

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
FERRY NUCLEAR POWER PLANT OPERATIONS MANUAL

TEMPORARY INSTRUCTION

TITLE: OFF-GAS SYSTEM ACTIVATED CARBON ANALYSIS

TYPE OF
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OFF-GAS SYSTEM ACTIVATED CARBON ANALYSIS

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10CFR50.59 Applicability Check

	Yes	No
Is there a change to the plant as described in the FSAR? Reason: <u>Chemistry Analysis being performed, doesn't change plant.</u>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a change to a procedure/instruction as described in the FSAR? Reason: <u>This RTI not described in FSAR.</u>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a test or experiment not described in the FSAR? Reason: <u>Chemistry Analysis being performed.</u>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there a change to the Technical Specifications?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Is there an effect on the environment or change on the Environmental Protection Plan? Reason: <u>No environmental impact.</u>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Answers to all questions are "No", no potential for an Unreviewed Safety or Environmental Question exists, no further review required.

Answers to one or more questions is "Yes", further review required.

Prepared By: Ally Date: 6/27/86
Reviewed By: STW Date: 6/27/86
Approved By: STW Date: 6/27/86

Scope of Revision: Incorporate NRC comments.

OFF-GAS SYSTEM ACTIVATED CARBON ANALYSIS

1.0 DESCRIPTION

1.1 Purpose

This instruction provides a plan and implementation for investigation of Off-Gas Treatment System activated carbon after the occurrence of ignition in both N64-D014 vessels during testings. Included in this procedure are methods and rationales for the investigation to determine acceptability of adsorbent for use in situ, and any intrusion of organic vapor contamination in the system as a whole.

1.2 General Discussion

1.2.2 Sampling

1.2.1.1 The inlet of adsorbers 14A and 14B will be sampled, using a multi-slotted tube thief sampler. This sample will be used to determine acceptability for further use based on General Electric Specification 21A9375, Activated Carbon for Charcoal Adsorbers, Off-Gas System.

1.2.1.2 The inlet of adsorbers 12A and 12B will be sampled and tests performed by this procedure to determine the presence of possible system contamination by hydrocarbons, including ethylene glycol. Tests will also be performed per General Electric 21A9375 to provide current acceptance data for this adsorber which was not involved in ignition.

1.2.1.3 A representative sample will be taken from a drum in storage of the same type of activated carbon used in the Off-Gas adsorber vessels whose contents have not been used previously and whose seal is intact. This sample will undergo the same testing in this procedure as described in subsections 1.2.1.1 and 1.2.1.2.

1.2.1.4 Sampling will be performed in a manner to achieve representation. Guidance in sampling is provided by ASTM E-300.

1.2.2 Methods for Implementation

1.2.2.1 Tasks to be completed to perform this instruction shall be performed in accordance with PNFP Work Order System PAF-0905, Rev. 4.

1.2.2.2 Sampling shall be according to this instruction, RTI-0008

1.2.2.3 Analyses shall be performed by approved independent contractors.

1.2.3 Analyses to be Performed

1.2.3.1 Conformance to General Electric 21A9375

Samples collected from subsections 1.2.1.1, 1.2.1.2 and 1.2.1.3 shall be analyzed for conformance with General Electric Specification 21A9375 using procedures outlined in this specification, ASTM procedures and/or approved vendor procedures.

1.2.3.2 Hydrocarbon Contamination

Samples collected from subsection 1.2.1.2 and 1.2.1.3 shall be analyzed to determine intrusion of organics/hydrocarbons into the Off-Gas Treatment system. ASTM Procedures and/or approved vendor Procedures shall be used.

1.2.3.3 Ignition Temperature

Samples collected in subsections 1.2.1.1, 1.2.1.2, and 1.2.1.3 shall be analyzed for ignition temperature per ASTM D3466-76 with flow conditions altered to closely approximate actual conditions in the adsorbers at the time of ignition. Flow rate shall be adjusted so as to maintain a superficial velocity across the test bed of 4.0 +/- 0.1 feet per minute.

1.2.4 Acceptance Criteria

Passing all analytical testing specifications per GE 21A9375 and no indicated organic contamination shall be the basis for continued use in situ.

Analytical results outside acceptance criteria of GE 21A9375 or detectable organic contamination shall have an engineering evaluation performed to determine suitability for further use and the possible need for further investigation.

1.3 Interferences

None

1.4 Special Precautions

None

2.0 APPARATUS

1. Sampler: Seeburo Equipment Company

TEMP CHANGE
<u>001</u>
PAGE <u>1</u> OF <u>1</u>

3.0 REAGENTS

None

4.0 PROCEDURE

4.1 Samplings N64-D012A, N64-D012B and N64-D014B Tanks

1. Obtain a sample from the Off-Gas Charcoal Adsorber N64-D012A . The sample point will be located on the bottom side where a thermowell had been removed from the tank.
2. Insert the tube horizontally until the top of sampler is even with the sample port opening.
3. Rotate the sampler 180 degrees and leave the registering slots facing upward prior to sampling.
4. Open the sampler registering slots.
5. Allow the sampler to sit undisturbed for approximately 20 seconds then close the registering slots and remove the sampler from the vault.
6. Place sample bottles directly beneath the registering slots.
7. Open the registering slots and roll sampler over such that the charcoal will fall into the sample bottles.
8. Place approximately one third of the sample in an individual sample bottle and consolidate the rest in composite bottle. Label each bottle with a sample I.D. sticker (PNFP Form No. 6073) containing the following information:
 - a. MPL No. of Adsorber bed sampled.
 - b. Date and time of sample collection.
 - c. Initials of person obtaining sample.
 - d. Depth and location identification for each individual sample shall be recorded.

TCN-001

9. Obtain a sample of the Off-Gas Adsorber N64-D0012B and N64-D014B as per Steps 2-8 Section 4.1.
10. Perform analysis as per Attachment 1 for each sample obtained.

4.2 Sampling N64-D0014A and N64-D0014B Tanks

Note: 12 foot sampler should be utilized for this method of sampling

1. Obtain a sample from the Off-Gas Charcoal Adsorber N64-D014A. The sample point will be located where the tank fill port was removed at the top of tank.
2. Ensure the sampler registering slots are closed.
3. Place the sampler vertically into the bed to a minimum penetration of four (4) feet into the charcoal bed.
4. Rotate the sampler 180 degrees prior to sampling.
5. Open the sampler registering slots once the sampler has penetrated such that representative samples of the upper half of the bed can be obtained. Asitate the sampler for approximately ten (10) seconds to ensure complete filling of sample compartments.
6. Allow the sampler to sit undisturbed for approximately 20 seconds then close the registering slots and remove the sampler from the vault.
7. Place sample bottles directly beneath the registering slots.
8. Open the registering slots and roll sampler over such that the charcoal will fall into the sample bottles.

9. Place approximately one third of the sample in an individual sample bottle and consolidate the rest in a composite bottle. Label each sample bottle with an I.D. sticker (PNPP Form No. 6073) containing the following information:
 - a. MPL No. of Adsorber bed sampled.
 - b. Date and time of sample collection
 - c. Initials of person obtaining samples
 - d. Depth and location identification for each individual sample shall be recorded.
10. Repeat Steps 2-9 Section 4.2 one in each quadrant of the tank, each time placing the sample into a new bottle.
11. Obtain a sample from the Off-Gas Charcoal Adsorber N64-D014B as described in Steps 2-10 Section 4.2. The sample point will be located where the tank fill port was removed.

4.3 Charcoal Drum Sampling

1. Utilizing the 5 foot sampler obtain samples from the charcoal drums, located in the warehouse, as per Steps 2-9 Section 4.2.

5.0 CALCULATIONS

None

6.0 REFERENCES

1. General Electric Specification 21A9375
2. ASTM D3466-76
3. ASTM E-300

7.0 RECORDS

The following documents are generated by this instruction:

Quality Assurance Records

None

Non Quality Records

None

Records identification and disposition are accomplished in accordance with the Records Retention/Disposition Schedule (RR/DS) and handled in accordance with PAF-1701, Plant Records Management.

8.0 ATTACHMENTS

8.1 Attachment 1 - Sample Data Sheet

ATTACHMENT 2

General Electric Specification 21A9375

Activated Carbon For Charcoal Adsorbers, Off-Gas System

NUCLEAR ENERGY DIVISION

DOCUMENT TITLE ACTIVATED CARBON FOR CHARCOAL ADSORBERS, OFF-GAS SYSTEM

SPECIFICATION DRAWING OTHER _____ TYPE PURCHASE

FMF OFF-GAS SYSTEM

LEGEND OR DESCRIPTION OF GROUPS

MPL No. ██████████, N64-D021, ██████████

PERRY

2065

JUL 22 '76

PERRY

REVISIONS			
2	<p>REWRITTEN WITH CHANGES Per ECN NE 71526. General Document Change. Changes too extensive to be identified with a spade.</p> <p style="text-align: center;"><i>E.S. Hubbard</i> JUN 17 1976</p> <p>CHKD BY: E.S. HUBBARD</p>	<p>RECEIVED</p> <p>JUL 20 1976</p> <p>PERRY PROJECT</p> <p>T-1138</p>	
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			225
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CHKD BY M. P. REZOS 7/11/71	ISSUED <i>[Signature]</i> C. SMITH, JR. JUN 17 1976	CONT ON SHEET 2 SH NO. 1	

3. DESCRIPTION

3.1 Granular activated carbon is used in adsorber vessels in nuclear power plant off gas systems. This carbon acts as a medium to retard the progress of xenon and krypton gases present in the off-gas stream, allowing the radioactive isotopes to decay to levels acceptable for release to the atmosphere.

4. REQUIREMENTS

4.1. Properties

4.1.1. Activated carbon, as specified herein, shall have the following material properties:

4.1.1.1. Arbitrary adsorption coefficients K_{arb} measured in accordance with Paragraph 5.2.2.:

- a. K_{arb} Xenon: No less than $1170 \frac{\text{cm}^3 \text{ Xe at STP}}{\text{gm carbon atm}}$
- b. K_{arb} Krypton: No less than $59.7 \frac{\text{cm}^3 \text{ Kr at STP}}{\text{gm carbon atm}}$

4.1.1.2. Apparent density: (Measured in accordance with ASTM D-2854).
No less than 0.50 grams per cubic centimeter.

4.1.1.3. Attrition hardness. (Measured in accordance with the Stirring Abrasion Test Paragraph 5.2.4). Average particle size reduction shall be no greater than 15 percent per millimeter.

4.1.1.4. Moisture content shall be as follows:

- a. Maximum permitted (in manufactured charcoal, measured in accordance with ATSTM D2867). No greater than 2 weight percent
- b. Equilibrium desorption moisture content (measured in accordance with Paragraph 5.2.3). No greater than 3 weight percent.

4.1.1.5 Particle size distribution.*

Nominal mesh size:	8 x 16 USS
+ 8 mesh	5 percent maximum
- 16 mesh	5 percent maximum
- 20 mesh	0.5 percent maximum
through 12, on 16 mesh	30 percent minimum
through 8, on 12 mesh	30 percent minimum
(or other particle size distribution approved by Buyer)	

4.1.1.6 Ignition Temperature. Ignition temperature shall not be less than 250°C, measured in flowing air, in accordance with the ASTM standard methods for testing ignition temperature. One test shall be conducted for every four lots, on an aggregate sample consisting of equal portions from the four lots.

5. EXAMINATION AND TEST

5.1 Buyer Notification

5.1.1 The Seller shall allow the Buyer 7 days prior notice of scheduled production runs or tests.

5.2 Test Procedure

5.2.1 General

5.2.1.1 The exact test procedures and equipment used shall be subject to Buyer approval.

5.2.2 Determining Arbitrary Adsorption Coefficient (K_{arb}) for Krypton and Xenon on Activated Carbon.

*Measured in accordance with ASTM D2862.

5.2.2.1 Equipment. The following test equipment shall be used in performing this test:

- a. Recording microbalance - with sensitivity ratio of weight change to sample load of 1×10^{-6} g/g. (Cahn Model "RG", Cahn Div., Ventron Instrument Corp., or Buyer approved equivalent)
- b. Vacuum Chamber - capable of 10^{-6} mm Hg operation, surrounding the sample pan of the microbalance, and associated vacuum equipment, so that the balance can be operated while the chamber is evacuated.*
- c. Glassware - capable of injecting controlled amounts of Xenon or krypton into the system.
- d. Thermometer (0.2°C division) - with ground glass joint, capable of insertion in close proximity to the sample pan in the vacuum chamber.*

5.2.2.2 Sample Preparation. Activated carbon samples shall be preheated at 120°C for 4 hours and placed in a dessicator containing anhydrous calcium sulfate (CaSO_4) until equilibrated at room temperature, then placed in the balance pan in the vacuum chamber, which shall be maintained at $25 \pm 1^{\circ}\text{C}$ as indicated by the internal thermometer.

5.2.2.3 Test Sequence. Test as follows:

- a. The system shall be evacuated to 10^{-6} mm Hg for 1 hour minimum, or until the weight stabilizes, with the prepared carbon in place upon the balance pan.
- b. The vacuum side of the apparatus shall then be closed off from the weighing chamber and gas inlet and the exact weight of carbon noted.
- c. Xenon or krypton gas shall then be allowed to enter until a pressure of 0.1 mm Hg is obtained.
- d. Gas adsorption shall be allowed to continue until equilibrium is reached and no more weight gain is noted, admitting xenon or krypton periodically to maintain system pressure at $0.1 \pm .001$ mm Hg.
- e. Weight of the carbon shall again be noted at the end of the test period; the system can then be purged in preparation for the next test.

5.2.2.4 Results. The difference between initial and final weights of the carbon shall be considered the weight of krypton or xenon adsorbed on the carbon; this value shall be converted to a volume in cubic centimeters at standard temperature and pressure (STP - 0°C , 1 atm). This value, multiplied by 7600 to bring it to 1 atmosphere and divided by the initial weight of carbon, shall be reported as the arbitrary adsorption coefficient: K_{arb} , cm^3 STP/grams carbon - atm.

*See Figure 1 for a suggested experimental setup.

5.2.3 Determining Equilibrium Desorption Moisture Content. The equilibrium moisture on the activated charcoal at 25°C, 33-percent relative humidity (R.H.) shall be determined as follows:

5.2.3.1 Process. Dried carbon is first exposed to high humidity and then to low humidity until it equilibrates, and the net retention of moisture is measured. Specifically, air of 75-80 percent R.H. is passed through a sample of carbon until approximately 10 percent moisture is adsorbed, after which air of 33 percent R.H. is passed through until equilibrium is attained. The net gain in weight represents the equilibrium desorption moisture at 33 percent R.H.

5.2.3.2 Apparatus. Test equipment shall include, but not be limited to the following:

- a. Constant temperature bath at 25°C.
- b. Three gas-washing bottles with fritted glass cylinders, 250 ml. (Scientific Glass Apparatus No. 6069 or engineering approved equivalent): One to contain water, the other two for saturated magnesium chloride solution.
- c. Flowmeter: 1000cc air per minute.
- d. Adsorption tube - (special construction; see Figure 2.1). An ordinary U-tube, in which the sample fills both legs, should not be used because of the distorted air-flow pattern through it. The dimensions given in the diagram are for example only and need not be adhered to exactly. The important point is that the carbon bed is contained as a vertical cylinder.
- e. Balance: accurate to a centigram.
(See Figure 2.2 for the arrangement of the apparatus).

5.2.3.3 Test. The test shall be performed as follows:

- a. Dry a sample of carbon (at least 50 cc) at 130°C for 6 hours.
- b. Obtain the tare weight of the empty adsorption tube (weight A), fill to the 10 cm mark (does not have to be exact) with dried sample and reweigh (weight B). Place the tube in the water bath.
- c. Pass air through just the water-wash bottle and then through the sample at a 1000cc/min flow rate, until approximately 10 percent moisture is adsorbed, as determined by weighing. The time required for this to occur varies with the type of carbon; usually 1-2 hours is sufficient.

5.2.3.3 (Continued)

- d. Change the air flow to pass through the $MgCl_2$ wash bottles and the sample. Weigh periodically until equilibrium is attained (weight C), Depending on the carbon type this may require 2 to 6 hours.
- e. Calculate:

$$\text{Equilibrium Desorption Moisture (\%)} = \frac{\text{wt. C} - \text{wt. B}}{\text{wt. B} - \text{wt. A}} \times 100$$

Notes

1. Passing air through a saturated solution of $MgCl_2$ at $25^\circ C$, is a convenient method of obtaining 33 percent R.H. Other means of producing this humidity may be used, i.e. diluting a saturated air stream with dry air, but the humidity of the final air stream should be checked by an independent method.
2. For carbons with equilibrium desorption moisture level well below 10 percent (e.g. 1 to 3 percent) it is not necessary to initially adsorb 10 percent. This level is specified to cover most carbon types. Actually, at the high-humidity level it is only necessary to adsorb several percent of water above the desorption equilibrium level. By reducing the amount first adsorbed, the time necessary to reach desorption equilibrium is reduced more than proportionally. Of course, the final value must be known before the procedure is modified, but it is applicable as a means of quality control for different carbon lots from the same source.

5.2.4 Stirring Abrasion Test. An indication of the abrasion resistance of an activated carbon sample is obtained by measurement of the percentage reduction of the average particle size resulting from the action of a T-bar stirrer in a special apparatus.

5.2.4.1 Apparatus. The equipment shall consist essentially of an inverted T-shaped stirrer turning rapidly in a cylindrical vessel containing the activated carbon. The clearance at the ends of the stirrer and bottom are the only critical dimensions. The speed of the shaft is 875 ± 15 rpm. This speed is obtained with 2:1 reduction by a V-belt from a 1750 rpm motor, 1/10 h.p. or larger. A simple frame for holding the drive motor and bearing container assembly is also required.

5.2.4.2 Test. Perform the test as follows:

- a. Prepare a sample of activated carbon having a volume of 250 to 500 ml.
- b. Place the sample on the top (coarsest) screen of a stack of U.S. Sieves numbers 12, 16, 20, 40, 50, and 70. Shake the screens for 15 minutes \pm 10 seconds on a Ro-Top sieve shaker.
- c. After the shaking period, the screens are removed from the shaker and the weight of the carbon on each screen is recorded. Discard the -70 material.
- d. The remaining fractions are then recombined and blended, then introduced into the abrasion apparatus.
- e. The abrasion apparatus is operated for one hour \pm one minute.
- f. After the stirring period, the carbon is removed and rescreened (steps b and c). Measure the -70 material in the bottom pan and record as the percent dust formation.

5.2.5.3 Calculations

- a. The average particle size, before and after stirring, is obtained using the equation:

$$\bar{D} = \frac{\sum WD}{\sum W}$$

W = weight of a mesh fraction in grams.

D = opening (in mm) that corresponds to the average of the opening in the two sieves that enclose the specific mesh fractions.

- b. The percentage reduction in particle size corrected for 1 mm is calculated as follows:

$$\frac{\% \text{ Reduction}}{1 \text{ mm}} = \frac{(D_i - D_f)}{(D_i)^2} \times 100$$

- c. The value obtained is reported as the percentage reduction in particle size from abrasion.

5.3 Sampling

5.3.1 A representative sample of 10 pounds minimum shall be taken from each lot (defined below), mixed thoroughly, and placed in a clean, dry container with an airtight closure. The method by which representative samples are obtained is subject to Buyer approval.

5.3.2 Each sample shall be labelled according to lot and, after completion of tests, shall be retained for possible retest or until the lot has been accepted.

5.3.3 A "lot", for purposes of this specification, shall be defined as no more than 14000 lbs. of activated carbon, produced without change in materials by one continuous process, or in successive increments using the same process.

5.4 Independent Laboratory Testing

5.4.1 Samples from all lots endorsed by the Seller shall be analyzed by an independent testing laboratory selected by the Seller and approved by the Buyer.

5.4.2 Samples which fail to meet the requirements imposed by this specification shall be retested by the same laboratory with respect to the property or properties in question. Failure to meet specified requirements upon retest shall be considered sufficient cause for rejection of the lot, subject to the provisions of Paragraph 5.7.

5.4.3 If the samples satisfy specified requirements upon independent laboratory retest, the lot shall be considered acceptable by the Buyer.

5.4.4 All independent laboratory testing required shall be arranged and financed by the Seller.

5.5 Audit

5.5.1 At the Buyer's option, required sampling and tests shall be performed in the presence of a Buyer quality-assurance representative or other Buyer approved agent.

5.6 Retests

5.6.1 If a lot sample fails any requirement, the Seller may, at his option perform and report a retest of the failed requirements, rather than reject the lot. Failure to meet the requirements upon retest shall be considered sufficient cause for rejection of the lot, subject to the provisions of Paragraph 5.7. If all requirements are met upon retest, the lot may be endorsed by the Seller and samples forwarded to the independent lab (Paragraph 5.4).

5.7 Waiver of Requirements

5.7.1 The Seller may request that the Buyer waive specific requirements for a given lot, any such waiver being granted strictly at the option of the Buyer.

6. PREPARATION FOR SHIPMENT

6.1 General

6.1.1 Activated carbon shall be shipped in moistureproof fiber drums. The drums shall be laminated (or lined) with vapor-barrier material MIL-B-131, or aluminum, and the closure shall be sealed moisture-tight by using cover gaskets, by heat-sealing, or by other Buyer-approved method. Additional protection may be used to exclude contaminating vapors and liquids. Avoid methods of handling that tend to grind the grains. Vendor shall demonstrate water-vapor transmission rate be less than .15g/100 sq. in. (approx. 5 g. for a 55 gallon drum per day for an atmosphere of 90% relative humidity).

6.1.2 Each drum shall be plainly marked with the drum number and the total number of drums in the shipment (e.g. #5 of 100), complete "ship to" address, purchase order number, MPL number, lot number, quantity/weight, description of material, and handling marks such as: fragile, keep dry, and up . Export shipping packs shall be containerized. Lots shall be clearly identified and shall remain segregated while awaiting shipment.

6.2 Shipment of Tested Material

6.2.1 Shipment of a carbon lot shall be made only after the Buyer has been informed on certified results of required tests, and has expressly authorized the Seller to proceed with such shipment.

7. SUBMITTALS TO BUYER

7.1 General

7.1.1 Submittal requirements to the Buyer shall apply to the Seller and to the Seller's subcontractors. If any changes are made by either the Buyer or Seller on the submittals, a new revision shall be sent to the Buyer by the Seller.

7.1.2 The following items shall be submitted in accordance with the requirements of Attachment "A" - "Document Submittal Requirements." Attachment "A" lists the documents to be submitted by the Seller to the Buyer, the number of copies, required submittal dates, and whether these submittals are for information, approval or certification.

7.2 Test Data

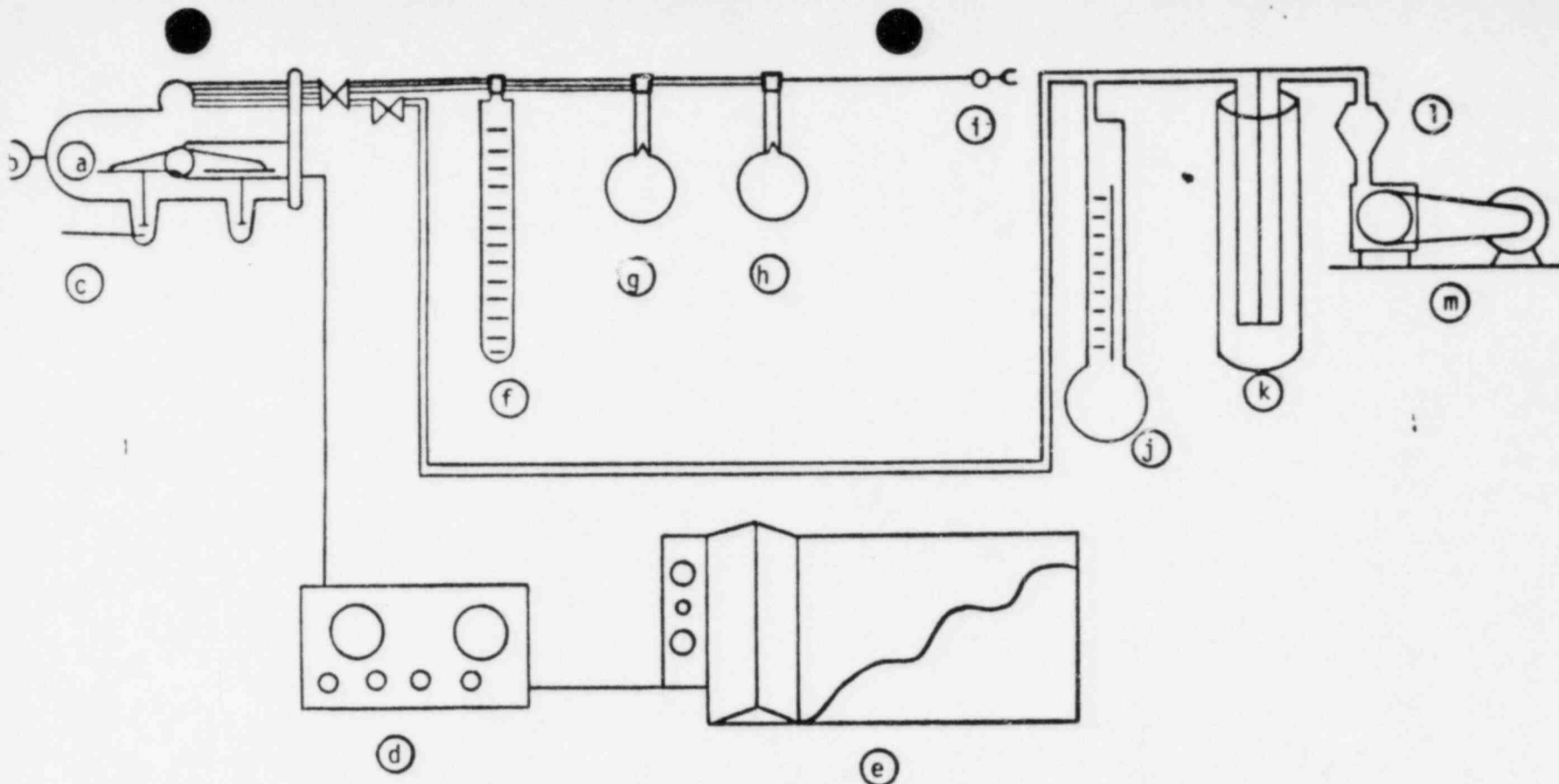
7.2.1 The Seller shall submit the following test data:

- a. Certified test reports for all tests performed.
- b. Detailed descriptions of test procedures and equipment used to obtain certified test data, or Buyer-approved ASTM procedures.
- c. Description of the method used to obtain a representative carbon sample.

7.3 Other Instructions

7.3.1 The Seller shall also submit the following:

- a. Storage instructions.
- b. Names of one or more independent testing laboratories that the Seller considers competent to perform the tests specified herein.



Legend

- | | |
|--------------------------|-----------------------|
| a. balance mechanism | g,h. gas flasks |
| b. vacuum chamber | i. air/utility inlet |
| c. 0.2° div. thermometer | j. McCleod gauge |
| d. balance control box | k. cold trap w/Dewar |
| e. recorder | l. oil diffusion pump |
| f. manometer | m. mechanical pump |

FIGURE 1. DIAGRAM OF THE APPARATUS
USED IN K_{ARB} DETERMINATION

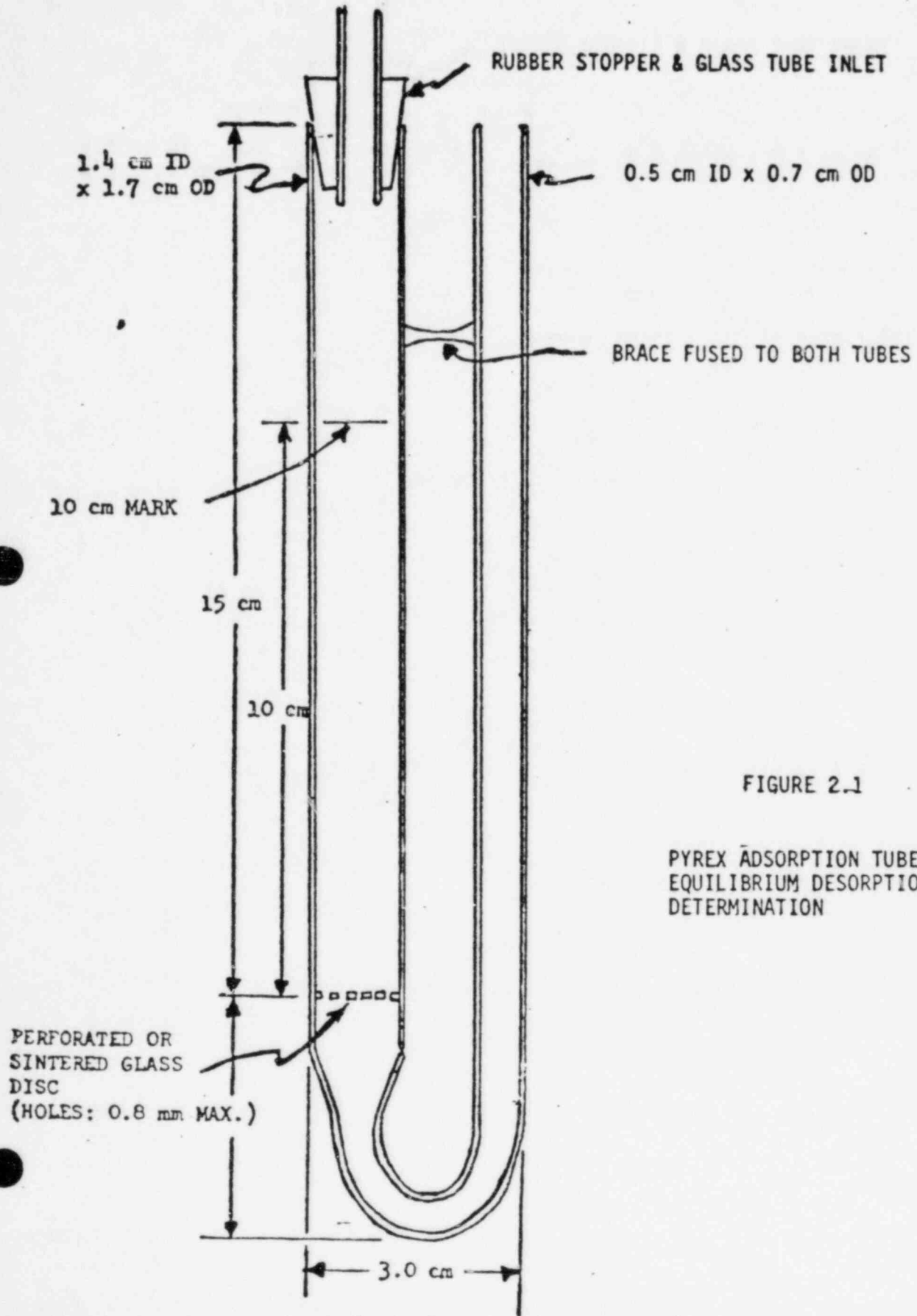


FIGURE 2.1

PYREX ADSORPTION TUBE USED IN
EQUILIBRIUM DESORPTION MOISTURE
DETERMINATION

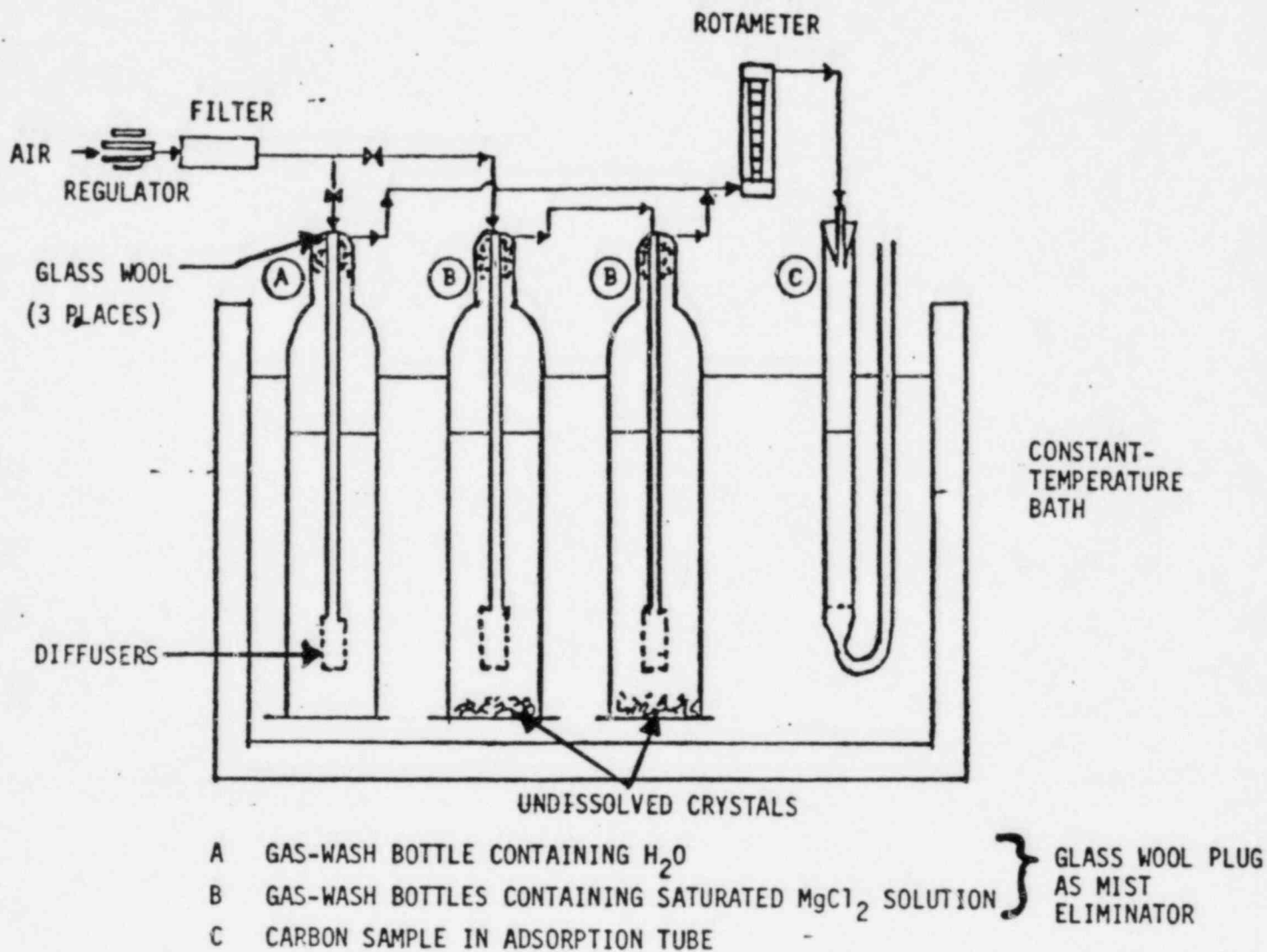


FIGURE 2.2 APPARATUS ARRANGEMENT FOR EQUILIBRIUM
DESORPTION MOISTURE DETERMINATION

ATTACHMENT 3

Tabulation of Test Results of

Barneby-Cheney Co. Supplied Carbon

ANALYSIS PERFORMED
 BY: NUCLEAR CONSULTING SERVICES, INC.
 JUNE 30-JULY 6, 1986

ANALYSIS RESULTS
 ACTIVATED CARBON FROM
 ADSORBER VESSELS AND WAREHOUSE

CARBON MFR : BARNEBY-CHENEY CO.
 CARBON TYPE: 483

ANALYSIS AND PROCEDURE	SAMPLE/DATE/RESULT							
	D-0014A TOP 6-27-86	D-0014B TOP 6-27-86	D-0012A BOTTOM 7-3-86	D-0012B BOTTOM 7-2-86	D-0014B BOTTOM 7-2-86	BC-483 LOT 1605 6-30-86	BC-483 LOT 1605 6-30-86	BC-483 LOT 1605 6-30-86
APPARENT DENSITY (g/cc) ASTM D2854	0.57	0.55	0.56	0.58	0.57	0.58	0.59	0.59
MOISTURE WT.(%) ASTM D2867	0.8	0.6	0.6	0.6	0.6	1.8	2.0	1.9
ASH WT. (%) ASTM D2866	1.6	1.8	1.7	1.7	1.5	1.5	1.6	1.9
HARDNESS (%) ASTM D3802	95.4	95.3	86.1	93.5	86.1	92.6	91.8	91.9
VOLATILE WT (%) NUCON PROC.121	1.1	1.8	1.9	3.0	1.9	1.7	3.9	2.3
IGNITION TEMP (DEG C) ASTM D3466	405	390	415	370	370	385	395	370
IGNITION TEMP (DEG C) @ 4fpm	153	220	280	300	280	315	215	280
¹ K ¹ -KRYPTON NUCON PROC.30 (SEE NOTE 1)	53	53	57	54	57	54	54	54
¹ K ¹ -XENON NUCON PROC.30 (SEE NOTE 1)	1090	1050	1150	1075	1150	1120	1100	1080

PARTICLE SIZE
 DISTRIBUTION
 ASTM D2862

% ON 6 US MESH	0	0	0	0	0	0	0.1	0
% ON 8 US MESH	1.4	3.3	2.0	2.1	4.9	0.4	0.1	0.2
% ON 12 US MESH	39.8	35.9	34.4	43.8	44.2	50.2	41.1	43.7
% ON 16 US MESH	55.4	55.8	59.6	51.9	50.4	46.4	54.7	52.0
% ON 20 US MESH	3.1	4.6	3.7	2.1	0.3	2.1	3.8	3.2
% THRU 20 US MESH	0.3	0.4	0.3	0.1	0.2	0.2	0.2	0.9

NOTE 1: AVERAGE OF 3 DETERMINATIONS

ATTACHMENT 4

Carbon Sample Test Report

Of The Original Barneby-Cheney Co. Carbon