

LIBRARY

N 65-20808

FACILITY FORM ONE	ACCESSION NUMBER	77	(TITLE)	
	CASE#	CR-57666	(CODE)	03
	NASA CR OR TRR OR AD NUMBER		CATEGORY	

LIBRARY

HYDROGEN-OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS

Prepared for

National Aeronautics and Space Administration
 Lewis Research Center
 21000 Brookpark Road
 Cleveland 35, Ohio
 Attn: D. G. Soltis

Contract NAS 3-2781

EOS Report 4110-ML-10

15 August 1964

Prepared by

E. Findl
 E. Findl
 Manager
 Chemical and Fluid Systems

GPO PRICE \$ _____

OTS PRICE(S) \$ _____

Hard copy (HC) \$1.00

Microfiche (MF) 50

Approved by:

Bm. Wilner
 B. Wilner
 Associate Manager

ELECTRO-OPTICAL SYSTEMS, INC.

Pasadena, California

TABLE OF CONTENTS

1. Introduction	1
2. Technical Discussion	2
2.1 Asbestos Studies	2
2.2 Multi-cell Design	5
2.3 Single Cell Design	6
2.4 Instrumentation	6
2.5 Test Cell Construction	7
3. Plans for Next Period	8
4. Financial Statement	9

1. INTRODUCTION

This report reviews the progress made on the development of a regenerative hydrogen/oxygen fuel cell (NAS Contract 3-2781) during the period 30 June through 31 July, 1964. Additional data on hydrogen permeability through asbestos matrices was obtained and are reported herein. A new multicell design has been completed. Fabrication of this new multi-cell, as well as accessory items, has been initiated. A 6-inch electrode diameter single cell, incorporating separator plate design features used in the multi-cell unit, has been designed and fabricated.

2. TECHNICAL DISCUSSION

2.1 Asbestos Studies

[One of the factors governing the usage of porous asbestos as the separator material in the H_2/O_2 regenerative cell is the degree to which it must be compressed to prevent gas leakage.] This leakage can occur both through and around the edge of the asbestos matrix. Low degrees of compression permit the storage of relatively large amounts of water, but the resulting matrix is more susceptible to gas leakage. The reverse is true for high degrees of compression. In order to evaluate the optimum degree of compression, a series of gas leakage tests was conducted. The apparatus used was the same as that reported in 4110-QL-2, dated July 26, 1964, for gas leakage tests on various grades of asbestos.

The data obtained are shown on Figure 1. Compression ratios, i.e., the initial/final asbestos thickness were varied between 7/6 and 7/3. Initial asbestos thickness, i.e., prior to compression was ≈ 0.07 inches. The type of curve presented on Figure 1 is similar to that presented in 4110 QL-2 for the effect of electrolyte/asbestos weight ratios on leakage rate. It is interesting to note that the 7/4 compression ratio appears to be the optimum. One might expect the 7/3 ratio to show less leakage, but apparently, at the 7/3 value, an appreciable quantity of the electrolyte is squeezed out of the asbestos, increasing the permeability somewhat over the 7/4 value.

In addition to compression ratio tests, additional leakage rate experiments were carried out using electrolytic grade asbestos. This material is of a higher purity than the commercial grade asbestos used during the previous portions of the program. It is also presumably more reproducible in its chemical and physical characteristics. Results of these tests plotting the average of 3 runs per size are shown on Figure 2. The leakage rate is much lower than that exhibited by

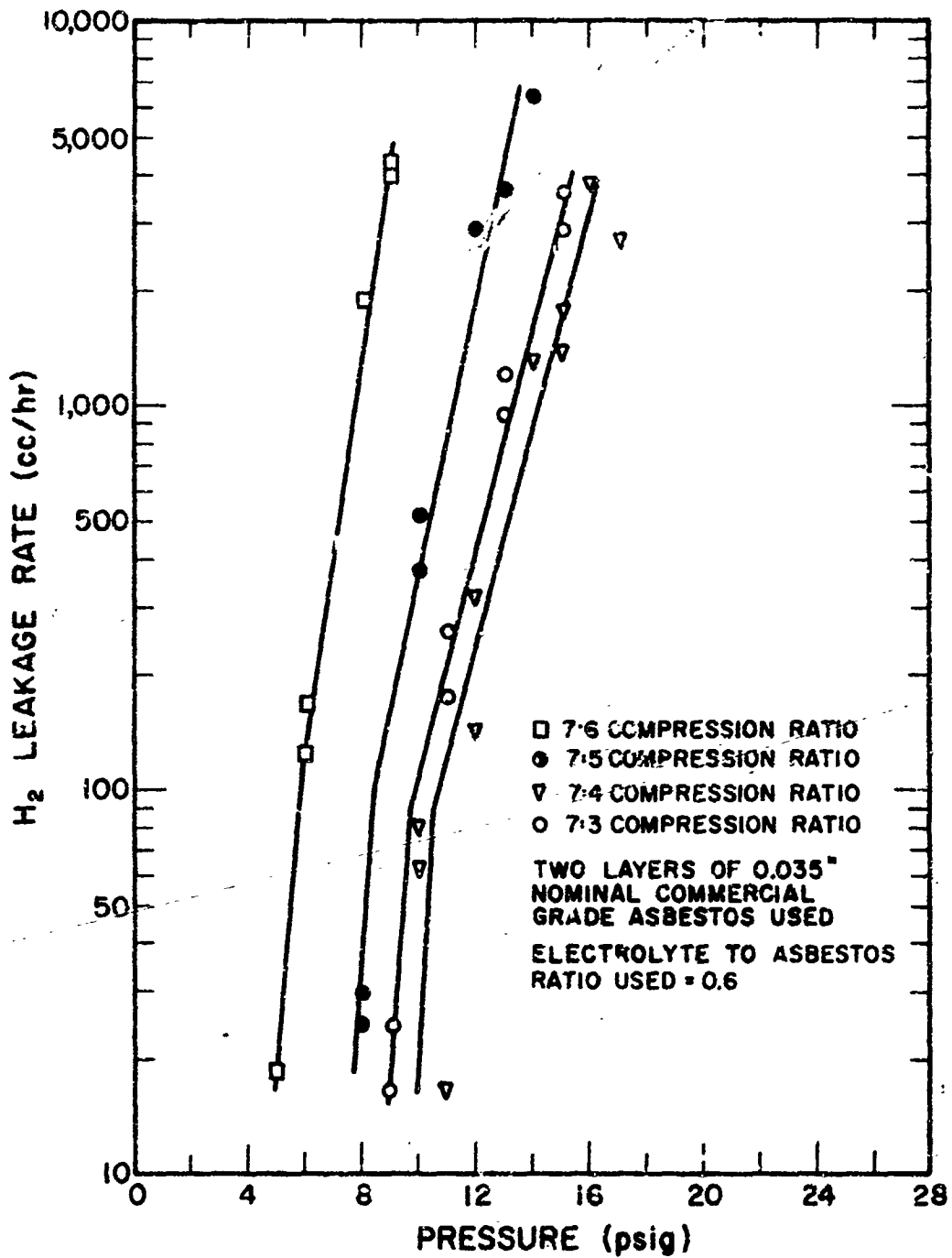


FIG. 1 EFFECT OF ASBESTOS COMPRESSION RATIO ON PERMEABILITY OF HYDROGEN THROUGH TWO LAYERS OF 0.035 INCH COMMERCIAL ASBESTOS

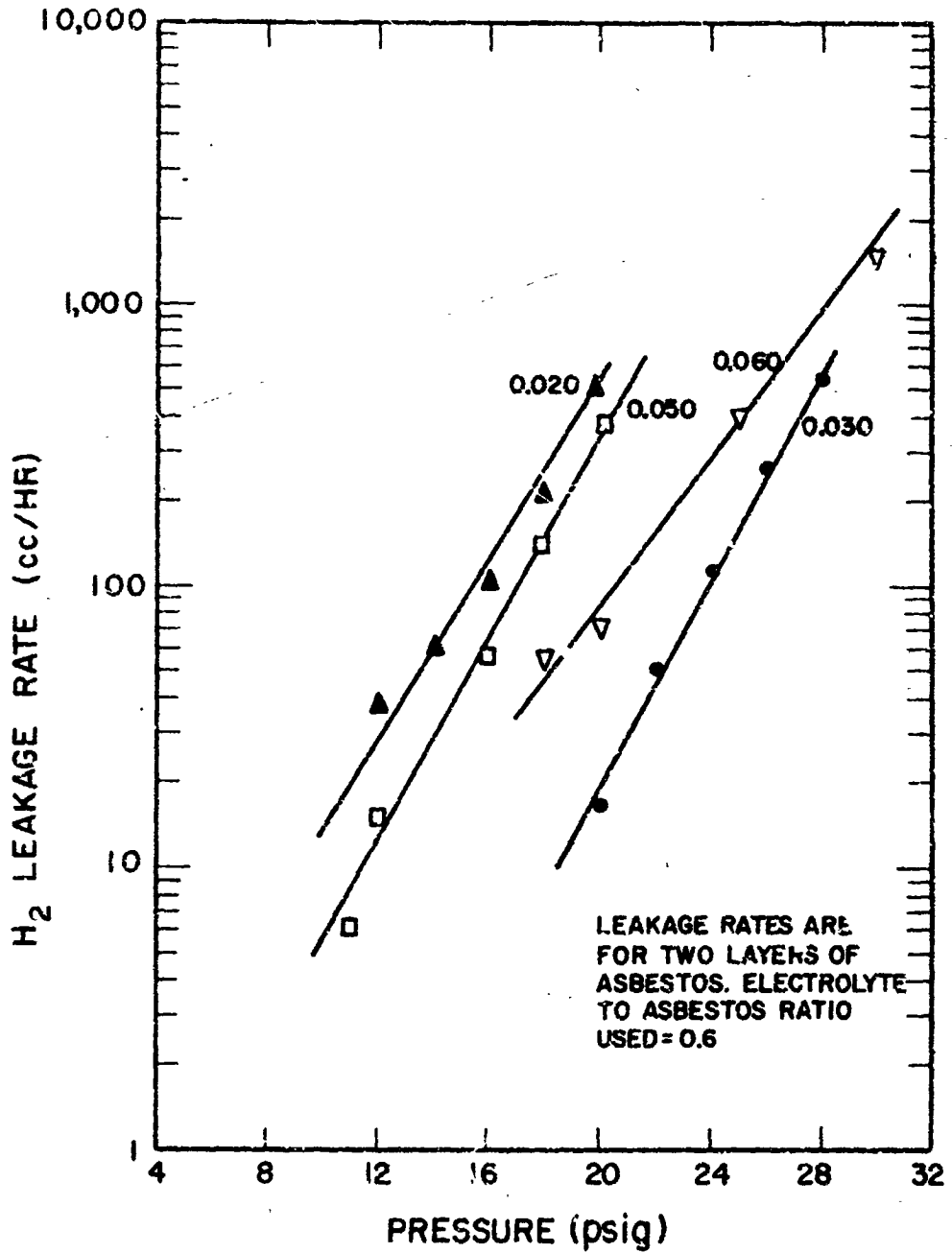


FIG. 2 H₂ LEAKAGE RATE FOR ELECTROLYTIC GRADE ASBESTOS

commercial asbestos. The reason for the anomalous behavior of the 0.030 material is not known. However, it appears that, from a gas permeability standpoint, the electrolytic grade asbestos should equal or better the performance characteristics of the commercial materials.

Measurements have also been made of the breakover pressure of two combinations of asbestos thickness that would add up to an 0.070 inch matrix thickness. This breakover pressure is the differential pressure required to initiate a measurable H₂ leakage through the asbestos. For this test, the electrolyte/asbestos ratio used was 0.6/1, the compression ratio used was 7/4 and the gas used was hydrogen.

<u>Matrix Composition</u> (Electrolytic Grade Asbestos)	<u>Minimum Breakover Pressure</u> (Psid)
1 layer 0.050" + 1 layer 0.020"	12
1 layer 0.030" + 2 layers 0.020"	17

Since a differential pressure of less than 1 psi is maintained in the multicell system, the use of either of these combinations should be satisfactory.

2.2 Multi-cell Design

As a result of discussions between technical personnel at NASA-Lewis and EOS concerned with the development of the H₂/O₂ regenerative cell, certain design changes of the 75 watt unit were agreed upon. These changes were recommended to improve reliability and performance. Design changes recommended and accomplished during this reporting period include the following:

1. Replacement of the rubber pressure balancing diaphragm by a stainless steel bellows.
2. Incorporation of an improved separator gasket and seal.
3. Incorporation of improved gas distribution and elimination of separator plate external drill holes.

4. Elimination of magnesium as an external structural material.
5. Elimination of thermal storage tanks.
6. Incorporation of unipotential tankage.

Each of these changes has been made along with other modifications to simplify fabrication and assembly, increase gas porting area to the pressure balancing bellows, and to minimize the hazards involved in testing. A set of the new design drawings has been supplied to the NASA technical monitor.

2.3 Single Cell Design

In order to evaluate electrode performance prior to installation in the 75 watt multi-cell unit, a single cell, 6-inch electrode diameter fuel cell, has been designed and fabricated. This cell contains features similar to that used on the multi-cell unit, but does not contain a pressure balancing mechanism. Therefore, the H_2 and O_2 tank volumes within the cell must be carefully balanced prior to its use in the regenerative mode of operation. The cell has been fabricated using panel tankage to eliminate corrosion problems, and has been designed to have a large structural factor of safety.

In addition to electrode evaluation, the single cell unit will be tested for a 48 hour period using a 65 minute charge and 35 minute discharge (300 n.m. orbit) cycle.

2.4 Instrumentation

Certain instrumentation changes are being made to improve the operational characteristics of the test equipment. These include better data recording features and a capability for complete automatic cycling of the multi-cell unit. Pertinent electronic instrumentation will be placed in a suitable cabinet to both consolidate the equipment and improve its usefulness.

The design of both the pneumatic and electronic instrumentation for the single and multi-cell units has been completed. Fabrication of both has been started.

2.5 Test Cell Construction

Due to the possible hazards involved in testing the multi-cell unit, a new test facility has been designed and will be built with corporate funds. The facility is essentially a block house containing the steel test chamber used during the preceding stages of the program. Modifications to the steel chamber improving its pressure venting characteristics are also being accomplished. The block house will be attached to the fuel cell laboratory and all test operations will be carried out by remote operation. Suitable control panels and visual monitoring facilities will be provided.

3. PLANS FOR NEXT PERIOD

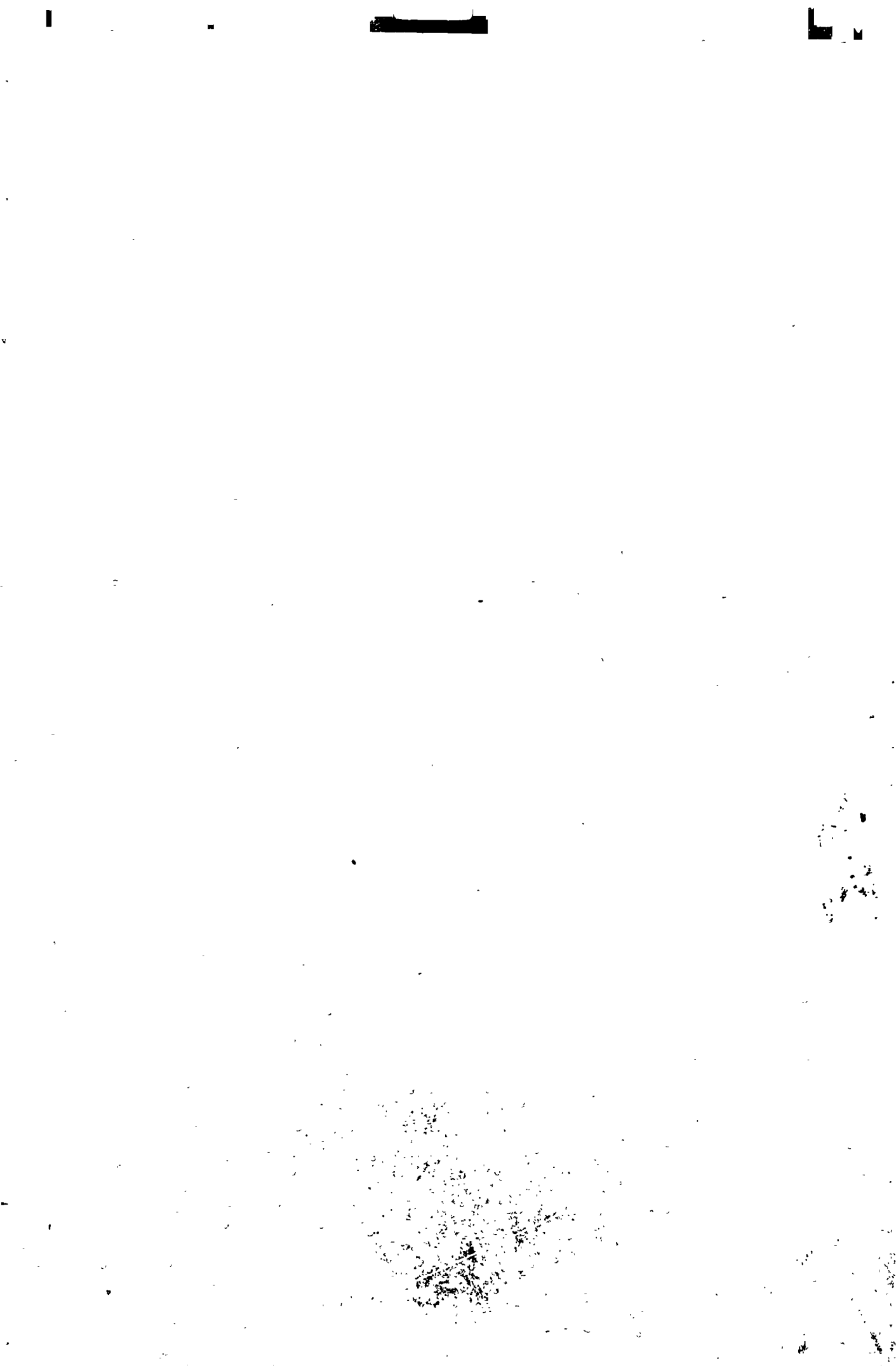
Single cell testing will be started during the next reporting period. Present plans call for initial check out of the cell and instrumentation followed by a short series of cycles in the primary mode of operation. This will be followed by a short series of cycles in the secondary mode during which time gas volumes will be adjusted. Finally, a 48 hour test cycle will be initiated.

It is anticipated that some sections of the multi-cell unit will be delivered during the next reporting period. These will be inspected upon receipt for dimensional correctness and visually checked for mechanical faults. Tankage will be pressure checked to 500 psig.

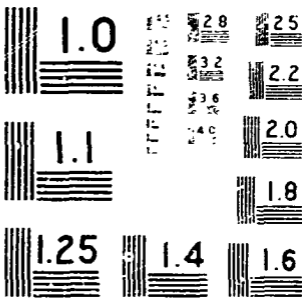
4. FINANCIAL STATEMENT

Manhours and dollar expenditure for the period June 29 through July 31, 1964 were as follows:

Direct Labor Hours	777
Direct Labor Dollars	\$ 3,399.44
Purchases and Commitments	\$ 2,332.99
Total Dollar Expenditure	\$11,196.79



EN



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963

RI

95