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TESTING AND VERIFICATION OF GRANULAR BED FILTERS FOR THE REMOVAL OF PARTICULATE AND ALKALIS

Tenth Quarterly Report for the Period January 1—March 31, 1983

Work Performed Under Contract No. AC21-80ET17093

Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

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ABSTRACT

The Westinghouse Electric Corporation with Ducon, Inc. and Burns and Roe, Inc. are conducting a test and evaluation program of a Granular Bed Filter (GBF) for gas cleaning applications in pressurized-fluidized bed combustion processes. This work is funded by DOE PRDA for Exploratory Research, Development, Testing and Evaluation of Systems or Devices for Hot Gas Clean-up.

This report describes the status of the testing of the subpilot scale GBF unit under simulated Pressurized-Fluidized Bed Combustion (PFBC) conditions through Phase IV.

1. INTRODUCTION

The Westinghouse Electric Corporation with Ducon, Inc. and Burns and Roe, Inc. are conducting a program to test and evaluate the Ducon granular-bed filter (GBF) for gas cleaning applications in Pressurized-Fluidized Bed Combustion (PFBC) Power Plants. The granular bed filter system may serve to remove from the gas stream both particulate and alkali metal compounds.

Figure 1-1 shows a schematic diagram of one element of the subpilot-scale Ducon granular bed filter. The element shown consists of four parallel operating filter compartments. Each compartment contains a granular filter-bed through which the ash and dust-laden gas pass (Figure 1-1a), depositing the ash and dust particles on the surface of the filter media. With increasing deposits of the particulates, the system pressure drop increases until a point is reached when it is no longer practical or economical to operate. The GBF system is then cleaned by sequentially backflushing each element (Figures 1-1b). For this purpose, a backflush motive air is introduced into an eductor at the outlet (clean air side) of a filter element. The motive air passes through the eductor (inducing additional clean gas from the clean-air plenum) and into the GBF element housing, up through each filter bed at a velocity and rate sufficient to gently fluidize each bed and dislodge the accumulated ash and dust material. The dislodged ash is elutriated and expelled from the element by passing back through the inlet opening provided at the top of each compartment. Figure 1-1 shows a four-bed element. Commercial scale GBF systems could consist of multiple elements each comprised of ten, twelve, or more parallel operating beds. An alternative design that uses a single bed, cylindrical element configuration has also been tested. This design is schematically illustrated in Figure 1-2.

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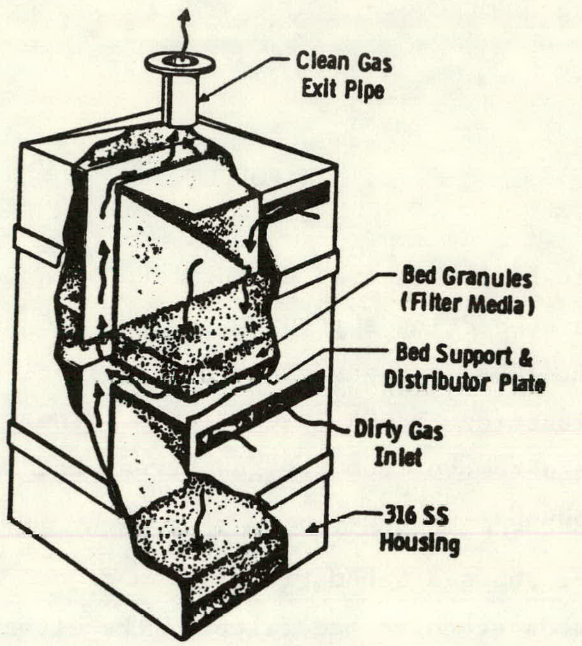
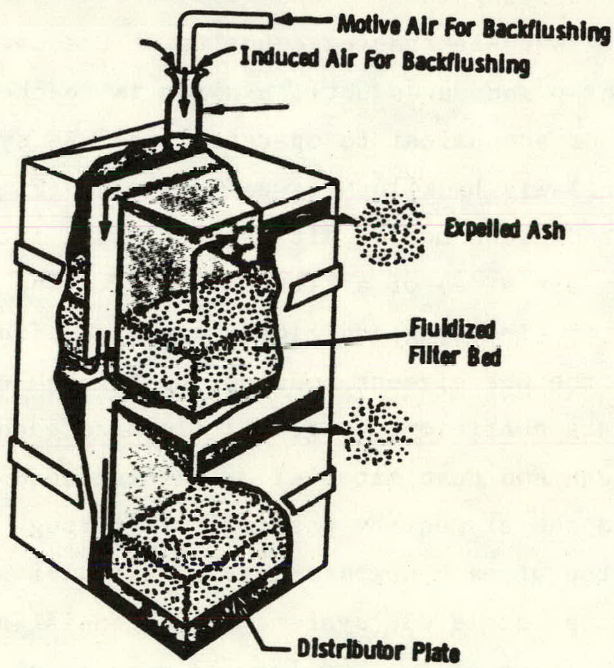
FIG. 1 – SHALLOW BED – GBF CONCEPT



GBF ELEMENT – FILTRATION MODE



GBF ELEMENT – CLEANING MODE

Fig. 1-1 – Schematic representation of Ducon GBF element

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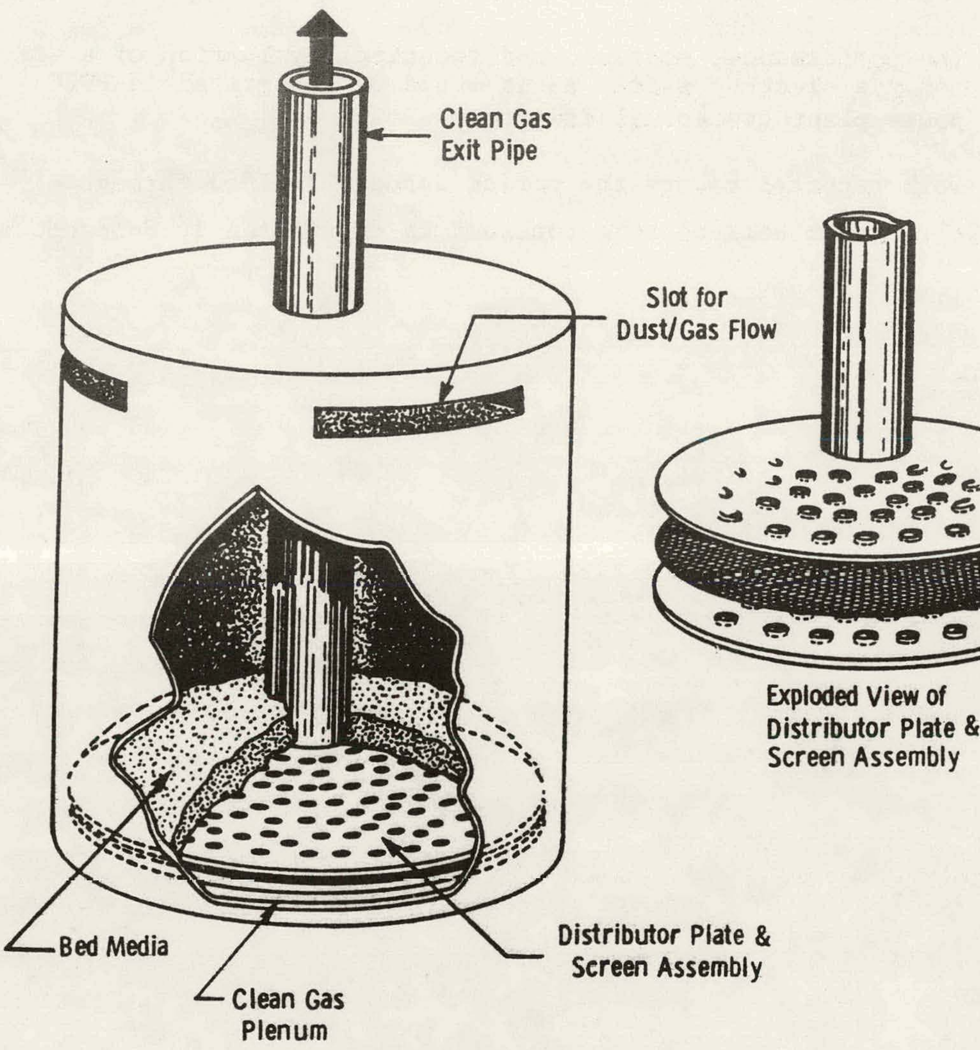

Fig. 1-2 – Schematic of single-bed, cylindrical GBF element

The major technical objectives of this work are:

1. The design and testing of a subpilot scale, multi-element (6) GBF to operate to temperatures of 900°C (1650°F) and pressures to 16 atm., at approximately 500 acfm.

2. Test and analysis to define the design approach and filter operation to accomplish alkali removal in PFBC.

3. The performance, economic and technical evaluation of a GBF hot gas clean-up system as it would be integrated in PFBC power plant conceptual designs.

The work reported covers the period January 1, 1983 through March 31, 1983. Prior work on this contract is documented in References 1 through 9.

2. TASK 1.1 - DEFINITION AND PRELIMINARY EVALUATION OF PFBC PLANT CONCEPTS AND HOT GAS CLEAN-UP REQUIREMENTS

A draft copy of the reference PFBC system description write-up has been prepared by Burns and Roe. The report covers the overall plant descriptions, performance and costs.

In this study, three existing PFBC plant designs were modified to conform to the overall criterion and assumptions set forth in this study,[1] and to include a GBF for hot gas particulate clean-up and a fixed granular bed for alkali control. The specification of each plant design has included the following considerations:

1. Mass and energy balance
2. Overall plant performance
3. Sketch of plant layout
4. Estimate of plant costs
5. Conceptual design for GBF
6. Conceptual design for the alkali gettering bed
7. GBF and alkali bed operational characteristics
8. Estimate of turbine maintenance intervals

Submittal of the Burns and Roe report and its review and issue as a topical report completes the Task 1 work scope. A summary of the results from this study are provided in Reference 4.

3. TASK 1.2 - DESIGN AND ESTING OF THE SUBPILOT SCALE GRANULAR BED FILTER

This task encompasses the specification, design and testing of a multiple-element Ducon GBF subpilot scale unit. Testing has been conducted at the Westinghouse Synthetic Fuels Division's Hot Gas Test Facility at their Test and Development Center located at Madison, PA at the Westinghouse Waltz Mill site. Figure 3-1 shows a schematic diagram of the test facilfty in which redispersed fly ash (or other dusts) are fed at high temperature and pressure into the test vessel containing the GBF subpilot unit. Provisions for gas sampling are available on both the inlet and exit lines of the vessel. Figure 3-2 shows a photograph of the test facility. Figure 3-3 shows a schematic diagram of the instrumentation and controls typically used in the GBF test programs. Three test phases have been completed and reported, References 6, 7 and 8.

During this report period, a fourth test phase has been completed utilizing the modified, single bed cylindrical element filter configuration. A summary of the GBF test programs and results from Test Phase IV are presented.

3.1 Specification of the GBF Subpilot Unit Design

A preliminary report on the design and operating criteria for the GBF subpilot unit has been completed, Reference 1. The report provides the basis for specifying or calculating the major design and operating parameters for the GBF. This work was then updated to include an analysis of the design and operation of the eductor used in the GBF backflush system for high pressures and high temperatures, Reference 2. These studies have formed the design basis for the GBF subpilot test unit used in test Phases I, II, and III.

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Operating Conditions

Pressure - Up to 150 psig (capability to 220 psi)
Temperature - 200 - 1600°F
Flow Rates - Up to 12 lb/s

Vessel - 56" Dia × 110" Length

Piping - 10" Sh. 80 with 6" Inconel Liners

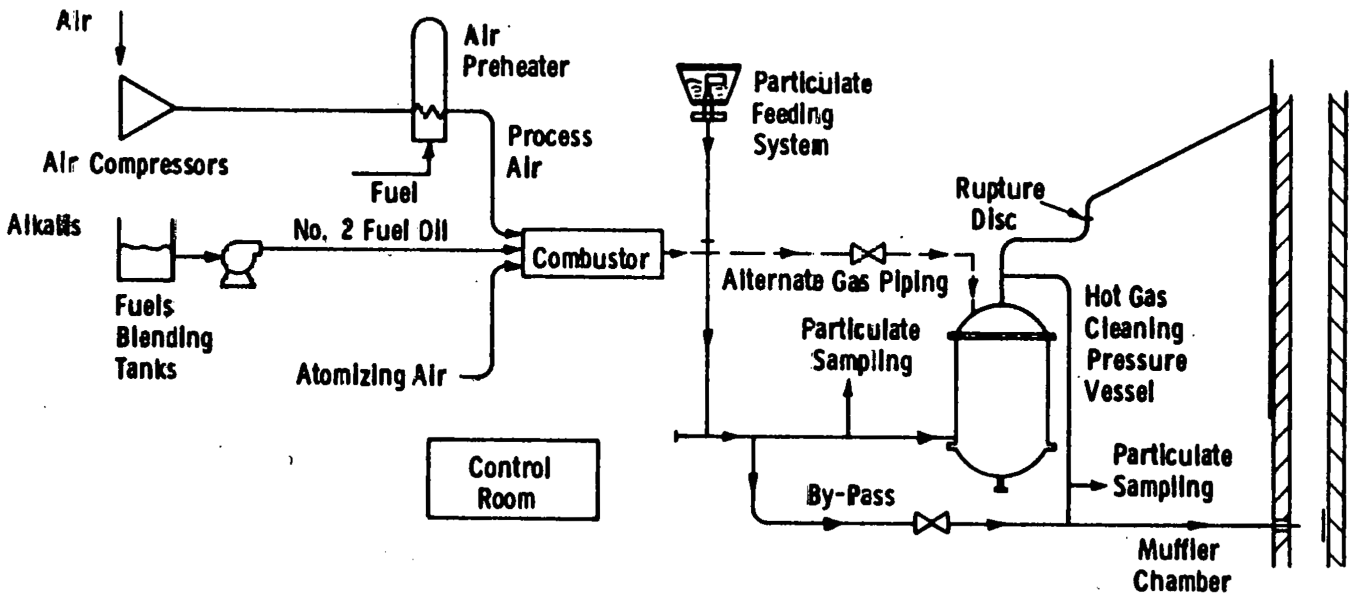

Fig. 3-1—Schematic diagram of W-hot gas clean-up facility

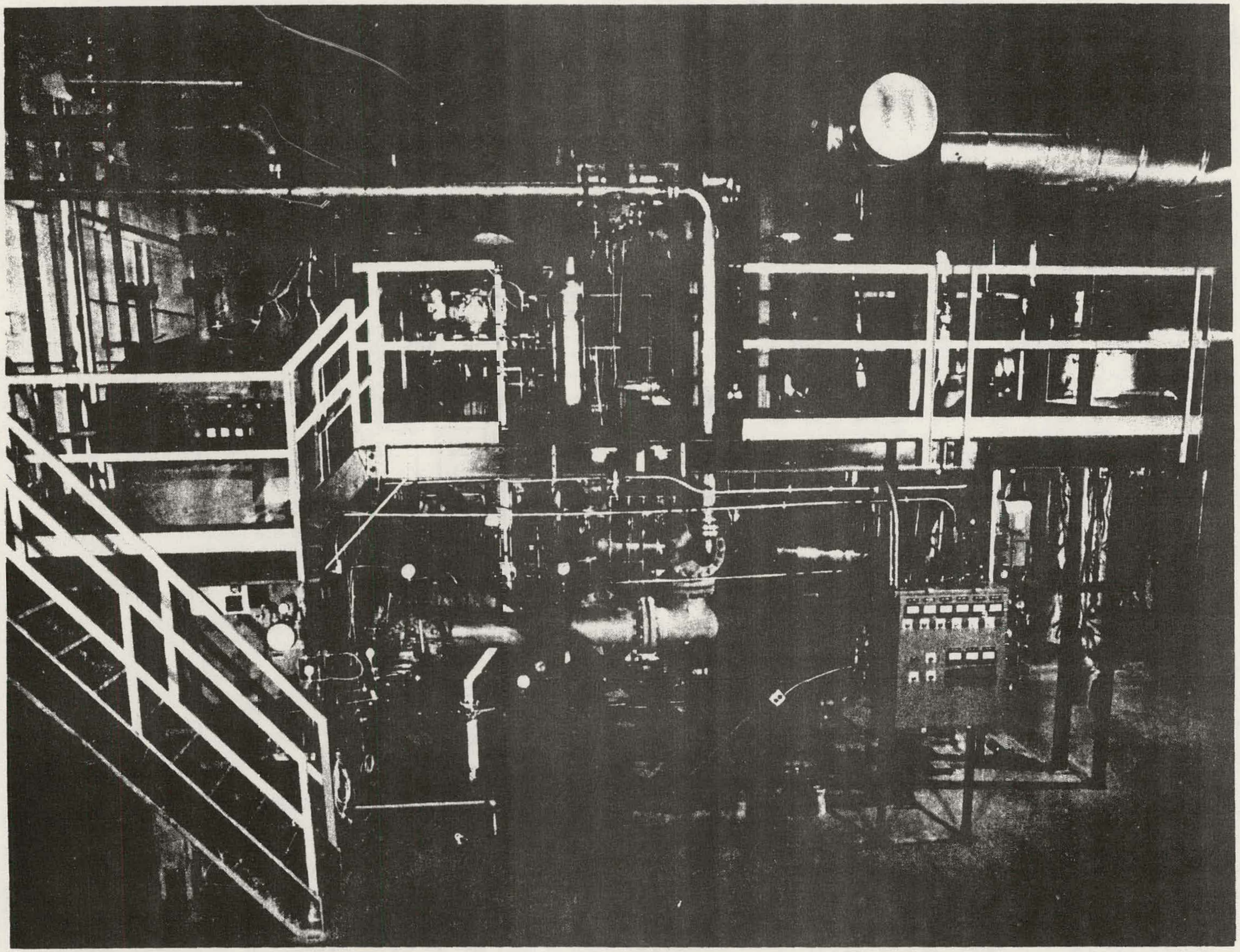

Figure 3-2 - Hot Gas Clean-up Test Facility
(1982)

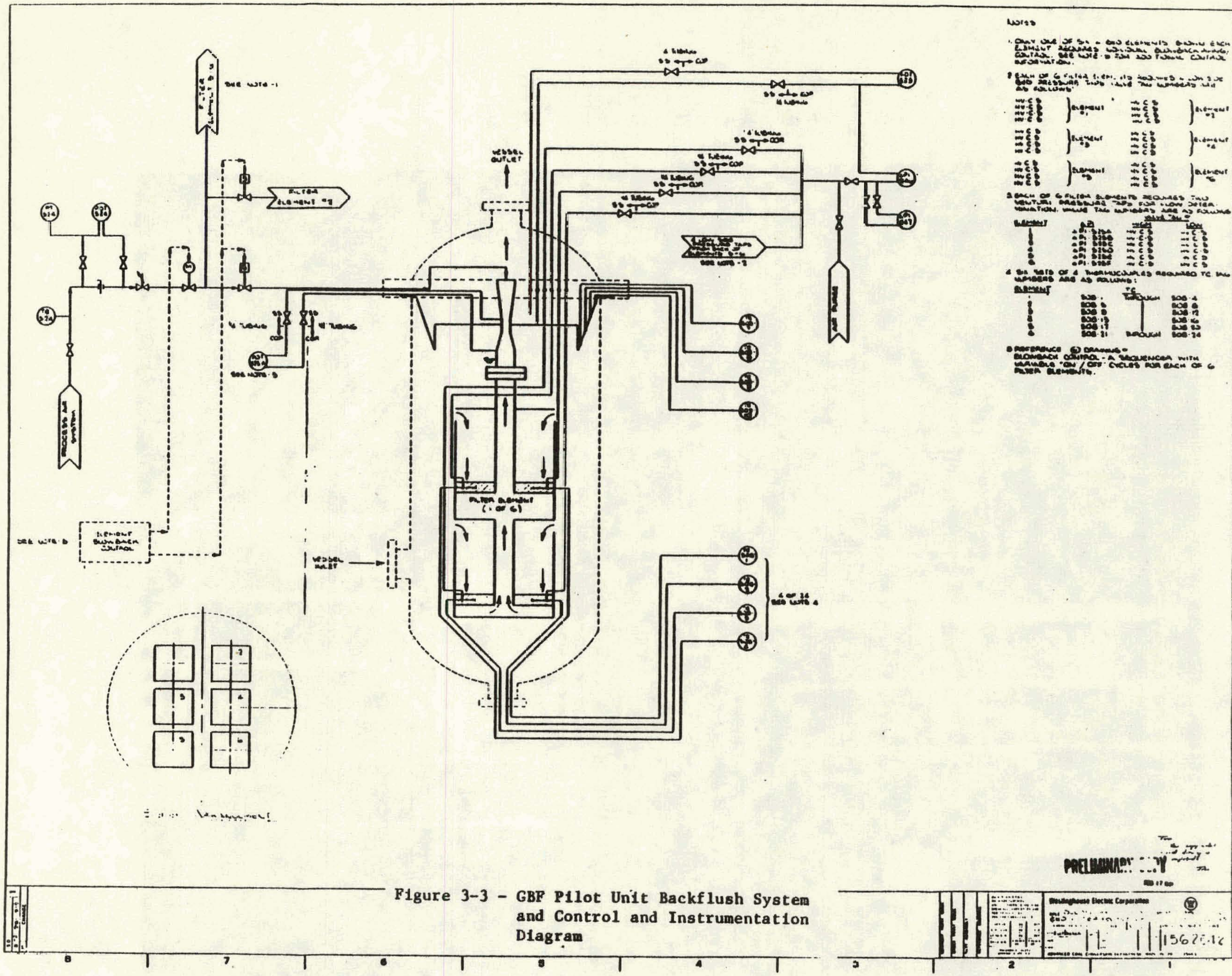

Figure 3-3 - GBF Pilot Unit Backflush System and Control and Instrumentation Diagram

3.2 GBF Subpilot Unit Design and Fabrication

Design and fabrication of the original, rectangular, 6 element 24 bed GBF test unit was conducted by Ducon, Inc. Drawings and description of the test unit assembly were included in Reference 2.

The overall design basis for that unit is premised on a flow of 500 acfm at 1650°F (900°C) temperature and operation at 10 atm pressure with a maximum filter pressure drop during the filtration cycle of 5 psi. This filter pressure drop criteria actually translates to a maximum operating pressure differential of 9 psi that will occur when one element is backflushed (i.e., during the cleaning cycle). A redesign of filter element configuration to the single bed, cylindrical geometry illustrated in Figure 1-2 above and utilized in test Phase IV is described in Reference 9. Also included in Reference 9 is the basis and data for bed media selection and evaluation.

3.3 Test Program Status (Phases I, II, and III)

The subpilot GBF test unit was delivered to the Westinghouse SFD-TDC facility site in September of 1981. Figures 3-4 and 3-5 show overall views of the test unit. Prior to initial hot gas testing, a series of cold-flow, ambient pressure tests were conducted to determine the flow vs pressure drop characteristics of the operating beds, observe the fluidization characteristics of the shallow beds, and to develop correlations between the measured eductor pressure drop and total mass flow through the eductor. These studies are reported in detail in Reference 5. In addition, hot gas testing of the unit has been conducted in three test phases. This work is reported in References 6 through 8 and briefly summarized below. Table 3-1 shows the overall scope and accomplishments of test work through Phase III.

In test Phase I, the GBF unit was operated under simulated PFBC conditions feeding reentrained ash obtained from the second stage, cyclone catch of the Curtiss Wright Technology Rig. Test conditions were 1600°F (874°C) nominal operating temperature at 165 psi (11 atm) pressure using a 1370 μm tabular alumina as the bed media. The GBF

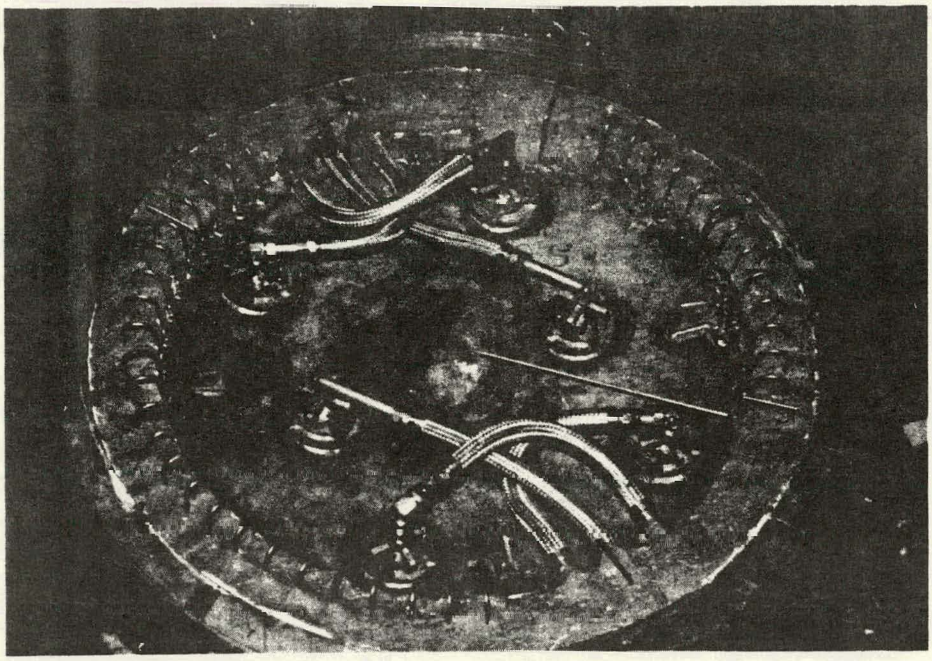

Figure 3-4 - Top view of GBF subpilot test unit showing the internal backflush piping lines, pressure tap leads and the applied thermal insulation on the inner portion of the support flange.

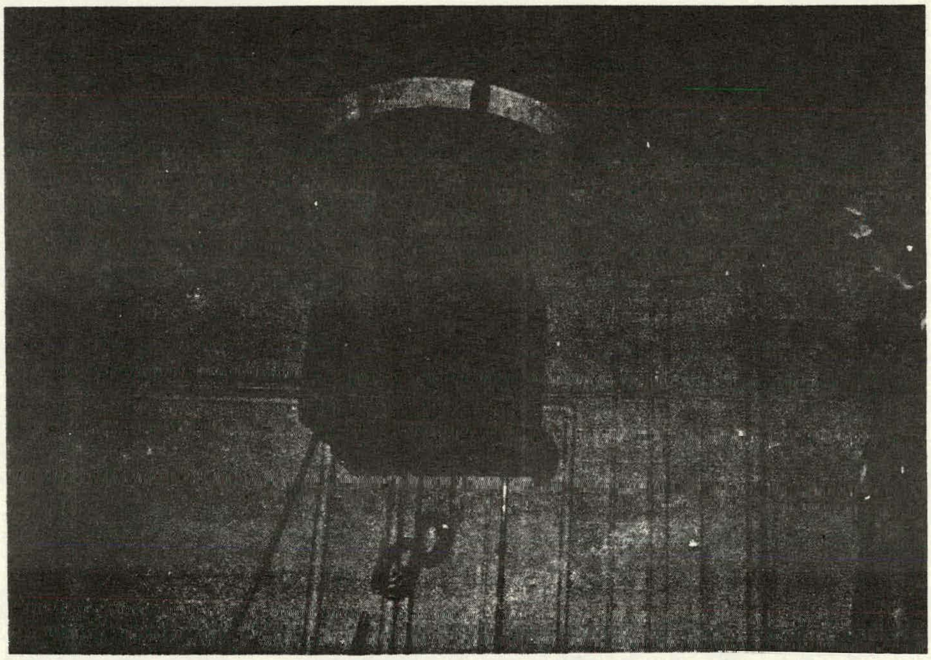

Figure 3-5 - View of GBF subpilot test unit being lifted to test facility pressure vessel. View shows applied thermal insulation around the outside of the support flange.

Table 3-1

SUMMARY OF GBF TEST ACCOMPLISHMENTS THROUGH PHASE III

Test Phase	Conditions	Major Accomplishments	Limitations/Observations
I	• 1600°F/165 psi • 50 hrs operation • 103 cycles • 6 element/24 bed GBF with 1370 μm tabular alumina media	• Demonstrated integrated operation of GBF test unit, instrumentation and controls at conditions • Showed that elutriated dust cake agglomerates would readily settle with no apparent crossover to other parallel operating filter elements • Backflush times as low as 6 seconds	• Test operations plagued by leaks in gasket seals and failed back-flush lines • Mechanical design modified to circumvent further problems in Phase II
II	• 1600°F/90 to 165 psi • 50 hrs operation • 90 cycles • 6 element/24 bed GBF with 1370 μm tabular alumina media	• Confirmed ability to sustain stable baseline pressure drop over repeated cleaning cycles and clean on-line • Overall collection efficiencies between 96 to 99% possible with the 1370 μm size bed granules	• Maldistribution of backflush flow identified as major factor in bed media elutriation - test unit modified to eliminate problem in Phase III • Screen & flow distributor plate warping observed in post test unit inspection
III	• 1500°F/125 psi • 71 hrs operation • 282 cycles • 6 element/6 bed GBF with 620 μm sand media-reinforced screens	• Achieved 99.2% overall collection efficiency (test average) sufficient to meet or exceed PFBC requirements • Showed that 80% of dust penetrating does so during backflush cycle. • Identified improved design possibilities for achieving still higher performance/more flexible operation.	• GBF test unit modifications made to fix previous problems has left unit relatively inflexible • Experienced 18 to 30% loss of sand media in off-line cleaning mode • Base-line Δp increased suggesting inefficient cleaning

unit was operated for approximately 50 hours at conditions (cumulative time) and tested through about 103 operating cycles at a nominal filter face velocity of 40 ft/min (12 m/min). The significant accomplishments of this test phase (Phase I) have included:

- The integrated operation of the GBF test unit, its instrumentation and controls at PFBC conditions
- Showed that elutriated dust cake agglomerates would readily settle with no apparent crossover to other parallel operating elements
- That backflush times as low as 6 seconds could be achieved.

During testing, several mechanical design problems with the GBF unit were encountered that limited test data results and that necessitated subsequent repair. Two of the fiberfrax gaskets that provided dust seals between the elements and their respective eductor sections had failed providing a direct dust path to the clean-gas filter side and resulting in poor collection efficiency. Also, the tube couplings connecting the flexible backflush lines to the eductor had all loosened and some had detached. The ability to backflush and clean these filter elements was lost. Following this testing, the GBF unit was removed from the test facility vessel and the failed backflush lines and eductor-to-element dust seals repaired (see Reference 6).

A second series of tests (Phase II) have since been conducted. Results of this testing are reported in Reference 7 and showed the inability to maintain a uniform distribution of the backflush flow between the filter beds. This led to excessively high backflush flows through some of the filter beds, the possibility of bed media being elutriated and poor system performance. Subsequent cold flow testing showed significant differences between the flow resistance of the respective filter bed distributor plate and screen assemblies. Analysis of this data confirmed that the measured differences in flow resistance could indeed result in bed media elutriation in some of the filter beds.

A third test phase (Phase III) was conducted aimed at evaluating an alternative bed media (620 μm sand) for improved dust collection efficiencies. In addition, the test unit was modified by sealing-off all but one filter bed per element to circumvent the backflush flow problems encountered in Test Phase II. Results of this work are described in detail in Reference 8. The significant accomplishments of test Phase III are:

- At a nominal 50 (ft/min) filter face velocity, the overall test average collection efficiency was 99.2%. This performance level was averaged over approximately 230 operating cycles with inlet dust loadings that ranged to about 10,000 to 15,000 ppm with outlet loading measured from 13 ppm to 153 ppm.

- Increasing filter face velocity showed decreased collection efficiency. At 75 and 100 ft/min filter velocities, collection efficiencies were measured at 98.5% and 96.5% respectively.

- Most of the dust penetrating the filter unit does so during or immediately following the backflush cycle. Outlet dust samples taken only during the filtration portion of the operating cycle showed dust penetrations that were lower by nearly an order of magnitude compared to outlet dust samples taken over both filtration and cleaning cycle. This result suggests that overall collection efficiencies of 99.9% or greater could be achieved if backflushing could be done without fluidizing the filter media.

- Online cleaning of the test unit could not be accomplished because of high operating pressure drops that were associated with the eductor modifications necessitated by the reduced flow operation.

- Utilizing off-line cleaning, a stable baseline pressure drop cycle was achieved with the 620 μm sand media and backflush velocities of about 1.2 ft/s.

- Post test analysis show some bed media loss ranging from about 18 to 34% of the initial change. Since tests were conducted over a relatively wide range of backflush flows, the bed media loss cannot be satisfactorily resolved.

A fourth test phase has now been completed. Results of this testing are reported.

3.4 Modified Filter Element Design

Drawings of the redesigned filter element are provided in Reference 9. The single bed, cylindrical filter element was sized to accommodate the original flow capacity of the 4-bed rectangular element design used in Test Phase I and II. This has allowed utilizing the existing eductor section, flow measuring instrumentation and dished head support structure. Six new filter elements were fabricated by Ducon Inc. and delivered to Westinghouse. Figures 3-6, 3-7, and 3-8 show the modified subpilot scale GBF test unit. With the modified test unit, the backflush piping was also changed to eliminate the flexible tubing previously used in Test Phases I and II. Figure 3-7 shows the backflush piping arrangement that used 3/4 inch diameter stainless steel tubing with thermal expansion loops. All fitting and tube connections were seal-welded to avoid loosening or detachment. Figure 3-8 shows the GBF test unit assembly being loaded into the test vessel. For Test Phase IV each of the cylindrical filter elements were loaded with a dual bed media comprising the 1370 μm alumina previously used in Test Phases I and II and a 584 μm (equivalent) stainless steel wire shot. The purpose of the alumina media was to provide a horizontal surface over the screen assembly (which was slightly concave) to allow a uniform depth for the SS wire shot. The overall depth of the dual media filter bed was approximately 3 inch; 1.5 inch alumina and 1.5 inch SS wire shot. Cold flow data and projections of the filter media pressure drop flow characteristics under hot test conditions are provided in Reference 9.

3.5 GBF Test Results - Phase IV

Results from the Phase IV testing are summarized in Table 3-1. The GBF test unit was operated for approximately 50 hours at gas temperatures of 1550°F, pressures from 80 to 125 psig, with a filter face velocity of about 45 ft/min and through 140 operating (filtration/cleaning) cycles. During the course of this testing, backflush flow conditions were varied and the test unit cleaned on-line. The maximum system pressure drop (Δp prior to cleaning) was

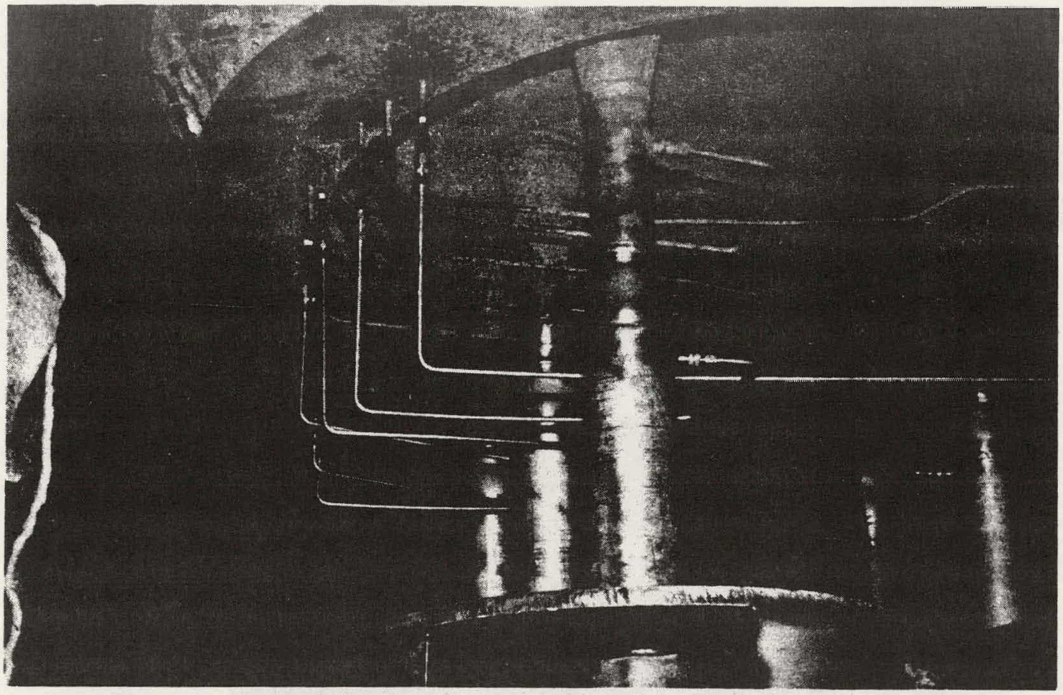

Figure 3.6 - Photograph Showing Attachment of New Cylindrical GBF Elements to Existing Dish Head Support Plate

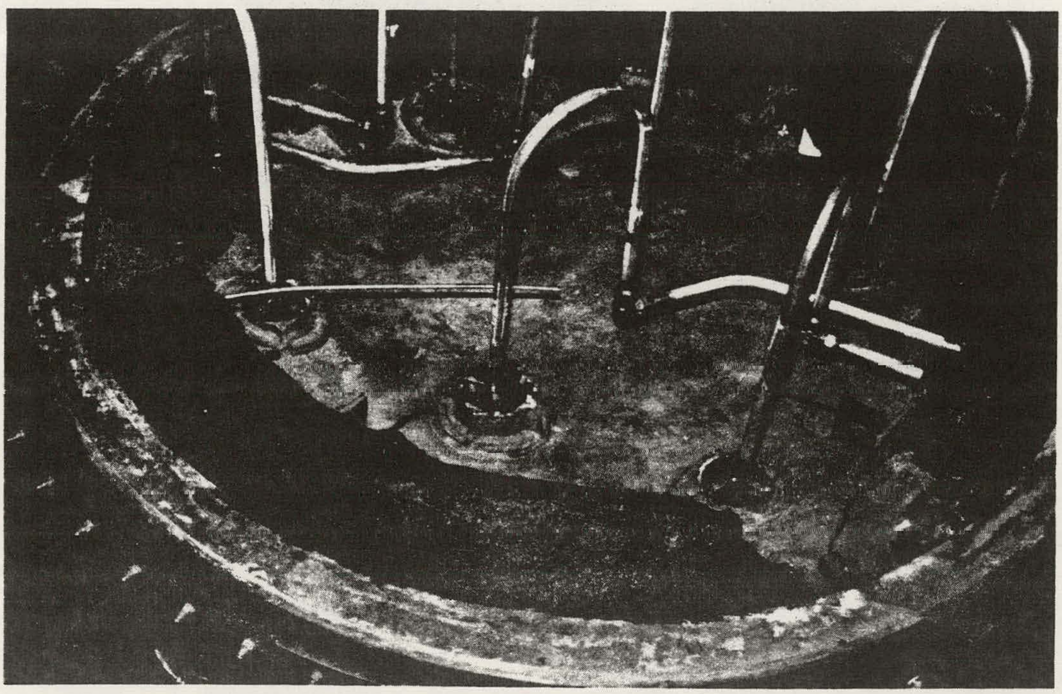

Figure 3.7 - Photograph Showing Modified Backflush Piping Arrangement

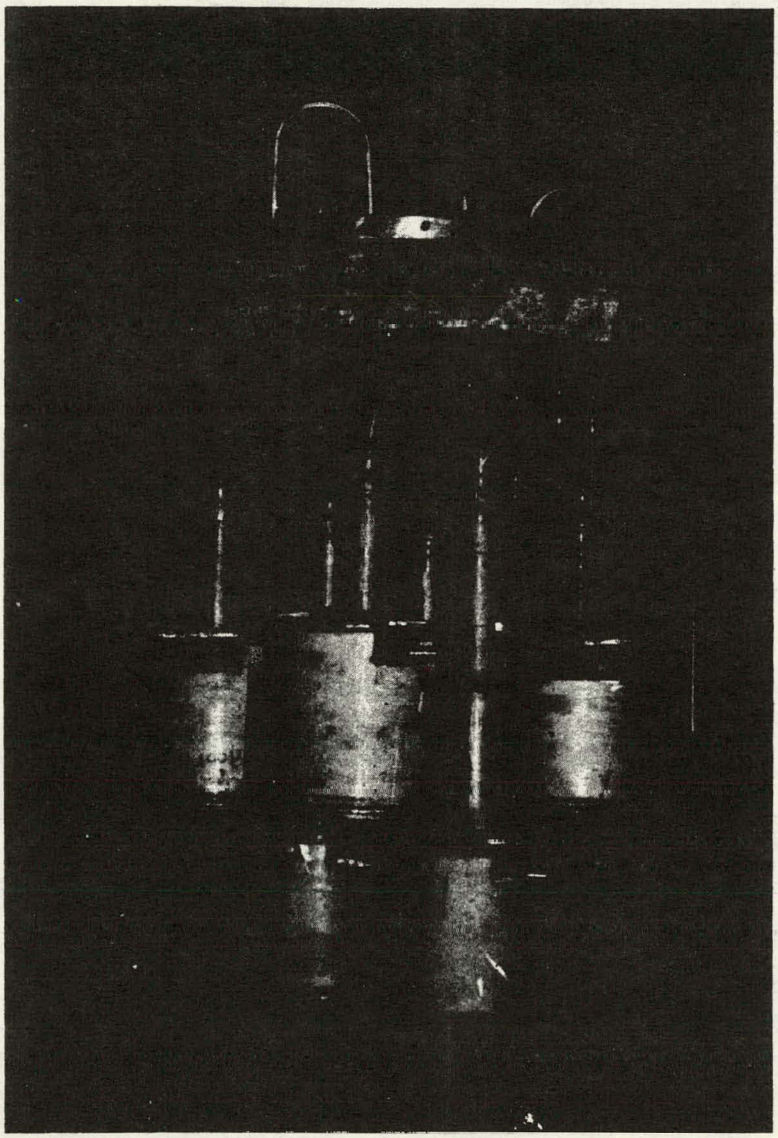

Figure 3.8 - Photograph of Assembled GBF Unit Readied for Testing

varied from 15 in. H_2O to 30 in. H_2O with the filter unit operating at a stable baseline Δp (pressure drop after cleaning) of less than 10 in. H_2O. Figure 3-9 shows a segment of the filter unit pressure drop trace that was taken from one series of the test program. Stable operating cycles could be maintained with online cleaning and with backflush velocities as low as 1.0 ft/sec. Based on an earlier fluidization characterization of the bed media, this backflush velocity should be below the minimum fluidization condition. Figures 3-10 and 3-11 show the measured pressure drop across each eductor during backflush for each element and the measured response of the thermocouples that were located in each filter bed. Figure 3-10 shows these data early in the test program while the data in Figure 3-11 corresponds to a later time. The individual filter elements are identified in Figure 3-10 by the E-1, E-2 etc. designation. The onset of backflush is shown by the pronounced increase in the recorded Δp trace.

Each filter element is backflushed in sequence as indicated by the time scale. The two sets of data represent two different backflush conditions. The magnitude of the measured eductor Δp is related to the backflush flow entering the respective filter element by the equation

$$\dot{M}_{eductor} = 0.2982\ (\rho g)^{1/2}\ (\Delta P)^{1/2}$$

Tables 3-2 and 3-3 give a summary of the backflush conditions corresponding to data represented in Figures 3-10 and 3-11. Shown are the measured eductor and motive flows, calculated backflush superficial velocity corresponding to the measured flows and the overall performance of the eductor as determined from the mass flow measurements. Average values are given in the tables although the actual data show the backflush flow varies during the cleaning cycle in any given element. The data also shows that the backflush flow varies between filter elements even though the motive flow is the same in each. The calculated backflush velocity from the Figure 3-10 data show values that range between filter element from 1.5 to 2.1 ft/s. This is somewhat

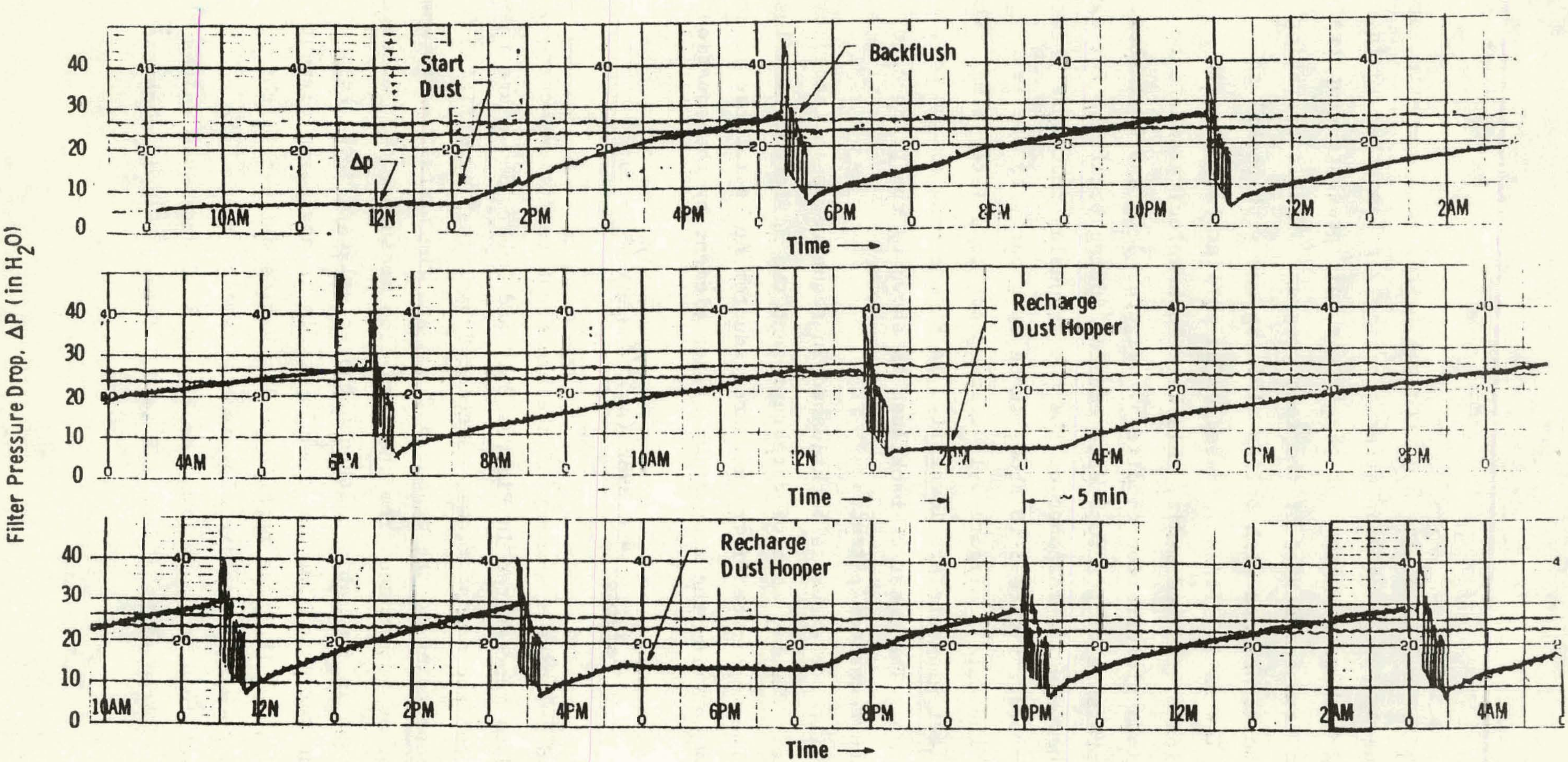

Figure 3.9 – GBF - PRESSURE DROP VS TIME TRACE - PHASE IV

Figure 3.10 - CHARACTERISTICS OF GBF ELEMENTS DURING BACKFLUSH 2-1-83

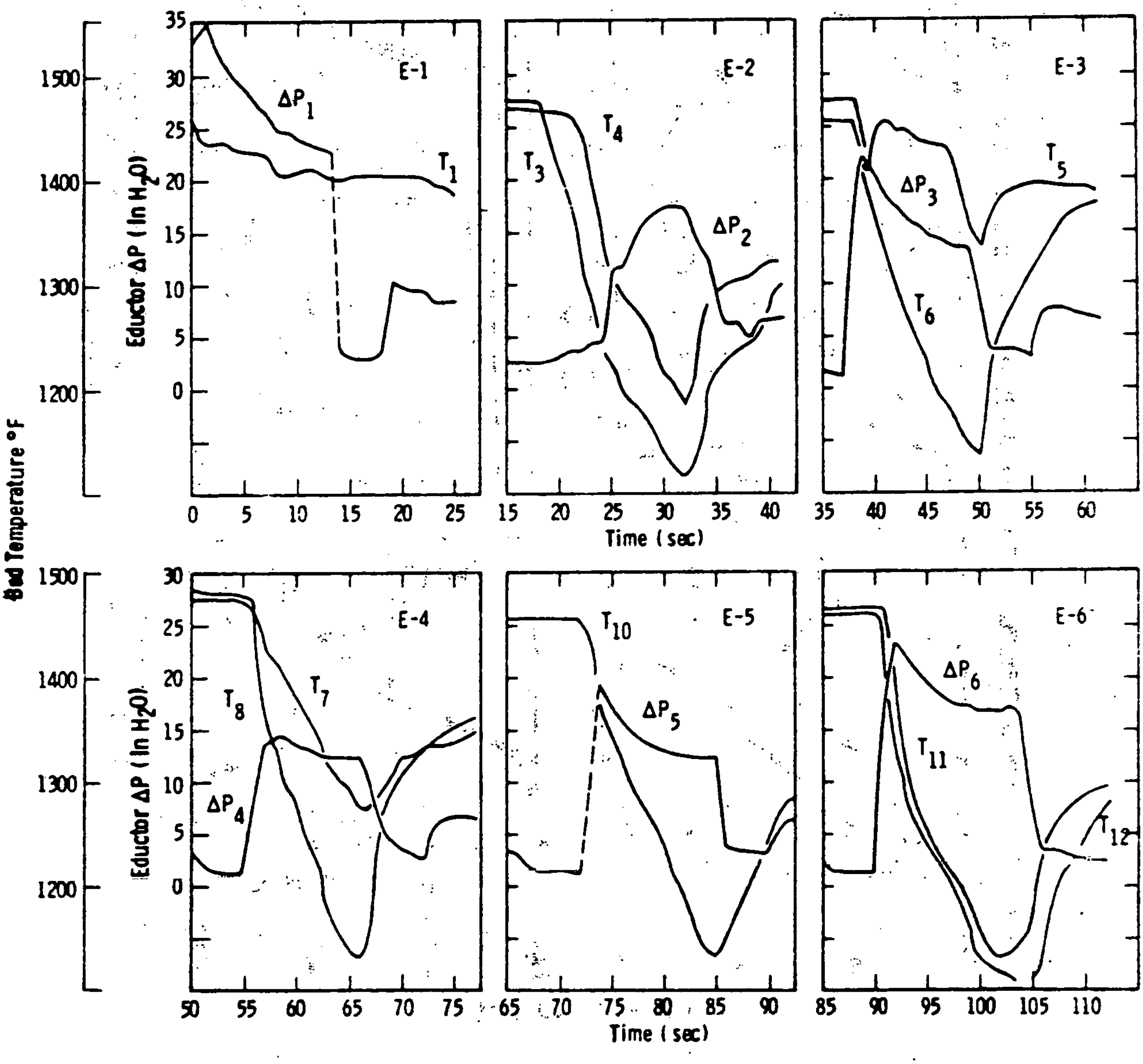

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Figure 3.11 - CHARACTERISTICS OF GBF ELEMENTS DURING BACKFLUSH 2-4-83 (19: 44: 26)

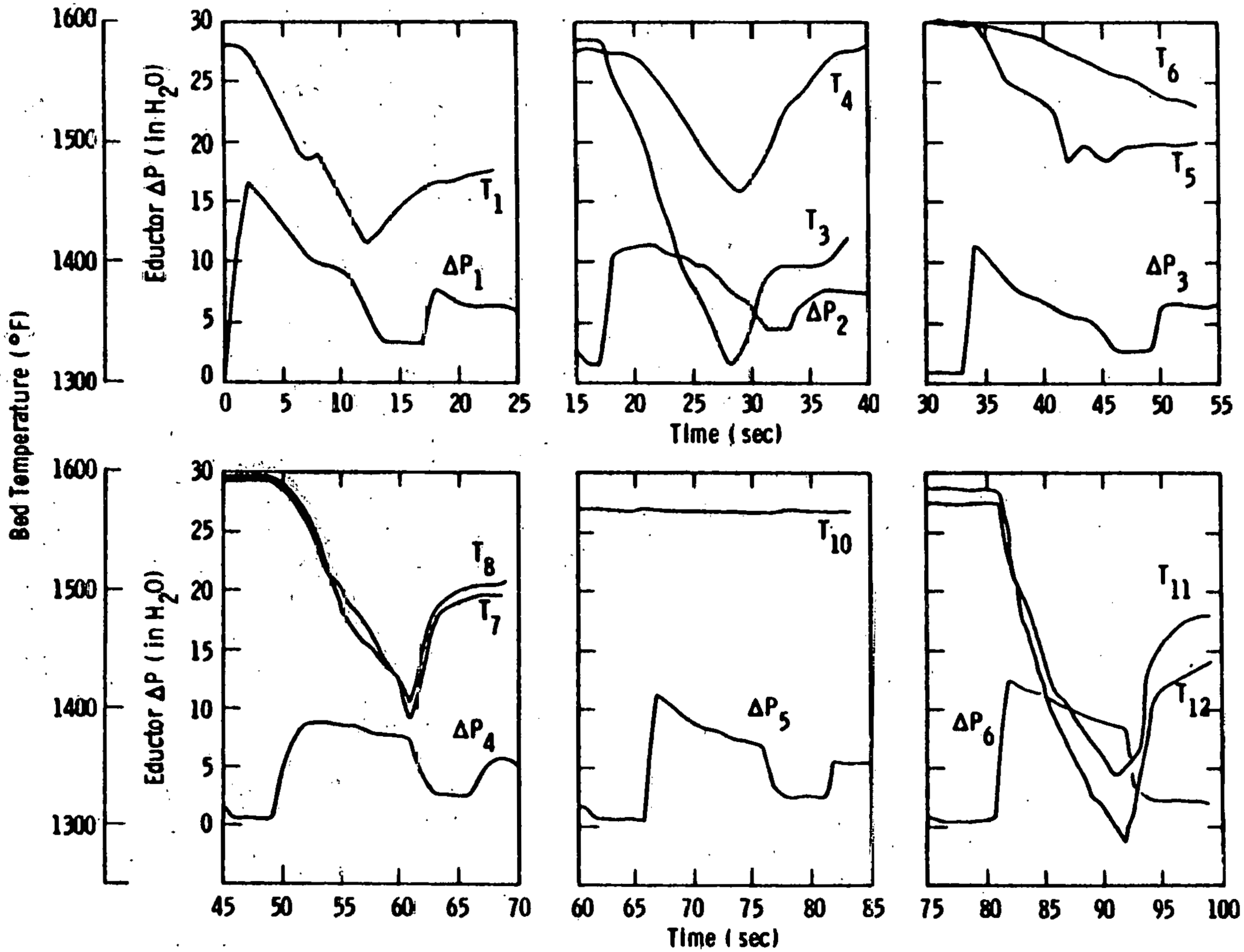

Table 3-2

SUMMARY OF GBF BACKFLUSH CONDITION FOR DATA GIVEN IN FIGURE 3-10

	GBF ELEMENT					
	1	2	3	4	5	6
$\Delta P_{eductor}$ (in H_2O)	29	15	77	14	15	20
$M_{eductor}$ (lb/s)	0.70	.51	.55	.50	.51	.59
M_{motive} (lb/s)	0.40	0.40	.40	.09	.09	.09
$V_{backflush}$ (ft/s)	2.1	1.5	1.6	1.5	1.5	1.7
$X = \frac{\text{Induced flow}}{\text{Motive flow}}$	0.75	0.27	0.37	0.26	0.27	.47

Table 3-3

SUMMARY OF GBF BACKFLUSH CONDITIONS FOR DATA GIVEN IN FIGURE 11

	GBF ELEMENT					
	1	2	3	4	5	6
$\Delta P_{eductor}$ (in H_2O)	12	9	8	8	10	11
$M_{eductor}$ (lb/s)	.46	.40	.38	.38	.42	.44
M_{motive} (lb/s)	.24	.24	.24	.24	.24	.24
$V_{backflush}$ (ft/s)	1.3	1.2	1.1	1.1	1.2	1.3
$X = \frac{\text{Induced flow}}{\text{Motive flow}}$	.91	.66	.58	.58	.75	.83

higher than the projected minimum fluidization condition but below the expected velocity for media elutriation. The data in Figure 3-11 show conditions where the filter beds were backflushed at superficial velocities of 1.1 to 1.3 ft/s, and correspond to conditions most typical of Test Phase IV. The intent in Test Phase IV was to operate the filter during backflush at about 1.0 ft/s superficial velocity but the changing conditions in the bed and variability in the backflush flow precluded operating at any one precise set point. In test Phase IV, backflushing was likely occurring at or near the minimum fluidization condition of the media (about 1.2 ft/s) and the static bed, reverse flush operation as originally planned may not have been realized throughout the full backflush cycle, nor under all test conditions or in all filter elements. The operating margin between the velocity for efficient elutriation of dust agglomerates and the minimum fluidization condition of the stainless steel wire shot used for bed media appears too narrow to safely accommodate variations that occur in the backflush conditions.

The temperature plots shown in Figures 3-10 and 3-11 correspond to thermocouple readings taken in the bed media in each filter element during the backflush cycle. Two thermocouples were positioned 180^{o} apart in each filter element and are consecutively numbered as identified in the Figures 3-10 and 3-11. Thermocouples T2 (Element 1) and T9 (Element 5) were inoperative. Figure 3-10 shows the response of the thermocouple during the backflush cycle when relatively cold motive air is introduced through the filter media. The thermocouples in both Element 2 and 6 show similar transient temperature behavior. In each bed, both thermocouples respond nearly identically during backflush suggesting that the flow is being distributed equally around the filter bed. This should result in the most efficient cleaning. The magnitude of the temperature change during backflush in these cases is about 350^{o}F. Filter Elements 3 and 4 respectively, show differences between the two measured temperature transients. The effect is more pronounced in filter Element 3. This suggests the possibility that the backflush flow is not distributing uniformally around the filter bed and conditions of high local velocity may result. Filter Elements 1 and 5 each contain only one operative thermocouple. The relatively small change in temperature that is observed in Element 1 suggest possible nonuniform distribution of the backflush flow in this particular test.

The thermocouple data shown in Figure 3-11 corresponds to lower backflush flow conditions and somewhat latter in the test program. In this specific case, the two temperatures measured within Element 4 show almost identical transients. Element 6 shows similar temperature measurements. The temperature transients measured in filter Elements 2, 3, and 5 again may indicate a nonuniform distribution of the backflush flow around each of the respective filter beds. A comparison of the two test runs (Figures 3-10 and 3-11) further suggests that the specific backflush characteristics probably change with test conditions and accumulation of operating cycles.

Measurements of the filter collection efficiency during the test program were made and are shown in Figure 3-12 plotted as a function of the number of operating cycles. Initially high overall collection efficiencies were obtained that are in excess of 99.3%. These data correspond to measured outlet dust loadings that ranged from 7 to 40 ppm with inlet dust loadings from 2740 to 4875 ppm. After about 40 operating cycles (14 hours of testing), the performance of the filter unit decreased significantly. In the later portions of the test program, the data show considerable scatter but all measurements showed collection efficiency to be less than 95%. Some of the data scatter may be the result of special diagnostic tests done to determine if one of the GBF elements had failed catastrophically. This was done by manipulating the backflush sequence to systematically isolate (or shut down) each element for a portion of the test run. These tests proved inconclusive and the test program was halted when the performance of the filter unit had deteriorated and there was no apparent or identifiable single reason.

The removal and inspection of the test unit, Figures 3-13 through 3-17 showed that some of the wire shot bed media had penetrated to the clean gas side, Figure 3-14 (top view). Figures 3-15 through 3-17 show close-up views of the filter beds after testing. As seen, in five of the six filter elements, a portion of the distributor plate is exposed, clearly indicating that the bed media had been displaced. Only in Element 6 was the bed media still totally covering the distributor plate assembly.

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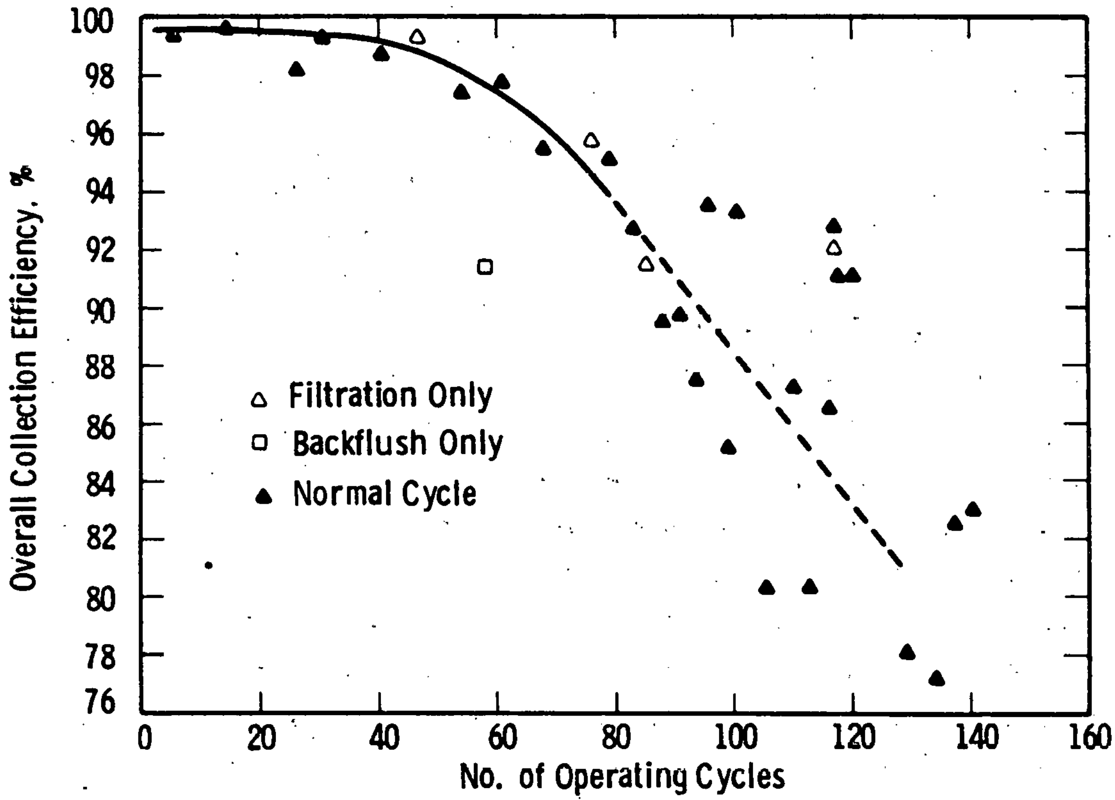


Fig. 3.12 Measured trend in GBF performance with increasing number of operating cycles

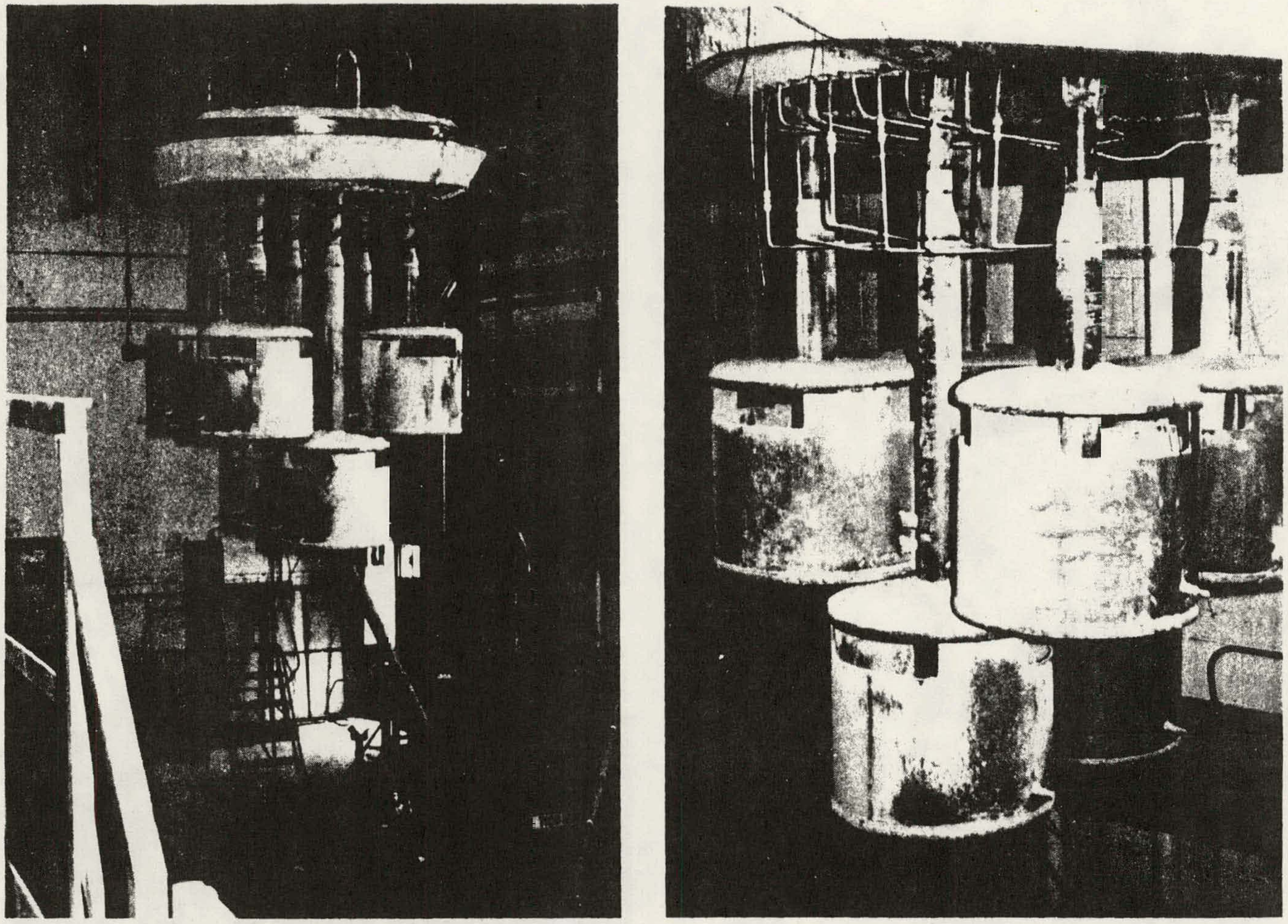
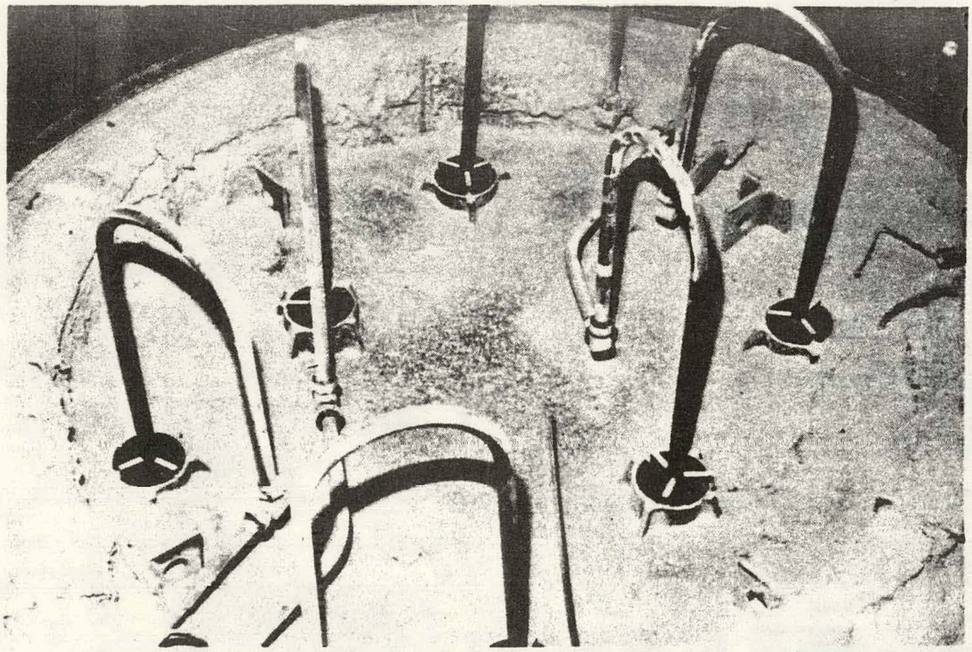
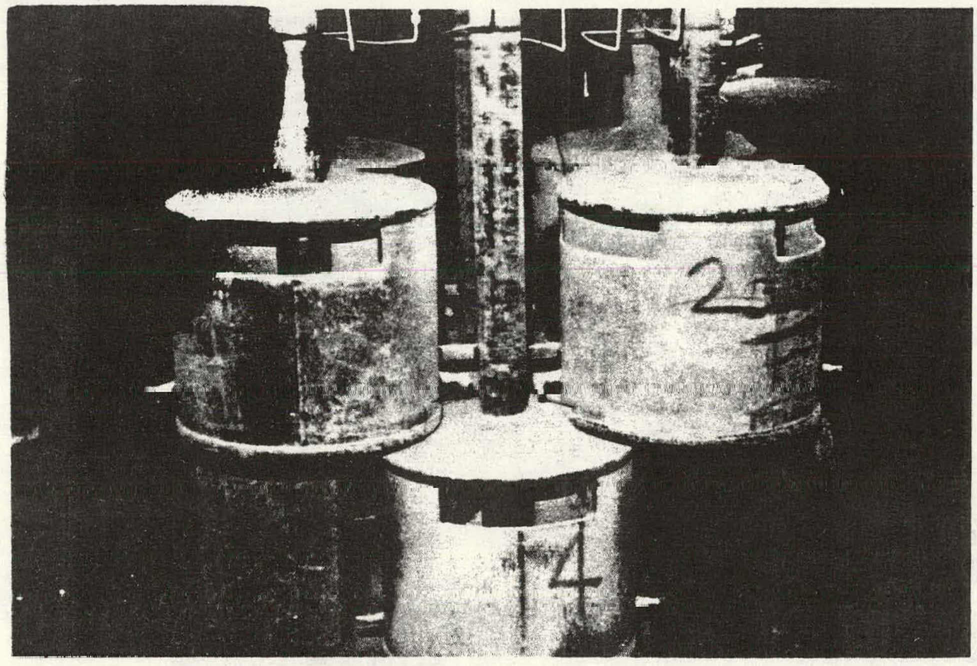


Figure 3.13 - GBF Subpilot Unit Assembly (Cylindrical Elements) After Testing, Phase IV



View of Outlet Section of GBF Unit Showing Blowback Lines and **Accumulated Dust**



View of Cylindrical Elements Prior to Post Test Inspection

Figure 3.14 - Photographs of GBF Subpilot Unit After Testing, Phase IV

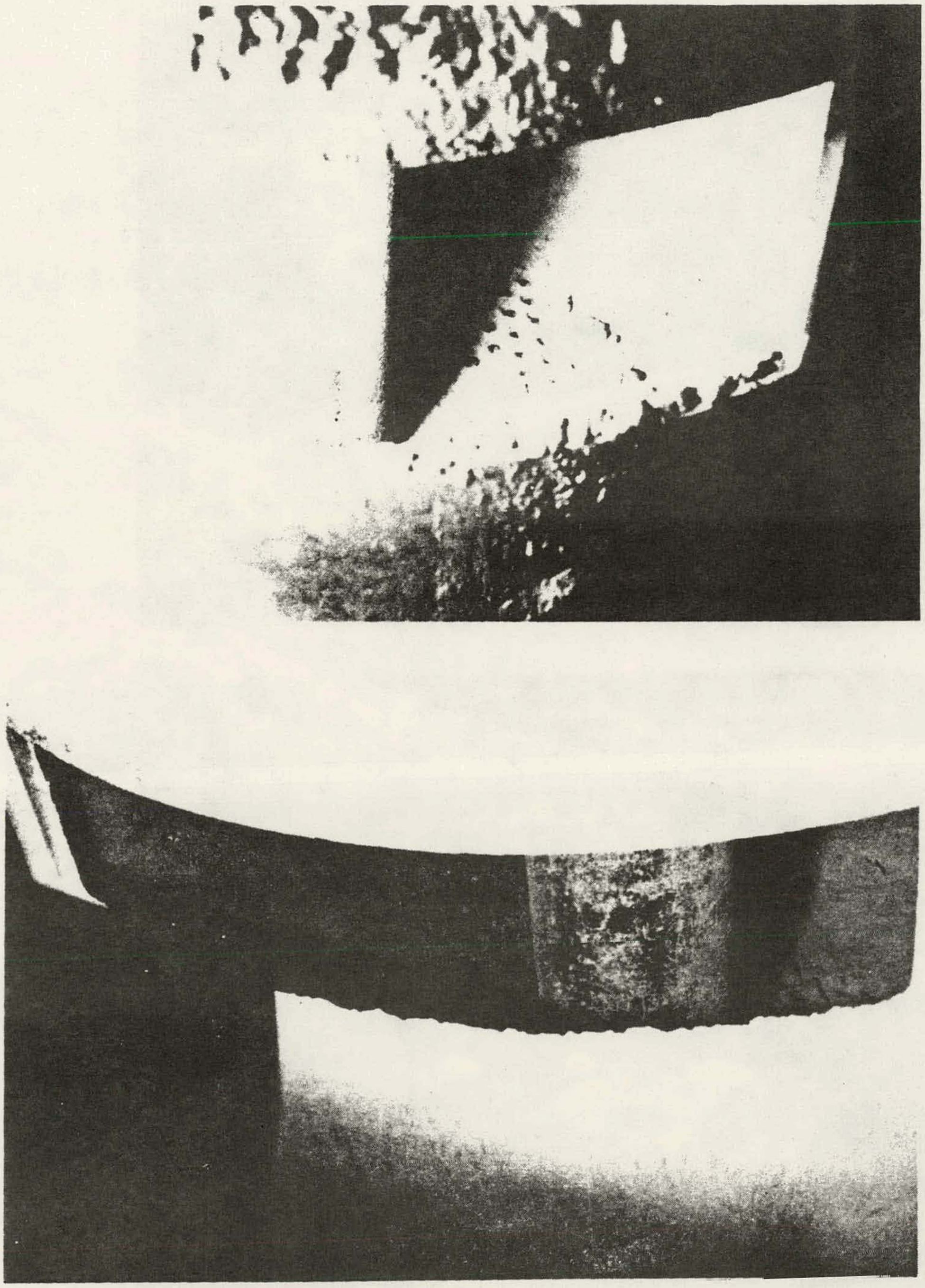


Figure 3.15 - Appearance of Filter Beds After Testing, Elements 1 and 2
(Phase IV)

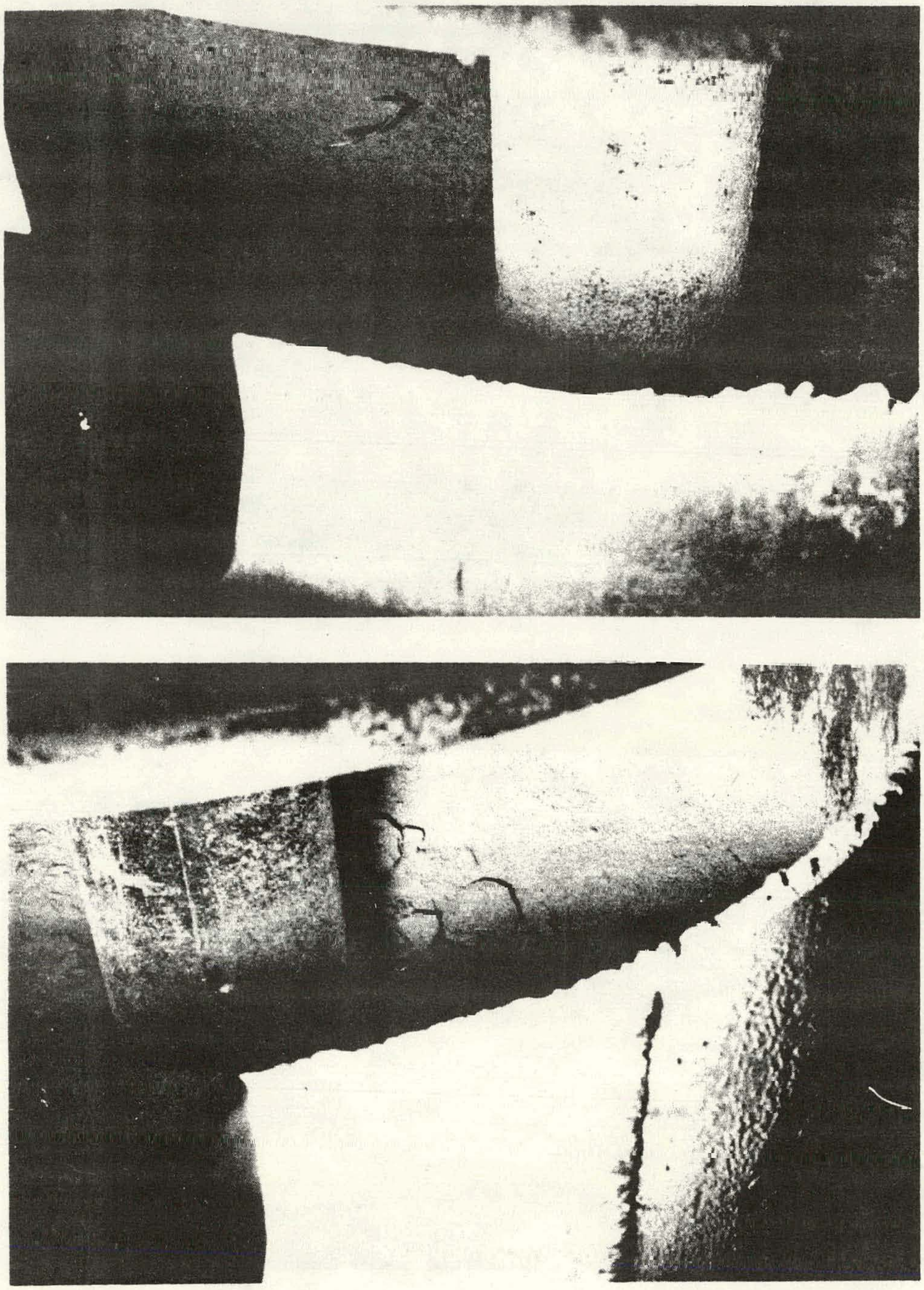
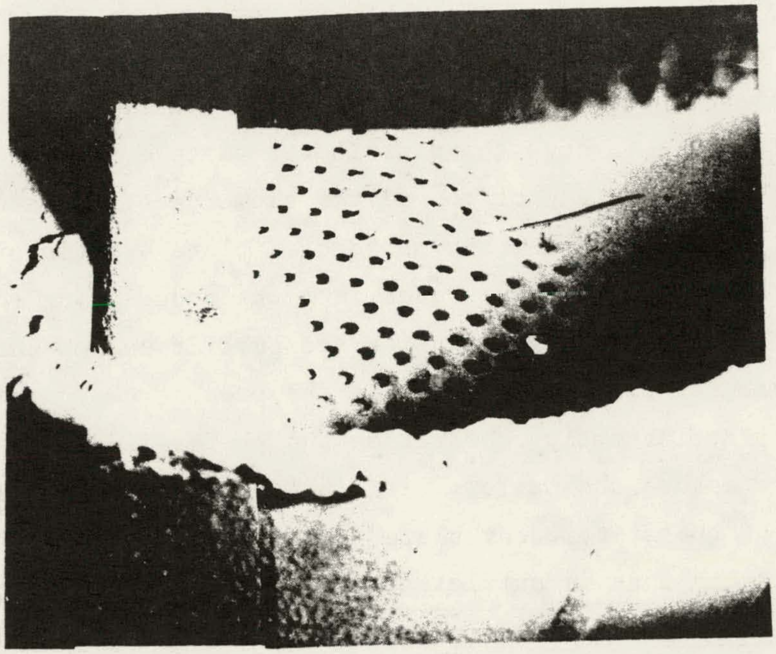
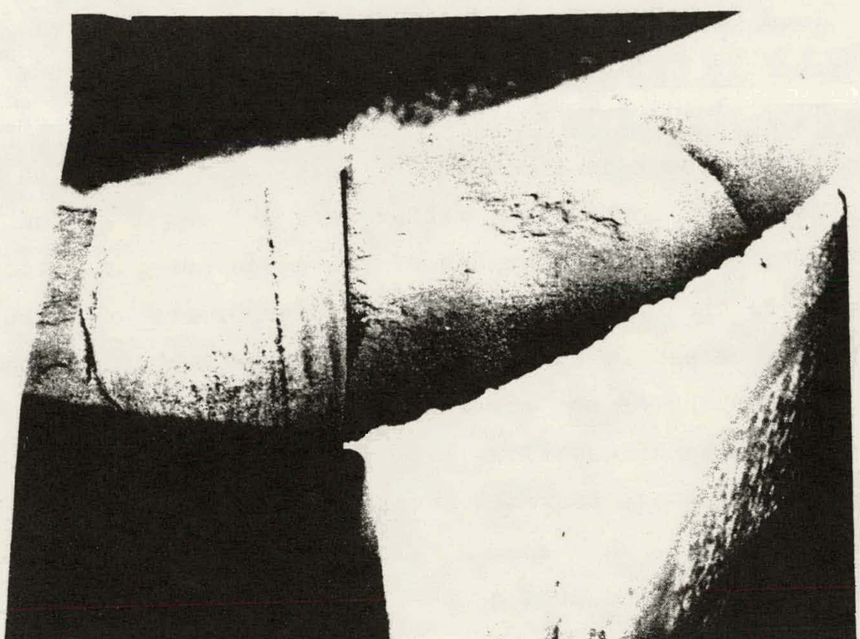


Figure 3.16 - Appearance of Filter Beds After Testing, Elements 3 and 4
(Phase IV)



ment 5



Element 6

.17 - Appearance of Fter Beds After Testing, Elements 5 and 6
(Phase IV)

The appearance of the filter beds suggest that again, a nonuniform distribution of the backflush flow occurred, with most of the flow being directed through the distributor plate assembly in the exposed areas. Inspection of the filter elements after vacuuming the bed contents showed that the top perforated plate was distorted over its surface and had physically separated from the underlaying screen. This can cause a significant change in the pressure drop-flow characteristics of the distributor plate assembly. In the present design of the distributor plate assembly, the screen and perforated plates must remain in contact to assure the uniform distribution of the backflush flow over the surface of the distributor plate. The present design is susceptible to thermal stress that is sufficient to separate screen and plate. The recovery of bed media on the clean gas side suggests that in one or more of the beds some type of tear or failure in the screen occurred that was sufficient to allow the media to pass-thru. From visual inspection of the unit it could not be determined where or how this occurred.

The results of sieving the recovered contents of each filter bed are given in Table 3-4. This analysis shows that nearly all the alumina media was lost from the beds and from 50 to 90% of the stainless steel shot. It is not known how much of either material was lost due to elutriation on backflush and how much of the media escaped through the screen assembly to the clean gas side. Redesign of the distributor plate assembly is necessary to circumvent both the mechanical failure possibility and warping of the metal plate that can cause a nonuniform distribution of the backflush flow.

Plans and work are presently continuing to implement a Phase V test program on a bench scale, single GBF element. Cold flow and hot gas tests would be conducted at the Westinghouse R&D Center using the existing test facilities.

Table 3-4

GBF-CYLINDRICAL ELEMENTS

SUMARY OF BED MATERIAL RECOVERED

TEST PHASE IV

Element	Wt Total (kgms)	Wt SS Wire Shot (kgms)	Wt Alumina (kgms)	Wt Dust (by difference) (kgms)
1	7.06	5.60	0.18	1.28
2	4.26	2.78	.76	0.72
3	19.32	16.20	1.41	1.71
4	8.43	6.67	0.47	1.29
5	4.82	3.5	0.15	1.17
6	9.76	8.12	0.69	0.95

Initial Charge

S.S. Wire Shot: 30.27 kgms

Alumina: 7.57 kgms

4. TASK 1.3 - ALKALI MEAL REMOVAL

Work on this task has been aimed at the evaluation and selection of possible alkali sorbents that could be used with the Granular Bed Filter system. Tests have been conducted on a number of candidate materials to measure their overall alkali uptake and the chemical kinetics between the alkali and sorbent. Results of this work have been reported (References 1 through 7) and the scope of the planned work completed. Additional alkali gettering work is still being carried through on the DOE contract DE-AC21-80MC16372 "High Temperature Removal of Alkali and Particulates in Pressurized Gasification Systems." The monitoring of this work will continue throughout the contract period and data applicable to the GBF concept will be incorporated into the final system evaluations.

5. TASK 1.4 - PFBC SYSTEM PERFORANCE

A preliminary set of parametric studies have been conducted to evaluate specific GBF design and operating parameters with respect to their impact on the three PFBC reference plant concepts.[3] The impact of the different GBF design and operating parameters is measured by the calculated reduction (or increase) in the net plant output relative to the same plant operating without the GBF. For a given PFBC concept, this basis provides a simple normalized comparison to evaluate the relative effects of selected parameters, and the relative sensitivity of varying one parameter over a range of conditions. Also, between plant concepts, the analysis has provided a relative basis for determining if a different set of GBF operating and design parameters are more appropriate for one PFBC concept over the next.

In addition, a preliminary set of economic trade-offs have been completed that compare the all-cyclone PFBC steam cooled and air cooled plants to the reference PFBC plants developed in Task 1.1. The all-cyclone plant description was developed under an independent Westinghouse study funded by ANL/DOE, Contract ANL 31-109-38-6308. For the purpose of the present study, an economic comparison is made between the cooto for particulate gas clean-up between the two plants as a function of the operating characteristics of the GBF unit (face velocity), Reference 6. No system studies have been conducted this report period. Additional planned work in this task has been reduced in favor of increased GBF test work.

6. TASK 1.5 - COMMERCIAL SCALE GBF CONCEPTUAL DESIGN

Initial efforts scheduled in this task have been reported.[3] Additional work on this task has been reduced in favor of Phase IV testing.

7. REFERENCES

1. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalis," DOE/ET17093-T1, (Quarterly Report for the Period October through December 1980), to be issued.

2. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T2, (Quarterly Report for the Period January through March 1981), to be issued.

3. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T3, (Quarterly Report for the Period April through July 1981), to be issued.

4. "Testing and erification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T4, (Quarterly Report for the Period August through October 1981).

5. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T5, (Quarterly Report for the Period October 1981 through December 1981).

6. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T6, (Quarterly Report for the Period January through June 1982).

7. "Testing and Verification of Granular Bed Filters for Removal of Particulates and Alkalies," DOE/ET17093-T7 (Quarterly Report for the Period April through June 1982).

8. "Testing and erification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T8 (Quarterly Report for the Period July through September 1982).

9. "Testing and Verification of Granular Bed Filters for Removal of Particulate and Alkalies," DOE/ET17093-T9 (Quarterly Report for the Period October 1982 through December 1982).

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