EXPERIMENT TECHNICAL DOCUMENTATION

DOT–TSC–NASA–71–4

TEST PLAN

IN-FLIGHT AEROSOL ANALYSIS EXPERIMENT T003

DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
CAMBRIDGE, MASSACHUSETTS

TEST PLAN PROCEDURE

for

EXPERIMENT T-003

March 20, 1971

Revision: 2

APPROVED:

3-30-71

SKYLAB EXPERIMENT T-003

U.S. DEPARTMENT OF TRANSPORTATION

SPECIFICATION CHANGE NOTICE **20**

TRANSPORTATION SYSTEMS CENTER
55 BROADWAY
CAMBRIDGE, MASSACHUSETTS 02142

Specification Title and Date

TEST PLAN (REV. 2) March 21, 1971

[ ] Preliminary
[ ] Final
[x] Record

File opposite spec.
page no. para. 3.33 and 3.3.4

Page 1 of 1

Date MAY 19 1971

Originator W. Harriott

Tel. No. 617-494-2608

Applicable References

ICD 13M12231(T003) IRN D-6

SPECIFICATION CHANGE: (with reasons)

MDAC-WD revision of vibration and acoustic criteria in accordance with dynamic test article tests. ECPW007-9C1 May 18, 1971

This revision was not negatiable by TSC

Revisions are on sheets 2, and 3 of D-6

APPROVAL

Engineering	Reliability	Program Mgr.
		5/19/71

SKYLAB EXPERIMENT T-003

U.S. DEPARTMENT OF TRANSPORTATION

SPECIFICATION CHANGE NOTICE	21	TRANSPORTATION SYSTEMS CENTER 55 BROADWAY CAMBRIDGE, MASSACHUSETTS 02142

Specification Title and Date TEST PLAN (rev 2) 3-20-71	[ ] Preliminary [ ] Final [X] Record
File opposite spec. page no. Appendix A	Page 1 of 1 Date July 12, 1971
Originator K.J. Bray Tel. No. 617-494- 2626	Applicable References

SPECIFICATION CHANGE: (with reasons)

Para 4.0 and para 5.0: Non operational temperature to 20 F
Electronics are checked by mfg. at low temperature and a low temp. is unnecessary for checkout since low environ. temp is 40 F

5.4 E_{HV} TO 800
Voltage more consistent with actual use

5.6 Eliminate: Main Board
$E_{21} \doteq 0$
Error in original transcription

5.9 Change 140 sec to 200 seconds and $T_{off} = 200$
Safety shutoff is designed for low voltage shutoff. Design is 140 sec at 9V but is 200 sec at shutoff voltage

APPROVAL

Engineering		Reliability		Program Mgr.	
				[signature]	7/13/71

DEPARTMENT OF TRANSPORTATION · UNITED STATES OF AMERICA

T-003 TEST PLAN

1.0 INTRODUCTION

This document defines the type, sequence and procedural details required to perform each test on the T-003 experiment aerosol analyzer, its subsystems and components. This plan utilizes the flexibility allowed for instruments in criticality category 4, and requires only those tests necessary to show the instrument's ability to perform satisfactorily in its intended environment.

The tests are grouped as follows: (a) components and subsystem evaluation; (b) qualification unit, and (c) flight and backup units.

2.0 COMPONENT AND SUBSYSTEM EVALUATION

2.1 Parts Inspection

All parts or materials received will be inspected and tested for all characteristics which effect or determine their identification fit or function. The R&QA engineer will perform or arrange for all inspections, certifications, and tests specified on the purchase documents and will impound material which fails to meet specifications.

From time of receipt to integration in the payload, parts and materials for T-003 will retain their identity in terms of part number, lot number, purchase order, serial number and inspection stage and status (i.e., inspected, waiting, in-process/accepted or rejected and reference to the inspection report). Storage conditions will protect the quality of parts and materials and prevent their damage, deterioration, loss or substitution.

Available standards for soldering microelectronics, and packaging will be utilized for workmanship and visual criteria. Evidence of inspection status will be on or with all parts and materials at all times and will be positive to the extent of their being a direct and obvious relationship between the article and its evidence. The evidence will not damage or in any way effect the quality of the articles. Records of inspection and tests will be maintained for all parts, materials, and end items. They will contain evidence that required inspections and tests have been performed. Transportation Systems Center Form 7000.7, see Figure 1.

2.2 Subsystem Inspection and Test

2.2.1 Test Log.- Each major subsystem or system of the T-003 experiment will have a separate log which is a continuous record of all events in the life of the item. It will account for all periods including idle periods, any movement of the item and parameter measurements including the approved test data sheets and test summary sheets required by Experiment General Specifications (EGS). It will include a detailed record of all operating and test time. It will include the record of maintenance and repair and all approved splicing records required by the EGS. The Continuous Record form will be TSC Form 7000.8, see Figure 2.

2.2.2 Selection of Parts for Incorporation in Instrument (Selected Components).- Certain parts are selected for use in the T-003 instrument by characteristics of the parts performance.

2.2.2.1 Photomultiplier Tube (PM). Ref T3-TP-2 (0)

The RCA 1P21 photomultiplier tube will be selected for instrument incorporation after visual inspection and the following criteria are met.

1. Anode sensitivity of at least 250 A/l at 1000 volts (A/l) = amps/lumen
2. Dark current no greater than 0.002 microamps at 18 A/l
3. PM will be integrated into the optical subsystem and final usage will depend on results of tests of paragraph 2.4.

2.2.3 Optical System Light Source. Ref T3-TP-2 (0)

The GE2121D lamp will be visually inspected under a 10X magnification and selected for the following characteristics:

1. A clean, bright, uniformly looped filament.
2. A good weld between filament ends and supports, with filament ends not touching glass.
3. A well centered lens, i.e., an undistorted filament image when viewed axially.

4. Lamp leads with no nicks, especially as leads leave glass at meniscus.

2.3 Electronics Subsystem Test

The electronics subsystem will be tested in accordance with the "Acceptance Procedures for the Aerosol Analyzer Electronics Subsystem" T-3-TP-3 (Appendix A).

2.4 Optical Subsystem

The optical subsystem will be assembled and aligned according to "Optical Tube Alignment" T-3-TP-1 (Appendix B).

After assembly the optical system performance will be tested according to part A of the "Calibration Plan" T-3-TP-4 (Appendix C).

2.5 Pneumatic Subsystem

The acceptance criteria for the pump performance and the system lines of the pneumatic system will be as a total integrated system composed of all screens, filter-impactor, filters, and optical system. If flow criteria specified in "Air Flow Calibration" T-3-TP-5 (Appendix D) are met, the pneumatic subsystem is considered acceptable.

2.6 Battery Check

The no load voltage on a freshly charged battery will be 11 ±0.2 volts for acceptance.

2.7 Filter-Impactor Subsystem

The only tests on the filter-impactor insert will be visual check and, mechanical fit and function. Air will not be passed through cleaned units.

3.0 ACCEPTANCE TESTS AND ENVIRONMENT

3.1 Acceptance Criteria

The aerosol analyzer's function is to size and count particles within a specific time and to display the results of the counting/sizing cycle in each size channel. With these considerations the instrument will be acceptable if:

1. No observable physical damage occured as a result of an environmental test, and
2. The instrument performs functionally before and after the test: i.e., a) the instrument operates, cycles properly and reads out counts and, b) that test particles introduced into the analyzer are read in the proper size range with proper counts according to paragraph 4.0 "Calibration Plan" T-3-TP-4 (Appendix C).

3.2 Selection of Environmental Criteria

The instrument will be required to perform in the environments stated in Skylab Interface Control Document 13M12231, T-003, Inflight Aerosol Analysis, its revisions IRN R1, R2, R3 and current updates at time of test.

Environmental tests will be performed on the analyzer in configuration (stowed or unstowed) that conforms to the particular phase of the flight profile.

3.3 Test Environments

The following are the environmental conditions from the Interface Control Document.

3.3.1 Thermal Environment.- (Table II, IRN3)

THERMAL ENVIRONMENT

(ENVIRONMENT FOR CREW QUARTERS AREA, LOWER FLOOR)

CONDITION			°F MINIMUM	°F MAXIMUM
PRELAUNCH	PRIOR TO VAB (KSC)	BULK GAS	NOT CONTROLLED	NOT CONTROLLED
		SURFACE	NOT CONTROLLED	NOT CONTROLLED
	(VAB & PAD) (KSC)	BULK GAS	40	60
		SURFACE	35	90
LAUNCH	BULK GAS		40	80
	SURFACE		40	90
PRE-HABITATION COAST	BULK GAS		40	80
	SURFACE		40	90
HABITATION	BULK GAS		55	90
	SURFACE		55	105
ORBITAL STORAGE	BULK GAS		40	80
	SURFACE		40	100

3.3.2 Pressurization.- (Table I, IRN 2)

PRESSURIZATION		
CONDITION	MAX PSIA	MIN PSIA
Prelaunch	26.0	Ambient
Ascent	26.0	N/A
Pre-Habitation Orbit	26.0	0.5
Habitation	6.0	4.8
Orbital Storage	6.0	0.5

The maximum pressurization rate is 0.3 psi/min occuring during prelaunch.
The maximum depressurization rate is 6.0 psi/min occuring during prelaunch.

THE EXPERIMENT MUST BE CAPABLE OF WITHSTANDING THIS ENVIRONMENT.

3.3.3 Vibration.- (Table V, IRN-1)

Sinusoidal Vehicle Dynamics Environment

The experiment shall withstand the given frequency range, logarithmically, at the rate of 3.0 octaves/minute from the low frequency to the high frequency in the thrust direction. 3 Hz to 60 Hz (4.3 octaves).

3 - 7 Hz at 0.43 inches D.A. Disp.
7 - 14 Hz at 1.1 g peak
14 - 25 Hz at 0.11 inches D.A. Disp
25 - 60 Hz at 3.6 g peak

The experiment shall withstand the given frequency range, logarithmically, at the rate of 3.0 octaves/minute from the low frequency to the high frequency in the radial and tangential directions. 2 Hz to 20 Hz (3.3 octaves).

2 - 4 Hz at 0.34 inches D.A. Disp.
4 - 7 Hz at 0.28 g peak
7 - 20 Hz at 0.08 g peak

3.3.3 (Continued)

Sinusoidal Vibration Evaluation Environment

The experiment shall withstand the given frequency range, logarithmically, at the rate of 1.0 octave/minute from the low frequency to the high frequency in three mutually perpendicular directions. 20 Hz to 2,000 Hz (6-2/3 octaves).

20 - 100 Hz at 0.002 inches D.A. Disp.
100 - 2000 Hz at 1 g peak

[illegible]FF LEVEL RANDOM VIBRATION ENVIRONMENT

THE EXPERIMENT SHALL WITHSTAND THE SPECIFIED RANDOM VIBRATION FOR 1.0 MINUTE IN EACH OF THE THREE MUTUALLY PERPENDICULAR DIRECTIONS. THE EXCITATION SHALL BE APPLIED AS ONE INPUT OVER THE FREQUENCY INTERVAL FROM 20 TO 2,000 Hz.

THRUST AND TANGENTIAL	NORMAL TO WALL
20 - 60 Hz AT +6 dB/OCTAVE	20 - 100 Hz AT 0.2 g^2/Hz
60 - 2000 Hz AT 0.02 g^2/Hz	100 - 2000 Hz AT -4 dB/OCTAVE

BOOST LEVEL RANDOM VIBRATION ENVIRONMENT

THE EXPERIMENT SHALL WITHSTAND THE SPECIFIED RANDOM VIBRATION FOR 2.0 MINUTES IN EACH OF THREE MUTUALLY PERPENDICULAR DIRECTIONS. THE EXCITATION SHALL BE APPLIED AS ONE INPUT OVER THE FREQUENCY INTERVAL FROM 20 TO 2,000 Hz.

THRUST AND TANGENTIAL	NORMAL TO WALL
20 - 100 Hz AT +6 dB/OCTAVE	20 - 100 Hz AT 0.1 g^2/Hz
100 - 2000 Hz AT 0.02 g^2/Hz	100 - 2000 Hz AT -4 dB/OCTAVE

SCN 020 May 25,71

3.3.4 Sound Levels.- (Tables VI and VII, IRN-1)

SOUND PRESSURE LEVELS INDUCED BY M509 AND T020 THRUSTERS	
ONE-THIRD OCTAVE BAND CENTER FREQUENCY (Hz)	ONE-THIRD OCTAVE BAND SOUND PRESSURE LEVEL IN THE OWS REVERBERANT FIELD* AT 5 PSIA (dB RE: 0.0002 CYNES/CM^2)
10	75
12.5	75
16	75
20	75
25	75
31.5	75
40	75
50	75
63	75
80	75
100	75
125	75
160	75
200	75
250	76
315	80
400	84
500	88
630	90
800	93
1,000	94
1,250	99
1,600	102
2,000	105
2,500	107
3,150	109
4,000	110
5,000	112
6,300	113
8,000	114
10,000	113
12,500	112
16,000	110
20,000	109
OVERALL SOUND PRESSURE LEVEL	121.6

*THESE LEVELS APPLY AT DISTANCES GREATER THAN 6 FEET FROM THE SOURCE. AT DISTANCES OF APPROXIMATELY 16 INCHES AND 4 INCHES ADD 6 dB AND 13 dB, RESPECTIVELY, TO THE LEVELS SHOWN.

THE EXPERIMENT MUST BE CAPABLE OF WITHSTANDING THIS ENVIRONMENT

ONE THIRD OCTAVE BAND ACOUSTIC SPECIFICATION IN dB RE:0.0002 DYNES/CM^2

1/3 Octave Band Center Frequency (Hz)	Liftoff Level (dB) 1/2 Minute Duration	Boost Level (dB) 2 Minutes Duration
5	109.0	102.0
6.3	111.0	104.0
8	113.0	106.0
10	115.0	108.0
12.5	117.0	110.0
16	119.0	112.0
20	121.0	114.0
25	123.0	116.0
31.5	125.0	118.0
40	127.0	119.5
50	129.0	121.0
63	130.0	122.5
80	131.0	124.0
100	132.0	125.5
125	133.0	126.0
160	133.0	127.0
200	132.0	128.0
250	130.0	128.0
315	128.0	127.0
400	126.0	126.5
500	124.0	126.0
630	122.0	126.0
800	120.0	125.5
1,000	119.0	125.0
1,250	118.0	124.5
1,600	117.0	123.5
2,000	116.0	122.5
2,500	115.0	121.5
3,150	114.0	120.0
4,000	113.0	118.5
5,000	112.0	117.0
6,300	111.0	115.5
8,000	110.0	113.5
10,000	109.0	111.5
Overall	141.5	138.5

3.3.5 Acceleration.- An acceleration test will be performed on the qualification instrument (see paragraph 4.1).

3.3.6 RFI Test. - An RFI Test according to MIL-STD-461A (see paragraph 4.6).

4.0 QUALIFICATION UNIT

The qualification unit will be subjected to the following tests as a minimum. Following each test listed below, the instrument will be subjected to acceptance criteria, paragraph 3.1.

4.1 Acceleration

The test specimen shall be mounted in the equipment storage container in a non-operating condition. The container will be rigidly mounted to the centrifuge test platform.

The equipment shall be subjected to acceleration along an axis parallel to the longitudinal spacecraft axis, acceleration 0.0 g to 6.0 g ± 0.5 g in 150 seconds. The centrifuge will be increased in a linear manner from 0.0 g to 6.0 g ± 0.5 g's. The 6.0 g ± 0.5 g acceleration shall then be held 150 seconds, and then decreased to 0.0 g in 150 seconds.

4.2 Sinusoidal and Random Vibration Tests

The test specimen shall be mounted in the equipment stowage container in a non-operating condition. The container will be rigidly mounted to the test platform.

The equipment will be subjected to the environment stated in paragraph 3.3.3.

4.3 Temperature Cycle

The test specimen will be placed within a test chamber. The unit will be non-operating condition during this test. With the test specimen installed in the test chamber, subject the unit to the following test sequence in order shown.

Step 1 - Ambient temperature, pressure at 14.7 psia.

Step 2 - Raise shroud temperature to +105°F ±4°F. Hold Pressure

Step 3 - Maintain these conditions for one (1) hour

Step 4 - Adjust chamber to ambient temperature and pressure. Remove test specimen.

Step 5 - Conduct acceptance test in accordance with section 3.1.

Step 6 - Repeat steps 1 and 2, and then

Step 7 - Cycle shroud temperature; 105°F to 40°F to 105°F in 90 minutes at 14.7 psia. The dwell time at each temperature will be 10 minutes.

Step 8 - Repeat step 7 three (3) times.

Step 9 - Repeat steps 4 and 5.

4.4 Temperature and Pressure

With specimen installed as in the above paragraph, stabilize the chamber temperature at 75°F ±2°F. When stabilization has been achieved, reduce the pressure in the test chamber to 0.5 psia. Back fill the chamber with N_2 to a pressure of

26.0 psia. After one (1) hour at these conditions, return chamber to ambient conditions, remove unit and perform acceptance test in accordance with paragraph 3.1.

4.5 Acoustic Tests

The instrument will be subjected to the sound levels shown in paragraph 3.3.4. The instrument will be out of the stowage container for M509 and T020 thruster sound levels with equivalent noise at 6 feet from source.

For liftoff and boost levels the instrument will be stowed in its container.

4.6 RFI Test

The arrangement for performing the radiated interference test is the method from MIL-STD-461. Further testing will be performed by McDonnell Douglas Corp., Western Division in the OWS.

4.7 The following tests will be performed if the unit performs at an acceptable level in the above tests. (4.1 through 4.6)

4.7.1 Temperature.- Steps 7 and 8 of Section 4.3 will be repeated with temperature extremes of 125°F and 0°F.

4.7.2 Vibration.- Sinusoidal, liftoff and boost level vibration of section 3.3.3 will be repeated at increased stress conditions.

5.0 FLIGHT AND BACKUP UNITS

Flight and backup units will be subjected to the following tests only. A functional test (ref. par. 3.1.) will be seen at end of each environmental tests.

5.1 Vibration

Vibration testing will be limited to Sinusoidal Vibration Evaluation of paragraph 3.3.3.

5.2 Temperature Cycle

The temperature cycle of paragraph 4.3 will be used.

6.0 DEVELOPMENT UNIT TESTS

The feasibility of the program has been demonstrated by the original T-003 instrument which was subjected to Apollo Environmental Criteria. With this background of a similar configuration, there is high reliability that the subsystems will withstand the environment in the present instrument. A prototype model of exact configuration with the exception of the battery pack and pump housing has been tested at the vibration levels stated in the test of paragraph 5.1.

ACCEPTANCE PROCEDURES FOR THE ELECTRONICS SUBSYSTEM

T-3-TP-3 (0)

1.0 SCOPE

This specification defines the tests to be conducted on the Aerosol Analyzer electronics subsystem, being manufactured by Bendix Research Laboratories of Southfield, Michigan, to determine its compliance with the specifications of Contract DOT/TSC-24.

2.0 REFERENCE DRAWINGS

Bendix Research Laboratories Report #5354.

3.0 TEST EQUIPMENT

3.1 Battery: 6 series connected Yardney PMC-1 Silvercel batteries, freshly charged to a voltage between 10.8 and 11.2.

3.2 Power Supply: Lambda

S/N____________________

3.3 Volt Meter: HP 5265A Digital Volt Meter

S/N____________________

3.4 VOM: Simpson 260; 2 required

S/N____________________

3.5 Pulse Generator: General Radio

S/N____________________

3.6 Oscilloscope: Tektronix, w/HV probe

S/N____________________

3.7 Test Cables: Including Cannon Harness per DOT/TSC Drawing 630074A

3.8 Interface Loads

3.8.1 Motor, Sperry 490-229, 12V DC, Brushless

3.8.2 Lamp, GE 2121D or 222

3.8.3 Photomultiplier tube, RCA 1P21, with dynode resistor per Drawing 630051A

3.9 Environmental Chamber

4.0 TEST CONDITIONS

Unit under Test S/N________________

This test will consist of five phases: three operational and two non-operational.

1.	Operational	+75°F
2.	Non-Operational	20 F
3.	Operational	+75°F
4.	Non-Operational	+105°F
5.	Operational	+75°F

5.0 PROCEDURE

The test will run at 75°F. Increase temperature to +105°F and soak for one (1) hour. Lower temperature to 75°F and repeat test. Lower temperature to 20 F and soak for one (1) hour. Increase temperature to 75°F and repeat test.

5.1 Connect the two boards together using the Cannon Harness (630074A). Connect the "+ remote sensing" lead and the "+2.25 lamp" lead together and to one lead of the GE 2121D lamp. Connect the "- remote sensing" lead and the "Lamp return" lead together and to the other lead of the GE 2121D lamp. Connect the "+12 volt motor" lead to the + motor lead and the "motor return" lead to the negative motor lead. Connect the "motor lamp" lead to the negative motor lead through a 56Ω resistor.

DO NOT REVERSE MOTOR LEAD POLARITIES

Connect the high voltage coaxial line to the photomultiplier tube, the shield being ground and the center conductor being -850 volts.

Connect the coaxial signal lead from the amplifier module on the main board to the photomultiplier tube through the microdot connector.

Connect "+9 Battery" to the + lead of the Yardney battery through the Simpson milliampmeter. Connect the "-Battery" to the negative terminal.

5.2 Using the DVM measure the open circuit voltage of the Yardney battery pack

	1st Run	2nd Run	3rd Run
I = 0 V =	______	______	______

5.3 Push the start switch. The pilot light and illuminating lamps should be the only lights on, the readout lamps off, and the motor running.

Pilot Light On	______	______	______
Motor Running	______	______	______
Readout Lamp Off	______	______	______
Illuminating Lamp On	______	______	______

5.4 Verify that the voltage on pin 3 of the main board is +5 ±.01 volts. If necessary adjust R32 on the secondary board.

E_3	______	______	______

Read the following voltages:

Main Board

E_{HV} = 800 ±10V	______	______	______

Secondary Board

E_{19} = + 2.25V ±.1V (Illuminating Lamp)	______	______	______
E_{15} = 2.75V ±.2V (Motor Lamp)	______	______	______

E_{13} = 12V ±.2V (Motor)	______	______	______
E_8 = Battery	______	______	______
$I_{BAT} \leq$ 450 ma	______	______	______

These readings are to be taken during the seventy seconds following the start button being pushed. Several runs will be needed to take all readings.

5.5 All readings should remain constant for 70 seconds. At the end of this time, the pilot lamp will go out and the readouts will be on. Record the following data after 70 seconds:

	1st Run	2nd Run	3rd Run
E_{19} = 0V	______	______	______
E_{15} = E_2 = E_{13} = 13V ±1V	______	______	______
Pilot Lamp Off	______	______	______
$I_{BAT} \leq$ 500 ma	______	______	______
Display Lamps Readout			
T = 70-78 1---0	______	______	______
T = 78-86 2---0	______	______	______
T = 86-94 3---0	______	______	______

5.6 After T = 94 seconds, the experiment turns itself off automatically.

T = 94 Experiment Off

I_{BAT} = 0

5.7 Remove PMT signal by disconnecting microdot connector. Using Simpson 260 meter measure input resistance of amplifier. Adjust gain pot in amplifier module (Drawing 2173380) to give reading of 5K. Then apply output pulse of GR Pulse Generator to input of amplifier through 1.0 Meg Resistor.

Use negative pulse output. Adjust pulse for 50 microseconds width. Set repetition rate for 150 Hz. Use scope to look at output pin #21 of pulse height detector (Ref. Drawing 2173381). Increase amplitude of input pulse until pulse waveform appears at pin #21.

Record amplitude of pulse into amplifier (after 1.0 Meg Resistor).

Level 1 pulse amplitude ____________________

Repeat this procedure while looking at pin 19 of detector module to determine

Level 2 pulse amplitude ____________________

Repeat, looking at pin 17 of detector module to determine

Level 3 pulse amplitude ____________________

5.8 After determining detector level settings, adjust pulse input to amplitude between first and second levels. Make a run and record readings. First channel should read 9000 ±50. Second and third channels read - - - 0.

	1st Run	2nd Run	3rd Run
Ch 1	________	________	________
Ch 2	________	________	________
Ch 3	________	________	________

Repeat, with input pulse amplitude between second and third levels. First and third channels should read 0, the second reading 9000 ±50.

Ch 1	________	________	________
Ch 2	________	________	________
Ch 3	________	________	________

Repeat, with input pulse amplitude exceeding third channel trip level. First and second channels should read 0, the third reading 9000 ±50.

	1st Run	2nd Run	3rd Run
Ch 1			
Ch 2			
Ch 3			

5.9 Check safety shutoff module and overflow. Disconnect pin 7 of the secondary board from pin 13 of the main board. Adjust pulse generator rep rate to 200 Hz and the amplitude to trigger the second level. Push switch S1 and record.

Over Flow Light On				
	Ch 1			
	Ch 2			
	Ch 3			

After about 200 seconds the experiment will turn off.

Toff = 200 ±25 seconds

________ ________ ________

TEST BY : ________________ Date __________

APPROVED : ________________ Date __________

________________ __________

T-003 OPTICAL TUBE ALIGNMENT

T-3-TP-1 (0)

Positioning of Light Source and Photomultiplier Tube

The optical tube assembly (650001) (Note drawings cited in text are appended) is mounted in a V-block, on an optical bench within a laminar air flow enclosure, positioned so that the lamp holder assembly is towards the operator and in a horizontal plane.

A 1" section of .09" O.D. teflon tubing is temporarily cemented to the pinch off tube of optical tube lamp (G.E. 2121D), with DeKhotinsky (or equivalent) cement.

The lamp is then inserted in the condenser lens clamp (620026A); the extension tubing passing through the mounted lamp holder assembly (620020A) is held by clamping to a magnetic adjustable indicator base (type Brown & Sharpe #7743), permitting the positioning of the lamp precisely and holding it in the lamp holder assembly. With the accumulator assembly (630031A) and the light trap assembly (630003) removed, a 14X alignment microscope with a depth of field of approximately 1mm is positioned on the optical bench to view the focused image of the aperture plate (620007A), in the sample area of the particle nut (620024A).

The lamp is now positioned so that the center and most uniform part of the filament image is centered, focused and fills 1/3 of the aperture at 90° to the air flow. To better view the filament of the lamp, a very low DC voltage is applied with mini clips to the lamp leads to produce a dim glow (approx. .5 - .6V). Once the lamp is positioned, the mirror and light trap is reassembled.

During the following tests, black masking tape should be temporarily placed over the back of the accumulator to keep stray light from striking the back of the mirror. Room lights should be off, or shielded, to avoid stray light striking the optical unit, producing erroneous signals.

Apply -1 KV regulated DC to the photomultiplier tube, negative polarity to the back lead, positive 1 KV to the red lead and shield.

With the lamp of the optical unit off and using a picoammeter (EG&G type ME 705) connected to the microdot signal connector of the P.M. tube, the value of dark current is recorded (.002 µa or lower). If the P.M. tube had recently been exposed to light, this value may be high until the tube stabilizes again.

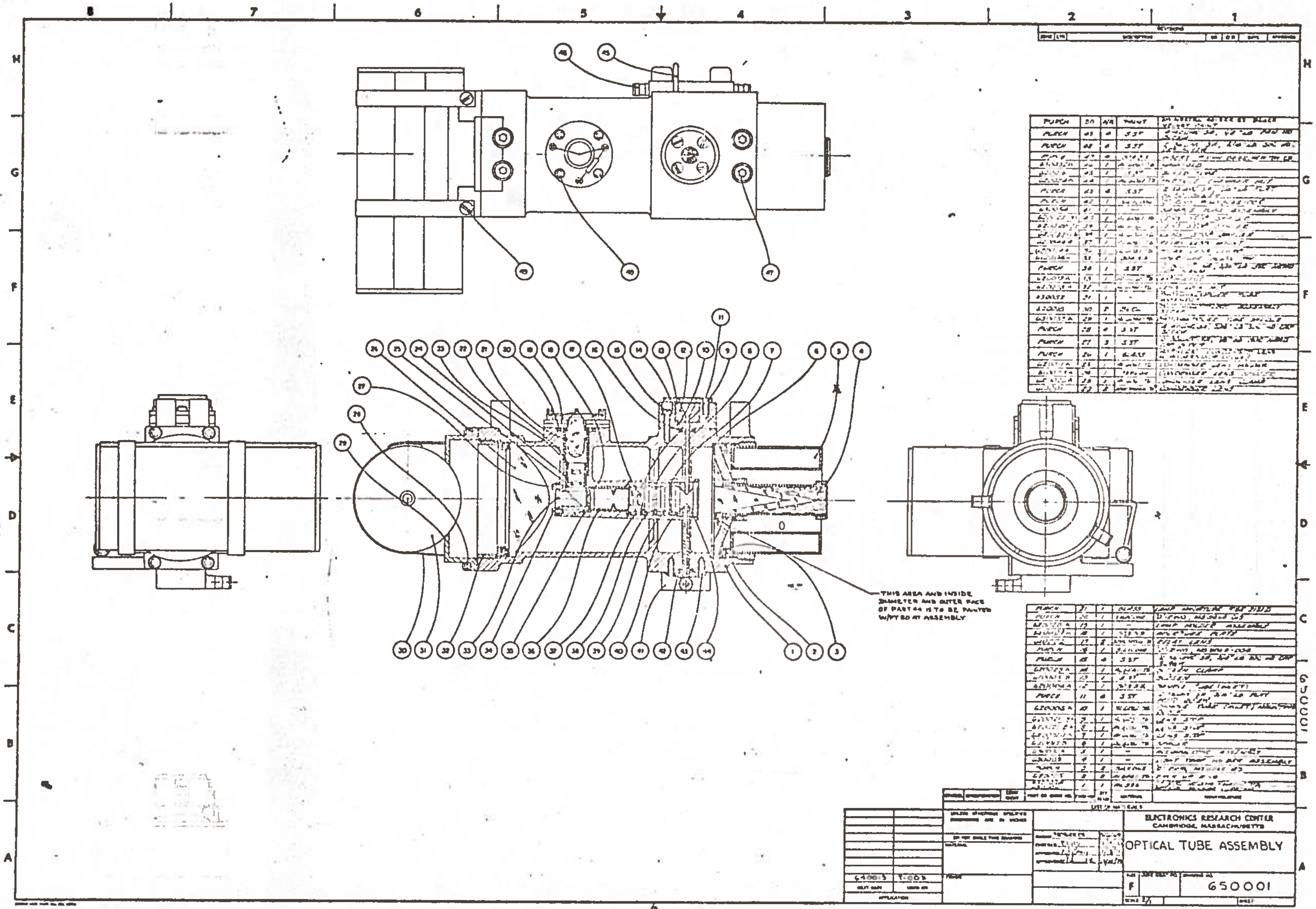
The stray light value (.080 µa or lower) is obtained by applying 1.9V regulated DC to the lamp of the optical unit, with no particles in the sample area. If too much stray light is detected, the source must be located and eliminated.

The signal value (40 - 50 µa) is obtained by inserting a piece of .004" diameter tinned wire in the sample area, and 1.9V regulated DC to the lamp of the optical unit. By loosening the P.M. tube assembly straps (620018), the P.M. tube can be positioned for maximum signal.

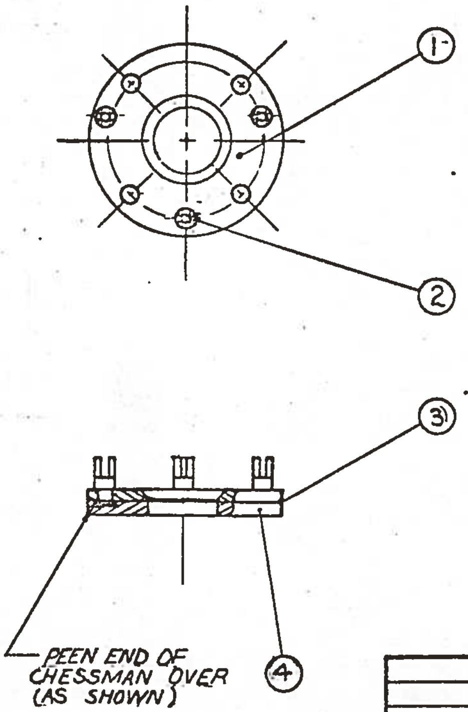
When all the P.M. output values are within their normal range, the 2121D lamp may be cemented to the lamp holder assembly. This is accomplished by mixing a small amount of 1/1 Devcon "5 minute" epoxy and applying it to the top edge of the hole in the lamp holder assembly in such a way that it will run down around the base of the lamp and bond it to the holder. (The epoxy is better controlled if cured slightly before applying.)

When the epoxy has cured, the piece of teflon tubing can be removed from the lamp pinch off tip and the lamp leads connected to their proper terminals.

Stycast 1090 (Everson & Cuming) is used to fill any voids around the lamp base and the holder, and provide an opaque surface.


THIS AREA AND INSIDE DIAMETER AND OUTER FACE OF PART 44 IS TO BE PAINTED W/PT 50 AT ASSEMBLY
LIST OF MATERIALS
ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS
OPTICAL TUBE ASSEMBLY
650001
F
650015
T-003
APPLICATION

REVISIONS					
LTR	DESCRIPTION	DR	CHK	DATE	APPROVED
A	FIND NO. 2 QTY WAS 5	RAR	KJB	11-30-70	KJ Bray



PART OR IDENT NO	FIND NO	QTY REQD	MATERIAL	NOMENCLATURE
G20013A	4	1	———	LAMPMOUNT (BOTTOM BOARD)
PURCHASE	3	A/R	EPOXY	EMERSON & CUMING, "STYCAST" #1090
PURCHASE	2	3	———	CHESSMAN LERCO #5075-B2
G30029A	1	1	———	LAMPMOUNT (TOP BOARD)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	DECIMALS ±.005 FRACTIONS ±1/64 ANGLES ±0° 15'
DO NOT SCALE THIS DRAWING	
MATERIAL	—
FINISH	—
NEXT ASSY	G50001
USED ON	T-003
APPLICATION	

WARREN ASSOC INC
T910-7

DRAWN	[illegible]	7/5/69
CHECKED	[illegible]	7/15/69
APPROVED	[illegible]	[illegible]
APPROVED	[illegible]	11-4-69

ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS

LAMP HOLDER ASS'Y

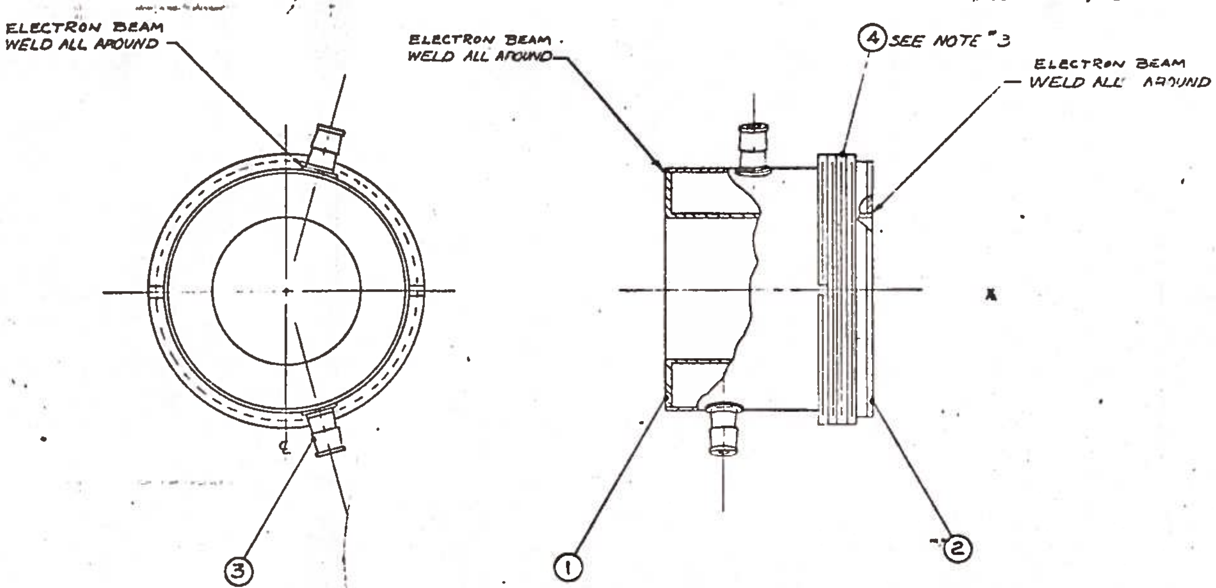
SIZE	CODE IDENT NO.	DRAWING NO.
B		G20020A
SCALE 2/1		SHEET

8000 / 6 ERC 4/69

ZONE	LTR	DESCRIPTION	DR	CHK	DATE	APPROVED
	A	NOTE 3 SPEC WAS MIL-A-8625-1	GK	KJG	10-29-70	[illegible]

NOTES:

1. TEST FOR LEAKAGE @ 10 P.S.I.
2. INSTALL PART #4 (AS SHOWN) BEFORE WELDING PART #3 TO PART #2. WELD PRIOR TO ANODIZING
3. VAPOR BLAST AND BLACK ANODIZE PER MIL-A-8625C, TYPE II, CLASS 2. (MASK PART 4)
4. .005 THICK, 718 BRAZING SHEET PERMISSIBLE IN WELD JOINT



PART OR IDENT NO.	FIND NO	QTY REQD	MATERIAL	NOMENCLATURE
620008A	4	1	———	LENS LOCK NUT
620009	3	2	———	OUTER SHELL TUBE
630030	2	1	———	OUTER SHELL
620010	1	1	———	INNER SHELL

SYMBOL | SPECIFICATION | CODE IDENT

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMALS ±.005 ANGLES FRACTIONS ±1/64 ±0°15'

DO NOT SCALE THIS DRAWING

MATERIAL —

FINISH SEE NOTE #3

650001	T-003
NEXT ASSY	USED ON
APPLICATION	

WARREN ASSOC INC
T810-7

DRAWN J. WEST 7/15/69
CHECKED [illegible] 7-15-69
APPROVED [illegible] 1/13/69
APPROVED [illegible] 11/14/69

ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS

ACCUMULATOR ASS'Y

SIZE C | CODE IDENT NO. | DRAWING NO. 630031 A

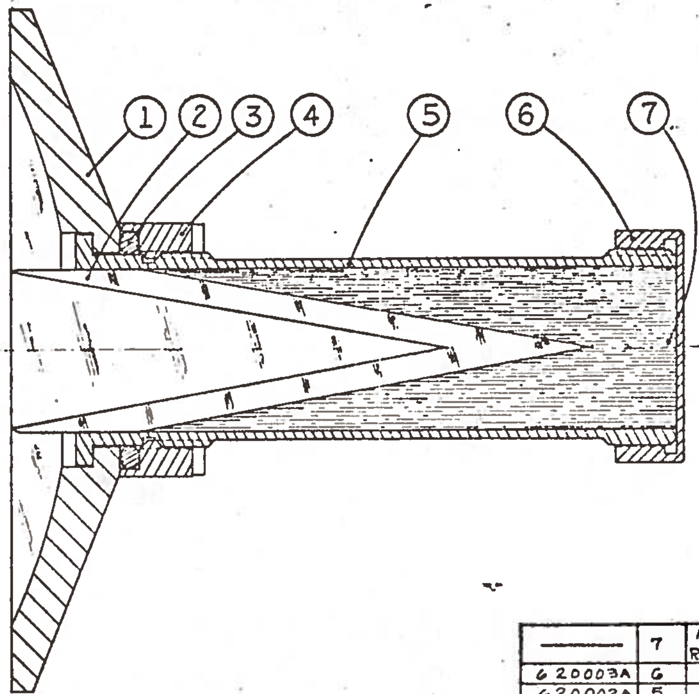
SCALE 2/1 | SHEET

630031A

630003

ZONE	LTR	DESCRIPTION	DR	CHK	DATE	APPROVED

REVISIONS



NOTES:

1. LIGHT TRAP (PART 2) SHALL BE POSITIONED WITHIN LIGHT TRAP HOLDER (PART 5) AS SHOWN USING ADHESIVE (PART 7) SO THAT ENTRANCE PLANE OF LIGHT TRAP IS MOUNTED IN LINE WITH FLAT SURFACE OF PARABOLIC MIRROR FACE (PART 1) AS SHOWN.

SYMBOL	SPECIFICATION	CODE IDENT	PART OR IDENT NO.	FIND NO	QTY REQD	MATERIAL	NOMENCLATURE
			———	7	AS REQD	———	STYCAST #1090 EMERSON & CUMING
			620003A	6	1	———	LIGHT TRAP HOLDER CAP
			620002A	5	1	———	LIGHT TRAP HOLDER
			620001A	4	1	———	LIGHT TRAP HOLDER NUT
			———	3	1	SILICONE	O-RING MS 9068-014
			630001B	2	1	———	LIGHT TRAP
			630002A	1	1	———	PARABOLIC MIRROR

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DO NOT SCALE THIS DRAWING

MATERIAL

FINISH

NEXT ASSY	USED ON
650001	T-003

APPLICATION

DRAWN	ROBERTS	4/3/69
CHECKED	BRAY	4/3/69
APPROVED	[illegible]	[illegible]
APPROVED	[illegible]	2/1/70

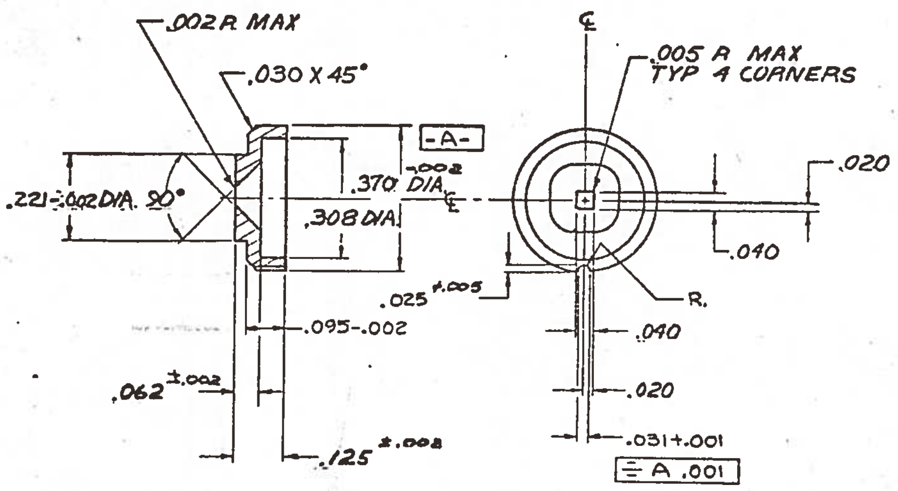
ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS

LIGHT TRAP HOLDER ASSY

SIZE	CODE IDENT NO.	DRAWING NO.
C		630003

SCALE 5/1 SHEET

REVISIONS					
LTR	DESCRIPTION	DR	CHK	DATE	APPROVED
A	.221-.002 DIA WAS .220; .030 X 45° WAS .03X45°; .370-.002 DIA WAS .368-.002; ADDED DATUM A; .025+.005 WAS .017 +.003; .095-.002 DIM. REPLACES .030 DIM.; .031+.001 DIM ADDED .016 R CHANGED TO R.	RAR	KJB	11-23-70	KJ Bray



NOTES:

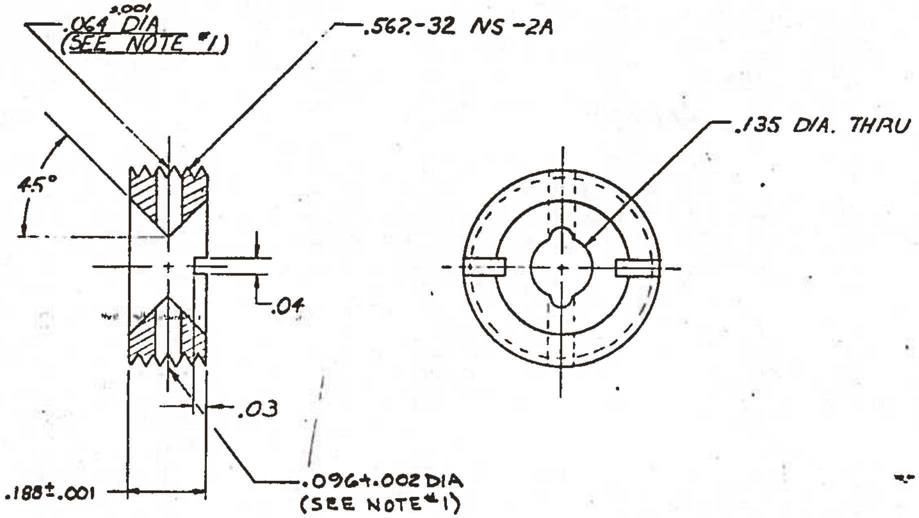
1. FINISH: BLACK PASSIVATE PER MIL-F-14072 (E 300)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMALS ±.005 FRACTIONS ±1/64 ANGLES ±0°15'	WARREN ASSOC INC. T 910-7	ELECTRONICS RESEARCH CENTER CAMBRIDGE, MASSACHUSETTS	
DO NOT SCALE THIS DRAWING	DRAWN JJESI 7/9/65	APERTURE PLATE	
MATERIAL 303 S.ST.	CHECKED 7/5/65		
FINISH SEE NOTE # 1	APPROVED KJ Bray	SIZE B	DRAWING NO. 620007A
	APPROVED	SCALE 4/1	SHEET

NEXT ASSY	USED ON
G50001	T-003
APPLICATION	

8810 / 4 ERC 4/69

REVISIONS					
LTR	DESCRIPTION	DR	CHK	DATE	APPROVED
A	NOTE 2 READ: FINISH: PART TO BE ALKALI CLEANED AND CAUSTIC ETCHED PRIOR TO BLACK ANODIZING PER MIL-A-8625-1 .158±.001 WAS .188	JK	KJG	11/20/70	[signature]



NOTES:

1. .064 DIA AND .096 DIA HOLES TO BE IN LINE WITHIN .001 ACROSS BORE. HOLES TO BE DRILLED AFTER ASSEMBLY INTO OPTICAL HOUSING.
2. VAPOR BLAST AND BLACK ANODIZE PER MIL-A-8625C, TYPE II, CLASS 2, TO OBTAIN MATTE FINISH.

G50001	T-003
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS ±.005
FRACTIONS ±1/64
ANGLES ±0° 15'
DO NOT SCALE THIS DRAWING
MATERIAL 6061-T6 AL
FINISH SEE NOTE #2

WARREN ASSOC INC.
T910-7
DRAWN [signature] 7/1/69
CHECKED [signature] 7/3/69
APPROVED [signature] 7/25/69
APPROVED [signature] 11-3-69

ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS

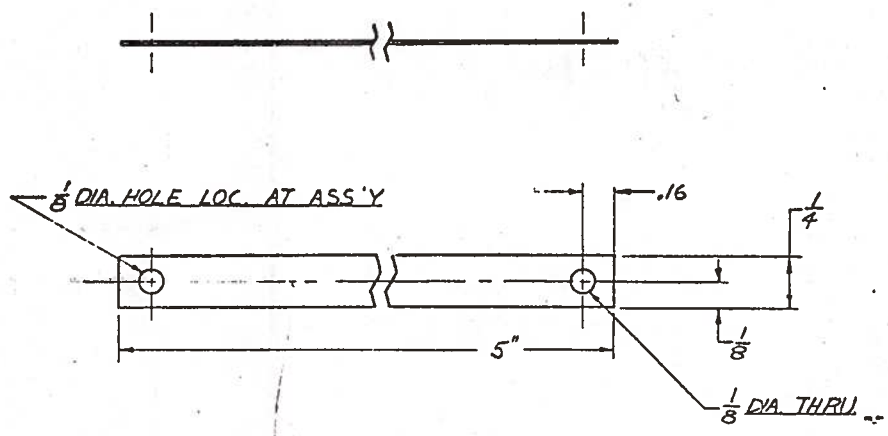
PARTICLE CHAMBER NUT

SIZE B | CODE IDENT NO. | DRAWING NO. 620024A
SCALE 4/1 | SHEET

8610 / 4 ERC 4/69

REVISIONS					
LTR	DESCRIPTION	DR	CHK	DATE	APPROVED

NOTE: TWO(2) REQD PER ASSY



650001	T-003
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS ±.005
FRACTIONS ±1/64
ANGLES ±0°15'
DO NOT SCALE THIS DRAWING
MATERIAL .010 BeCu
FINISH

WARREN ASSOC INC
T910-7
DRAWN J. West 7/11/69
CHECKED 7/15/69
APPROVED
APPROVED

ELECTRONICS RESEARCH CENTER
CAMBRIDGE, MASSACHUSETTS

P.M. ASS'Y STRAP

SIZE B | CODE IDENT NO. | DRAWING NO. 620018
SCALE 2/1 | SHEET

0610 / 4 ERC 4/69

CALIBRATION PLAN

T-3-TP-4 (0)

1.0 GENERAL

Calibration of the T-003 will be accomplished at three points in time during assembly and check-out of T-003.

1.01 Optical Subsystem Calibration:

The optical subsystem as a separate unit prior to assembly in the completed Aerosol Analyzer (AA). (See 2.0)

1.02 Post Assembly Calibration:

After the optical subsystem has been integrated with the electronics instrument case and hardware to form a complete unit. (See 3.0)

1.03 Post Environmental Acceptance Test:

The assembled unit will be calibrated after each phase of the environmental testing. (See 4.0)

1.04 The following commercial instruments will be used for calibration:

1 - Wavetek Model 114 pulse generator

2 - H. P. Model 214A pulse generator

3 - Tektronix Model 550 Oscilloscope

4 - Nuclear Data Model 3300 Multi Channel Analyzer (MCA) for Sections 2.0 and 3.0. It may be necessary to use another MCA calibrated against the Model 3300 MCA for Section 4.

5 - Triplett Model 630A Multimeter

1.05 All calibrations will be performed with the filter impactor in place. Prior to each calibration, the flow rate will be verified at 0.5 l/min as outlined in Air Flow Calibration (T-3-TP-5).

1.06 Pertinent calibration data will be recorded on data sheets at the end of this section.

2.0 OPTICAL SUBSYSTEM CALIBRATION

The Optical Subsystem shall be previously assembled and tested as in Optical Tube Alignment (T-3-TP-1).

2.1 A breadboarded amplifier/filter identical in design and performance to the flight hardware will be used to check the optical subsystem. The gain and band-pass of this amplifier will be measured using the Wavetek pulse generator.

2.2 The PM tube and the scattered light noise at the amplifier output will be measured as a function of PM tube voltage (700V - 1000V) and PM tube load resistance (1KΩ to 10KΩ) using the oscilloscope and MCA. The combined PM tube and scattered light noise peak shall not exceed 20 mV at 800V PM voltage and 5KΩ load resistance.

2.3 Monodispersed aerosols of 1.1 micron polystyrene latex (PSL) will be passed through the optics. The peak amplitude and signal-to-noise ratio shall be measured as a function of PM tube voltage and load resistance, as in par. 2.2. The peak signal-to-noise ratio for 1.1 μm PSL shall be equal to or greater than 2 to 1 at 800 volts and 5KΩ load resistance.

2.4 Considering signal-to-noise ratios and level limitations of T-003 electronics, the best values of high voltage and load resistance (gain) will be determined.

3.0 POST ASSEMBLY CALIBRATION

After complete assembly of the aerosol analyzer, the following tests will be performed.

3.1 Using the voltage and gain determined in Section 2.4, a calibration curve will be obtained using at least three sizes of monodispersed aerosols from 1 μm to 9 μm. Slight modifications in voltage and/or gain, if needed, will be made to correct for changes due to amplifier/filter, instrumentation/packaging, etc.

3.2 Using the calibration curve obtained in 3.1, the three levels of the T-003 readout will be set to correspond to particle sizes of 1 - 3 μm, 3 - 9 μm, and greater than 9 μm. The levels will be set using the H. P. pulse generator on the input to the filter/amplifier.

3.3 Operation of each level will be verified by inserting a pulse from the H. P. pulse generator into the input of the filter/amplifier. The amplitude of this pulse shall be set at the midpoint of each level for one complete cycle of the T-003. This pulse shall have a repetition rate of 60 pulses per second. Each level should read 6000±30 counts.

3.4 Monodispersed particles of at least two different sizes from 1 µm to 9 µm will be passed through the optics. The results will be simultaneously recorded on the T-003 readout and the MCA. These two readouts will be compared for verification of count rate and level set.

4.0 POST ENVIRONMENTAL ACCEPTANCE TEST

Upon completion of each phase of the qualification test, further calibration will be performed to insure continued optimized operation of the T-003.

4.1 One size of monodispersed aerosol will be passed through the optics. The count rate and sizing information will be simultaneously recorded with the MCA and the T-003 readout. This information, along with signal-to-noise ratio, will be checked against that obtained in Section 2.0.

4.2 All discrepancies noted during testing as outlined in par. 4.1 will be recorded as to cause and correction.

4.3 Further calibration will be performed if any problems noted during testing as outlined in par. 4.1 and 4.2 deem it necessary.

T-003 AIR FLOW CALIBRATION

AIR FLOW EVALUATION AND CURVE CORRECTION

J. B. Thompson

Due to the changing of the actual air flow in the Aerosol Analyzer when a ball type flowmeter was used for measurement, it was necessary to devise a static means of measuring the flow.

By using an AA unit (Prototype 1) with a pressure tap, it was possible to measure the pressure drop across the inlet tube, outlet tube and bleed tube, with a Dwyer 422-23 Manometer, as shown in the diagram (Fig. 1).

Values of air flow (cc/min) vs pressure drop (H20) for the inlet tube were available from a curve (Fig. 2) previously established.

With the Dwyer Manometer, the flow rate was set at each point on the inlet tube curve for the indicated pressures. At each point a new flow rate was read on a Manostat Flowmeter Type 36-541-12 with a saphire float temporarily connected to the input of the inlet tube. With these new values, a corrected curve was plotted for the Manostat Flowmeter (Fig. 3), providing a correlation between flowmeter readings and actual air flow once the meter is removed.

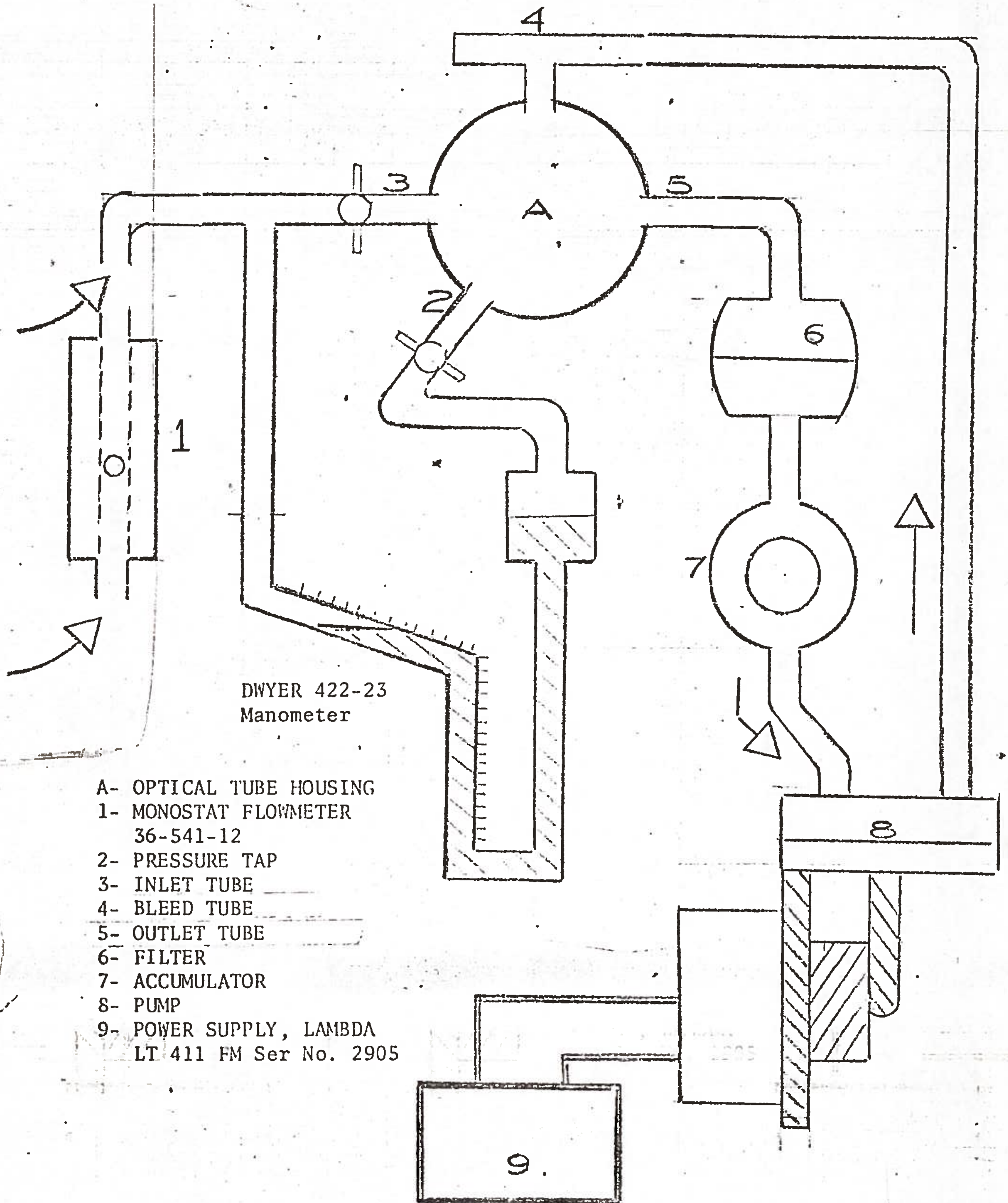
This correlation curve, in conjunction with the Manostat Flowmeter, will be used for air flow measurement on all T-003 instruments.

TABLE 1

Pressure drops across aerosol analyzer inlet tube of Prototype 1 in water vs. manostat flowmeter readings to be used for curve correction of flowmeter 36-541-12. See Fig. 3.

FLOW METER	CC/MIN	INLET PRESS
12.1	960	3.3
11.1	850	2.8
9.9	740	2.3
8.8	629	1.8
7.6	524	1.3
6.5	423	.95
5.4	327	.67
4.2	235	.44
2.4	148	.23

Pressure drops are with flowmeter removed.



A- OPTICAL TUBE HOUSING
1- MONOSTAT FLOWMETER
36-541-12
2- PRESSURE TAP
3- INLET TUBE
4- BLEED TUBE
5- OUTLET TUBE
6- FILTER
7- ACCUMULATOR
8- PUMP
9- POWER SUPPLY, LAMBDA
LT 411 FM Ser No. 2905

FIG 1
TEST S TUP

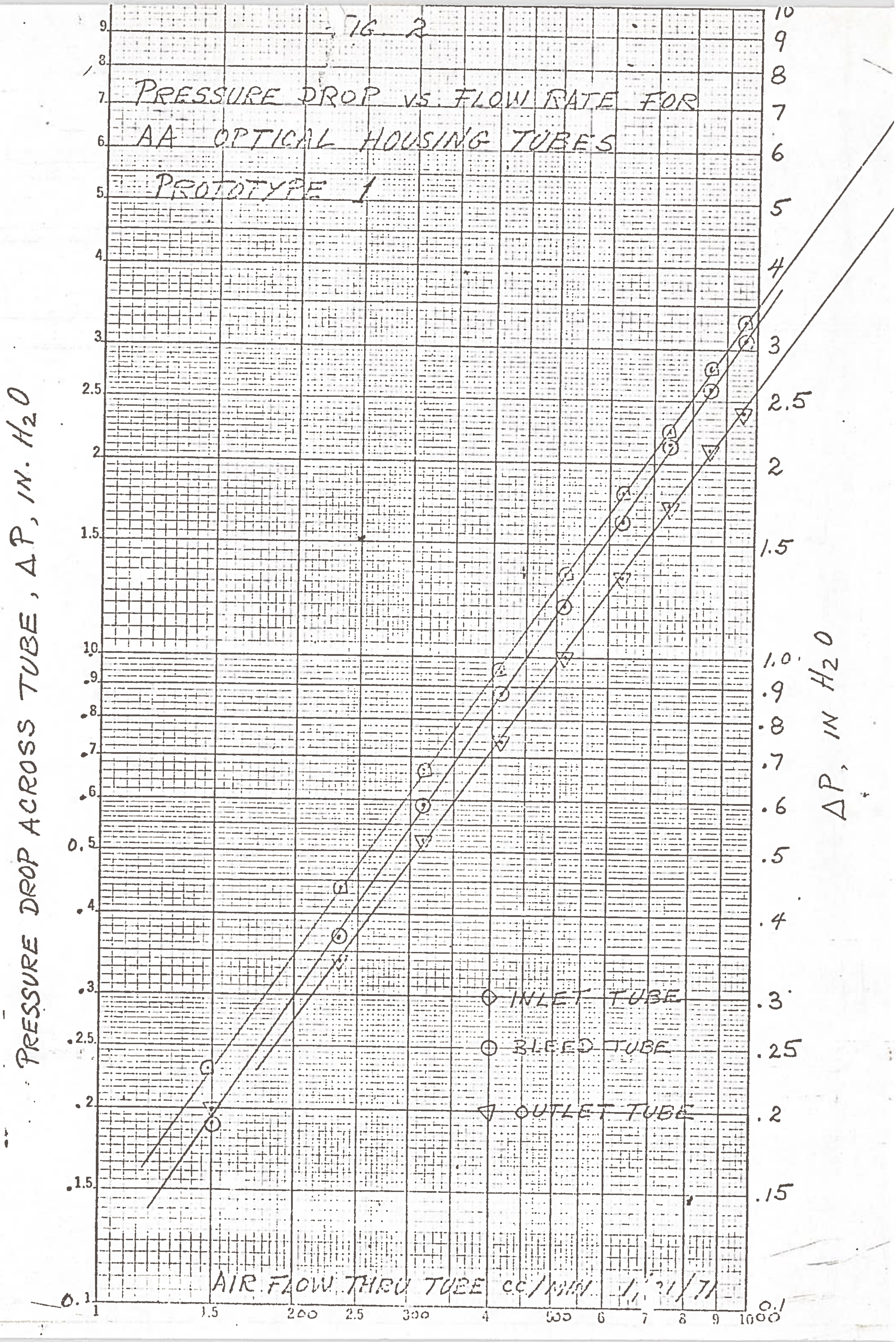


FIG. 2
PRESSURE DROP vs. FLOW RATE FOR
AA OPTICAL HOUSING TUBES
PROTOTYPE 1
PRESSURE DROP ACROSS TUBE, ΔP, IN. H_2O
ΔP, IN H_2O
INLET TUBE
BLEED TUBE
OUTLET TUBE
AIR FLOW THRU TUBE cc/MIN
1/21/71

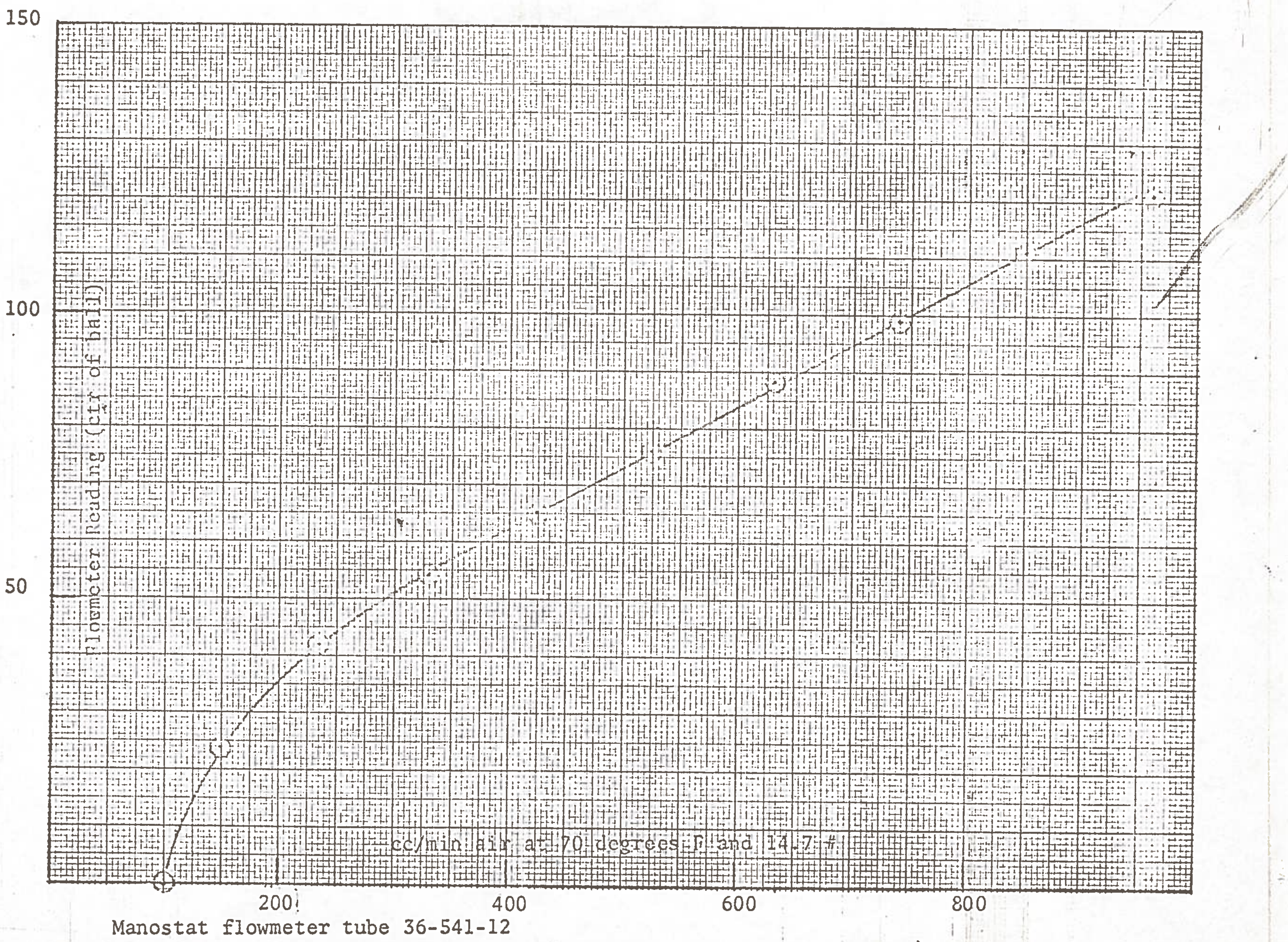


FIG. 3 Flwmeter Corrected Curve