-1-44.20a - See remarks for S-1-44.20
S-1-47.15 - Coal present in hydrometer sieve analysis.
S-1-48.65 - Coal present in hydrometer sieve analysis.

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SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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	SAMPLE NUMBER				
	S-1a-51.80	S-1a-52.85	S-1a-53.15	S-1a-54.80	S-1a-55.10
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	
Sand: 4.76 - 0.075 mm (% by weight)	6	0	0	1	
Silt: 0.075 - 0.005 mm (% by weight)	63	39.5	46	28	
Clay: <0.005 mm (% by weight)	31	60.5	54	71	
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	29	33	43	49	
Plastic limit [PL] (% of dry soil weight)	19	20	18	20	
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	10	13	25	29	
Unified soil classification	CL	CL	CL	CL	
As received water content [w] (% of dry soil weight)	9.8	10.1	10.0		14.7
Activity: A = PI ÷ % finer than 0.002 mm	0.39	0.27	0.59	0.47	
Liquidity index: $I_L = (w - PL) \div PI$	-0.9	-0.8	-0.3		
$CaCO_3$	-	-	-	-	

REMARKS: S-1a-51.80 - Begin samples from drill hole S-1a.
S-1a-54.80 - Variable color within core.
Coal present in hydrometer sieve analysis.

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ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

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	SAMPLE NUMBER				
	S-1a-55.60	S-1a-56.00	S-1a-58.05	S-1a-58.20	S-1a-58.75
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	0
Sand: 4.76 - 0.075 mm (% by weight)	27.5	2	0.5	22.5	4
Silt: 0.075 - 0.005 mm (% by weight)	37.5	59	40.5	41.5	12
Clay: <0.005 mm (% by weight)	35	39	59	36	84
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	29	33	48	31	64
Plastic limit [PL] (% of dry soil weight)	15	17	24	16	26
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	14	16	24	15	38
Unified soil classification	CL	CL	CL	CL	CH
As received water content [w] (% of dry soil weight)	9.4	8.7			
Activity: A = PI ÷ % finer than 0.002 mm	0.47	0.52	0.49	0.50	0.49
Liquidity index: $I_L = (w - PL) \div PI$	-0.4	-0.5			
$CaCO_3$	-	-	-	-	-

REMARKS: S-1a-55.60 - Coal present in hydrometer sieve analysis.
S-1a-56.00 - Coal present in hydrometer sieve analysis.
S-1a-58.20 - Coal present in hydrometer sieve analysis.
S-1a-58.75 - Only coal present in hydrometer sieve analysis.

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Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1a-61.05	S-1a-62.25	S-1a-66.15	S-1a-68.60	S-1a-70.60
Gravel: 76 - 4.76 mm (% by weight)		0	0	0	0
Sand: 4.76 - 0.075 mm (% by weight)		45.5	0.5	8.5	0
Silt: 0.075 - 0.005 mm (% by weight)		41.5	35	42	17
Clay: <0.005 mm (% by weight)		13	64.5	49.5	83
Coefficient of uniformity: C_u = D60 ÷ D10		51.3	2.6		
Coefficient of curvature : C_z = $(D30)^2$ ÷ (D60 x D10)		10.6	0.6		
Liquid limit [LL] (% of dry soil weight)		25	28	32	55
Plastic limit [PL] (% of dry soil weight)		16	16	15	23
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)		9	12	17	32
Unified soil classification		CL	CL	CL	CH
As received water content [w] (% of dry soil weight)	2.0	10.4	10.8	7.9	12.1
Activity: A = PI ÷ % finer than 0.002 mm		0.82	0.33	0.43	0.48
Liquidity index: I_L = (w - PL) ÷ PI		-0.6	-0.4	-0.4	-0.3
$CaCO_3$	+	+	-	TR	-

REMARKS: S-1a-61.05--Core composed of very competent material. Particle size distribution and Atterberg Limit tests not performed.
S-1a-62.25--Core competent at top becoming more friable downwards. Coal present in hydrometer sieve analysis.
S-1a-66.15--Carbonized leaf fossils near bottom of core. Coal present in hydrometer sieve analysis.
S-1a-68.60--Coal present in hydrometer sieve analysis.

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Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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Reviewed by: H. W. Olser

	SAMPLE NUMBER				
	S-1a-75.60	S-1a-75.75	S-1a-76.35	S-1a-76.50	S-1a-79.20
Gravel: 76 - 4.76 mm (% by weight)	0			0	0
Sand: 4.76 - 0.075 mm (% by weight)	15.5			13.5	22
Silt: 0.075 - 0.005 mm (% by weight)	47.5			67.5	51
Clay: <0.005 mm (% by weight)	37			19	27
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	39			NP	NP
Plastic limit [PL] (% of dry soil weight)	19			NP	NP
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	20			NP	NP
Unified soil classification	CL			ML	ML
As received water content [w] (% of dry soil weight)		7.6	12.2		
Activity: A = PI ÷ % finer than 0.002 mm	0.67				
Liquidity index: $I_L = (w - PL) \div PI$					
$CaCO_3$	-			TR	+

REMARKS: S-1a-75.60--Variable color and texture within core. Coal present in hydrometer sieve analysis.
S-1a-76.50--Coal present in hydrometer sieve analysis.

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Location: Sheridan, Wyoming

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SOIL SAMPLE TEST RESULTS

Date: 10/21/75
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Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1a-79.75	S-1a-80.65	S-1a-83.80	S-1a-86.20	S-1a-89.75
Gravel: 76 - 4.76 mm (% by weight)	0		0	0	0
Sand: 4.76 - 0.075 mm (% by weight)	25.5		2	69.5	16
Silt: 0.075 - 0.005 mm (% by weight)	53.5		51.5	14.5	49
Clay: <0.005 mm (% by weight)	21		46.5	16	35
Coefficient of uniformity: C_u = D60 ÷ D10				120	
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$				18.2	
Liquid limit [LL] (% of dry soil weight)	NP		31	NP	31
Plastic limit [PL] (% of dry soil weight)	NP		18	NP	19
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	NP		13	NP	12
Unified soil classification	ML		CL	SM	CL
As received water content [w] (% of dry soil weight)	12.6	4.3	8.9	14.5	9.3
Activity: A = PI ÷ % finer than 0.002 mm			0.38		0.44
Liquidity index: $I_L = (w - PL) \div PI$			-0.7		-0.8
$CaCO_3$	+	+	+	+	-

REMARKS: S-1a-79.75--Coal present in hydrometer sieve analysis.
S-1a-80.65--Core composed of very competent material. Particle size distribution and Atterberg Limit tests not performed.
S-1a-86.20--Coal present in hydrometer sieve analysis.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1a-95.95	S-1a-101.50	S-1a-113.30	S-1a-120.00	S-1a-120.55
Gravel: 76 - 4.76 mm (% by weight)	0	0	0		
Sand: 4.76 - 0.075 mm (% by weight)	0	0.5	1		
Silt: 0.075 - 0.005 mm (% by weight)	24.5	55.5	66.5		
Clay: <0.005 mm (% by weight)	75.5	44	32.5		
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	49	43	28		
Plastic limit [PL] (% of dry soil weight)	24	21	20		
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	25	22	8		
Unified soil classification	CL	CL	CL		
As received water content [w] (% of dry soil weight)	11.1	10.4	7.7	9.5	11.3
Activity: A = PI ÷ % finer than 0.002 mm	0.45	0.66	0.31		
Liquidity index: $I_L = (w - PL) \div PI$	-0.5	-0.5	-1.5		
$CaCO_3$	-	-	-		

REMARKS: S-1a-95.95--Coal predominant in hydrometer sieve analysis.
S-1a-113.30--Coal present in hydrometer sieve analysis.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1a-121.50	S-1a-123.30	S-1a-124.60		
Gravel: 76 - 4.76 mm (% by weight)	0		0		
Sand: 4.76 - 0.075 mm (% by weight)	14.5		51.5		
Silt: 0.075 - 0.005 mm (% by weight)	47		35		
Clay: <0.005 mm (% by weight)	38.5		13.5		
Coefficient of uniformity: C_u = D60 ÷ D10			44.7		
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$			9.9		
Liquid limit [LL] (% of dry soil weight)	32		26		
Plastic limit [PL] (% of dry soil weight)	17		20		
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	15		6		
Unified soil classification	CL		SM-SC		
As received water content [w] (% of dry soil weight)	8.5	11.6	10.0		
Activity: A = PI ÷ % finer than 0.002 mm	0.49		0.57		
Liquidity index: $I_L = (w - PL) \div PI$	-0.6		-1.7		
$CaCO_3$	-		-		

REMARKS:

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/17/75
Analyst: Eric Smirnow
Reviewed by:

	SAMPLE NUMBER				
	S-1-10.60	S-1-11.00	S-1-17.05	S-1-18.15	S-1-20.90
As received water content (% of dry soil wt.)	11.0	18.2		14.6	17.9
As received bulk density (g/cc)	2.22	2.23	2.16	2.22	2.11
Dry bulk density - calculated/measured - (g/cc)	2.00	1.89		1.94	1.79
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-	2.25	2.19		2.21	2.10
Grain density (g/cc)	2.68	2.70	2.64	2.66	2.60
Void ratio (calculated)	0.34	0.43		0.37	0.45
% Porosity (calculated)	25.4	30.1		27.1	31.1
% Saturation (calculated)	86.8	113.9		104.6	102.8

REMARKS:

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/17/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olson

	SAMPLE NUMBER				
	S-1-27.25	S-1-27.65	S-1-40.30	S-1-41.75	S-1-43.65
As received water content (% of dry soil wt.)		4.2	8.0	8.1	10.0
As received bulk density (g/cc)	2.20	2.34	2.37	2.36	2.23
Dry bulk density - calculated/measured - (g/cc)		2.24	2.19	2.18	2.03
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-		2.41	2.36	2.42	2.26
Grain density (g/cc)	2.69	2.69	2.63	2.85	2.66
Void ratio (calculated)		0.20	0.20	0.30	0.31
% Porosity (calculated)		16.5	16.6	23.3	23.7
% Saturation (calculated)		57.8	105.7	75.9	85.7

REMARKS:

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/21/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1-47.15	S-1-48.65	S-1a-51.80	S-1a-52.85	S-1a-53.15
As received water content (% of dry soil wt.)	15.0	11.5	9.8	10.1	10.0
As received bulk density (g/cc)	2.29	2.28	2.30	2.35	2.35
Dry bulk density - calculated/measured - (g/cc)	1.99	2.04	2.10	2.13	2.14
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-	2.24	2.27	2.31	2.34	2.34
Grain density (g/cc)	2.65	2.64	2.66	2.68	2.69
Void ratio (calculated)	0.33	0.29	0.27	0.25	0.26
% Porosity (calculated)	24.9	22.7	21.3	20.3	20.4
% Saturation (calculated)	119.5	104.0	96.0	106.3	104.4

REMARKS: S-1a-51.80 - Begin samples from drill hole S-1a.

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Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/20/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olsen

	SAMPLE NUMBER				
	S-1a-55.10	S-1a-56.00	S-1a-61.05	S-1a-62.15	S-1a-68.60
As received water content (% of dry soil wt.)	14.7	8.7	2.0		7.9
As received bulk density (g/cc)	2.14	2.30	2.59	*	2.38
Dry bulk density - calculated/measured - (g/cc)	1.87	2.12	2.54		2.21
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-	2.16	2.31	2.60		2.36
Grain density (g/cc)	2.65	2.62	2.70	2.65	2.62
Void ratio (calculated)	0.42	0.24	0.06		0.19
% Porosity (calculated)	29.6	19.3	6.1		15.7
% Saturation (calculated)	92.4	95.9	84.0		110.5

REMARKS: *S-1a-62.15--Test not performed-broken sample jar.

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/20/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1a-70.60	S-1a-76.35	S-1a-80.65	S-1a-83.80	S-1a-86.20
As received water content (% of dry soil wt.)	12.1	12.2	4.3	8.9	14.5
As received bulk density (g/cc)	2.32	2.23	2.55	2.36	2.15
Dry bulk density - calculated/measured - (g/cc)	2.07	1.99	2.45	2.17	1.88
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-	2.29	2.24	2.53	2.37	2.17
Grain density (g/cc)	2.66	2.66	2.66	2.72	2.64
Void ratio (calculated)	0.29	0.34	0.09	0.25	0.41
% Porosity (calculated)	22.3	25.4	8.2	20.3	29.0
% Saturation (calculated)	112.1	95.4	126.8	95.0	93.8
REMARKS:					

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 10/20/75
Analyst: Eric Smirnow
Reviewed by: H. W. Olsen

	SAMPLE NUMBER				
	S-1a-89.75	S-1a-95.95	S-1a-101.50	S-1a-113.30	S-1a-124.60
As received water content (% of dry soil wt.)	9.3	11.1	10.4	7.7	10.0
As received bulk density (g/cc)	2.30	2.33	2.32	2.33	2.33
Dry bulk density - calculated/measured - (g/cc)	2.10	2.10	2.10	2.16	2.12
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)-saturated-	2.31	2.31	2.32	2.33	2.33
Grain density (g/cc)	2.66	2.66	2.67	2.60	2.68
Void ratio (calculated)	0.26	0.27	0.27	0.20	0.27
% Porosity (calculated)	20.8	21.3	21.3	16.9	21.0
% Saturation (calculated)	94.0	109.8	102.3	98.5	101.1

REMARKS:

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 3/25/76
Analyst: J. Odum
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1-12.30	S-1-13.03	S-1-19.50	S-1-28.05	S-1-34.80
Gravel: 76 - 4.76 mm (% by weight)	0	0	0	0	
Sand: 4.76 - 0.075 mm (% by weight)	2	1	24	13	
Silt: 0.075 - 0.005 mm (% by weight)	17	18	51	56	
Clay: <0.005 mm (% by weight)	81	81	25	31	
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	55	64	28	34	
Plastic limit [PL] (% of dry soil weight)	33	30	19	11	
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	22	34	9	23	
Unified soil classification	MH	CL	CL	CL	
As received water content [w] (% of dry soil weight)					
Activity: A = PI ÷ % finer than 0.002 mm	.33	.53	.43	.96	
Liquidity index: I_L = (w - PL) ÷ PI					
$CaCO_3$	(trace)	(trace)	(trace)	(+)	
	*	*	*	*	*

REMARKS: *S-1-12.30, mostly coal on hydrometer sieves
*S-1-13.03, ----do----------
*S-1-19.50, ----do----------
*S-1-28.05, less than 5% coal fragments on hydrometer sieves
*S-1-34.80, material not suitable for soil index tests

Submitter: R. A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
SOIL SAMPLE TEST RESULTS

Date: 3/25/76
Analyst: J. Odum
Reviewed by: H. W. Olser

	SAMPLE NUMBER				
	S-1-38.65	S-1-50.90	S-1a-63.65		
Gravel: 76 - 4.76 mm (% by weight)	0	0	0		
Sand: 4.76 - 0.075 mm (% by weight)	9	1	28		
Silt: 0.075 - 0.005 mm (% by weight)	38	43	49		
Clay: <0.005 mm (% by weight)	53	56	23		
Coefficient of uniformity: C_u = D60 ÷ D10					
Coefficient of curvature : $C_z = (D30)^2 \div (D60 \times D10)$					
Liquid limit [LL] (% of dry soil weight)	41	47	20		
Plastic limit [PL] (% of dry soil weight)	18	23	20		
Shrinkage limit [SL] (% of dry soil weight)					
Plasticity index [PI] (% of dry soil weight)	23	24	0		
Unified soil classification	CL	CL	CL		
As received water content [w] (% of dry soil weight)					
Activity: A = PI ÷ % finer than 0.002 mm	.53	.53			
Liquidity index: $I_L = (w - PL) \div PI$					
$CaCO_3$	(trace)	(trace)	(+)		
	*		*		

REMARKS: *S-1-38.65, some coal particles on hydrometer sieves
*S-1a-63.65, ----do----------

Submitter: Richard A. Farrow
Location: Sheridan, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 3/25/76
Analyst: Jack Odum
Reviewed by: H. W. Olse

	SAMPLE NUMBER				
	S-1-12.30	S-1-13.03	S-1-34.80a	S-1-34.80b	S-1-38.65
As received water content (% of dry soil wt.)					
As received bulk density (g/cc)	2.01	1.81	2.42	2.84	2.28
Dry bulk density - calculated/[illegible] - (g/cc)	1.87	2.03	2.26	2.51	2.15
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)					
Grain density (g/cc)	2.75	2.67	2.74	3.13	2.67
Void ratio (calculated)					
% Porosity (calculated)					
% Saturation (calculated)					

REMARKS: S-1-13.03, coal stringers
S-1-34.80a, gray, silty shale (hard)
S-1-34.80b, yellowish brown siltstone with iron (hard)

Submitter: Richard A. Farrow
Location: Buffalo, Wyoming

ENGINEERING GEOLOGY LABORATORY
MOISTURE/DENSITY TEST RESULTS

Date: 3/25/76
Analyst: Jack Odum
Reviewed by: H.W. Olsen

	SAMPLE NUMBER				
	B-61.90				
As received water content (% of dry soil wt.)					
As received bulk density (g/cc)	2.07				
Dry bulk density - calculated/[redacted] - (g/cc)	1.90				
Measured bulk density (g/cc)					
Calculated bulk density (g/cc)					
Grain density (g/cc)	2.64				
Void ratio (calculated)					
% Porosity (calculated)					
% Saturation (calculated)					

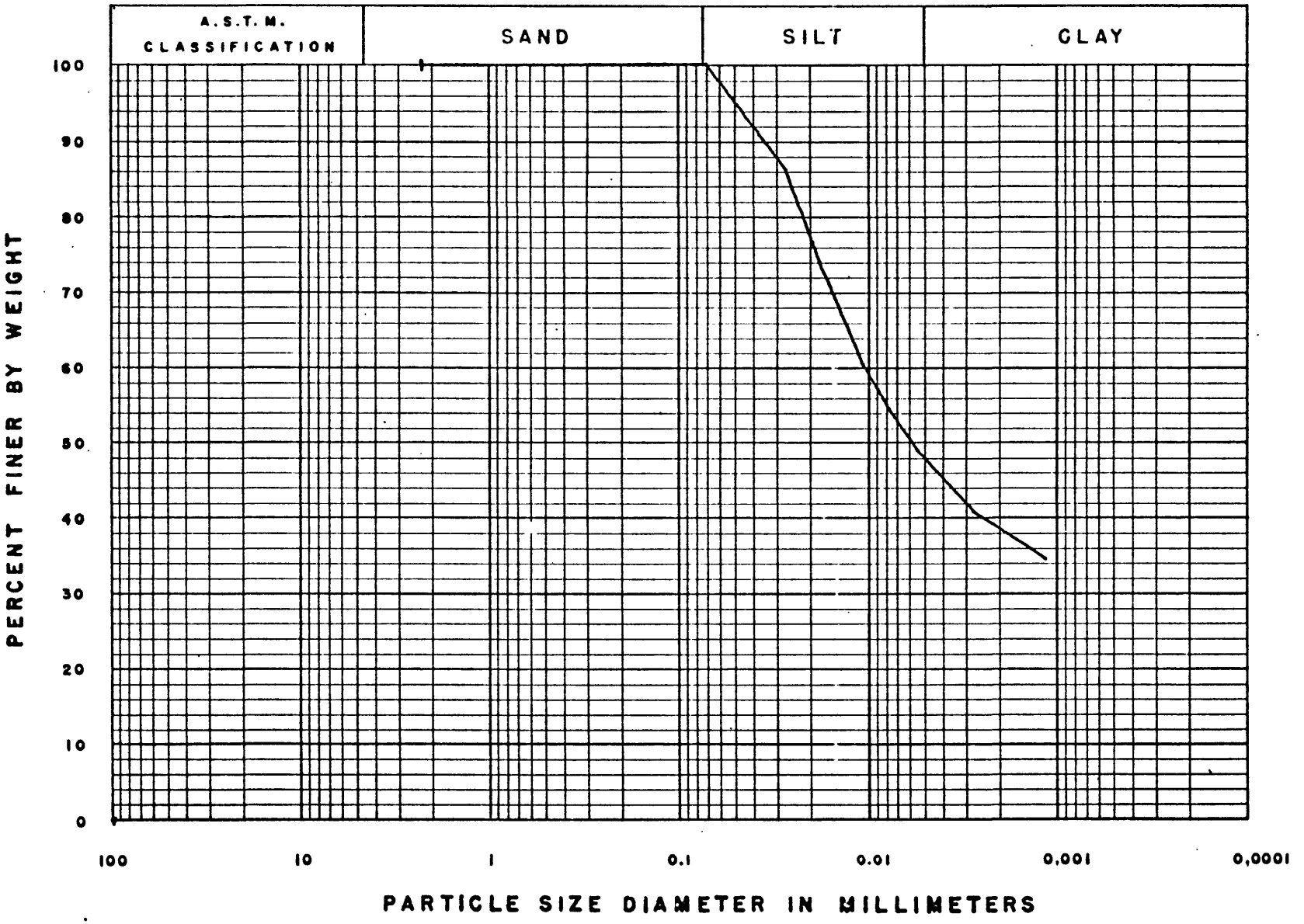
REMARKS:

D57

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-8.40



D58

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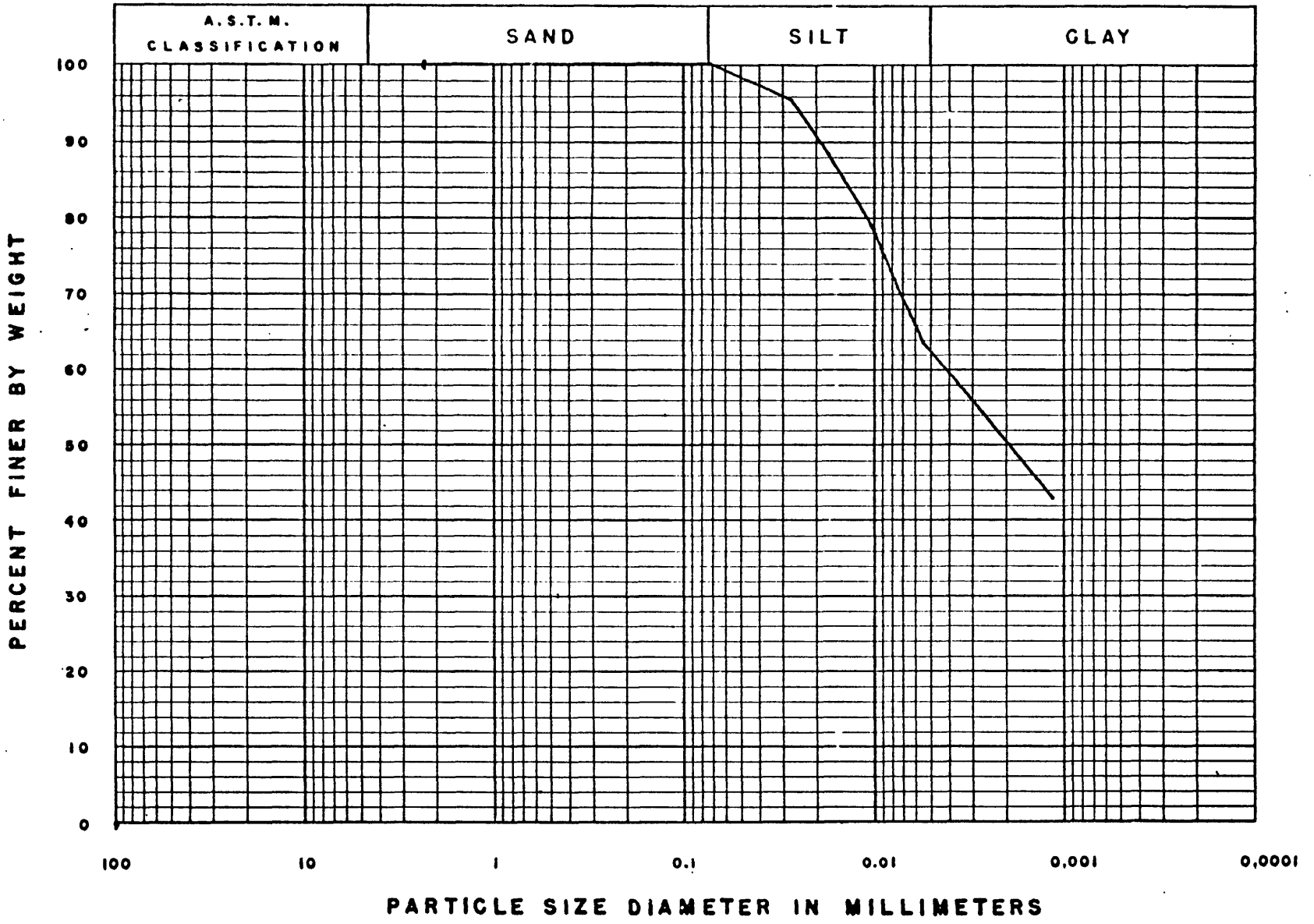
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-9.20



D59

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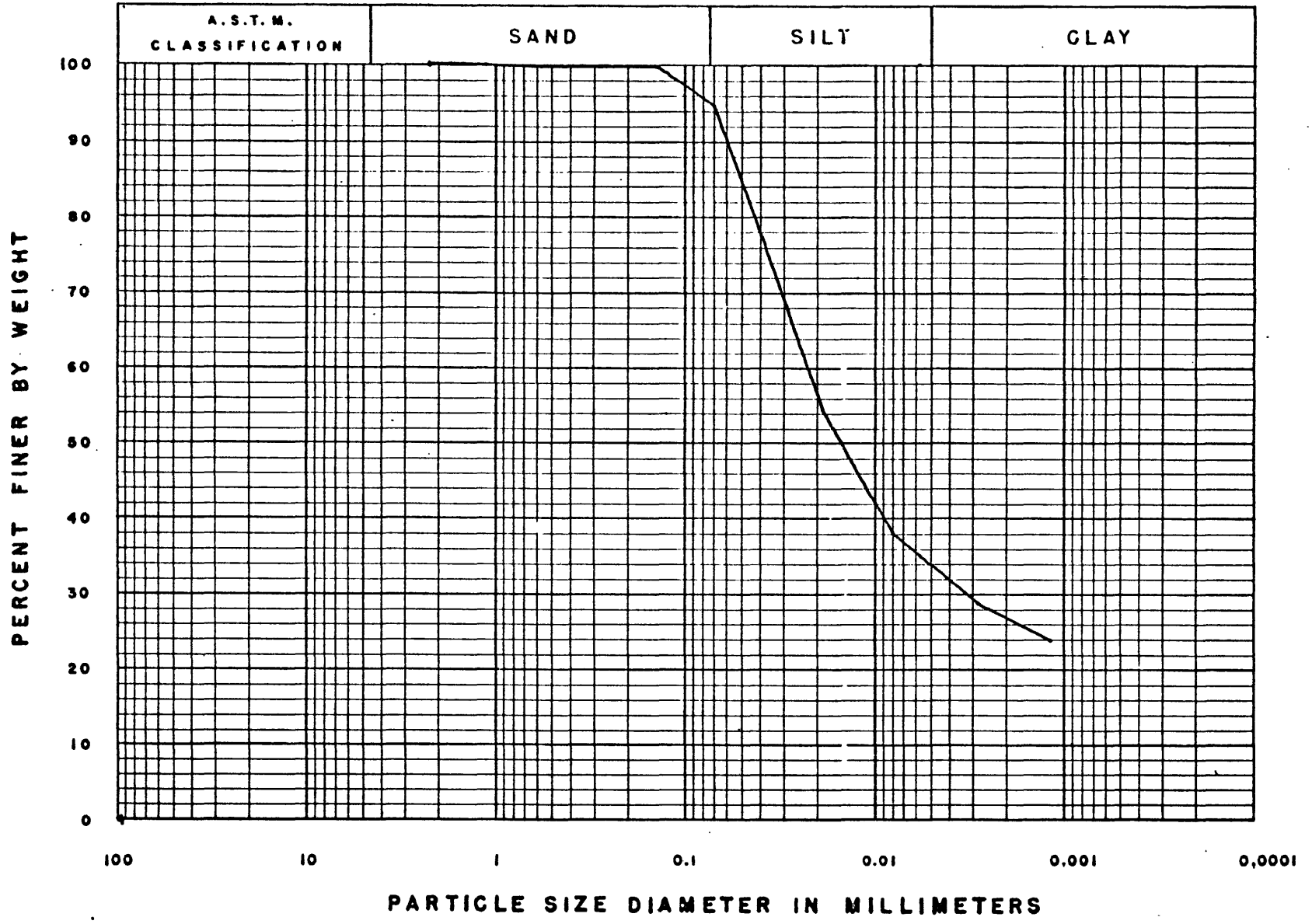
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-9.85



D60

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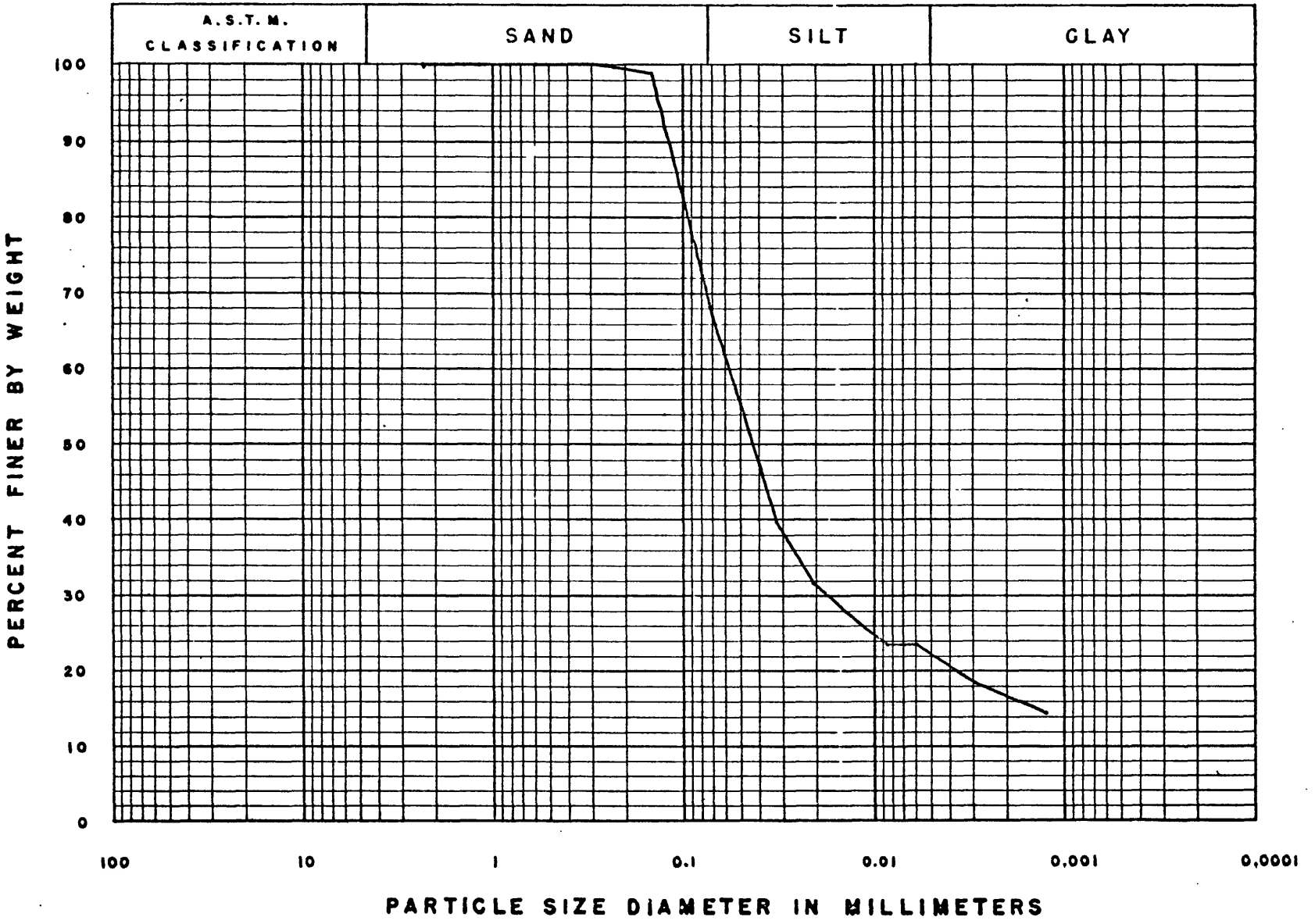
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-10.60



D61

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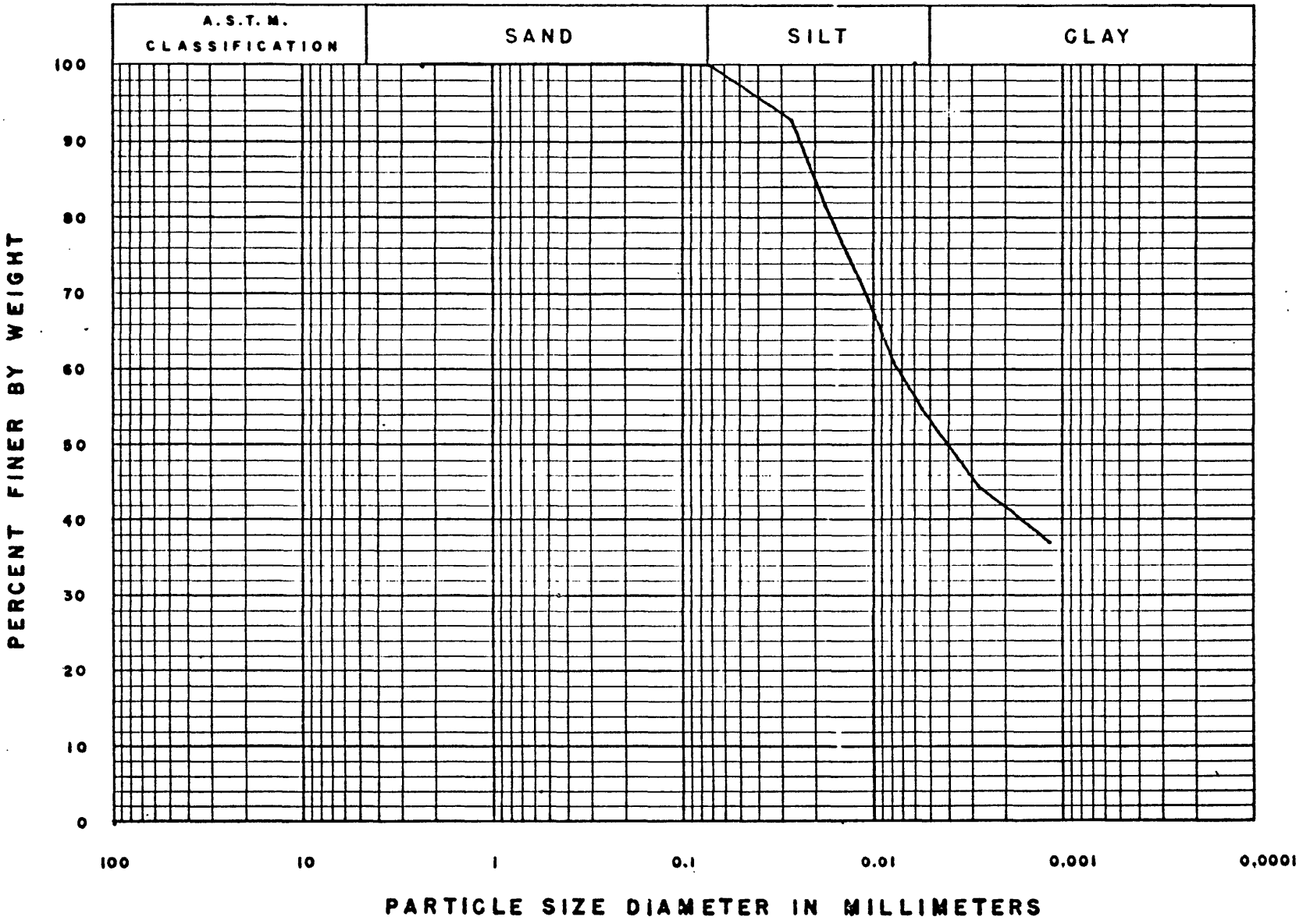
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-11.00



D62

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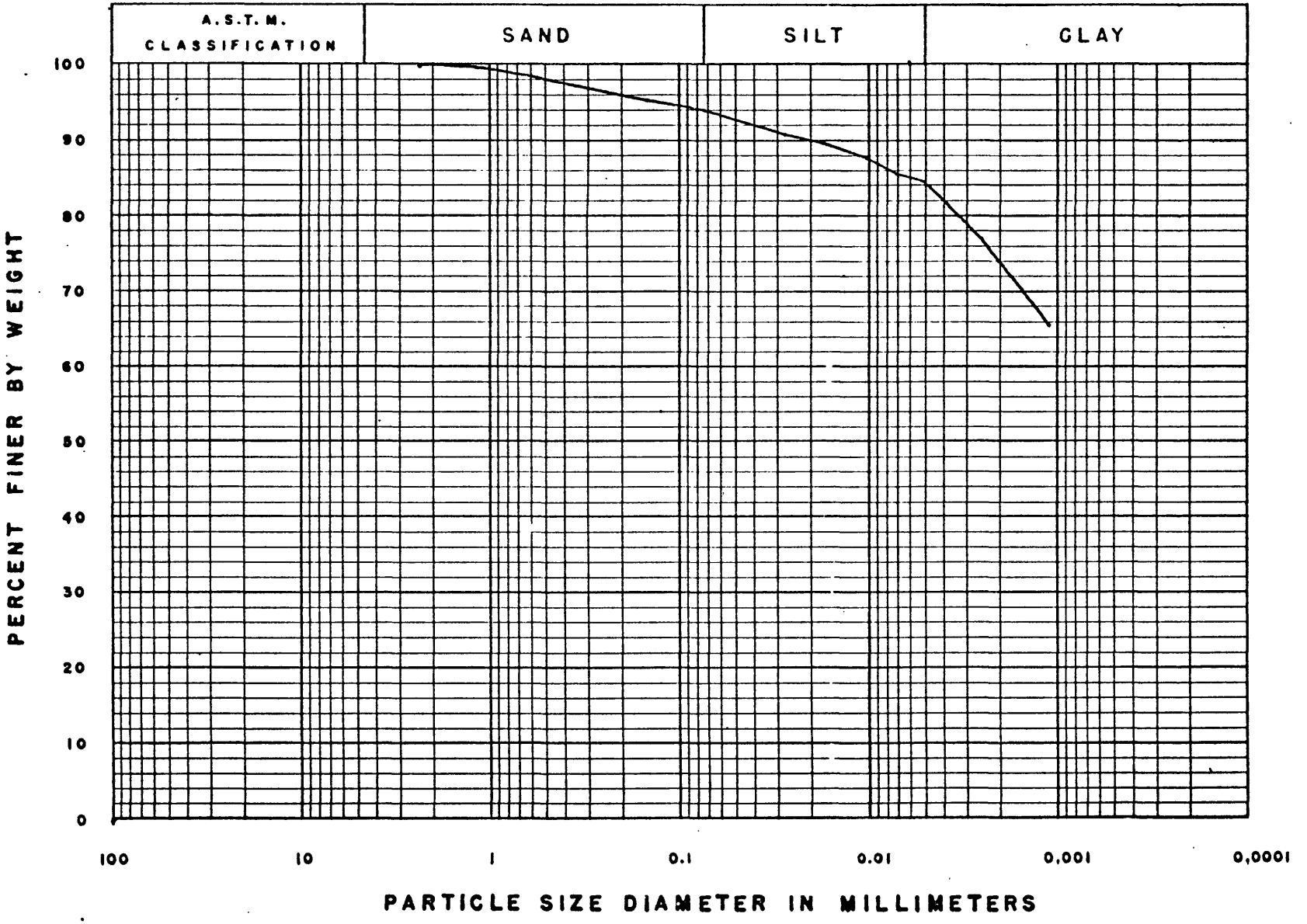
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-15.30



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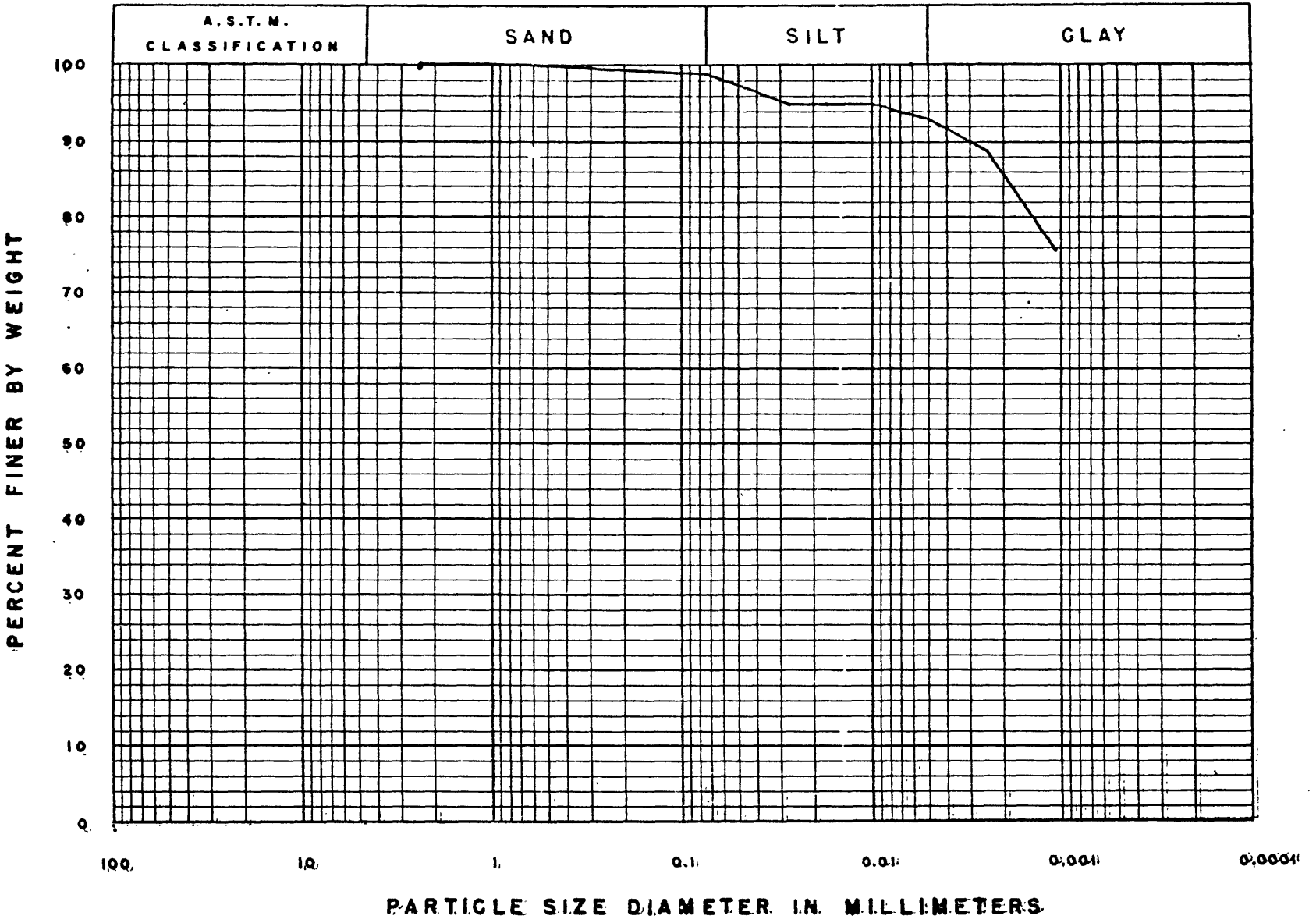
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-15.45



D64

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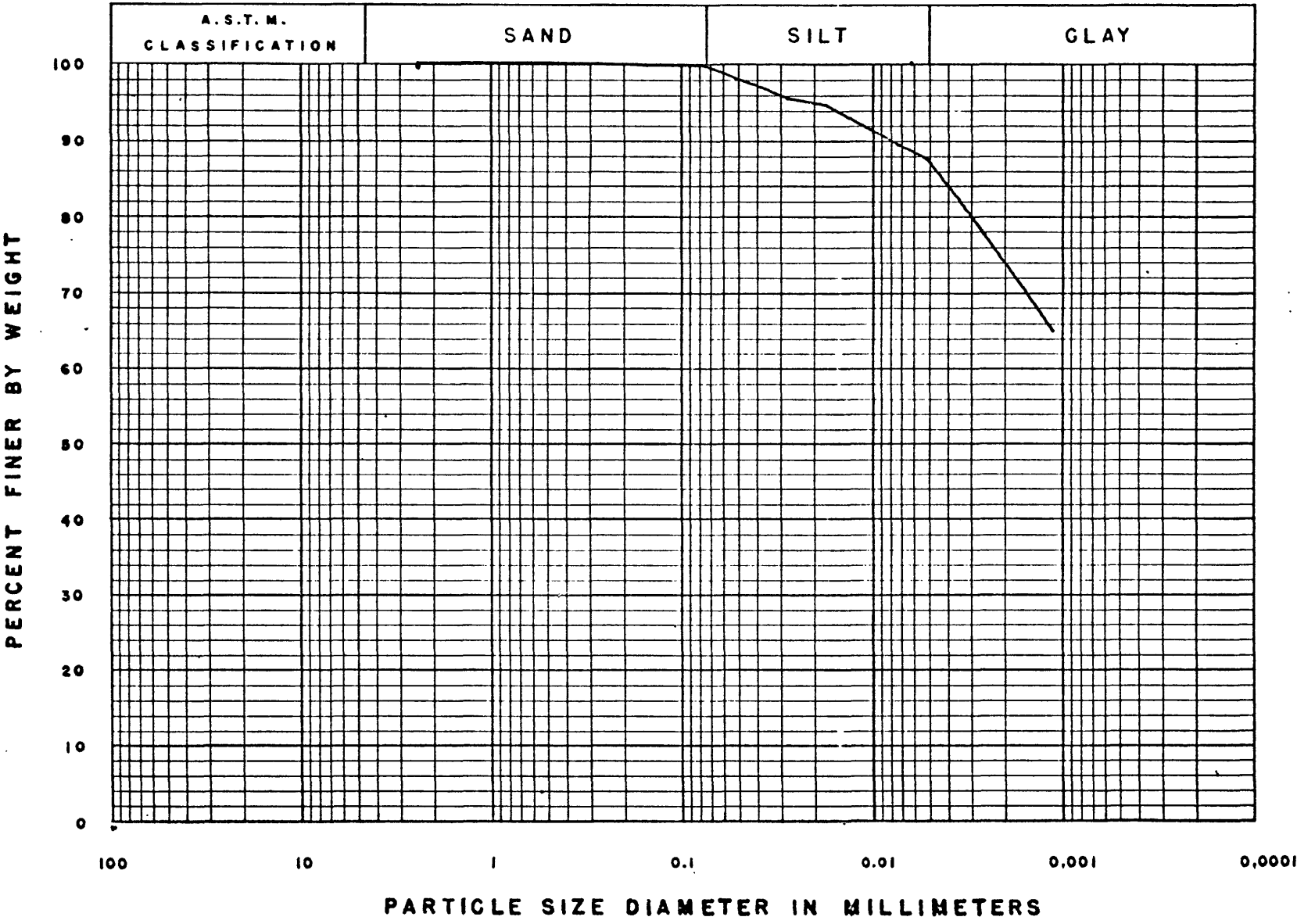
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-15.90



D65

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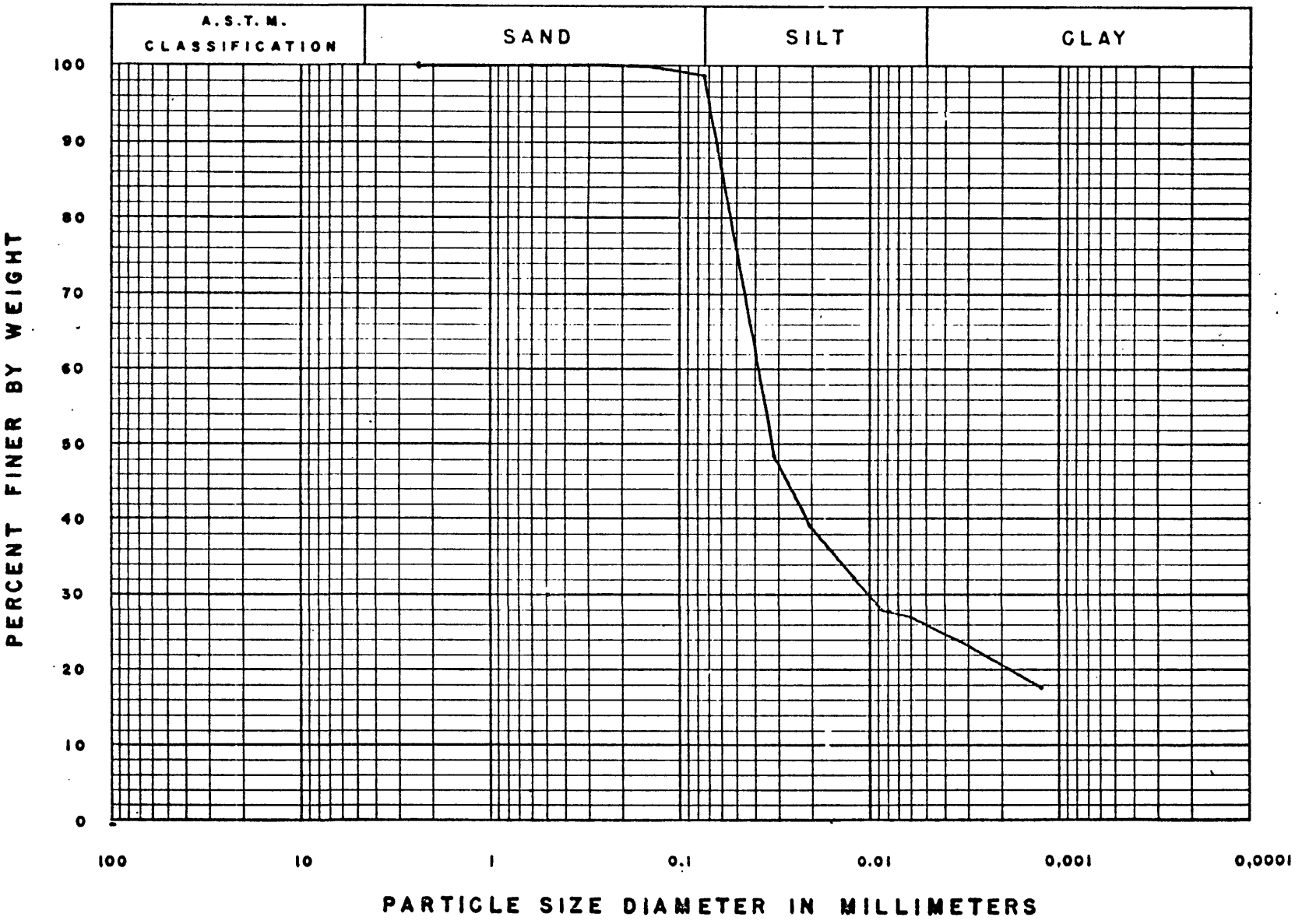
PARTICLE SIZE DISTRIBUTION CURVE

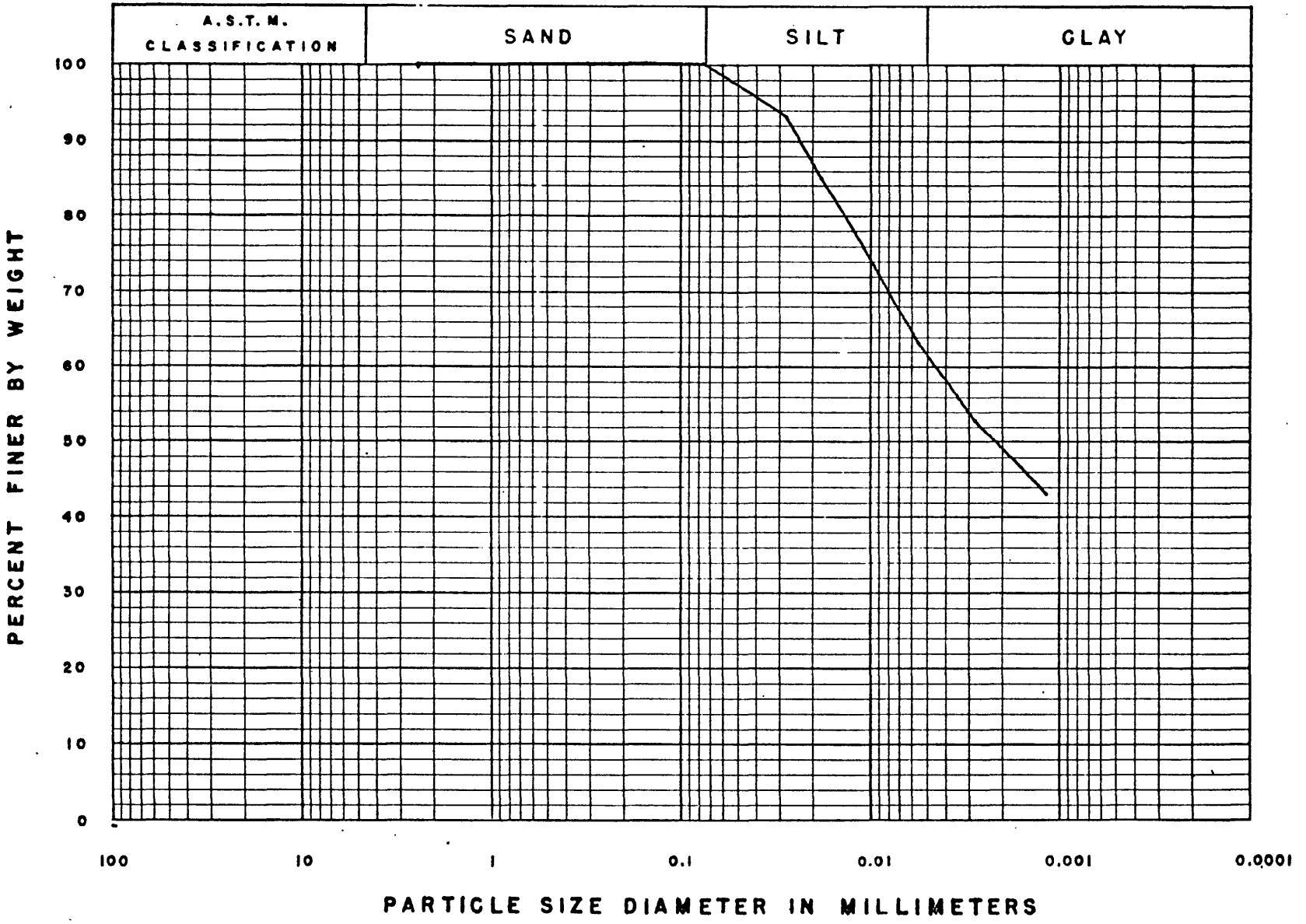
SAMPLE NUMBER S-1-17.05



ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-18.15



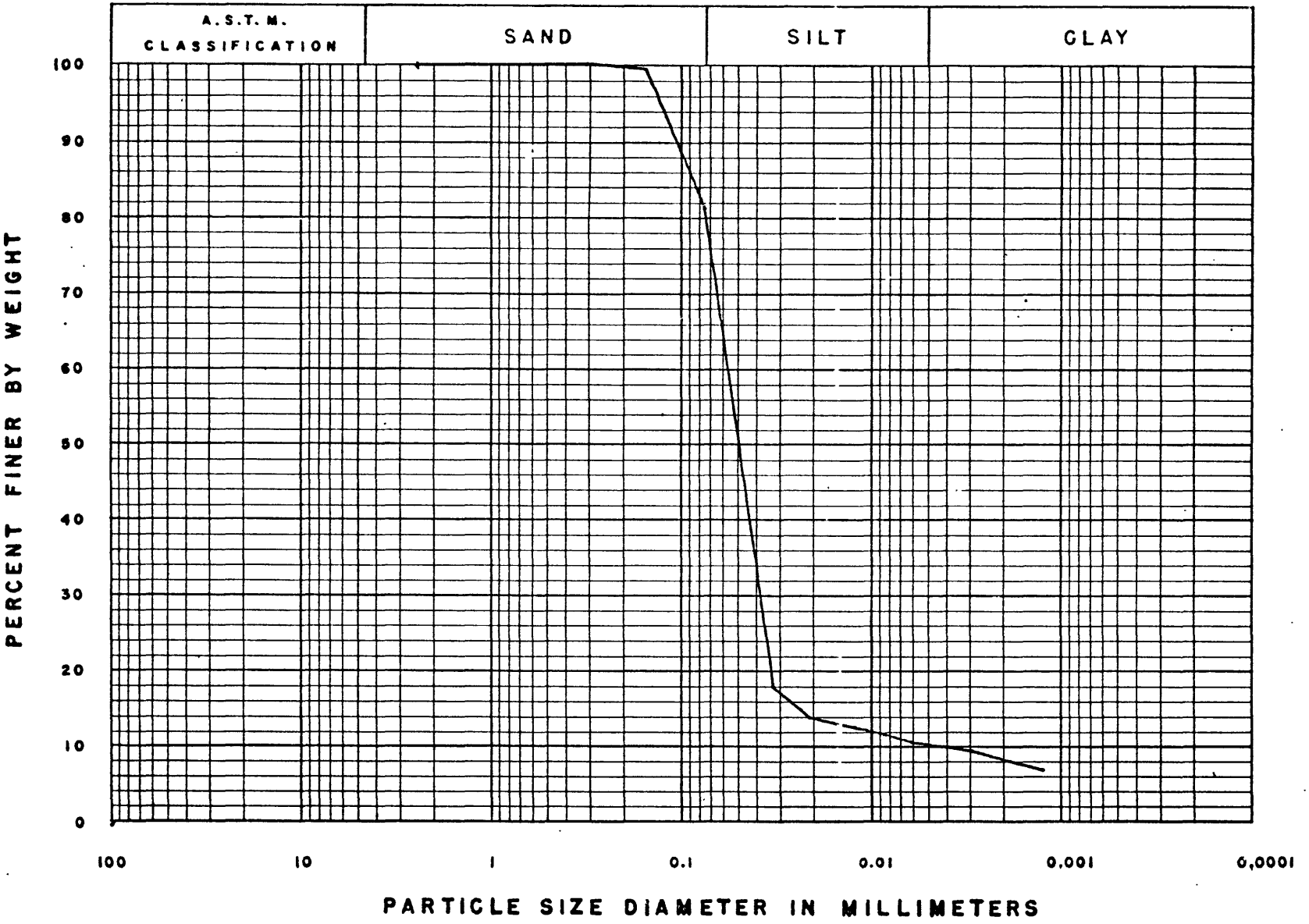
D67

GPO 831

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-19.05



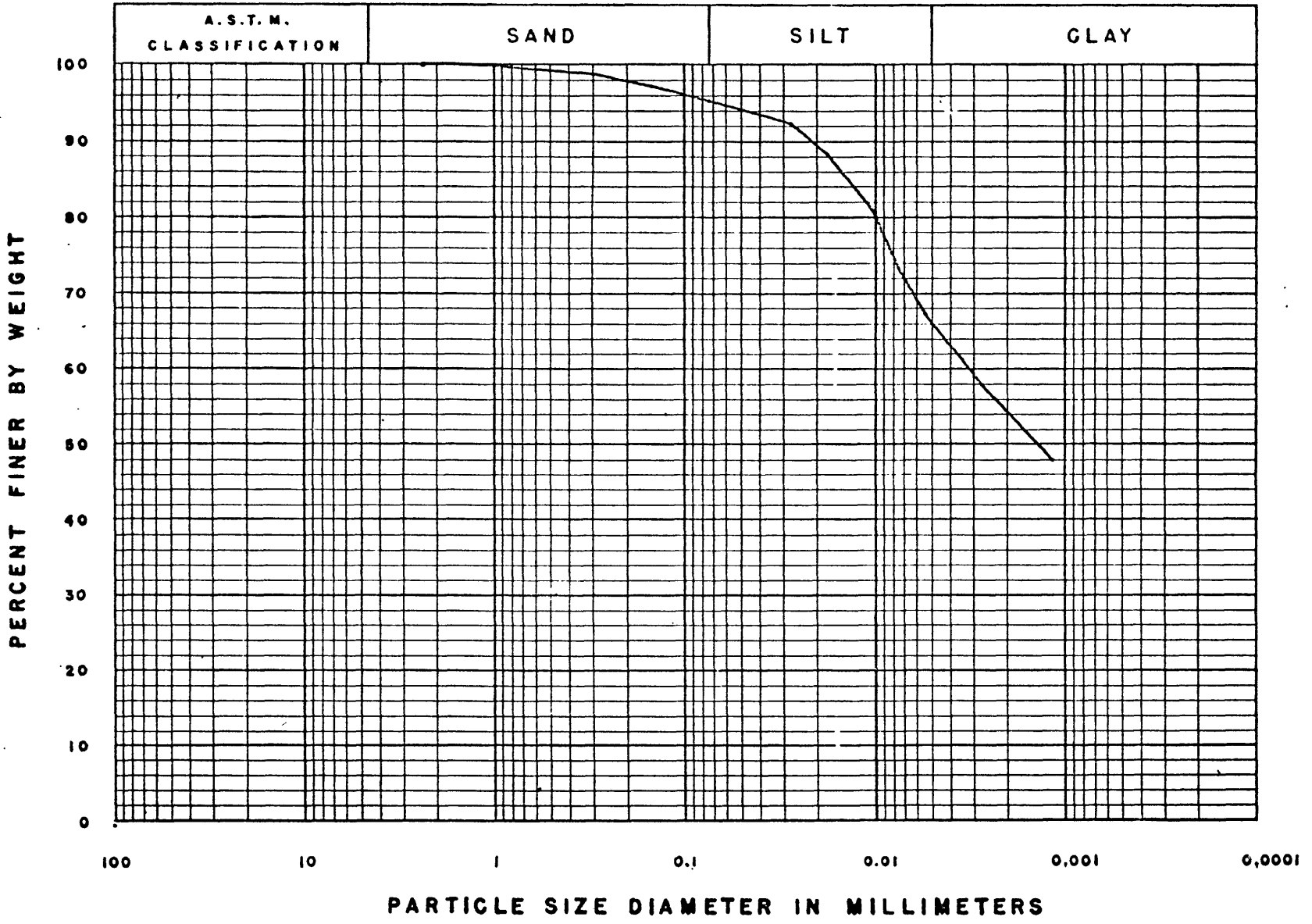
D68

GPO 831-711

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-20.90



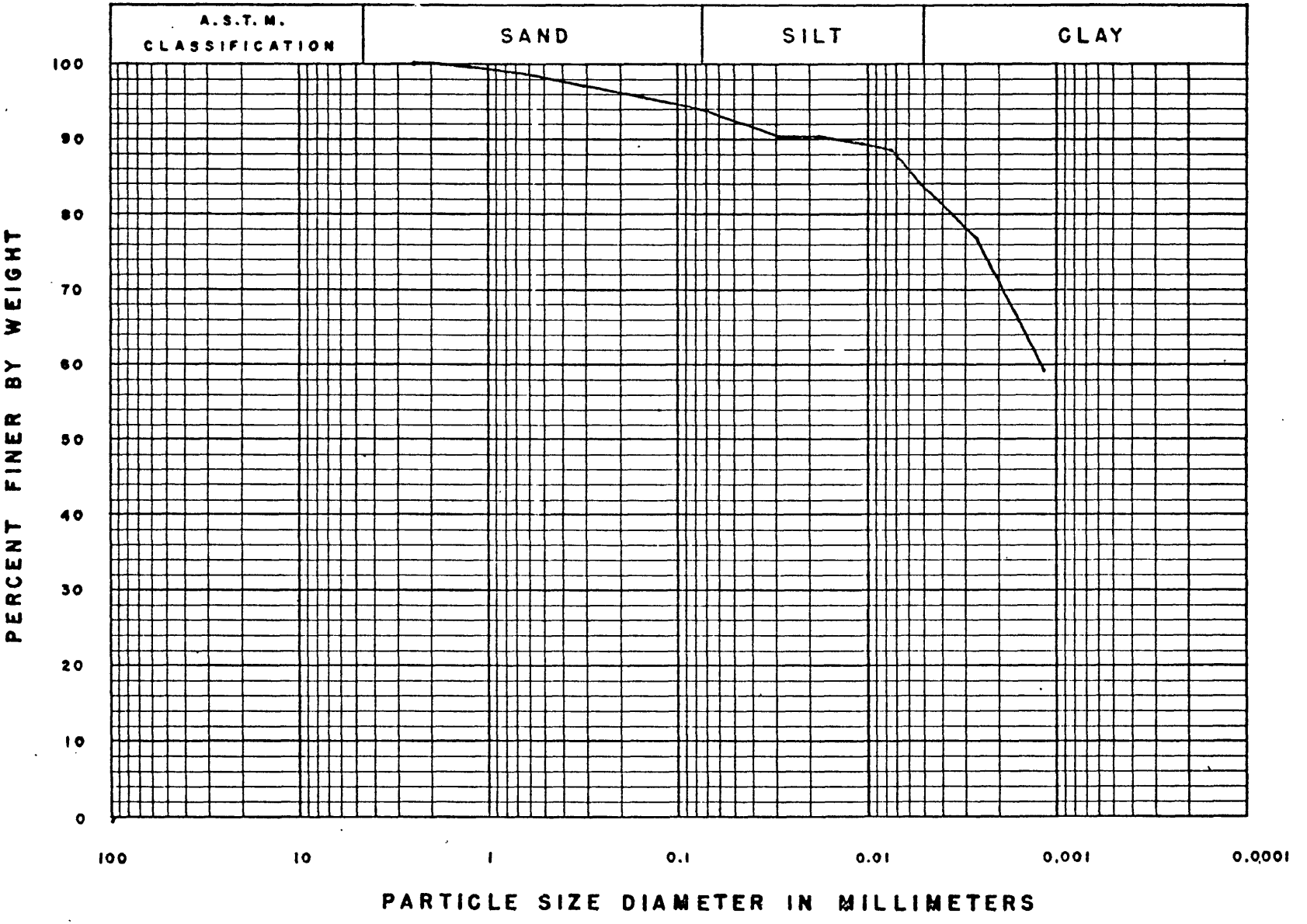
D69

GPO 831-718

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-23.25



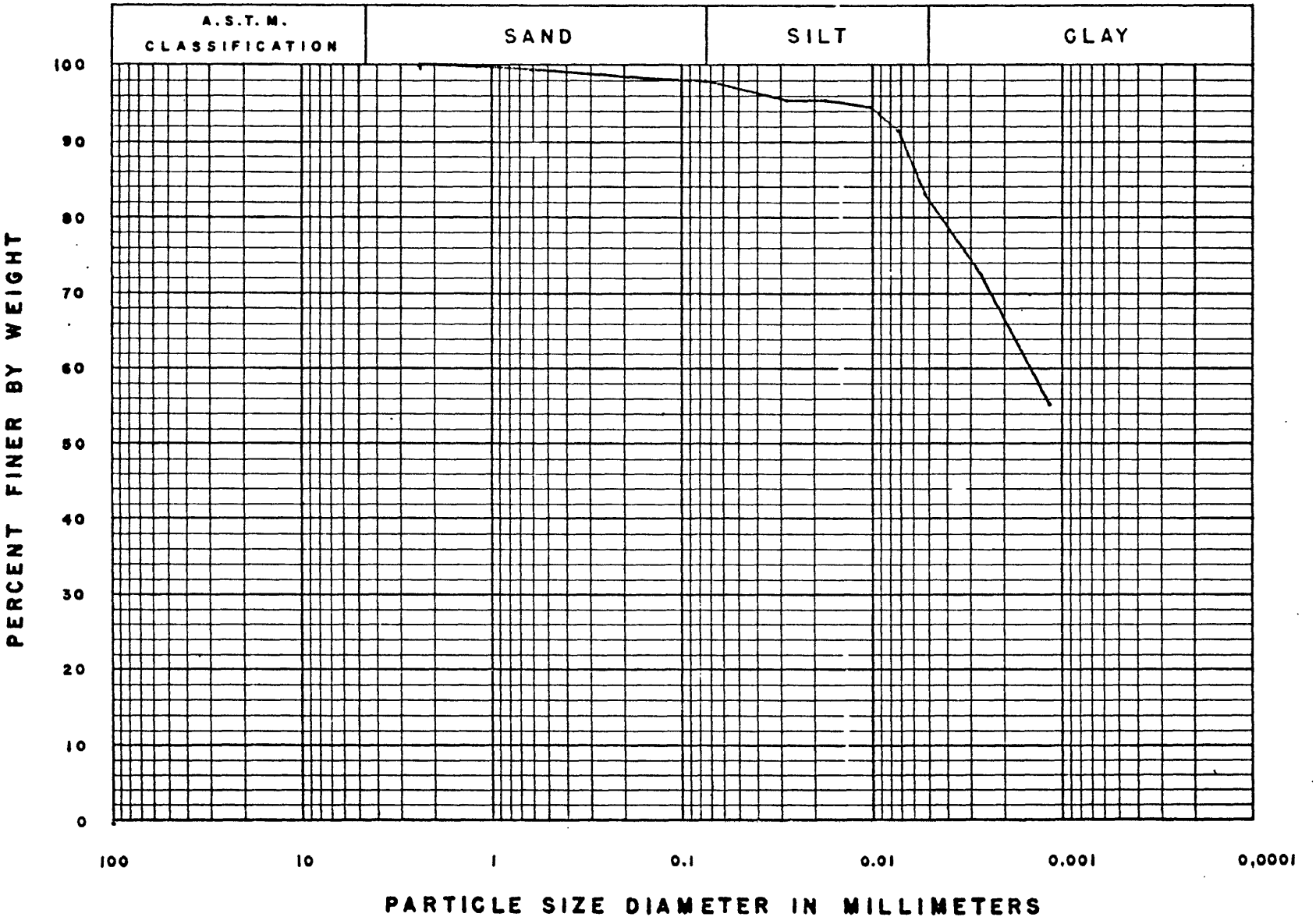
D70

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-25.25



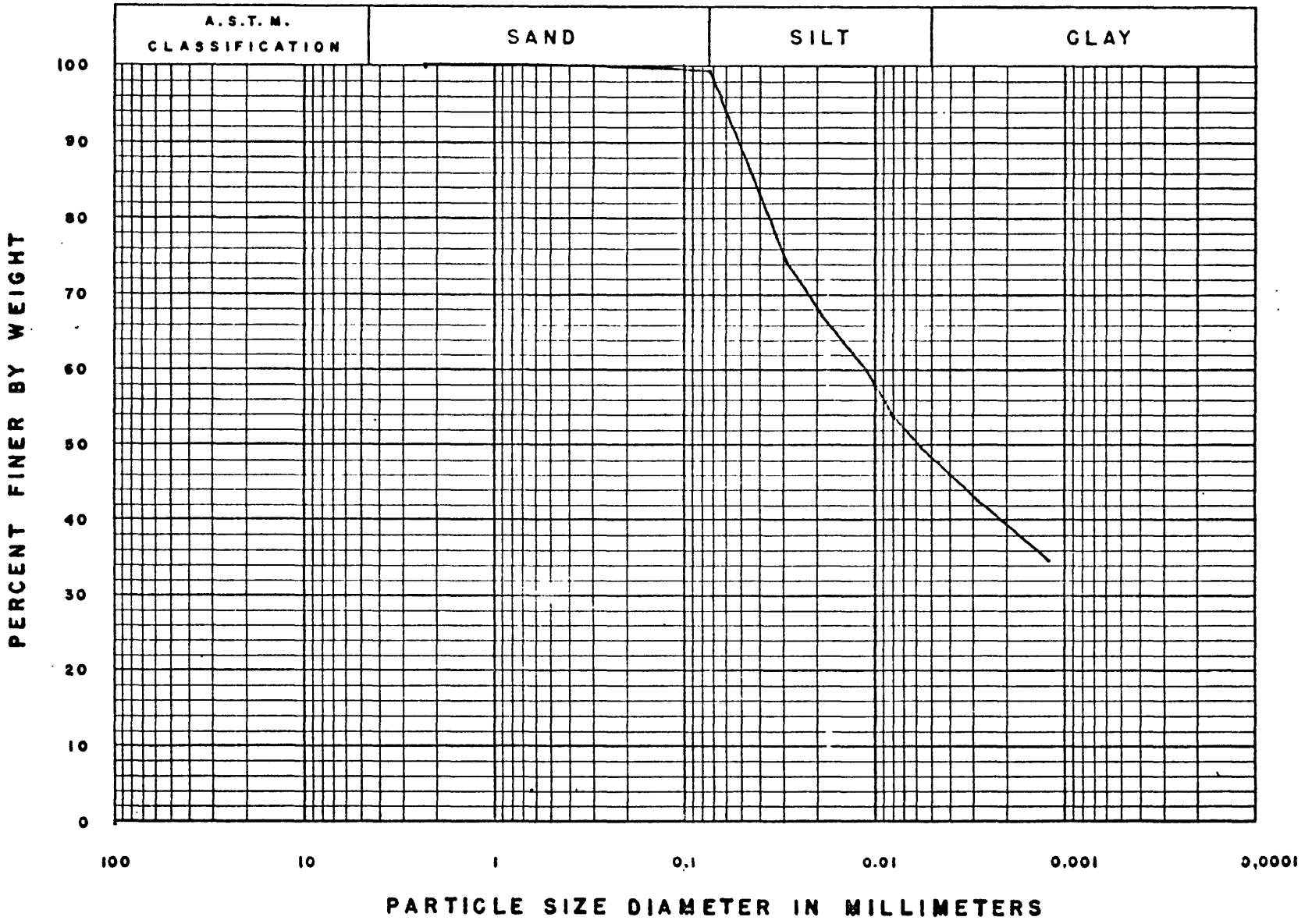
D71

GPO 821-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-26.00



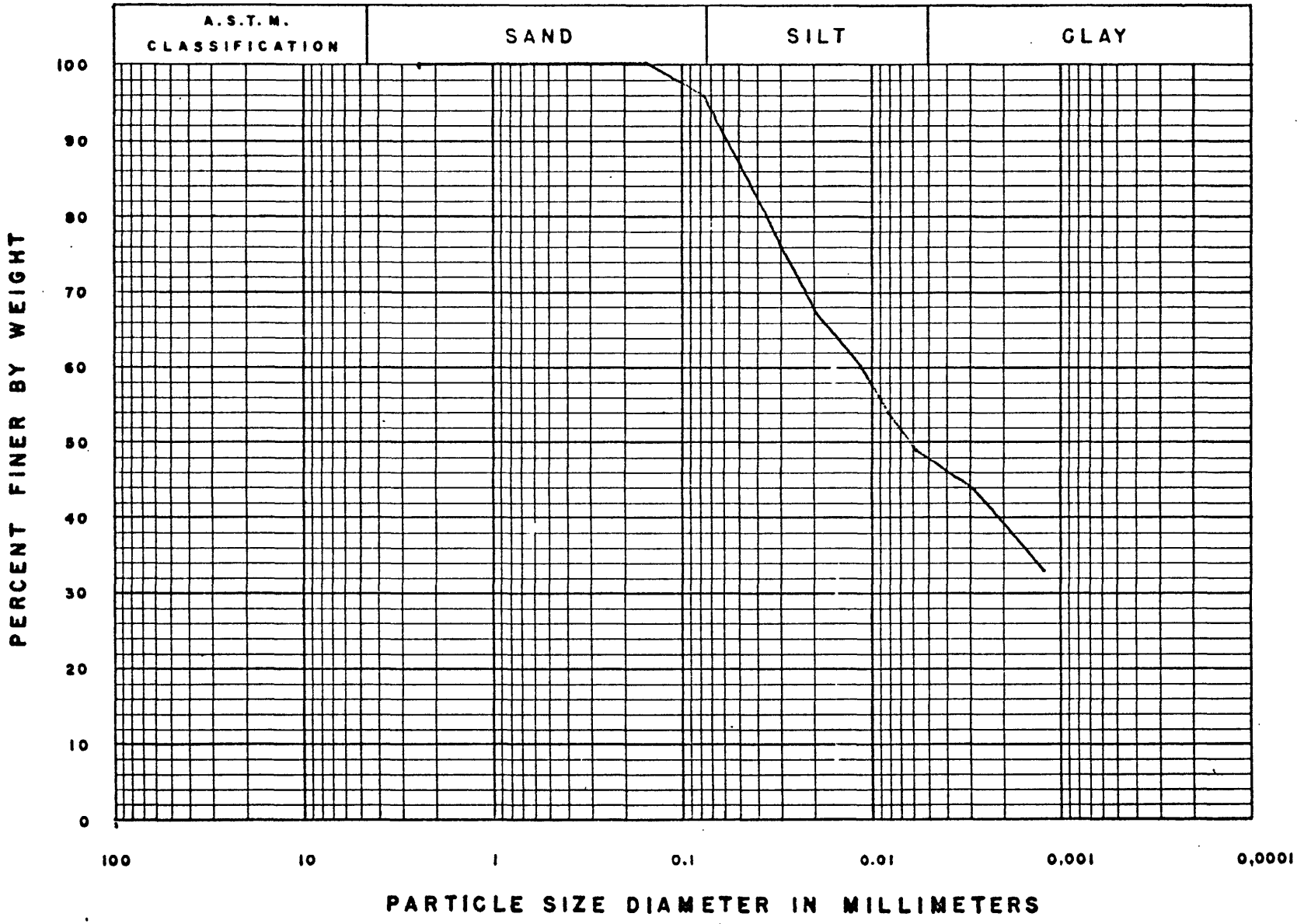
D72

GPO 831-7

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-27.10



D73

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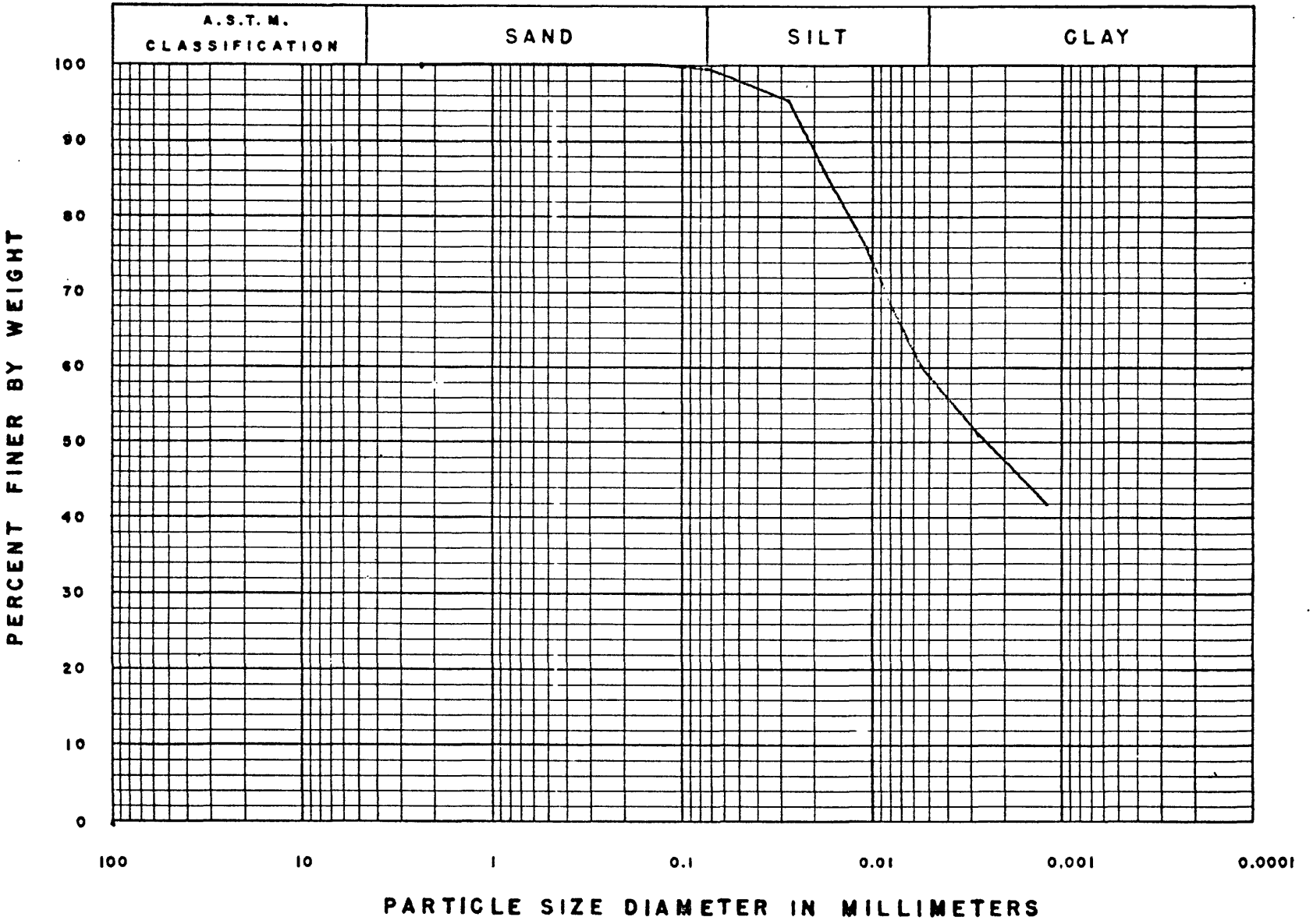
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-27.65



D74

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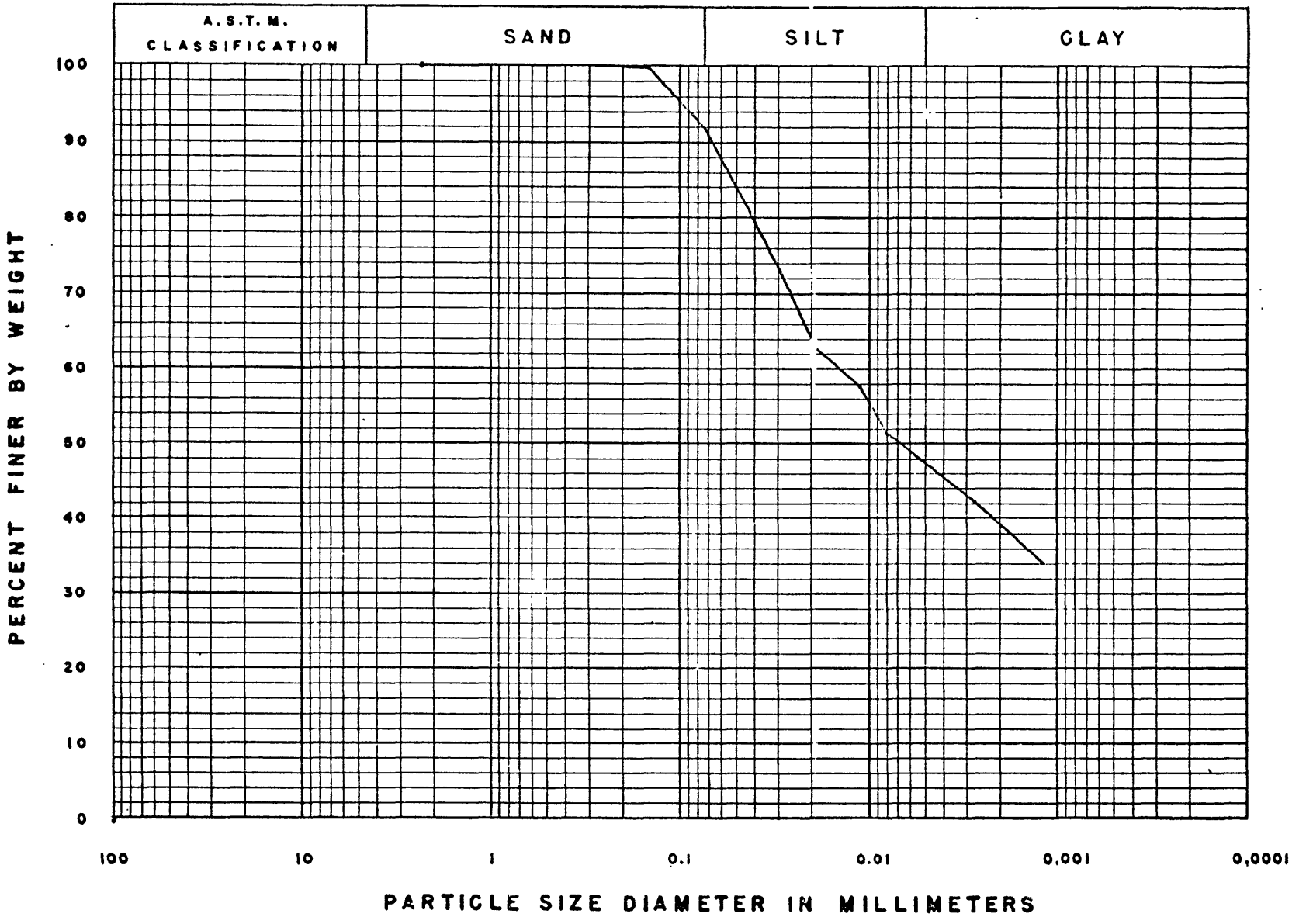
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-30.25



D75

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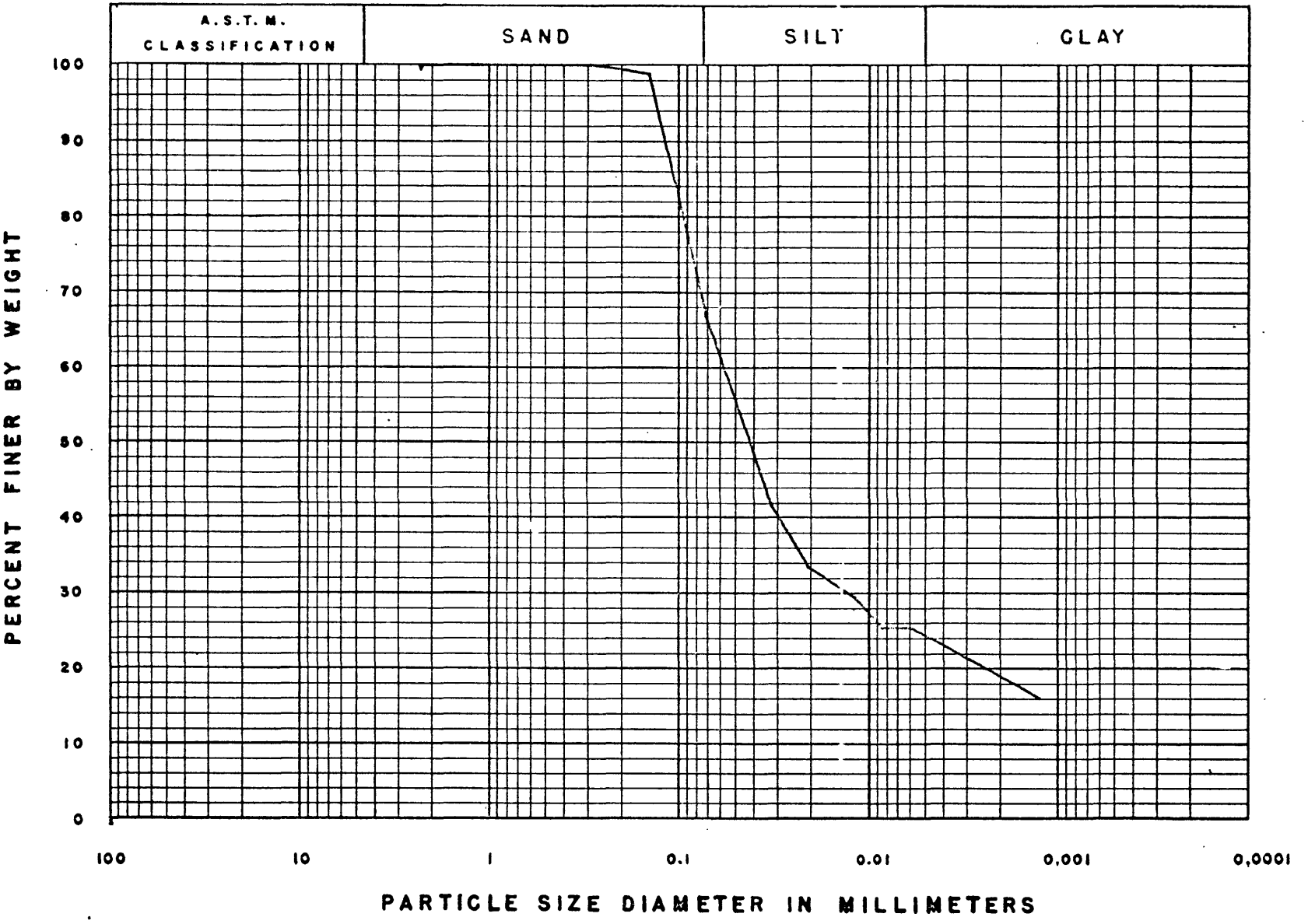
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-32.55



D76

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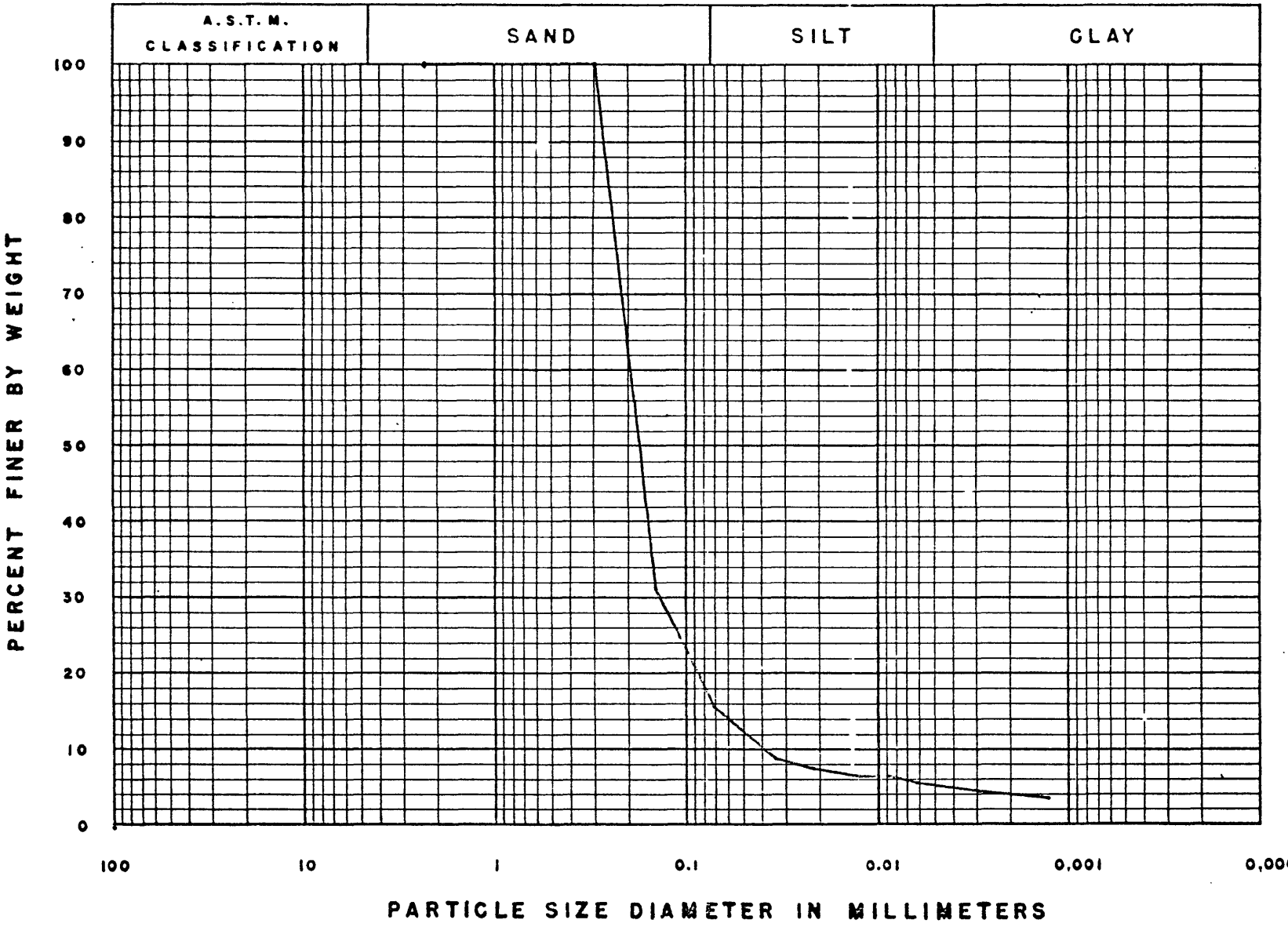
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-33.5



077

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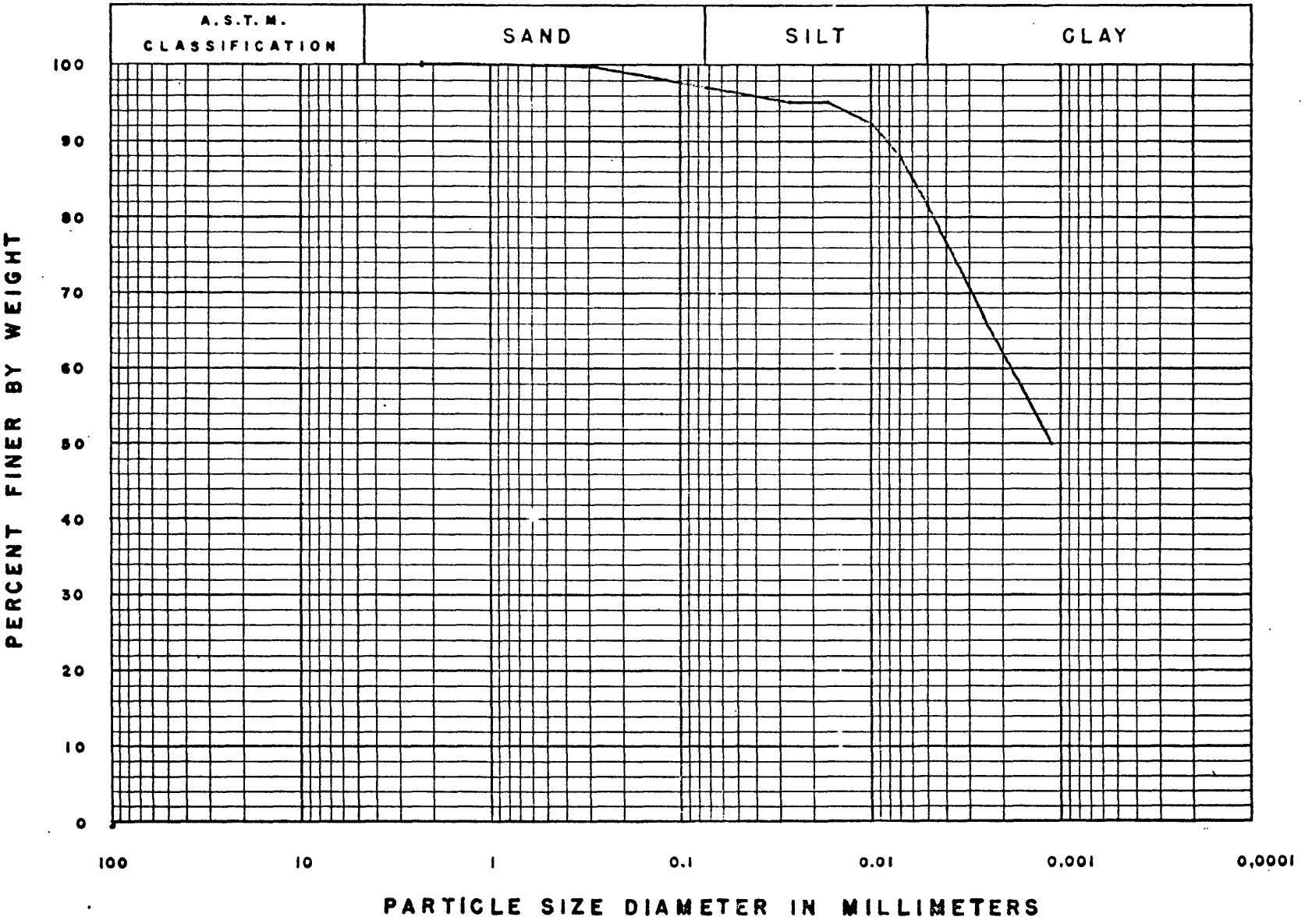
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-35.50

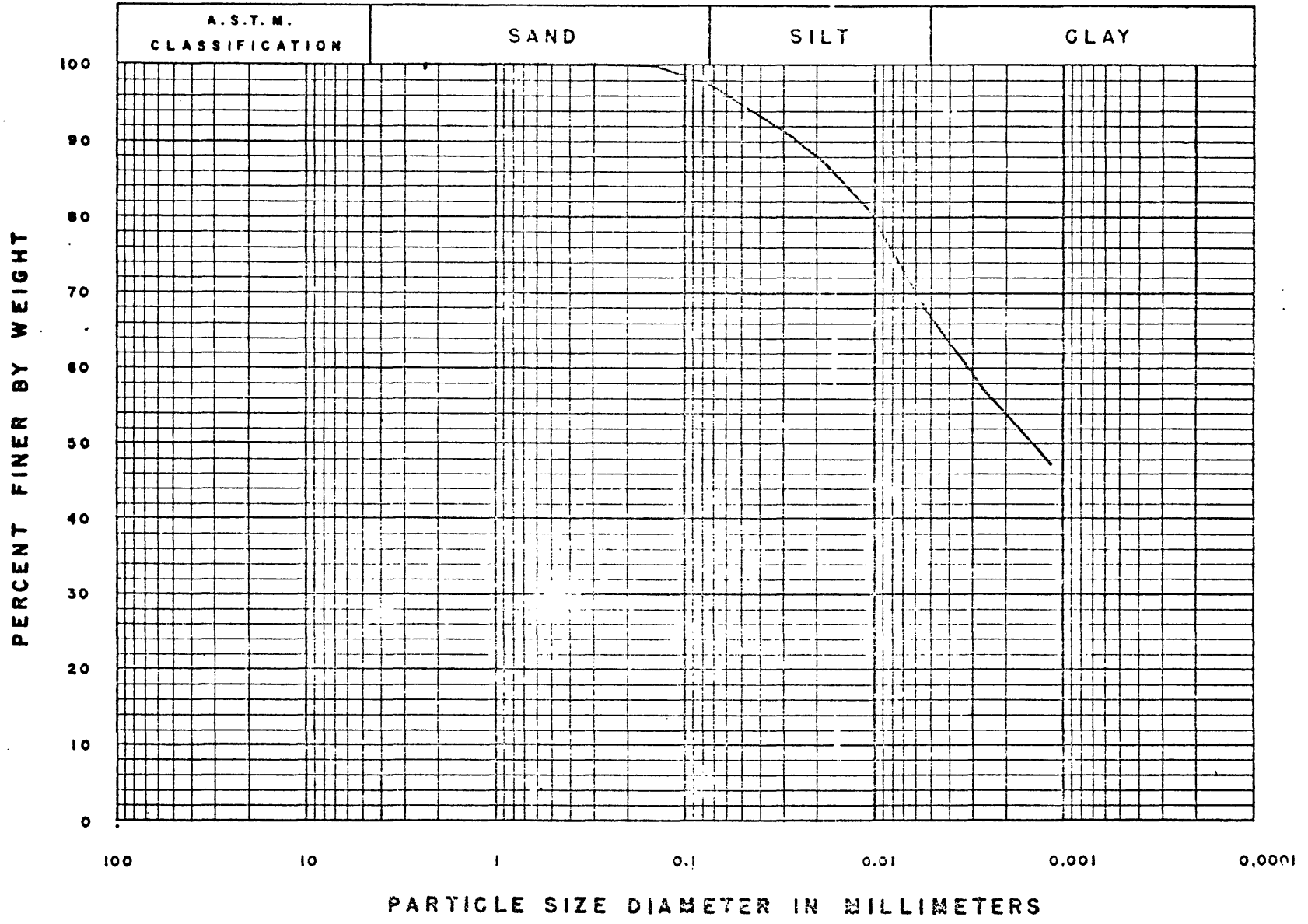


D78

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-36.80



D79

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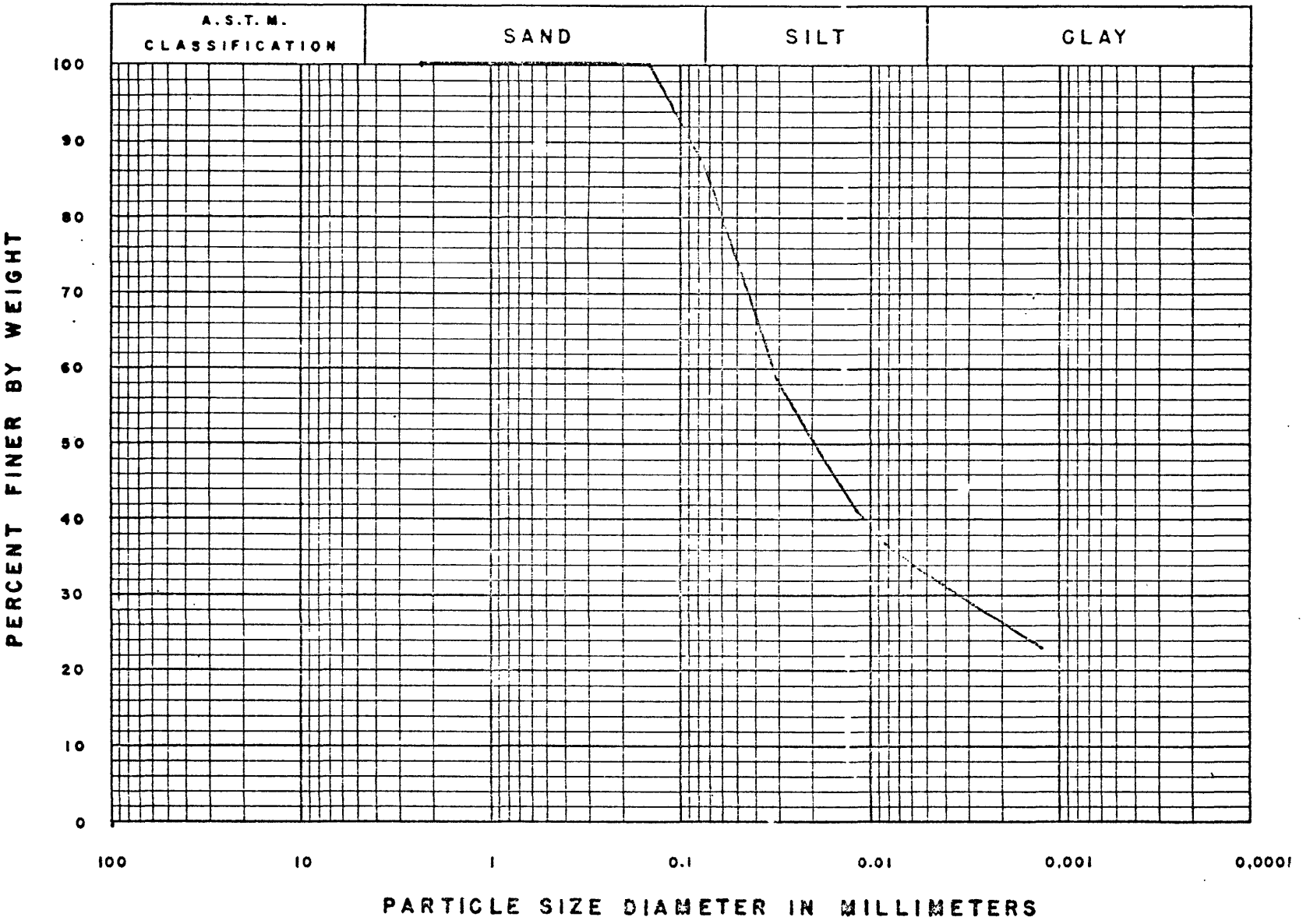
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-40.'0



D80

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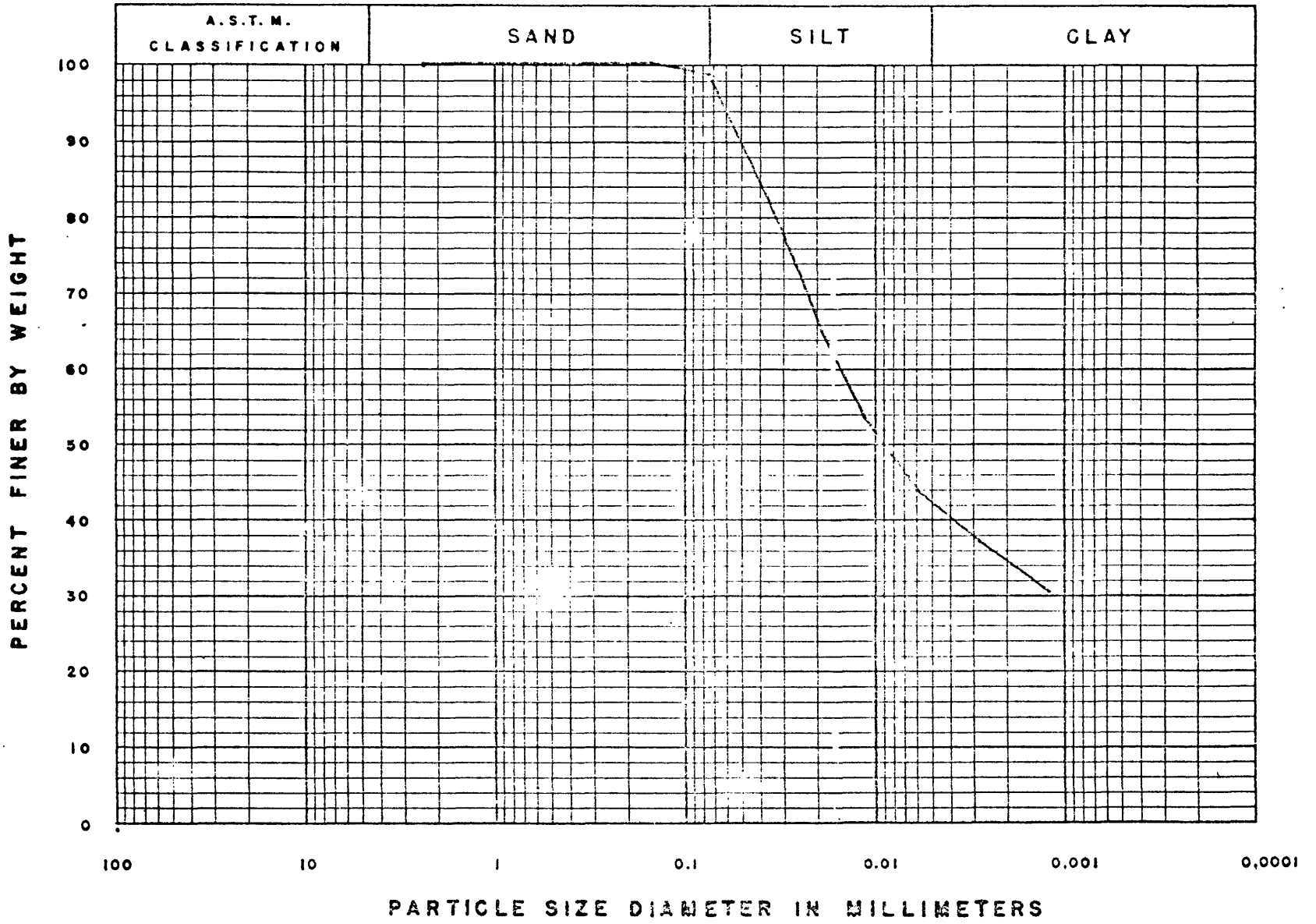
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-41.00



D81

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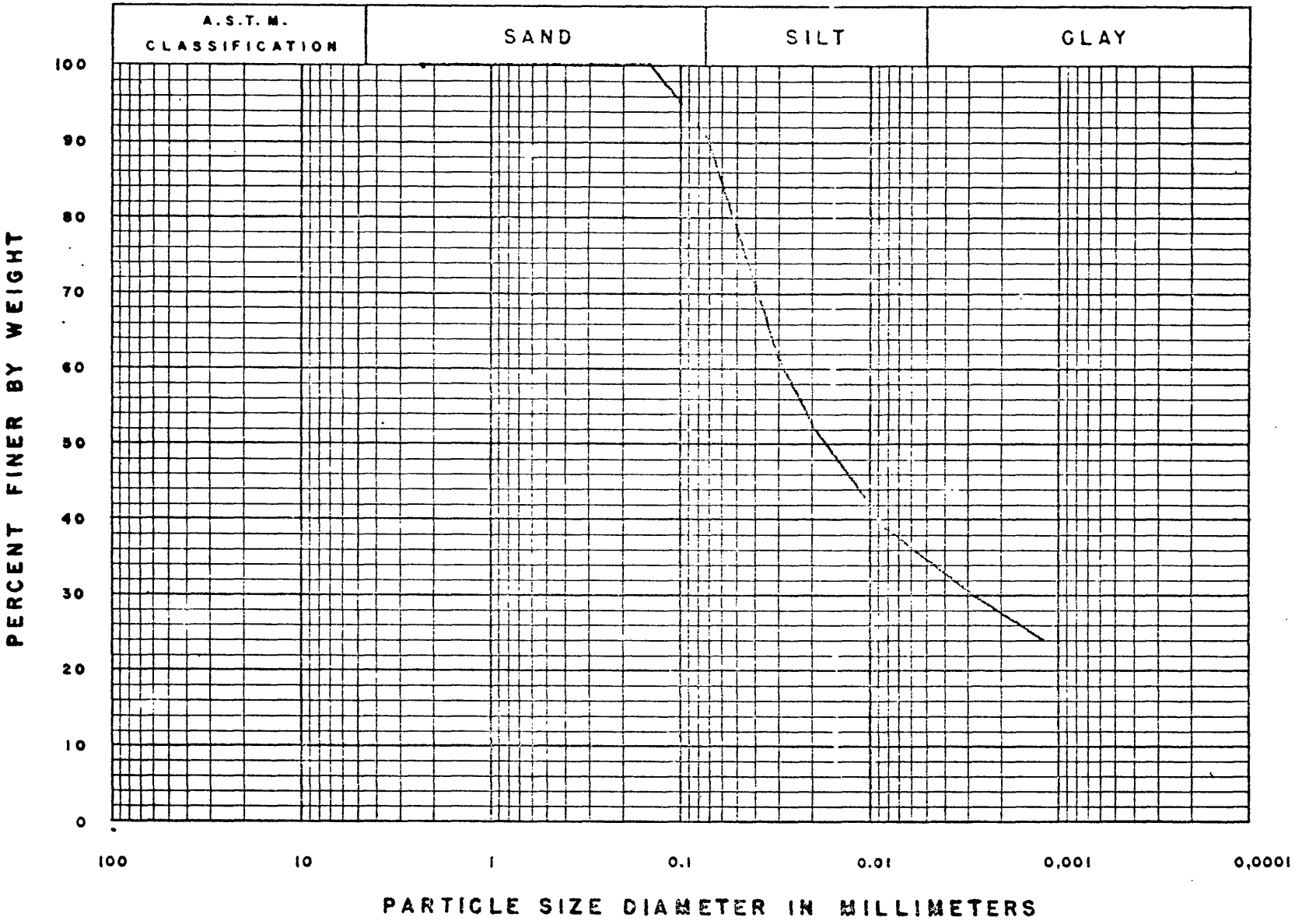
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-41.30



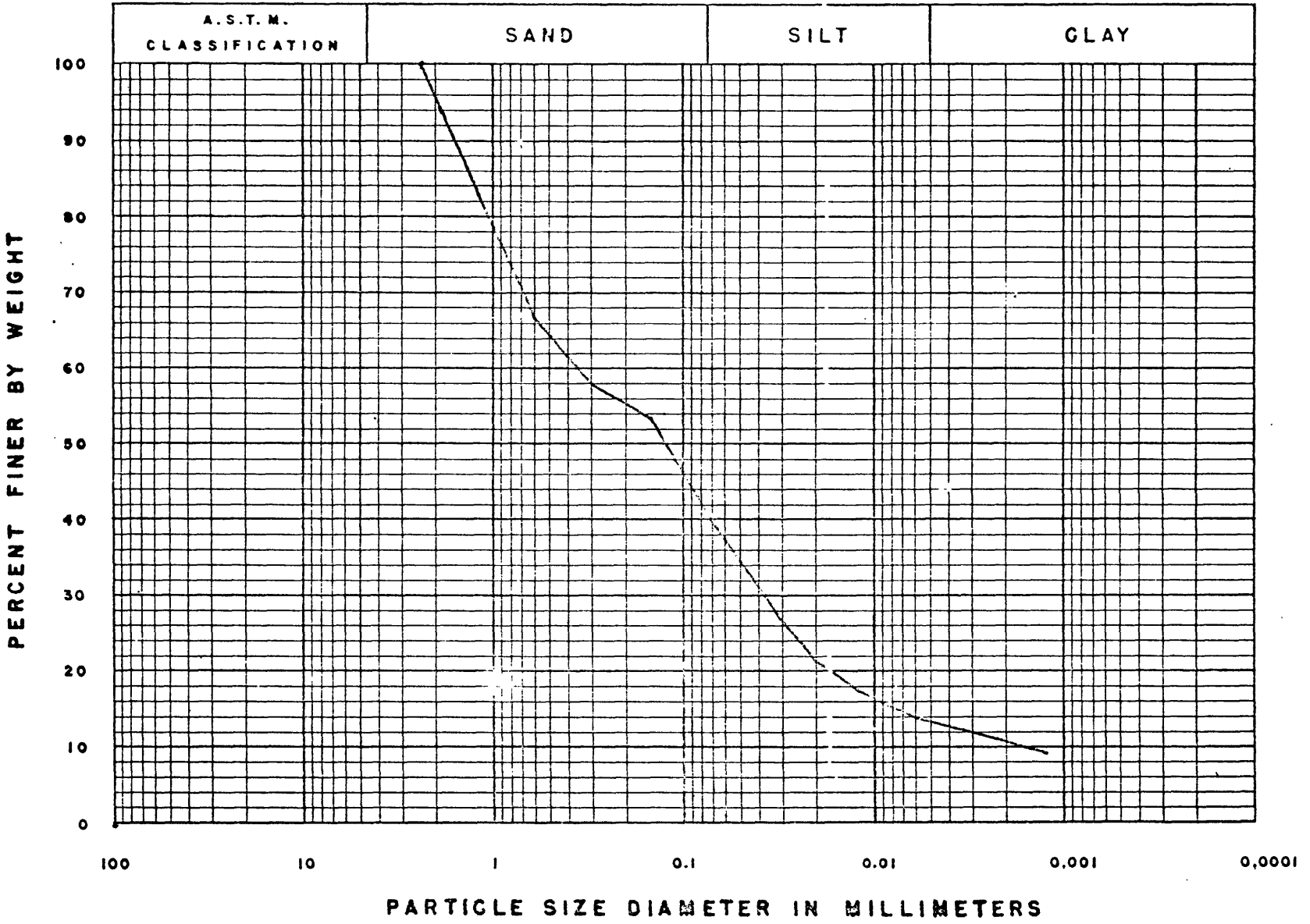
D82

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-41.75



D83

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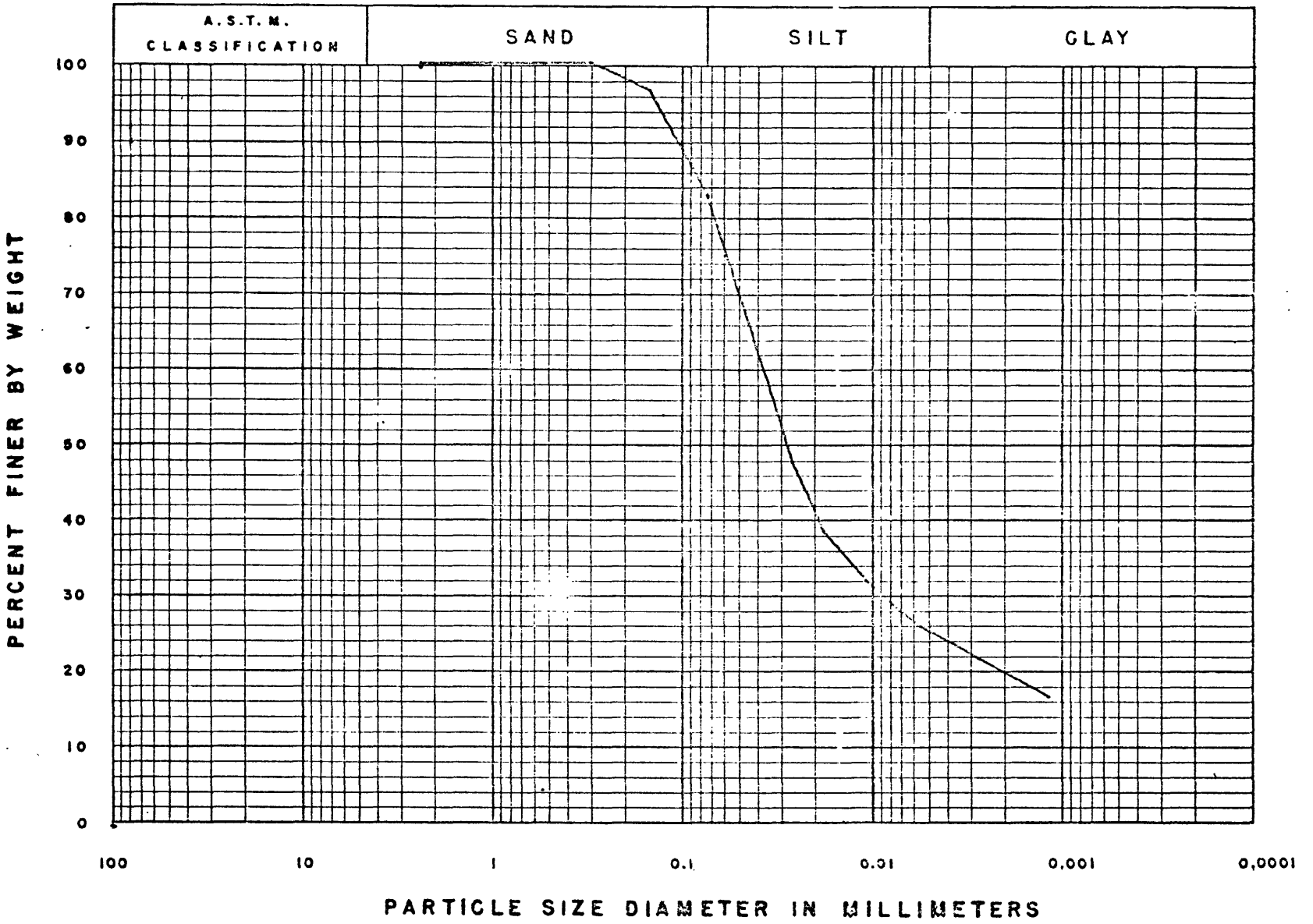
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-43.65



D84

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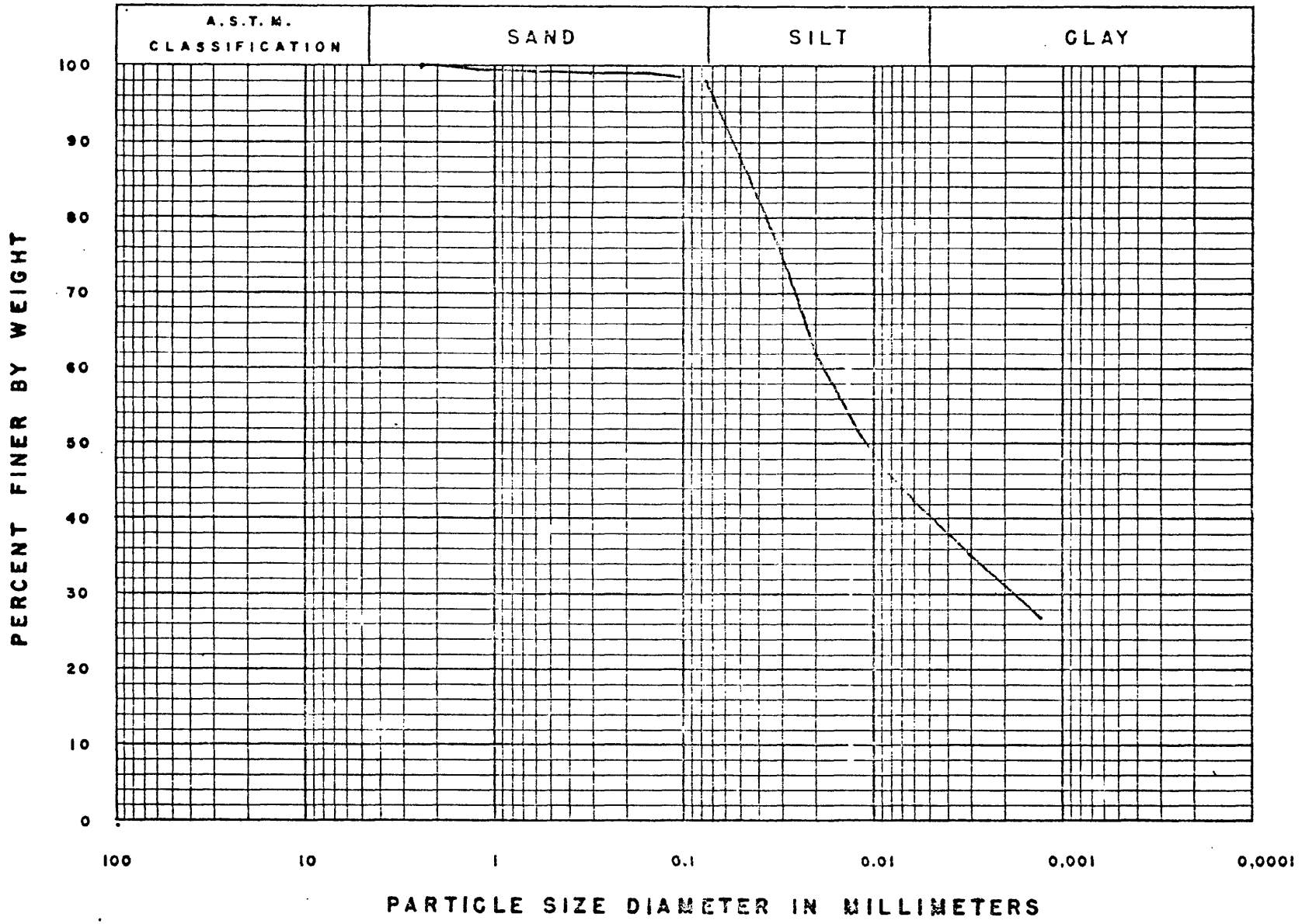
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-44.20



D85

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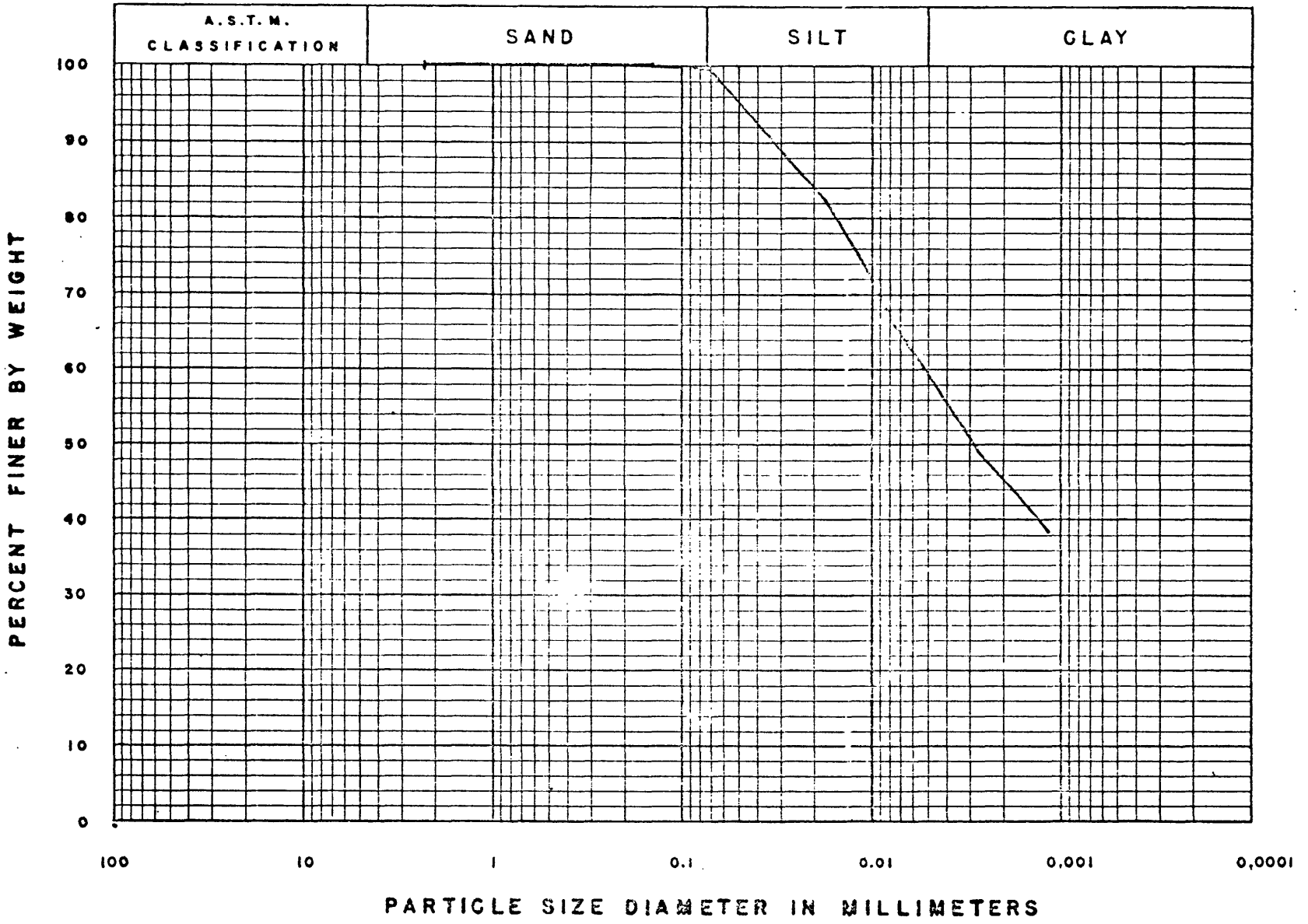
PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-44,20a



D86

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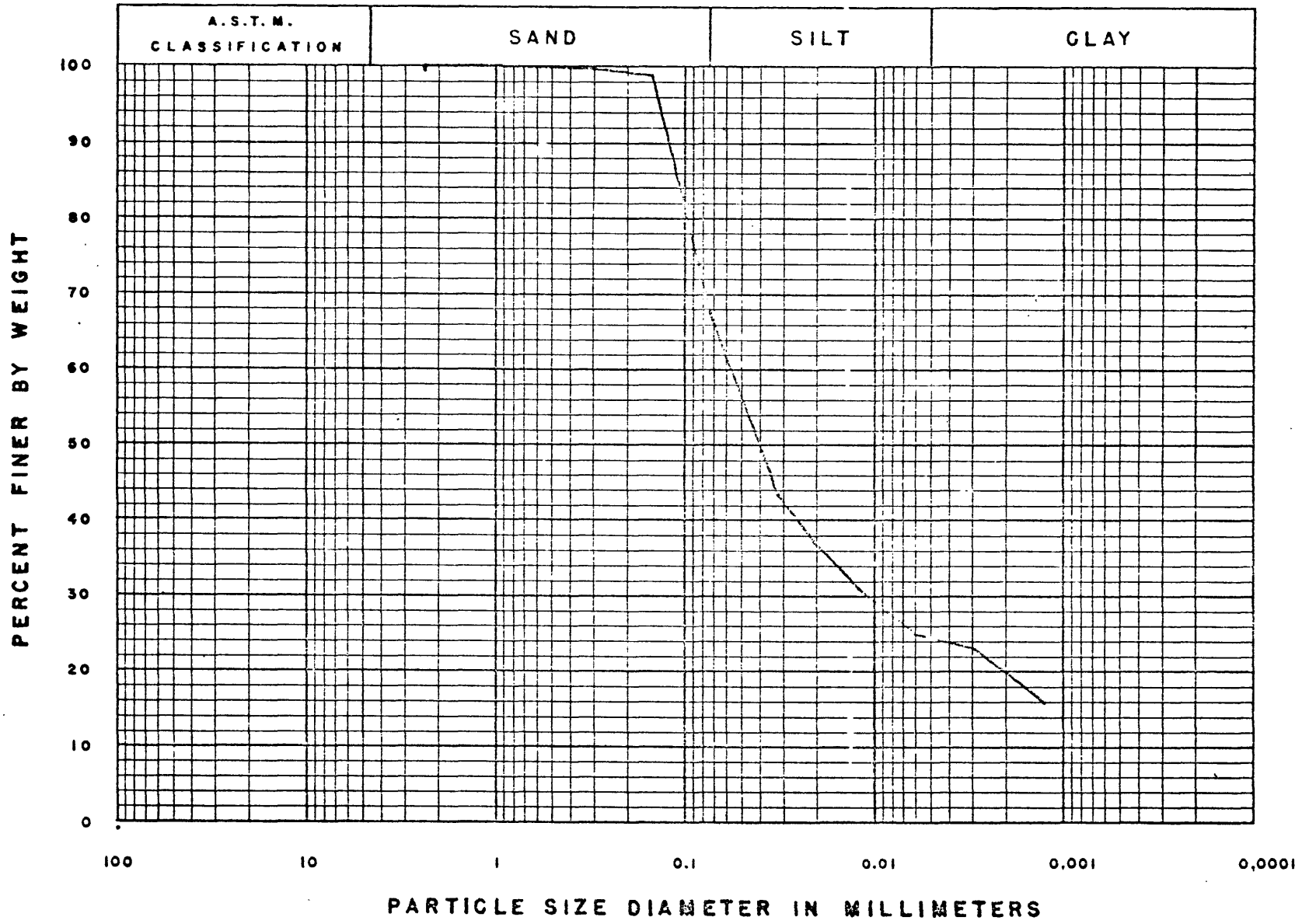
ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-45.45



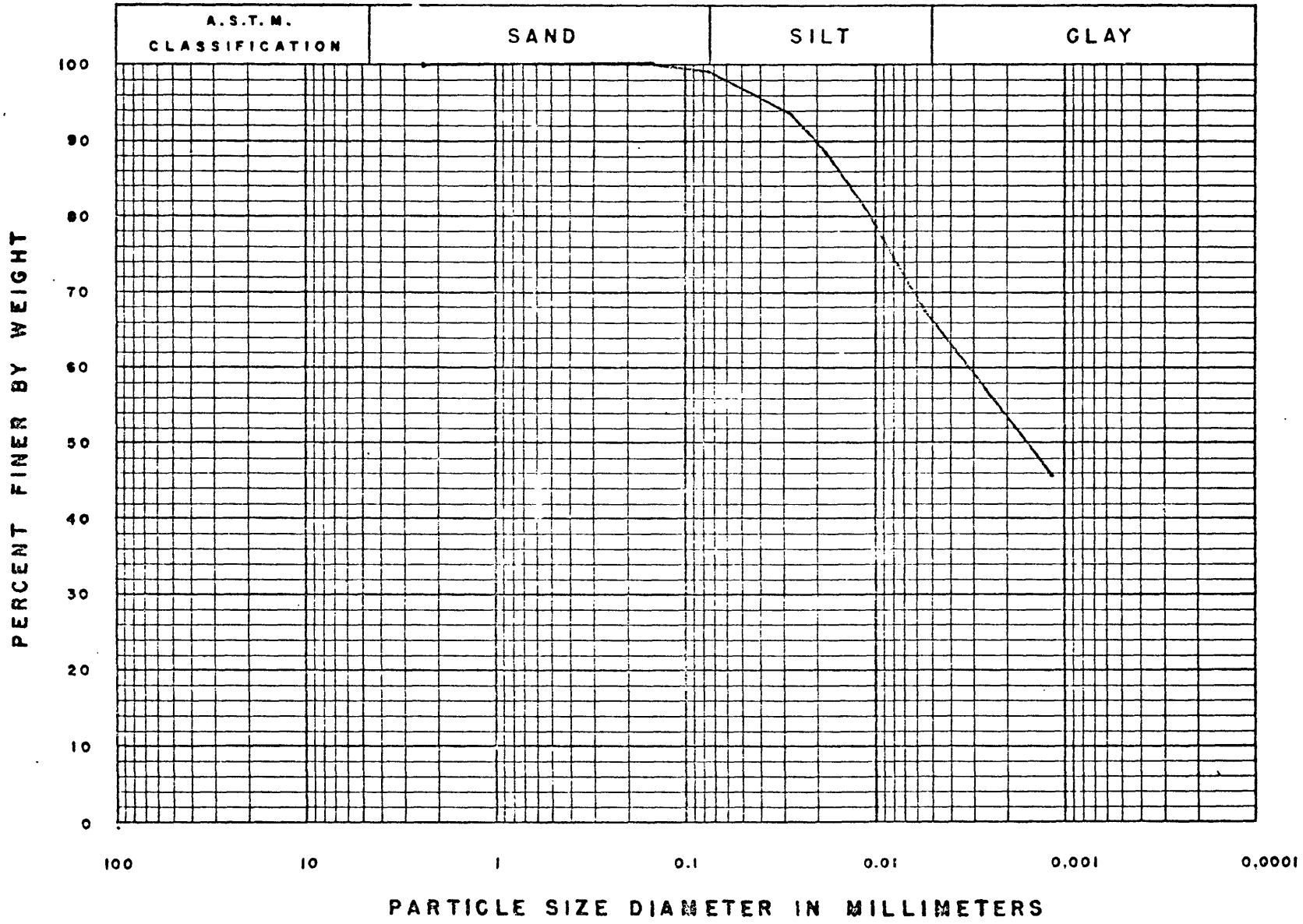
087

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-47.15



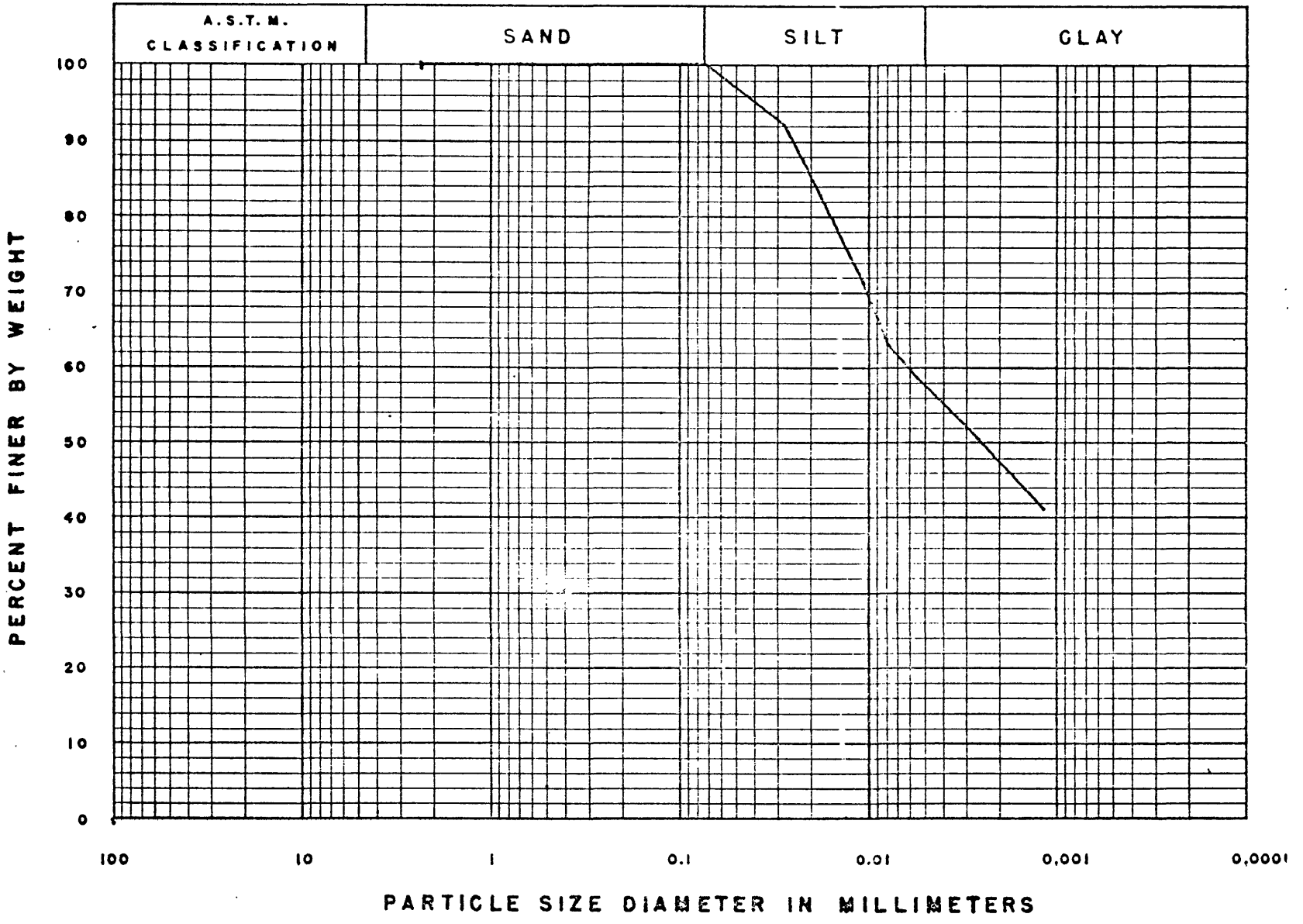
D88

GPO 831-7

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-48.65



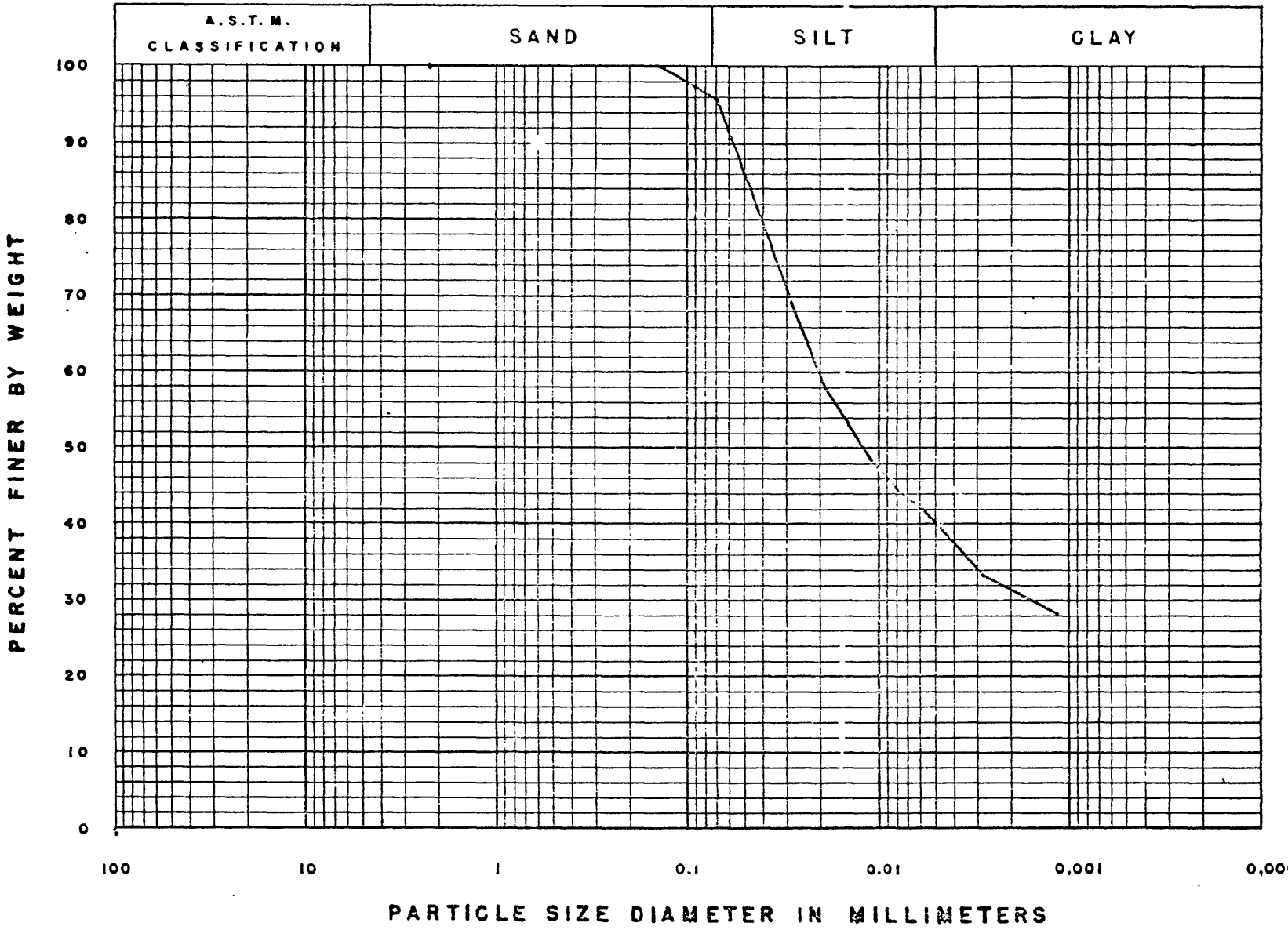
D89

GPO 831-718

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1-51.30



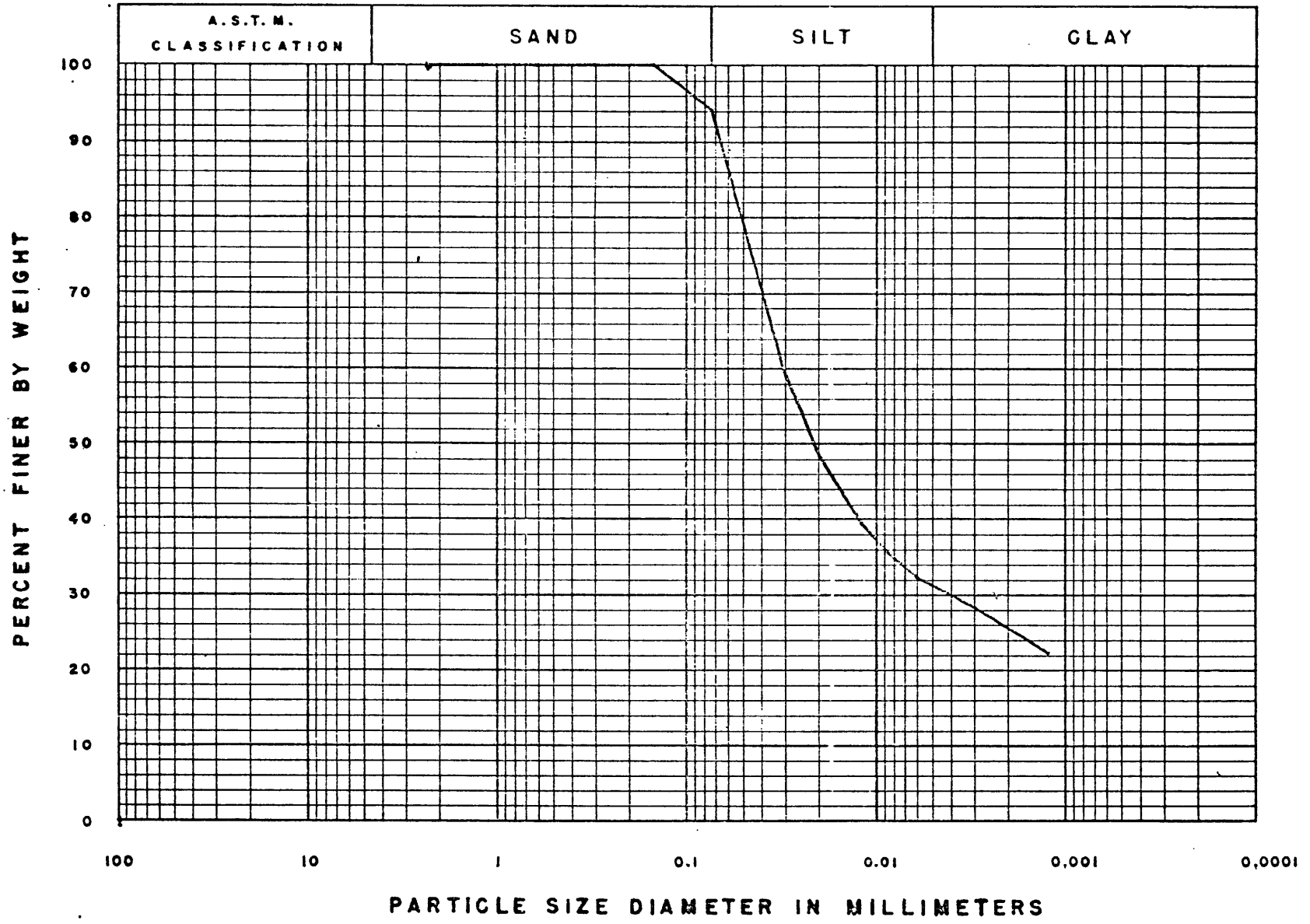
D90

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-51.80



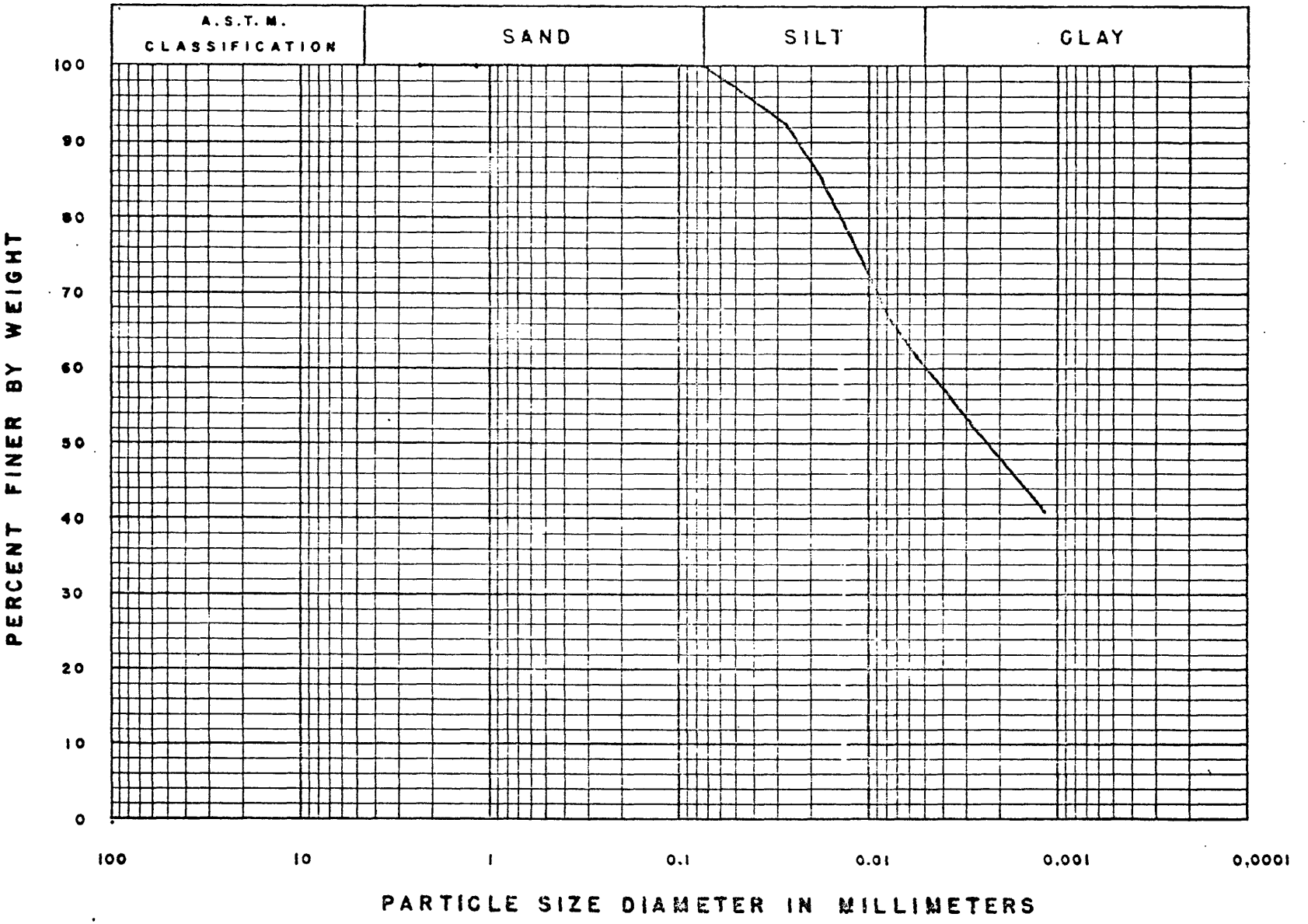
D91

GPO 831-7

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-52 85



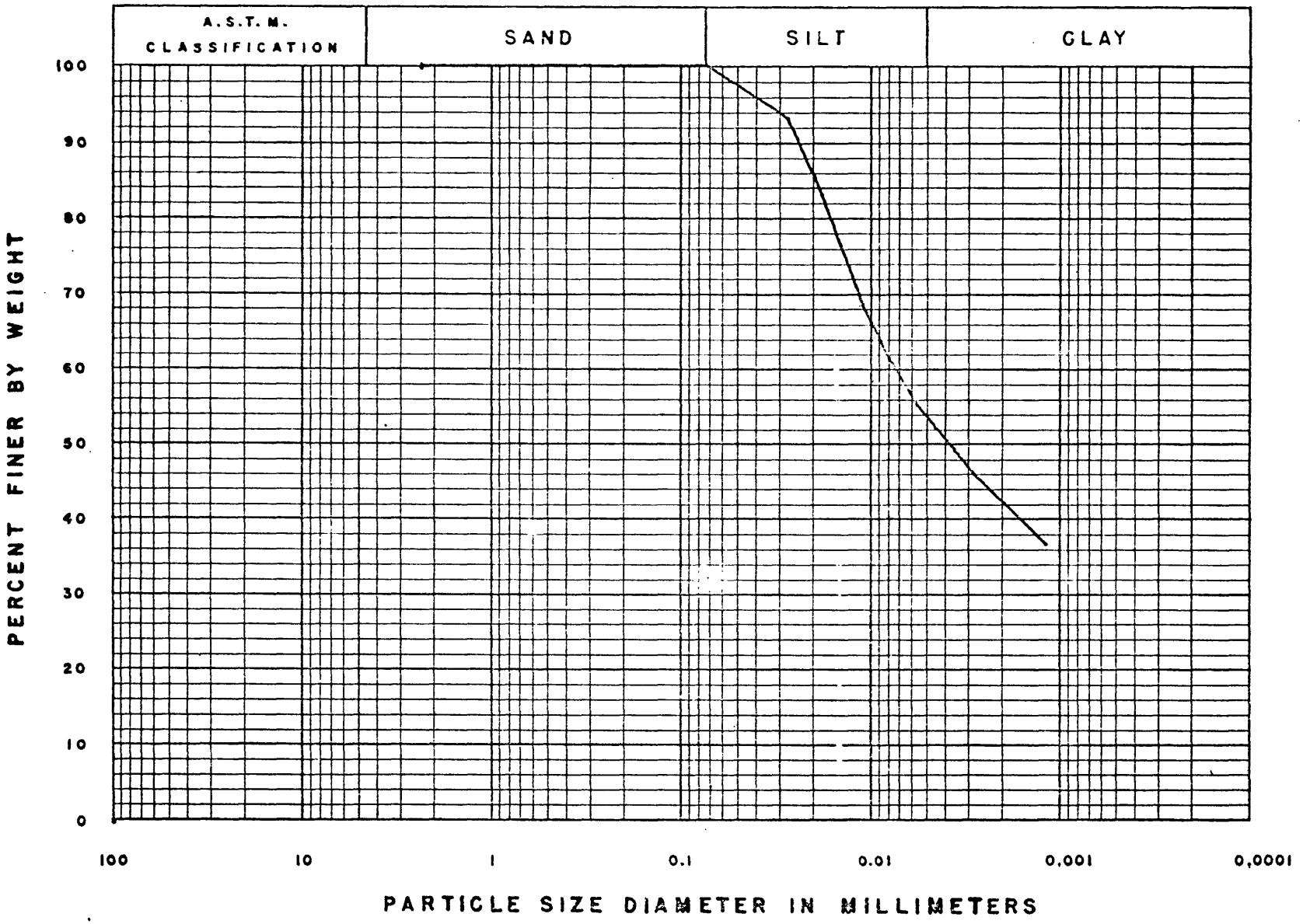
D92

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-5?.15



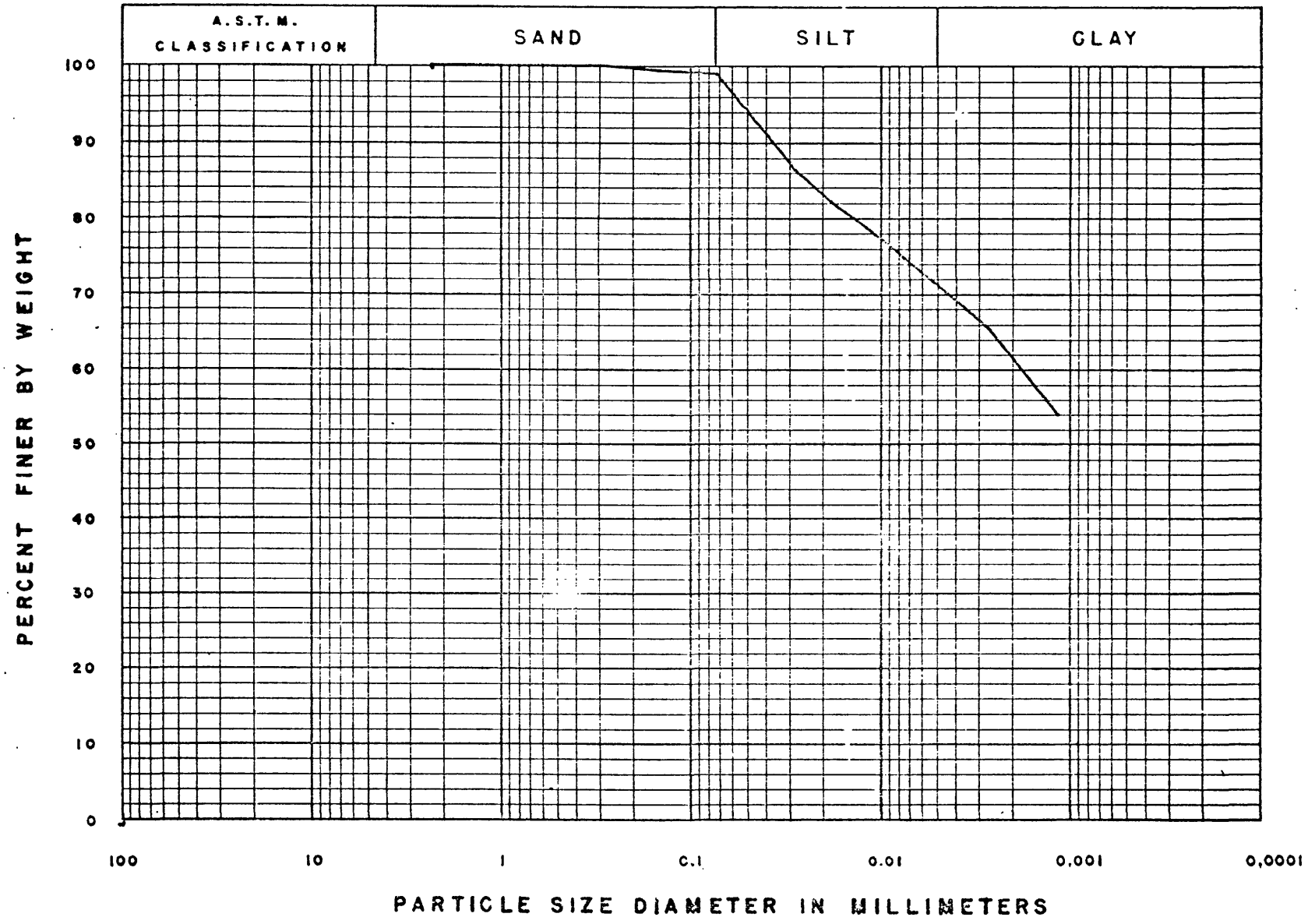
D93

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-54.80



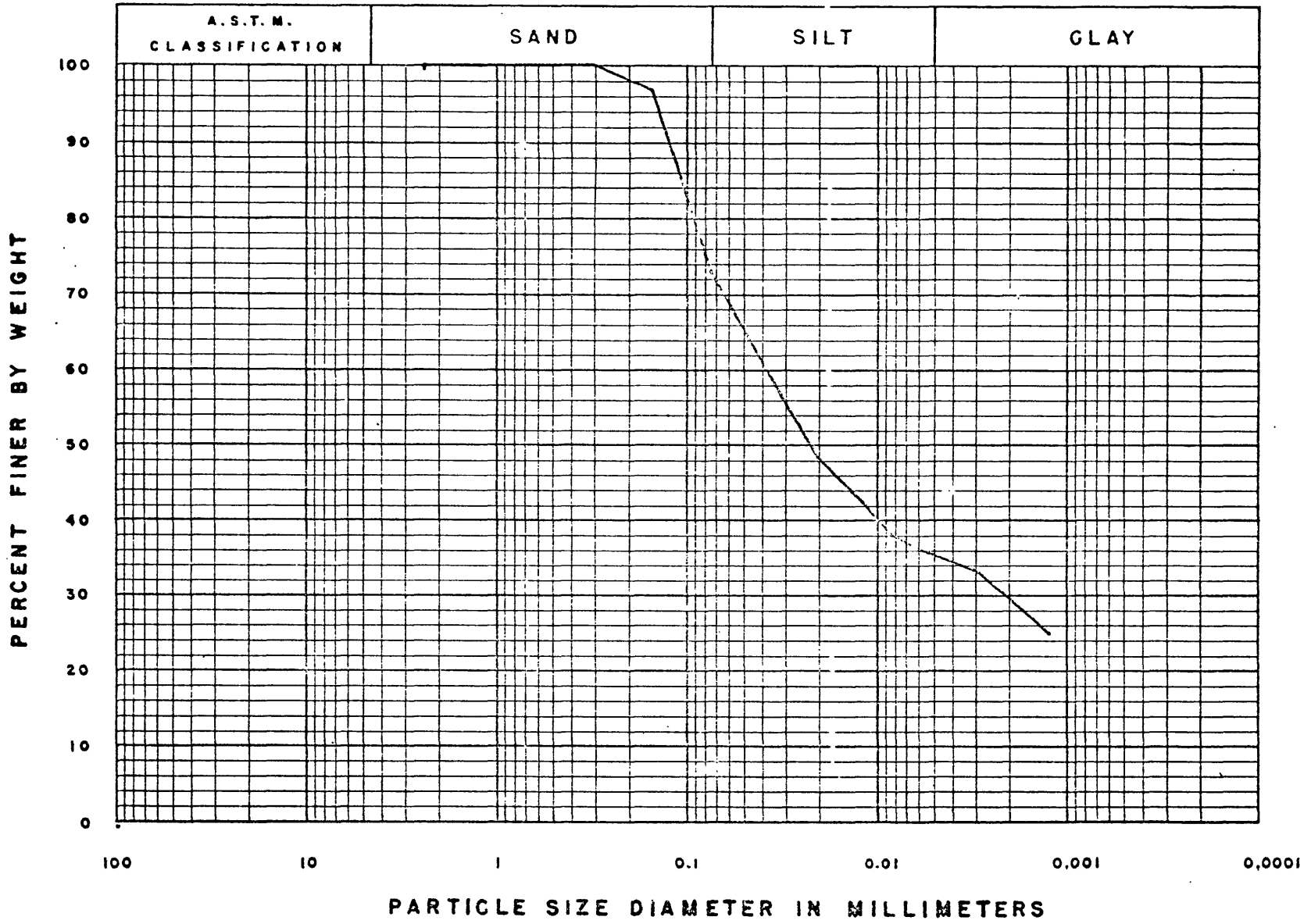
D94

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-55.60



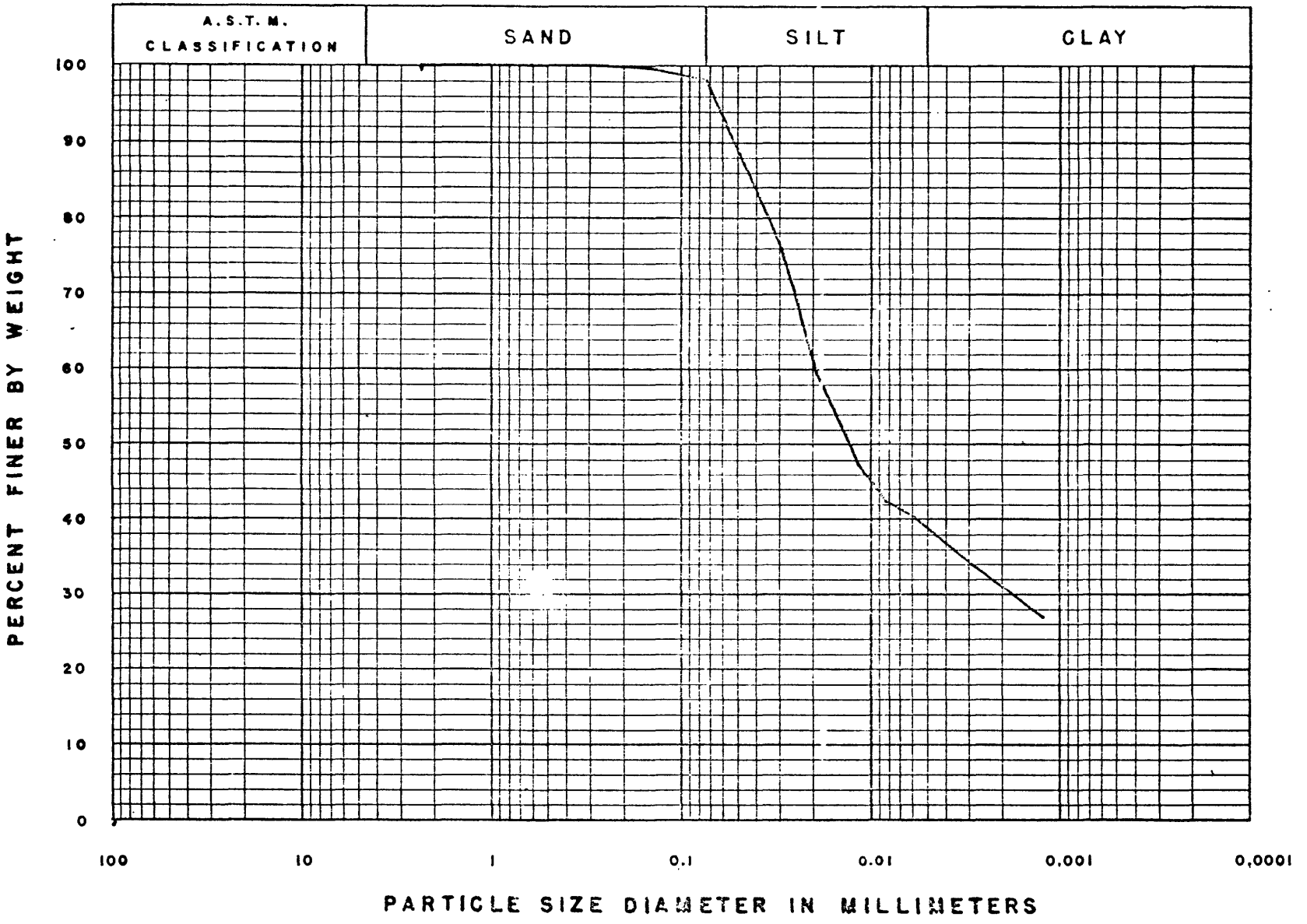
D95

GPO 831-7

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-56.00

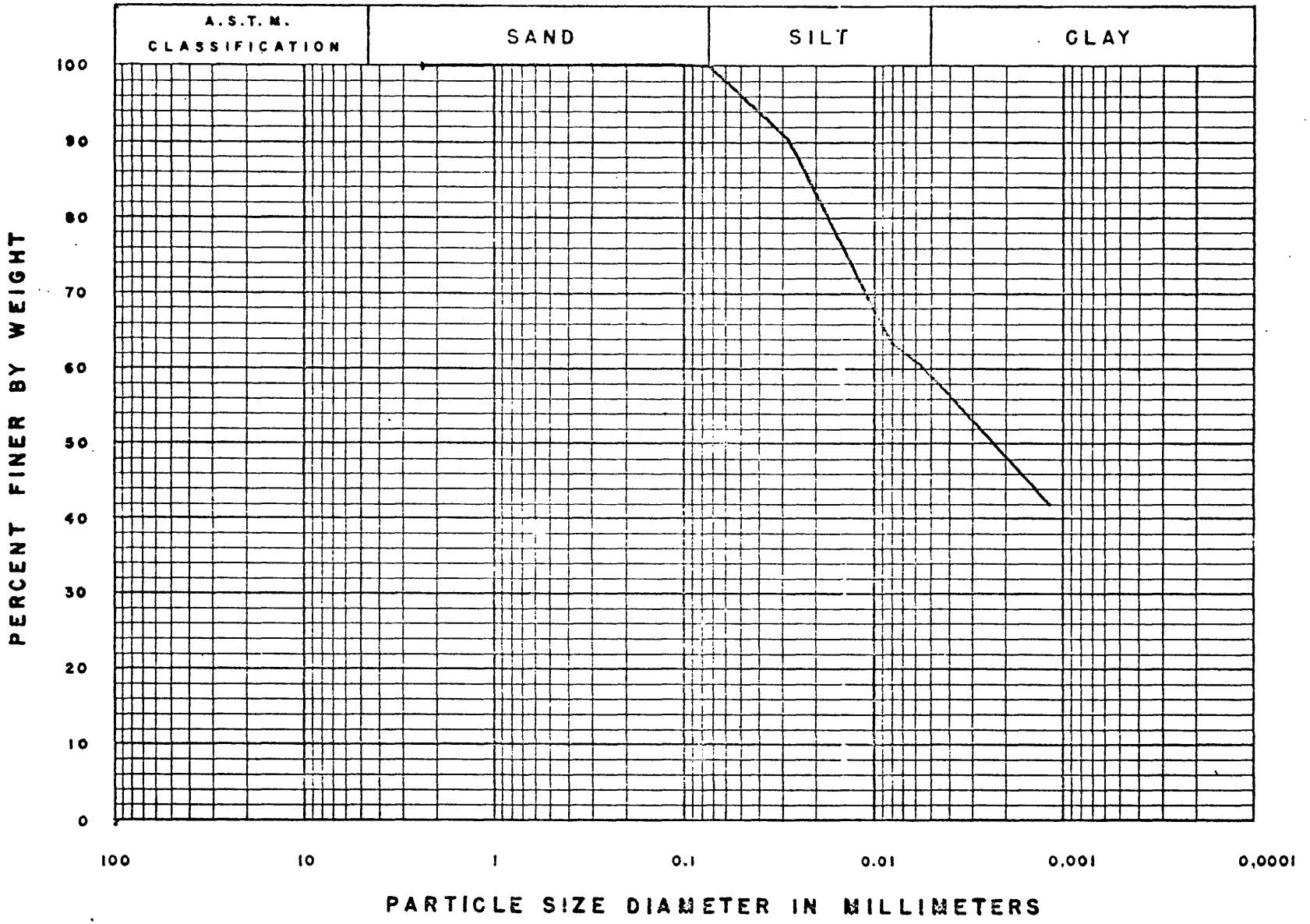


D96

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-58.05



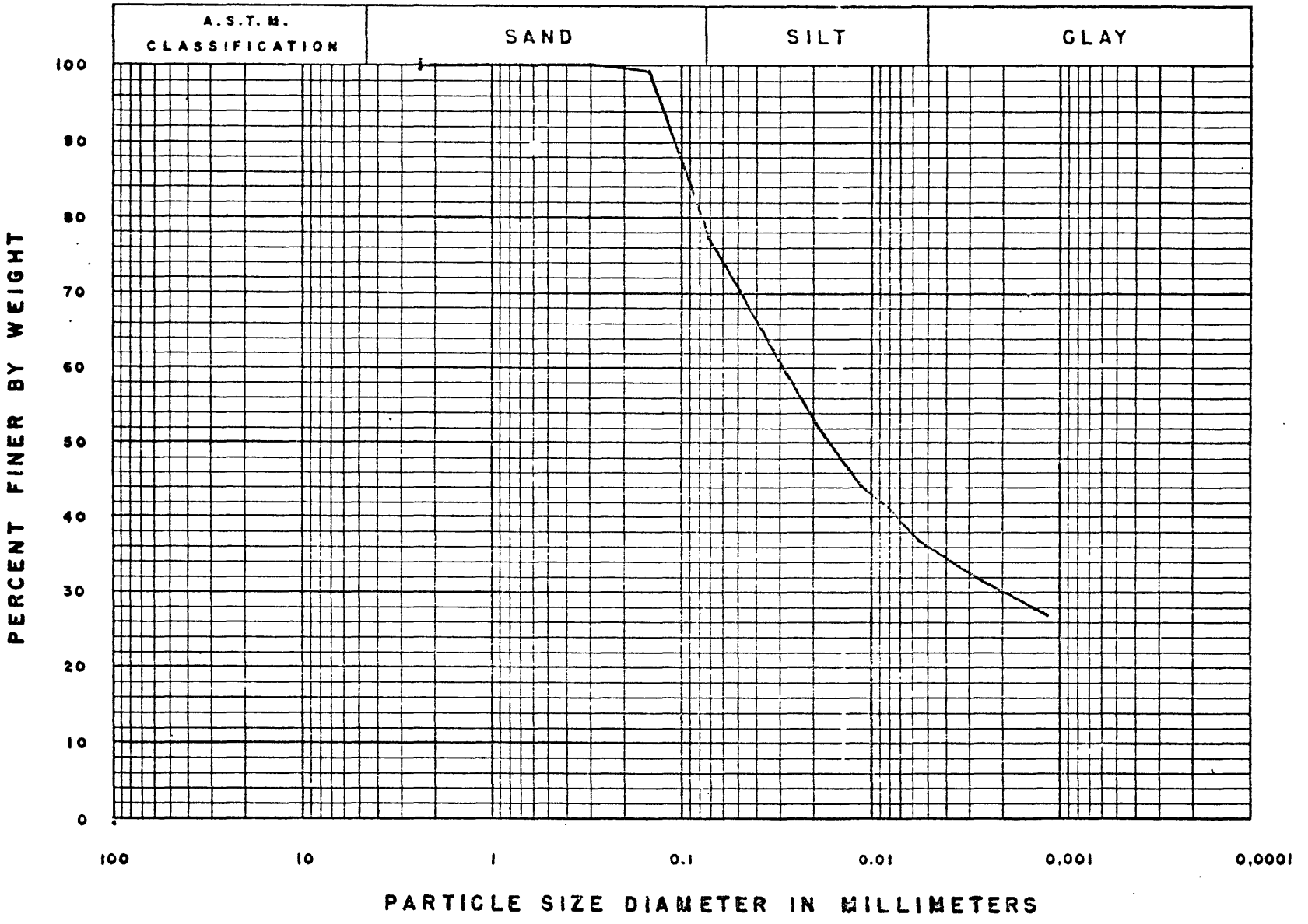
D97

GPO 931-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-58.20



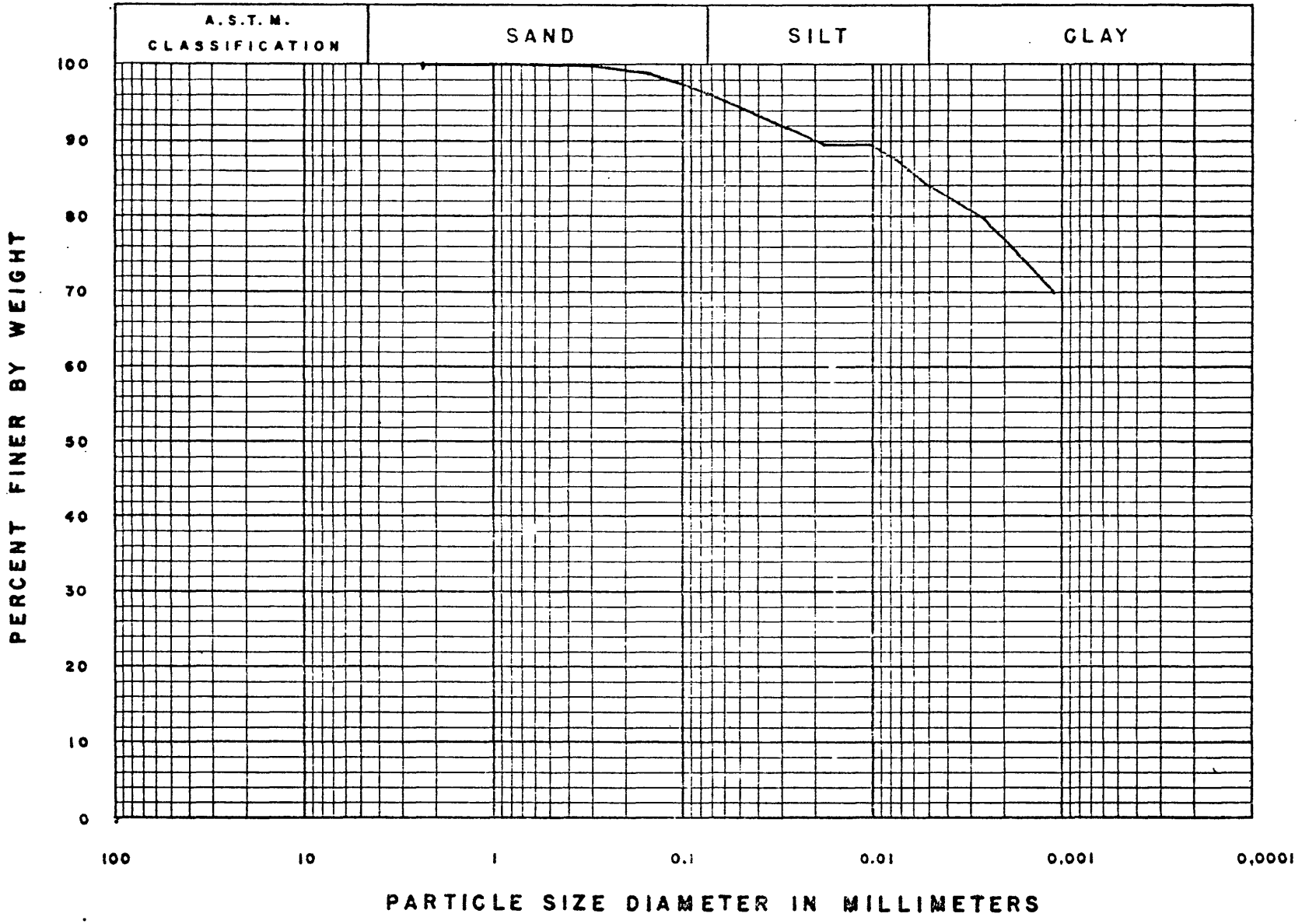
D98

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-5[illegible].75



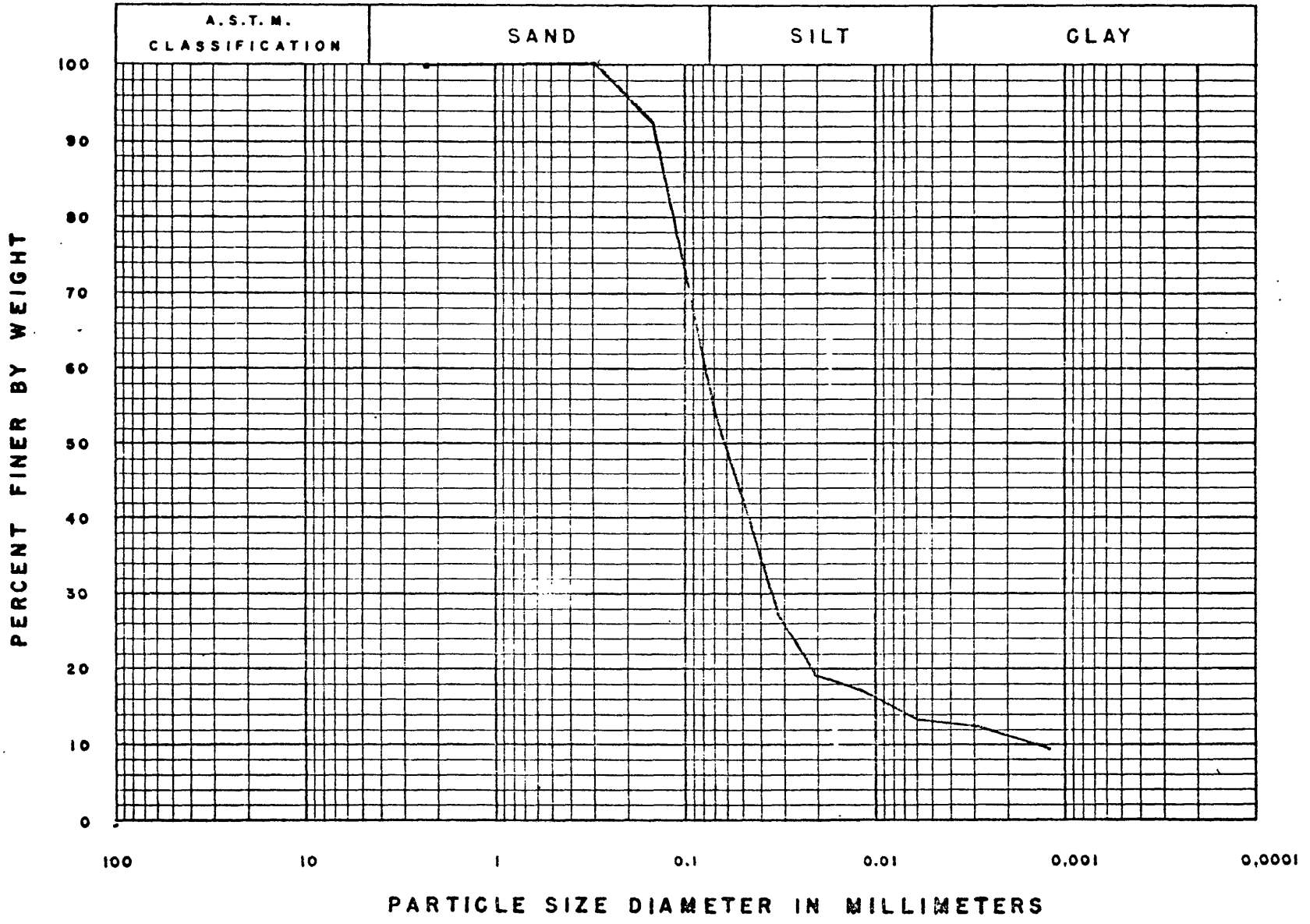
D99

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-(2.25

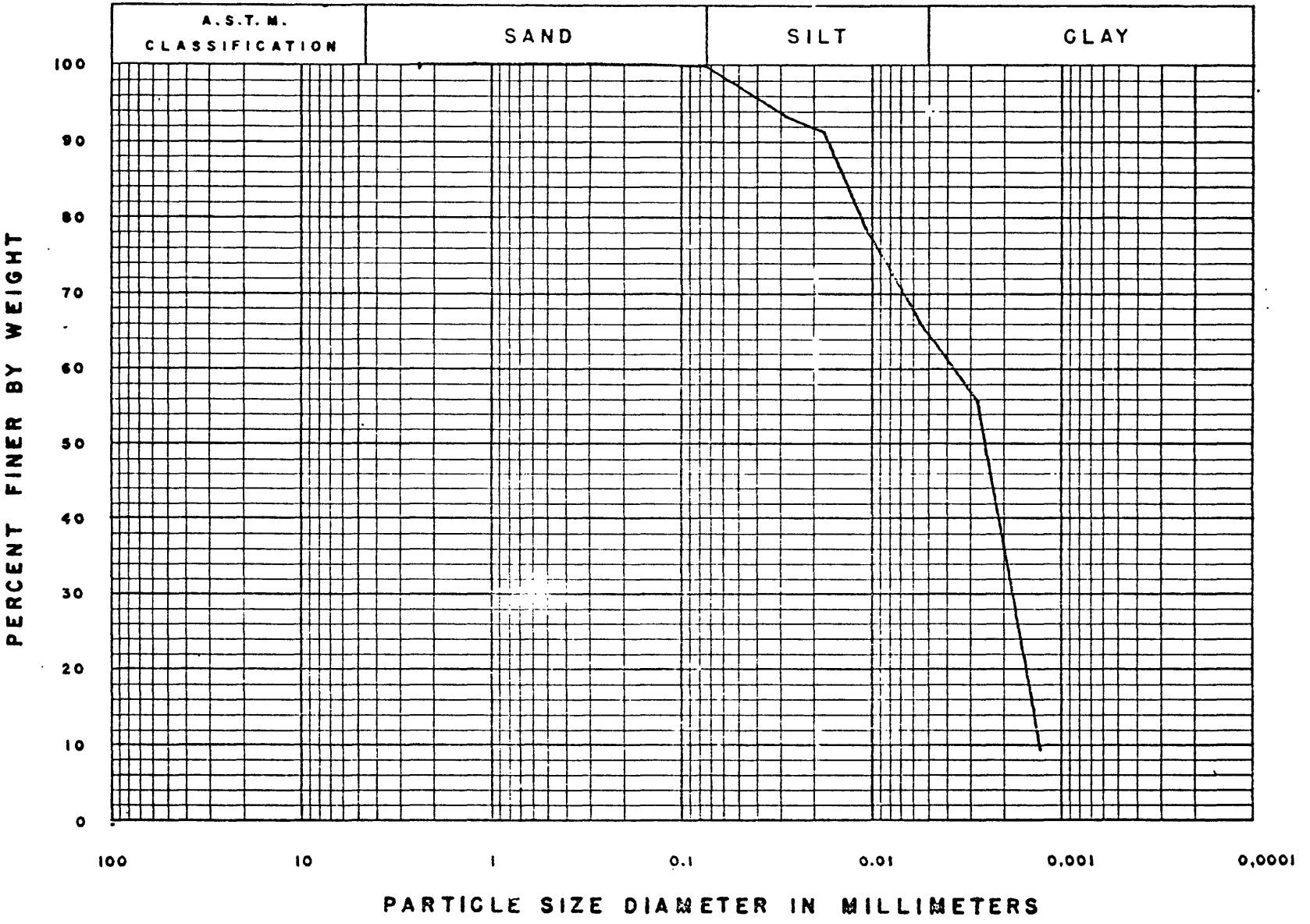


D100

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-66.15



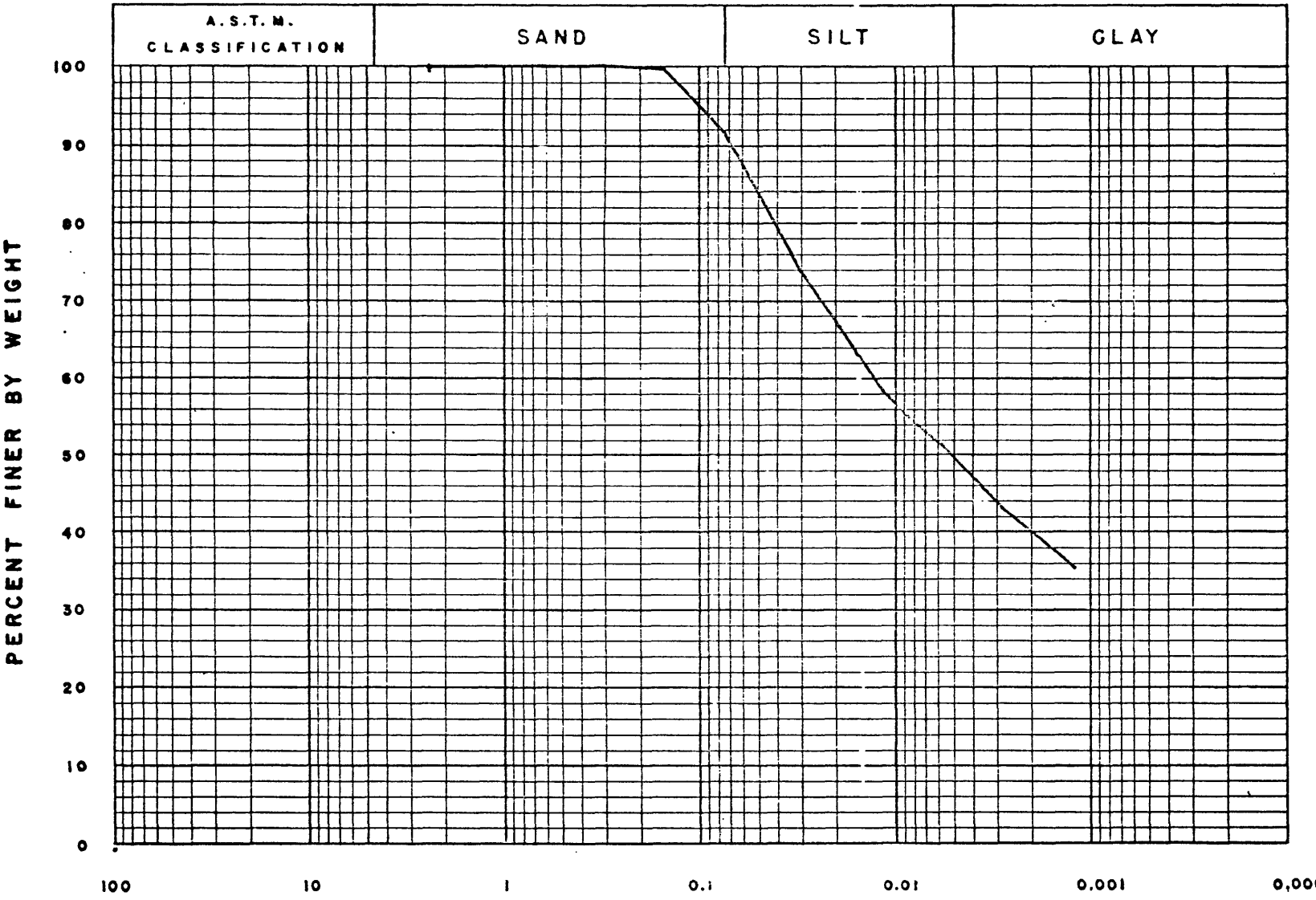
D101

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-68.60



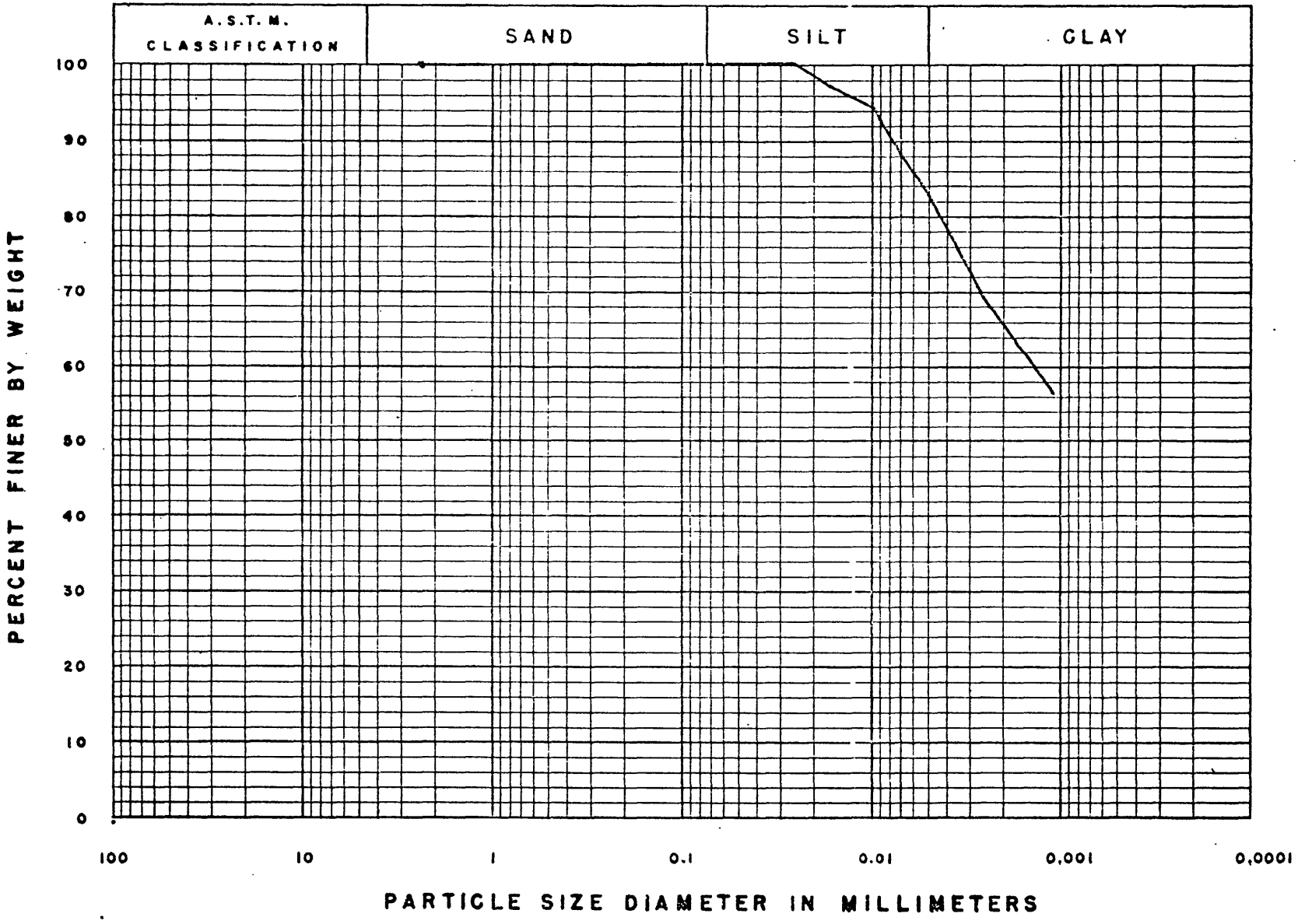
D102

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-70.50



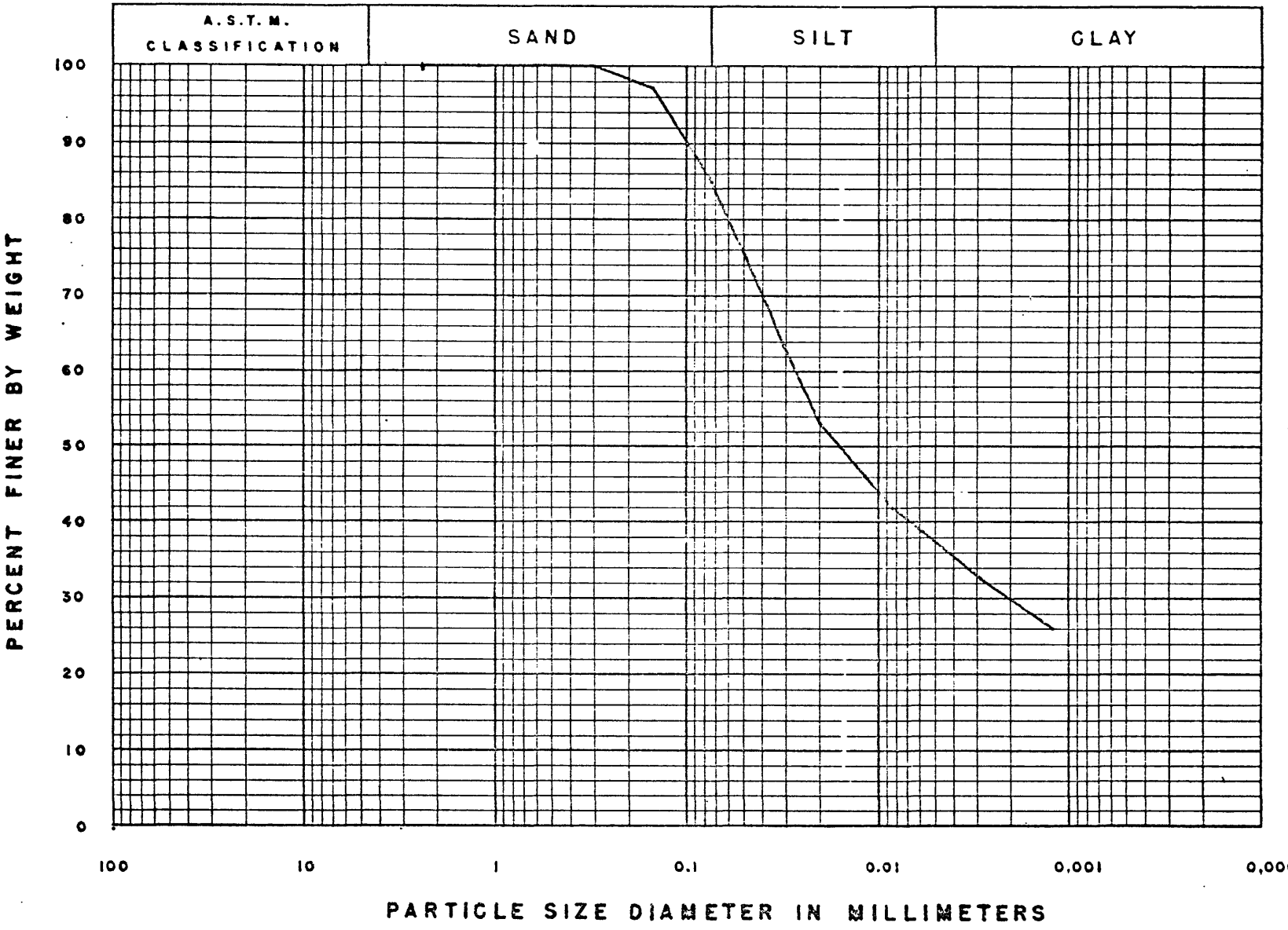
D103

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-7[illegible].60



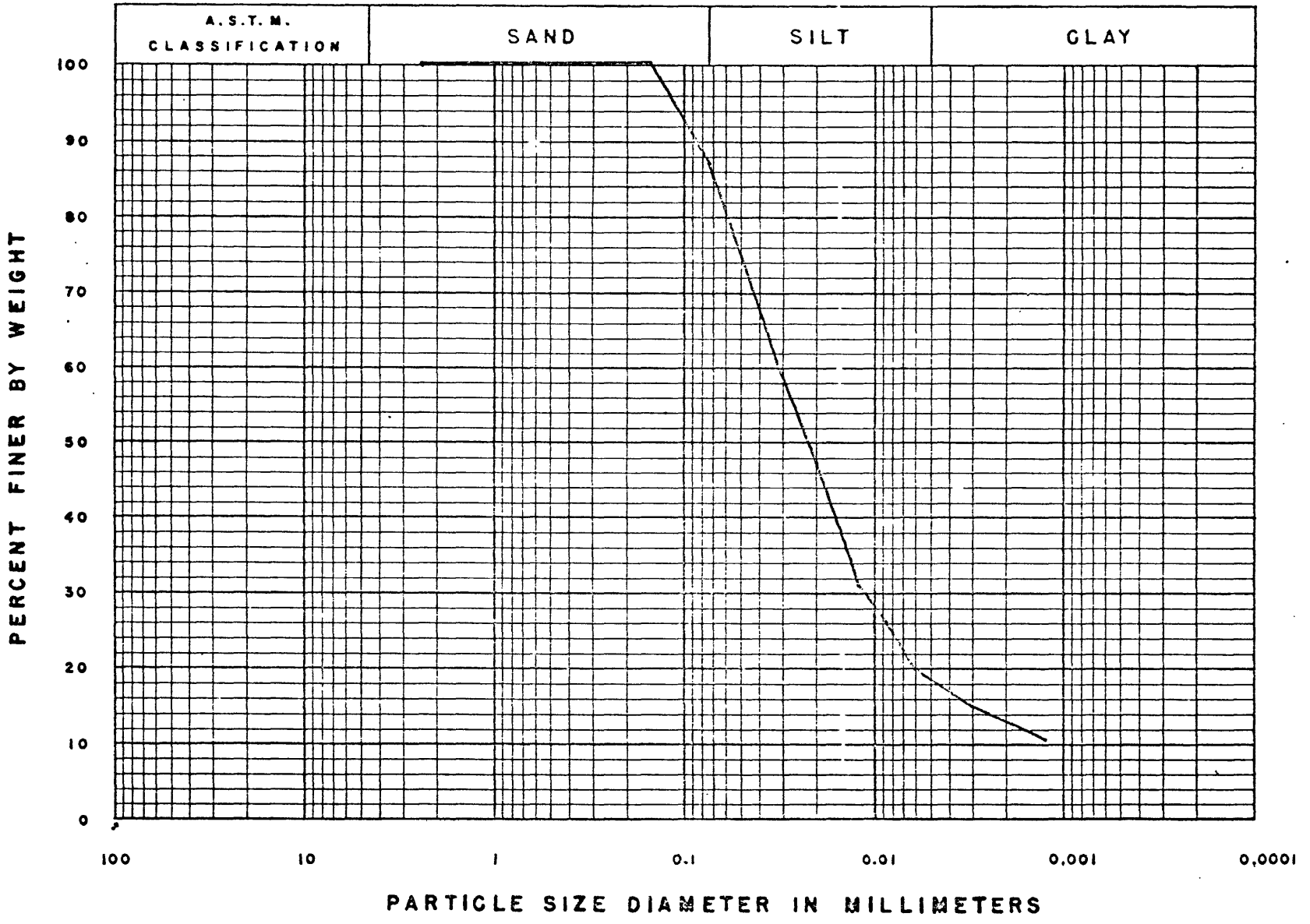
D104

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-76.50



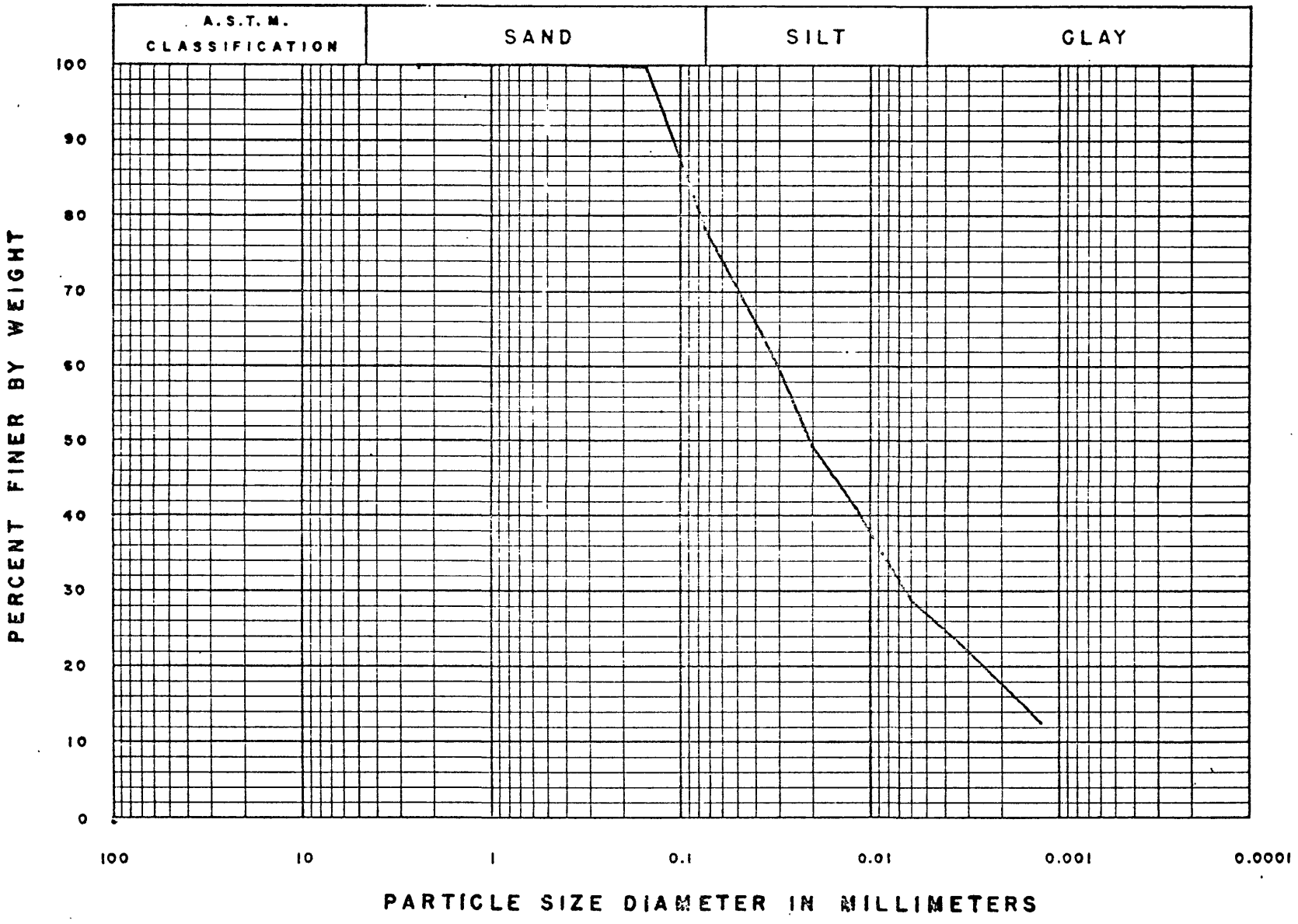
D105

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-79.20



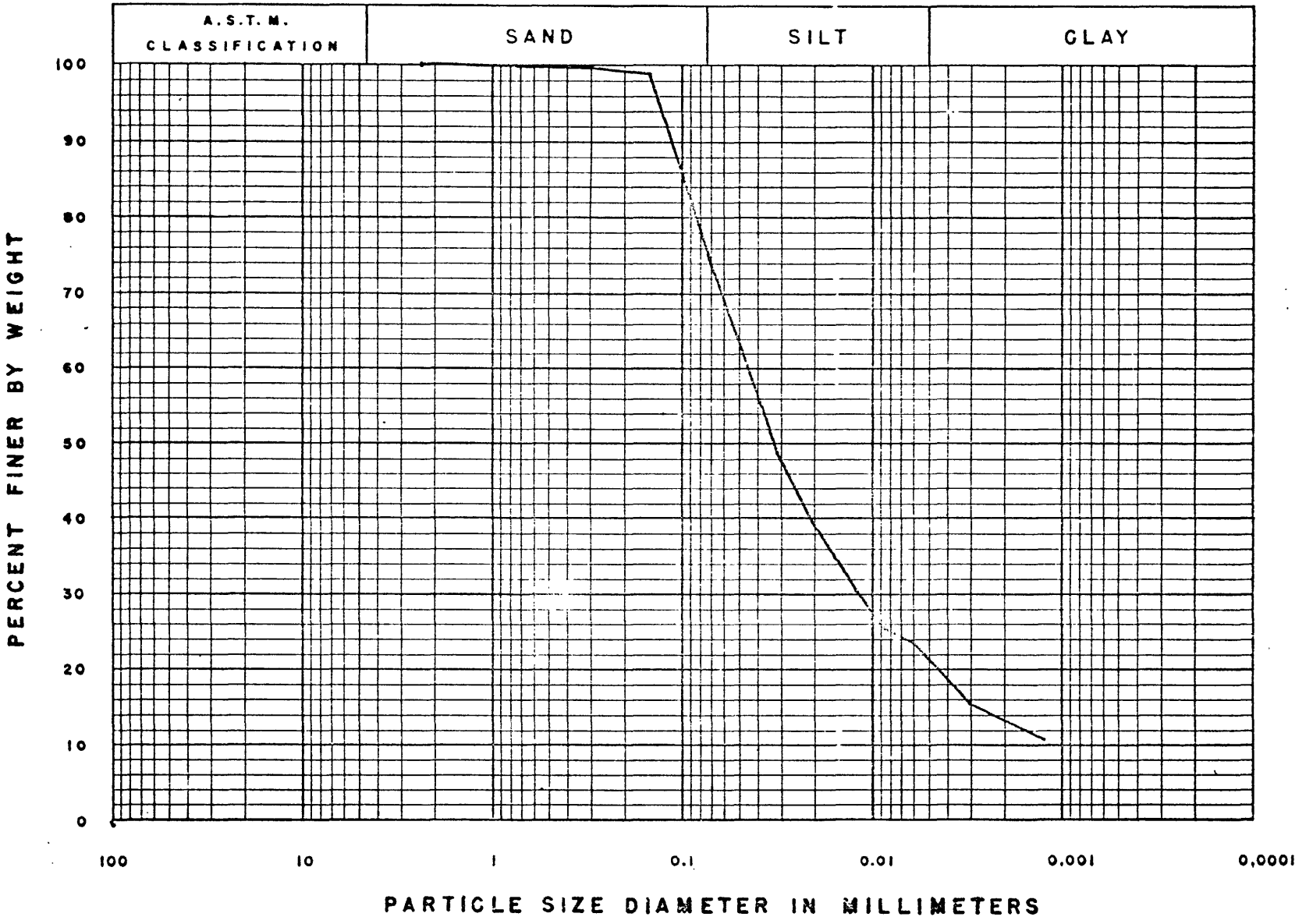
D106

GPO 831-

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-79.75



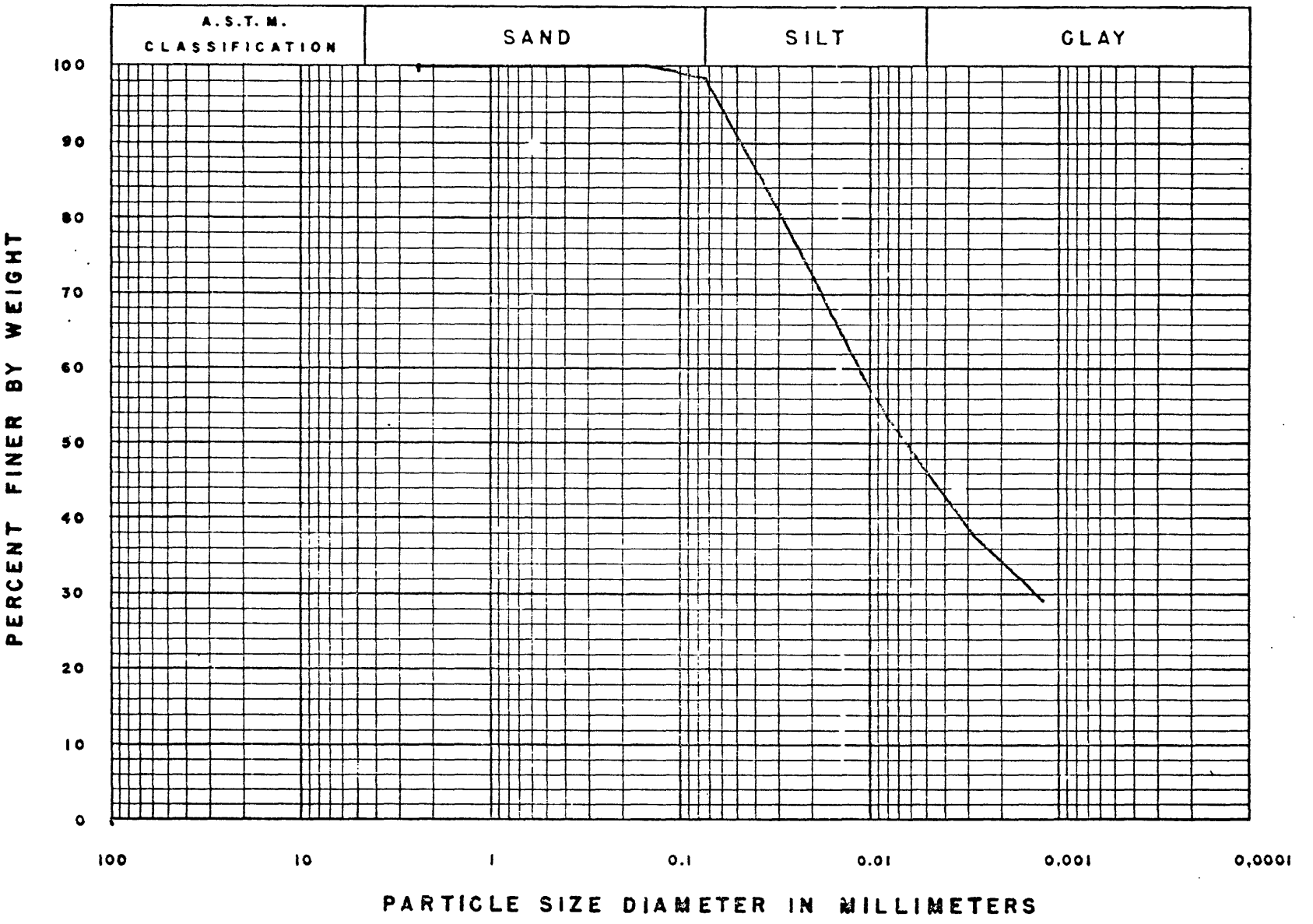
D107

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-83,80



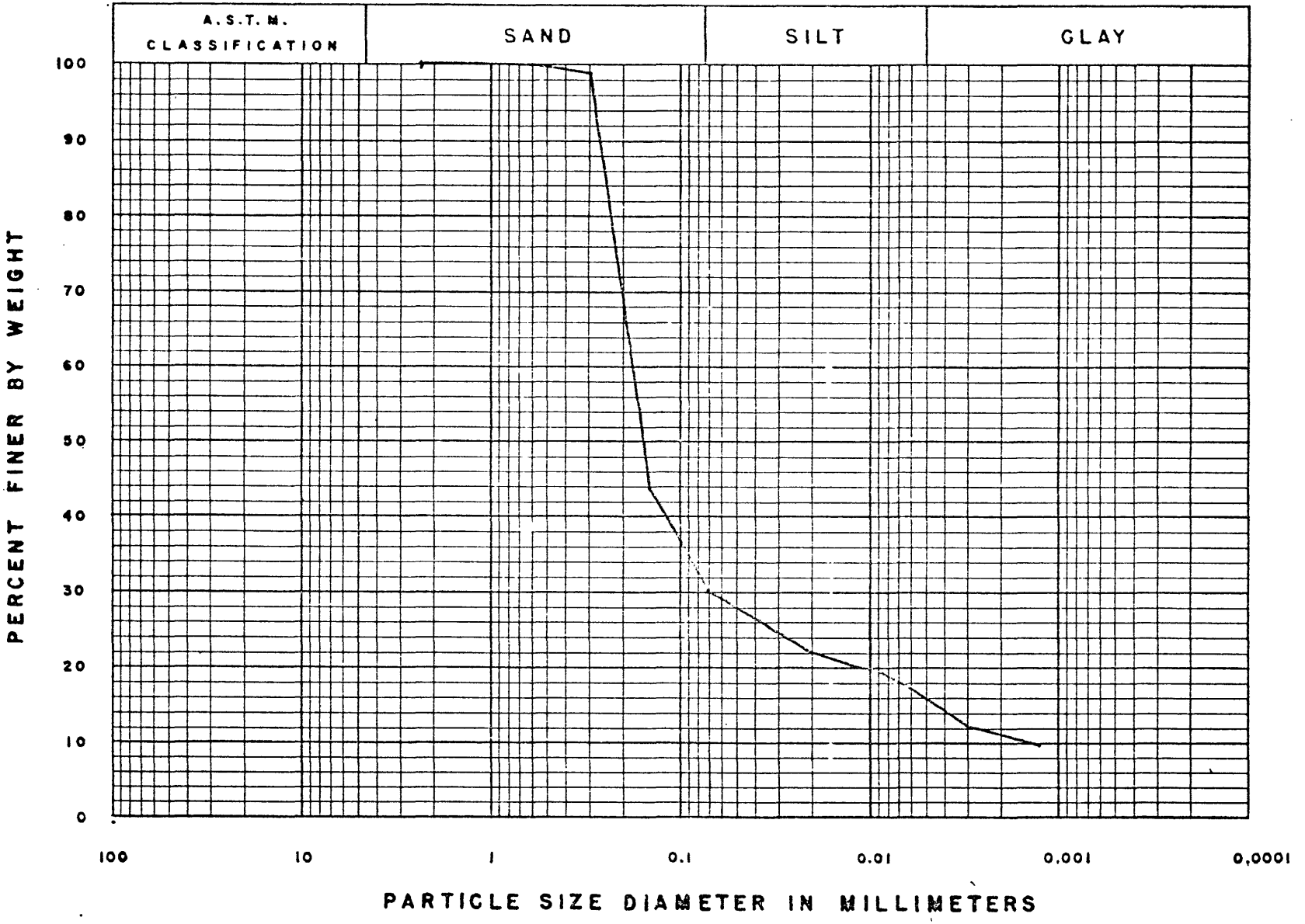
0108

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-86.20



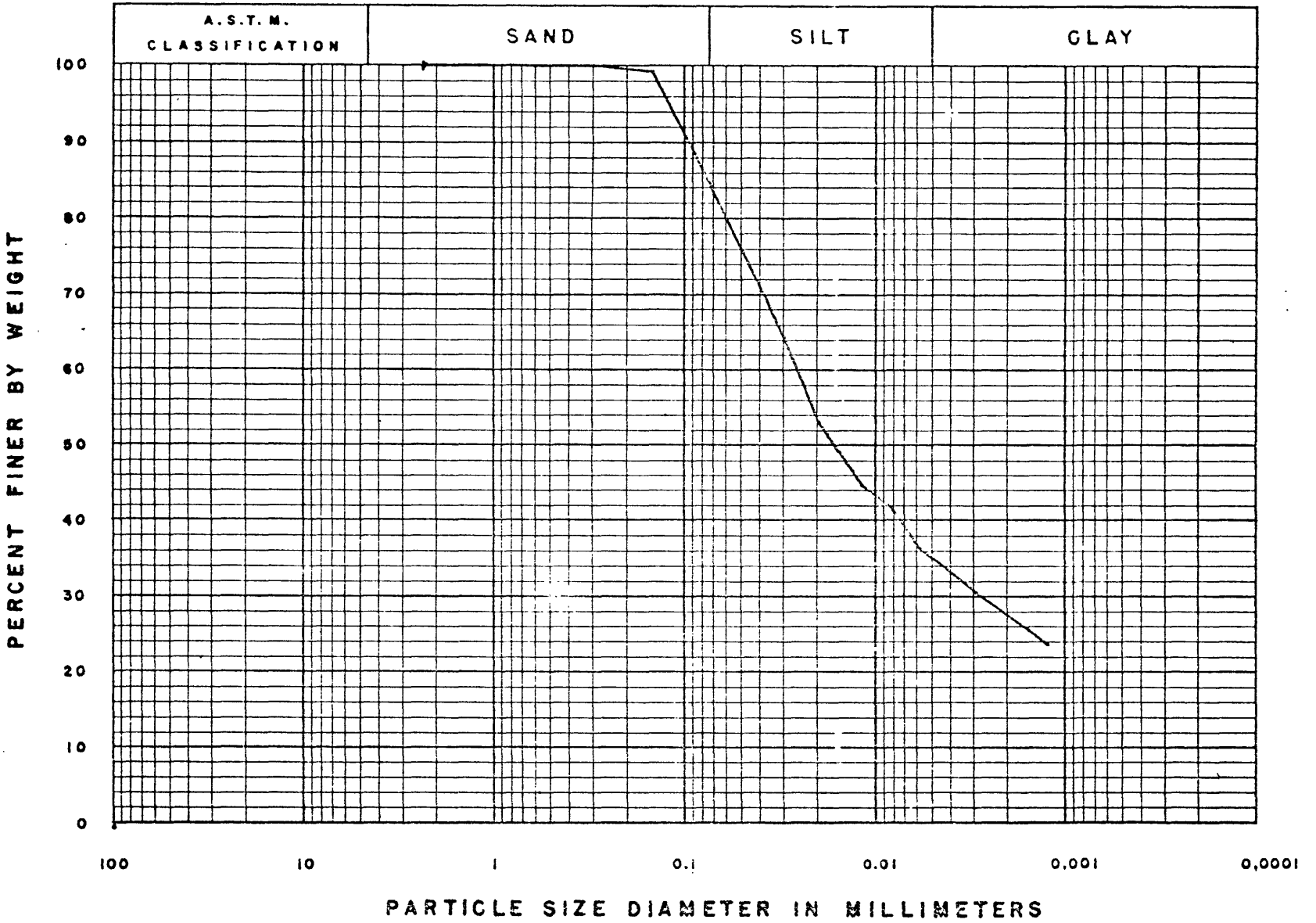
D109

GPO 631-718

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-89.75



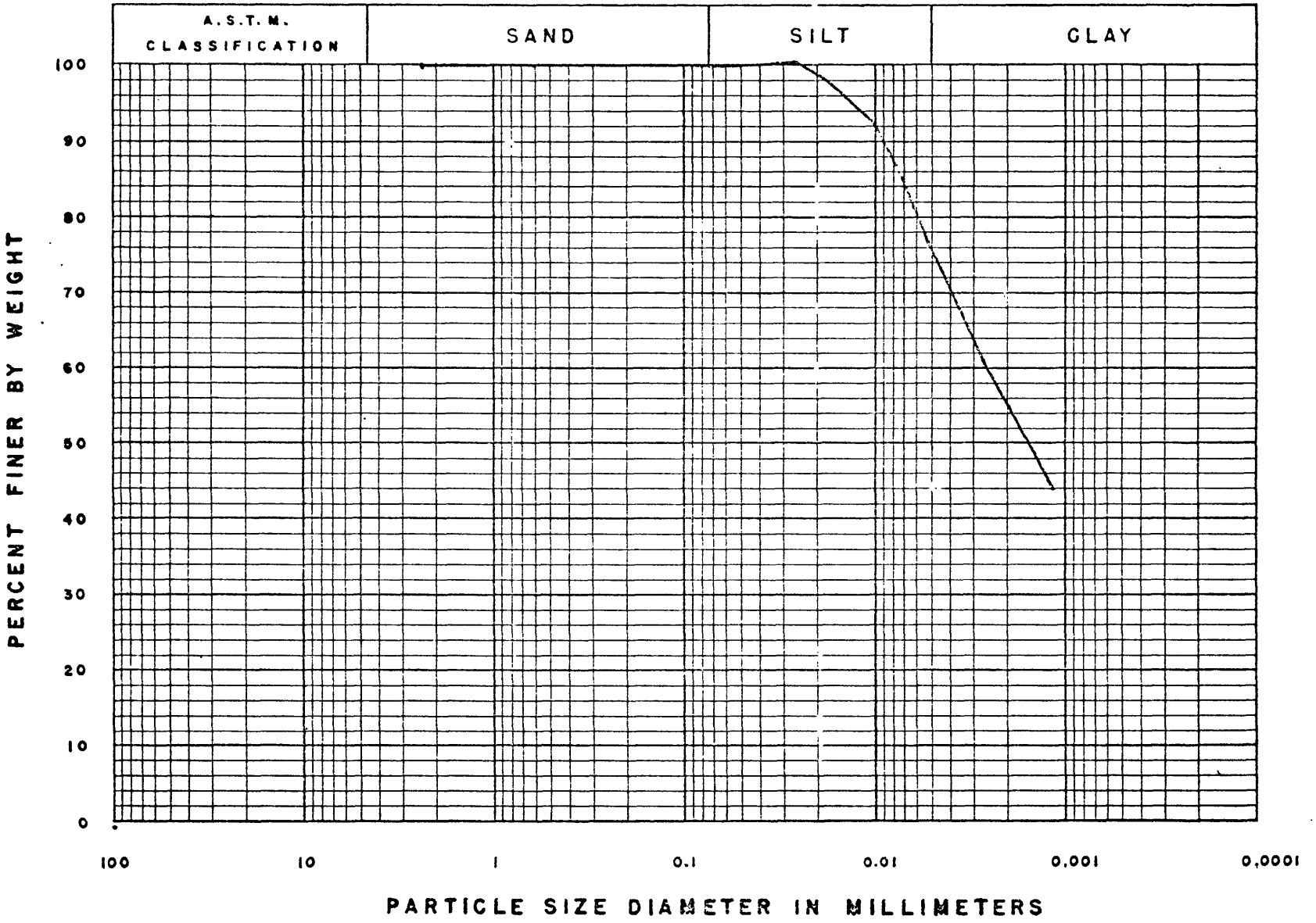
D110

GPO 831-71

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-05.95



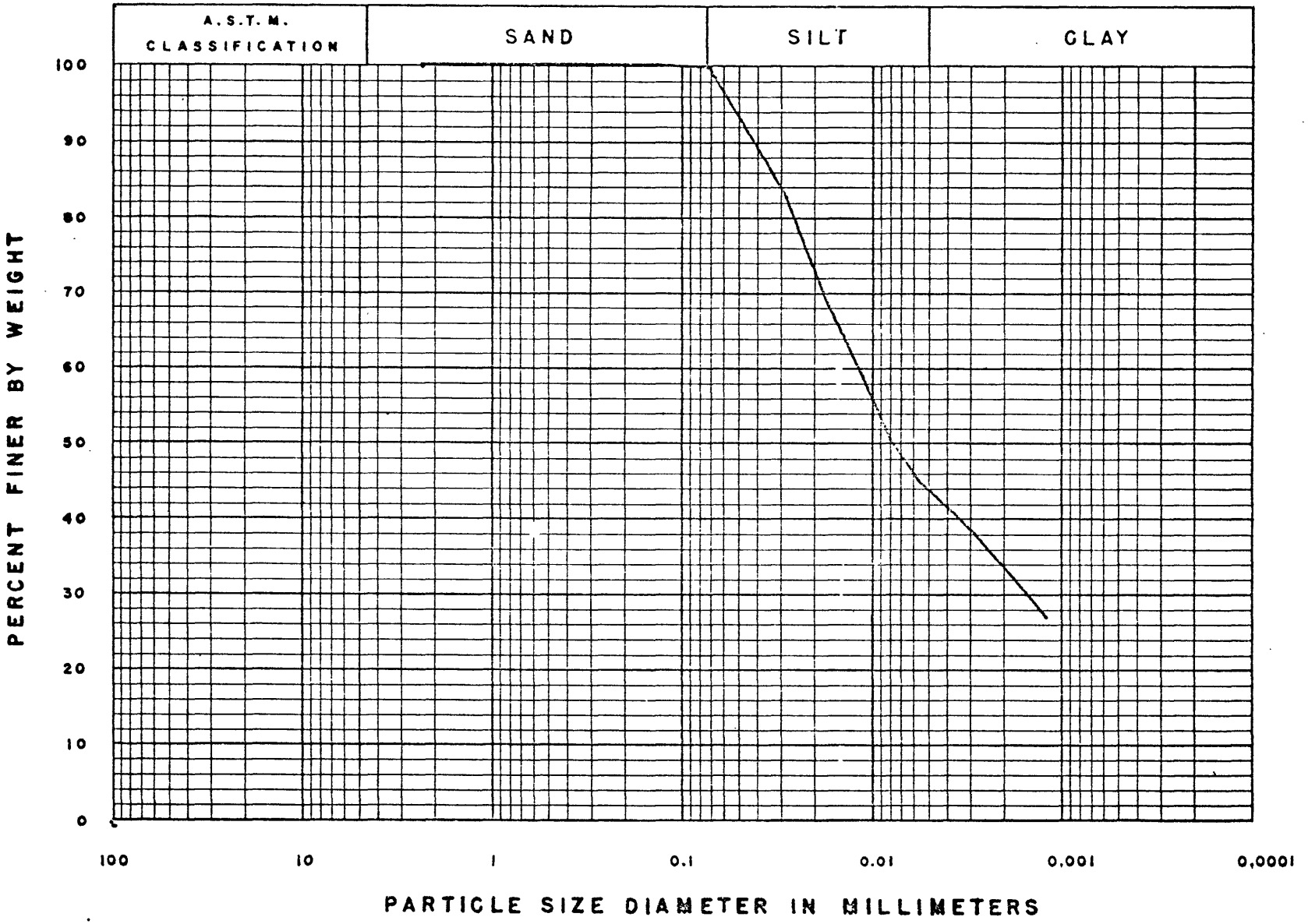
0111

GPO 831-7

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-101.50



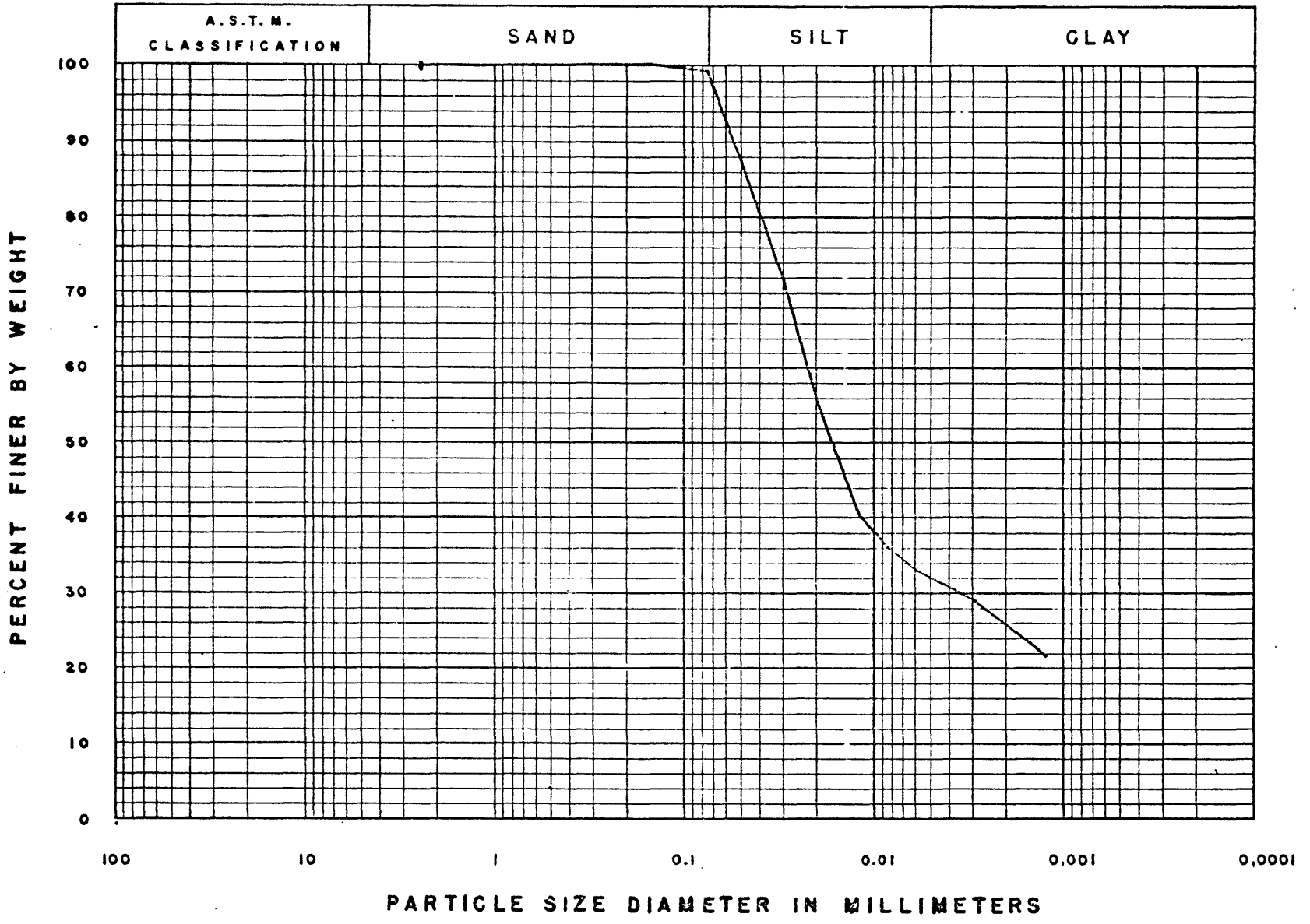
D112

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-113,30



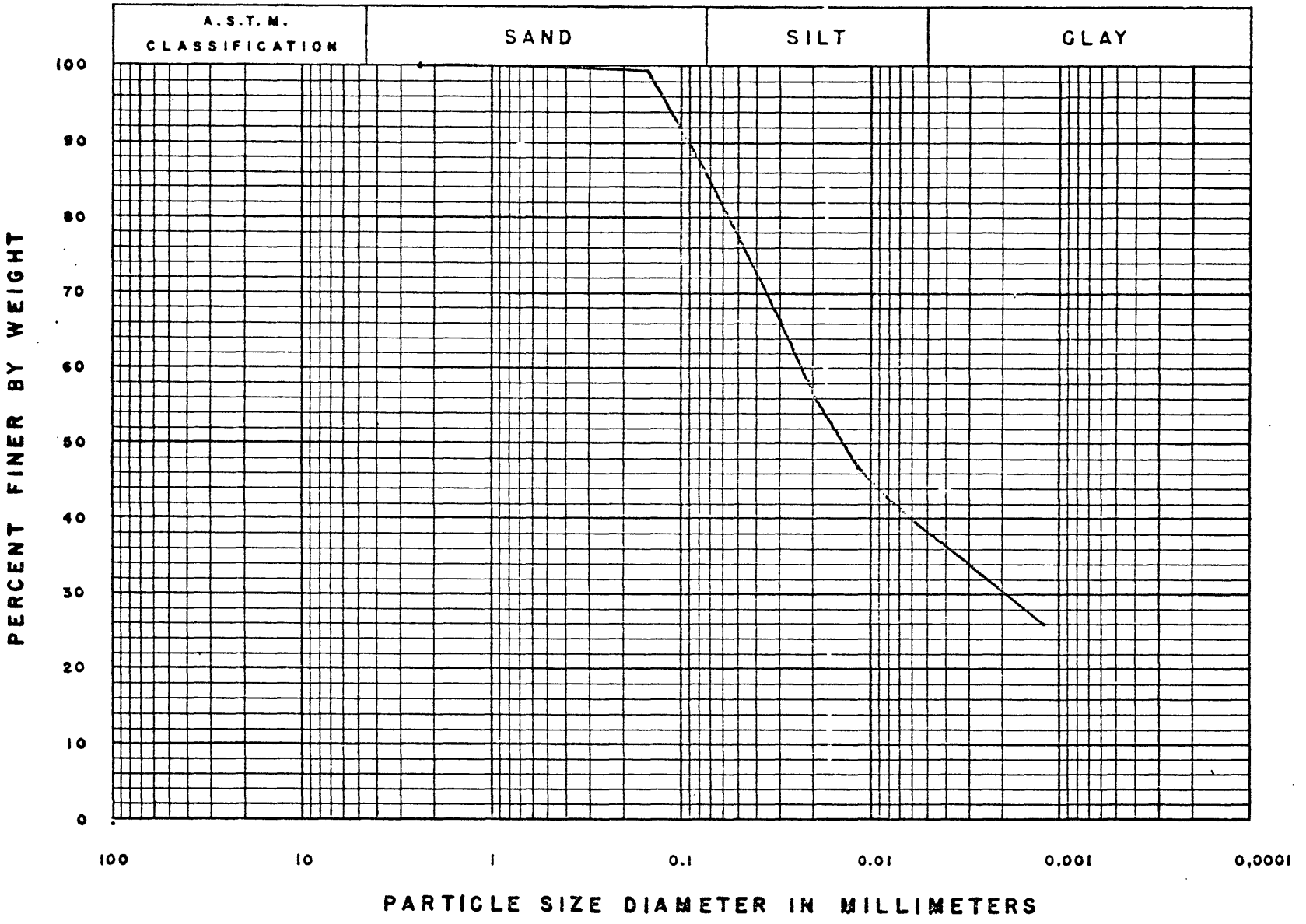
D113

GPO 831-715

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-1?1.50

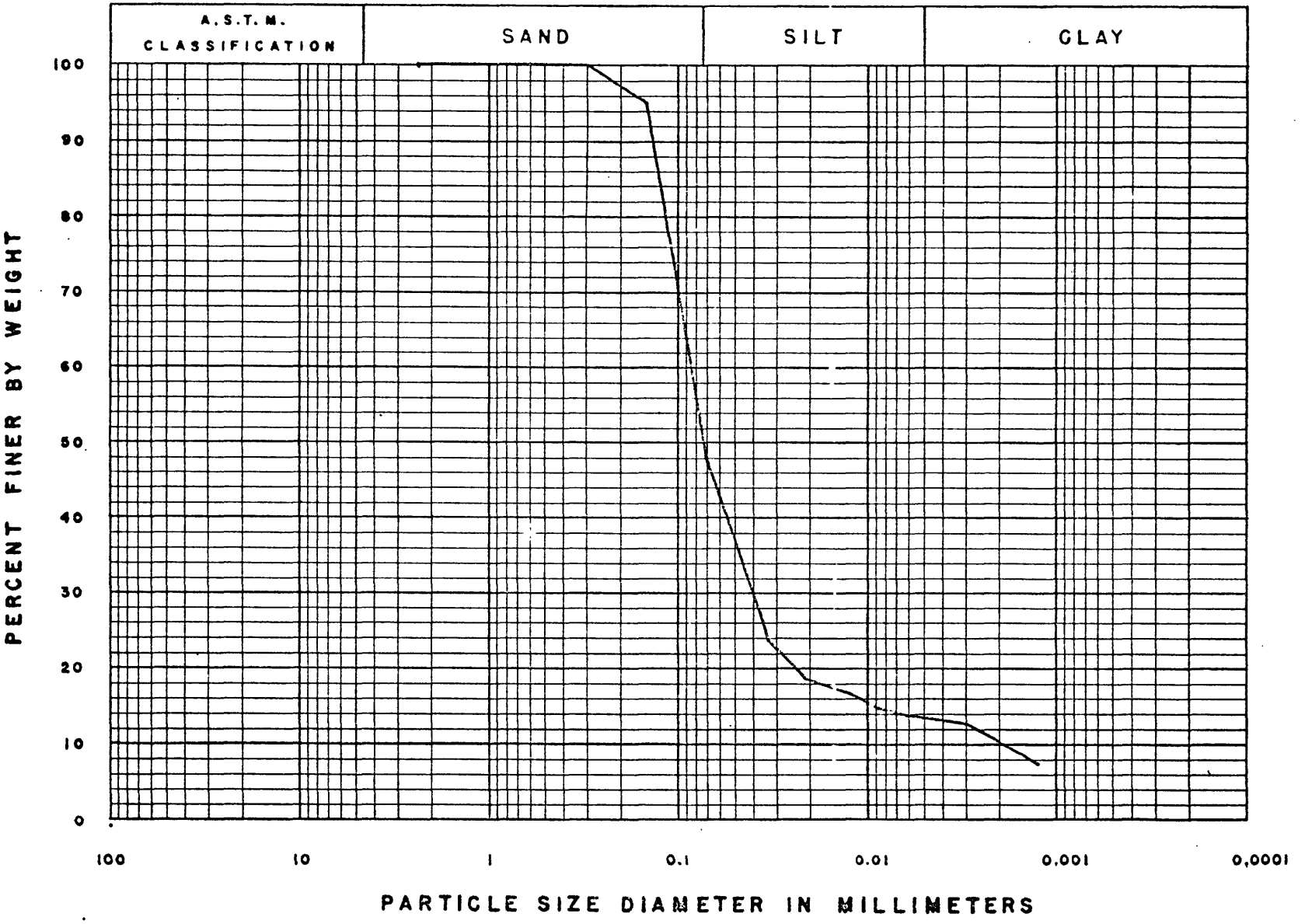


D114

ENGINEERING GEOLOGY LABORATORY

PARTICLE SIZE DISTRIBUTION CURVE

SAMPLE NUMBER S-1a-124.60



Summary of static test results

[Leaders (---) indicate no data]

Depth		Core diameter (in.)	Core length (in.)	End parallelism (in.)	Unconfined compressive strength (psi)	Tangent Young's modulus ($psiX10^4$)	Poisson's ratio	Tangent range (psi)	Bulk modulus ($psiX10^4$)	Shear modulus ($psiX10^4$)
m	(ft)									
8.90	(29.2)	1.89	3.73	0.0003	55	0.38	0.36	0-20	0.44	0.14
9.70	(31.8)	1.92	3.73	.0002	270	.63	.45	0-50	2.22	.22
10.45	(34.3)	1.91	3.73	.0002	215	.56	.47	0-50	3.0	.19
11.10	(36.4)	1.91	3.72	.01	50	.31	.40	0-20	.52	.11
11.40	(37.4)	1.91	3.86	.01	50	.25	.18	0-10	.13	.11
16.40	(53.8)	1.85	3.74	.01	1,220	14.6	.10	0-150	5.9	6.7
18.90	(62.0)	1.93	3.72	.01	230	.44	.18	0-20	.22	.19
21.05	(69.1)	1.91	3.7	.01	110	.25	.11	0-10	.11	.11
27.55	(90.4)	1.93	3.72	.0003	380	5.2	.36	0-100	6.3	1.9
41.60	(136.5)	1.88	4.16	.01	835	11.9	> .50	---------	------	------
42.00	(137.8)	1.89	3.72	.005	1,625	30.6	.39	0-500	45.7	11.0
50.90	(167.0)	1.87	3.76	.015	220	4.75	.38	0-150	6.3	1.7
51.65	(169.5)	----	----	------	875	6.43	.50	0-150	------	------
52.50	(172.3)	1.86	4.18	.01	1,725	23.3	.41	0-550	46.7	8.24
52.60	(172.6)	1.88	4.15	.01	2,595	56.0	.37	400-1,200	70.0	20.5
53.45	(175.4)	1.95	3.72	.01	395	1.67	.08	35-75	.65	.78
55.75	(182.9)	1.88	3.72	.01	405	3.67	.39	0-100	5.39	1.32
66.25	(217.4)	1.83	3.89	.01	1,385	14.0	.23	150-300	8.75	5.68
78.90	(258.9)	1.87	3.73	.01	924	11.5	.09	0-300	4.65	5.29
80.95	(265.6)	----	----	.01	>4,300	250	.25	0-2,500	167	100
84.05	(275.8)	1.80	4.16	.01	1,620	9.75	.47	100-400	52.0	3.32
85.90	(281.8)	1.80	3.97	.01	340	3.33	.37	0-50	4.14	1.22
89.60	(294.0)	1.86	3.85	.01	1,290	12.8	.40	0-350	21.3	4.57
101.05	(331.5)	----	----	------	2,110	25.3	.37	550-1,000	31.6	9.27
113.05	(370.9)	1.86	4.10	.01	2,000	32.0	.47	200-800	162	10.9
115.35	(378.5)	1.81	4.00	.01	1,880	24.0	.15	0-300	11.4	10.4
119.85	(393.2)	1.87	4.15	.01	1,920	37.3	.45	400-950	124	12.9
121.35	(398.1)	----	----	.01	1,845	19.0	.35	0-300	21.1	7.04
124.25	(407.7)	1.84	4.18	.01	1,040	18.0	.33	150-400	18.0	6.75

Results of ultrasonic pulse elastic testing

[Leaders (---) indicate no data]

Depth		Compressional velocity		Shear velocity		Poisson's ratio	Young's modulus		Shear modulus		Bulk modulus	
meters	(ft)	m/sec	ft/sec	m/sec	ft/sec		dynes/cmX10^{11}	psiX10^{6}	dynes/cmX10^{11}	psiX10^{6}	dynes/cmX10^{11}	psiX10^{6}
8.70	(28.5)	0.051	1,670	0.024	800	0.35	0.003	0.005	0.002	0.003	0.006	0.008
10.15	(33.3)	.060	1,960	.021	680	.43	.003	.004	.001	.002	.010	.014
18.60	(61.0)	.222	7,275	.084	2,755	.42	.046	.067	.024	.034	.134	.194
27.25	(89.4)	.054	1,770	------	------	------	------	------	------	------	------	------
27.55	(90.4)	.249	8,165	------	------	------	------	------	------	------	------	------
34.80	(114.2)	.249	8,155	.085	2,800	.43	.051	.074	.026	.037	.183	.266
40.45	(132.7)	.091	3,000	.039	1,290	.39	.010	.014	.005	.008	.021	.031
41.60	(136.5)	.181	5,925	.100	3,280	.28	.058	.084	.033	.048	.063	.092
43.20	(141.7)	.056	1,825	------	------	------	------	------	------	------	------	------
49.30	(161.7)	.175	5,740	.038	1,255	.48	.010	.015	.005	.007	.010	.146
51.65	(169.5)	.038	1,260	.014	465	.42	.001	.002	.001	.001	.004	.006
52.60	(172.6)	.098	3,205	.033	1,090	.43	.008	.011	.004	.006	.029	.041
53.45	(175.2)	.203	6,660	------	------	------	------	------	------	------	------	------
55.75	(182.9)	.059	1,940	.028	920	.36	.005	.007	.003	.004	.008	.012
60.90	(199.8)	.151	4,950	.069	2,275	.37	.034	.050	.018	.026	.062	.089
62.00	(203.4)	.299	9,795	.095	3,130	.44	.061	.089	.031	.045	.260	.377
68.75	(225.6)	.137	4,480	.051	1,675	.42	.017	.025	.009	.013	.051	.074
70.75	(232.1)	.132	4,335	.037	1,200	.46	.007	.011	.004	.005	.043	.063
78.90	(258.9)	.120	3,920	.051	1,685	.39	.016	.024	.009	.012	.035	.051
80.95	(265.6)	.106	3,490	.032	1,055	.45	.007	.010	.004	.005	.035	.050
84.05	(275.8)	.175	5,745	.070	2,295	.41	.032	.046	.016	.024	.081	.118
85.90	(281.8)	.067	2,210	.029	945	.39	.005	.007	.002	.004	.010	.015
89.60	(294.0)	.050	1,630	.025	815	.33	.004	.005	.002	.003	.005	.008
101.05	(331.5)	.176	5,760	.061	2,015	.43	.025	.036	.013	.018	.086	.125
113.05	(370.9)	.076	2,490	.027	880	.43	.005	.007	.002	.003	.016	.023
124.25	(407.6)	.167	5,470	.032	1,054	.48	.007	.010	.004	.005	.090	.130