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FINAL TECHNICAL REPORT: SRC BURN TEST IN 700-hp OIL-DESIGNED BOILER

Evaluation of Fabric Filter for Particulate Emission Control

September 1983

Work Performed Under Contract No. AC05-78OR03054

Wheelabrator-Frye, Inc.
Corapolis, Pennsylvania

and

International Coal Refining Company
Allentown, Pennsylvania

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Annex Volume E: Evaluation of Fabric Filter for Particulate Emission Control

September 1983

International Coal Refining Company
Allentown, Pennsylvania

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SRC TEST BURN PROGRAM

WHEELABRATOR-FRYE INC.

SUMMARY

The International Coal Refining Company (ICRC) is under contract from the Department of Energy (DOE) to study the technical feasibility and marketing potential of solvent-refined coal (SRC) fuels for oil-fired boiler applications. The technical aspects of the boiler fuel system conversion, combustion performance, and emission control system performance were studied through an SRC combustion test program, conducted at the Pittsburgh Energy Technology Center (PETC). Testing was conducted on the 700-hp watertube industrial boiler, designed for oil firing. Base-line data was collected by firing No. 6 fuel oil. Feasibility data were obtained by firing three types of SRC fuels: Pulverized SRC Solids, SRC Residual Oil, and SRC-Water Slurry.

The scope of work performed by the Air Pollution Control (APC) Division of Wheelabrator-Frye Inc. (WFI) and WFI Sciences was as follows: (1) provide mobile electrostatic precipitator (ESP); (2) operate and maintain the ESP; (3) provide a report on evaluation of ESP performance; (4) provide a reverse air pilot filter (PF); (5) operate and maintain the PF; (6) provide a report on evaluation of the PF performance; (7) provide equipment and personnel for assessment of particulate mass emissions at the ESP inlet and outlet and boiler outlet; (8) provide a report on particulate mass emissions data; (9) provide equipment and personnel for determination of particulate mass emissions from the existing pulse-jet baghouse (PJ); and (10) provide a report on the PJ mass emissions.

Results from the ESP evaluation report indicate that the fly ash from combustion of all three SRC fuels is easily removable by a conventional dry ESP. A relatively small collecting area is needed to collect the fly ash, but rapper reentrainment may necessitate a larger box. The pilot ESP was not set up to minimize rapping reentrainment, which was evident during the test program. Full-size units can be designed to minimize rapping reentrainment by varying the number of ESP fields, by minimizing plate height, and by using a low rapping intensity.

Results from the fabric filter feasibility evaluation report indicate that the particulate emissions from SRC fuels combustion were successfully controlled to less than 0.01 $lb/10^6$ Btu, well within the particulate emission limit of the Federal Environmental Protection Agency (EPA) New Source Performance Standard (NSPS) of 0.03 $lb/10^6$ Btu for electric utility steam-generating units. The amount of controlled particulate emissions from the SRC fuels combustion was equal to or less than the controlled particulate emissions from the No. 6 fuel oil combustion. Thus, the SRC Test Burn Program clearly established that the conventional fabric filters make a feasible control device for emissions from SRC-fuel-fired boilers.

Results from the boiler emission report show that the uncontrolled particulate emissions averaged 0.92 $lb/10^6$ Btu for SRC Solids, 0.20 $lb/10^6$ Btu for SRC Residual Oil, and 0.91 $lb/10^6$ Btu for SRC-Water Slurry.

A detailed review of the findings of ESP and Boiler Emission studies is provided in the reports submitted by Wheelabrator-Frye Inc. and WFI Sciences for the SRC Test Burn Program.

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ABSTRACT

Three types of Solvent Refined Coal Fuels namely, Pulverized SRC Fuel Solids, SRC Residual Fuel Oil and SRC Fuel Water Slurry were fired, one at a time, in a 700 HP boiler designed for oil firing. The purpose was to demonstrate the suitability of SRC Fuels in serving as an alternative to fuel oil and to evaluate the feasibility of fabric filters for control of emissions from SRC fuel fired boilers. Two types of fabric filters, namely a Pulse Jet, full scale Baghouse and a Reverse Air, pilot scale filter were tested. The Pulse Jet Baghouse was an existing full scale unit with a cloth area of 1924 square feet and a gas flow capacity of approximately 10,000 ACFM at 400°F. The Reverse Air Pilot Filter was a bench scale, portable unit with a cloth area of 1 square foot and a gas flow capacity of up to 6 ACFM at 400°F. This report presents the results of particulate mass emission rates, operating conditions and performance of the two fabric filters. The particulate emissions from all fuel types were easily controlled to less than 0.01 Lb/million BTU within normal and conventional working range of the fabric filters and with no special or restrictive operating conditions.

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ABBREVIATIONS

Names	Products
ESP	Electrostatic Precipitator
FC	Field Comparator
FF	Fabric Filter
PJBH	Pulse Jet Baghouse
RAPF	Reverse Air Pilot Filter
SRC	Solvent Refined Coal

Names	Organizations
AAF	American Air Filter
APC	Air Pollution Control Division
B&W	Babcock & Wilcox
DOE	Department of Energy
EPA	Environmental Protection Agency
GE/MATSCO	General Electric Company
ICRC	International Coal Refining Company
PETC	Pittsburgh Energy Technology Center
SCS	Southern Company Services
SRI	Southern Research Institute
U.S.	United States of America
WFI	Wheelabrator-Frye Inc.
WFI SC.	WFI Sciences Company

Units	Description
ACF	Gas Volume at Actual Conditions , ft^3
ACFM	Gas Volume Rate at Actual Conditions , ft^3/min
ACR	Air-To-Cloth Ratio, CFM/sq ft ,FPM , ft/min
BTU	British Thermal Unit
CFM	Cubic Feet Per Minute, ft^3/min
^oF	Degrees Fahrenheit, Temperature ^oF
FPM	Speed, Feet Per Minute, ft/min
Ft	Length, Feet , ft
Gr	Weight of Dust in Grains, Gr

Units	Description
Hg	Mercury
HP	Horsepower
Hr	Hour
ID	Inside Diameter, Induced Draft as in ID Fan
in.	Length, Inches, in.
k_2	Specific Resistance, in. w.g./FPM /Lb sq ft
Lb	Pounds , Lb
LOI	Loss of weight on ignition (heating) at certain temperature
Max	Maximum
Min	Minimum or Minute
ml	Milliliters
No.	Number
NSPS	New Source Performance Standard
Oz	Ounces, Weight
psig	Pressure, Pounds per Square Inch, Gage
S	Filter Drag, $\Delta P/ACR$, in. w.g./FPM
SDCF	Gas Volume at Standard, Dry Conditions, ft^3
SDCFM	Gas Volume Rate at Standard, Dry Conditions, ft^3/min ($68^{o}F$, 29.92 in. Hg, Dry)
Sq ft	Area, Square Feet
w.g.	Water Guage or Water Column, in.
Wt	Weight
yd	Length, Yard
ΔP	Pressure Drop Across the Cloth, Dust Collector , in. w.g.
η	Efficiency
$1-\eta$	Dust Penetration
μ	Length, Microns, 10^{-6} Meter, Permeability of Fabric

GLOSSARY OF TECHNICAL TERMS FOR FABRIC FILTERS

The feasibility of the fabric filters is evaluated with several performance results of the filter, dust layer, dust emissions, and flue gas flow. Some of these results are described here.

<u>Pressure Drop</u> ΔP in. w.g.

Pressure drop is a measure of filter resistance across the Pulse Jet Baghouse or the filter cloth of Reverse Air Pilot Filter. The baghouse pressure drop ranged between 0.8 and 2.3 in. w.g. The pilot filter pressure drop ranged between 0.1 and 4.5 in. w.g.

<u>Air-To-Cloth Ratio</u> ACR CFM/Sq Ft or FPM

Air to-cloth ratio is a measure of air or flue gas volume flow rate in CFM per square foot of filter cloth area. Air-to-cloth ratio is also called filtration velocity or superficial filter velocity. The baghouse air-to-cloth ratio was not directly controlled and ranged between 2.8 and 4.0. The pilot filter air-to-cloth ratio was directly controlled and ranged between 1.6 and 4.2.

<u>Drag</u> S in. w.g./FPM

$S = \Delta P/ACR$

Drag is a measure of filter resistance per unit value of air-to-cloth ratio. Drag compares filter resistance values when air-to-cloth ratios are different. The baghouse drag values ranged between 0.2 and 0.8. The pilot filter drag values ranged between 0.1 and 1.9.

Dust Loading $C \quad \frac{Gr}{SDCF}$

Dust loading is a measure of mass of dust per unit volume of flue gas.

Dust Load $\frac{\text{Lb of dust}}{\text{sq ft of filter}} = \frac{1}{\text{ACR } C \ t}$

Dust load is a measure of mass of dust accumulated per unit area of filter cloth. Dust load is a measure of dust layer for a specific, continuous time period of operation, usually without any cleaning of the dust from the filter cloth.

Specific Resistance $k_2 \quad \frac{\text{in. w.g.}}{\text{FPM}} \Big/ \frac{\text{Lb}}{\text{sq ft}}$

$$k_2 = \frac{\Delta S}{\text{Dustload}} = \frac{\Delta P}{\text{ACR}} \Big/ \frac{\text{Lb of Dust}}{\text{sq ft of filter}}$$

$$= \frac{\Delta P}{(\text{ACR})^2 \ C \ t}$$

Specific resistance is a measure of dust layer resistance. Specific resistance compares the filter resistance when both air-to-cloth ratio and dust load values are different. Drag is inversely proportional to ACR whereas specific resistance is inversely proportional to $(\text{ACR})^2$.

Fabric Permeability μ CFM/sq ft

Fabric permeability is a measure of ambient air volume rate in CFM passing through one square foot of filter fabric area when that air flow causes a pressure drop of 0.5 in. w.g. across the cloth. Fabric permeability of dirty cloth and of the vacuumed dirty cloth indicate the measure of plugging or blinding of the filter cloth.

Emission Rate   Lb/million BTU

Dust emission rate is a measure of mass of dust per million BTU of heat input to a combustion source.

Dust Collection Efficiency η %

$$\eta = \left(1 - \frac{C_{out}}{C_{in}}\right) \times 100$$

Dust Penetration $1-\eta$ %

$$1-\eta = \frac{C_{out}}{C_{in}} \times 100$$

I. EXECUTIVE SUMMARY

The Solvent Refined Coal (SRC) Burn Test Program was undertaken by International Coal Refining Company (ICRC) with a contract from the Department of Energy (DOE). The main objective of the test program was to demonstrate the feasibility of SRC Fuels in displacing fuel oil in oil fired boilers. A 700 HP, oil fired boiler was tested to obtain baseline data and SRC Fuel feasibility data. The baseline data was obtained by firing No. 6 Fuel oil. The SRC fuel feasibility data was obtained by firing three forms of SRC Fuels: Pulverized SRC Fuel Solids, SRC Residual Fuel Oil, and SRC Fuel Water Slurry. The purpose of this report was to determine the feasibility of a fabric filter as an efficient dust collector in controlling particulate emissions of SRC Fuel fired boilers. The results of the feasibility study are summarized in Tables 4 and 8.

The major accomplishment of the feasibility evaluation of fabric filters was that the particulate emissions from a SRC Fuel fired, oil firing designed boiler were successfully controlled to less than 0.01 Lb/million BTU. This emission rate was well within the particulate emission limit 0.03 Lb/million BTU of the United States Environmental Protection Agency (EPA), New Source Performance Standard (NSPS), issued on June 11, 1979 for electric utility steam generating units. This accomplishment was shown by testing a Reverse Air Pilot Filter and a Pulse Jet Baghouse without any special or restrictive operating conditions (Tables 5 and 9). The amount of controlled particulate emissions from the SRC Fuel combustion was equal to or less than the controlled particulate emissions from the No. 6 Fuel Oil combustion. Thus, the SRC Test Burn Program clearly established that the conventional fabric filters make a feasible control device for emissions from SRC Fuel fired boilers.

The reverse air cleaning as well as pulse jet cleaning proved equally applicable in successful operation of the fabric filters. The Reverse Air Pilot Filter and Pulse Jet Baghouse used a fabric primarily made of glass fibers. Both fabric filters were operated within their conventional, normal operating limits and they performed at a dust removal efficiency as high as 99.9% after a short period of operation of only 54 hours. The flyash of SRC Fuels was relatively easy to remove from the fabric with normal cleaning procedures. The frequency of reverse cleaning for flyash of SRC Fuel Water Slurry was higher than that for the flyash of the other two forms SRC Fuels or the No. 6 Fuel Oil. The frequent cleaning was necessitated by Lomar-D, a wetting additive used in SRC Fuel Water Slurry making process. The Pulse Jet Baghouse performance was indifferent to the flyash of all three SRC Fuels and of No. 6 Fuel Oil.

II. PERFORMANCE EVALUATION

The fabric filters proved to be a simple and successful choice for the control of flyash from SRC Fuel combustion. The flue gas of SRC Fuel combustion averaged less than 350^{o}F temperature at the fabric with an average of less than 13% moisture. The dust concentration of the flue gas at the boiler exit averaged less than 0.5 Gr/SDCF for Pulverized SRC Fuel Solids and SRC Fuel Water Slurry and less than 0.1 Gr/SDCF for SRC Residual Fuel Oil. For the three SRC Fuels, the average carbon content (loss on ignition, LOI, at 750^{o}C) of the flyash ranged between 64 and 92% wt. For the conventional coal, the carbon content of the flyash may average 10% wt. The higher % wt of carbon content in the flyash of SRC Fuels is a consequence of extremely low ash content (0.5% wt) inherent in the SRC Fuels. The Pulse Jet Baghouse is a full scale unit and was designed to operate at an air-to-cloth ratio (ACR) of up to 6 CFM/sq ft. The Reverse Air Pilot Filter is a miniature pilot unit and can be operated at an air-to-cloth ratio up to 6 CFM/sq ft.

A. Pulse Jet Baghouse

Table 4 presents the summary of Pulse Jet Baghouse performance results. The Pulse Jet Baghouse outlet emission rate for SRC Residual Fuel Oil and SRC Fuel Water Slurry averaged 0.004 Lb/million BTU, significantly less than the U.S. EPA NSPS of 0.030 Lb/million BTU. The higher emission rate during Pulverized Fuel SRC Solids firing was primarily a consequence of dirty gas leakage through the bypass valve.

Were it not for the boiler flue gas sneakage past the baghouse bypass valve, the dust emission rate for Pulverized SRC Fuel Solids and SRC Residual Fuel Oil would have been similar to that for the SRC Fuel Water Slurry (between 0.001 and 0.010 Lb/million BTU). The Pulse Jet Baghouse operated at an air-to-cloth ratio between 2.8 and 4.0 at a pressure drop between 0.8 and 2.5 in. w.g. with the specific resistance (k_2) between 1 and 36. The cleaning time pulse interval was 40 seconds. This resulted in the entire baghouse being cleaned 13 times every hour. The compressed air for bag cleaning was delivered at 75 psig. The Pulse Jet Baghouse test data did not show any significant difference in control of flyash from the three SRC Fuels.

B. Reverse Air Pilot Filter

Table 8 presents the summary of Reverse Air Pilot Filter performance results. The Reverse Air Pilot Filter outlet emission rate for Pulverized SRC Fuel Solids and SRC Residual Fuel Oil averaged 0.002 Lb/million BTU. For SRC Fuel Water Slurry and No. 6 Fuel Oil it averaged 0.011 Lb/Million BTU. All values were significantly less than the U. S. EPA NSPS of 0.030 Lb/million BTU. The Reverse Air Pilot Filter was operated at an air-to-cloth ratio between 2 and 4 at a pressure drop between 1.7 and 4.5 in. w.g. with the specific resistance (k_2) values between 7 and 82 for the three SRC Fuels. The k_2 values for the No. 6 Fuel Oil were between 200 and 3,000. The reverse cleaning air-to-cloth ratio was 1 CFM/sq ft for a duration of 1 minute followed immediately by a 1 minute settle time. No settle time was allowed before the reverse cleaning. The decrease in pressure drop after cleaning for the SRC Fuel Water Slurry flyash was not as much as that for the flyash of the other two SRC Fuels. On the basis of dust penetration through the filter cloth, outlet dust concentration, and frequency of cleaning, the flyash of Pulverized SRC Fuel Solids and SRC Residual Fuel Oil was much easier to control than that of the SRC Slurry. The relatively high pressure drop and frequent cleaning during firing of SRC Fuel Water Slurry were mainly due to Lomar-D, a wetting reagent used in making of the slurry. There are alternate reagents available that may or may not cause the same operating constraints as Lomar-D.

C. Fabric Filters for SRC Burn

On the basis of the results of the SRC Burn Test Program, it is concluded that the fabric filters are a feasible application for flyash emission control of SRC Fuel fired in oil designed boilers. The test program did not encounter any abnormal operating conditions for the boiler. The boiler exit dust loading varied widely with fuels, combustion conditions, start-ups, and shutdowns. However, the fabric filters performed quite uniformly and efficiently under those variety of conditions. The duration of test periods was adequate to provide certain conclusive results and other qualitative indications.

The difference in the Pulse Jet Baghouse performance among the three SRC Fuels was not significant. However, the Reverse Air Pilot

Filter necessitated higher frequency of cleaning for the SRC Fuel Water Slurry than for the other two SRC Fuels. Also, the Reverse Air Pilot Filter outlet dust concentration for the SRC Fuel Water Slurry was higher than that for the other two SRC Fuels. The effects of varying boiler operating conditions were not analyzed. The effects of gas flow properties and inlet dust properties were not clearly quantifiable. The effects of inlet dust loading were implicitly indicated in the dust layer specific resistance values. The duration of conditioning phase was not clearly identifiable for all of the three fuels. The amount of dust penetration decreased with an increase in the time of dust exposure for each cloth. With only 54 hours of operation, the significance of the effects of startup and shutdown, in increasing the filter resistance or in affecting the cleanability of the fabric could not be determined. Only one fabric, made of fiberglass, was evaluated by measuring the change in operating pressure drop and by its permeability before and after the fabric's use in the test program. The determination of fabric life could not be done in the available time.

III. INTRODUCTION

A. Scope of SRC Burn Test Program

In order to demonstrate the feasibility of SRC in replacing fuel oil in oil fired boilers the International Coal Refining Company, Allentown, Pennsylvania under the contract from DOE undertook an SRC Burn Test Program consisting of performance and emission testing of various SRC Fuels in a 700 HP, oil fired, water tube boiler of the Pittsburgh Energy Technology Center (PETC) in Bruceton, Pennsylvania. Figure 1 shows the flue gas area flow diagram and the sampling sites. The 700 HP boiler, the flue gas cooler, Pulse Jet Baghouse, Induced Draft fan and the stack were the main components of the test facility. They played an active role in the SRC Burn Test Program. The flyash emissions were controlled by a full scale Pulse Jet Baghouse, a small Reverse Air Pilot Filter, and a mobile electrostatic precipitator (ESP). The Pulse Jet Baghouse cleans the fabric (bags) with a jet pulse of compressed air from the clean side of the bag into the dirty side. The Reverse Air Pilot Filter cleans the fabric (cloth) with a steady flow of flue gas in the reverse direction; i.e., from the clean side of the fabric into the dirty side. Three types of SRC Fuels were burned: Pulverized SRC Fuel Solids, SRC Residual Fuel Oil, a 50% wt solution of Pulverized SRC Fuel Solids in process solvent, and SRC Fuel Water Slurry, a mixture of pulverized SRC Solids and demineralized water. Table 1 presents the Time Table of the field work performed for the SRC Burn Test Program.

B. Scope of the Report

This report presents feasibility data of fabric filter as an effective particulate emission control equipment for the oil designed boilers using SRC as a primary fuel. The report examines two types of fabric filters: Pulse Jet and Reverse Air. The examined parameters of fabric filter performance included filtration rate, pressure drop across the cloth, dust collection efficiency, and flue gas emission properties.

C. Objectives of Fabric Filter Study

The purpose of the fabric filter study was to determine the effectiveness of collecting the relatively fine size and high carbon flyash of the SRC Fuels and to provide necessary data for the design of a commercial fabric filter unit. To achieve this two types of fabric filters were operated at conventional values of pressure drop, air-to-cloth ratio, and other operating parameters normally encountered in the industry. The Reverse Air Pilot Filter was operated at various air-to-cloth ratios with a predetermined pressure drop limit of 4. in. w.g. across the filter fabric and by cleaning the fabric at a reverse air-to-cloth ratio of 1 CFM/sq ft for 1 minute. The Pulse Jet Baghouse was operated with a flue gas flow rate limited by the gas volume rate needed at the ESP. The pressure drop across the Pulse Jet Baghouse was controlled to less than 4 in. w.g. by setting the pulse interval to clean the bags with a jet of 75 psig air.

D. Methodology

The fabric filter evaluation study was performed with air-to-cloth ratio as an independent variable for the Reverse Air Pilot Filter and with pulsing interval as an independent variable for the Pulse Jet Baghouse. Reverse Air Pilot Filter was tested for 7, 15, 8 and 8 days for No. 6 Fuel Oil, Pulverized SRC Fuel Solids, SRC Residual Fuel Oil, and SRC Fuel Water Slurry, respectively. Pulse Jet Baghouse was tested for 10, 5, and 3 days for Pulverized SRC Fuel Solids, SRC Residual Fuel Oil, and SRC Fuel Water Slurry, respectively. The operation and testing of the Reverse Air Pilot Filter and testing of the Pulse Jet Baghouse were performed by WFI Sciences Company, a department of the Air Pollution Control Division of Wheelabrator-Frye Inc. in Pittsburgh, Pennsylvania.

The SRC Burn Test Program was conducted under the general direction of ICRC, which also provided the SRC Fuels for all Test Burns. Southern Company Services, Inc. under a contract to ICRC, provided on-site project management including qualifying the operating conditions of the boiler for its test worthiness. General Electric/MATSCO under contract to PETC operated the 700 HP boiler and the Pulse Jet Baghouse. Southern Research Institute (SRI), under a contract to ICRC, evaluated the mobile ESP. GE/MATSCO and PETC together performed sampling and analysis of boiler exit emissions before the flue gas cooler. WFI Sciences also performed sampling and analysis of boiler exit emissions before the gas cooler.

IV. SRC BURN TEST PROGRAM

A. Pulse Jet Baghouse

A.1 Design

The exhaust gases of the oil fired, 700 HP boiler pass through an American Air Filter Pulse Jet Baghouse. The Pulse Jet Baghouse is 11' square and 27' high with one hopper equipped with an air operated double dump valve that continually empties the hopper. The Pulse Jet Baghouse is designed to clean 16,000 ACFM at up to 400°F, 12% moisture, and 6 CFM/sq ft air-to-cloth ratio. As shown in Figure 1, the cleaned gas from the Pulse Jet Baghouse is drawn by an induced draft fan and discharged into atmosphere via an insulated, sheet metal stack of 24 in. inside diameter.

The Pulse Jet Baghouse contains 120 bags arranged in 10 rows of 12 bags each. Each bag is 11'-9" long with a diameter of 5 1/4". The Pulse Jet Baghouse has a total cloth area of 1924 sq ft. The bags were cleaned with a pulse of 75 psig clean air jet. Table 3 provides the equipment description. As shown in Figures 2 and 3 there are two compressed air manifolds, one on each side of the Pulse Jet Baghouse such that each manifold cleans the corresponding half (six bags) of any one of the ten rows. Each manifold is 79" long and 6" inside diameter. The two manifolds together clean 12 bags of a row simultaneously. Rows 1, 2, and 3 are each cleaned simultaneously with rows 9, 10, and 8, respectively. Rows 4, 5, 6, and 7 are cleaned individually, only one row at a time. Figure 3 shows the cleaning sequence for the rows of bags. Seven consecutive pulses would clean the entire Pulse Jet Baghouse (i.e., all ten rows). The frequency of pulsing was set so as to limit the pressure drop across the Pulse Jet Baghouse to less than 4 in. w.g.

A.2 Operation

The Pulse Jet Baghouse was operated only a few hours a day because its operation depended on the running of the boiler. Usually it was not operated overnight. When not in use overnight, there was no effort made to keep the Pulse Jet Baghouse at flue gas temperature to prevent cooling and condensation. The cleaning air was nonheated ambient air. The Pulse Jet Baghouse was designed to carry the entire volume of the boiler exit gas. However, during the SRC Fuel Burn Test Program it carried approximately half of the design gas volume rate.

On November 3, 4, and 15, the pulse interval; i.e., the time period between two consecutive pulses was measured to be 9 seconds, implying a pulsing frequency of 7 pulses per minute; i.e., the entire Pulse Jet Baghouse cleaning frequency of once per minute. On November 15, the pulse interval was increased to 30 seconds and finally, on November 16 to 40 seconds. During the rest of the days in November 1982 and all days of December 1982 and January 1983, the Pulse Jet Baghouse was pulsing at an interval of 40 seconds, i.e., at a frequency of 90 pulses per hour. Thus the entire baghouse was being cleaned approximately 13 times per hour. The pulsing frequency was reduced to increase the pressure drop across the baghouse because the Pulse Jet Baghouse was operating at relatively low values of pressure drop and air-to-cloth ratio. The pulsing frequency was not reduced to slower than 40 seconds because GE/MATSCO did not want to risk irreversible plugging of the newly installed bags.

Prior to SRC Burn schedule of October 1982, the Pulse Jet Baghouse was fitted with a new set of felt bags manufactured by Huyck Felt Division of BTR Paper Group. Prior to performance testing of the baghouse, the bags had cleaned the flue gas of the 700 Hp boiler, when it was burning Pulverized SRC Fuel Solids as its primary fuel. The baghouse flue gas volume rate was dependent on the flue gas volume rate required through the mobile ESP. After setting the desired level of ESP flue gas volume rate, the balance of the boiler flue gas was sent to the baghouse. Whenever the boiler encountered combustion difficulties, the baghouse was bypassed so as not to plug the bags with oily, sticky flyash and other undesirable products of incomplete or improper combustion.

On the first day of Pulse Jet Baghouse testing it was seen that the outlet particulate concentration 0.03 Gr/SDCF was abnormally high for a fabric filter unit. It was inferred that the butterfly valve in the bypass duct of the Pulse Jet Baghouse was not sealing well and was letting the inlet (dirty) gas into the stack. This situation was corrected during December 1982, just prior to SRC Fuel Water Slurry testing.

A.3 Testing

The Pulse Jet Baghouse was not tested with No. 6 Fuel Oil firing because it did not have a new set of bags installed until after the baseline testing with No. 6 Fuel Oil firing was completed. The Pulse Jet Baghouse has no indicators or recorders for monitoring its performance, except for an air pressure gauge to show the pressure of cleaning air supplied to the air header manifolds. To monitor the performance during testing, an additional air pressure gauge was installed near one of the manifolds. Also, a U tube manometer was installed on the two air lines one each from the dirty and clean sides of the bahouse to monitor the pressure drop. The pulse interval was measured by using a digital wrist watch.

The gas flow rate and particulate emissions were measured at the Pulse Jet Baghouse stack approximately 8 diameters downstream from the ID fan and 4 diameters upstream from the stack opening to atmosphere. The particulate emissions were measured by an instack filter as per EPA Method 17. The sampling train consisted of a goose neck, stainless steel nozzle; an Alundum thimble or a 47 mm diameter, glass fiber, sheet filter as a primary filter; a 47 mm sheet filter as a backup filter; a heated, stainless steel probe; a heated Teflon unbilical cord; an ice-bath cooled, stainless steel coiled condenser; a silica gel desiccant holder; and an EPA type meter control box. An integrated sample of flue gas was analyzed for carbon dioxide and oxygen content. The gas velocity and temperature were measured at each particulate traverse point in the stack. The particulate sampling at the stack consisted of traversing the stack cross section at a total of 12 points for 10 or more minutes per point so as to utilize all available test time during any one test day. Only one stack test a day was performed, except on December 13, 1982 (during SRC Residual Fuel Oil Burn) when two tests, each of two-hour duration were performed. The baghouse inlet gas flow properties and particulate emissions values were based on the results of the boiler exit flue testing and the mobile ESP inlet gas testing each reported in separate report volumes.

A.4 Analysis

The particulates collected in the thimbles and 47 mm sheet filters were dried at 105°C, desiccated, and weighed. The formulas for calculations of gas flow rate, particulate emission rates, filter drag, and filter specific resistance are presented in the Glossary. Normally, a specific resistance value is calculated for a period without any cleaning event. Since the Pulse Jet Baghouse was cleaned continually, the specifice resistance value was labeled Modified Specific Resistance. The baghouse outlet particulate concentration, dust penetration, air-to-cloth ratio, pressure drop, drag, and specific resistance results are graphically presented to show daily variations. The baghouse inlet dust loading, % wt. loss on ignition of inlet flyash, inlet gas temperature and moisture results are also presented graphically for each of the three SRC Fuels. The baghouse pressure drop, drag, and specific resistance values are plotted for various air-to-cloth ratios also.

B. Reverse Air Pilot Filter

B.1 Design

The Reverse Air Pilot Filter is a portable, fabric filter unit containing one square foot of cloth in a vertical position. The Reverse Air Pilot Filter is a miniscale pilot unit. Instead of a set of fabric bags of, say, 11 1/2" diameter and 30' length, it uses one 12" x 12" piece of fabric, framed taut in a vertical, diamond position, serving as a bag of infinite diameter, inside a test chamber where the cavity on either side of the fabric is equal in shape and in volume.

Figure 4 is a schematic diagram of gas flow path of the Reverse Air Pilot Filter and its sampling components. The flue gas is drawn from a source emission duct and piped to the test cloth chamber where filtration takes place under actual temperature and moisture conditions. Heating jackets maintain the flue gas carrying lines and the filter chamber at any desired, constant temperature. In the filtration mode, electrically operated solenoid valves 1 and 2 are closed while valves 3 and 4 are open. In this mode the gas passes from the hopper side of the chamber, through the filter cloth, through the tubular, Balston filter No. 3, the condenser, the dryer, the vacuum pump, the rotameter, and the dry test meter and finally is discharged into ambient air.

During reverse air cleaning, the valves 1 and 2 are open while valves 3 and 4 are closed. Thus, in the cleaning mode, the flue gas is precleaned by Balston filter No. 1 before it enters the clean air side of the filter chamber. The air passes from the clean air side, through the cloth, to the dirty side and thus in the reverse direction. The dust removed by reverse air cleaning is trapped by Balston filter No. 2 and the clean gas passes through the condenser and the subsequent components.

The condensor is kept in an ice-bath and it condenses moisture from the flue gas before the gas enters the pump, the rotameter, and the dry test meter. The silica gel dryer is placed between the condenser and the pump to remove all residual moisture not condensed by the condenser so that driest possible gas will enter the dry test meter.

The filter fabric; i.e., the cloth is first numbered, dried at 105°C, and then tare weighed. When needed, the tared filter cloth is removed from individually sealed bag and installed in a specially designed frame which snugly fits between two halves of the filter test chamber. The hopper that collects the dust filtered out by the cloth is removable by unscrewing the pipe thread from the retaining nut. The Reverse Air Pilot Filter requires a head room of 8' and a floor space of 6' x 6' to arrange and conveniently operate the unit. The test chamber can be operated with the flue gas having 500°F temperature, 15% volume moisture and 6 CFM flow rate.

The instrument panel has one, type J temperature indicator with a 10 point pushbutton switch and two temperature controllers: one for test filter chamber and the other for heated flue gas line. There are six additional rotary switch equipped power controls to maintain temperatures of the inlet and outlet cavities of the reverse and forward filters and the gas sample lines. A Heise, digital manometer provides 8 differential pressure readings with two valves: one four-way and the other two-way.

B.2 Operation

To operate the Reverse Air Pilot Filter, first a clean filter cloth is installed. Then the three Balston filters are installed. The other components are securely connected and the entire train is leak tested at about 200 in. w.g. vacuum. After the successful leak test, the flue gas sample lines, filters, and the test chamber are set to desired temperatures. Once the desired temperatures are achieved, the forward flow filtration is begun at a rotameter rate to correspond the predetermined air-to-cloth ratio. A typical test data period involves a nominal 60 minutes of filtration time. A rotameter reading, a dry gas meter reading, 10 temperature readings, and 8 pressure differential readings, are made every 10 minutes. Several sets of readings are recorded in a nominal one hour period. Depending upon the available process time and occurances of start and stop events, a nominal one hour period may be less or more than 60 minutes. This loose definition of one hour period makes the time weighing of hourly average values mathematically inconsistent from one period to another. However, in the presence of a plethora of readings and variables, the effects of unequal time were considered inconsequential.

When desired, the cleaning of the filter fabric was accomplished by 30 seconds or one minute of reverse air flow and subsequent 30 seconds or one minute of dust settling time of no gas flow through the filter. After this two part cleaning activity, the forward flow was resumed immediately to determine reduction in pressure drop across the cloth.

Table 7 presents the description of the filter cloth. The 3 x 1 twill, glass fiber cloth was used with fill side facing the dirty gas. In this manner, the gas enters from the bulky yarn side and hence the dust gets trapped easily and quickly on the cloth and very little dust penetration occurs. For the No. 6 Fuel Oil testing, one new filter cloth was used for each test day except that filter cloth No. 5 was used for two consecutive days. Thus, six filter cloths for No. 6 Fuel Oil got less than 8 hours of dust exposure time. For the three SRC Fuels only one new cloth was used for all test days of any one form of SRC Fuel. Thus, each of the three filter cloths for the three SRC Fuels got over 38 hours of dust exposure time. Use of several cloths for any one type of fuel was designed to provide daily inlet dust loading and dust collection efficiency results. However, due to availability of only a few hours of exposure to the flue gas, the amount of dust collected was too small to condition any one cloth and to provide consistent outlet dust loading. Therefore, subsequent testing was performed with only one new cloth individually for each of the three forms of SRC Fuel.

The Reverse Air Pilot Filter was operated for as many hours of stable boiler operation as were available. The pilot filter cleaned with the boiler flue gas at actual conditions except that cleaning gas was the flue gas cleaned of particulate matter. When not in use overnight, the pilot filter was kept heated above 220°F to avoid any moisture condensation on the dust layer and to have the pilot filter quickly available for testing the next day at proper temperatures. Thus, the Reverse Air Pilot Filter was not subjected to cooling and condensing thermal cycles as the Pulse Jet Baghouse was. The pilot filter received the flue gas from a duct between the flue gas cooler and the inlet to the mobile ESP. This duct of 16" inside diameter carried approximately 5,000 ACFM at 320°F. From this duct, a sample probe of the pilot filter isokinetically drew the boiler flue gas at a rate of less than 5 ACFM to provide the desired flue gas filtration rate(air-to-cloth ratio)at the filter cloth. The cleaning of the cloth was not performed until the pressure drop across the cloth reached 4 in. w.g. or whenever the cleaning data was desired.

B.3 Testing

The Reverse Air Pilot Filter was equipped with self contained sampling components which assisted in the determination of the inlet and outlet particulate concentration. The inlet particulate matter was collected in the hopper and Balston filter No. 2, and on the filter cloth. Outlet particulate matter was collected in the Balston filter No. 3. Moisture was collected in the condenser and the silica gel dryer. The sampled gas volume was measured by the dry test meter. Various temperature and pressure readings provided the monitoring data for the pilot filter and assisted in determining the gas volume readings at proper reference conditions. The temperature in the test filter chamber was considered to be the temperature of the inlet gas even though it was a few degrees higher or lower than that of the flue gas leading to the mobile ESP. The isokinetic sampling of the flue gas was maintained by adjusting the rotameter rate throughout the sampling period. Isokinetic sampling consisted of maintaining the velocity of the sampled gas at the tip of the sampling nozzle to be the same as the velocity of the flue gas in the sampling cross section of the duct between the flue gas splitter and the mobile ESP inlet. The pilot filter was first tested for the firing of the No. 6 Fuel Oil and then the three forms of SRC Fuel.

B.4 Analysis

The particulates collected in the hopper, the Balston filters, and the filter cloth were dried at 105°C, desiccated and weighed. The formulas for calculation of particulate concentration, filter drag, and filter specific resistance are presented in the Glossary. Normally, a specific resistance (k_2) value is calculated for a period without any cleaning event. However, the Reverse Air Pilot Filter k_2 values reported in the Tables and Graphs were calculated for nominal one hour periods. As indicated in Tables 11 and 12, during certain one hour periods the cleaning of the filter cloth had taken place. The Reverse Air Pilot Filter outlet particulate concentraion, dust penetration, air-to-cloth ratio, pressure drop, drag, and specific resistance values are graphically presented to show hourly variations. The pilot filter inlet particulate concentration and filter cloth permeability are presented graphically for each of three SRC Fuels. The filter pressure drop, drag and k_2 values are plotted for various air-to-cloth ratios.

V. SRC BURN TEST RESULTS

The reported results are representative of the SRC burn boiler emissions because they were obtained by appropriate procedures of sampling and analysis. The test results were reproducible because they compared reasonably well with one another under similar operating conditions. Several variables contributed in establishing a specific value of a test result. The reported test results are arithmetic averages as opposed to weighted averages.

The numbers, dates, and time of the tests are presented in Table 1. The results of certain measurements such as dust collection efficiency, outlet dust concentration and emission rate, drag, drag rise, dust load, and specific resistance can be reported as a discrete value for a specific time period such as one hour, 13 hours, etc., or can be reported as a cumulative value to cover a total period of two or more consectuive hours. The tables and discussion of results present only the discrete time results. Certain cumulative results are presented in the graphs.

A. Pulse Jet Baghouse Operating Conditions

The operating conditions of the Pulse Jet Baghouse are presented in Table 5. These include air-to-cloth ratio, pressure drop, drag, and specific resistance. These results are shown in Graphs 6 through 9. The air-to-cloth ratio is an independent variable. However, the control of air-to-cloth ratio was exercised indirectly by the requirement of flue gas volume rate at the mobile ESP. Average air-to-cloth ratio was calculated by taking a ratio of measured ACFM at the baghouse stack and the total filter area of 1,924 sq ft. During the firing of Pulverized SRC Fuel Solids and SRC Residual Fuel Oil the closed bypass valve did not provide a good seal. Therefore, all of the flue gas volume at Pulse Jet Baghouse stack did not necessarily pass through the Pulse Jet Baghouse. Hence, the true air-to-cloth ratio was smaller than reported value in proportion to the gas volume that sneaked by the bypass valve. This leakage of the flue gas adversely affected the baghouse oulet dust concentration values. The amount of the leakage and the quantitative measure of the effects of this leakage were not measured.

The pressure drop across the baghouse is a variable dependent on air-to-cloth ratio, type of fuel, boiler operating conditions, and pulse interval and duration. Pulse duration was not measured. Pulse interval was varied from 9 seconds to 40 seconds. The pulse interval time was increased to determine the baghouse performance at higher pressure drop values.

The tabulation of results of baghouse operation on a daily basis (Table 5) indicates the influence, if any, of overnight nonoperation and moisture condensation on the values of pressure drop, drag, and specific resistance of dust layer. The specific resistance values are labeled as modified because the dust layer was continually being removed from the bags by pulsing the baghouse. Only a single measured value of inlet dust concentration for any one day was used in calculating the daily inlet dust load. Even though the baghouse was operating before and after the daily test periods, the dust load was calculated on the basis of dust deposition during the test period only. In this manner the reported dust load values were probably lower than the actual values, and therefore the reported values of specific resistance were conservatively higher than the actual values.

B. Pulse Jet Baghouse Performance Results

The main results of the Pulse Jet Baghouse emission tests are presented in Table 6. The baghouse inlet duct was not tested. The baghouse inlet dust loading was assumed to be the same as that at the boiler outlet. The true dust concentration at the baghouse inlet could be lower than that at the boiler outlet because of possible dust drop out in the flue gas cooler. However, the mobile ESP inlet dust concentration was consistently higher than the boiler outlet dust concentration in spite of not only the flue gas cooler, but also over 100' of duct work leading to the mobile ESP. The baghouse dust collection efficiency and dust penetration results were based on dust loading Gr/SDCF values.

Graphs 1, 2 and 3 show an average value of a result as a short horizontal line in the middle of two lines showing the upper and lower limits of the result for each of the three SRC Fuels. Graphs 4 through 9 display the results of Pulse Jet Baghouse performance for each test day. All test days of November 1982 were for Pulverized SRC Fuel Solids, of December 1982 for SRC Residual Fuel Oil, and of January 1983 for SRC Fuel Water Slurry. Graphs 10, 11, and 12 present the performance results for various air-to-cloth ratios.

C. Reverse Air Pilot Filter Operating Conditions

The results of operating conditions of the Reverse Air Pilot Filter are presented in Table 9. The air-to-cloth ratio was altered daily for the No. 6 Fuel Oil tests to study the influence on the filter performance. The air-to-cloth ratio for the Pulverized SRC Fuel Solids was maintained at 2.2, a common value for a reverse air fabric filter. Because of very low pressure drop values during SRC Residual Fuel Oil tests, the air-to-cloth ratio was increased to 2.8 and up to 4.0. The SRC Fuel Water Slurry testing was performed at air-to-cloth ratios between 2.5 and 4.2. However, pressure drop buildup rate was high and fabric cleaning was required frequently (Tables 11 and 12).

D. Reverse Air Pilot Filter Performance Results

The main results of the Reverse Air Pilot Filter emission tests are presented in Table 10. The actual gas volume rate for the Reverse Air Pilot Filter was the same as the air-to-cloth ratio because the pilot filter has only one square foot of filter cloth. The pilot filter inlet gas temperature and moisture were approximately the same as or slightly higher than those at the mobile ESP inlet duct or Pulse Jet Baghouse stack. The pilot filter dust collection efficiency and dust penetration results were based on dust concentration Gr/SDCF values.

Tables 11,12, and 13 present the cloth cleaning results, starting events, and filter permeability, respectively. In Table 12 the halt events include cleaning events as shown in the column marked as such. The continuous duration of cloth exposure or filtering time between two consecutive halt events ranged between 3 minutes and 545 minutes. Table 12 indicates the influence, if any, of moisture condensation and of condensation-evaporation cycling of the filter cloth in increasing the pressure drop due to several starts and stops of flue gas filtration activity. The pressure drop change values caused by cleaning activities are presented in Table 11. The dirty permeability in Table 13 is that of the dirty filter cloth that was dried in the oven at $105^{0}C$ and desiccated. The vacuumed permeability was measured after vacuuming the dirty cloth until all visible loose dust was removed.

Graphs 13, 14, and 15 exhibit the inlet dust loading and fabric permeability results for the fuels used in the SRC Burn Test Program. Graph 16 shws the pressure drop across the filter cloth as a function of inlet dust load. Graphs 17 through 37 show various results as a function of exposure time; i.e., filtration time, in hours. Graphs 38 through 47 exhibit various results as a function of air-to-cloth ratio. Graphs 48 through 51 indicate the pressure drop values as a filter cloth goes through the start-stop events. Graphs 52 through 55 provide a record of pressure drop variation by showing it for successive 10 minute intervals.

VI. DISCUSSION OF RESULTS

This section presents the discussion of results of feasibility evaluation of fabric filter as a dust collector of emissions of SRC Fuels burned in an oil designed boiler. The feasibility of fabric filter was evaluated by determining the role of the fuels and boiler operation, performance of fabric filter during the conditioning phase of the fabric, effects of start and stop events on the filter resistance, influence of flue gas and dust emissions, the caking and penetration of dust, and the blinding of filter fabric. Measurement of fabric life was not a part of this feasibility study.

A. Role of Fuels and Boiler Operation

The role of SRC Fuels and boiler operation in evaluating the feasibility of a fabric filter as an emission control device is two fold. First, the indirect role played by the handling characteristics of the SRC Fuels in the delivery system and in the boiler; and second, the direct role played by the physical and chemical properties of fuel in the combustion zone resulting in lower and easily collectable emissions. Table 2 presents the analyses of the four fuels and the boiler exit flue gas as a product of the combustion of each of these four fuels.

A.1 Fuels and Flue Gas Particulate

The range of ash content of the SRC Residual Fuel Oil (0.02-0.11% wt) was approximately the same as that of the No. 6 Fuel Oil (0.07-0.19 % wt). However, the boiler exit flue gas particulate concentration for SRC Residual Fuel Oil (0.09 Gr/SDCF) was approximately four times that for

No. 6 Fuel Oil (0.02 Gr/SDCF). The Pulverized SRC Fuel Solids and SRC Fuel Water Slurry had approximately the same range of ash content and the same boiler exit flue gas particulate emission rate. In order of decreasing average value of the carbon content (% LOI) in the boiler exit gas flyash, the three SRC Fuels ranked: 1. Pulverized SRC Fuel Solids (91%), 2. SRC Residual Fuel Oil (86%), and 3. SRC Fuel Water Slurry (77%).

The 700 HP boiler used for the SRC Burn Test Program was designed for oil firing. Fuel preparation, delivery, and feed systems were modified to handle the SRC Fuels. Effectiveness of such modifications can have a significant influence in facilitating efficient combustion of SRC Fuels and thus in controlling the amount of particulate and gaseous emissions and in imparting certain properties to the flyash leaving the boiler. Rates of fuel feed combustion primary, secondary and atomizing air flow, and fuel flow; delivery pressures of atomizing air and fuel at the burner; and temperatures of fuel, air and flue gas are some of the important operating parameters affecting the efficiency of SRC burn. Boiler operating conditions were monitored closely. However, several problems of fuel delivery and feed systems such as fuel line plugging, fuel stream interruption, and fuel flow rate fluctuations, etc., as well as problems of fuel combustion such as flame stability and flame out; flame length, envelope and brilliance; velocity of primary air and fuel to assure proper swirling and mixing; SRC melt down at the burner, and clinker formation, etc. continued to occur throughout the

November 1982 portion of the Pulverized Fuel Solids Burn Test Program. In spite of these experimental fluctuations, the fabric filters performed consistently well. These boiler operating problems did not occur for SRC Residual Fuel Oil and SRC Fuel Water Slurry.

A.2 Pulse Jet Baghouse

In order of increasing value of average drag the three SRC Fuels ranked: 1. Pulverized SRC Fuel Solids (0.45), 2. SRC Residual Fuel Oil (0.64), and 3. SRC Fuel Water Slurry (0.69). The inlet dust loading for the SRC Residual Fuel Oil (0.11 Gr/SDCF) was four times less than that for the other two SRC Fuels. There was no significant difference in the specific resistance values of Pulverized SRC Fuel Solids and SRC Fuel Water Slurry. The specific resistance values of SRC Residual Fuel Oil were relatively higher than those of Pulverized SRC Fuel Solids and SRC Fuel Water Slurry.

The Pulse Jet Baghouse outlet dust emissions for SRC Residual Fuel Oil and SRC Fuel Water Slurry were the same, 0.004 Lb/Million BTU, significantly less than 0.030 Lb/Million BTU, the U.S. EPA NSPS. Due to intrinsic nature of design of the bypass valve of the Pulse Jet Baghouse, the valve could not make a good seal to prevent the sneakage of dirty gas. Therefore, the baghouse outlet gas was contaminated by the inlet gas until the bypass duct was blanked off by a solid plate. The continual accumulation of dust at the bypass valve contributed to random variations of the dust concentration at the outlet duct of the Pulse Jet Baghouse. The dust penetration for SRC Fuel Water Slurry was only 0.3%. Were it not for the boiler flue gas sneakage past the baghouse bypass valve, the dust penetration for Pulverized SRC Fuel Solids and SRC Residual Fuel Oil would also have been less than 0.3%.

Average flue gas temperature of 260°F for SRC Fuel Water Slurry was almost 10° less than that for SRC Residual Fuel Oil and 40° less than that for Pulverized SRC Fuel Solids. However, some of the temperature difference might have been due to the differences in ambient air temperature. The average moisture content of the flue gas was the lowest (5%) for Pulverized SRC Fuel Solids and the highest (9%) for SRC Fuel Water Slurry.

A.3 Reverse Air Pilot Filter

In order of increasing value of average drag the four fuels ranked: 1. No. 6 Fuel Oil (0.5), 2. SRC Residual Fuel Oil (0.7), 3. SRC Fuel Water Slurry (1.1), and 4. Pulverized SRC Fuel Solids (1.4). However since the inlet dust loadings for the four fuels were different, the four fuels in order of increasing specific resistance ranked: 1. Pulverized SRC Fuel Solids (11), 2. SRC Fuel Water Slurry (24), 3. SRC Residual Fuel Oil (46), and 4. No. 6 Fuel Oil (904). The stickiness and fineness of the flyash of No. 6 Fuel Oil contributed to high specific resistance values.

The Reverse Air Pilot Filter outlet dust emissions for Pulverized SRC Fuel Solids and SRC Residual Fuel Oil were the same, 0.002 Lb/Million BTU, and for SRC Fuel Water Slurry and No. 6 Fuel Oil were the same, 0.011 Lb/Million BTU. These values were significantly less than 0.030 Lb/Million BTU, the U.S. EPA NSPS. Since the inlet dust loading for No. 6 Fuel Oil was very low, less than 0.04 Gr/SDCF, the wide variation in dust penetration values (between 10 and 40%) was not unexpected. In order of increasing overall dust penetration values (Table 8), the three SRC Fuels ranked: 1. Pulverized SRC Fuel Solids (0.2%), 2. SRC Residual Fuel Oil (0.9%), and 3. SRC Fuel Water Slurry (1.3%).

In order of increasing values of average flue gas moisture the four fuels ranked: 1. Pulverized SRC Fuel Solids (6%), 2. SRC Residual Fuel Oil (9%), 3. SRC Fuel Water Slurry (11%), and 4. No. 6 Fuel Oil (13%). The Pulse Jet Baghouse results confirmed this ranking for moisture level. The SRC Fuel Water Slurry exhibited the lowest flue gas temperature for both the baghouse and pilot filter. The loss on ignition analysis showed that the Pulverized SRC Fuel Solids flyash had the highest carbon content (91% wt) and the SRC Fuel Water Slurry flyash had the lowest carbon content (77% wt). The carbon content of the SRC Residual Fuel Oil flyash averaged 87% wt and that of the No. 6 Fuel Oil flyash averaged 37% wt.

B. Conditioning Phase Performance

When a new, clean bag; i.e., filter fabric; is exposed to a process flue gas, it goes through a conditioning phase in which it takes a few hours to a few days of exposure to build up a dust layer sufficient enough to provide filtration at constant drag. The new bag or cloth is not cleaned until a predetermined pressure drop across the cloth is realized. This is the initial period of conditioning phase. The rate at which the new cloth approaches a need for cleaning depends on dust, gas, and cloth properties. After a few subsequent cleaning events, the filter cloth displays a consistent and predictable rate of ΔP increase with dust exposure time, a consistent predictable amount of reduction in pressure drop after each cleaning, and a leveling of drag. When this stage is reached, the conditioning phase can be considered to be over.

B.1 Pulse Jet Baghouse

A new clean set of bags was installed in the Pulse Jet Baghouse in early October 1982. The Pulse Jet Baghouse was conditioned with flue gas during at least first four days of SRC Solids firing during which the baghouse performance was not tested. During subsequent six days of flue gas cleaning, the outlet dust concentration of the baghouse was random and higher than the 0.03 Lb/Million BTU, the U.S. EPA NSPS. Higher emissions were caused mainly by sneakage of dirty flue gas past the valve in the baghouse bypass ductwork. During the last four days of testing, the outlet particulate concentration and dust penetration continued to decrease. The randomness of the baghouse performance during middle six days might have been partly due to variations in the boiler operating conditions. During the first ten days of Pulverized SRC Fuel Solids firing, there was no conclusive evidence of completion of bag conditioning phase. However, steady values of outlet dust concentration for the last four days can be interpreted to imply that in the first ten days the fabric had conditioned itself to a steady state high level performance.

The Pulse Jet Baghouse was operated at a lower than design value of air-to-cloth ratio for two main reasons. First, the boiler gas volume was shared by the baghouse and the mobile ESP instead of all going to the baghouse. Second, the number of bags in the baghouse could not be altered easily. The baghouse was operated at a lower than design value of pressure drop for two main reasons. First, the baghouse was operated at a lower than design value of gas flow rate. Second, the pulsing frequency and pulse duration were not reduced low enough because as per GE/MATSCO doing so might cause irreversible plugging of the existing bags. These operating conditions might have been an important factor in lengthening the duration of conditioning phase. The conditioning phase performance of the baghouse for SRC Residual Fuel Oil and SRC Fuel Water Slurry firing is not discussed because the same filter bags were used during all of subsequent testing.

B.2 Reverse Air Pilot Filter - No. 6 Fuel Oil

Six, new clean cloths were used for No. 6 Fuel Oil, each for less than 8 hours. None of the cloths appeared to have completed conditioning phase. Cloths 1, 3, and 6 showed higher average pressure drop and drag values for every subsequent hours. Cloth 5 did the same for the first four hours, except the second hour. Very low dust loading (0.02 to 0.04 Gr/SDCF) and fine particle size of the flyash of No. 6 Fuel Oil resulted in very high values of specific resistance up to 2988. Except for the second hour of Cloth 2 and the fourth hour of Cloth 3, the measured values of dust penetration decreased with exposure time. Thus, the filtration efficiency continued to improve during the conditioning phase.

B.3 Reverse Air Pilot Filter - Pulverized SRC Fuel Solids

Only one cloth was used for 54 hours during Pulverized SRC Fuel Solids firing. During the first five hours of operation, average pressure drop increased from 1.4 to 3.1 in. w.g. This was a rapid increase implying a quick buildup of dust layer. During the next 10 hours the average pressure drop gradually increased from 3.1 to 4.0 in. w.g. The dust penetration for the first four hours of operation was 10%. Then it reduced to 1%. These results implied that the initial conditioning was accomplished within the first four or five hours. The conditioning phase was over by the 15th hour of operation. High specific resistance values (between 400 and 900) during the first three hours of operation were probably due to low air-to-cloth ratio and initially low dust load values.

B.4 Reverse Air Pilot Filter - SRC Residual Fuel Oil

Again, only one cloth was used for 54 hours during SRC Residual Oil Firing. During the first four hours of operation, the drag value increased from 0.02 to 0.51. The dust penetration after the first 13 hours was 3%. However, a subsequent 40-hour average dust penetration was only 0.2% implying that the conditioning phase was over in the first 13 hours or soon thereafter. The pressure drop did not reach a predetermined value of 4 in. w.g. even after a total exposure of 47 hours. The filter cloth was then cleaned to obtain the cleaning performance data. Due to low dust loading of SRC Residual Fuel Oil flyash and low pressure drop value, the cloth conditioning phase may be long for a full scale unit. However, high filtration efficiency was realized even during the conditioning phase.

B.5 Reverse Air Pilot Filter - SRC Fuel Water Slurry

Again, only one cloth was used for 38 hours during SRC Fuel Water Slurry firing. During the first 12 hours of operation, the drag values increased from 0.1 to 0.9. Then the cleaning was performed. During this initial period of conditioning phase the pressure drop increased from 0.1 to 3.6 in. w.g. Thereafter, the pressure drop and drag values continued to increase rapidly. After the first cleaning, the reduction in pressure drop for any subsequent cleaning was minimal and increase of pressure drop was rapid. Frequent cleaning was necessary. This implied that the conditioning phase for SRC Fuel Water Slurry firing led to partial plugging of the filter cloth. This partial plugging might have been caused by the Lomar-D, a wetting agent in the SRC Fuel Water Slurry making process. The dust penetration for the first three hours was 2%. For the subsequent six hours, it was 5% implying that the conditioning phase was not completed in the first nine hours. The dust penetration for the subsequent 24 hour exposure was only 0.2%. Thus, the filtration efficiency for SRC Fuel Water Slurry flyash did improve significantly during the conditioning phase even though relatively high pressure drop and frequent cleaning were persistent during the conditioning phase.

C. Effects of Start-Stop Events

The time the filter fabric was available in either dust collector was much more than the time it was actually filtering the dirty gas stream. This time difference is comprised of several halt (start-stop) events during which the fabric was not filtering. These events included stoppages for overnight shutdowns, delays inbetween tests, and reverse cleaning and dust settle time of the cloth. For any dry or wet dust collector, the event of terminating the gas flow as well as starting the gas flow into the unit makes the unit go through a cycle of cooling and heating, and condensing and evaporating the moisture and acid vapors. These start-stop or halt cycle events cause corrosion of and inertial and thermal stress in the structure and the working components of the dust collector. Moreover, in the case of fabric filter units, these events cause partial blinding or plugging of the cloth or to a lesser degree high pressure drop for the same air-to-cloth ratio. They also effect the fabric life. When a fabric filter unit is filtering, the flyash is deposited continuously and the fabric is cleaned continually. However, when the unit is not operating it is not being cleaned but the dust layer on the fabric may break up at places depending upon the amount of stress, shock, and vibrations transferred to the fabric from whatever activities contributing to such dust dislodging forces. Depending upon the properties of the deposited dust and the nature and amount of residual vapors, the dust may cement up and partially blind the fabric and increase the filter pressure drop when operating. Tables 5 and 12 present the pressure drop changes caused by halt events. Depending upon the properties of dust, the effects of halt events during conditioning phase may be different from those during steady state operating phase.

C.1 Pulse Jet Baghouse

The pressure drop and drag rise values at the beginning of a test were not significantly different from those at the end of a previous test; i.e., from the time when the Pulse Jet Baghouse halted receiving the flue gas. The baghouse operated at lower than design values of air-to-cloth ratio and pressure drop. This might be one of the reasons why the pressure drop and drag rise values due to halt events were not significant. In most cases, the pressure drop and drag rise across the baghouse decreased or remained the same after an overnight halt event. This was in spite of the fact that the baghouse was not kept heated overnight. The decrease in pressure drop and drag rise values might have been partly due to inadvertant additional cleaning of the bags after the baghouse was bypassed. The baghouse pressure drop and drag rise values indicated that blinding or plugging of filter bags was not occurring during the halt events.

C.2 Reverse Air Pilot Filter

As in the case of Pulse Jet Baghouse the pressure drop and drag rise values at the beginning of a test were not significantly different from those at the end of a previous test; i.e., when the Reverse Air Pilot Filter stopped receiving the flue gas. In contrast to Pulse Jet Baghouse, the filter cloth of Reverse Air Pilot Filter was kept heated to about 220°F overnight. This heating minimized moisture condensation; however, acid vapor condensation might have still occurred.

A 13-minute halt event for Cloth 5 during the pilot filter run No. 4 of the No. 6 Fuel Oil firing caused the pressure drop to increase from

0.3 to 1.5 in. w.g. This was a significant increase without any apparent cause such as increase in air-to-cloth ratio or decrease in temperature, etc. However, a combustion process difficulty was encountered 1 1/2 hours earlier. A 12-hour halt even for Cloth 7 during the pilot filter Run No. 36 of Pulverized SRC Fuel Solids firing caused the pressure drop to increase from 3.7 to 4.3 in. w.g. without any apparent cause. However, a combustion process difficulty was encountered two hours later. A 17-hour halt event for Cloth 10 during the pilot filter Run No. 71 of SRC Residual Fuel Oil firing made the pressure drop increase from 2.2 to 2.9 in. w.g. Again, there was no apparent cause. However, a combustion process difficulty was encountered prior to the last two hours of operation. A 19-hour halt event for Cloth 18 during the pilot filter Run No. 142 of SRC Fuel Water Slurry firing made the pressure drop increase from 3.4 to 4.7 in. w.g. without any obvious cause. However, a combustion process difficulty was encountered two hours later. These results implied that the halt events were not as significant as the process combustion difficulty in causing a notable increase in the filter cloth resistance.

D. Gas and Dust Emissions

The influence of rate of flue gas flow on the performance of a fabric filter can be determined by the results based on air-to-cloth ratios. Properties of flue gas, such as oxygen, carbon dioxide, carbon monoxide, total hydrocarbons and boiler exit gas temperature indicate efficiency of fuel combustion. Influence of these properties can be studied indirectly by examining the properties of dust emissions. The properties of dust emissions, namely, dust concentration of the flue gas, carbon content of the flyash, and particle size distribution of the flyash were measured.

E. Caking and Dust Penetration

Caking is a desirable phenomenon of buildup of dust layer or dust mat on the filter fabric. Primary function of a fabric as a dust collector is to effectively collect fine dust and fumes as opposed to large particles which can be removed by other means such as screening and inertial cyclonic collectors. Bleeding or penetration of dust through a filter fabric and blinding or plugging of filter fabric to restrict gas passage are two extremes of caking. Penetration or bleeding of dust through the filter fabric takes place noticeably during: 1. conditioning phase when the dust layer has not built sufficiently and 2. momentarily after each cleaning event of the fabric when the dust layer is removed or lessened. Sometimes the dust penetration is evidenced by increase in visible emissions. The adhesion and agglomeration of the dust in interaction with moisture, acid and organic vapors of the carrier flue gas are some of the other properties of caking useful in determining the susceptibility of the fabric filter to blinding or plugging. Blinding is a phenomenon of dust interception that reduces the available filtering area of the filter fabric. Blinding results in a rapid increase of filter resistance and renders the fabric filter economically and technically not feasible to operate.

Effects of caking are indirectly implied in the performance during the conditioning phase. Visual examination of the dust cake after a filter cloth was removed from the Reverse Air Pilot Filter showed sticky, rather compact dust layer for flyash of No. 6 Fuel Oil, SRC Residual Fuel Oil and SRC Fuel Water Slurry in order of decreasing intensity. Dust cake for Pulverized SRC Fuel Solids flyash was porous and easy to remove by reverse air cleaning.

In spite of the not so sticky and not so compact appearance of the SRC Fuel Water Slurry flyash, the need for frequent cleaning was probably due to operation at a high air-to-cloth ratio and the wetting agent Lomar-D in the SRC Fuel Water Slurry. The No. 6 Fuel Oil flyash had the lowest carbon content and the highest specific resistance but it did not require frequent cleaning. Pulverized SRC Fuel Solids flyash had the highest carbon content and the lowest specific resistance. The SRC Fuel Water Slurry flyash had the lowest carbon content of the three SRC Fuels but required most frequent cleaning. The reason for frequent cleaning was not revealed by the measured values of drag or specific resistance of dust layer.

Dust penetration results for Reverse Air Pilot Filter are presented in Table 10. The amount of dust penetration for No. 6 Fuel Oil flyash was the highest. This was due to small particle size and low concentration of flyash in the flue gas that required long periods of conditioning. Dust penetration for the Pulverized SRC Fuel Solids was about half of that for the other two SRC Fuels. However, the amount of dust penetration for all three SRC Fuels was too low, less than 0.2%, to indicate any significance of individual values of dust penetration.

F. Further Study

On the basis of present experience with the flyash of SRC Fuels combustion, a few recommendations can be made for a similar study again for further advances in the fabric filter feasibility evaluation for particulate emission control.

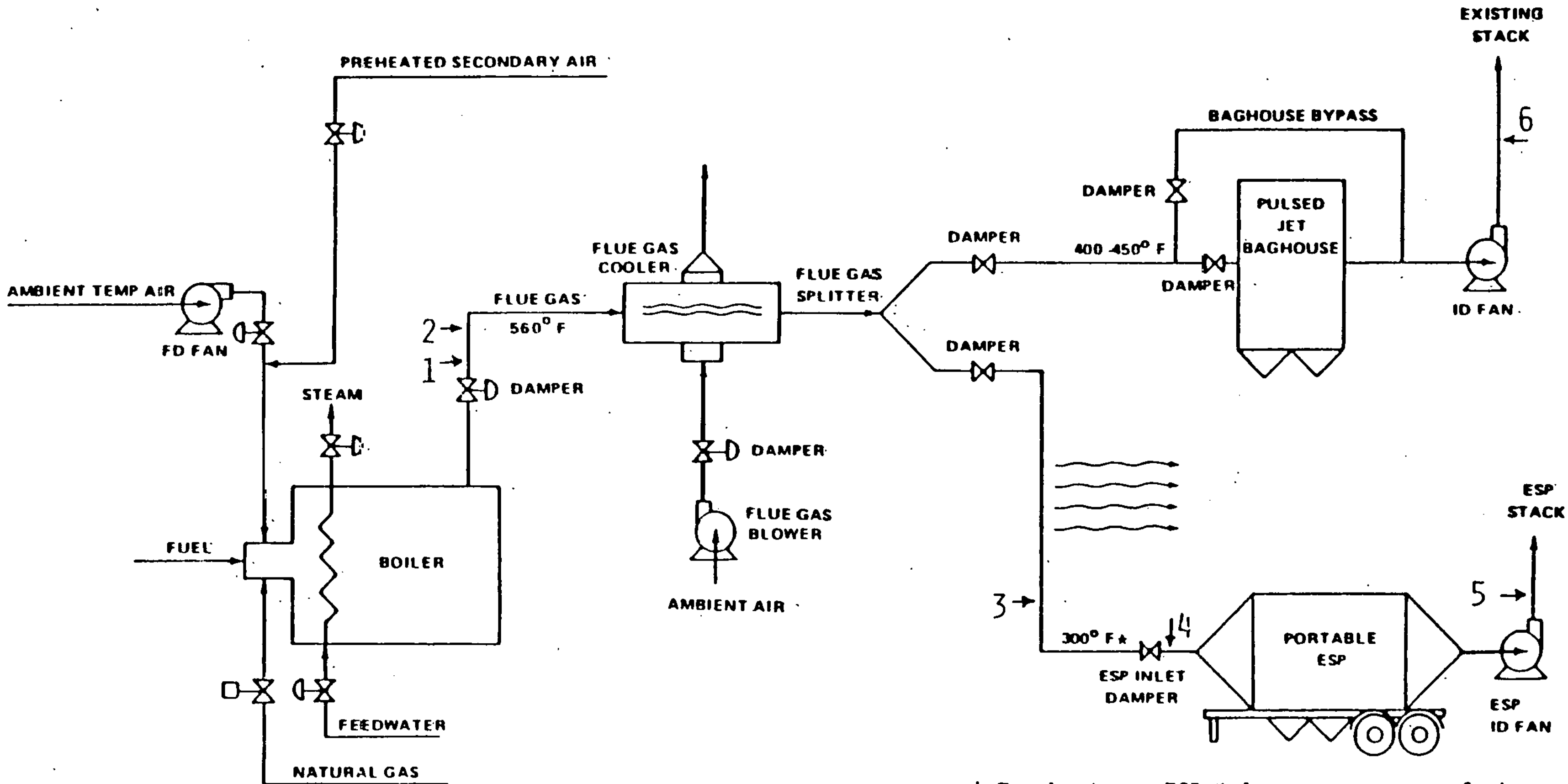
For a similar study again, one should limit the variation in air-to-cloth ratio and obtain dust penetration results every ten hours of dust exposure time. Also, for the SRC Fuel Water Slurry firing, one should start with and operate at a common practice air-to-cloth ratio of 2.2 rather than, say 4.0 actually used, so as to discover if the Reverse Air Pilot Filter would require less frequent cleaning and pressure drop and drag values would not rise rapidly after each cleaning. In addition, for all fuels one should turn off all of the pilot filter heating elements so that the pilot filter would go through heating and cooling cycles in a manner similar to that the Pulse Jet Baghouse did. Electrostatic fabric filtration for Reverse Air Pilot Filter, use of different fabric materials, and different weave and finish of each fabric material are other areas of fabric filter feasibility that may be evaluated. Operating one cloth for extended periods of time would assist in determining fabric life and cleanability characteristics. The Pulse Jet Baghouse air-to-cloth ratio or the pulse interval time should be increased to determine economic and technical feasibility of Pulse Jet Baghouse operation at 4 in. w.g. pressure drop. Besides pulse jet and reverse air, the shaker cleaning method of fabric filter operation may also be examined.

VII. CONCLUSIONS

The SRC Burn Test Program provided a variety of operating conditions to evaluate the fabric filter performance. Useful results were obtained. Application Engineering and economic analyses of the results would establish the feasibility of commercial application.

Two main conclusions of the fabric filter feasibility evaluation are: 1. The flyash emissions of SRC Fuel combustion in an oil designed boiler furnace can be controlled to less than 0.01 Lb/million BTU without requiring any special operating conditions for or modifications to the conventional fabric filters. 2. Both Pulse Jet Baghouse and Reverse Air Pilot Filter were operated at an air-to-cloth ratio between 2 and 4 CFM/sq ft without any significant rise in filter resistance over 4 in. w.g.

VIII. FIGURES, TABLES AND GRAPHS

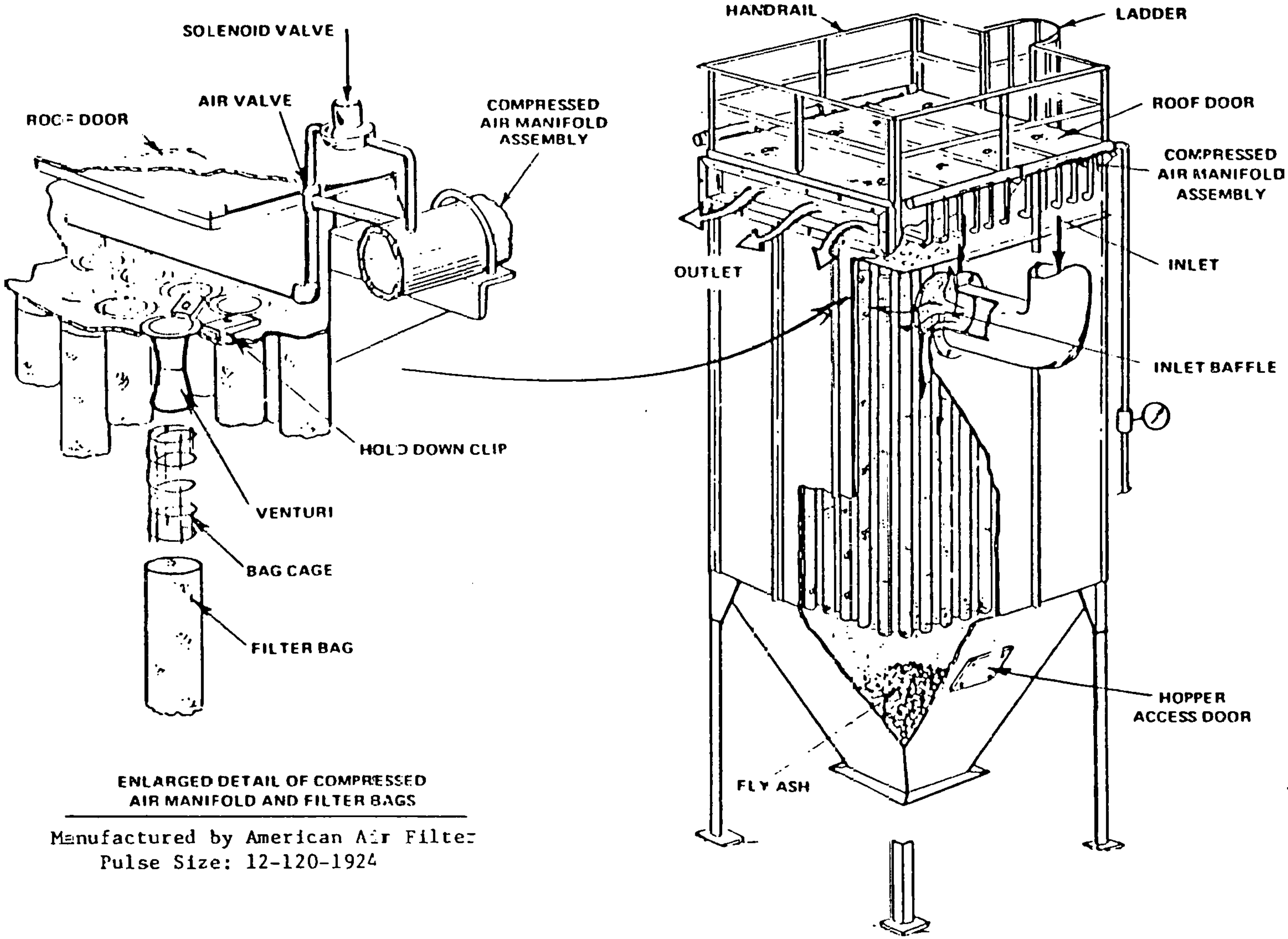


* To obtain an ESP inlet temperature of about 300° F. The flue gas line to the ESP was not insulated.

FLUE GAS SAMPLING SITES

NO.	NAME
1	BOILER OUTLET (GE)
2	BOILER OUTLET (WFI SC.)
3	INLET TO REVERSE AIR PILOT FILTER
4	ESP INLET
5	ESP OUTLET
6	PULSE JET BAGHOUSE STACK

FIGURE 1
FLUE GAS AREA FLOW DIAGRAM



Manufactured by American Air Filter
Pulse Size: 12-120-1924

FIGURE 2
PULSE JET BAGHOUSE

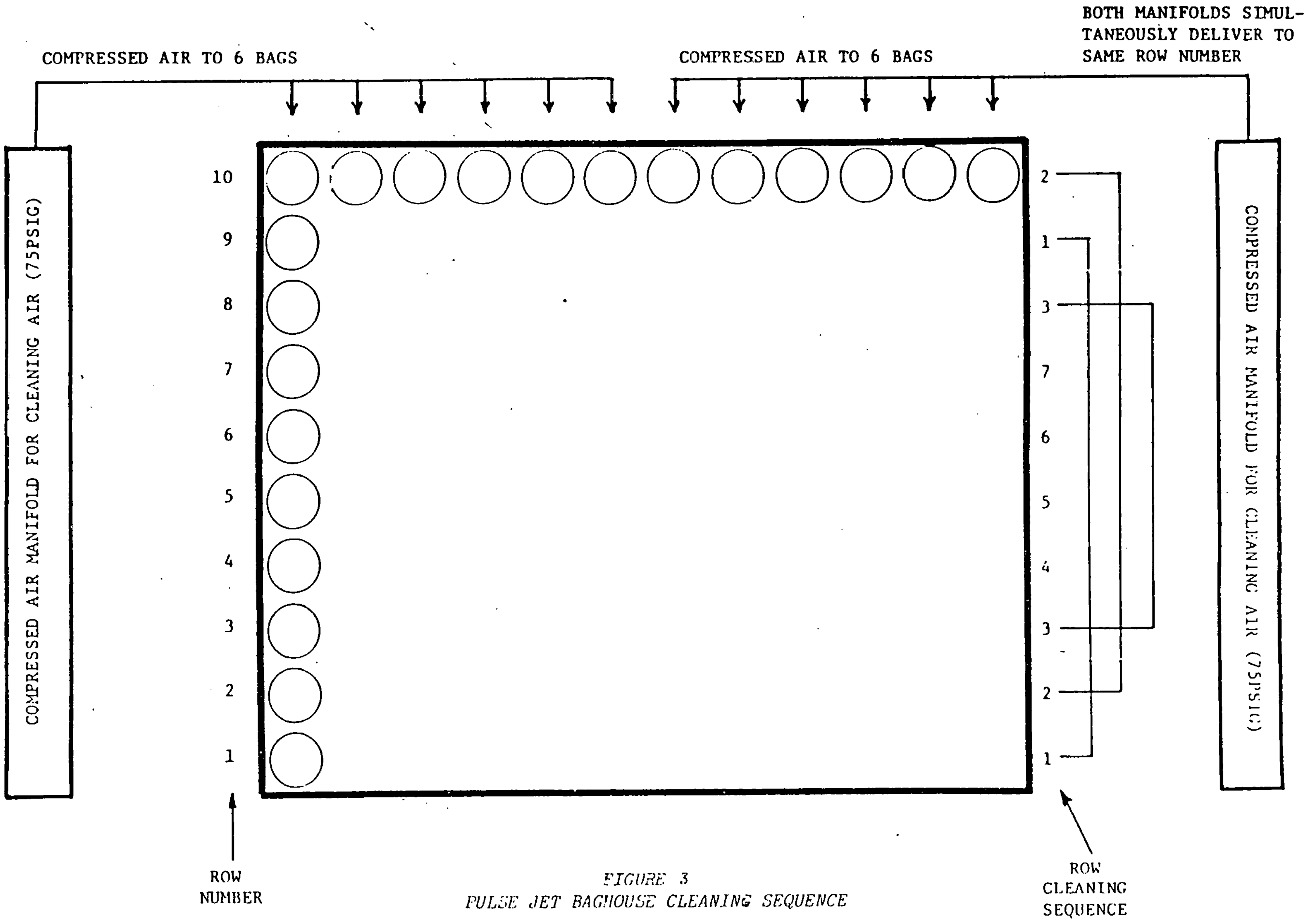


FIGURE 3
PULSE JET BAGHOUSE CLEANING SEQUENCE

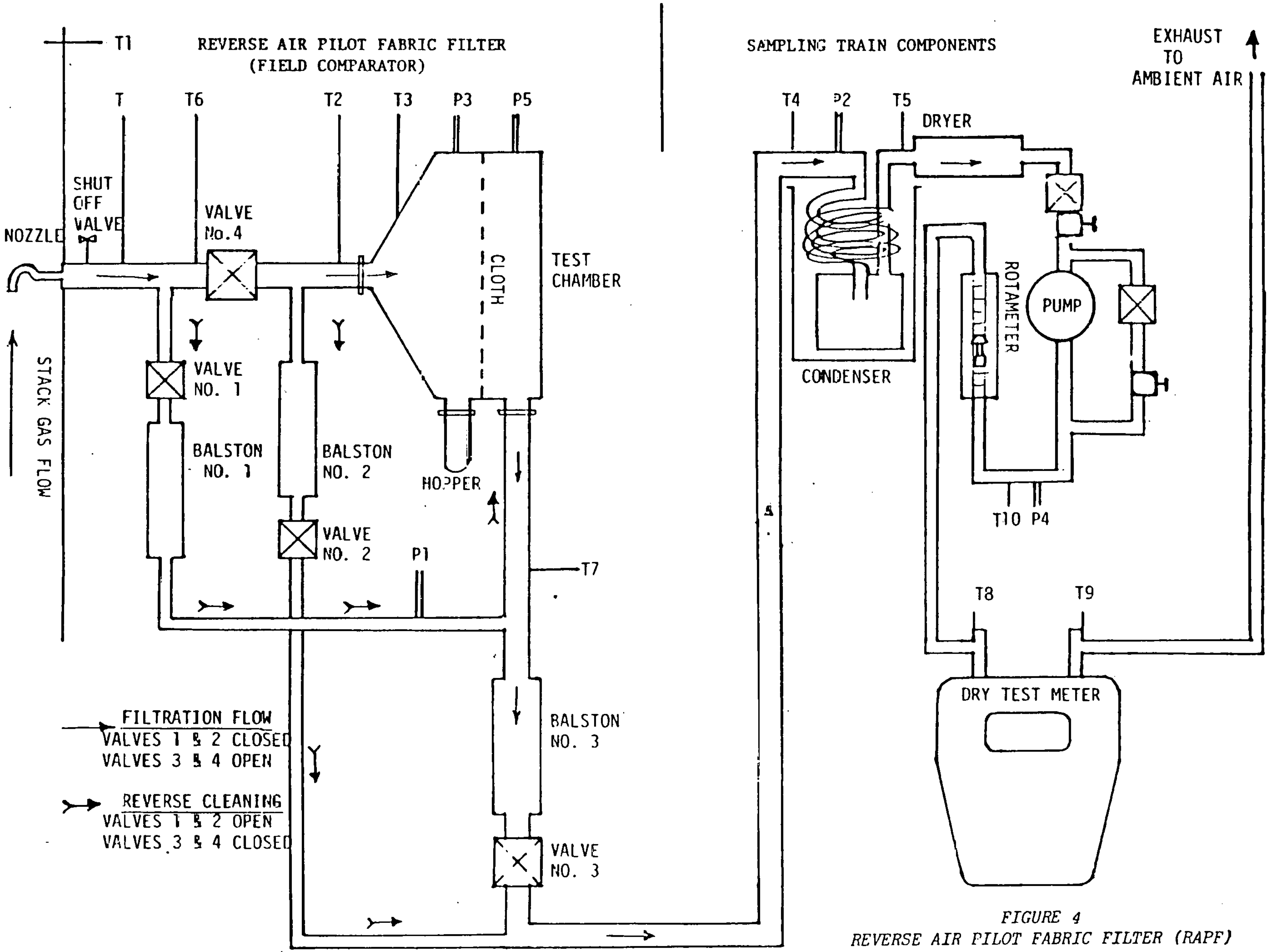


FIGURE 4
REVERSE AIR PILOT FABRIC FILTER (RAPF)

TABLE 1.1
TIME TABLE - NO. 6 FUEL OIL

TEST DATE	ESP INLET		ESP OUTLET		BOILER OUTLET		PULSE JET OUTLET		REVERSE AIR PILOT FILTER	
	TEST NO.	TIME	TEST NO.	TIME	TEST NO.	TIME	TEST NO.	TIME	TEST NO.	TIME
8-26-82	EI-1	10:55-13:10	EO-1	10:55-13:10	N.A.	--	N.A.	--	1=1-5	9:03-15:22
8-26-82	EI-2	13:46-15:55	EO-2	13:46-15:12						
8-27-82	EI-3	10:00-12:06	EO-3	10:00-12:06					2=1-4	9:42-14:25
8-27-82	EI-4	12:42-12:49	EO-4	12:42-14:49						
8-30-82	EI-5	9:16-11:26	EO-5	9:16-11:26					3=1-5	9:21-15:05
8-30-82	EI-6	12:45-14:53	EO-6	12:45-14:53						
8-31-82	EI-7	8:30-10:38	EO-7	8:30-10:38					4=1-5	8:45-17:26
8-31-82	EI-8	14:10-14:27	EO-8	14:10-14:26						
8-31-82	EI-9	15:54-18:00	EO-9	15:54-18:00						
9-1-82	EI-10	8:30-10:38	EO-10	8:30-10:38					5=1-4	8:40-17:33
9-1-82	EI-11	12:32-17:38	EO-11	12:32-13:32						
9-2-82	EI-12	8:34-10:41	EO-12	8:34-10:41					5=5-8	8:33-13:57
9-2-82	EI-13	12:33-14:44	EO-13	12:33-14:44						
9-3-82	EI-14	7:10-9:17	EO-14	7:10-9:17					6=1-7	6:01-13:48
9-3-82	EI-15	10:36-12:49	EO-15	10:36-12:49						

TABLE 1.2
TIME TABLE - PULVERIZED SRC FUEL SOLIDS

TEST DATE	ESP INLET TEST NO.	ESP INLET TIME	ESP OUTLET TEST NO.	ESP OUTLET TIME	BOILER OUTLET TEST NO.	BOILER OUTLET GE TEST NO.	BOILER OUTLET TIME	PULSE JET OUTLET TEST NO.	PULSE JET OUTLET TIME	REVERSE AIR PILOT FILTER TEST NO.	REVERSE AIR PILOT FILTER TIME
10-25-82										1	11:40-12:45
10-25-82										2	12:45-13:30
10-29-82	EI-1	11:13-13:12	EO-1	11:13-13:24	BO-1	1029-1	11:21-13:13			3	18:35-19:45
10-29-82	EI-2	18:42-20:09	EO-2	18:40-20:08	BO-2	1029-2	18:43-20:12			4	19:45-20:05
11-1-82	EI-3	13:35-15:57	EO-3	13:31-15:58	BO-3	1101-1	13:50-15:56			5-10	11:30-20:00
11-1-82	EI-4	17:21-19:46	EO-4	17:22-19:58	BO-4	1101-2	17:31-20:06				
11-3-82	EI-5	15:47-17:12	EO-5	15:48-17:19	BO-5	1103-1	15:58-17:31			11-12	16:00-17:30
11-4-82	EI-6	11:47-13:52	EO-6	11:46-13:51	BO-6	1104-1	11:51-13:55	PJ-1	11:15-14:00	13-14	11:50-14:00
11-5-82										15	18:30-19:39
11-8-82								PJ-2	11:45-11:55	16	11:30-15:51
11-10-82								PJ-3	10:58-13:42	17-19	10:58-13:45
11-11-82								PJ-4	13:17-14:26	20-22	12:58-16:50
11-12-82								PJ-5	15:10-16:40	23-24	15:00-16:25
11-15-82	EI-7	9:27-11:33	EO-7	9:28-11:34	BO-7	1115-1	8:58-11:01	PJ-6	8:20-13:48	26-29	10:00-19:47
11-15-82	EI-8	17:56-19:49	EO-8	17:55-19:58	BO-8	1115-2	18:00-19:54				
11-16-82	EI-9	8:44-11:10	EO-9	8:43-11:09	BO-9	1116-1	9:03-11:07	PJ-7	8:45-20:22	30-35	8:35-20:40
11-16-82	EI-10	16:35-16:57	EO-10	16:34-16:56	BO-10	1116-2	16:38-17:03				
11-16-82	EI-11	18:42-20:48	EO-11	18:41-20:47	BO-11	1116-3	18:43-19:26				
11-17-82	EI-12	8:40-10:45	EO-12	8:39-10:44	BO-12	1117-1	8:50-10:54	PJ-8	8:42-16:47	36-40	8:40-16:50
11-17-82	EI-13	14:34-16:40	EO-13	14:34-16:39	BO-13	1117-2	14:44-16:51				
11-18-82	EI-14	14:18-16:23	EO-14	14:17-16:22	BO-14	1118-1	14:22-16:25	PJ-9	14:19-18:31	41-45	15:15-18:50
11-18-82	EI-15	17:02-19:06	EO-15	17:01-19:05	BO-15	1118-2	17:02-19:07				
11-19-82	EI-16	9:00-11:05	EO-16	8:59-11:04	BO-16	1119-1	8:37-10:34	PJ-10	8:18-16:51	46-54	9:00-17:40
11-19-82	EI-17	11:42-11:57	EO-17	11:41-11:55	BO-17	1119-1	11:53-12:01				
11-19-82	EI-18	12:42-14:59	EO-18	12:41-14:58	BO-18	1119-2	12:41-14:47				
11-19-82	EI-19	15:37-17:33	EO-19	15:36-17:32	BO-19	1119-3	15:46-17:52				

TABLE 13
TIME TABLE - SRC RESIDUAL FUEL OIL

TEST DATE	ESP INLET		ESP OUTLET		BOILER OUTLET			PULSE JET OUTLET		REVERSE AIR PILOT FILTER	
	TEST NO.	TIME	TEST NO.	TIME	TEST NO.	GE TEST NO.	TIME	TEST NO.	TIME	TEST NO.	TIME
12-8-82	EI-20	10:07-12:16	EO-20	10:07-12:16	BO-20	1208-1	10:22-12:31			55-58	11:49-17:25
12-8-82	EI-21	14:57-17:05	EO-21	14:56-17:05	BO-21	1208-2	14:58-17:04				
12-9-82	EI-22	9:15-11:24	EO-22	9:14-11:23	BO-22	1209-1	9:00-11:07			59-64	9:02-16:21
12-9-82	EI-23	13:33-15:39	EO-23	13:33-15:38	BO-23	1209-2	13:23-15:30				
12-10-82	EI-24	11:44-13:51	EO-24	11:43-13:50	BO-24	1210-1	11:49-13:56			65-70	11:47-18:10
12-10-82	EI-25	16:00-18:04	EO-25	15:58-18:03	BO-25	1210-2	14:27-17:19				
12-13-82	EI-26	11:10-13:19	EO-26	11:10-13:19	BO-26	1213-1	11:06-13:14	PJ-11	11:15-13:19	71-74	11:15-16:20
12-13-82	EI-27	14:10-16:18	EO-27	14:11-16:18	BO-27	1213-2	14:13-16:23	PJ-12	14:13-16:15		
12-14-82	EI-28	9:56-12:03	EO-28	9:56-12:03	BO-28	1214-1	9:00-11:09	PJ-13	9:26-13:55	75-83	9:00-18:00
12-14-82	EI-29	13:02-15:12	EO-29	13:02-15:12	BO-29	1214-2	12:00-14:07				
12-14-82	EI-30	15:55-18:00	EO-30	15:55-18:00	BO-30	1214-2	15:30-17:40				
12-15-82	EI-31	8:58-11:04	EO-31	8:45-10:52	BO-31	1215-1	8:58-11:04	PJ-14	9:07-13:32	84-92	8:55-18:00
12-15-82	EI-32	11:34-13:41	EO-32	11:30-13:38	BO-32	1215-2	11:34-13:41				
12-15-82	EI-33	14:15-16:22	EO-33	14:04-15:16	BO-33	1215-2	14:15-16:22				
12-15-82					BO-34	1215-3	17:10-18:14				
12-16-82	EI-34	8:40-10:47	EO-34	8:40-10:45	BO-35	1216-1	8:34-10:40	PJ-15	8:25-13:19	93-100	8:40-17:30
12-16-82	EI-35	11:29-13:34	EO-35	11:28-13:34	BO-36	1216-2	11:15-13:20				
12-16-82					BO-37	1216-2	16:00-18:05				
12-17-82	EI-36	9:06-11:12	EO-36	9:08-11:14	BO-38	1217-1	9:21-11:28	PJ-16	9:35-13:57	101-108	9:20-17:01
12-17-82	EI-37	11:39-13:44	EO-37	11:40-13:45	BO-39	1217-1	11:52-13:57				
12-17-82	EI-38	14:26-16:32	EO-38	14:28-16:32	BO-40	1217-2	14:33-16:38				

TABLE 1.4
TIME TABLE - SRC FUEL WATER SLURRY

TEST DATE	ESP INLET		ESP OUTLET		BOILER OUTLET			PULSE JET OUTLET		REVERSE AIR PILOT FILTER	
	TEST NO.	TIME	TEST NO.	TIME	TEST NO.	GE TEST NO.	TIME	TEST NO.	TIME	TEST NO.	TIME
1-5-83	EI-39	10:25-11:31	EO-39	10:00-11:11	BO-41	0105-1	10:24-12:34			109-112	9:57-13:06
1-6-83	EI-40	8:42-10:49	EO-40	8:40-9:46	BO-42	0106-1	8:39-10:49			112	8:18-18:22
1-6-83	EI-41	11:27-12:27	EO-41	11:27-12:27							
1-7-83	EI-42	9:00-10:25	EO-42	9:00-10:24	BO-43	0107-1	9:01-10:31			113-120	8:39-17:04
1-7-83	EI-43	11:15-12:40	EO-43	11:15-12:40	BO-44	0107-1	11:16-12:45				
1-7-83	EI-44	15:30-16:30	EO-44	15:30-16:30	BO-45	0107-2	15:31-16:46				
1-10-83	EI-45	8:50-10:55	EO-45*		BO-46	0110-1	8:50-10:59			121-126	8:41-16:14
1-10-83	EI-46	12:53-14:55	EO-46*		BO-47	0110-2	12:53-15:27				
1-11-83	EI-47	8:45-10:53	EO-47	8:45-10:50	BO-48	0111-1	8:48-10:54	PJ-17	11:30-16:15	127-132	8:40-16:04
1-11-83	EI-48	11:30-13:35	EO-48	11:30-13:32	BO-49	0111-2	11:31-13:38				
1-11-83	EI-49	14:15-16:20	EO-49	14:15-16:18							
1-12-83	EI-50	8:50-10:55	EO-50	8:50-10:57	BO-50	0112-1	8:57-11:02	PJ-18	8:56-14:06	133-136	9:22-15:06
1-12-83	EI-51	12:03-14:08	EO-51	12:04-14:10	BO-51	0112-2	12:10-14:15				
1-12-83	EI-52	14:37-16:42	EO-52	14:38-16:43							
1-13-83	EI-53	7:51-10:06	EO-53	7:52-9:58	BO-52	0113-1	8:07-10:13	PJ-19	7:54-12:42		
1-13-83	EI-54	10:40-12:20	EO-54	10:41-12:22	BO-53	0113-2	10:45-12:51				
1-13-83	EI-55	12:47-14:14	EO-55	12:49-14:14							
1-14-83	EI-56	8:20-10:25	EO-56	8:21-10:26	BO-54	0114-1	8:22-10:28				
1-14-83	EI-57	11:25-13:04	EO-57	11:25-13:07	BO-55	0114-2	11:13-13:20				
1-14-83	EI-58	13:31-14:57	EO-58	13:34-14:59							

* No Tests Conducted

TABLE 2
FUEL & FLUE GAS ANALYSES

ANALYTICAL RESULTS	TYPE OF TESTS	NO. 6 FUEL OIL		PULVERIZED SRC FUEL SOLIDS		SRC RESIDUAL FUEL OIL		SRC FUEL WATER SLURRY	
		Parametric	Steady State	Parametric	Steady State	Parametric	Steady State	Parametric	Steady State
	UNITS	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
FUEL ANALYSIS									
Ultimate Analysis									
Hydrogen	% Wt	11.2 - 12.0	10.5 - 14.4	6.2 - 6.3	5.7 - 6.3	8.0 - 8.1	7.8 - 8.1	7.8 - 7.85	7.6 - 7.8
Carbon	% Wt	81.7 - 83.6	80.2 - 85.7	86.2 - 86.4	84.5 - 86.5	85.2 - 87.0	85.7 - 87.0	56.3 - 57.4	57.7 - 58.1
Nitrogen	% Wt	0.21 - 0.26	0.16 - 0.27	1.93 - 1.97	1.74 - 2.08	1.23 - 1.35	1.19 - 1.36	1.16 - 1.29	1.16 - 1.28
Sulfur	% Wt	0.63 - 0.68	0.50 - 0.71	0.82 - 0.93	0.88 - 1.03	0.40 - 0.49	0.42 - 0.57	0.69 - 0.71	0.65 - 0.70
Oxygen	% Wt	4.2 - 5.4	0.4 - 8.4	4.2 - 4.4	4.0 - 6.1	3.1 - 5.3	3.0 - 4.7	32.4 - 33.5	31.9 - 32.6
Ash	% Wt	0.07 - 0.14	0.07 - 0.19	0.36 - 0.42	0.03 - 0.52	0.04 - 0.08	0.02 - 0.11	0.38 - 0.55	0.27 - 0.49
Moisture	% Wt	5.8 - 7.8	5.0 - 6.7	0.37 - 0.38	0.42 - 0.66	0.18 - 1.32	0.23 - 1.32		
Heating Value (Dry Fuel)	BTU/Lb	17404 -17556	17421 -18168	15781 -15789	15686 -15852	16678 -16817	16601 -16808	10384 -10627	10512 -10632
Specific Gravity @ 75°F		0.9467							
Solids Particle Size Consist (-200 Mesh)	% Wt			96	90 - 100			87 - 91	88 - 91
SRC Concentration	% Wt							65.3 - 66.4	66.5 - 66.7
FLUE GAS ANALYSIS									
O_2	% Vol	0.6 - 5.1	2.3 - 2.5	3.1 - 5.4	2.7 - 6.5	0.4 - 4.4	2.4 - 2.7	2.1 - 4.0	3.0 - 3.1
CO_2	% Vol	11.8 - 15.4	13.3 - 13.8	12.8 - 14.7	11.7 - 15.1	13.8 - 16.7	14.6 - 14.9	14.0 - 16.0	14.7 - 15.2
CO	ppm Vol	22 - 190	20 - 48	70 - 370	30 - 313	25 - 123	29 - 49	51 - 280	60 - 87
SO_2	ppm Vol	445 - 560	378 - 533	566 - 667	499 - 674	315 - 409	345 - 391	714 - 797	621 - 752
	$LB/10^6 BTU$	0.90 - 0.97	0.69 - 1.00	1.26 - 1.29	1.17 - 1.36	0.59 - 0.71	0.65 - 0.73	1.38 - 1.47	1.20 - 1.47
NO_x	ppm Vol	202 - 241	167 - 239	402 - 494	447 - 950	468 - 533	427 - 542	321 - 440	334 - 409
	$LB/10^6 BTU$	0.25 - 0.34	0.22 - 0.32	0.56 0.80	0.63 - 1.54	0.57 - 0.76	0.56 - 0.74	0.41 - 0.65	0.47 - 0.56
THC (Total Hydro Carbons, Gaseous)	ppm Vol	0.2 - 2.0	0.2 - 1.0	1 - 2	1 - 2	0.2 - 0.8	0.3 - 0.8	1	1 - 2
Opacity	%	1 - 6	1 - 10	15 - 48	11 - 44	6 - 17	3 - 10	10 - 14	11 - 12
PARTICULATE EMISSIONS-BOILER EXIT									
Mass Emission Rate	Lb/Hr	0.6 - 1.2	0.5 - 1.1	28.5 - 35.5	17.5 - 34.1	2.4 - 6.5	2.5 - 5.2	23.4 - 31.8	19.3 - 25.7
Emission Rate Heat Input Basis	$LB/10^6 BTU$	0.02 - 0.04	0.02 - 0.04	1.07 - 1.26	0.66 - 1.25	0.09 - 0.24	0.09 - 0.20	0.86 - 1.15	0.74 - 1.00
Carbon Content (LOI)	%	25 - 73	27 - 47	61 - 93	41 - 95	51 - 89	68 - 90	67 - 71	64 - 75
Test Dates		Aug. 18-20	Aug. 23-Sept. 3	Oct. 24 & 25	Oct. 26-Nov. 12	Dec. 7,8,15,16	Dec. 10, 13-17	Jan. 5-10	Jan. 11-14
		1982						1983	

TABLE 3
EQUIPMENT DESCRIPTION
PULSE JET BAGHOUSE

PULSE JET BAGHOUSE	
MANUFACTURER:	American Air Filter
UNIT NAME:	Fabri-Pulse
SIZE OF UNIT:	12-120-1924
MATERIAL OF CONSTRUCTION	Structural Steel
BAG DATA	
FABRIC:	Huyglas, Needle Felted Fiberglass by Huyck Felt Division
BAG MANUFACTURER:	Filter Media Division of Carborundum Company
BAG DIAMETER:	5¼"
BAG LENGTH:	11' - 9"
NO. OF BAGS:	120
TOTAL CLOTH AREA:	1,924 sq. ft.
NO. OF ROWS OF BAGS:	10
NO. OF BAGS IN A ROW:	12
DISTANCE BETWEEN ROWS:	3¼"
DISTANCE BETWEEN BAGS:	6" Center to Center
DATE BAGS INSTALLED:	October, 1982
CLEANING DATA	
AIR PRESSURE:	75 psig
PRESSURE DROP:	0.8 to 2.5 in. w.g.
PULSE DURATION:	Electrical - not known
PULSE DURATION:	Mechanical - not known
PULSE INTERVAL:	9 - 40 seconds
CLEANING FREQUENCY:	13 times/hour
NO. OF PULSES TO CLEAN ALL ROWS:	7/unit
ID OF ROWS CLEANED IN PAIR:	1&9, 2&10, 3&8
COMPRESSED AIR MANIFOLD DIAMETER:	6" ID
MANIFOLD LENGTH:	79"
NO. OF MANIFOLDS:	2
COMPRESSED AIR VOLUME @ STP:	15.775 cu ft

TABLE 4
SUMMARY OF RESULTS
PULSE JET BAGHOUSE

TEST RESULTS	SYMBOL	UNITS	PULVERIZED SRC FUEL SOLIDS	SRC RESIDUAL FUEL OIL	SRC FUEL WATER SLURRY
PULSE JET OPERATION RANGE					
Air-To-Cloth Ratio	ACR	FPM	3.6 - 4.0	1.6 - 3.0	3.1 - 3.2
Pressure Drop	ΔP	in. w.g.	0.8 - 2.5	1.0 - 1.5	1.8 - 2.3
Drag	S	*	0.2 - 0.7	0.4 - 0.5	0.6 - 0.8
Specific Resistance	k_2	*	0.9 - 5.0	4.5 -36.0	2.1 - 4.3
INLET DUST LOADING					
At Actual Conditons	Gr/ACF	Gr/Ft^3	0.17 - 0.22	0.04 - 0.06	0.21 - 0.26
At 68°F, 29.92 in. Hg, dry	Gr/SDCF	Gr/Ft^3	0.35 - 0.46	0.08 - 0.13	0.43 - 0.55
Loss on Ignition @ 750°C	LOI	% Wt	82 - 92	79 - 88	64 - 71
OUTLET DUST EMISSIONS					
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.003 - 0.237	0.001 - 0.007	0.001 - 0.003
At Standard Conditions	Gr/SDCF	Gr/Ft^3	0.005 - 0.376	0.001 - 0.010	0.001 - 0.004
Emission Rate Heat Input Basis	Lb/MBTU	$Lb/10^6 BTU$	0.012 - 0.307	0.003 - 0.022	0.001 - 0.010
PULSE JET EFFICIENCY					
Gr/SDCF Basis	η	%	+ 78 - 98	x 91 - 99	99.2 - 99.9
Dust Penetration	$1-\eta$	%	22 - 2	9 - 1	0.8 - 0.1
PULSE JET GAS VOLUME RATE					
At Actual Conditions	ACFM	Ft^3/Min	6900 - 7800	3000 - 5800	5900 - 6200
At 68°F, 29.92 in. Hg, Dry	SDCFM	Ft^3/Min	4400 - 5000	2200 - 3800	3800 - 4000
PULSE JET GAS PROPERTIES					
Gas Temperature	t_s	°F	295 - 308	210 - 280	260 - 270
Gas Moisture	H_2O	% Vol.	4 - 6	6 - 9	8.8 - 9.4
Carbon Dioxide (Dry)	CO_2	% Vol.	8.2 - 13.0	8.8 - 11.2	9.5 - 11.0
Oxygen (Basis)	O_2	% Vol.	6.0 - 10.4	7.4 - 10.0	7.2 - 8.4
TEST DAYS			10	5	3

\+ This was the only low value, less than 97%. It was found in Test PJ-6

x This was the only low value, less than 96%. It was found in Test PJ-16. The lowest values of gas flow rate, temperature, moisture and carbon dioxide belonged to Test PJ-16.

TABLE 5
OPERATING CONDITIONS
PULSE JET BAGHOUSE

TEST NO	TEST DATE	SRC FUEL	CLEANING PULSE INTERVAL SECONDS	AIR CLOTH RATIO ACR FPM	PRESSURE DROP ACROSS FILTER CLOTH (in. w.g.) INITIAL ΔPo	FINAL ΔPT	AVG ΔPAV	FILTER DRAG S = ΔP/ACR (in w.g./FPM) INITIAL So	FINAL ST	AVG. SAV	DRAG RISE ΔS	DUST LOAD $x10^{-3}$ Lb/Ft^2	SPECIFIC RESISTANCE k_2
PJ-1	11-4-82	PULVERIZED SRC FUEL SOLIDS	9	4.0	0.8	0.9	0.85	0.20	0.22	0.21	0.02	23	1
PJ-6	11-15-82		30	3.6	1.8	2.5	2.1	0.50	0.69	0.58	0.19	38	5
PJ-7	11-16-82		40	4.0	2.1	2.3	2.2	0.53	0.58	0.55	0.05	31	2
PJ-8	11-17-82		40	3.8	1.8	2.3	2.0	0.47	0.50	0.52	0.13	37	4
PJ-9	11-18-82		↓	3.9	1.4	1.6	1.5	0.36	0.41	0.38	0.05	32	2
PJ-10	11-19-82			3.9	1.6	2.0	1.9	0.41	0.51	0.48	0.10	61	2
PJ-11	12-13-82	SRC RESIDUAL FUEL OIL		2.9	1.0	1.5	1.3	0.35	0.53	0.46	0.18	5	χ 36
PJ-13	12-14-83			2.9	1.0	1.1	1.1	0.35	0.39	0.39	0.04	9	5
PJ-14	12-15-82			3.0	1.2	1.4	1.3	0.40	0.47	0.44	0.07	8	9
PJ-15	12-16-82			3.0	1.4	1.5	1.5	0.47	0.50	0.50	0.03	7	5
PJ-16	12-17-82			1.6	1.2	1.2	1.2			0.77		4	
PJ-17	1-11-83	SRC FUEL WATER SLURRY		3.1	1.8	2.3	1.9	0.59	0.75	0.62	0.16	37	4
PJ-18	1-12-83			3.1	2.1	2.3	2.2	0.69	0.75	0.72	0.07	34	2
PJ-19	1-13-83			3.2	2.3	2.3	2.3			0.72		30	

χ An increase of only 0.5 in. w.g. in an initially low value of only 1 in. w.g. of pressure drop across the baghouse together with a relatively low value 0.005 Lb/sq ft of dust load resulted in a relatively high value of specific resistance.

TABLE 6.1
PERFORMANCE RESULTS - PULVERIZED SRC FUEL SOLIDS
PULSE JET BAGHOUSE

PERFORMANCE RESULTS	TEST NO. SYMBOL	UNITS	PJ-1 11-4-82	PJ-2 11-8-82	PJ-3 11-10-82	PJ-4 11-11-82	PJ-5 11-12-82	PJ-6 11-15-82	PJ-7 11-16-82	PJ-8 11-17-82	PJ-9 11-18-82	PJ-10 11-19-82
OPERATING CONDITIONS												
Air-To-Cloth Ratio	ACR	FPM	4.0	3.8	3.6	3.8	3.8	3.7	4.0	3.9	3.9	4.0
Inlet Dust Load		$X10^{-3}$ $\frac{Lb}{Ft^2}$	23					38	31	37	32	61
INLET DUST LOADING												
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.22					0.19	0.17	0.22	0.18	0.17
At 68^oF, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.46					0.39	0.35	0.43	0.37	0.35
OUTLET DUST EMISSIONS *												
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.0187	0.0104	0.1014	0.2372	0.2168	0.0564	0.0078	0.0076	0.0064	0.0034
At 68^oF, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.0294	0.0158	0.1579	0.3759	0.3360	0.0871	0.0121	0.0117	0.0100	0.0053
Emission Rate		Lb/Hr	1.2	0.66	6.0	14.9	13.6	3.4	0.51	0.49	0.42	0.22
Emission Rate Heat Input Basis	Lb/MBTU	$Lb/10^6BTU$	0.06	0.03	0.37	0.91	0.78	0.20	0.03	0.03	0.03	0.01
DUST COLLECTION EFFICIENCY												
Gr/SDCF Basis	η	%	93.6					77.7	96.5	97.3	97.3	98.4
Dust Penetration	1-η	%	6.4					22.3	3.5	2.7	2.7	1.6
OUTLET GAS VOLUME RATE												
At Actual Conditions	ACFM	Ft^3/min	7770	7390	6910	7320	7280	7040	7700	7450	7590	7610
At 68^oF, 29.92 in. Hg, Dry	+ SDCFM	Ft^3/min	4950	4840	4440	4620	4700	4560	4940	4850	4850	4890
OUTLET GAS PROPERTIES												
Gas Temperature	t_s	^oF	302	299	302	307	302	293	298	297	308	304
Gas Moisture	H_2O	% Vol.	4.3	4.1	5.4	6.0	5.6	5.6	4.6	5.2	5.1	5.0

* Pulse Jet Baghouse bypass valve was leaking dusty gas into the outlet gas stream. This condition might be the main reason for high outlet dust emissions and low efficiency for the Tests PJ-3 through PJ-6.

+ Average gas flow rate at the ESP inlet duct was 3200 SDCFM.

TABLE 6.2
PERFORMANCE RESULTS - SRC RESIDUAL FUEL OIL
PULSE JET BAGHOUSE

PERFORMANCE RESULTS	TEST NO. SYMBOL	UNITS	PJ-11 12-13-82	PJ-12 12-13-82	PJ-13 12-14-82	PJ-14 12-15-82	PJ-15 12-16-82	PJ-16 12-17-82
OPERATING CONDITIONS								
Air-To-Cloth Ratio	ACR	FPM	2.9	2.9	2.9	3.0	3.0	1.6
Inlet Dust Load		$X10^{-3}$ $\frac{Lb}{Ft^2}$	3	3	9	8	7	4
INLET DUST LOADING								
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.04	0.04	0.06	0.06	0.05	0.06
At 68^oF, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.08	0.08	0.13	0.12	0.10	0.11
OUTLET DUST EMISSIONS *								
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.0023	0.0009	0.0011	0.0009	0.0008	0.0072
At 68^oF, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.0035	0.0013	0.0016	0.0014	0.0012	0.0099
Emission Rate		Lb/Hr	0.11	0.04	0.05	0.04	0.04	0.19
Emission Rate Heat Input Basis	Lb/MBTU	$Lb/10^6BTU$	0.010	0.003	0.004	0.003	0.003	0.030
DUST COLLECTION EFFICIENCY *								
Gr/SDCF Basis	η	%	95.6	98.4	98.8	98.8	98.8	91.0
Dust Penetration	$1-\eta$	%	4.4	1.6	1.2	1.2	1.2	9.0
OUTLET GAS VOLUME RATE								
At Actual Conditions	ACFM	Ft^3/min	5520	5500	5530	5770	5840	3000
At 68^oF, 29.92 in. Hg, Dry	+SDCFM	Ft^3/min	3600	3510	3680	3710	3780	2180
OUTLET GAS PROPERTIES								
Gas Temperature	t_s	^oF	280	280	280	270	270	210
Gas Moisture	H_2O	% Vol.	6.4	8.4	6.8	8.9	7.5	5.6

+ Average gas flow rate at the ESP inlet duct was 3000 SDCFM during Tests PJ-11 through PJ-15 and 4200 SDCFM during Test PJ-16.

* PJBH bypass valve was leaking dusty gas into the outlet gas stream. This condition might be the main reason for high outlet dust emissions and low efficiency for the Tests PJ-11 and PJ-16.

TABLE G.3
PERFORMANCE RESULTS - SRC FUEL WATER SLURRY
PULSE JET BAGHOUSE

PERFORMANCE RESULTS	TEST NO. SYMBOL	UNITS	PJ-17 1-11-83	PJ-18 1-12-83	PJ-19 1-13-83
OPERATING CONDITIONS					
Air-To-Cloth Ratio	ACR	FPM	3.1	3.1	3.2
Inlet Dust Load		$X10^{-3}$ $\frac{Lb}{Ft^2}$	37	34	30
INLET DUST LOADING					
At Actual Conditons	Gr/ACF	Gr/Ft^3	0.26	0.25	0.21
At 68°F, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.55	0.50	0.43
OUTLET DUST EMISSIONS					
At Actual Conditions	Gr/ACF	Gr/Ft^3	0.0026	0.0004	0.0002
At 68°F, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.0042	0.0006	0.0003
Emission Rate		Lb/Hr	4.0	2.1	1.0
Emission Rate Heat Input Basis	Lb/MBTU	$Lb/10^6BTU$	0.010	0.001	0.001
DUST COLLECTION EFFICIENCY					
Gr/SDCF Basis	η	%	99.2	99.9	99.9
Dust Penetration	1-η	%	0.8	0.1	0.1
OUTLET GAS VOLUME RATE					
At Actual Conditions	ACFM	Ft^3/min	5950	5920	6200
At 68°F, 29.92 in. Hg, Dry	+ SDCFM	Ft^3/min	3790	3840	3970
OUTLET GAS PROPERTIES					
Gas Temperature	t_s	°F	260	260	270
Gas Moisture	H_2O	% Vol.	9.4	9.0	8.8

+ Average gas flow rate at the ESP inlet duct was 31,000 SDCFM.

TABLE 7
FABRIC DESCRIPTION
REVERSE AIR PILOT FILTER

STYLE:	W. W. Criswell Company S/442-57
FIBER:	Glass
YARNS:	Warp - ECDE 75 1/0 (Code explained in Appendix A) Fill - ECDE 50 1/0 Texturized (two-ply fill) - ECDE 150 1/10 Filament
WEAVE:	3 x 1 twill
THREAD COUNT:	Warp x Fill 54 x 30 per inch
WEIGHT:	Nominal 10 oz/yd^2
PERMEABILITY:	Nominal 40-55 CFM/Sq. Ft. @ 0.5 in. w.g. Actual 43-48 CFM/Sq. Ft. @ 0.5 in. w.g.
FINISH:	Teflon B applied to heat-cleaned fabric
LOSS ON IGNITION: @ 625^{o}	Nominal: 10% of original weight of fabric Minimum: 9% of original weight of fabric
MULLEN BURST STRENGTH: (ASTM 32, Method D3786-79)	470 psig fabric used for No. 6 Fuel Oil 420 psig fabric used for Pulverized SRC Fuel Solids and SRC Residual Fuel Oil 520 psig fabric used for SRC Fuel Water Slurry

TABLE 8
SUMMARY OF RESULTS
REVERSE AIR PILOT FILTER

TEST RESULTS	SYMBOL	UNITS	NO. 6 FUEL OIL	PULVERIZED SRC FUEL SOLIDS	SRC RESIDUAL FUEL OIL	SRC FUEL WATER SLURRY
OPERATING CONDITIONS						
Air-To-Cloth Ratio	ACR	FPM	1.6 - 3.4	2.1 - 2.4	2.7 - 4.1	2.6 - 4.2
Pressure Drop	ΔP	in. w.g.	0.1 - 3.6	1.7 - 4.0	1.8 - 3.0	2.0 - 4.5
Drag	S	*	0.1 - 1.3	1.0 - 1.8	0.6 - 1.9	0.5 - 1.7
Specific Resistance	k_2	*	172 - 2988	7 - 19	13 - 82	10 - 39
INLET DUST LOADING						
At 68°F, 29.92 in. Hg, Dry	Gr/SDCF	Gr/Ft^3	0.01 - 0.04	0.46	0.09	0.39
Loss on Ignition @ 750°C	LOI	% Wt		91	86.	77
OUTLET DUST EMISSIONS						
At Standard Conditions	Gr/SDCF	Gr/Ft^3	0.001 - 0.020	0.001	0.001	0.005
Emission Rate Heat Input Basis	Lb/MBTU	Lb/10^{6}BTU	0.002 - 0.050	0.002	0.002	0.011
DUST COLLECTION EFFICIENCY						
Gr/SDCF Basis	η	%	+ 60 - 90	99.8	99.1	98.7
Dust Penetration	$1-\eta$	%	10 - 40	0.2	0.9	1.3
GAS PROPERTIES AT FABRIC						
Gas Temperature	t_s	$^{\circ}$F	340 - 386	292 - 342	230 - 318	307 - 318
Moisture Content	H_2O	% Vol.	13	6	9	11
TEST DAYS			7	15	8	8

+See Footnote to Table 10 for comments on No. 6 Fuel Oil dust collection efficiency.

TABLE 9.1
OPERATING CONDITIONS - NO. 5 FUEL OIL
REVERSE AIR PILOT FILTER

CLOTH NO.	TEST DATE	OPER. HR.	AIR CLOTH RATIO ACR FPM	PRESSURE DROP ACROSS FILTER CLOTH INITIAL ΔPo in. w.g.	FINAL ΔPT	AVG ΔPAV	FILTER DRAG S = ΔP/ACR INITIAL So in. w.g./FPM	FINAL ST	AVG. SAV	DRAG RISE ΔS	DUST LOAD x10-4 Lb/Ft²	SPECIFIC RESISTANCE k_2
1	8-26-82	1	2.7	0.6	0.9	0.8	0.22	0.33	0.28	0.11	3	352
		2	2.8	1.0	2.4	1.7	0.36	0.86	0.61	0.50	3	1631
		3 *	2.8	2.6	3.6	3.1	0.93	1.29	1.11	0.36	3	1181
		4 *	2.8	2.1	2.8	2.5	0.75	1.00	0.88	0.25	3	822
		5 *	3.4	2.6	3.1	2.9	0.76	0.91	0.84	0.65	3	2167
2	8-27-82	1	3.0	0.3	0.2	0.2	0.10	0.07	0.08	-0.03	4	
		2	3.0	0.2	0.1	0.2	0.07	0.02	0.05	-0.04	4	
		3	2.9	0.1	0.1	0.1	0.03	0.03	0.03	0.00	4	
		4	2.9	0.1	0.1	0.1	0.03	0.03	0.03	0.00	4	
3	8-30-82	1	2.9	0.4	0.4	0.4	0.14	0.14	0.14	0.00	4	
		2	2.8	0.3	0.6	0.5	0.11	0.21	0.16	0.10	3	328
		3	2.8	0.6	1.9	1.3	0.21	0.68	0.45	0.47	3	1548
		4	2.8	1.8	2.6	2.2	0.64	0.93	0.79	0.29	3	957
		5 *	2.8	2.5	3.0	2.7	0.89	1.07	0.98	0.18	3	597
4	8-31-82	1	1.9	0.4	0.4	0.4	0.21	0.21	0.21	0.00	1	
		2	1.9	0.2	0.2	0.2	0.11	0.11	0.11	0.00	1	
		3	1.9	0.2	0.2	0.2	0.11	0.11	0.11	0.00	1	
		4	1.9	0.2	0.9	0.4	0.11	0.47	0.20	0.36	1	2988
		5	1.9	0.9	1.1	1.0	0.47	0.58	0.53	0.11	1	914
5	9-1-82	1	1.7	0.6	0.5	0.5	0.35	0.29	0.32	-0.06	3	
		2	1.6	0.4	0.3	0.4	0.25	0.19	0.22	-0.06	3	
		3	1.6	1.5	1.6	1.6	0.94	1.00	0.97	0.06	3	206
		4	1.1	1.7	1.9	1.8	1.55	1.73	1.64	0.18	2	870
	9-2-82	5 *	1.6	2.0	2.3	2.1	1.25	1.44	1.34	0.19	3	621
		6	1.9	1.0	1.4	1.2	0.53	0.74	0.63	0.21	4	595
		7	1.9	1.3	1.4	1.4	0.68	0.74	0.71	0.06	3	172
		8	1.8	1.5	1.4	1.5	0.83	0.78	0.81	-0.05	3	
6	9-3-82	1	1.9	0.3	0.5	0.4	0.16	0.26	0.21	0.10	2	538
		2	1.9	0.6	1.1	0.9	0.32	0.58	0.45	0.26	2	1368
		3	1.9	1.1	1.3	1.2	0.58	0.68	0.63	0.10	2	529
		4	1.9	1.3	1.4	1.4	0.68	0.74	0.71	0.06	2	320
		5	1.9	1.4	1.5	1.4	0.74	0.79	0.76	0.05	2	270
		6	1.9	1.5	1.5	1.5	0.79	0.79	0.79	0.00	2	
		7 *	1.9	1.6	1.6	1.6	0.84	0.84	0.84	0.00	2	

* cleaning at the end of this hour

Notes: 1. Negative drag rise was caused by a decrease in pressure drop instead of an expected increase in pressure drop as the filter collects the dust.

2. Specific resistance k_2: 1-10 low, 10-100 average, 100-1000 high, 1000-10,000 very high.

TABLE 9.2
OPERATING CONDITIONS - PULVERIZED SRC FUEL SOLIDS
REVERSE AIR PILOT FILTER

TEST DATE	OPERATING HOUR	AIR CLOTH RATIO ACR FPM	PRESSURE DROP ACROSS FILTER CLOTH (in. w.g.) INITIAL ΔPo	FINAL ΔPT	AVG ΔPAV	FILTER DRAG S = ΔP/ACR (in. w.g./FPM) INITIAL So	FINAL ST	AVG. SAV	DRAG RISE ΔS	DUST LOAD X10-4 Lb/Ft²	SPECIFIC RESISTANCE k_2
10-25-82	1	1.6	1.1	1.7	1.4	0.69	1.06	0.88	0.37	4	910
	2	1.6	1.7	1.9	1.8	1.06	1.19	1.13	0.13	3	465
10-29-82	3	2.1	2.1	2.8	2.5	1.00	1.33	1.17	0.33	6	600
	4	2.3	2.8	2.8	2.8	1.22	1.22	1.22	0.00	2	
11-1-82	5	2.4	2.9	3.1	3.0	1.21	1.29	1.25	0.08	63	12
	6	2.2	3.1	3.2	3.2	1.41	1.45	1.43	0.04	42	9
	7	2.2	3.2	3.3	3.3	1.45	1.50	1.48	0.05	59	8
	8	2.1	3.2	3.4	3.3	1.52	1.62	1.57	0.10	57	17
	9	2.1	3.4	3.6	3.5	1.62	1.71	1.67	0.09	57	15
	10	2.3	3.6	3.7	3.7	1.57	1.61	1.59	0.04	26	15
11-3-82	11	2.3	3.8	3.7	3.8	1.65	1.61	1.63	0.04	52	
	12	2.4	3.6	3.6	3.6	1.50	1.50	1.50	0.00	27	
11-4-82	13	2.4	4.0	4.0	4.0	1.67	1.67	1.67	0.00	63	
	14	2.2	4.0	4.0	4.0	1.82	1.82	1.82	0.00	50	
11-5-82	15 *	2.2	4.0	2.4	3.2	1.82	1.09	1.45	-0.73	58	
11-8-82	16	2.4	2.9	2.9	2.9	1.21	1.21	1.21	0.00	31	
11-10-82	17	2.3	3.1	3.2	3.2	1.35	1.39	1.37	0.04	53	7
	18	2.3	3.2	3.3	3.2	1.39	1.43	1.41	0.04	52	7
	19	2.6	3.3	3.4	3.4	1.27	1.31	1.60	0.04	46	8
11-11-82	20	2.1	3.5	3.6	3.6	1.67	1.71	1.69	0.04	47	8
	21	2.3	3.6	3.6	3.6	1.57	1.57	1.57	0.00	32	
	22	2.4	3.8	3.8	3.8	1.58	1.58	1.58	-0.00	19	
11-12-82	23	2.3	3.9	3.7	3.8	1.70	1.61	1.65	0.09	51	
	24	2.3	3.7	3.8	3.8	1.61	1.65	1.63	0.04	21	19
11-15-82	25	2.3	3.5	3.6	3.6	1.52	1.57	1.54	0.05	57	8
	26	2.2	3.6	3.8	3.7	1.64	1.73	1.68	0.09	51	17
	27	2.2	3.8	3.8	3.8	1.73	1.65	1.73	0.00	25	
	28	2.3	3.8	3.8	3.8	1.65	1.65	1.65	0.00	57	
	29	2.4	3.8	3.9	3.8	1.58	1.63	1.60	0.05	42	11
11-16-82	30	2.2	3.9	3.6	3.7	1.77	1.64	1.70	-0.13	71	
	31	2.3	3.6	3.7	3.7	1.57	1.61	1.59	0.04	51	7
	32	2.3	3.7	3.8	3.8	1.61	1.65	1.63	0.04	26	15
	33	2.1	3.6	3.5	3.6	1.71	1.67	1.69	-0.04	23	
	34	2.3	3.7	3.7	3.7	1.61	1.61	1.61	0.00	52	
	35	2.3	3.7	3.7	3.7	1.61	1.61	1.61	0.00	52	
11-17-82	36 *	2.4	4.3	3.1	3.7	1.79	1.29	1.54	-0.50	54	
	37	2.1	3.0	3.0	3.0	1.43	1.43	1.43	0.00	48	
	38	2.3	3.0	2.8	2.9	1.30	1.22	1.26	-0.08	43	
	39	2.2	2.8	2.8	2.8	1.27	1.27	1.27	0.00	51	
	40	2.2	2.8	2.8	2.8	1.27	1.27	1.27	0.00	42	
11-18-82	41	2.2	2.9	2.8	2.9	1.32	1.27	1.30	-0.05	51	
	42	2.2	2.7	2.6	2.6	1.23	1.18	1.20	-0.05	50	
	43	2.2	2.5	2.6	2.6	1.14	1.18	1.16	0.04	51	7
	44	2.2	2.6	2.6	2.6	1.18	1.18	1.18	0.00	51	
	45	2.2	2.6	2.6	2.6	1.18	1.18	1.18	0.00	29	
11-19-82	46	2.1	2.8	2.5	2.7	1.33	1.19	1.26	-0.14	48	
	47	2.2	2.6	2.3	2.4	1.18	1.05	1.11	-0.13	50	
	48	2.2	2.3	2.2	2.2	1.05	1.00	1.02	-0.05	51	
	49	2.2	2.3	2.2	2.2	1.05	1.00	1.02	-0.05	51	
	50	2.3	2.3	2.4	2.5	1.00	1.04	1.07	0.04	52	7
	51	2.2	2.4	2.5	2.4	1.09	1.14	1.11	0.05	50	9
	52	2.3	2.3	2.3	2.3	1.00	1.00	1.00	0.00	52	
	53	2.2	2.4	2.4	2.4	1.09	1.09	1.09	0.00	51	
	54 *	2.1	2.4	2.0	2.2	1.14	0.95	1.05	-0.19	32	
PERIODS OF CONSTANT ACR	1- 2 (2)	1.6	1.1	1.9	1.6	0.69	1.06	1.01	0.37		
	3-10 (8)	2.2	2.1	3.7	3.2	1.00	1.61	1.42	0.61		
	11-24 (14)	2.3	3.8	3.8	3.6	1.65	1.65	1.55	0		
	25-35 (11)	2.3	3.5	3.7	3.7	1.52	1.61	1.64	0.09		
	36-45 (10)	2.2	4.3	2.6	2.9	1.79	1.18	1.30	-0.61		
	46-54 (9)	2.2	2.8	2.0	2.4	1.33	1.14	1.08	-0.19		

* Cleaning during this hour

Notes:
1. Negative drag rise was caused by a decrease in pressure drop instead of an expected increase in pressure drop as the filter collects the dust.
2. Specific resistance k_2: 1-10 low, 10-100 average, 100-1000 high, 1000-10,000 very high.
3. Low ACR and low dust load values during the first three hours caused high k_2.

TABLE 9.3
OPERATING CONDITIONS - SRC RESIDUAL FUEL OIL
REVERSE AIR PILOT FILTER

TEST DATE	OPERATING HOUR	CONTINUOUS RUN NO.	AIR CLOTH RATIO ACR FPM	PRESSURE DROP ACROSS FILTER CLOTH (in. w.g.) INITIAL ΔPo	FINAL ΔPT	AVG ΔPAV	FILTER DRAG S = ΔP/ACR (in. w.g./FPM) INITIAL So	FINAL ST	AVG. SAV	DRAG RISE ΔS	DUST LOAD x10-4 Lb/Ft²	SPECIFIC RESISTANCE k_2
12-8-82	1	55	4.1	0.1	0.3	0.2	0.02	0.07	0.05	0.05	17	30
	2	56	2.8	0.2	0.6	0.4	0.07	0.21	0.14	0.14	12	115
	3	57	2.7	0.9	1.1	1.0	0.33	0.41	0.37	0.08	12	68
	4	58	2.7	1.2	1.4	1.3	0.44	0.51	0.48	0.07	12	59
12-9-82	5	59	2.8	1.8	1.9	1.9	0.63	0.67	0.65	0.04	12	33
	6	60	2.9	1.9	1.8	1.9	0.66	0.62	0.64	-0.04	12	
	7	61	2.8	1.8	1.8	1.8	0.64	0.64	0.64	0.00	12	
	8	62	2.7	1.9	1.9	1.9	0.70	0.70	0.70	0.00	12	
	9	63	3.0	2.0	1.9	2.0	0.68	0.64	0.66	-0.04	12	
	10	64	2.9	1.9	1.9	1.9	0.66	0.66	0.66	0.00	12	
12-10-82	11	65	2.9	2.1	2.0	2.0	0.73	0.69	0.71	-0.04	12	
	12	66	2.9	1.9	1.9	1.9	0.66	0.66	0.66	0.00	12	
	13	67	2.9	1.8	1.8	1.8	0.63	0.63	0.63	0.00	12	
	14	68	3.1	2.1	2.3	2.2	0.67	0.73	0.70	0.06	13	47
	15	69	3.5	2.2	2.2	2.2	0.63	0.63	0.63	0.00	14	
	16	70	3.5	2.2	2.2	2.2	0.63	0.63	0.63	0.00	7	
12-13-82	17	71	3.7	2.9	2.7	2.8	0.79	0.73	0.76	-0.06	16	
	18	72	3.5	2.7	2.6	2.7	0.76	0.73	0.75	-0.03	14	
	19	73	3.6	2.6	2.6	2.6	0.72	0.72	0.72	0.00	16	
	20	74	3.5	2.6	2.5	2.5	0.75	0.72	0.73	-0.03	14	
12-14-83	21	75	3.7	2.8	2.7	2.7	0.77	0.74	0.75	-0.03	15	
	22	76	3.6	2.6	2.5	2.5	0.73	0.70	0.71	-0.03	14	
	23	77	3.5	2.4	2.3	2.3	0.68	0.65	0.66	-0.03	14	
	24	78	3.5	2.3	2.2	2.3	0.65	0.62	0.64	-0.03	14	
	25	79	3.6	2.3	2.3	2.3	0.65	0.65	0.65	0.00	14	
	26	80	3.6	2.3	2.4	2.4	0.65	0.67	0.66	0.02	14	13
	27	81	3.6	2.4	2.5	2.5	0.67	0.70	0.69	0.03	14	20
	28	82	3.6	2.5	2.6	2.6	0.70	0.73	0.72	0.03	14	20
	29	83	3.6	2.5	2.6	2.6	0.70	0.72	0.71	0.02	14	13
12-15-82	30	84	3.7	3.1	3.1	3.1	0.83	0.83	0.83	0.00	16	
	31	85	4.1	3.0	3.4	3.2	0.73	0.83	0.78	0.10	16	64
	32	86	3.9	3.4	3.0	3.2	0.86	0.76	0.81	-0.10	15	
	33	87	3.6	3.0	2.3	2.7	0.82	0.63	0.73	-0.19	14	
	34	88	2.9	2.2	2.5	2.4	0.76	0.86	0.81	0.10	12	82
	35	89	3.2	2.5	2.5	2.5	0.78	0.78	0.78	0.00	13	
	36	90	3.1	2.4	2.4	2.4	0.78	0.78	0.78	0.00	12	
	37	91	3.1	2.4	2.5	2.4	0.78	0.81	0.79	0.03	12	24
	38	92	3.1	2.5	2.7	2.6	0.82	0.89	0.85	0.07	12	57
12-16-82	39	93	3.1	2.9	2.8	2.9	0.94	0.91	0.93	-0.03	12	
	40	94	3.0	2.8	2.6	2.7	0.94	0.88	0.91	-0.06	12	
	41	95	3.2	2.6	2.6	2.6	0.82	0.82	0.82	0.00	12	
	42	96	3.0	2.6	2.6	2.6	0.86	0.86	0.86	0.00	12	
	43	97	3.0	2.6	2.6	2.6	0.87	0.87	0.87	0.00	12	
	44	98	2.8	2.6	2.6	2.6	0.92	0.92	0.92	0.00	11	
	45	99	2.9	2.6	2.6	2.6	0.90	0.90	0.90	0.00	11	
	46	100	2.9	2.6	2.5	2.6	0.90	0.86	0.88	-0.04	12	
	47	101	3.1	2.8	2.5	2.7	0.92	0.82	0.87	-0.10	12	
12-17-82	48	102 *	3.4	2.5	1.8	2.2	0.73	0.52	0.63	-0.21	11	
	49	103	2.9	1.8	1.8	1.8	0.62	0.62	0.62	0.00	12	
	50	104	3.0	1.8	1.8	1.8	0.61	0.61	0.61	0.00	12	
	51	105	2.9	1.8	1.8	1.8	0.61	0.61	0.61	0.00	12	
	52	106	2.9	1.8	1.8	1.8	0.62	0.62	0.62	0.00	12	
	53	107 *	3.0	1.9	1.8	1.9	0.63	0.59	0.61	-0.04	12	
	54	108	3.4	1.9	1.8	1.9	0.56	0.53	0.55	-0.03	5	
PERIODS OF CONSTANT ACR	56- 58 (3)		2.8	0.2	1.4	.90	0.07	0.51	.33	0.44		
	59- 68 (10)		2.9	1.8	2.3	1.9	0.63	0.73	.66	0.10		
	69- 87 (19)		3.6	2.2	2.3	2.6	0.63	0.63	.71	0		
	88-108 (21)		3.0	2.2	1.8	2.4	0.76	0.53	.77	-0.23		

* Cleaning during this hour

Notes: 1. Negative drag rise was caused by a decrease in pressure drop instead of an expected increase in pressure drop as the filter collects the dust.

2. Specific resistance k_2: 1-10 low, 10-100 average, 100-1000 high, 1000-10,000 very high.

TABLE 9.4
OPERATING CONDITIONS
SRC FUEL WATER SLURRY
REVERSE AIR PILOT FILTER

TEST DATE	OPERATING HOUR	CONTINUOUS RUN NO.	AIR CLOTH RATIO ACR FPM	PRESSURE DROP ACROSS FILTER CLOTH (in. w.g.) INITIAL ΔPo	FINAL ΔPT	AVG ΔPAV	FILTER DRAG S = ΔP/ACR (in. w.g./FPM) INITIAL So	FINAL ST	AVG. SAV	DRAG RISE ΔS	DUST LOAD x10-4 Lb/Ft²	SPECIFIC RESISTANCE k_2
1-5-83	1	109	3.9	0.1	1.1	0.3	0.03	0.28	0.08	0.25	60	41
	2	110	4.0	1.6	2.1	1.9	0.40	0.52	0.46	0.12	58	20
	3	111	4.0	2.1	2.2	2.2	0.53	0.56	0.56	0.03	57	5
	4	112 *	4.1	2.2	2.2	2.2	0.54	0.54	0.54	0.00	13	
1-6-83	5	113	4.2	0.2	1.0	0.7	0.05	0.24	0.17	0.19	56	33
1-7-83	6	114	4.2	1.0	1.4	1.2	0.24	0.34	0.29	0.10	58	17
	7	115	4.2	1.5	1.9	2.0	0.36	0.46	0.41	0.10	59	17
	8	116	4.1	2.0	2.4	2.2	0.48	0.58	0.53	0.10	59	16
	9	117	4.1	2.4	2.9	3.0	0.59	0.71	0.67	0.12	58	20
	10	118	3.7	2.8	3.1	3.0	0.77	0.85	0.82	0.08	55	14
	11	119	3.6	2.6	3.4	3.1	0.72	0.94	0.85	0.27	54	40
	12	120 *	3.6	3.6	3.4	3.3	0.99	0.93	0.91	-0.26	27	
1-10-83	13	121 *	4.0	4.1	3.9	4.0	1.04	0.98	0.98	-0.06	56	
	14	122 *	3.7	4.0	3.9	4.0	1.09	1.07	1.04	-0.02	58	
	15	123 *	3.6	4.0	4.0	4.0	1.12	1.12	1.09	0.00	53	
	16	124 *	3.6	3.9	4.2	4.0	1.08	1.17	1.11	0.09	53	16
	17	125 *	3.5	4.4	4.4	4.2	1.27	1.27	1.21	0.00	52	
	18	126 **	3.4	4.6	4.4	4.1	1.35	1.29	1.20	-0.06	52	
1-11-83	19	127 **	3.8	3.8	3.2	4.0	0.99	0.83	1.02	-0.16	55	
	20	128	2.6	2.7	3.5	3.2	1.03	1.34	1.22	0.31	42	74
	21	129	2.6	3.5	3.6	4.0	1.36	1.40	1.40	0.04	41	9
	22	130	2.6	3.7	3.9	4.0	1.43	1.51	1.43	0.08	41	19
	23	131 *	2.6	4.0	3.7	4.0	1.55	1.43	1.40	-0.12	41	
	24	132 *	2.6	3.8	3.5	4.0	1.48	1.37	1.41	-0.11	41	
1-12-83	25	133 **	2.6	4.0	3.7	4.0	1.52	1.40	1.44	-0.12	48	
	26	134 *	2.5	3.6	3.7	4.0	1.42	1.46	1.50	0.04	42	9
	27	135 *	2.5	3.8	3.2	4.0	1.55	1.31	1.59	-0.24	41	
	28	136 *	2.5	3.9	4.3	4.1	1.55	1.71	1.63	0.16	42	37
	29	137 **	2.5	4.5	4.2	4.0	1.83	1.71	1.63	-0.12	42	
1-13-83	30	138 *	2.5	4.2	3.1	3.4	1.67	1.23	1.35	-0.44	25	
	31	139 *	2.5	3.2	3.0	3.3	1.30	1.22	1.34	-0.08	38	
	32	140 *	2.9	3.9	1.4	2.2	1.36	0.49	0.77	-0.87	32	
	33	141	4.1	2.9	3.4	3.2	0.71	0.84	0.79	0.13	33	39
1-14-83	34	142	2.7	4.7	3.9	4.0	1.77	1.47	1.51	-0.30	39	
	35	143	2.6	4.2	4.2	4.1	1.64	1.64	1.60	0.00	44	
	36	144 *	2.7	4.2	4.3	4.0	1.58	1.62	1.43	0.40	38	10
	37	145	3.0	4.3	4.5	4.4	1.43	1.50	1.47	0.07	39	17
	38	146 *	2.6	4.5	3.8	4.0	1.76	1.48	1.48	-0.28	35	
PERIODS OF CONSTANT ACR	109 -117 (9)		4.1	0.1	2.9	1.7	0.03	0.71	.41	0.68		
	118 -127 (10)		3.6	2.8	3.2	3.8	0.77	0.83	1.02	0.06		
	128 -137 (10)		2.6	2.7	4.2	3.9	1.03	1.71	1.46	0.68		
	138 -146 (9)		2.8	4.2	3.8	3.6	1.07	1.48	1.30			

* Cleaning during this hour
** Cleaning twice

Notes: 1. Negative drag rise was caused by a decrease in pressure drop instead of an expected increase in pressure drop as the filter collects the dust.

2. Specific resistance k_2: 1-10 low, 10-100 average, 100-1000 high, 1000-10,000 very high.

TABLE 10
PERFORMANCE RESULTS
REVERSE AIR PILOT FILTER

FUEL NAME	CLOTH NO.	OPERATING PERIOD OR RUN NO.	TEST DURATION	OPERATING AIR CLOTH RATIO	INLET DUST LOADING	OUTLET DUST CONCENTRATION	EMISSION RATE	DUST COLLECTION EFFICIENCY *	DUST PENETRATION
				ACR	Gr/SDCF	Gr/SDCF	Lb/MBTU	η	1-η
			Hrs	FPM	Gr/Ft³	Gr/Ft³	Lb/10⁶BTU	%	%
NO. 6 FUEL OIL	1	1st Hr	1	2.7	0.02	0.010	0.021	52	48
		2nd Hr	1	2.8		0.001	0.001	97	3
	2	1st Hr	1	3.0	0.03	0.001	0.002	96	4
		2nd Hr	1	3.0		0.014	0.031	47	53
		3rd Hr	1	2.9		0.003	0.006	89	11
		4th Hr	1	2.9		0.001	0.003	96	4
	3	1st Hr	1	2.9	0.02	0.015	0.033	27	73
		2nd Hr	1	2.8		0.009	0.021	53	47
		3rd Hr	1	2.8		0.002	0.004	92	8
		4th Hr	1	2.8		0.006	0.013	70	30
	4	1 - 3	3	1.9	0.01	0.008	0.017	37	63
		4 - 5	2	1.9		0.001	0.003	89	11
	5	1st Hr	1	1.7	0.04	0.011	0.024	36	64
		2 - 8	7	1.6		0.003	0.006	84	16
	6	1st Hr	1	1.9	0.02	0.020	0.044	48	52
		2 - 7	6	1.9		0.001	0.003	97	3
PULVERIZED SRC FUEL SOLIDS	7	1 - 4	4	1.9	0.46	0.005	0.011	99	1
		5 - 10	6	2.2		0.001	0.001	99.9	0.1
		11 - 54	39	2.3		0.001	0.001	99.9	0.1
SRC RESIDUAL FUEL OIL	10	55 - 67	13	2.9	0.09	0.003	0.006	97	3
		58 - 108	41	3.3		0.0002	0.001	99.8	0.2
SRC FUEL WATER SLURRY	18	139 - 112	3	4.0	0.39	0.008	0.018	98	2
		113 - 118	6	4.1		0.019	0.042	95	5
		119 - 146	24	3.0		0.001	0.002	99.8	0.2

* Low values and random variations in the dust collection efficiencies for No. 6 Fuel Oil resulted mainly from the very low inlet dust loading, insufficient time for filter cloth conditioning and inherent inaccuracies associated with very small amount of outlet dust collected in very short test durations.

TABLE 11
CLOTH CLEANING PERFORMANCE
REVERSE AIR PILOT FILTER

FUEL NAME	CLOTH NO.	EXPOSURE TIME Hrs	FILTRATION ACR FPM	CLEANING PARAMETERS: ACR FPM	CLEANING PARAMETERS: DURATION Minutes	CLEANING PARAMETERS: SETTLE TIME Minutes	PRESSURE DROP in. w.g.: ΔP Before Cleaning	PRESSURE DROP in. w.g.: ΔP After Cleaning	PRESSURE DROP in. w.g.: ΔP Reduction
NO. 6 FUEL OIL	1	3	2.8	1.0	2	0	3.6	2.1	1.5
		1	2.8	↓	↓	↓	2.8	2.6	0.2
		1	3.4				3.1		
	3	5	2.8	1.5	1		3.0	1.5	1.5
	4	5	1.9	1.9	1		1.1	1.0	0.1
	5	5	1.6	2.0	2		2.3	1.0	1.3
	6	7	1.9	1.0	1	↓	1.6	1.2	0.4
PULVERIZED SRC FUEL SOLIDS	7	15	2.2	1.1	1	1	4.0	2.5	1.5
		21	2.3	↓	↓	↓	4.1	2.9	1.2
		18	2.3				2.4	2.0	1.4
SRC RESIDUAL FUEL OIL	10	47	3.2				2.4	1.7	0.7
		5	3.0	↓			1.9	1.7	0.2
SRC FUEL WATER SLURRY	18	3	4.0	1.0			2.2	0.2	2.0
		8	4.0	1.1			3.6	2.8	0.8
Typical for 6 hrs; hourly			3.6	↓			4.6	3.6	1.0
Typical for 1 hr; ev. 10 min.			3.8				4.8	4.0	0.8
Typical for 19 hrs; hourly			2.7	↓	↓	↓	4.3	3.0	1.3

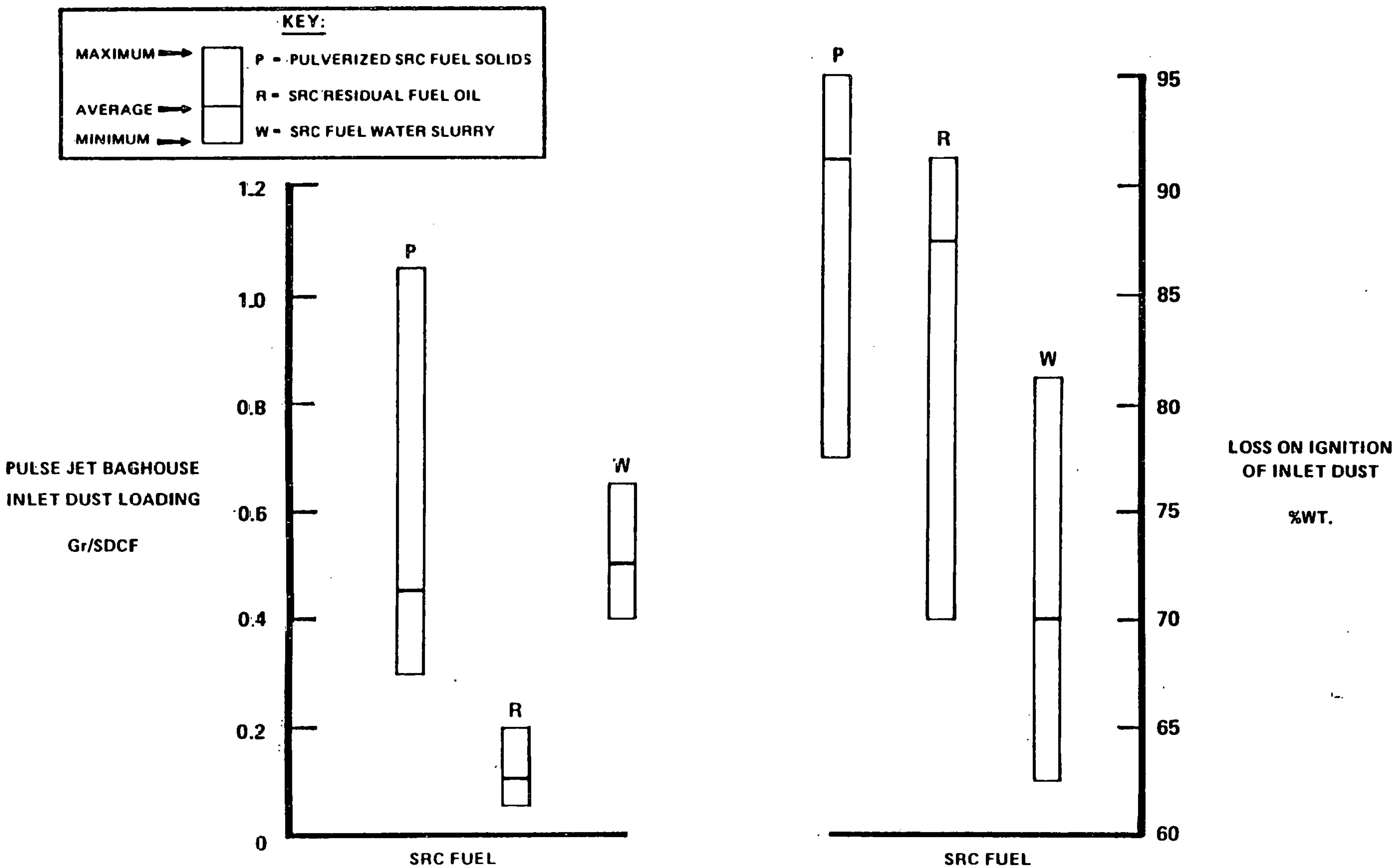
TABLE 12
START-STOP EVENTS
REVERSE AIR PILOT FILTER

FUEL NAME	CLOTH NO.	NO. OF START-STOP EVENTS	NO. OF CLEANING EVENTS*	DURATION OF HALT		ΔP INCREASE	
				minumum minutes	maximum minutes	minimum in. w.g.	maximum in. w.g.
NO. 6 FUEL OIL	1	4	2	14	26	0.1	0.2
	2	3		11	17	0	0
	3	4		8	15	-0.1	0
	4	6		7	109	-0.2	0.3
	5	9	1	3	15 hrs	-0.1	1.2
	6	2		7	23	0	0.1
PULVERIZED SRC FUEL SOLIDS	7	23	3	20	79 hrs	-0.3	0.6
SRC RESIDUAL FUEL OIL	10	14	1	18	19 hrs	0	0.7
SRC FUEL WATER SLURRY	18	43	25	8	19 hrs	-1.4	1.3

* included in number of start-stop events

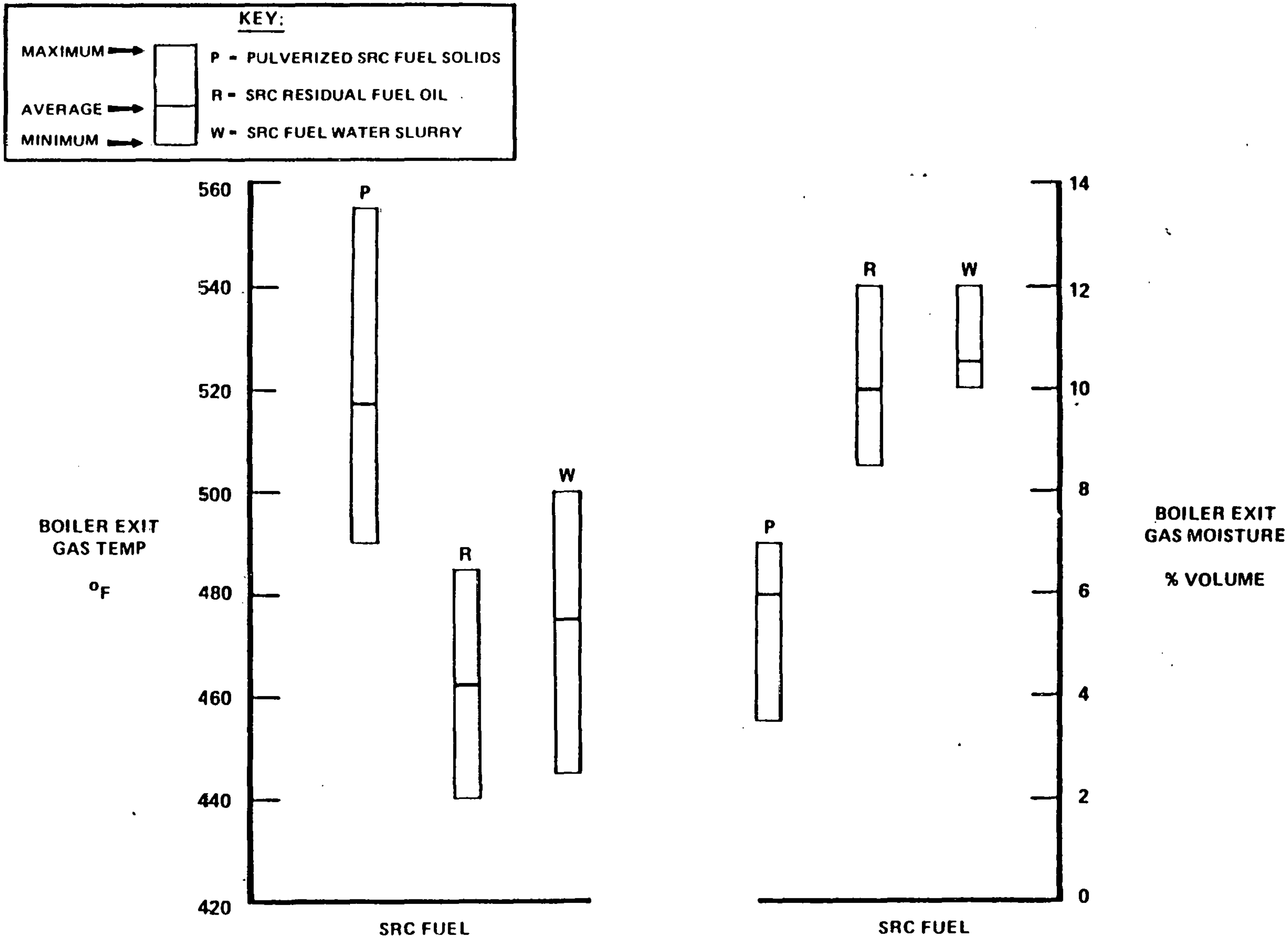
TABLE 13
FILTER CLOTH PERMEABILITY
REVERSE AIR PILOT FILTER

FUEL NAME	CLOTH NO.	DUST EXPOSURE	OPERATING RANGE	DRAG RANGE	AVERAGE PRESSURE DROP	FABRIC PERMEABILITY		
		TIME Hrs	ACR FPM	S in. w.g./FPM	ΔP in. w.g.	NEW	DIRTY	VACUUMED
						CFM/Sq. Ft. @ 0.5 in. w.g.		
NO. 6 FUEL OIL	1	5	2.7 - 2.8	0.3 - 1.1	3.0	46.5	23.8	34.6
	2	4	2.9	0.1	0.3	47.4	28.3	35.5
	3	5	2.8	1.0	2.8	48.0	19.8	31.9
	4	5	1.9	0.5	1.0	47.2	16.3	30.5
	5	8	1.1	1.6	1.8	47.1	29.4	34.4
	6	7	1.9	0.8	1.5	46.7	9.6	28.4
PULVERIZED SRC FUEL SOLIDS	7	48	1.6 - 2.2	1.1 - 1.8	4.0	46.0	6.1	37.0
SRC RESIDUAL FUEL OIL	10	53	2.7 - 3.1	0.7 - 1.0	3.1	46.4	15.5	32.0
SRC FUEL WATER SLURRY	18	33	2.5	1.7	4.3	45.1	2.2	29.6



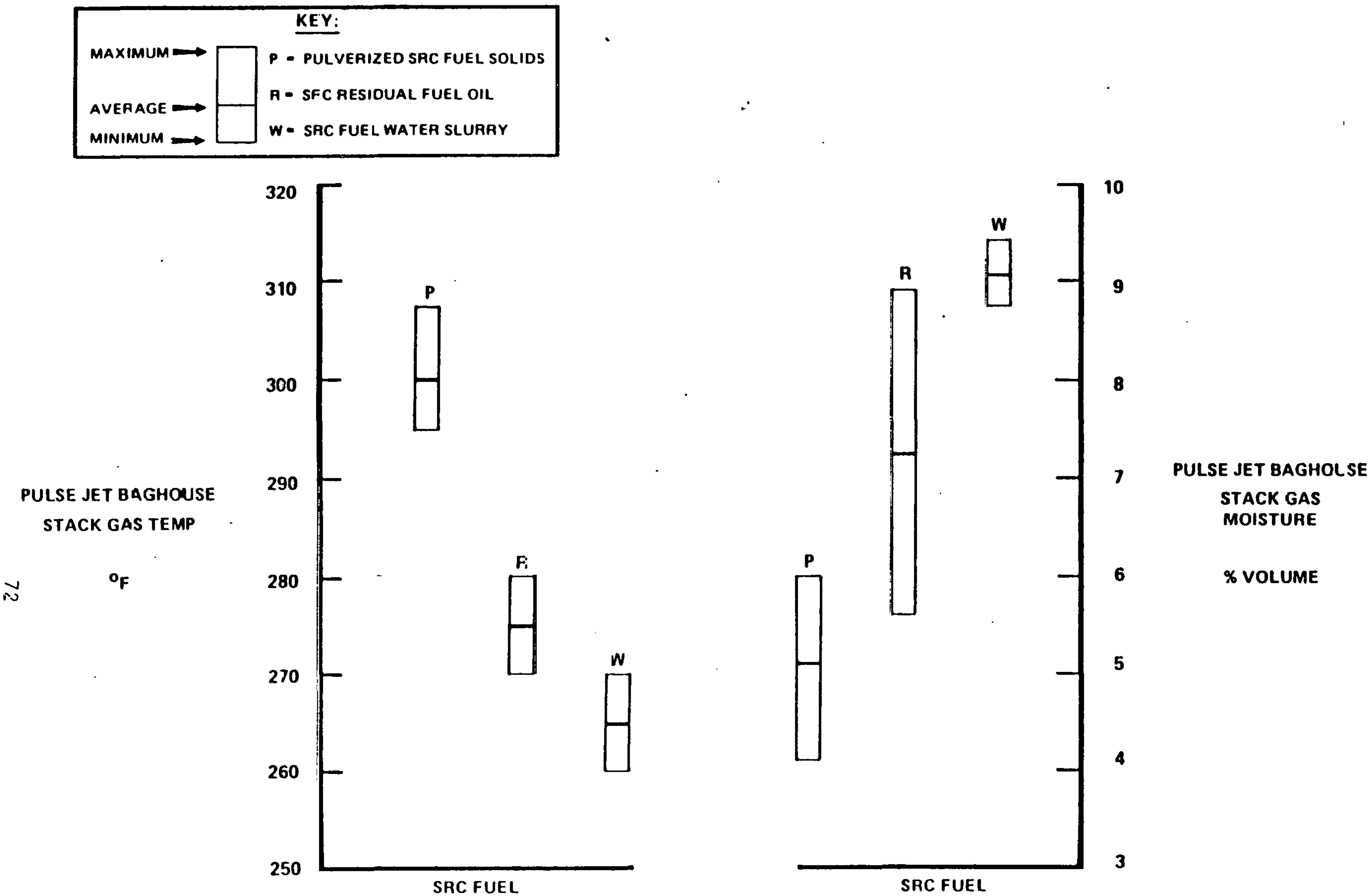
Graph 1

INLET DUST LOADING
AND
LOSS ON IGNITION FOR THREE FORMS OF SRC FUEL



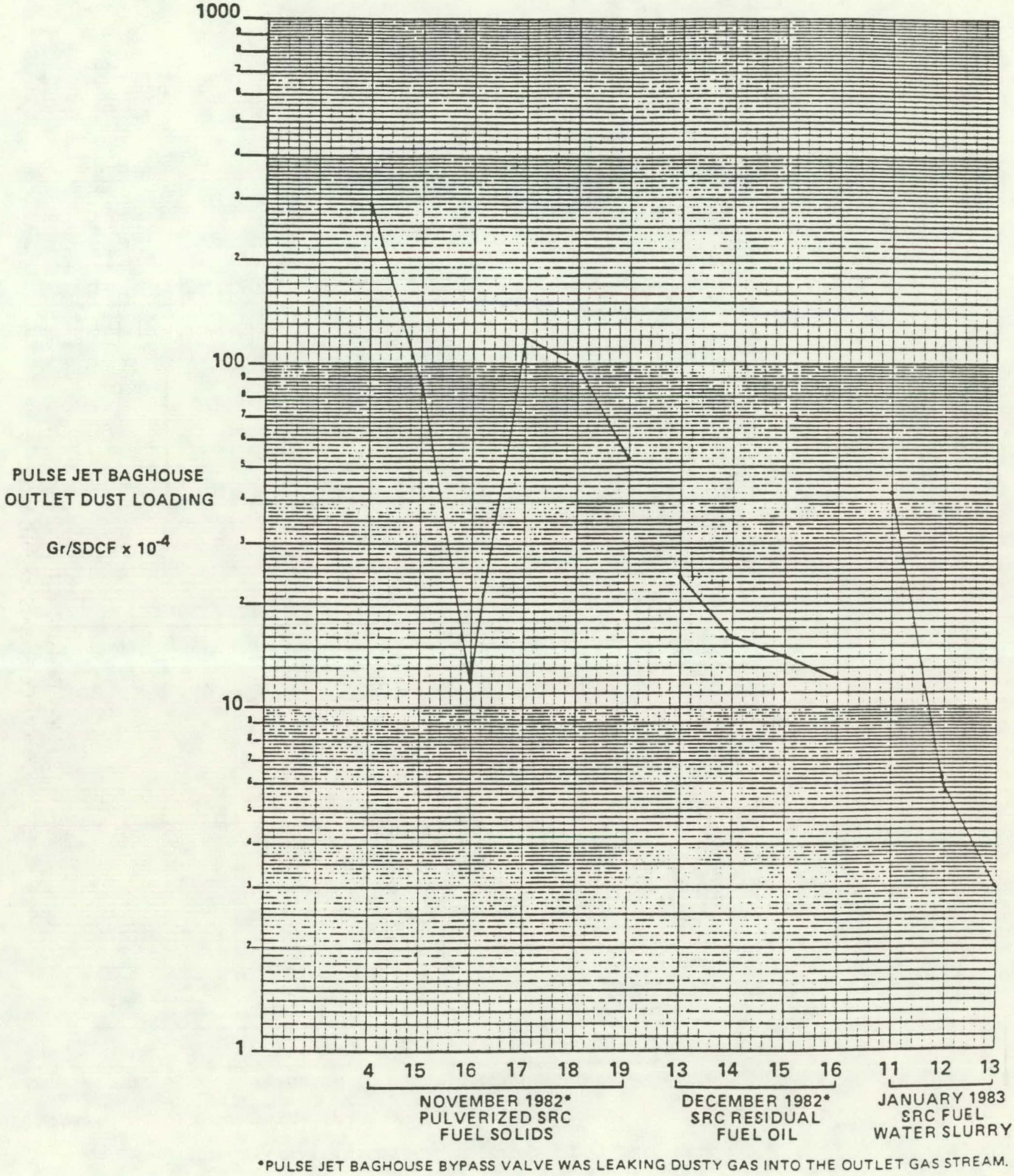
Graph 2

BOILER EXIT GAS TEMPERATURE & MOISTURE CONTENT
FOR THREE FORMS OF SRC FUEL



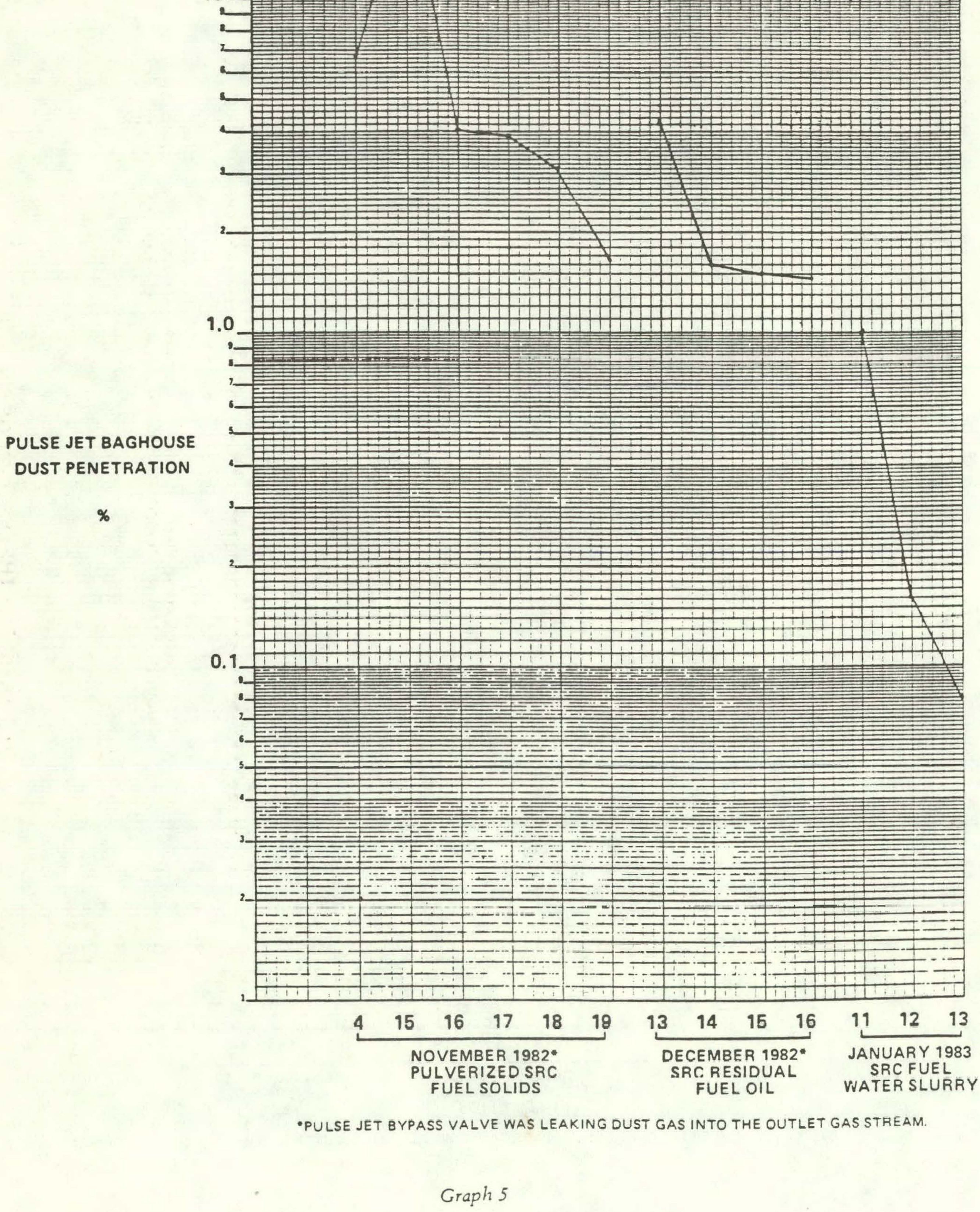
Graph 3

STACK GAS TEMPERATURE & MOISTURE CONTENT
FOR THREE FORMS OF SRC FUEL



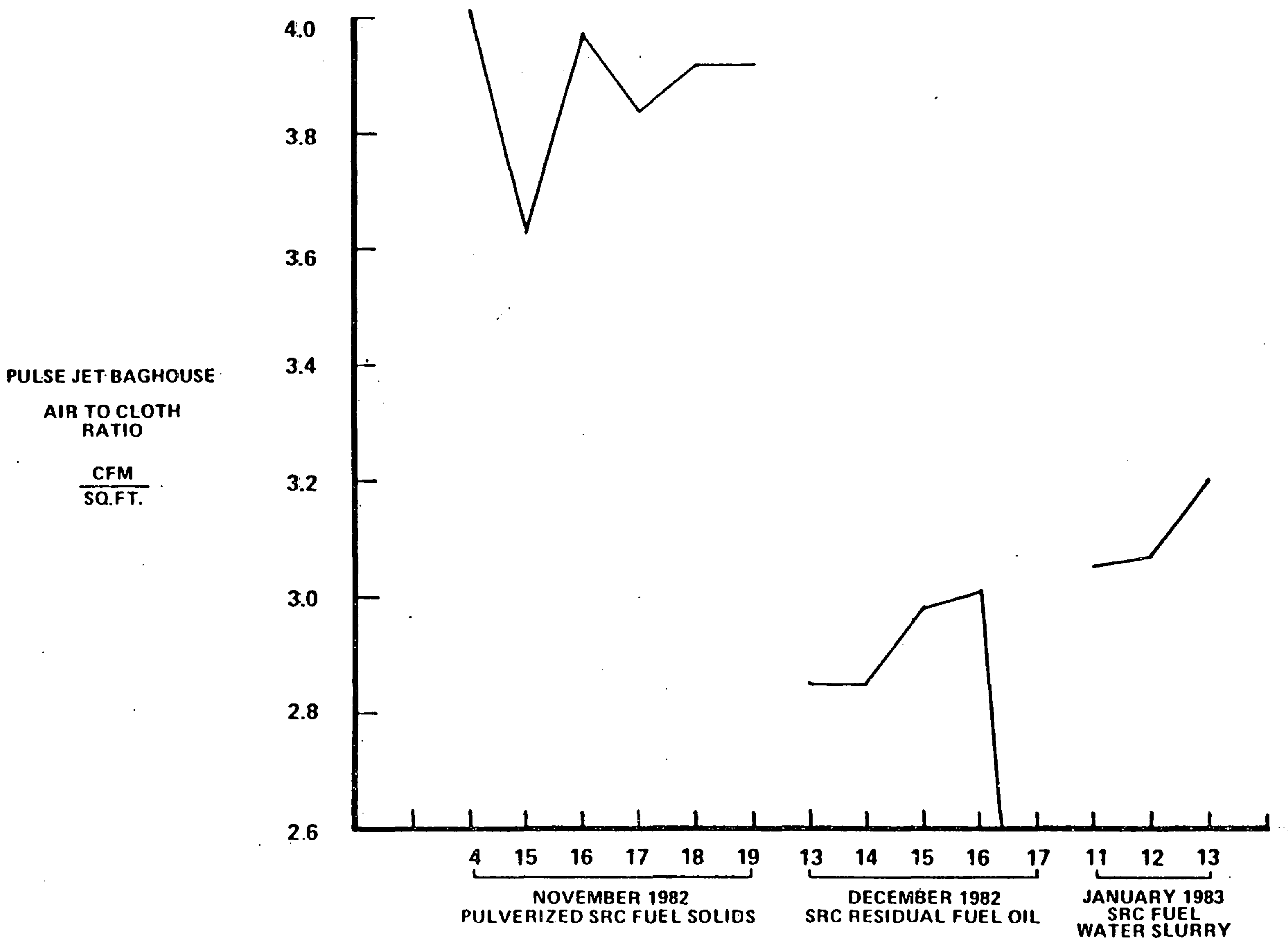
Graph 4

OUTLET DUST LOADING FOR THREE FORMS OF SRC FUEL



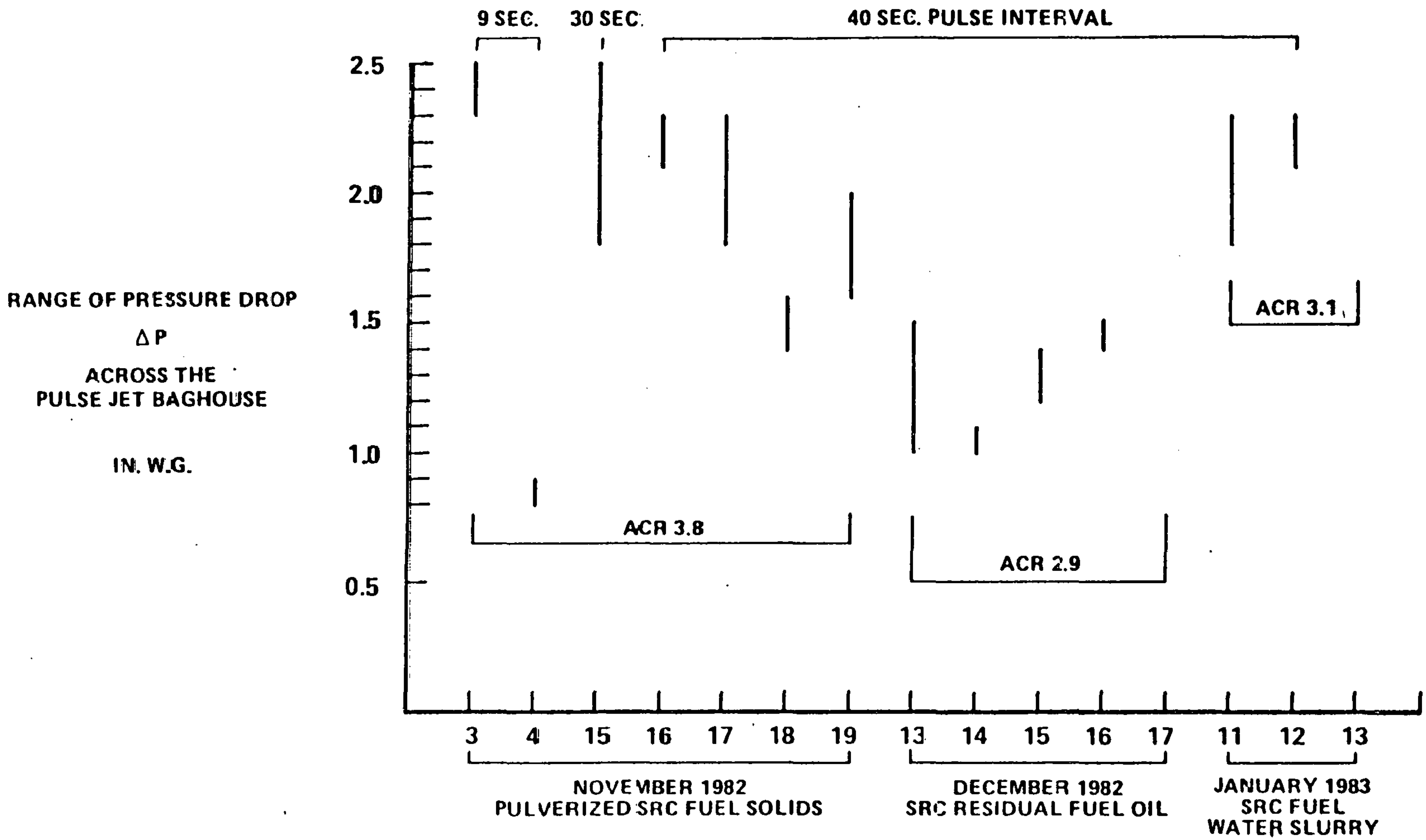
Graph 5

DUST PENETRATION FOR THREE FORMS OF SRC FUEL



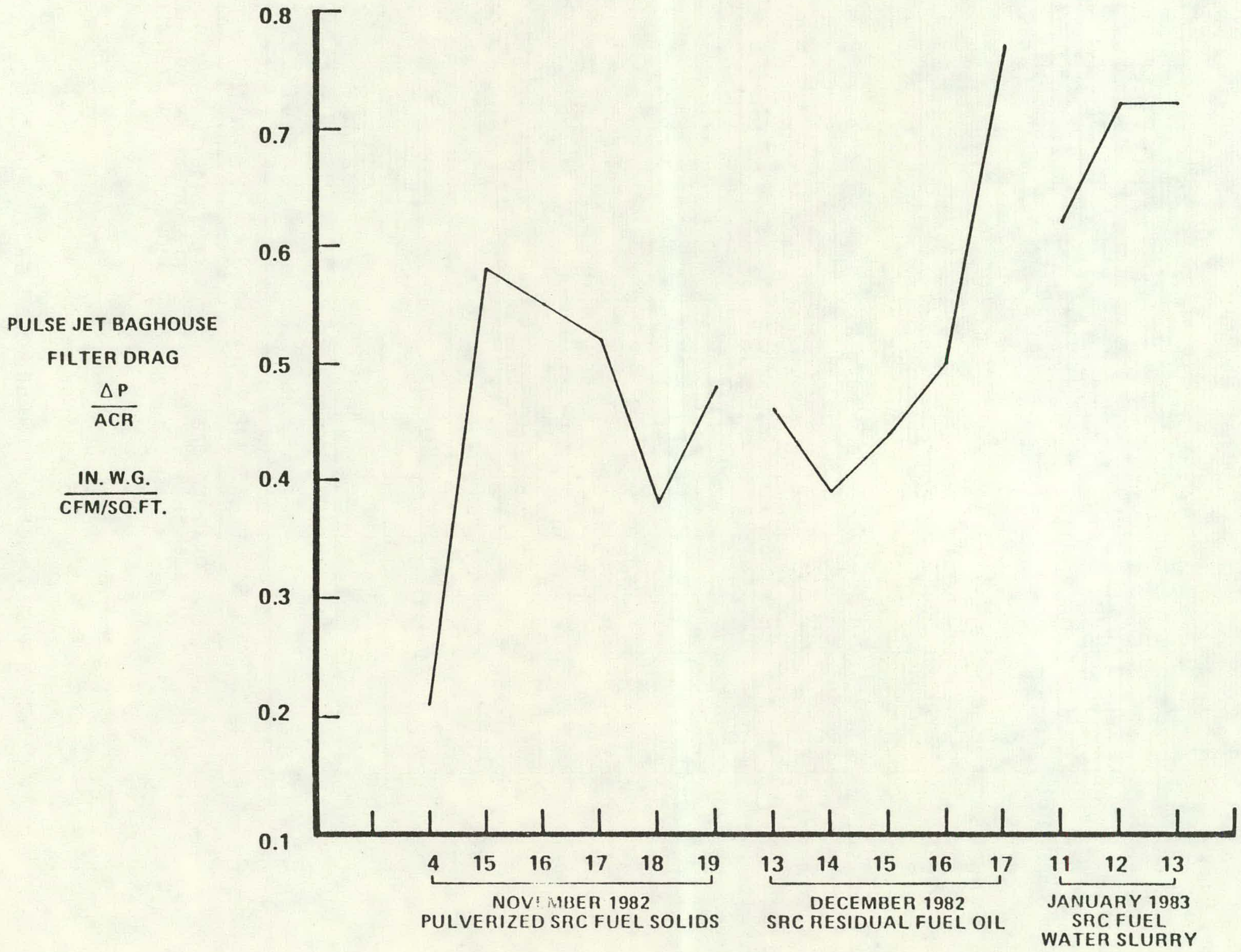
Graph 6

AIR TO CLOTH RATIO FOR THREE FORMS OF SRC FUEL



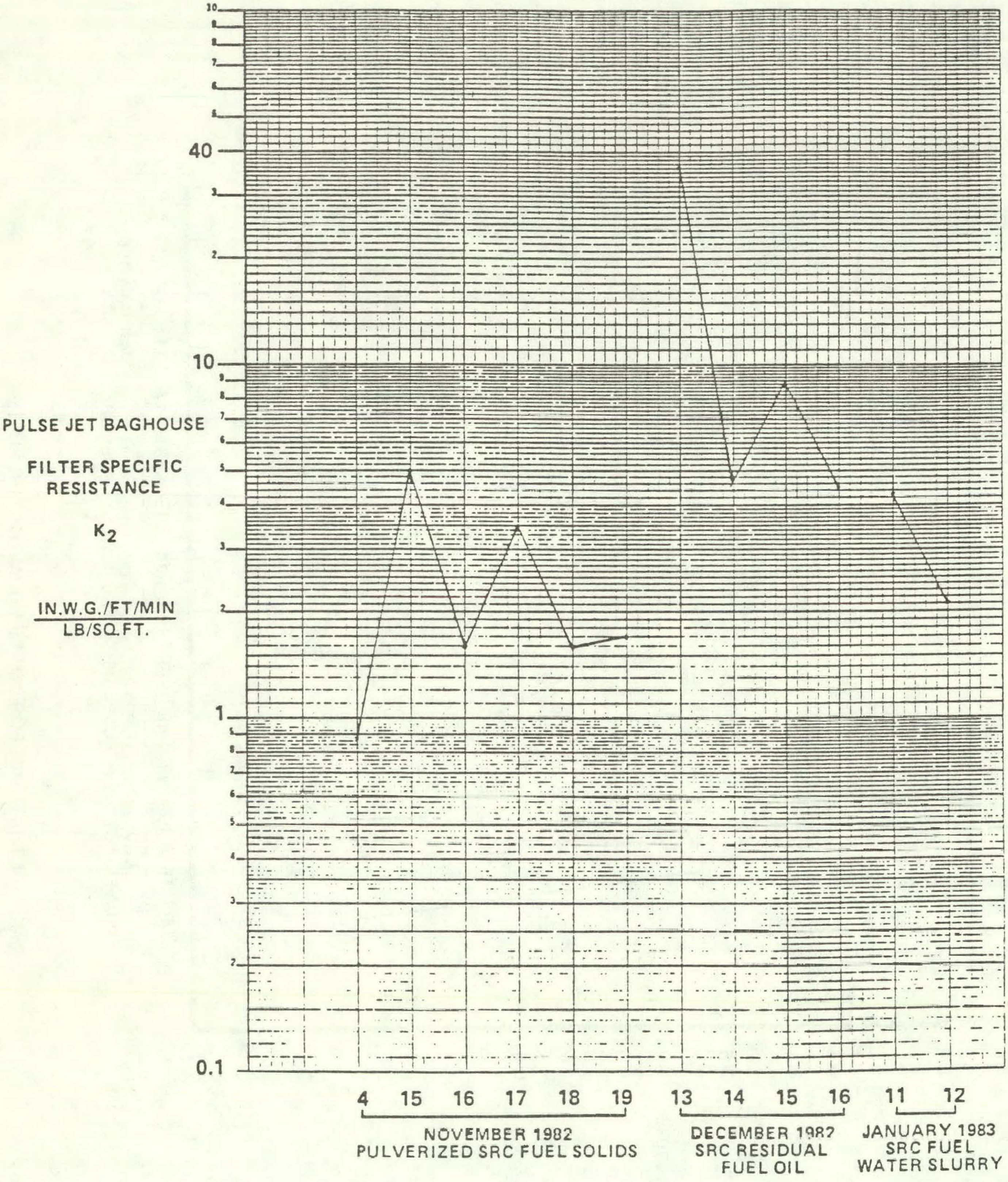
Graph 7

RANGE OF PRESS DROP FOR THREE FORMS OF SRC FUEL



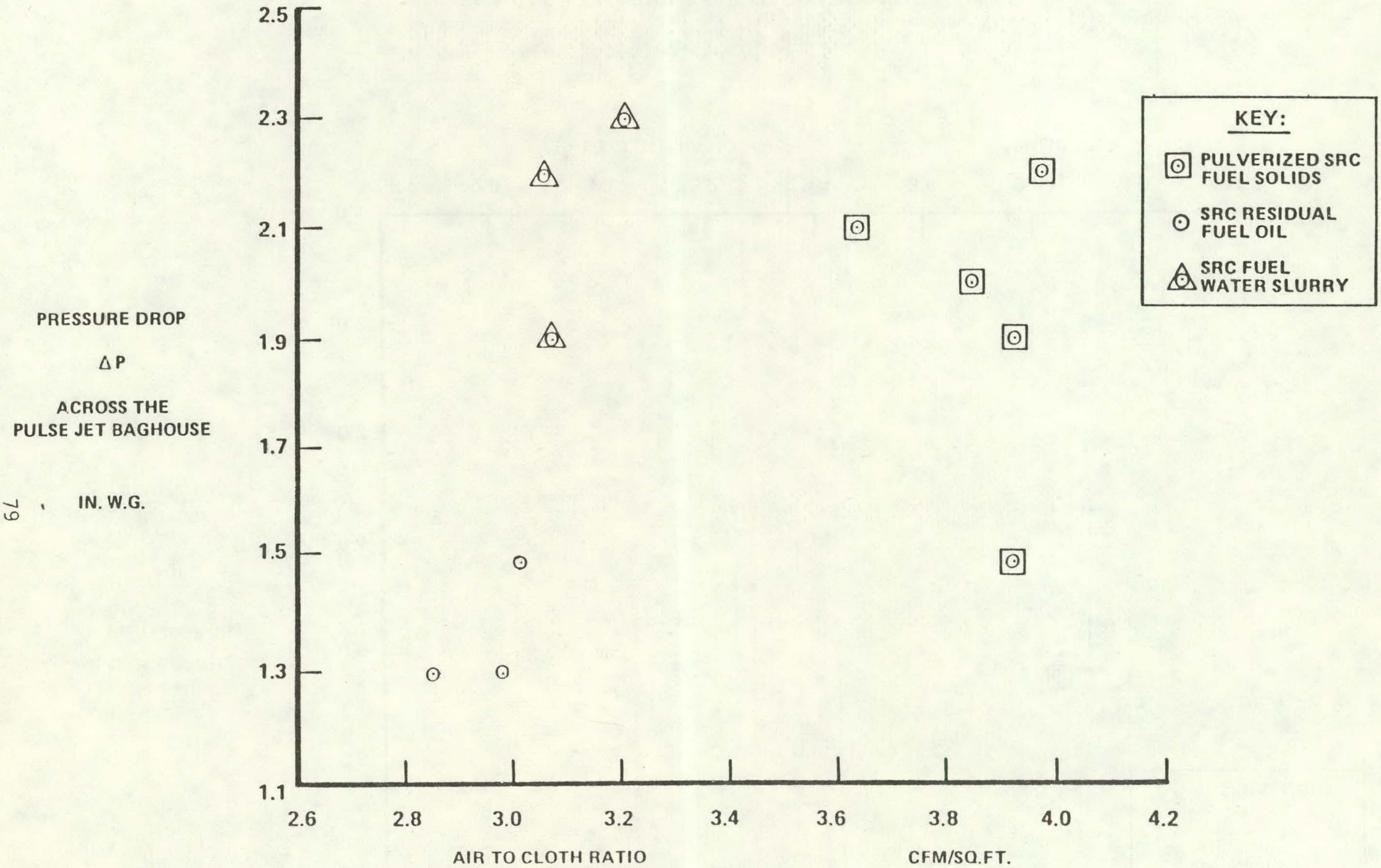
Graph 8

FILTER DRAG FOR THREE FORMS OF SRC FUEL



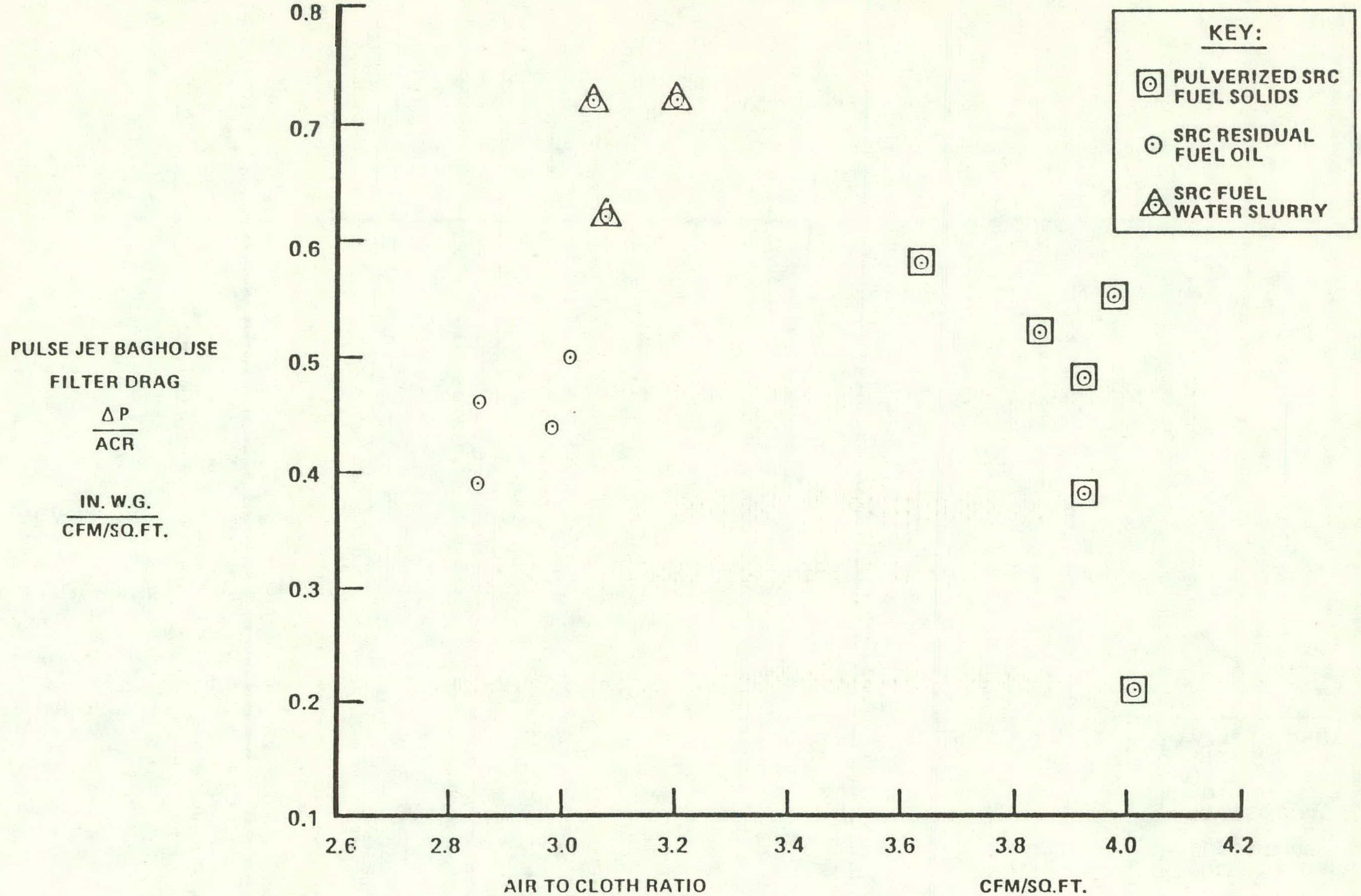
Graph 9

FILTER SPECIFIC RESISTANCE FOR THREE FORMS OF SRC FUEL



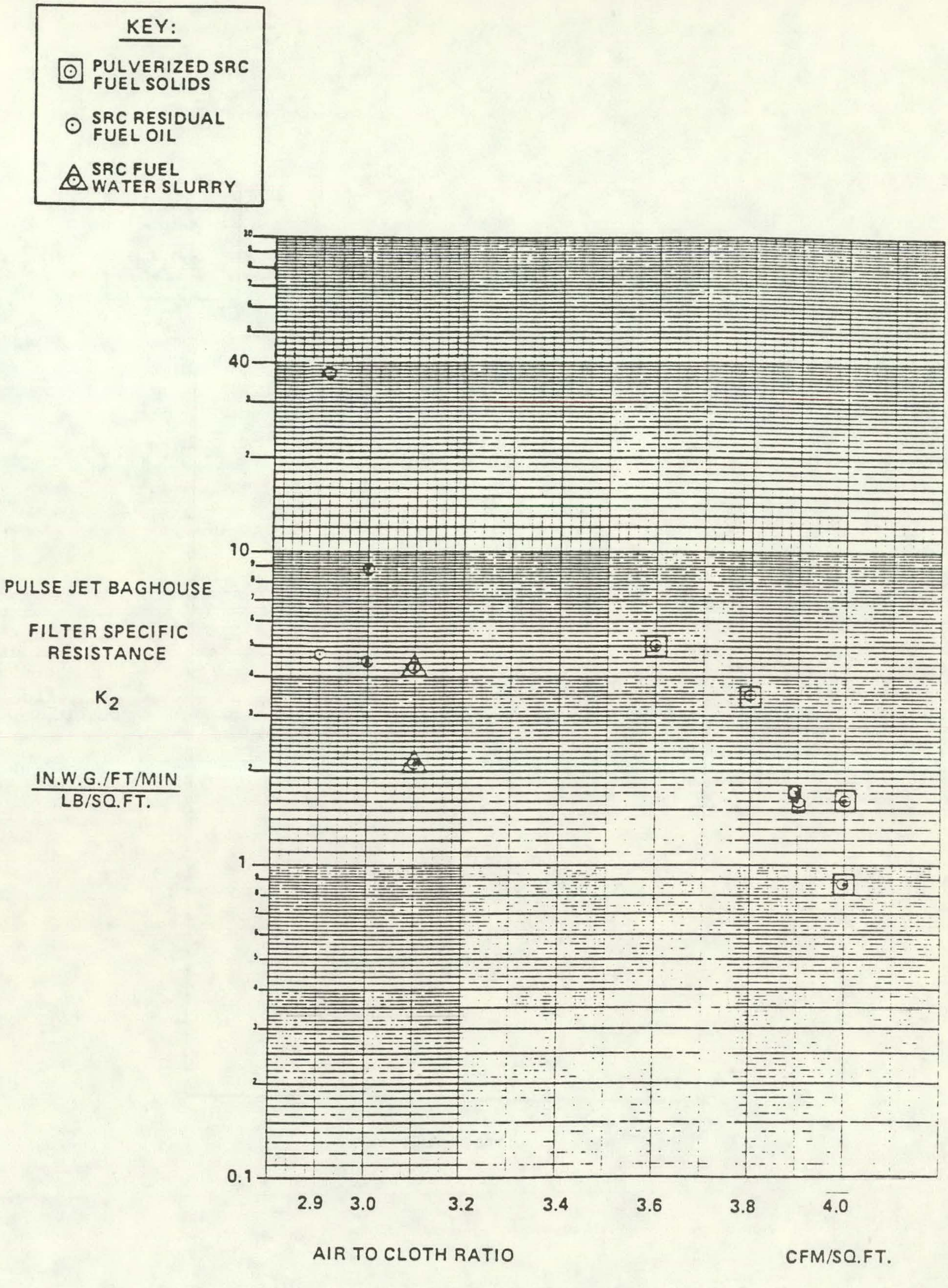
Graph 10

PRESSURE DROP AT VARIOUS AIR TO CLOTH RATIO VALUES



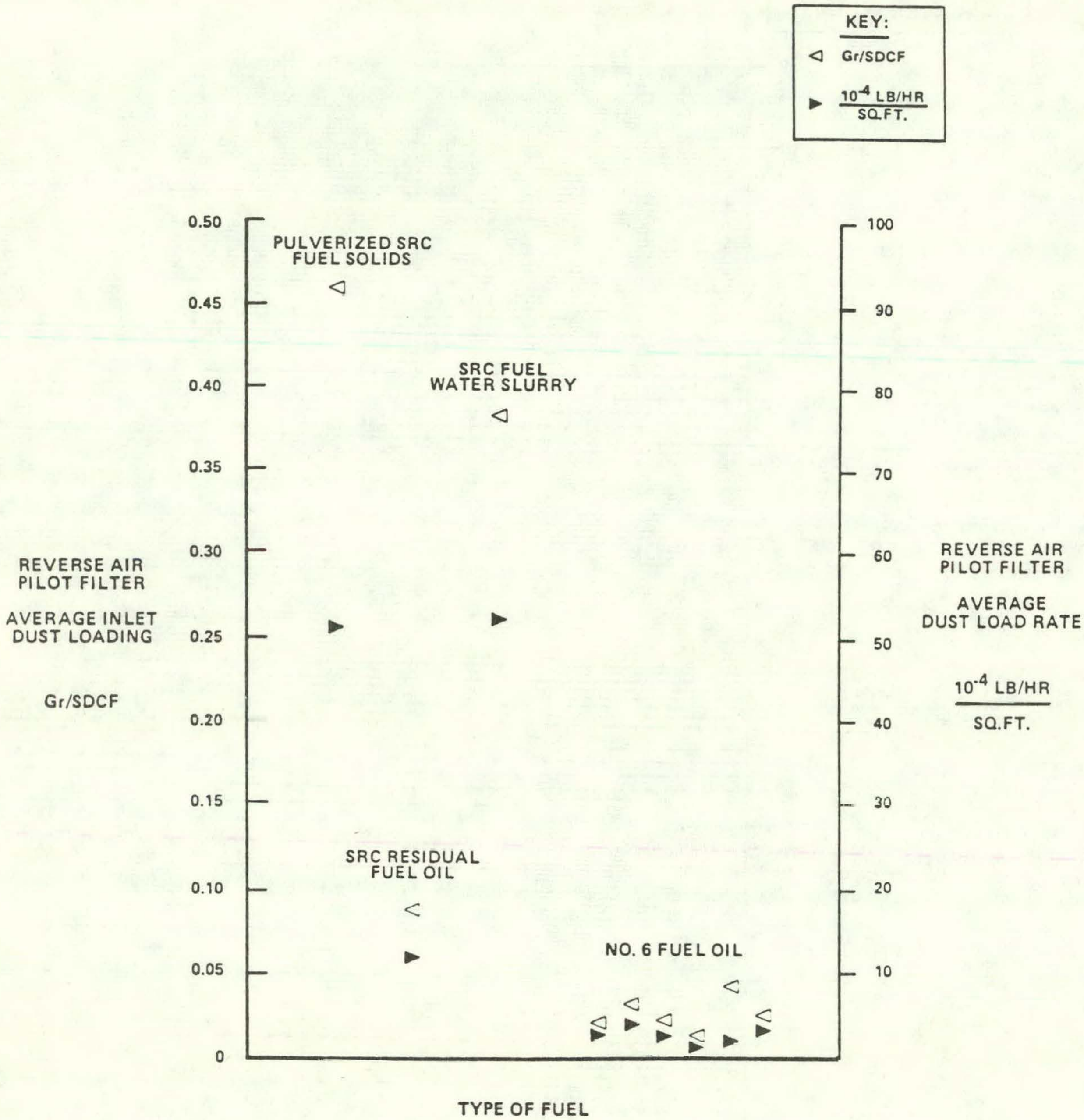
Graph 11

FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



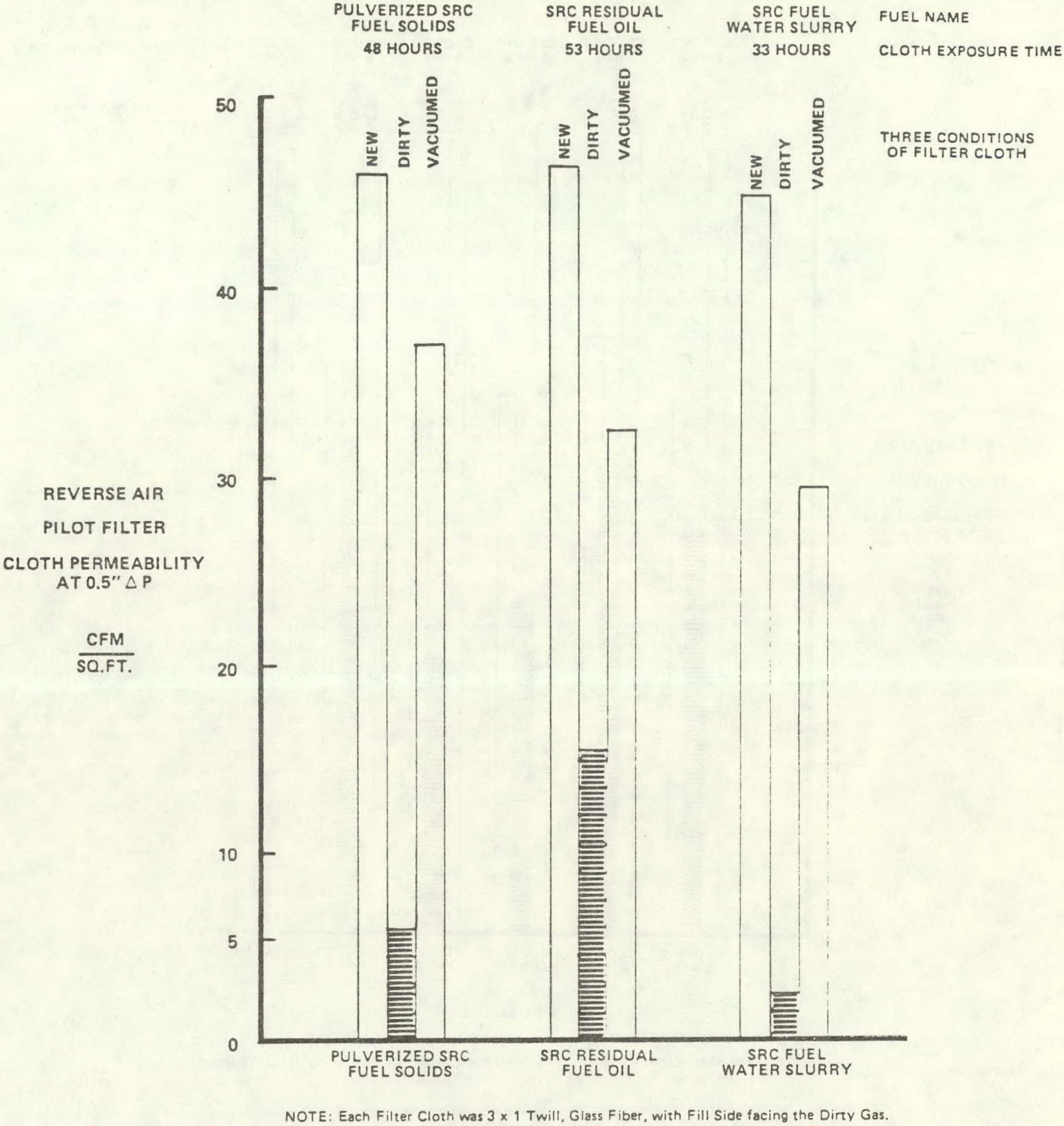
Graph 12

FILTER SPECIFIC RESISTANCE AT VARIOUS AIR TO CLOTH RATIO VALUES



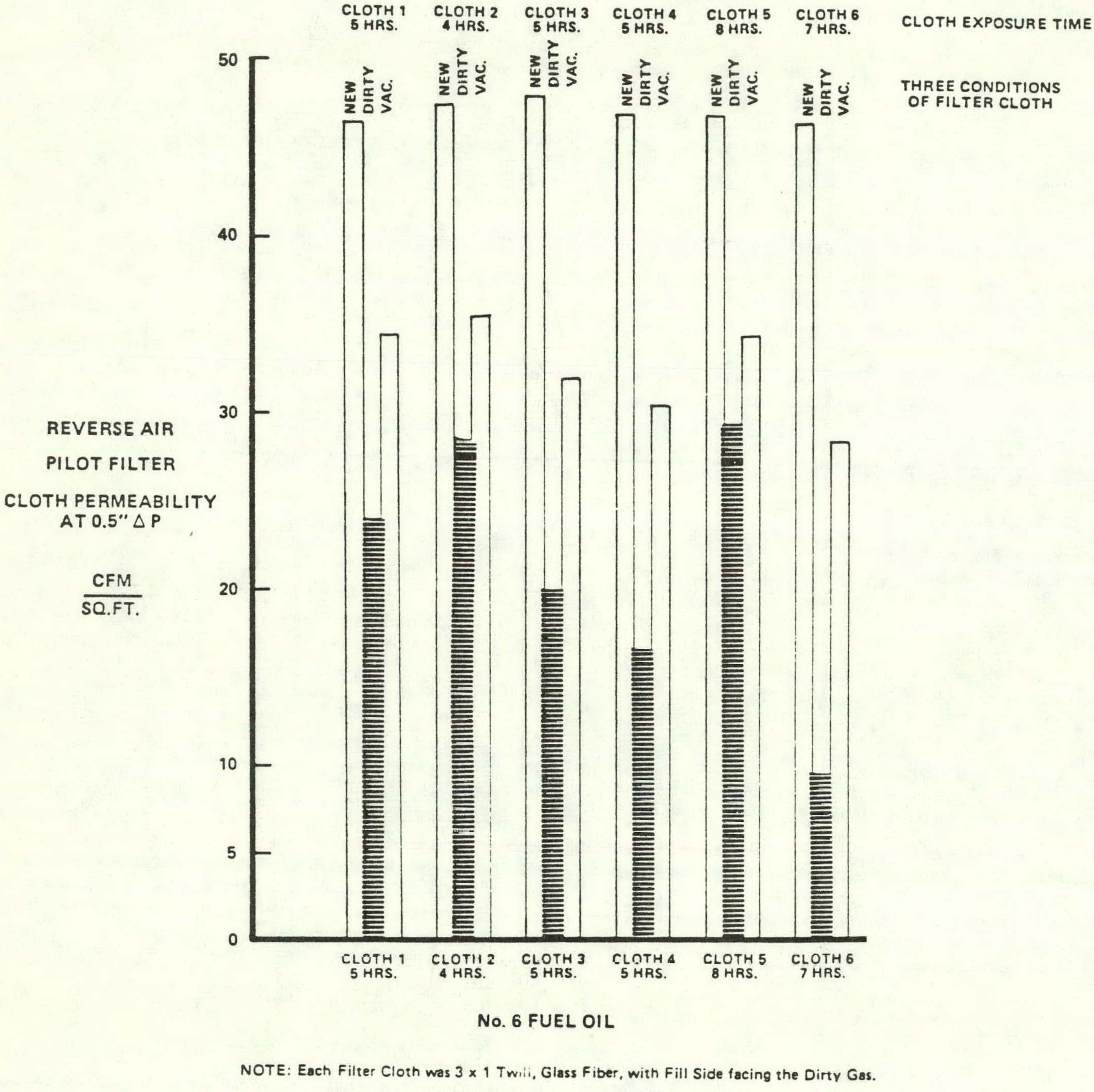
Graph 13

AVERAGE VALUES OF INLET DUST LOADING
&
FABRIC DUSTLOAD RATE FOR VARIOUS FUELS



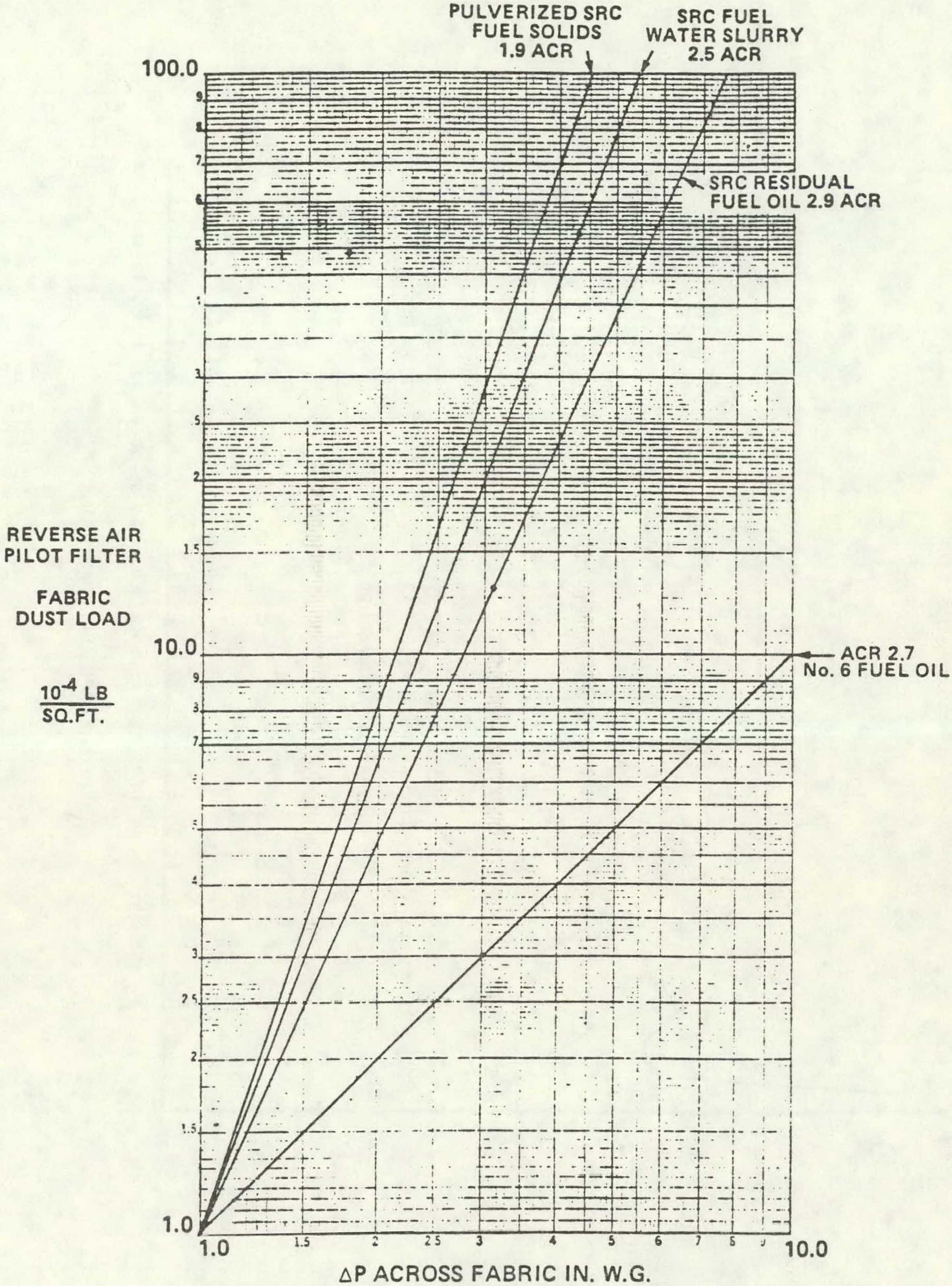
Graph 14

CLOTH PERMEABILITY FOR THREE FORMS OF SRC FUEL



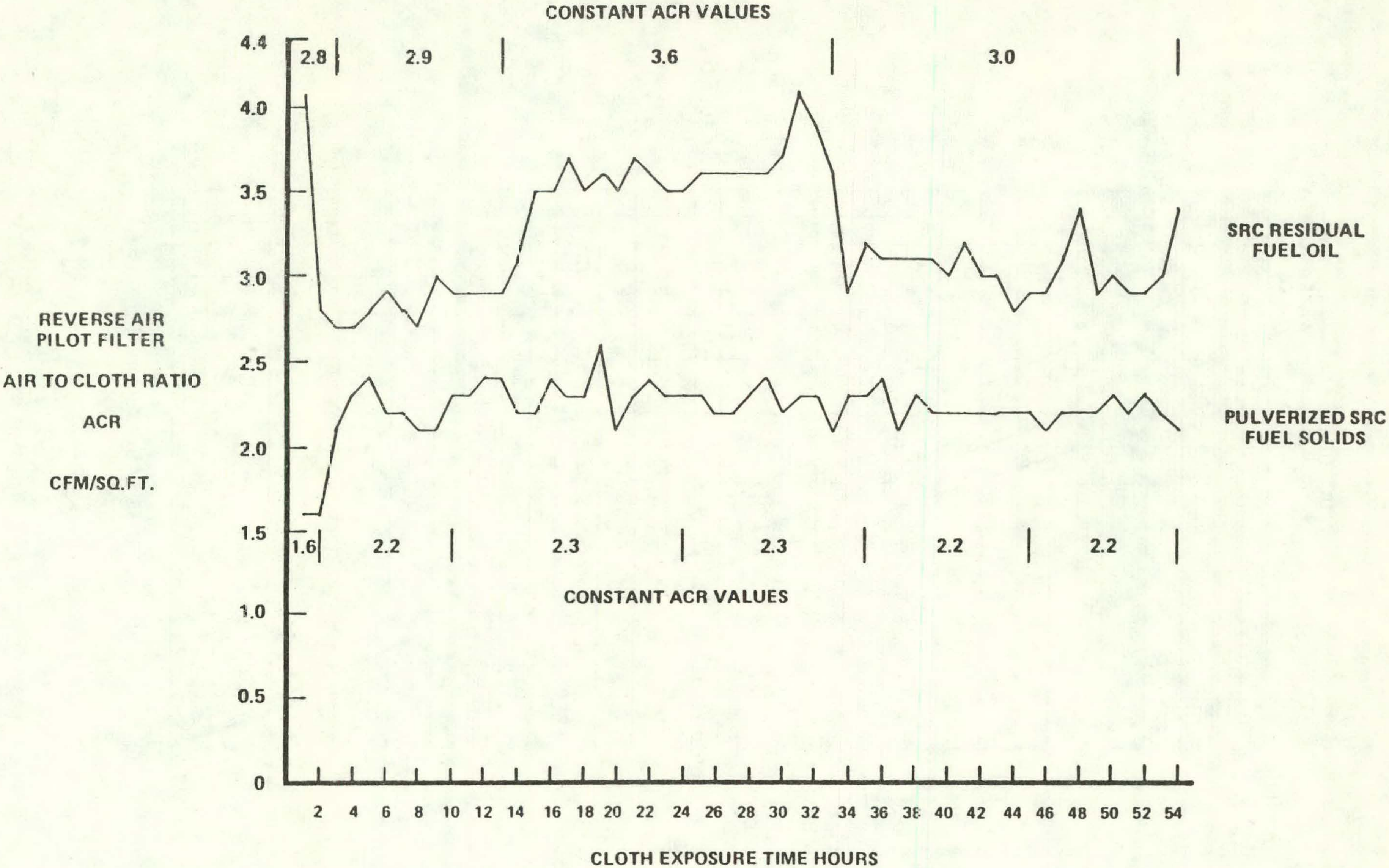
Graph 15

FILTER CLOTH PERMEABILITY FOR No. 6 FUEL OIL



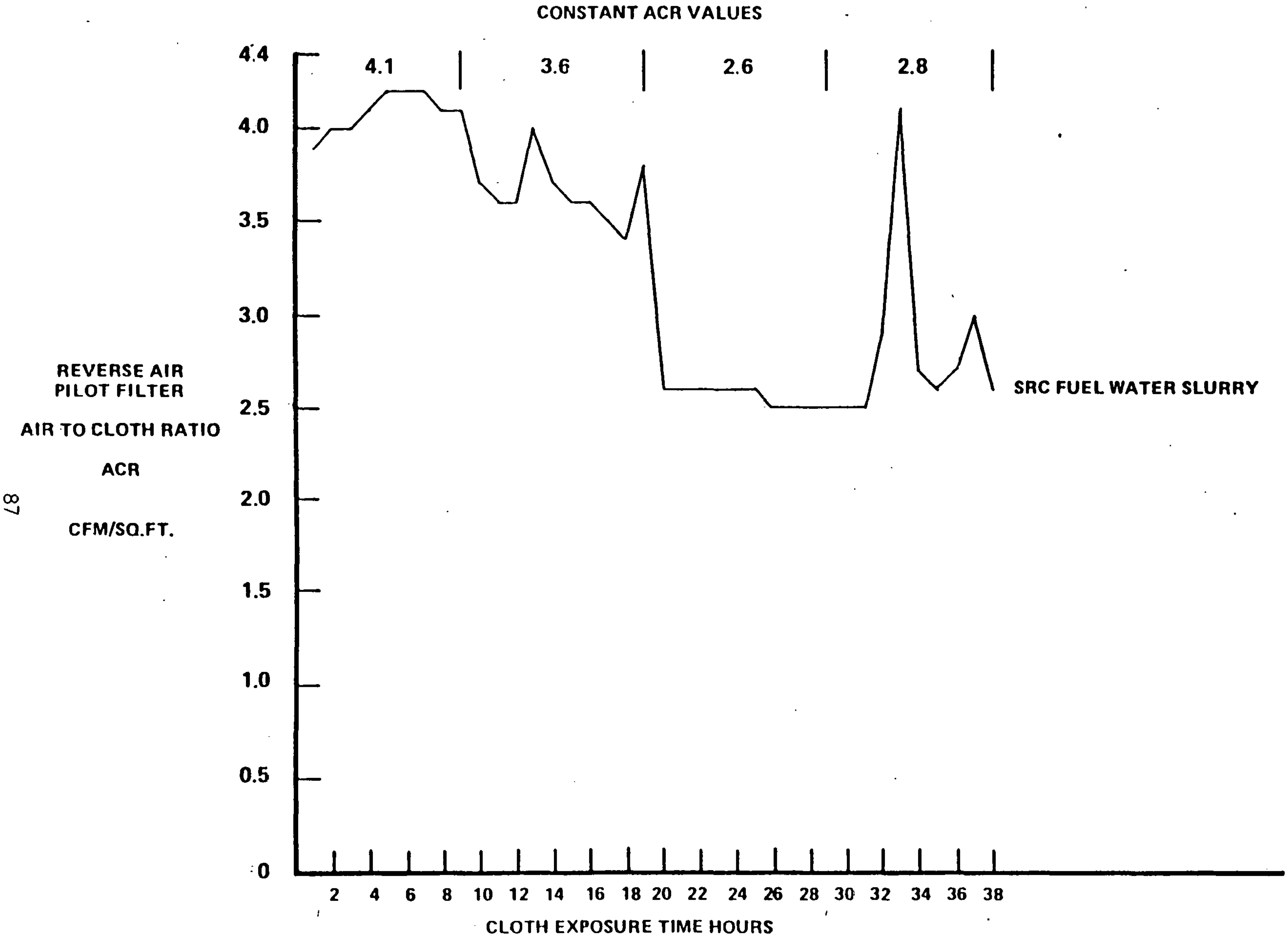
Graph 16

PRESS DROP AT VARIOUS DUST LOAD VALUES



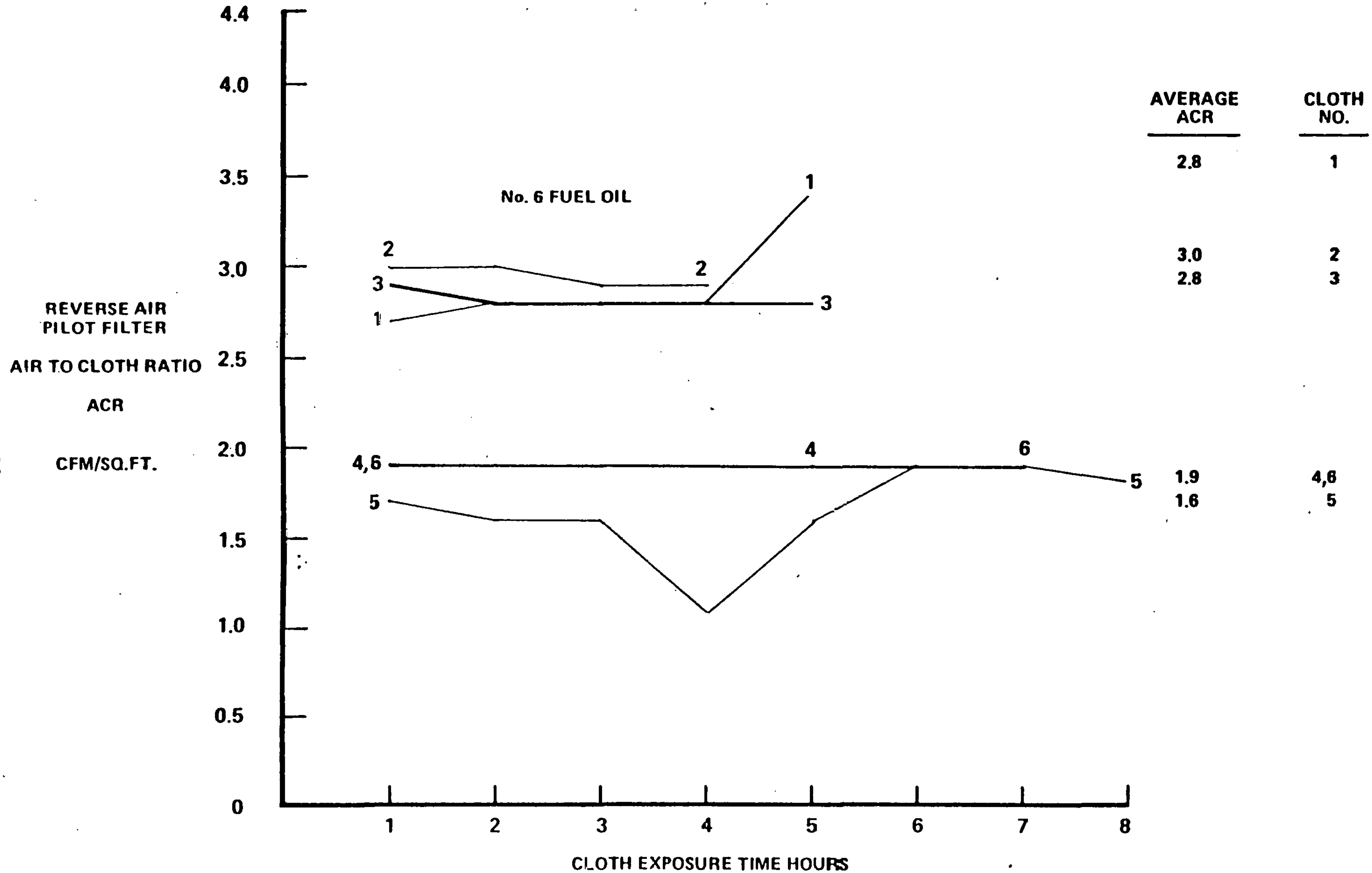
Graph 17

HOURLY VARIATION OF AIR TO CLOTH RATIO



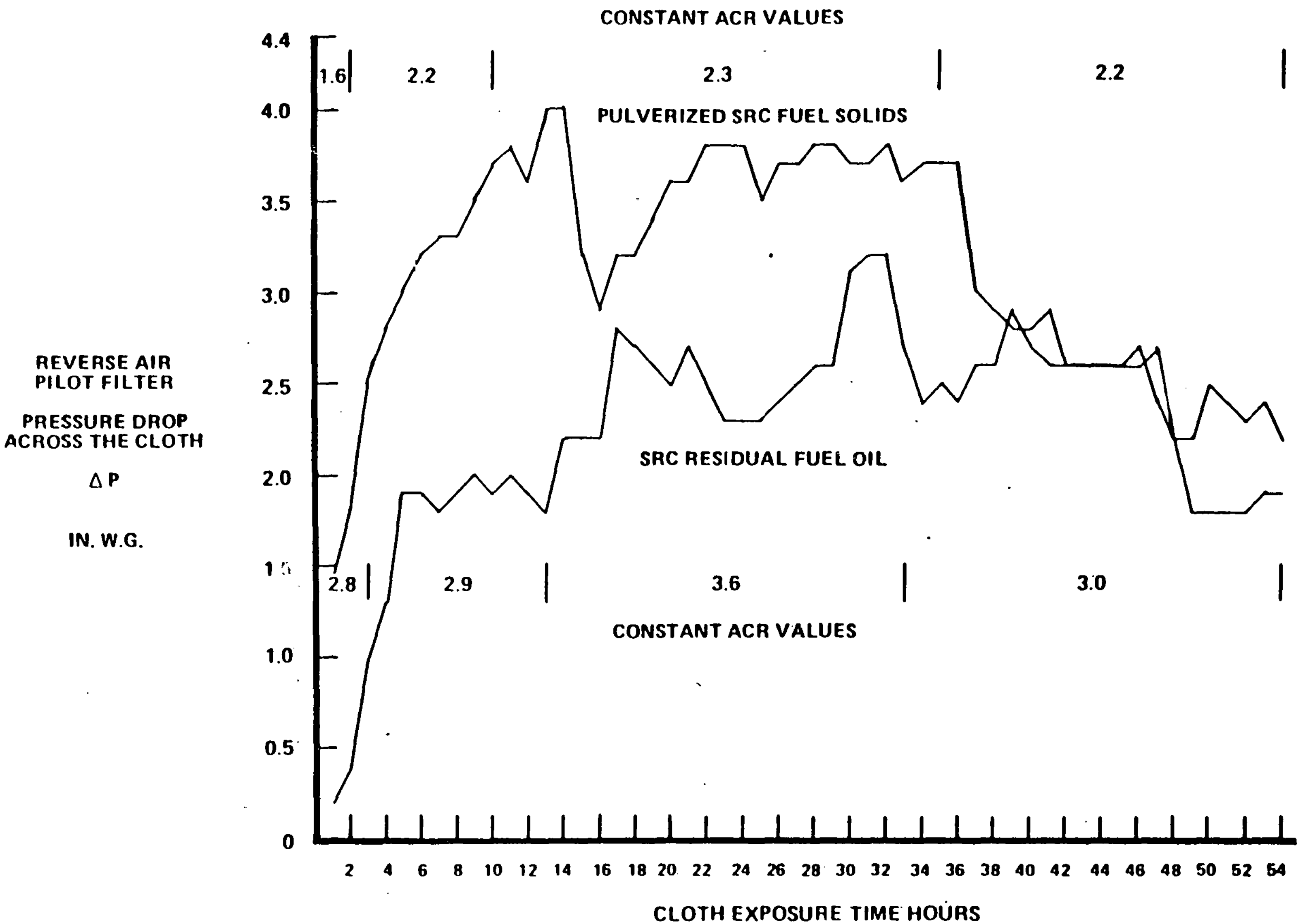
Graph 18

HOURLY VARIATION OF AIR TO CLOTH RATIO



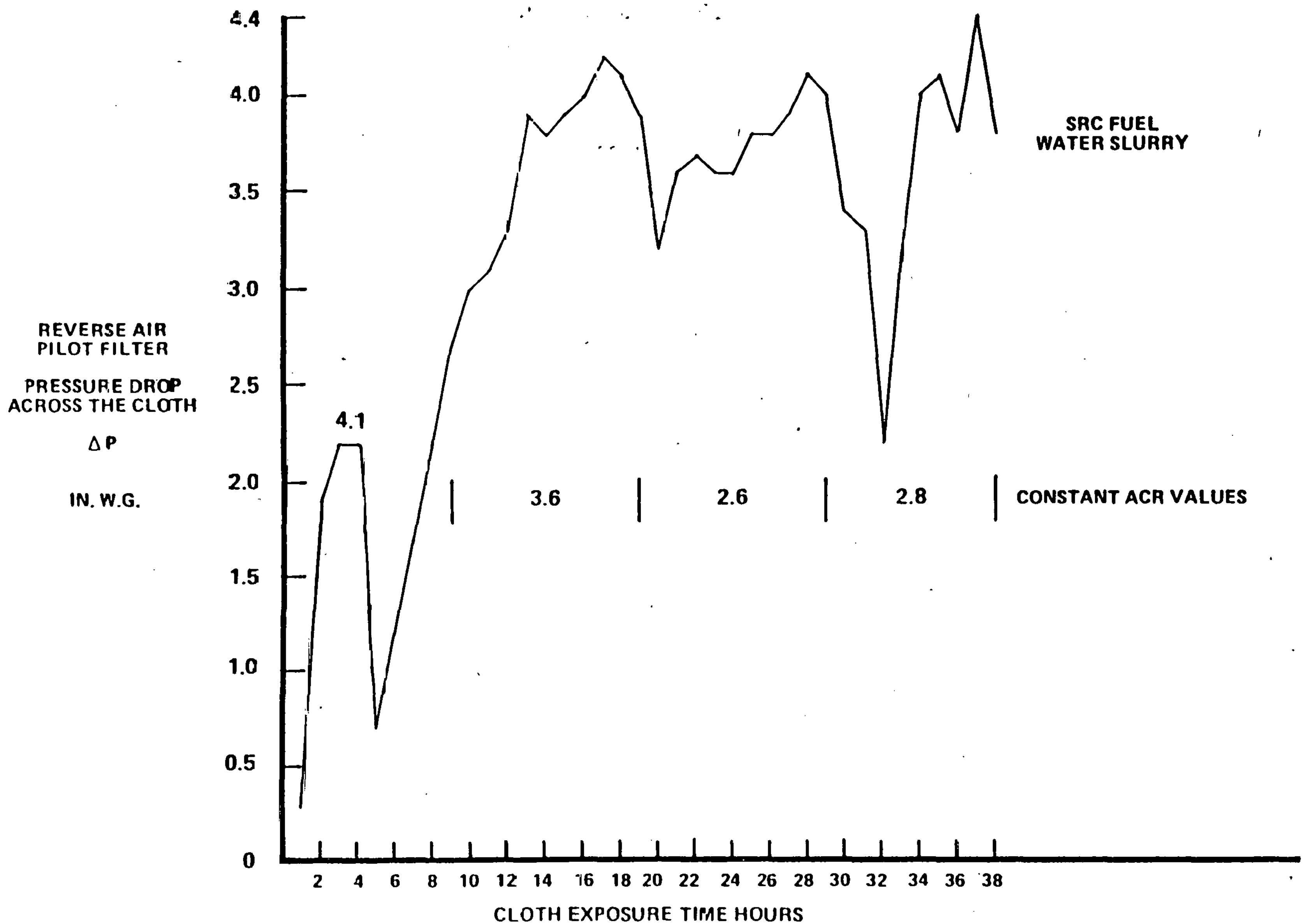
Graph 19

HOURLY VARIATION OF AIR TO CLOTH RATIO



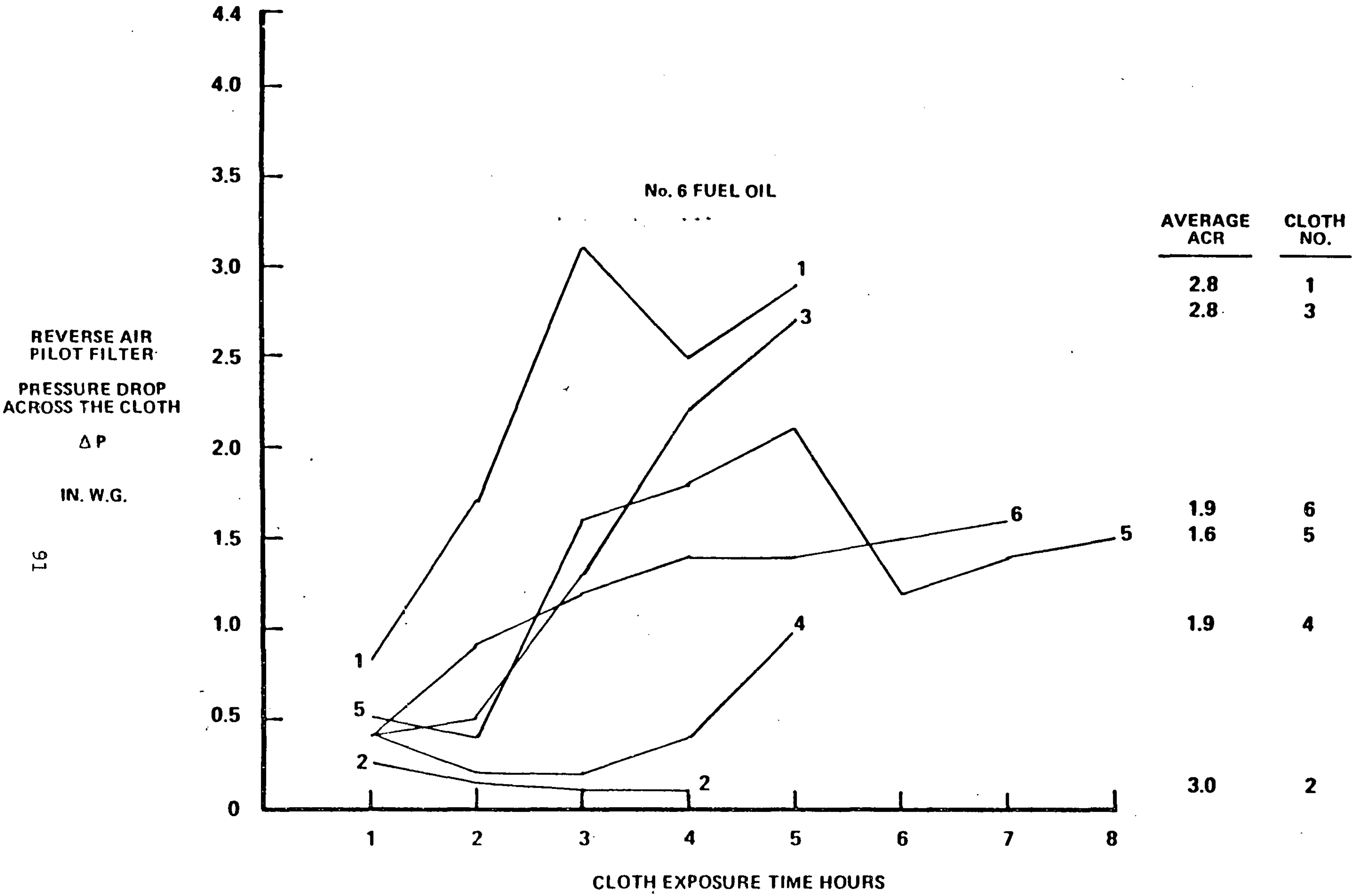
Graph 20

HOURLY VARIATION OF PRESSURE DROP



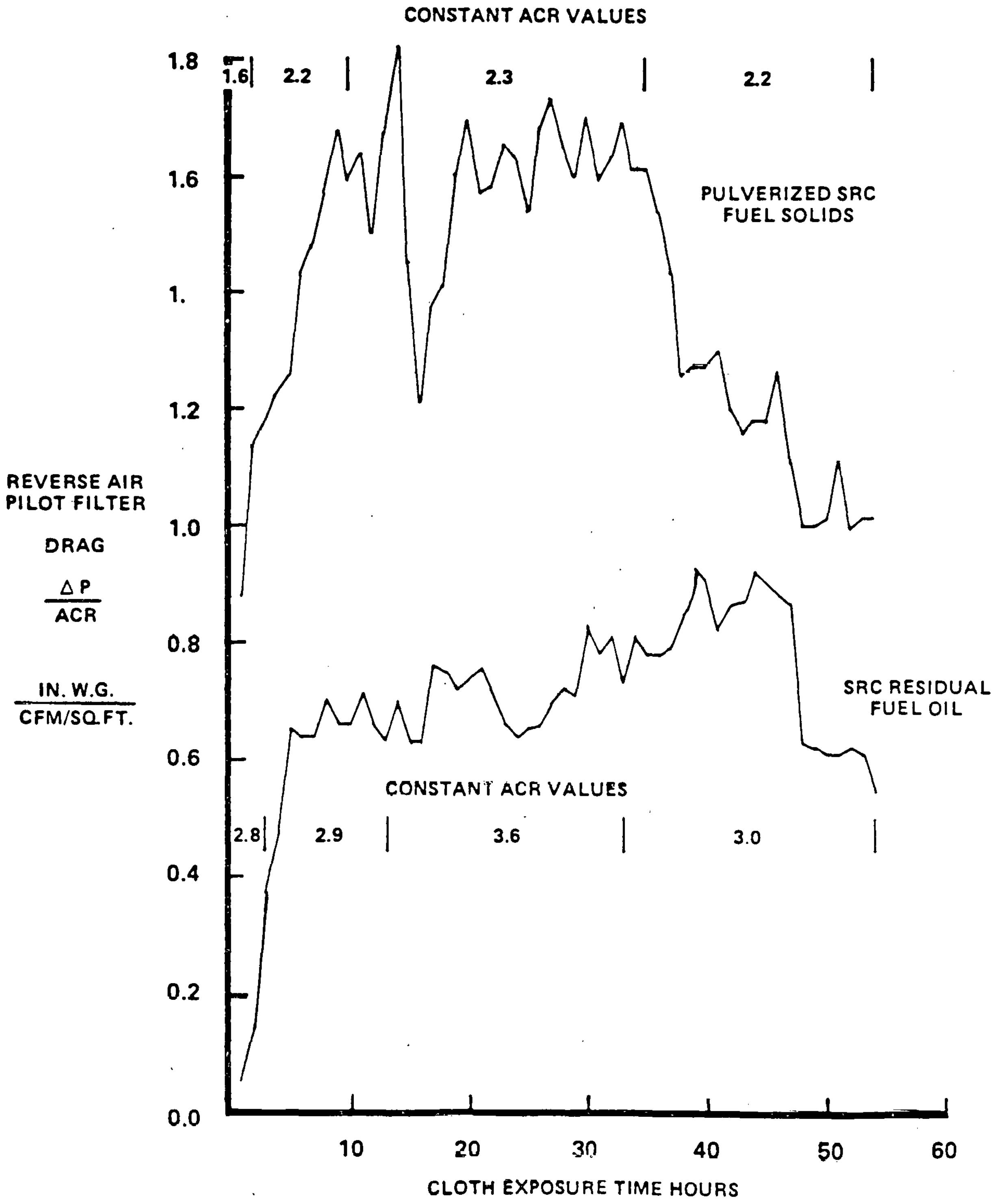
Graph 21

HOURLY VARIATION OF PRESSURE DROP



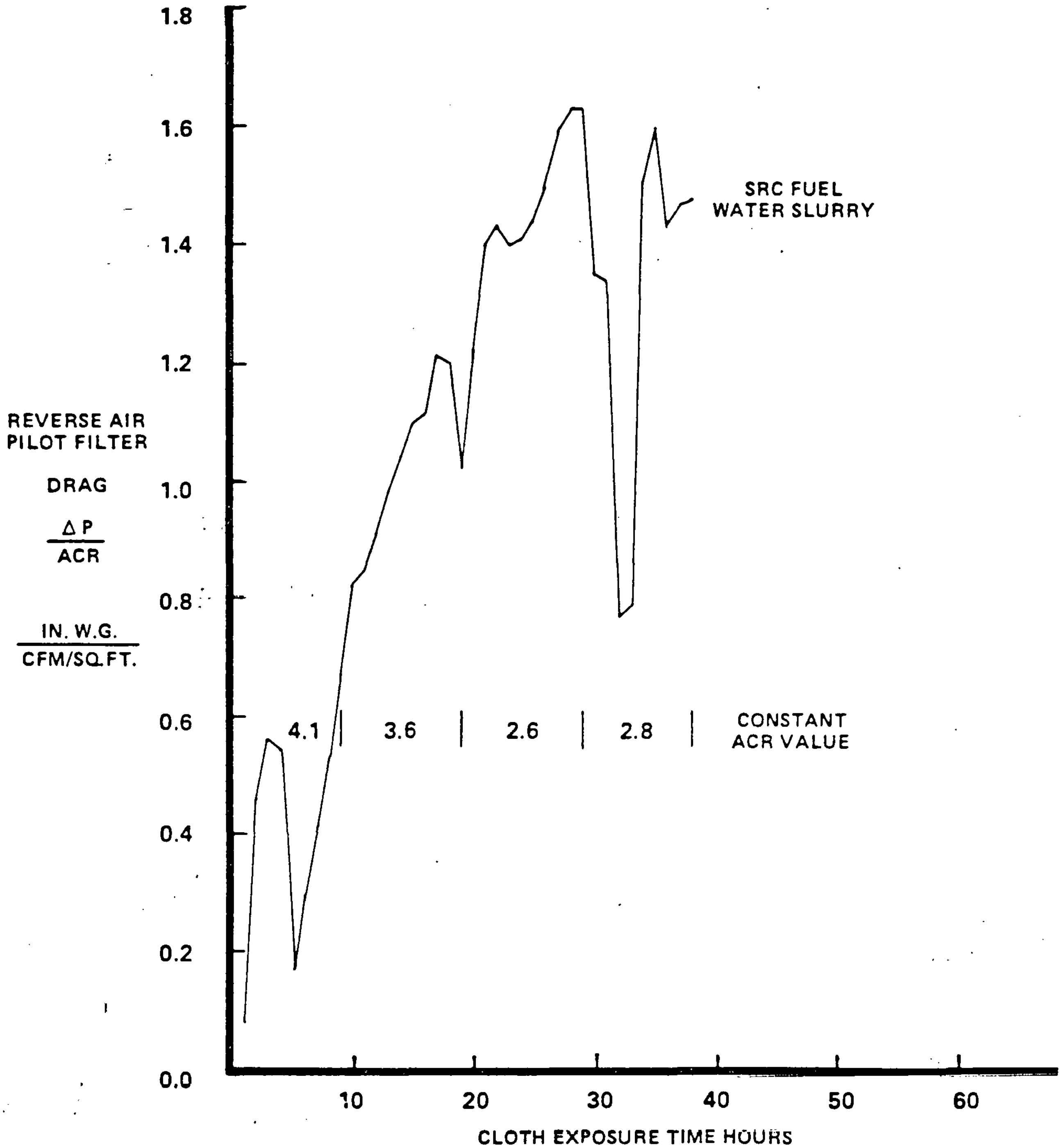
Graph 22

HOURLY VARIATION OF PRESSURE DROP



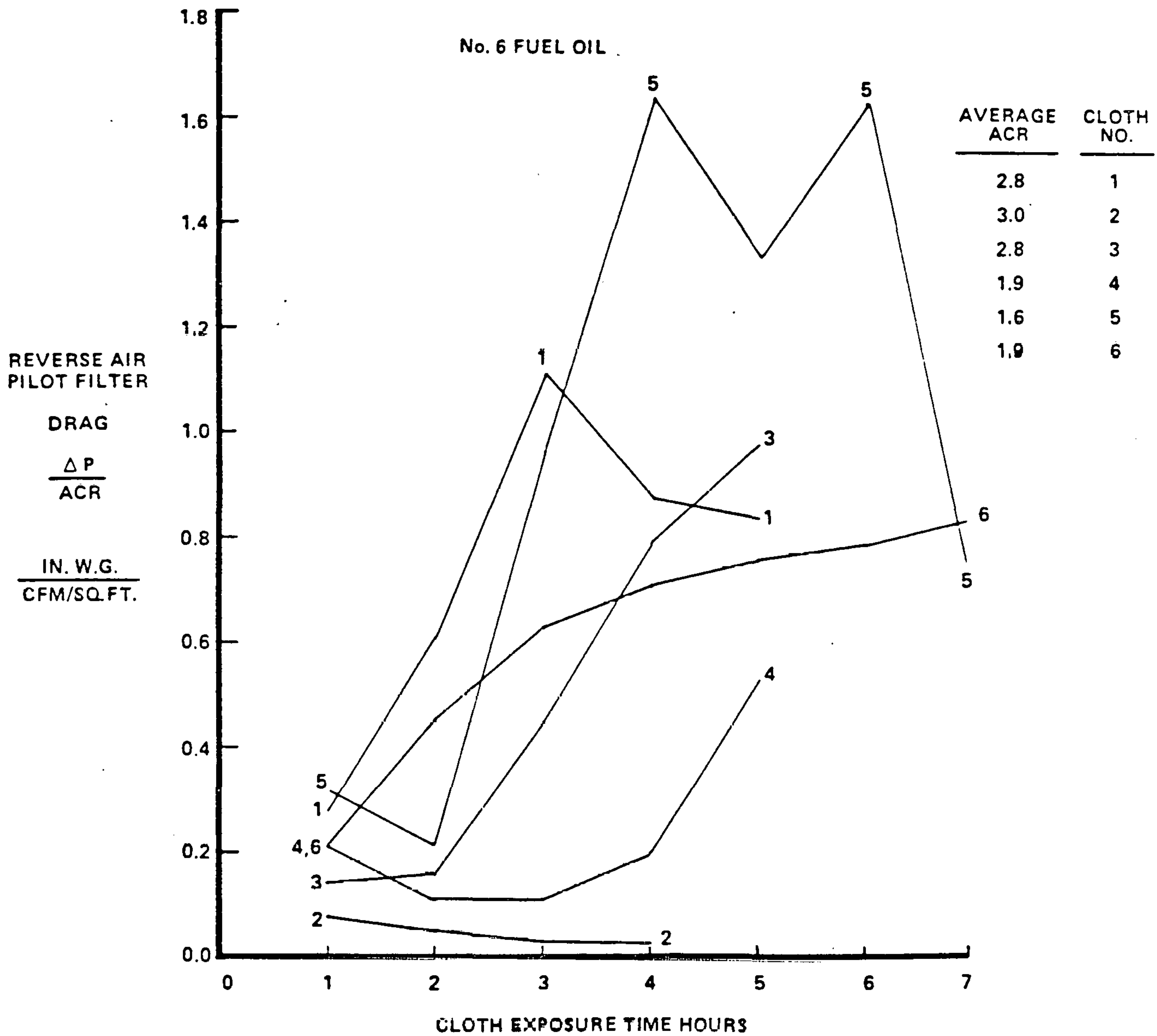
Graph 23

HOURLY VARIATION OF FILTER DRAG



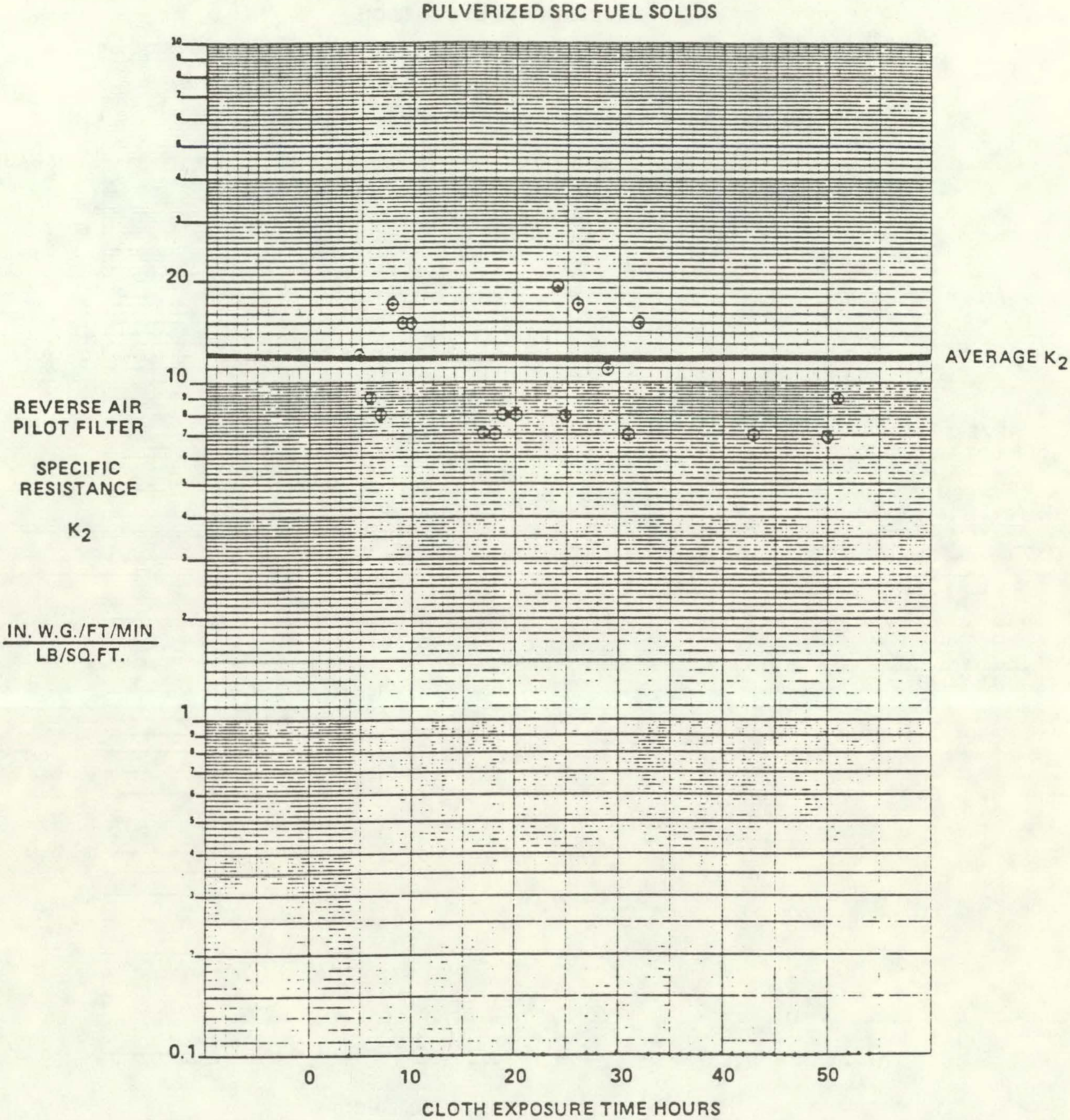
Graph 24

HOURLY VARIATION OF FILTER DRAG



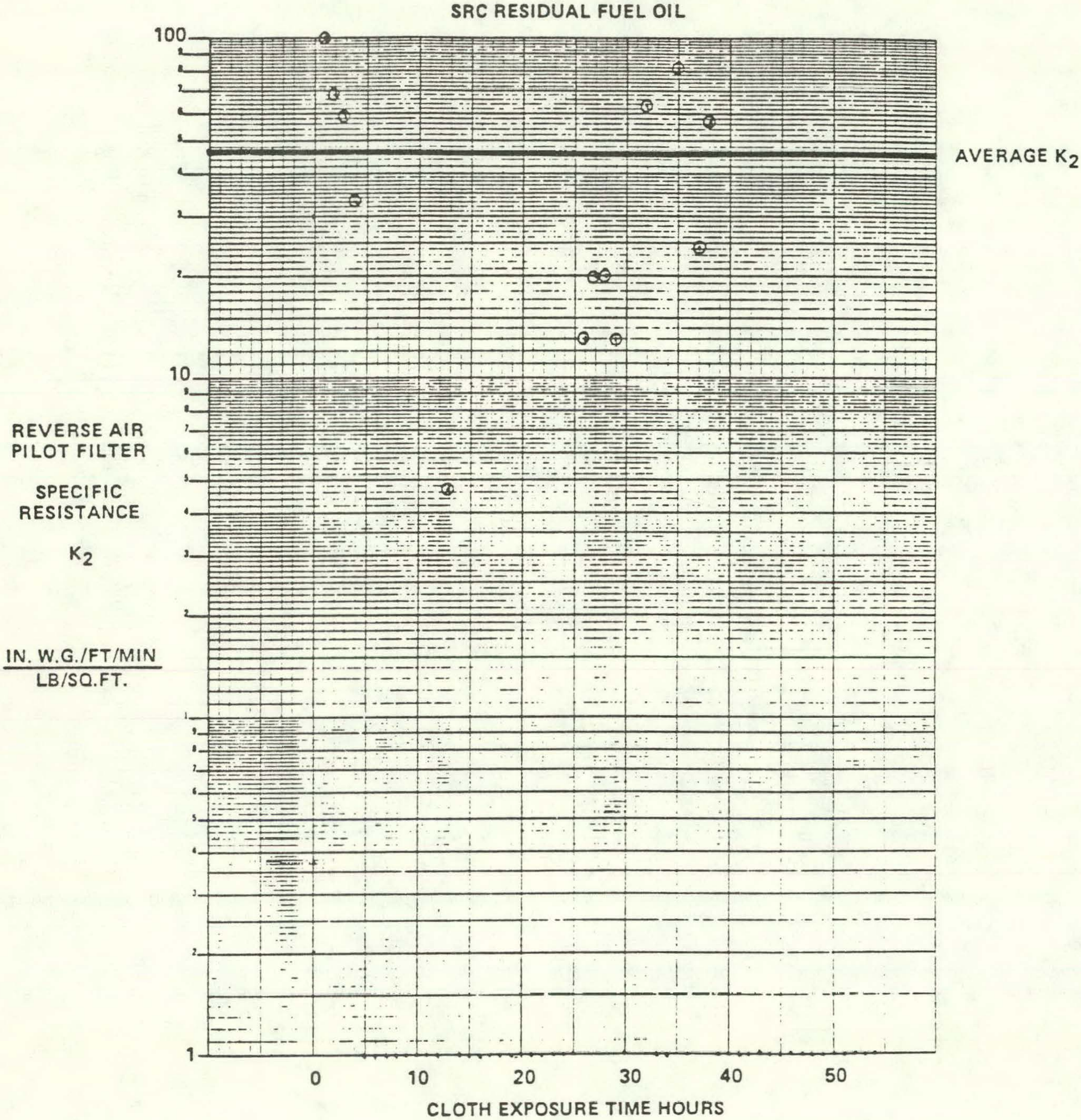
Graph 25

HOURLY VARIATION OF FILTER DRAG



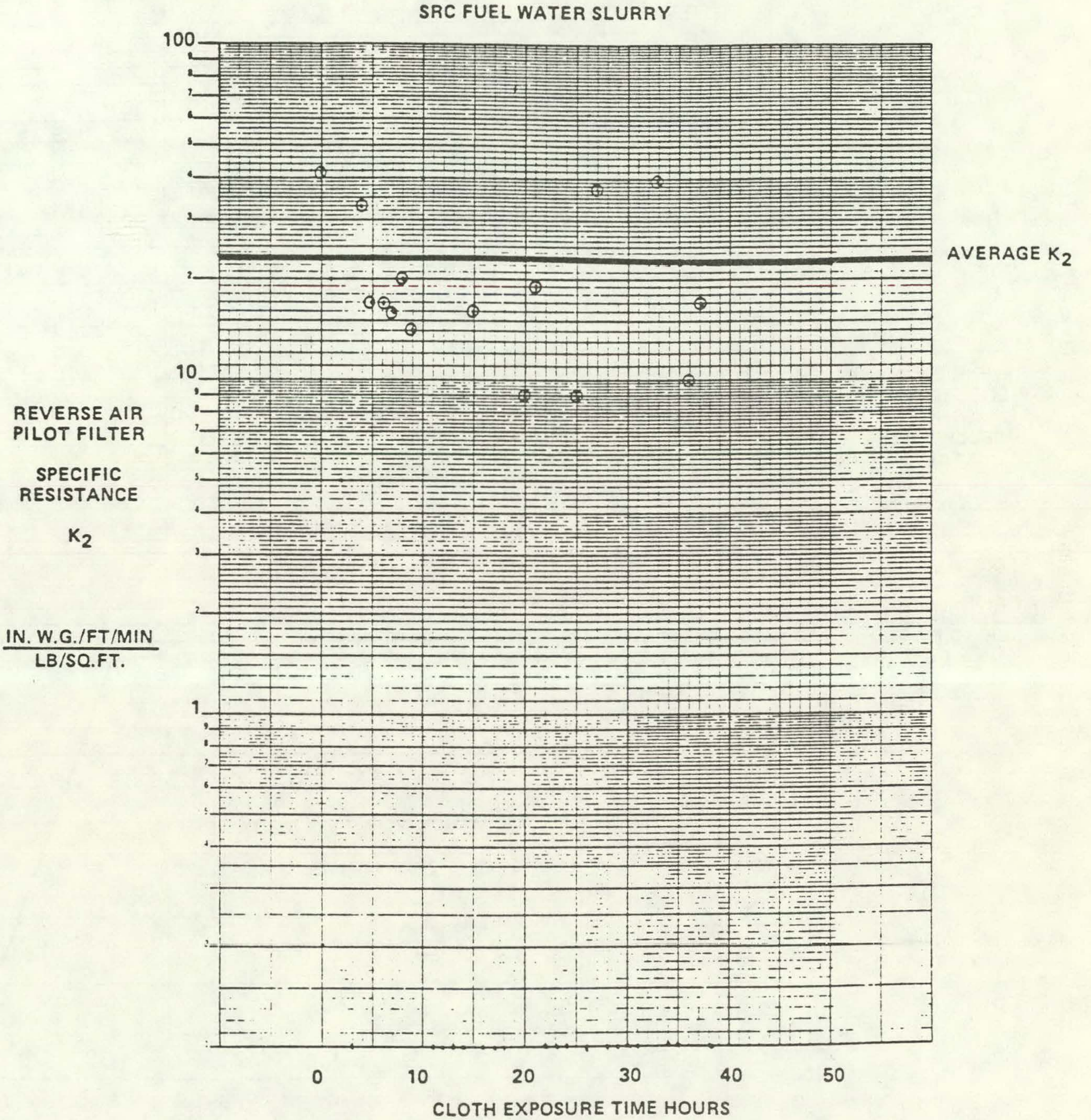
Graph 26

HOURLY VARIATION OF FILTER SPECIFIC RESISTANCE



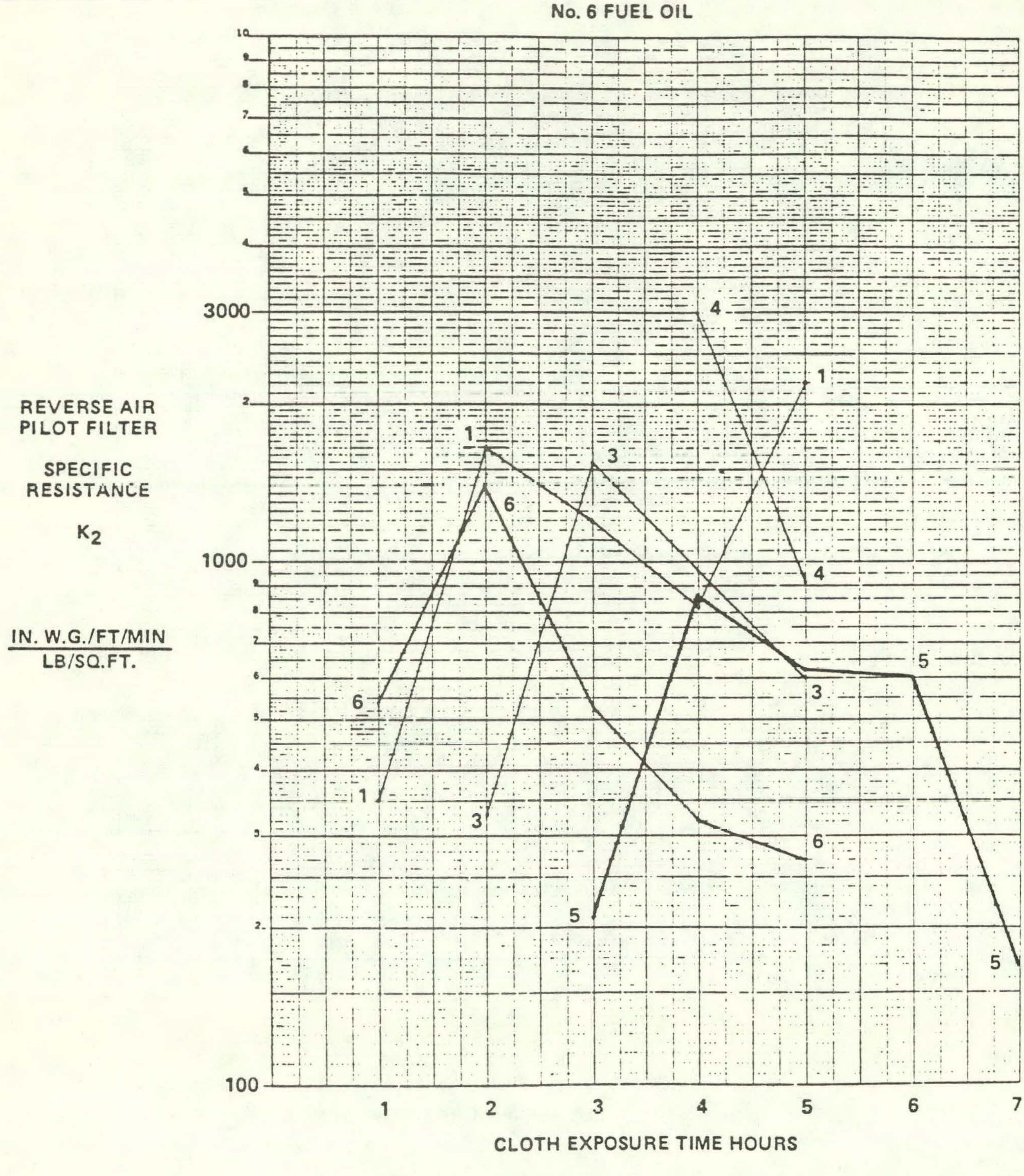
Graph 27

HOURLY VARIATION OF FILTER SPECIFIC RESISTANCE



Graph 28

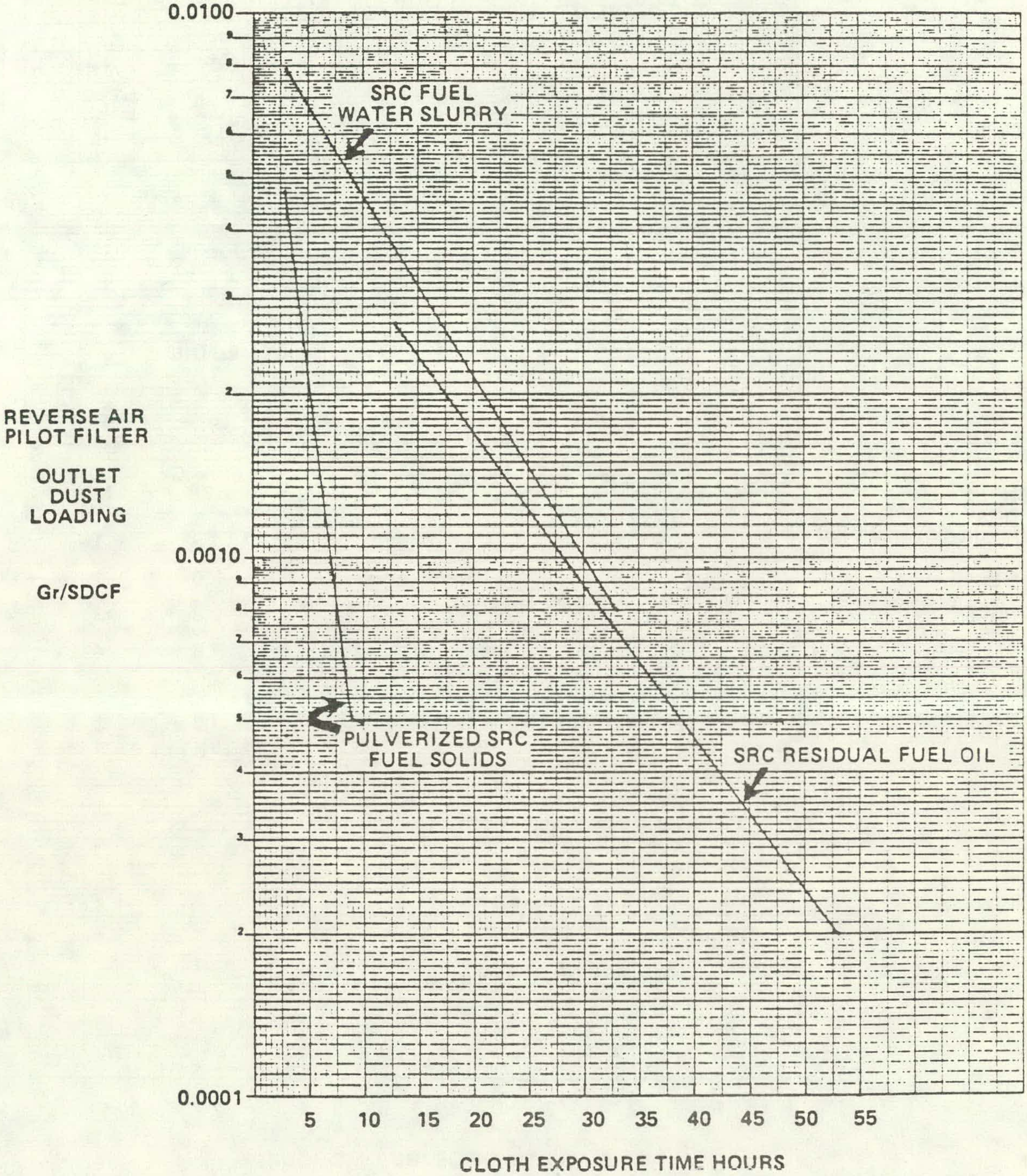
HOURLY VARIATION OF FILTER SPECIFIC RESISTANCE



NOTE: Each of the Six Curves is Identified by it's Filter Cloth Number.

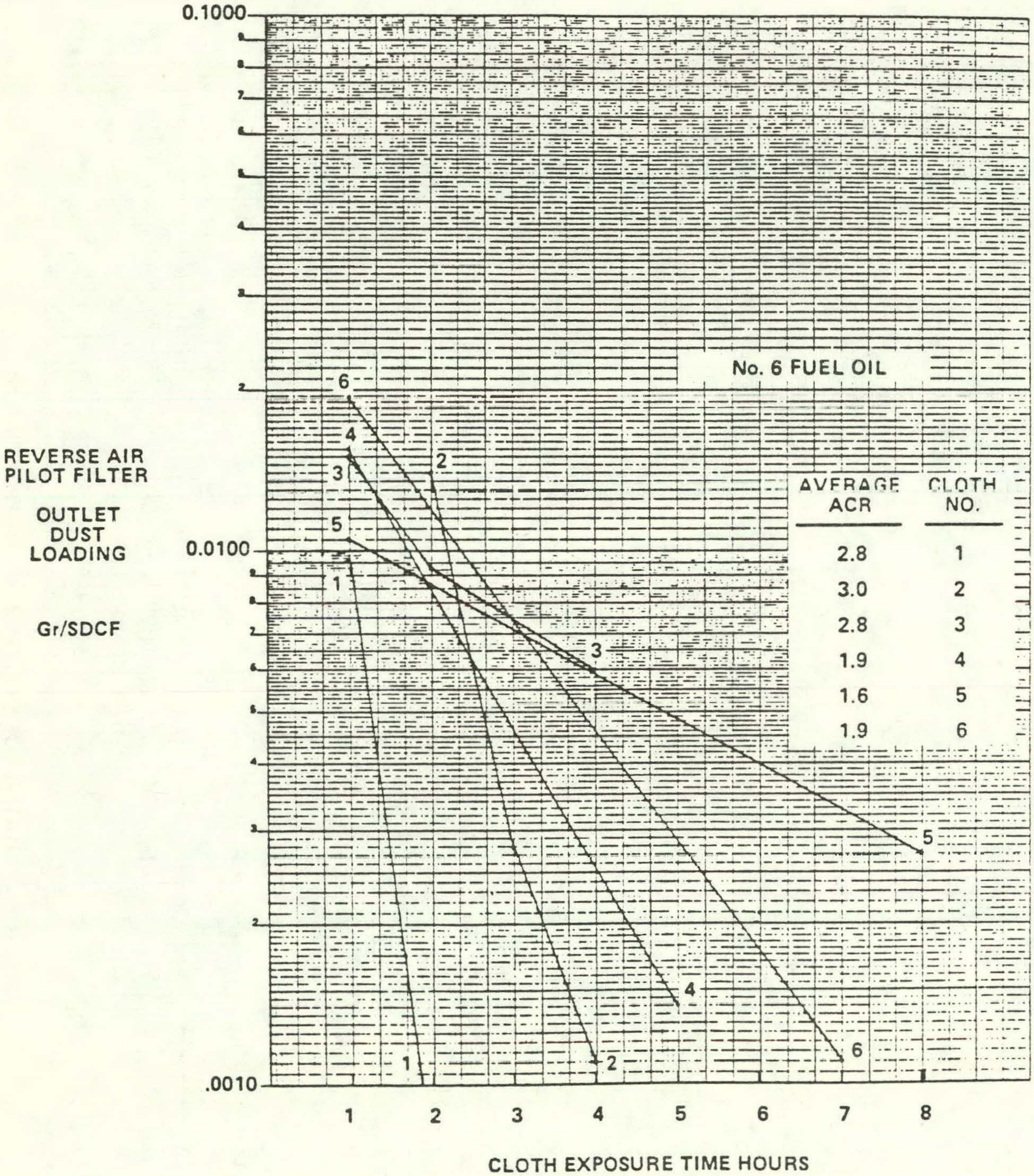
Graph 29

HOURLY VARIATION OF FILTER SPECIFIC RESISTANCE



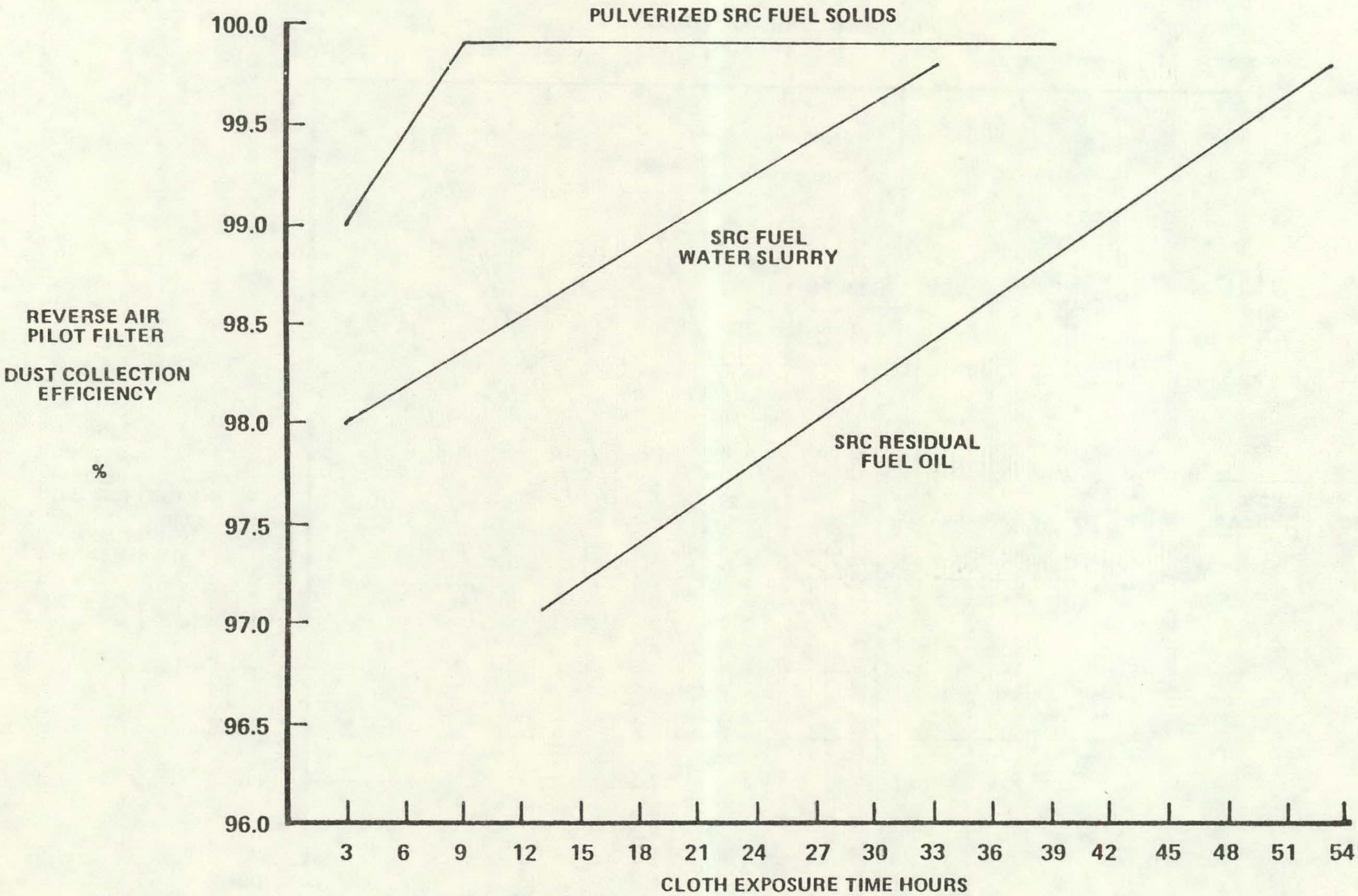
Graph 30

HOURLY VARIATION OF OUTLET DUST LOADING



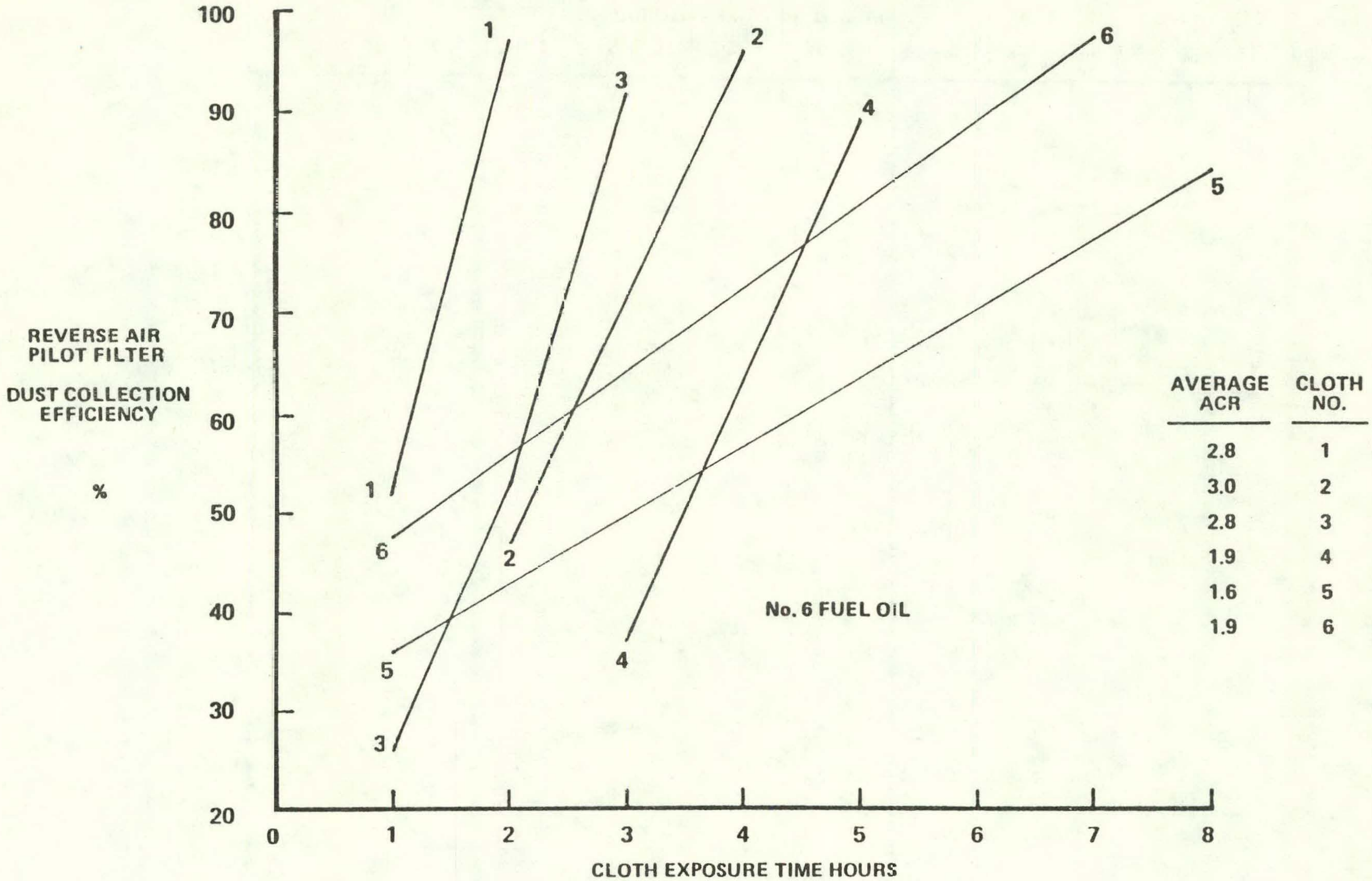
Graph 31

HOURLY VARIATION OF OUTLET DUST LOADING



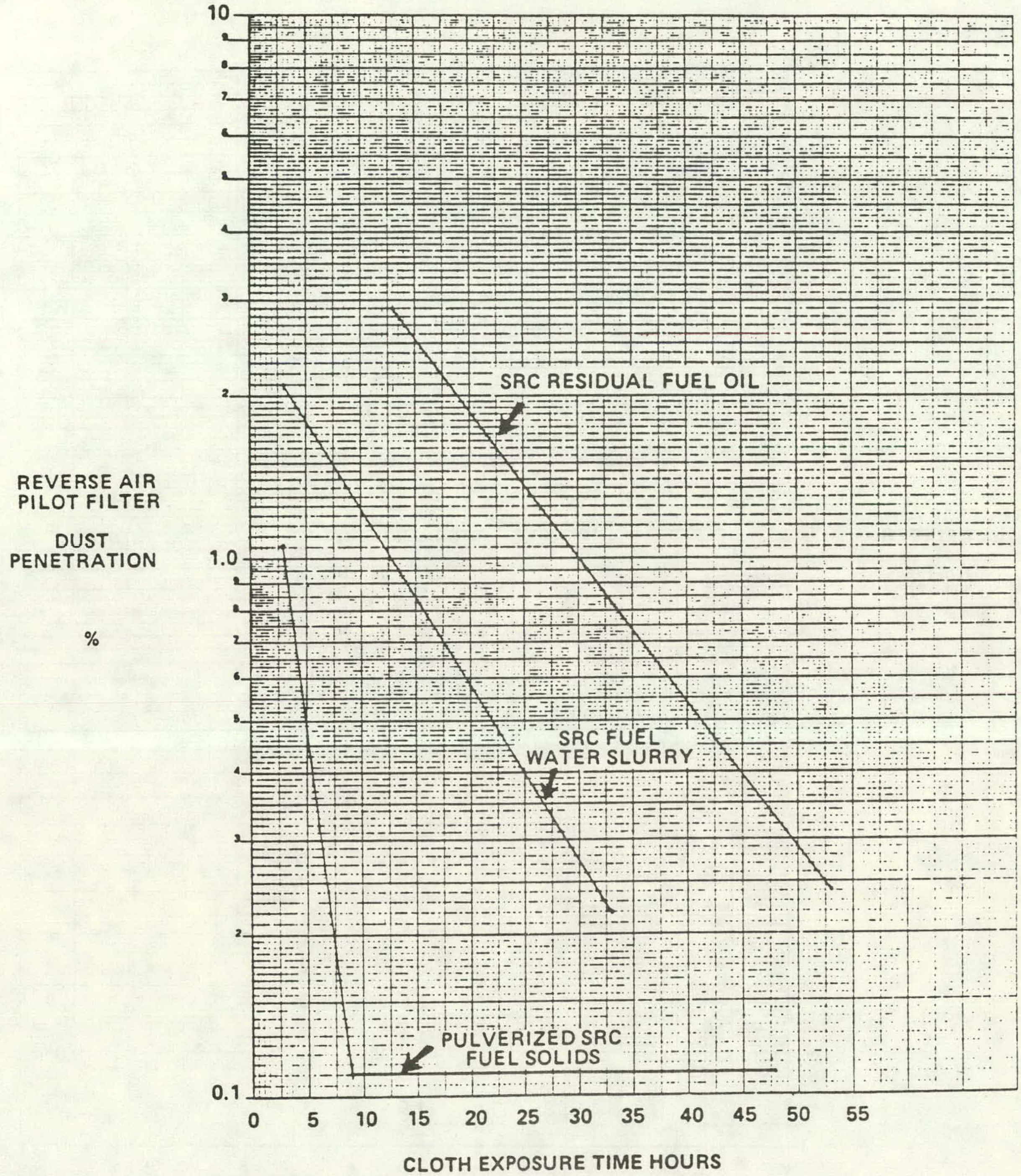
Graph 32

HOURLY VARIATION OF DUST COLLECTION EFFICIENCY



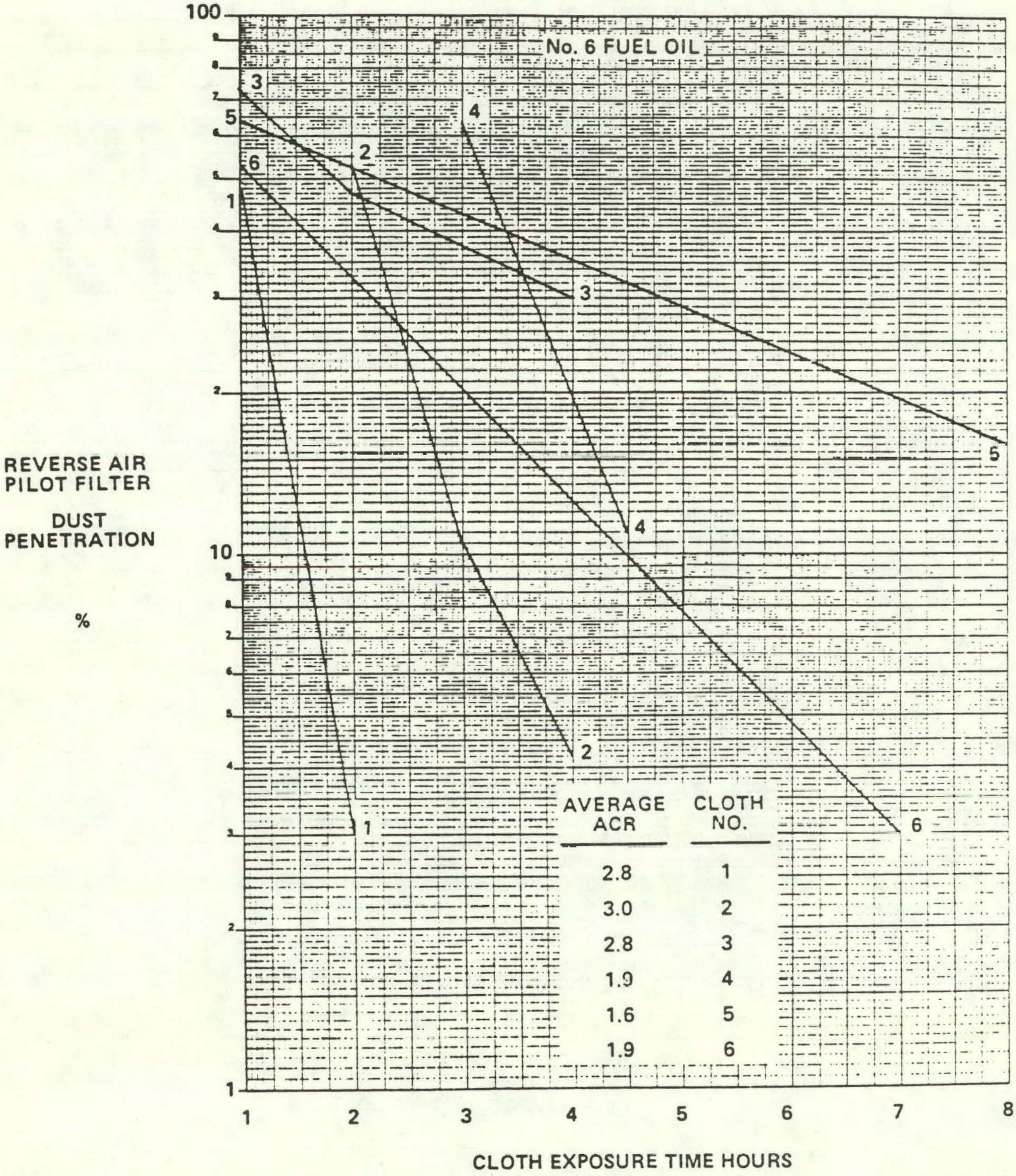
Graph 33

HOURLY VARIATION OF DUST COLLECTION EFFICIENCY



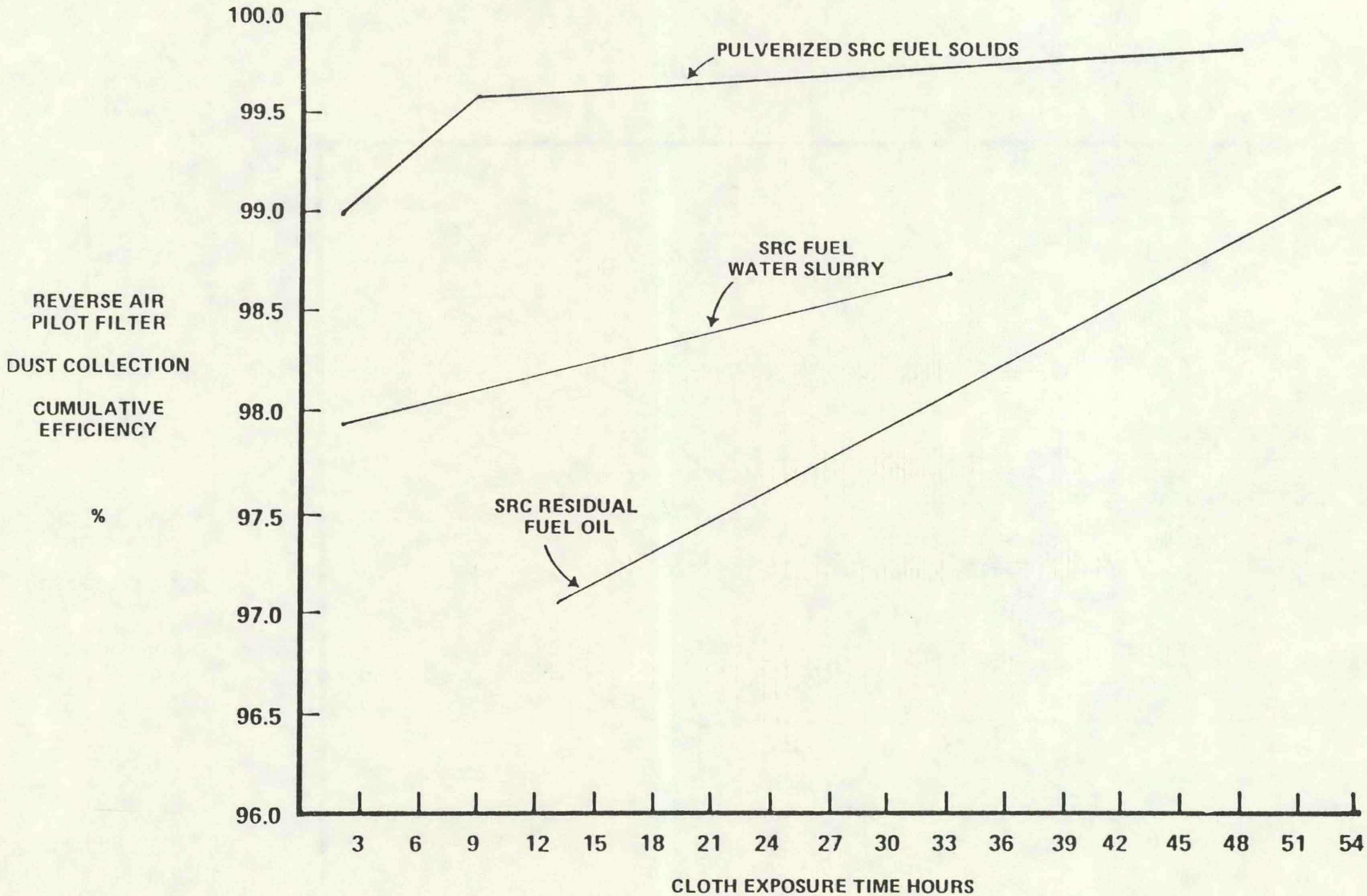
Graph 34

HOURLY VARIATION OF DUST PENETRATION



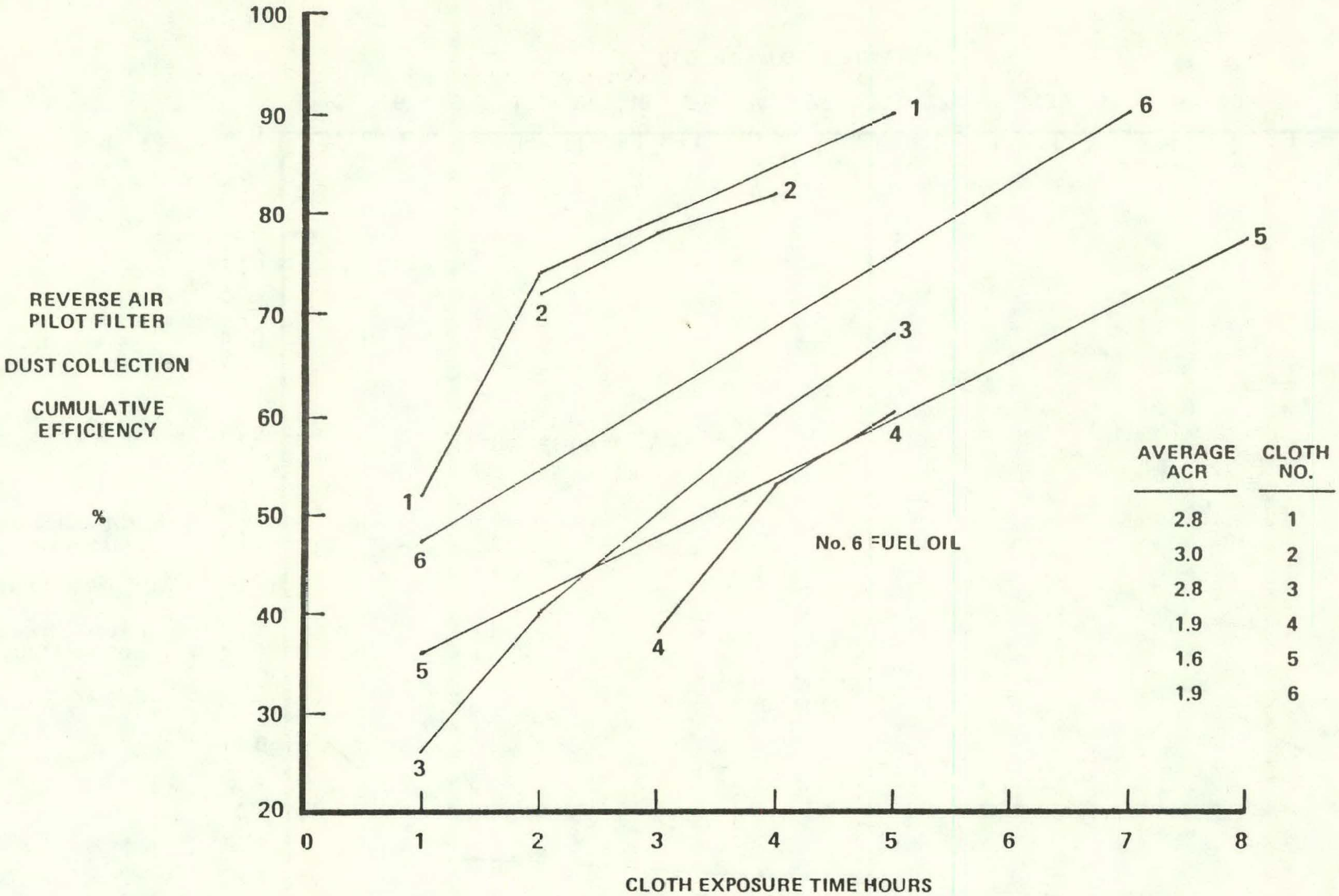
Graph 35

HOURLY VARIATION OF DUST PENETRATION



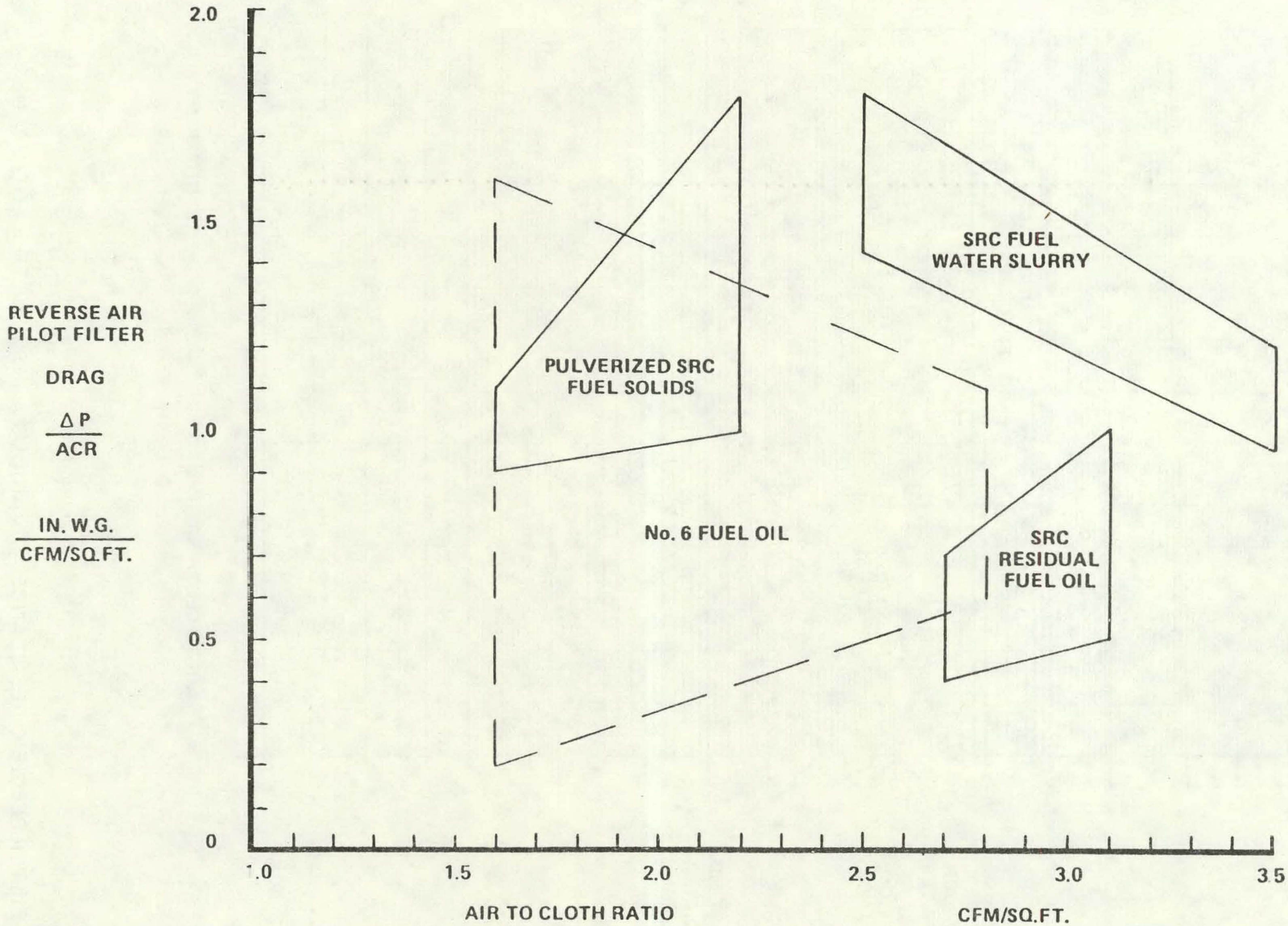
Graph 36

HOURLY VARIATION OF CUMULATIVE EFFICIENCY



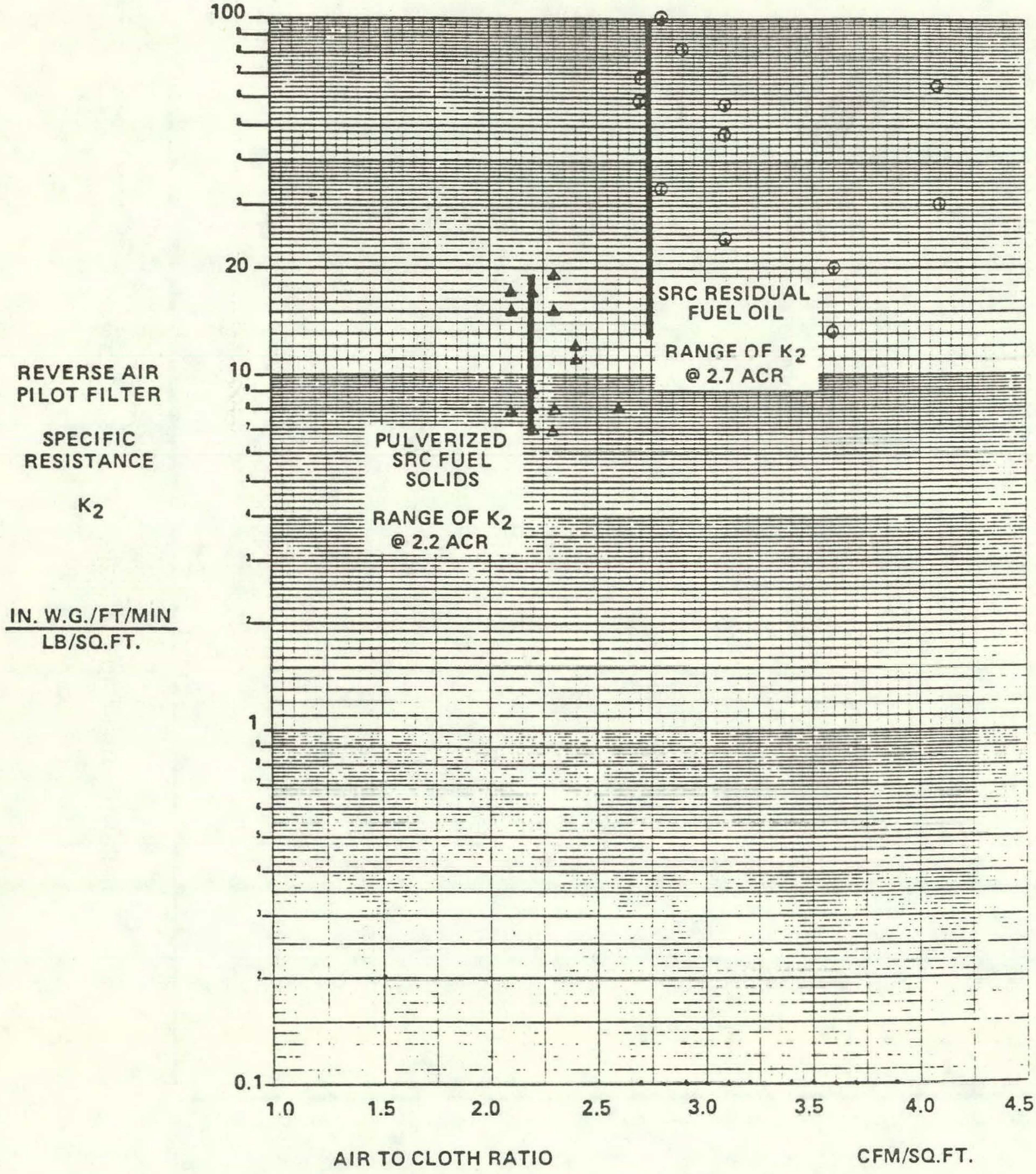
Graph 37

HOURLY VARIATION OF CUMULATIVE EFFICIENCY



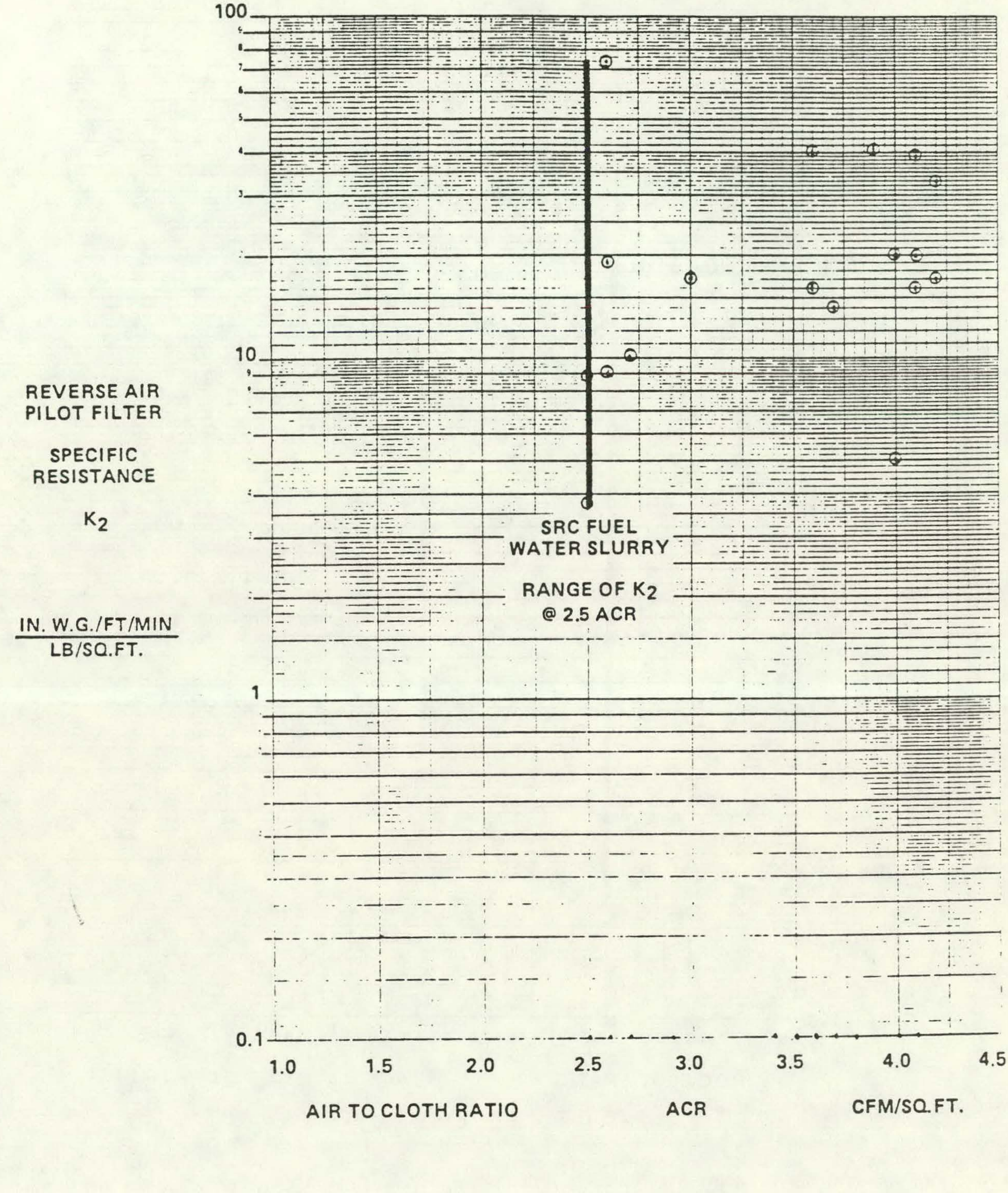
Graph 38

FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



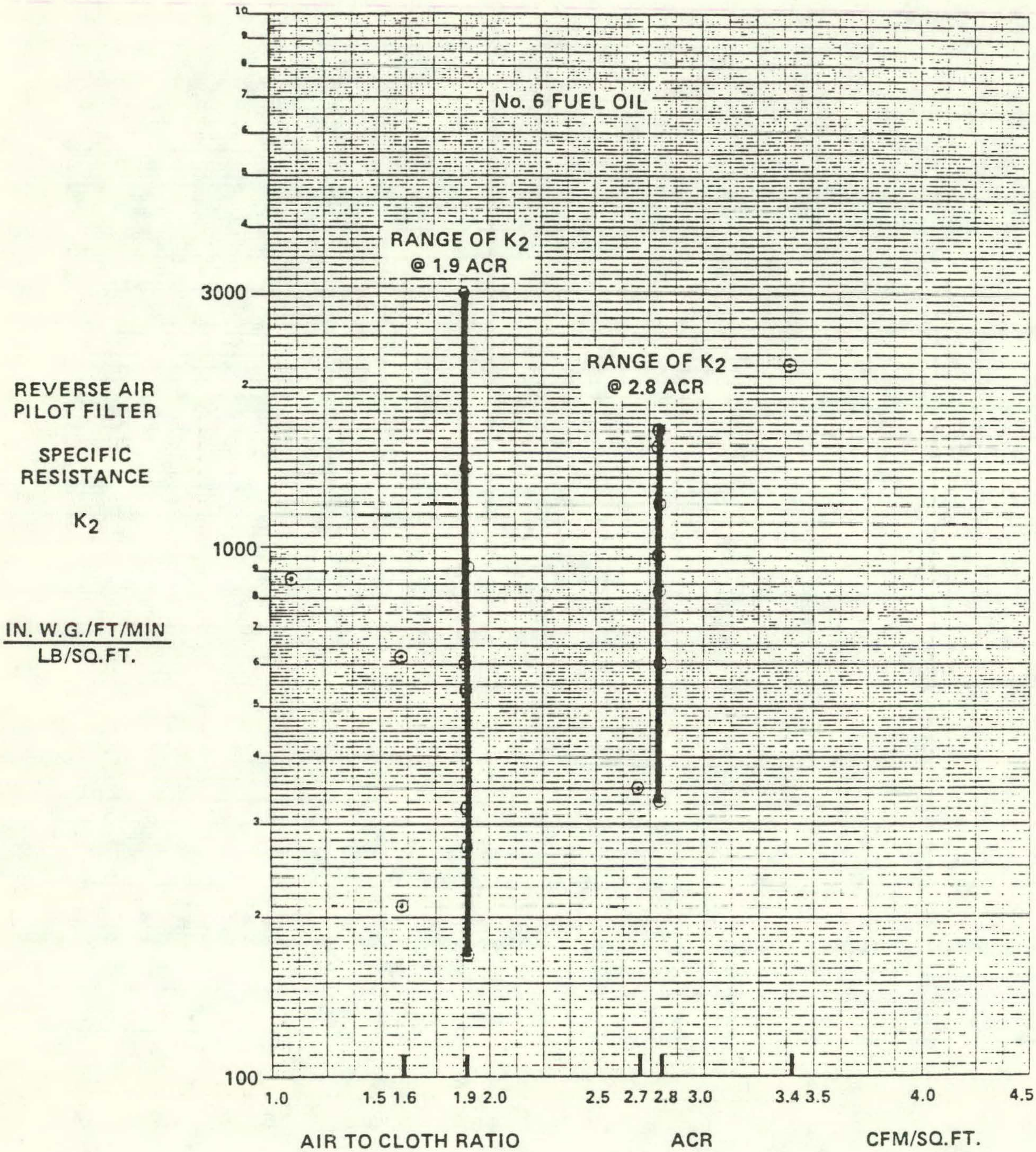
Graph 39

FILTER SPECIFIC RESISTANCE AT VARIOUS AIR TO CLOTH RATIO VALUES



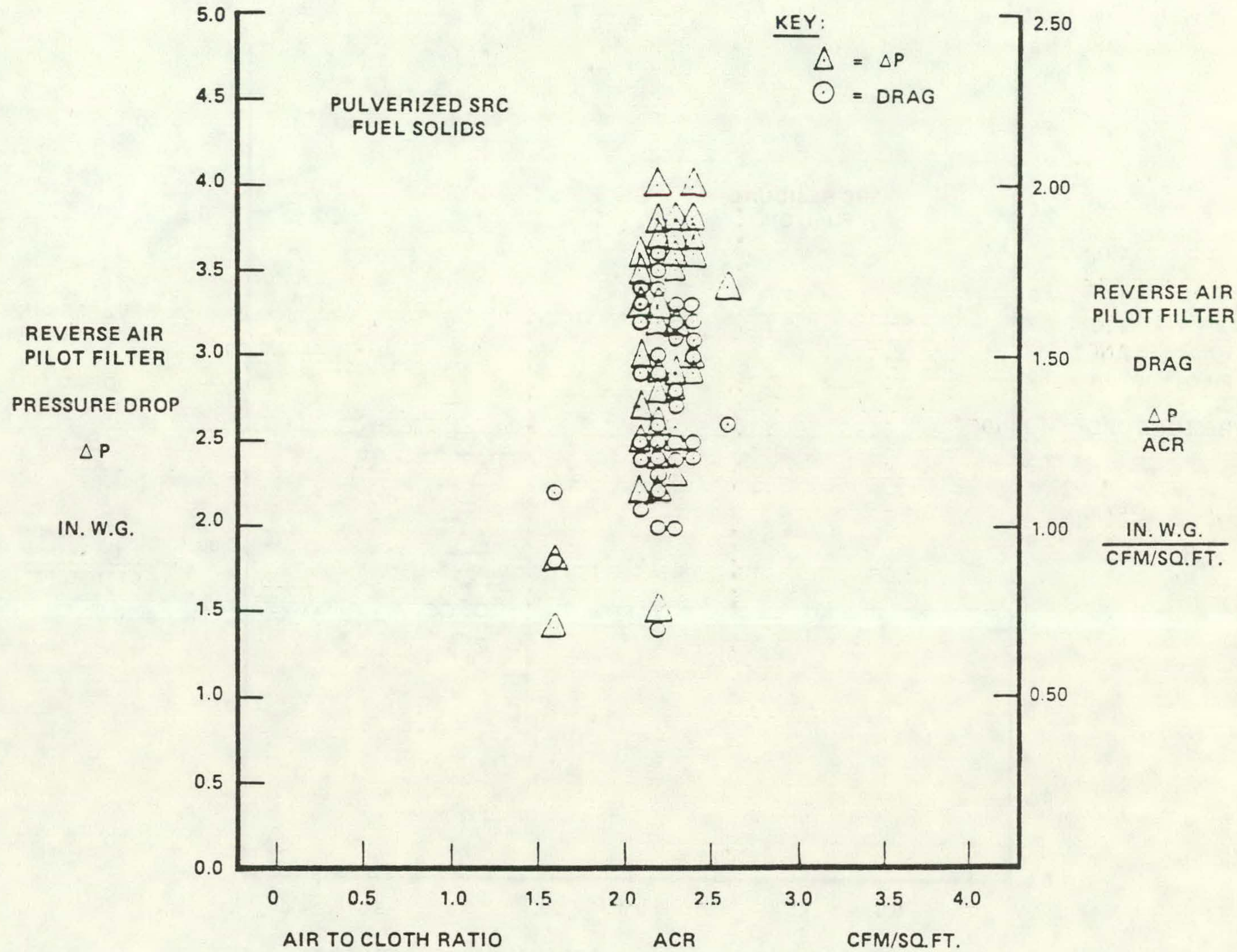
Graph 40

FILTER SPECIFIC RESISTANCE AT VARIOUS AIR TO CLOTH RATIO VALUES



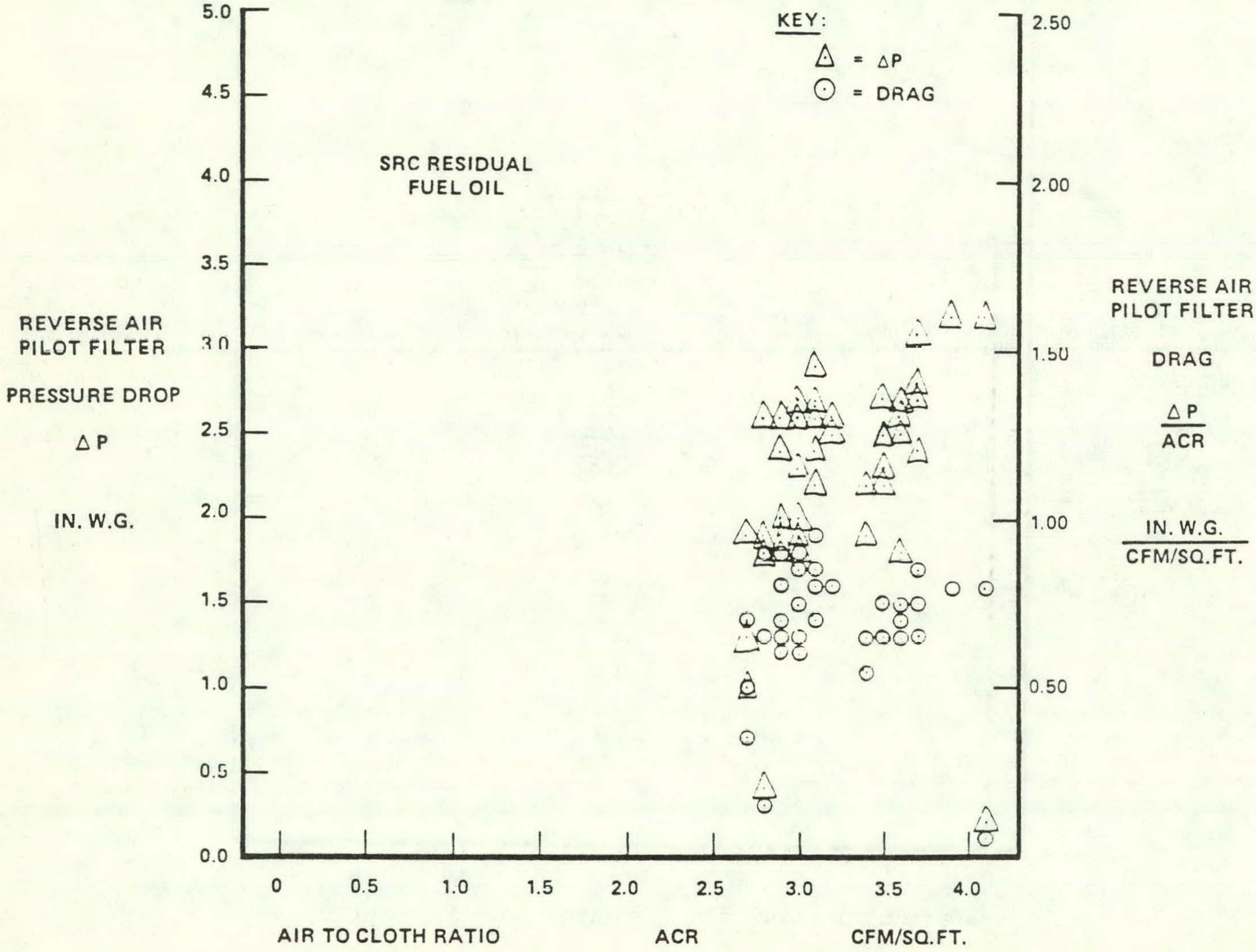
Graph 41

FILTER SPECIFIC RESISTANCE AT VARIOUS AIR TO CLOTH RATIO VALUES



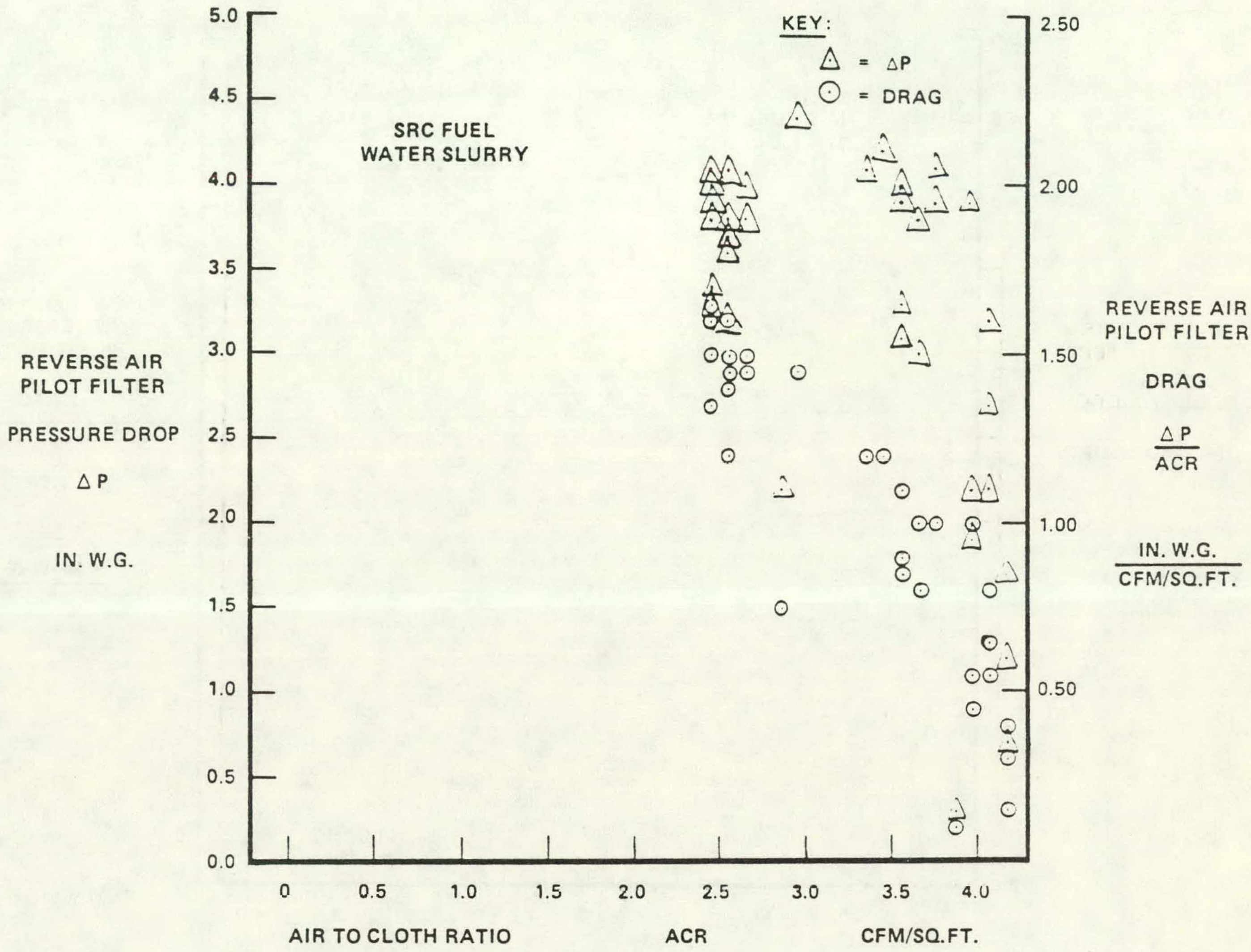
Graph 42

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



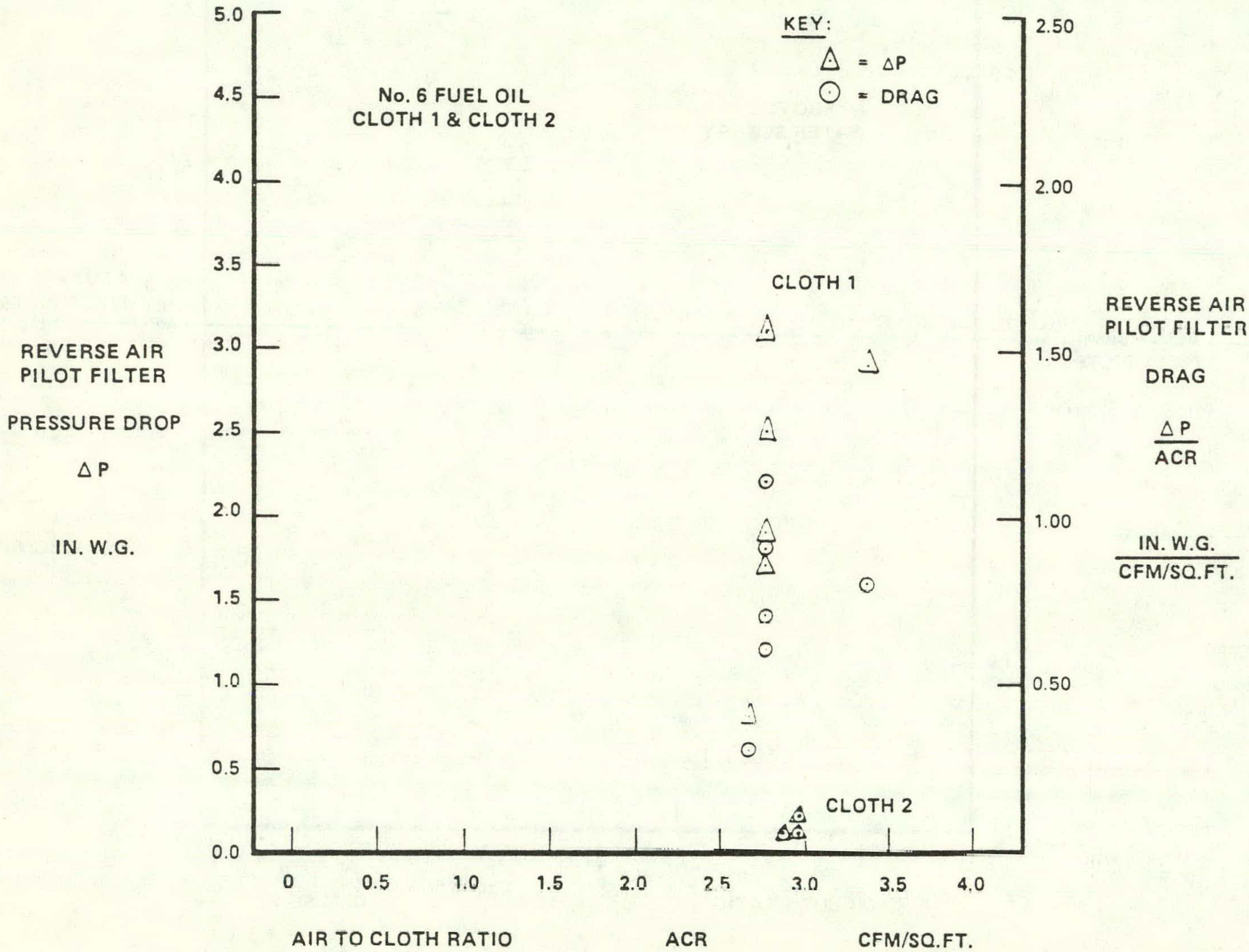
Graph 43

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



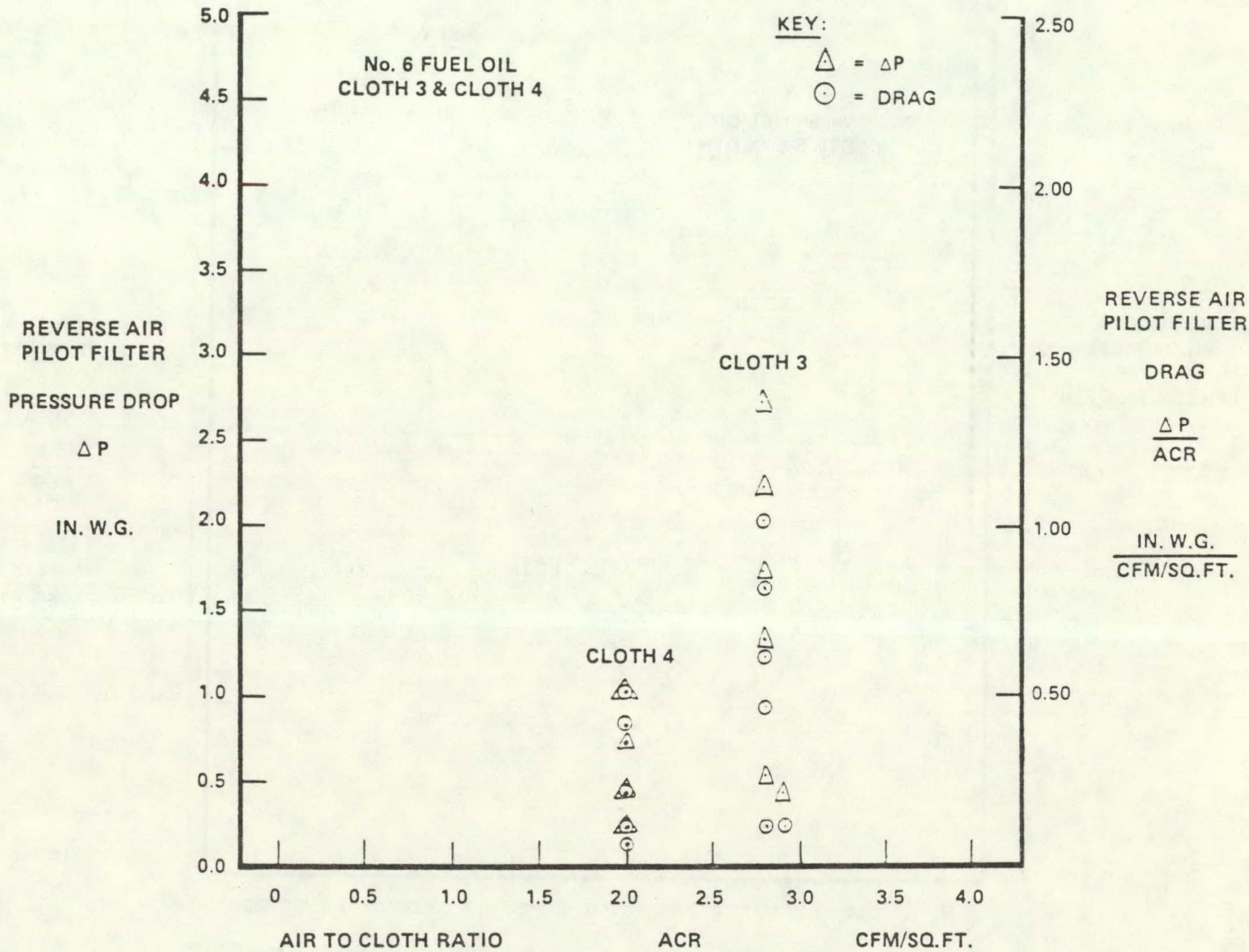
Graph 44

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



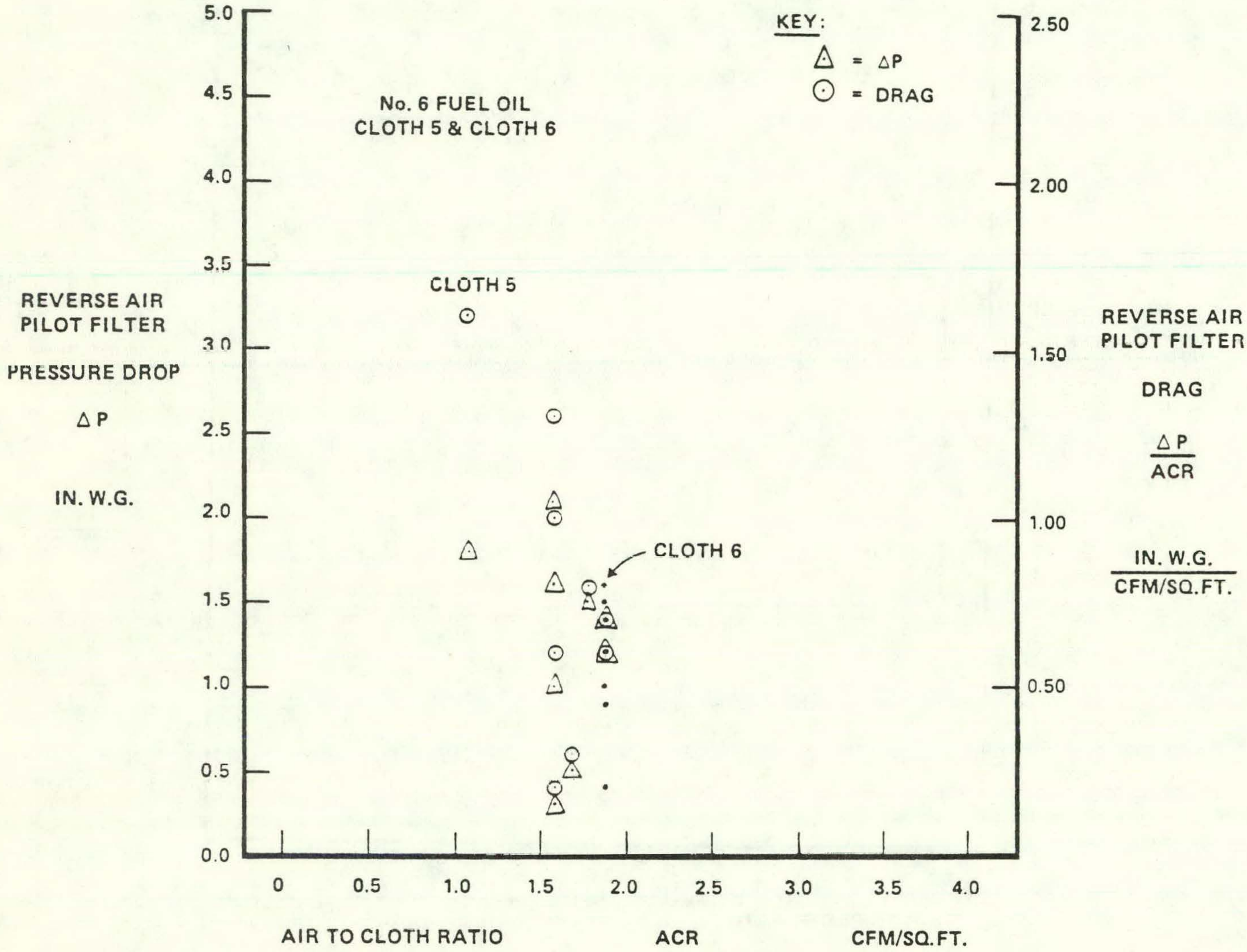
Graph 45

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



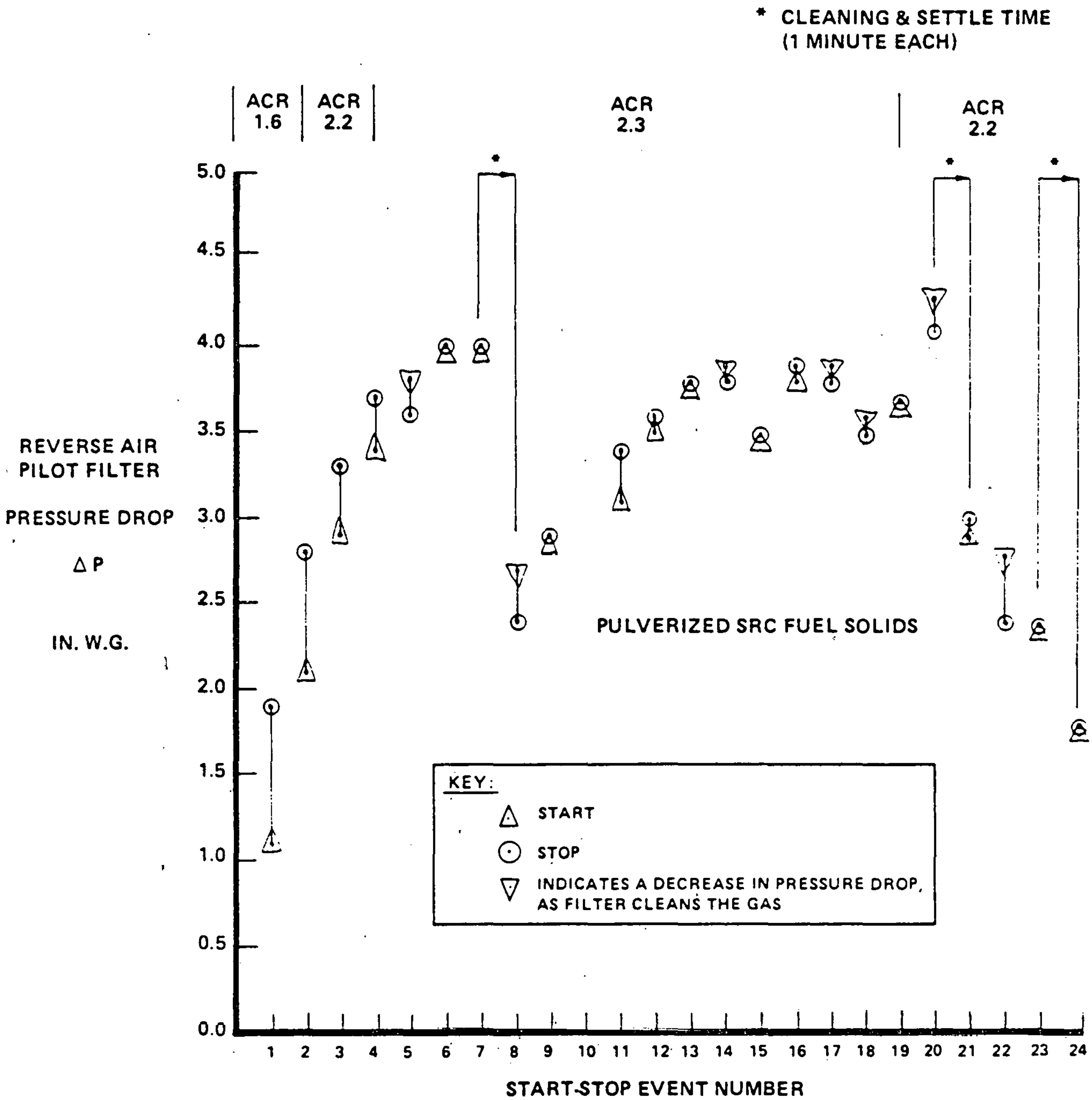
Graph 46

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



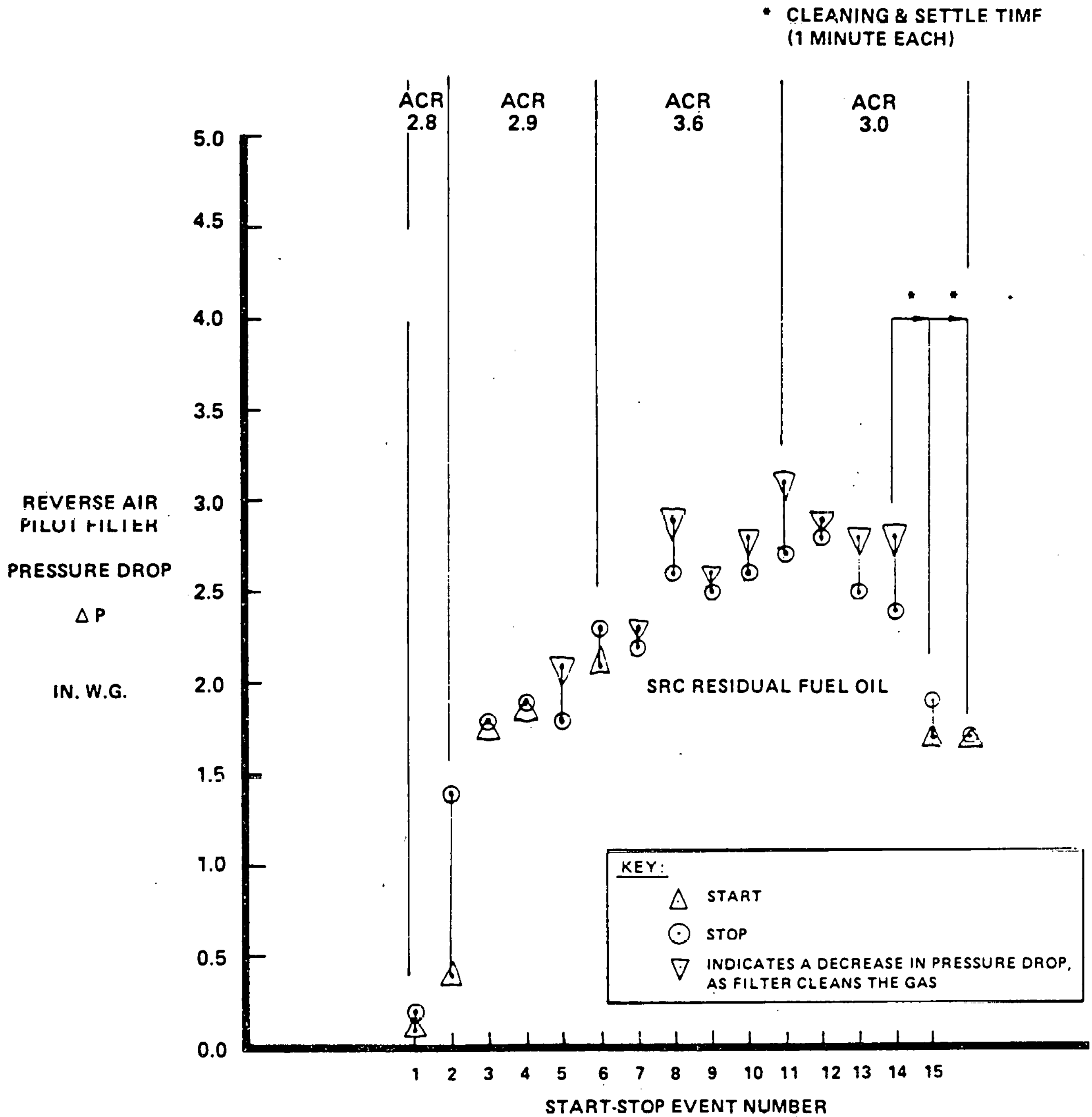
Graph 47

PRESSURE DROP & FILTER DRAG AT VARIOUS AIR TO CLOTH RATIO VALUES



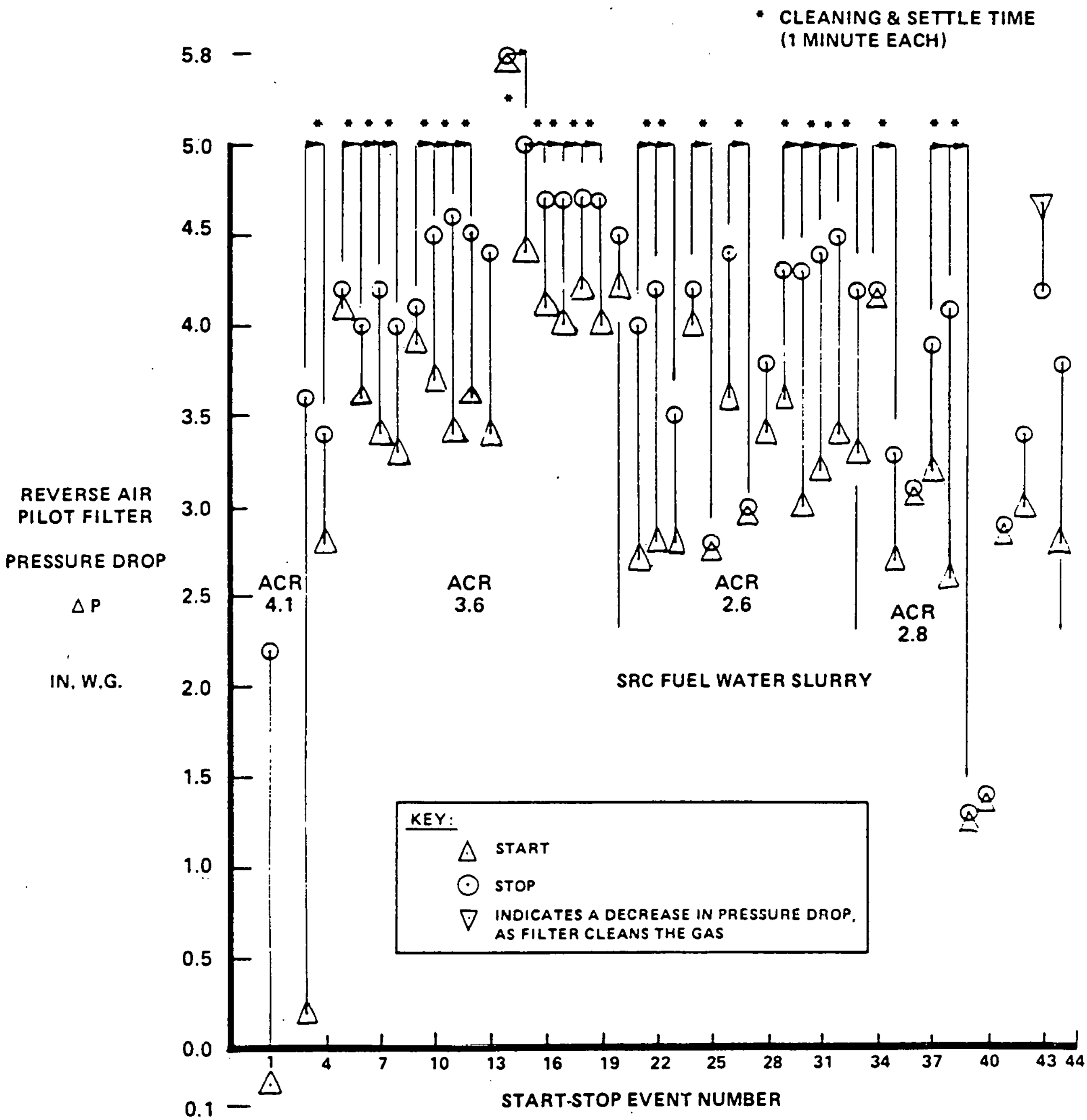
Graph 48

VARIATION OF PRESSURE DROP WHEN A FILTER GOES THROUGH A NUMBER OF START-STOP EVENTS



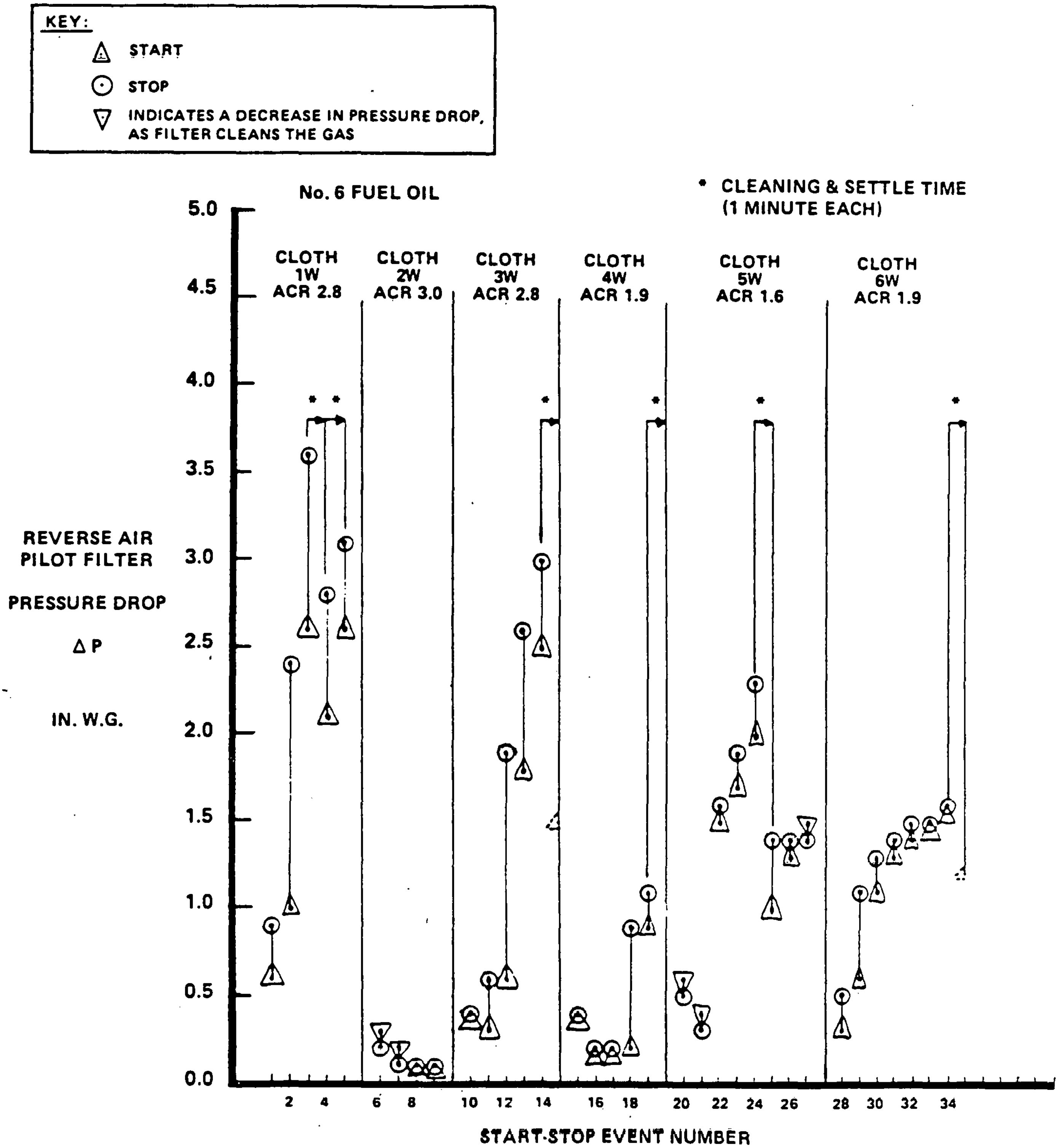
Graph 49

VARIATION OF PRESSURE DROP WHEN A FILTER GOES THROUGH A NUMBER OF START-STOP EVENTS



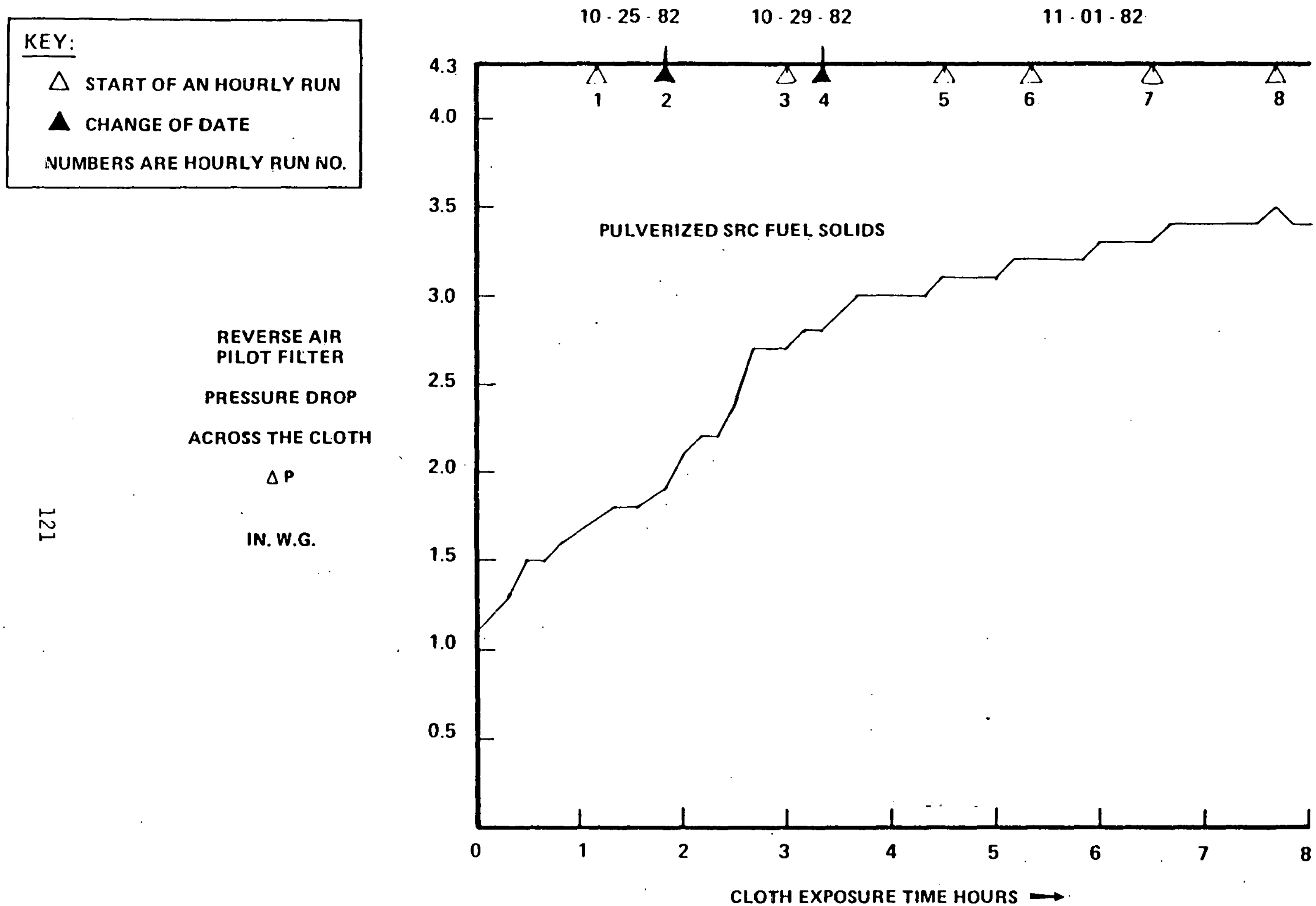
Graph 50

VARIATION OF PRESSURE DROP WHEN A FILTER GOES THROUGH A NUMBER OF START-STOP EVENTS



Graph 51

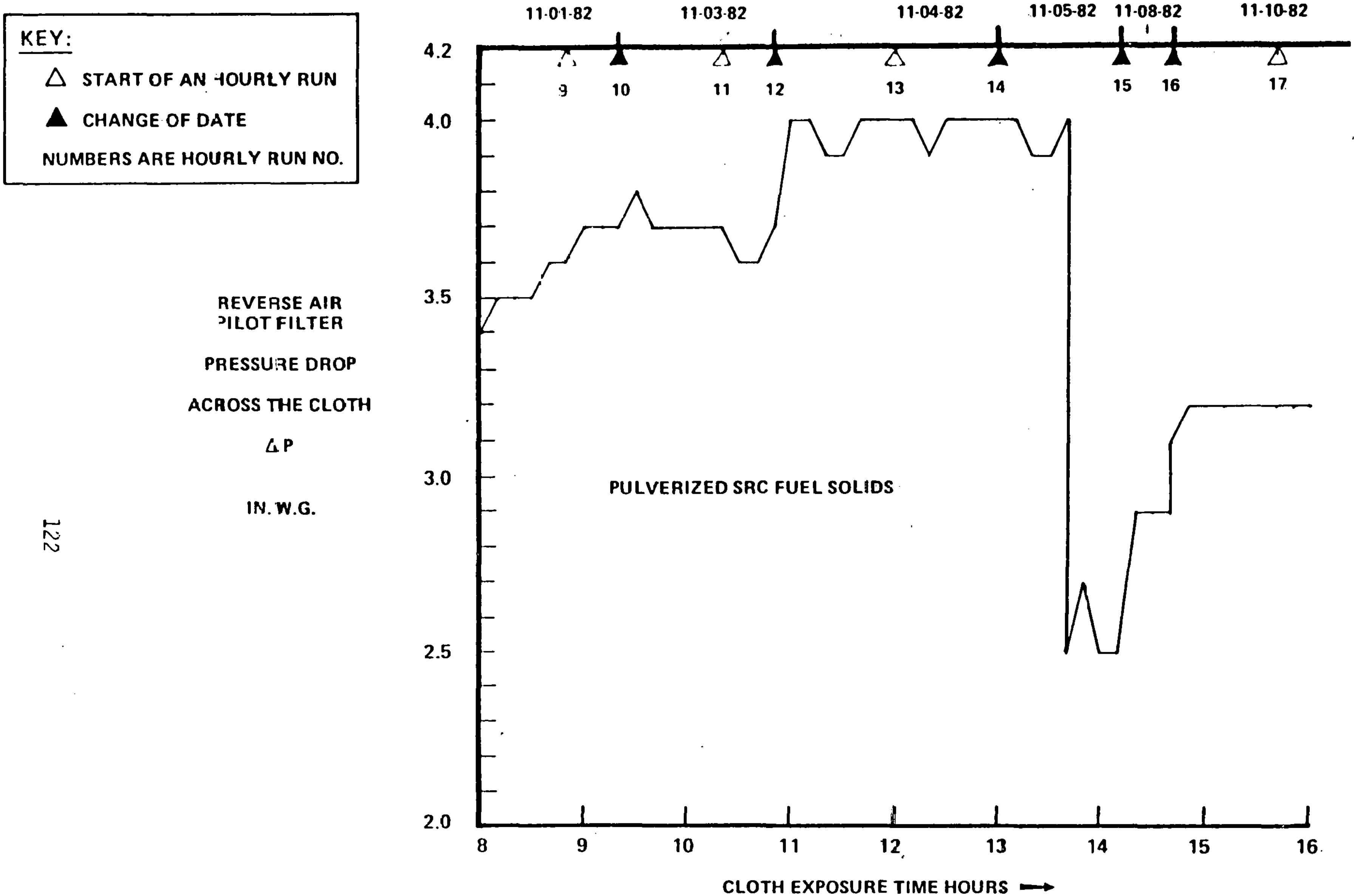
VARIATION OF PRESSURE DROP WHEN A FILTER GOES THROUGH A NUMBER OF START-STOP EVENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.1

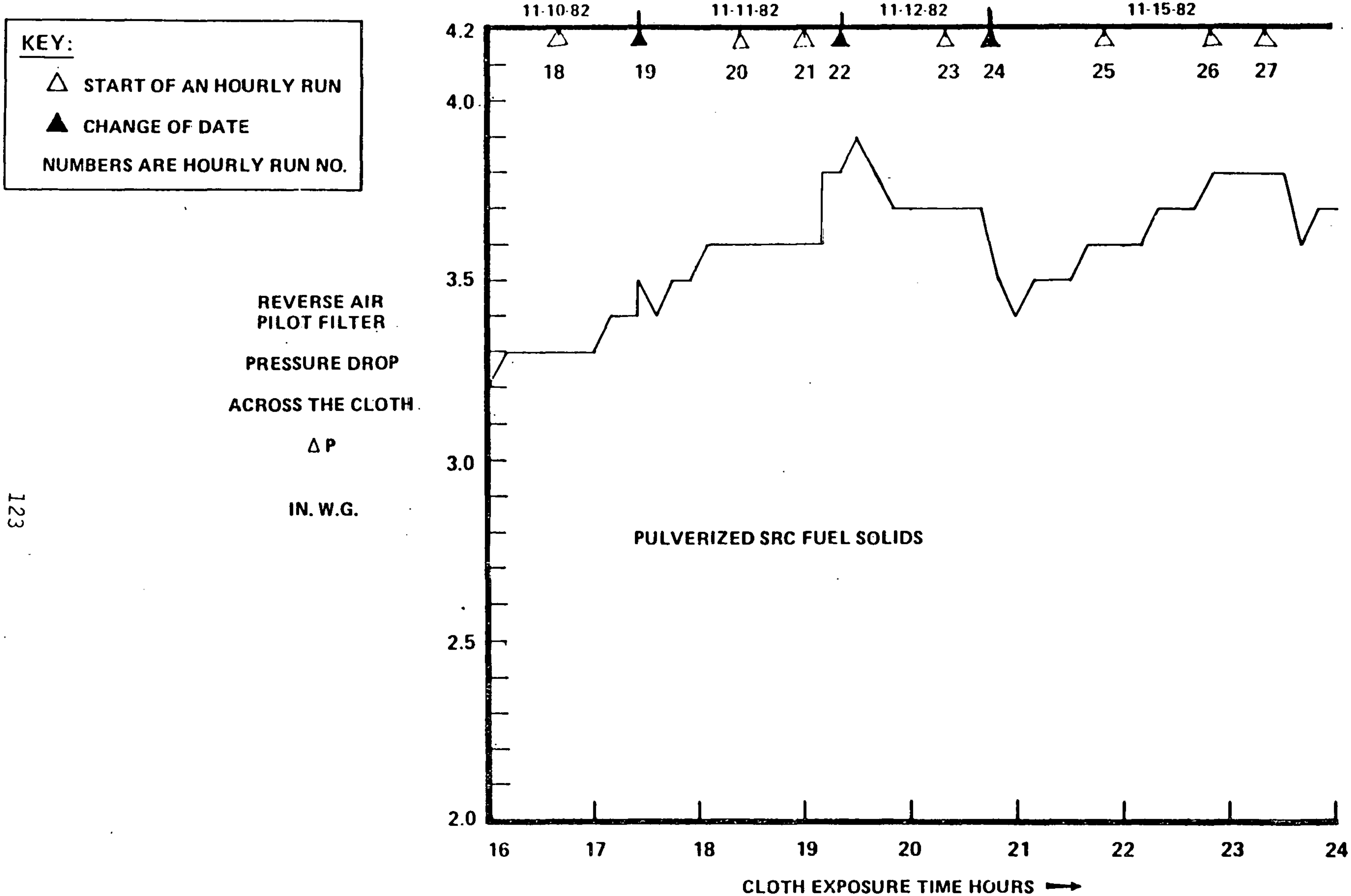
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.2

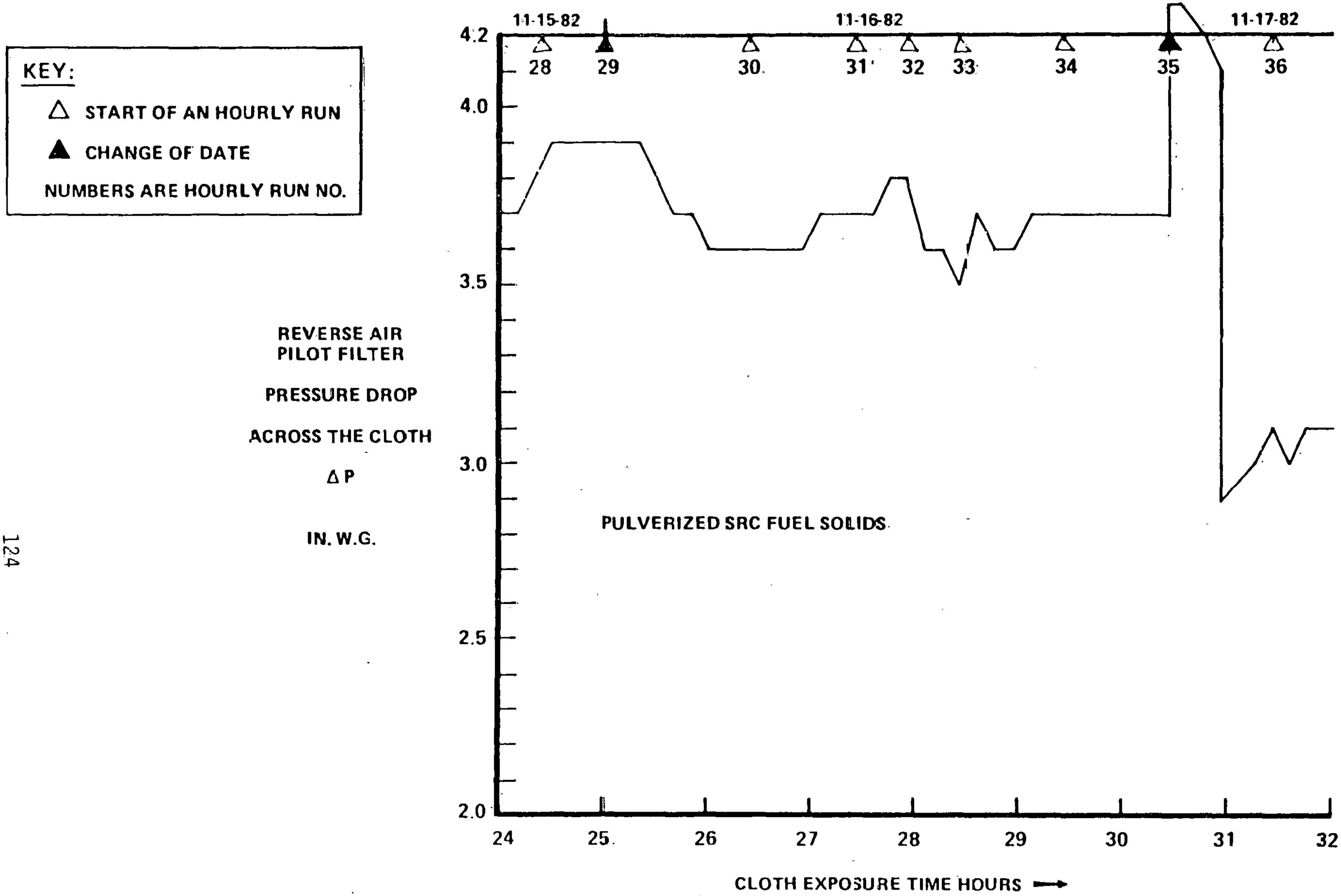
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.3

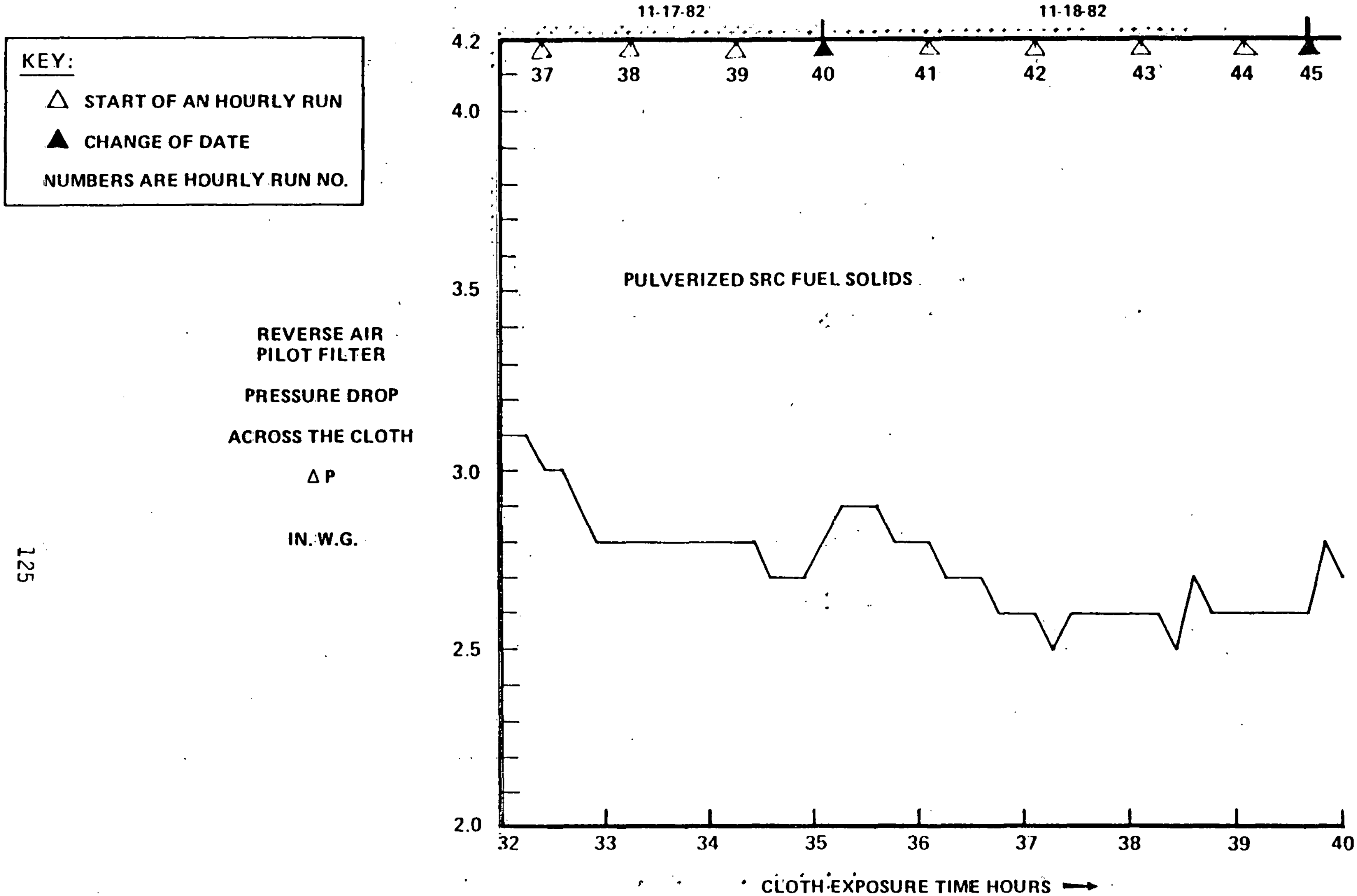
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.4

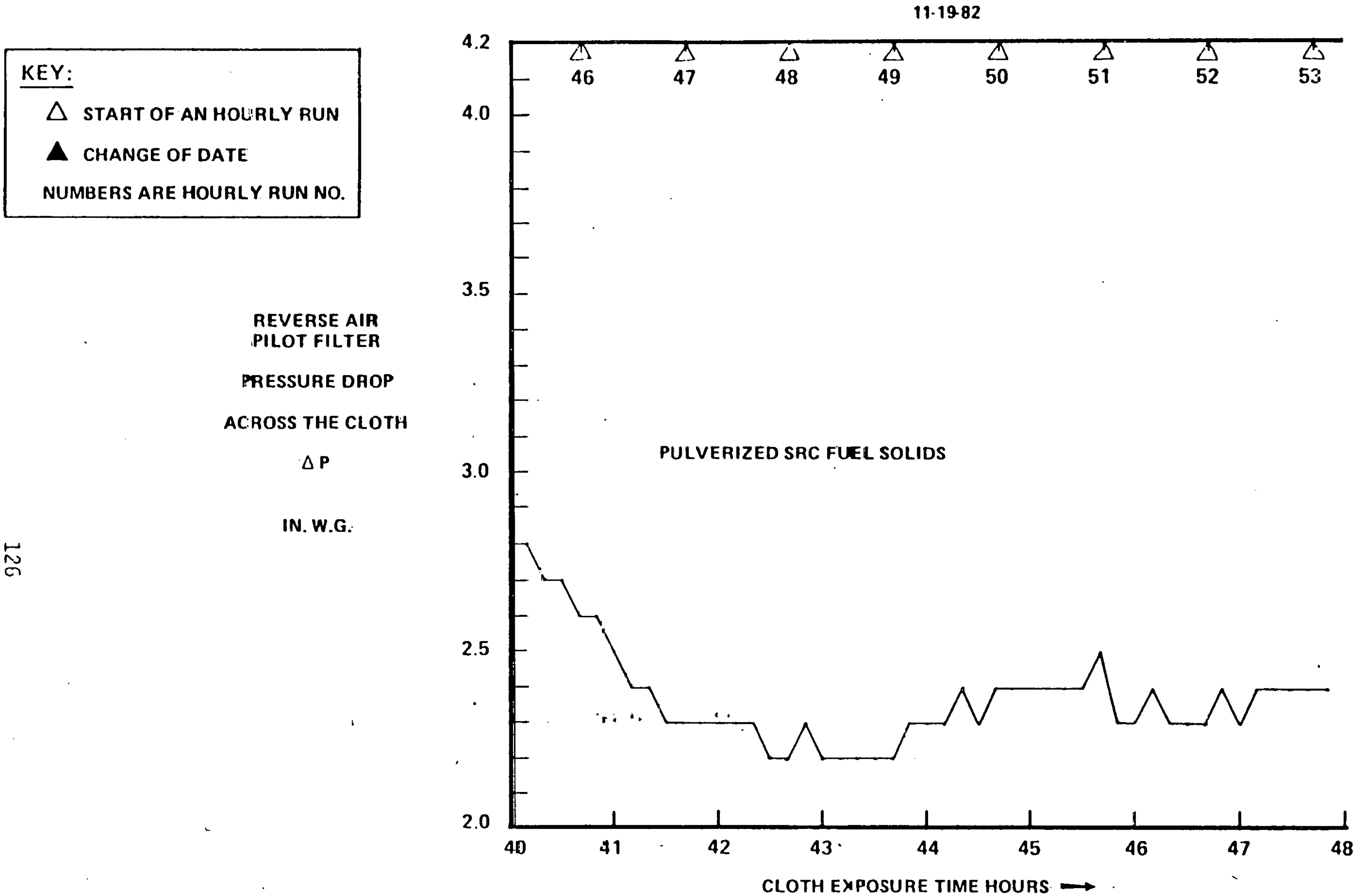
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.5

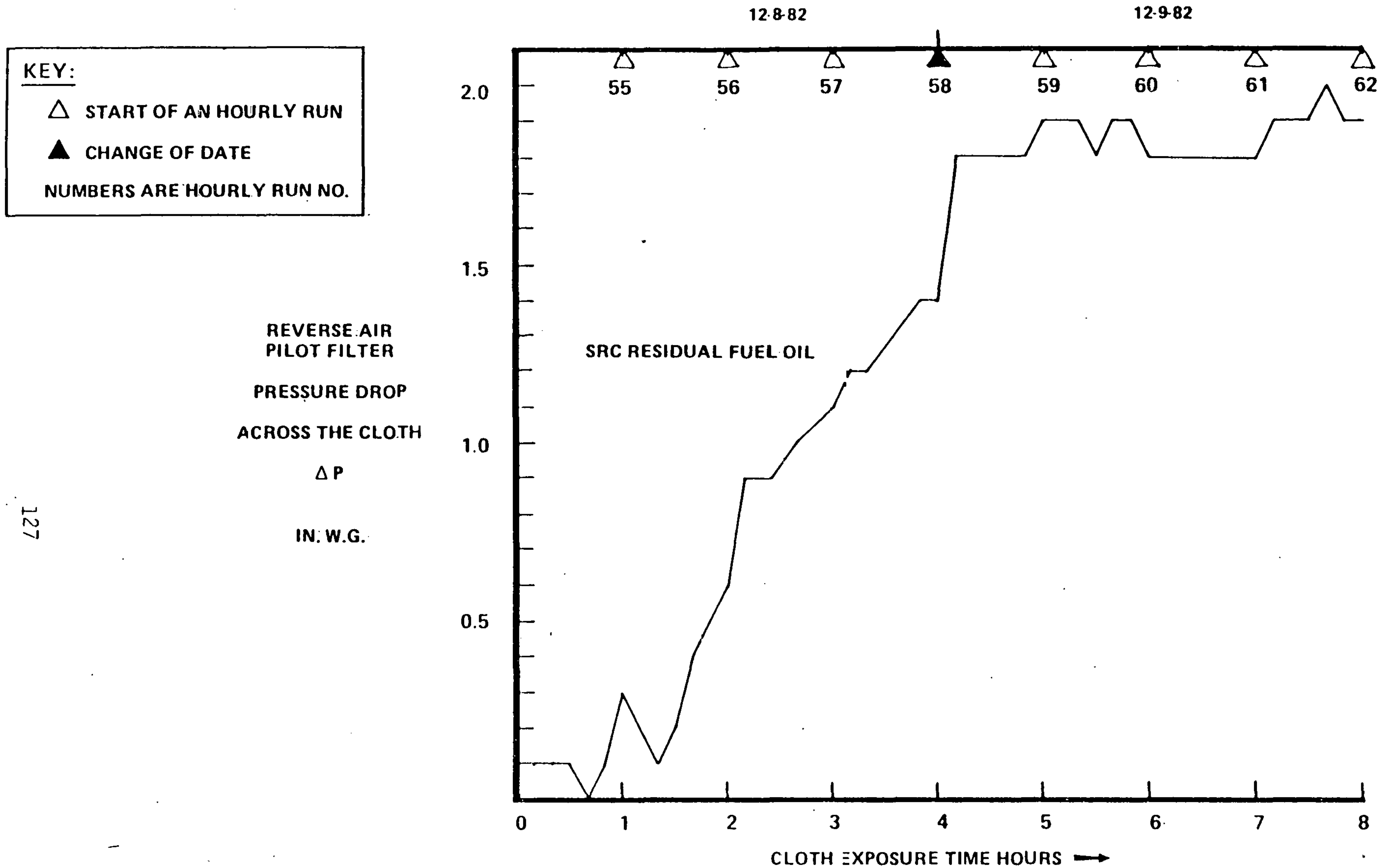
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 52.6

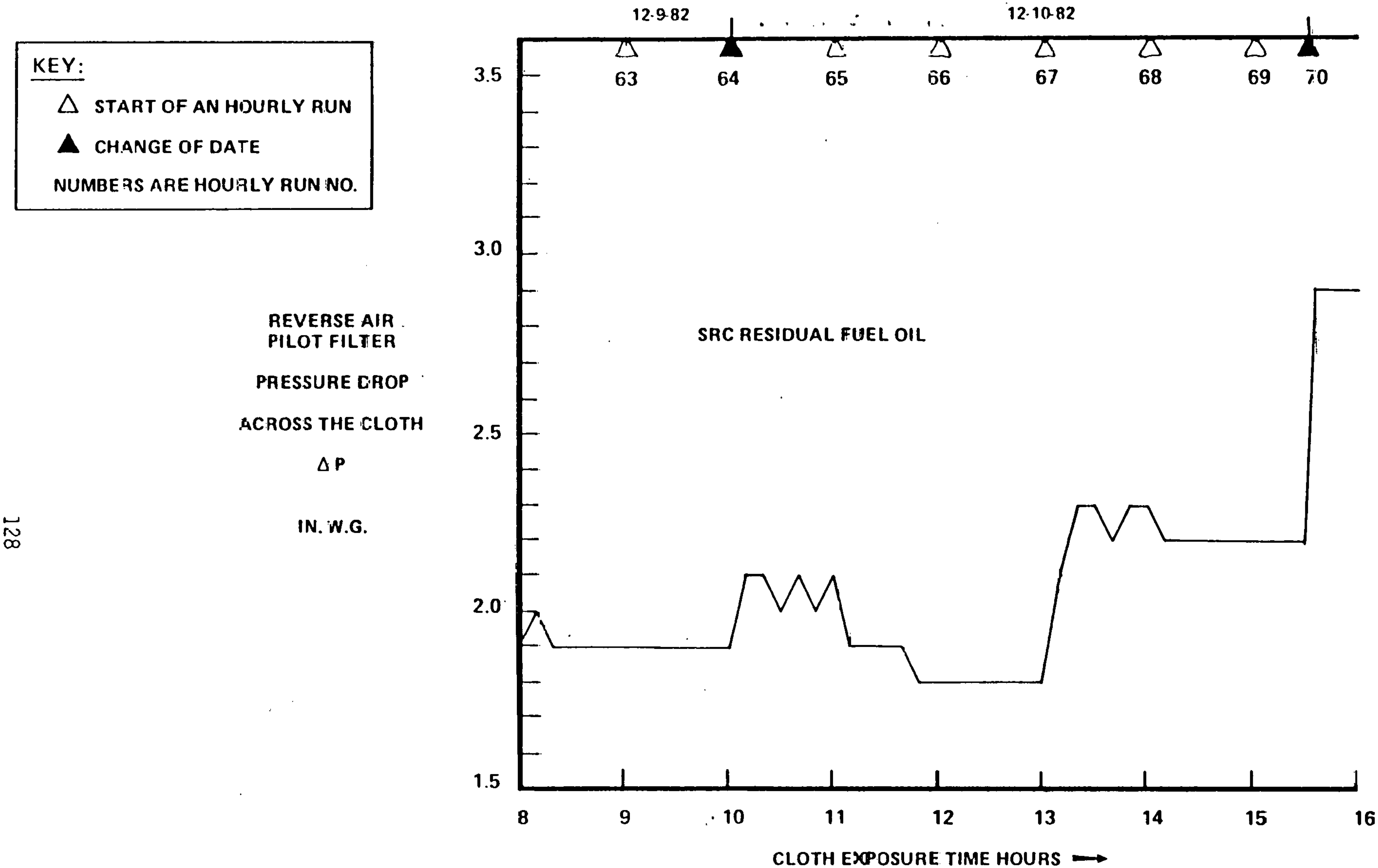
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 53.1

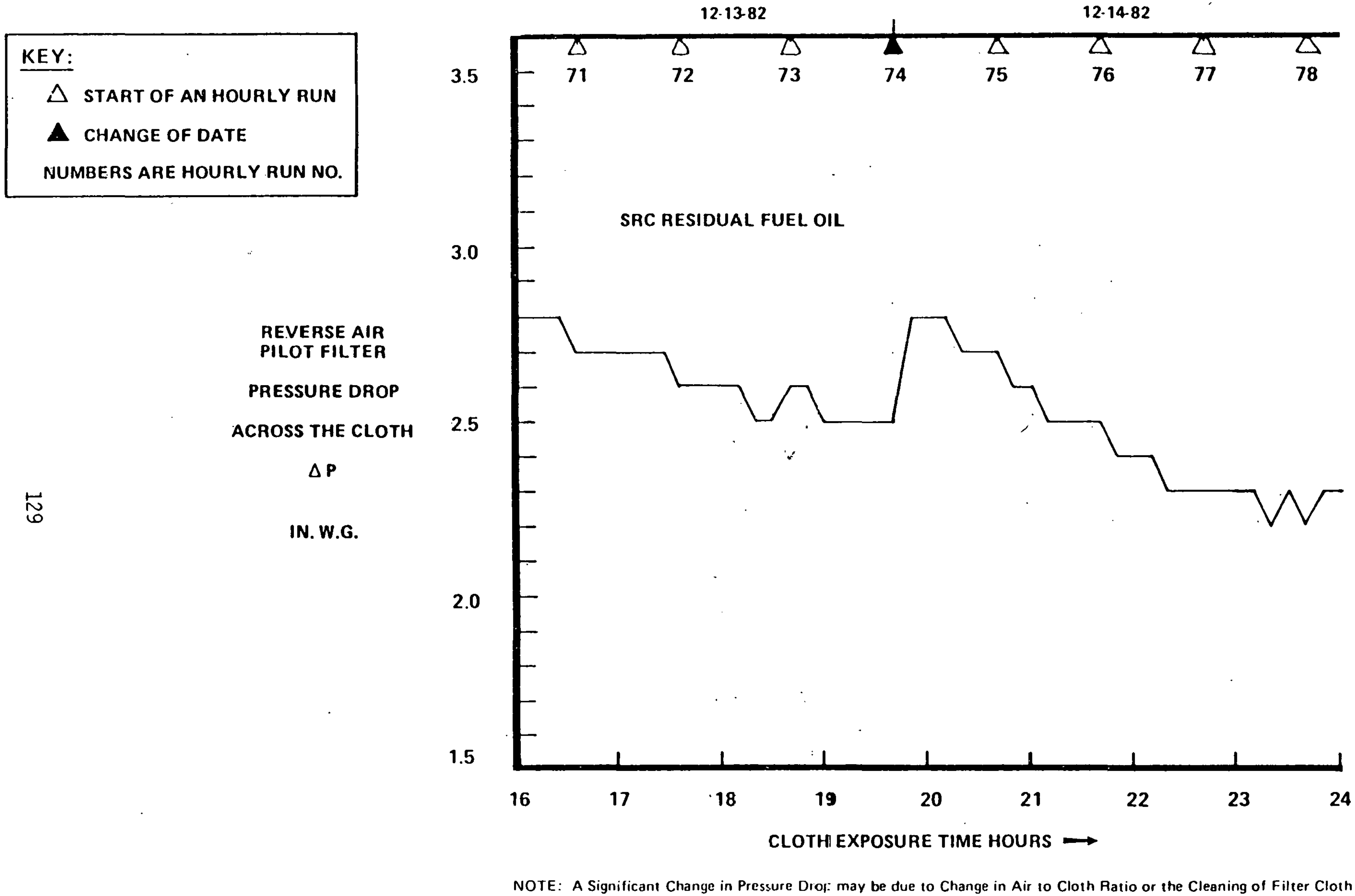
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

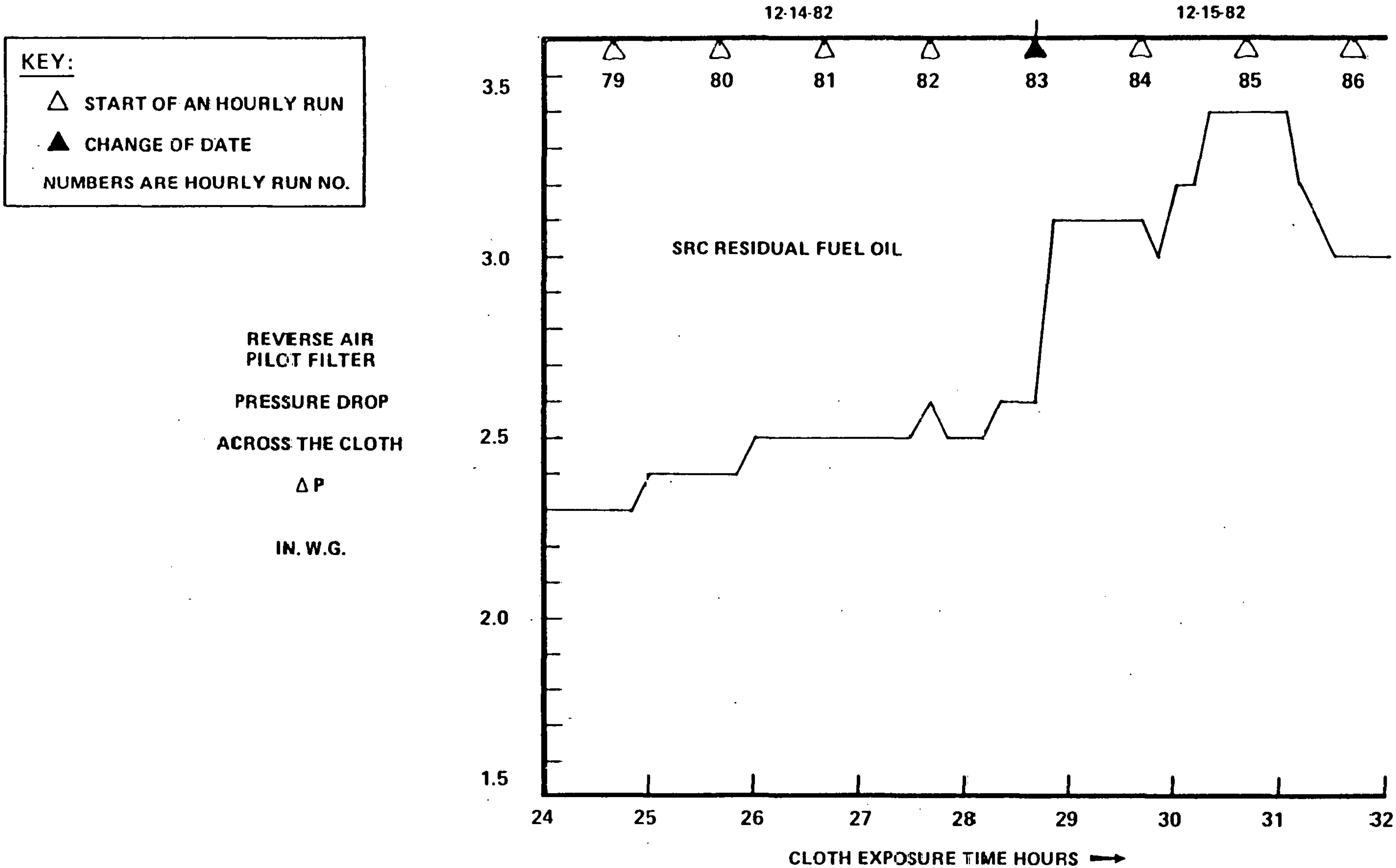
Graph 53.2

PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



Graph 53.3

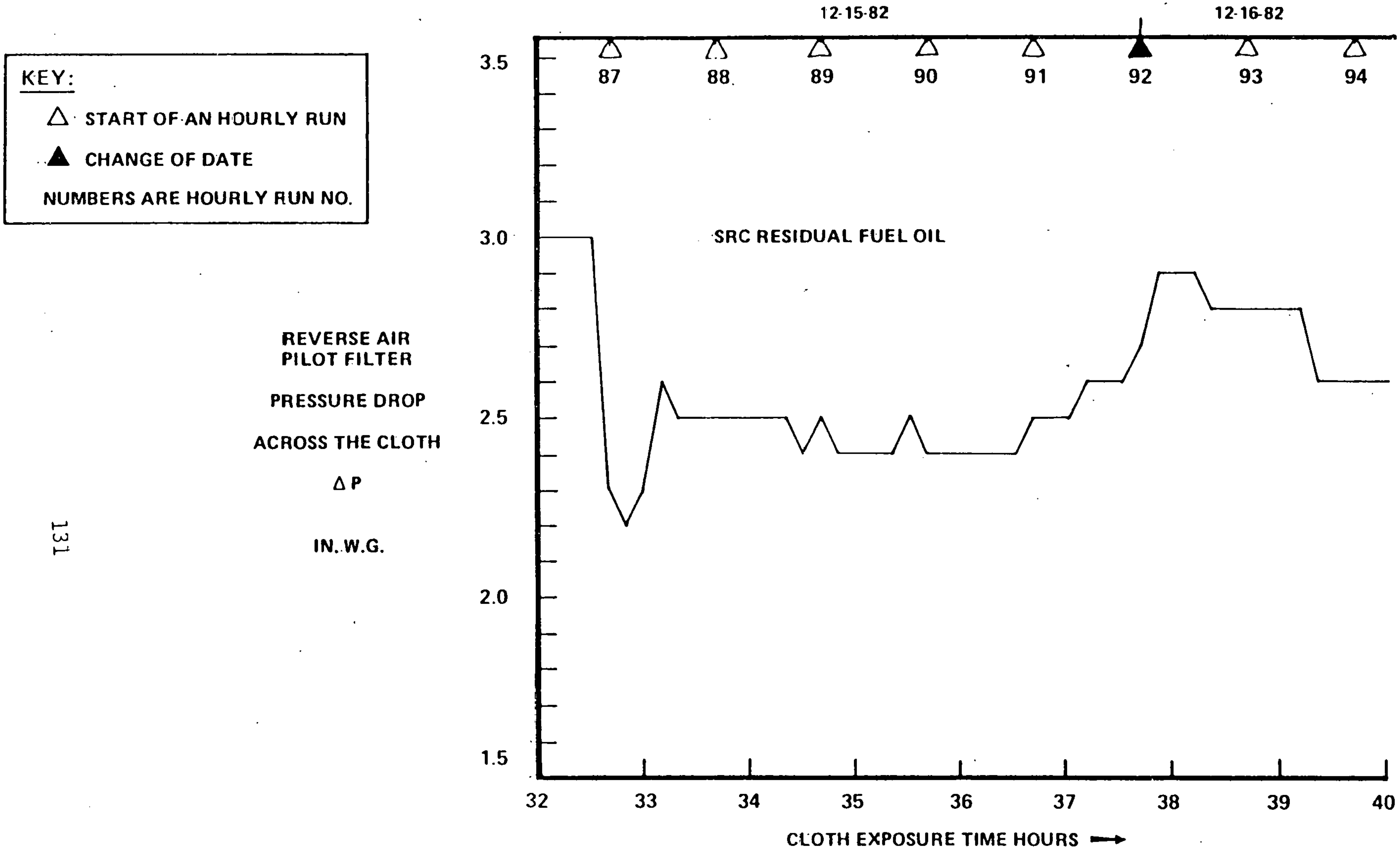
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE. A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 53.4

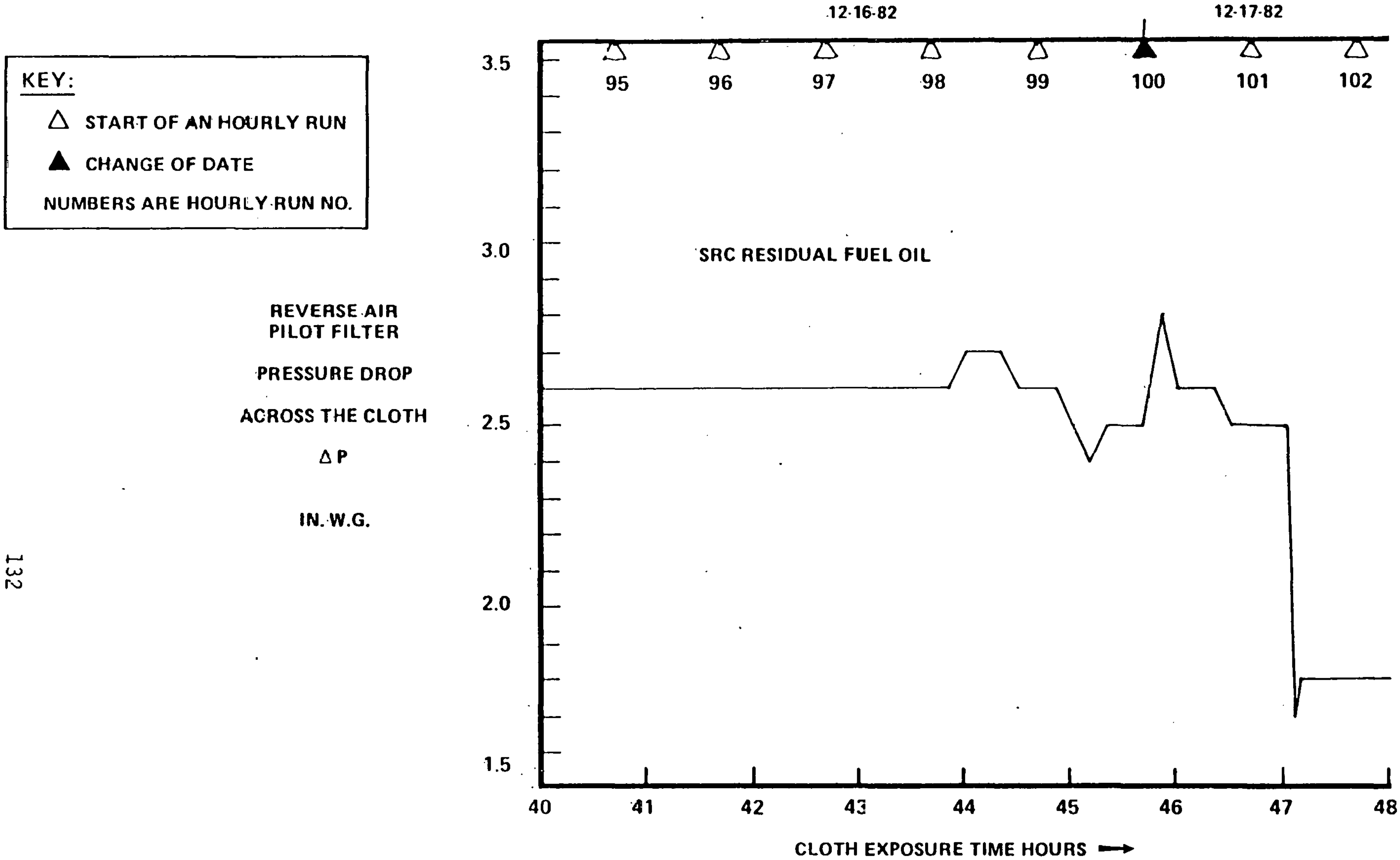
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 53.5

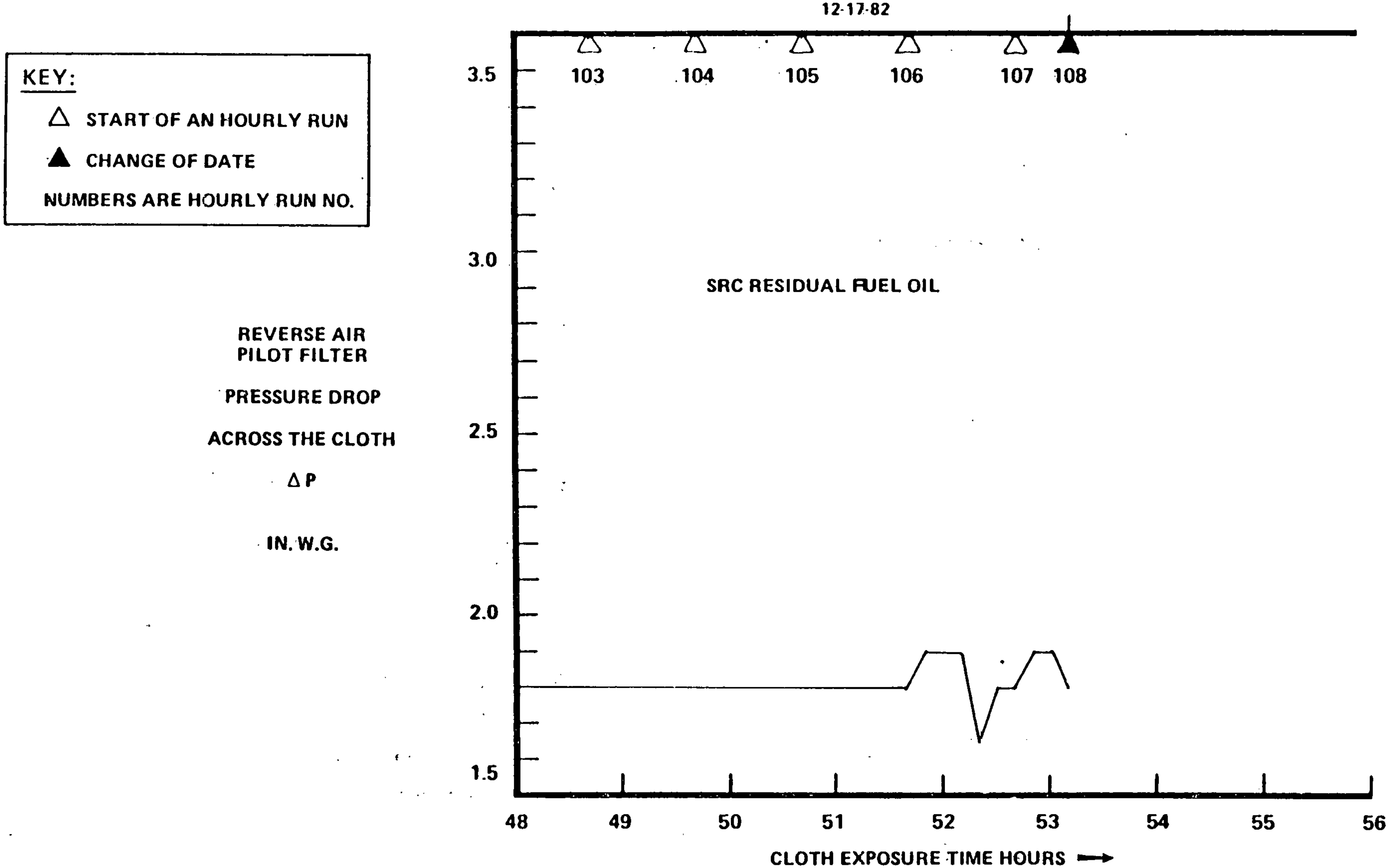
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 53.6

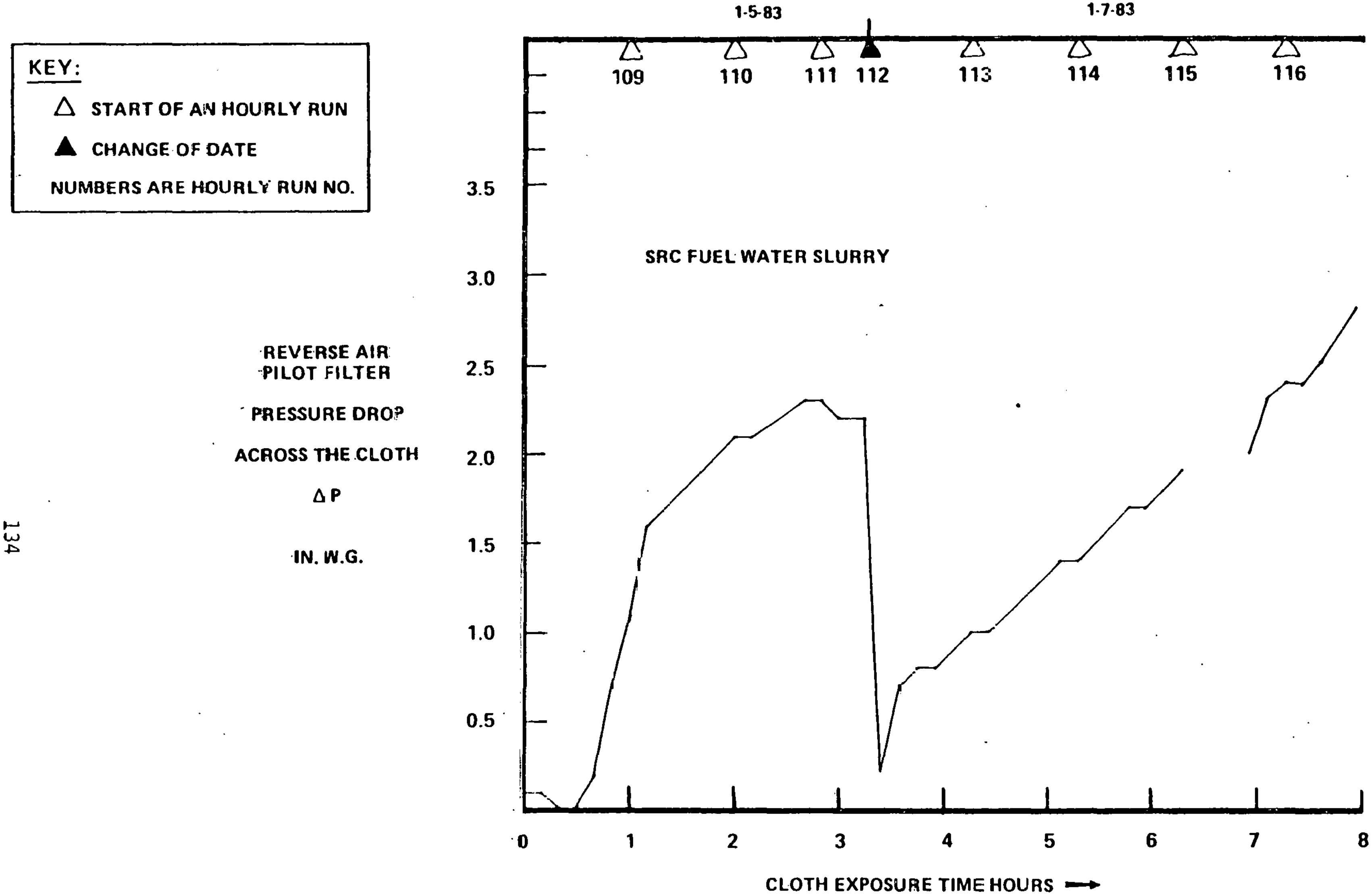
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 53.7

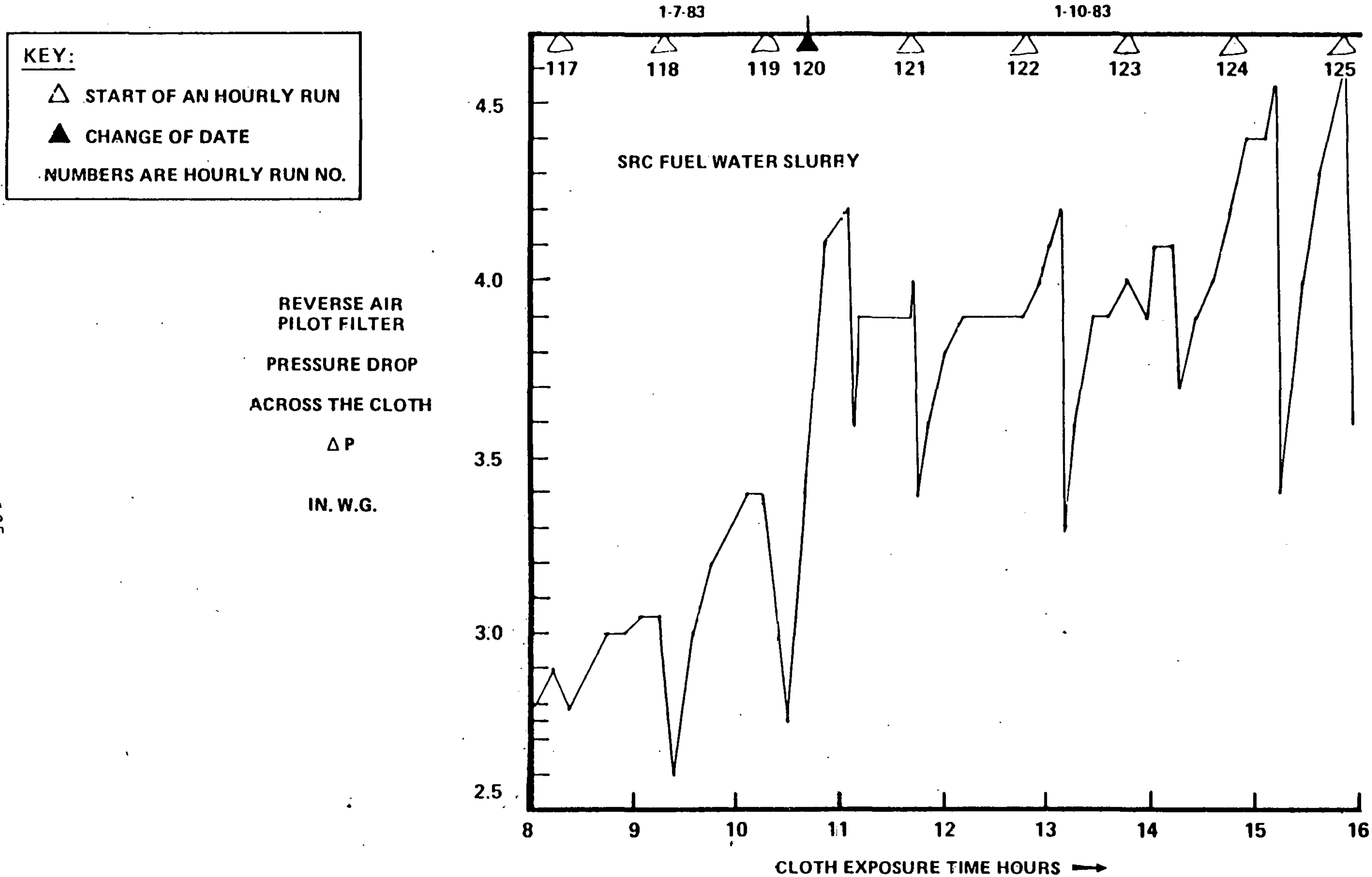
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 54.1

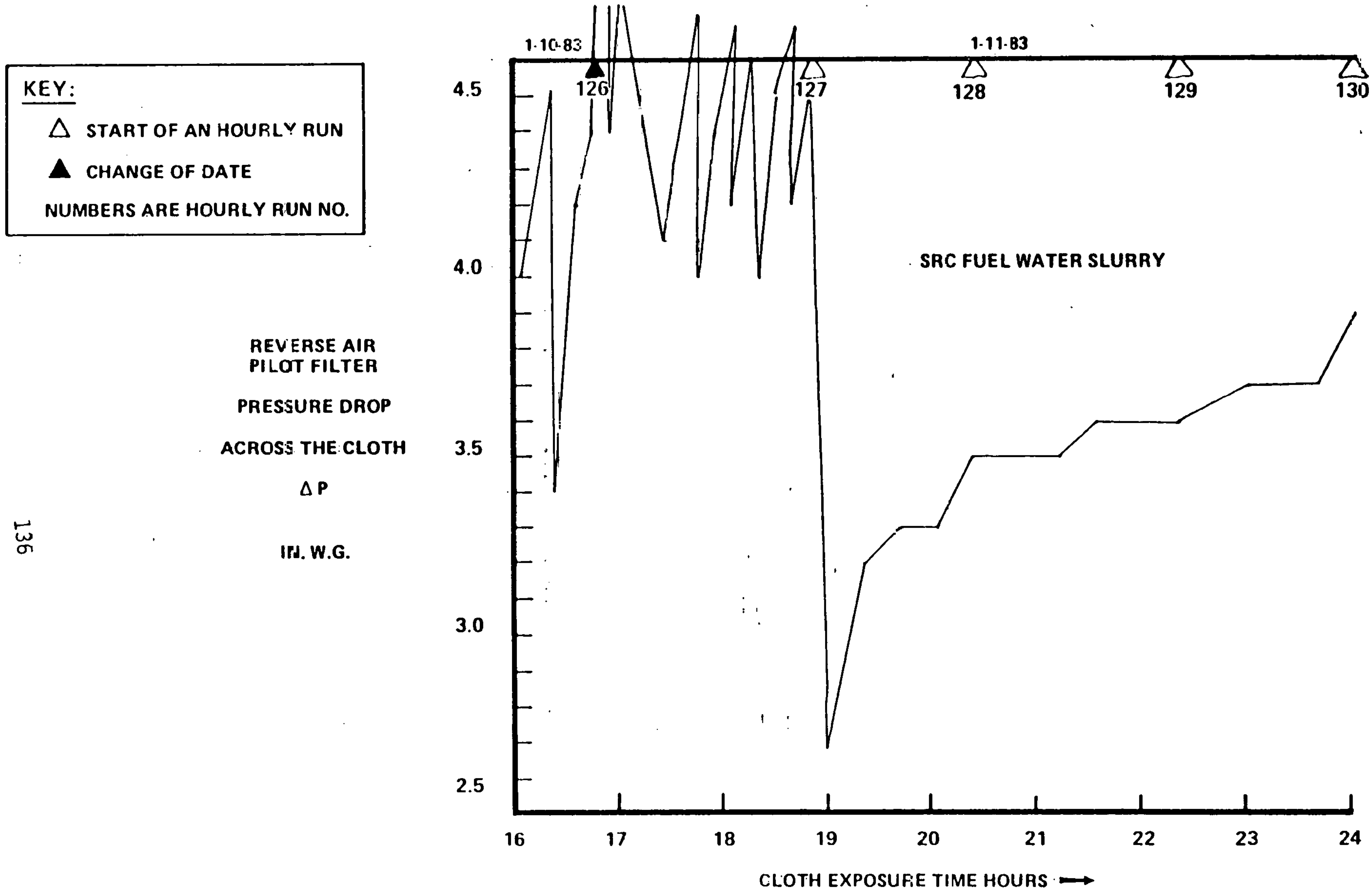
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 54.2

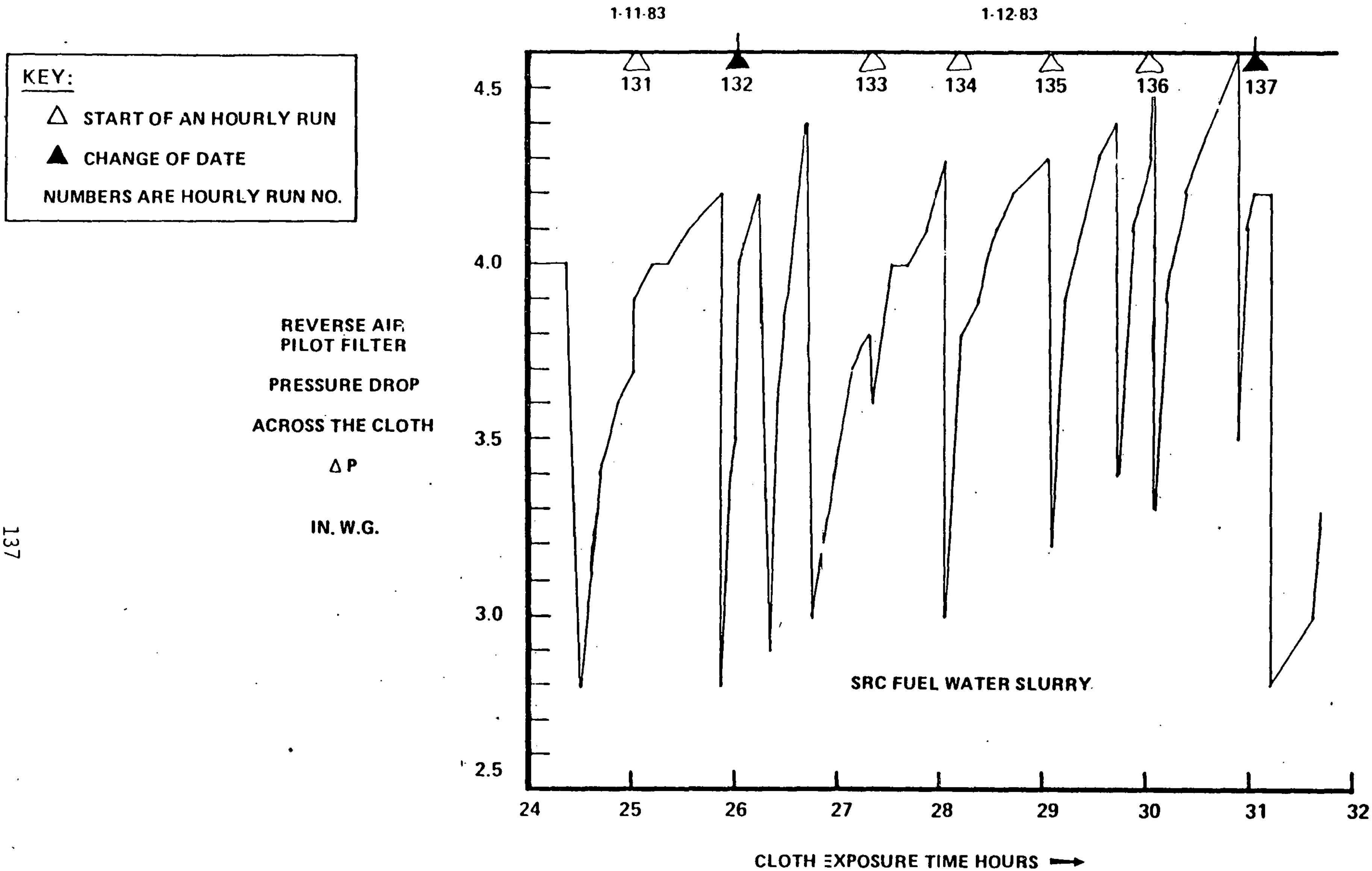
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 54.3

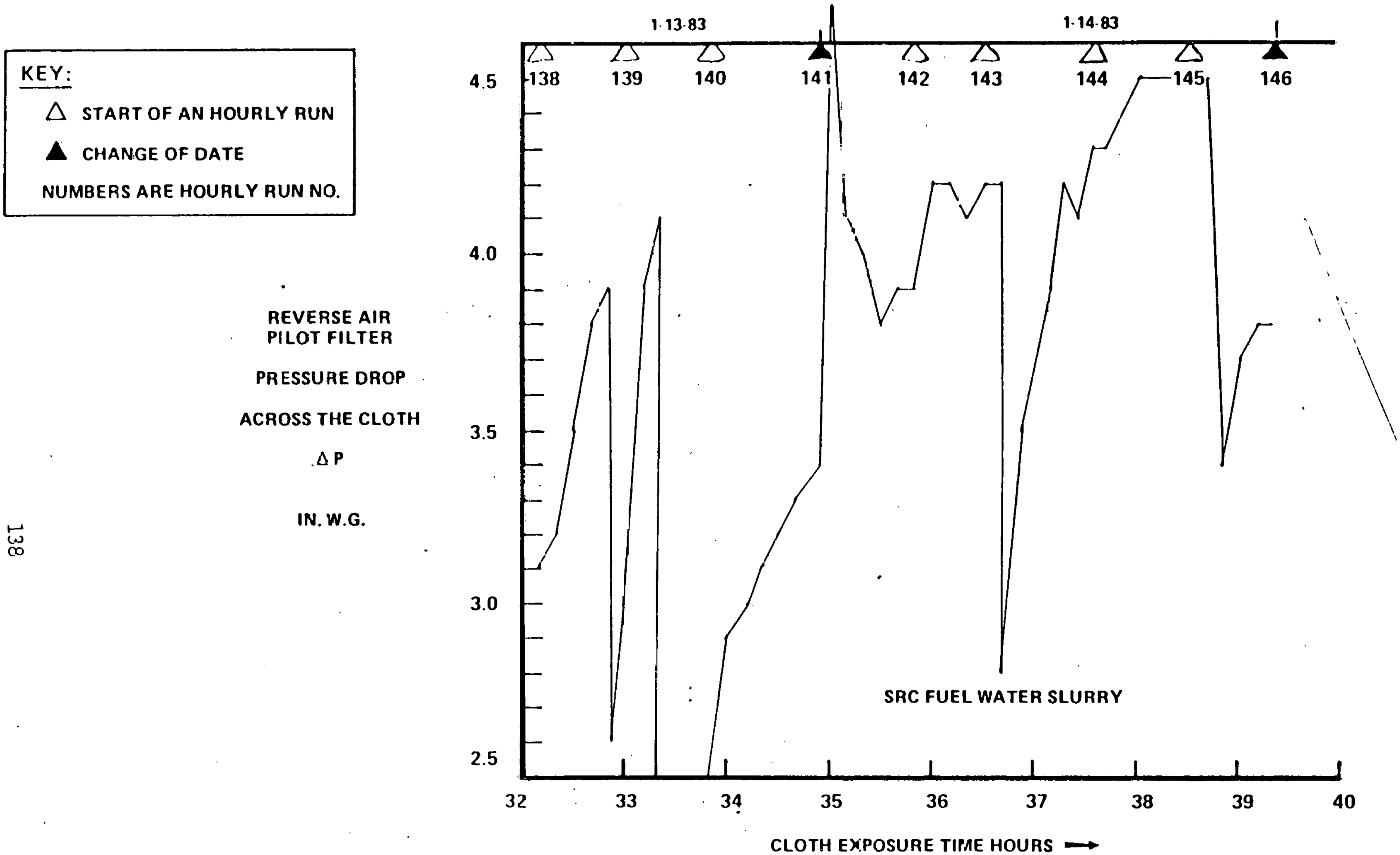
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 54.4

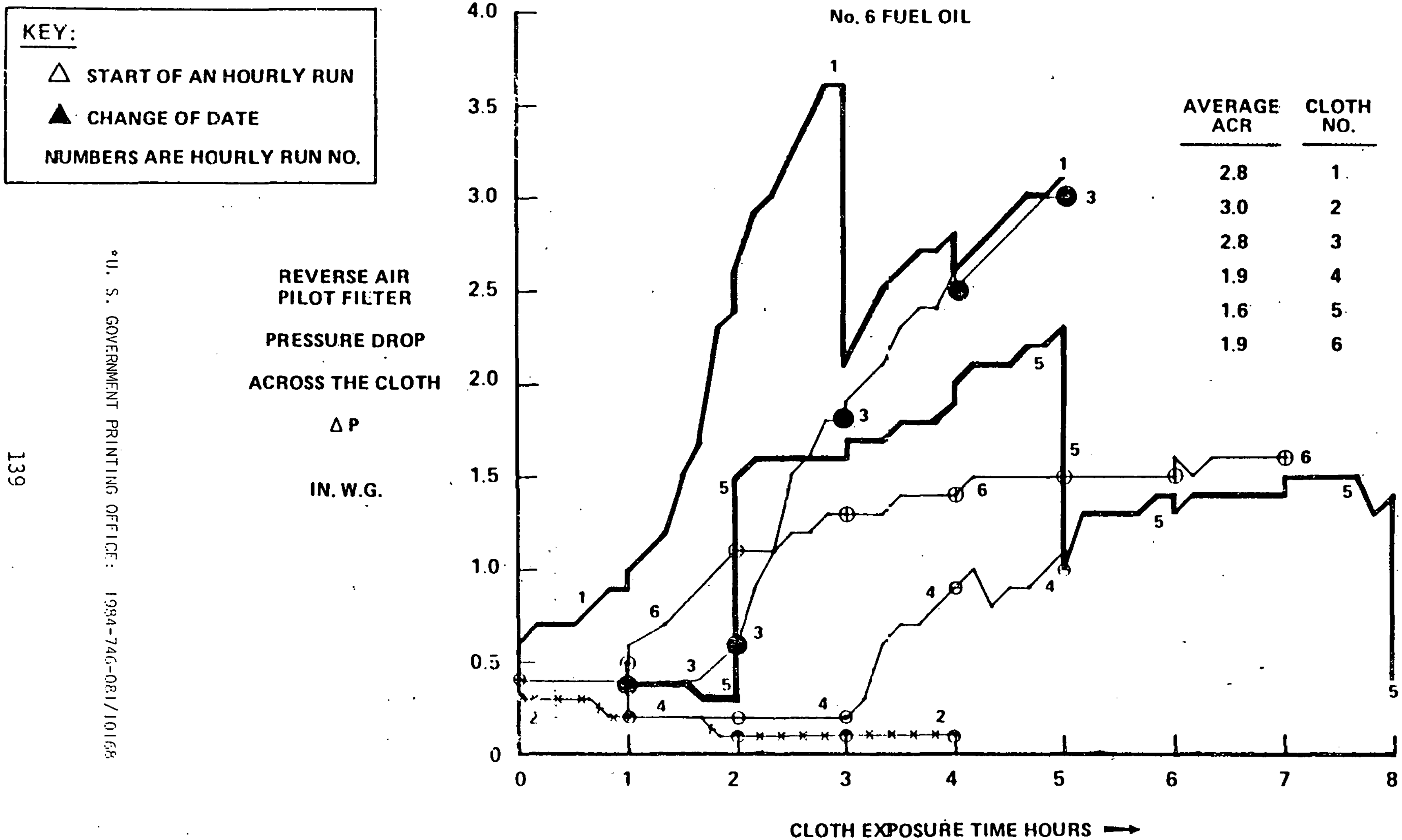
PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 54.5

PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS



NOTE: A Significant Change in Pressure Drop may be due to Change in Air to Cloth Ratio or the Cleaning of Filter Cloth

Graph 55

PRESSURE DROP PROFILE IN 10 MINUTE INCREMENTS

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