INTERDEPARTMENTAL COMMUNICATION
June 5, 1959

TO: G. R. Oscar Mail No. 201

CC: W. H. Clohessy, J. G. Gaume, W. S. Griffith, N. Kautsky, G. Gleason

FROM: R. H. Edgerley Mail No. A-193 Ext. 3310

In accordance with the recent decision made jointly by "Data Aquisition Unit" and the "Instrumentation Unit" (Ref. I.D.C., C. R. Harris to Dr. J. Gaume, 5-19-59), I am submitting the attached requirements for ESA 516.

It is our understanding that the Data Aquisition Unit will handle routine instrumentation and the design and procurement of the laboratory control systems for this project. The decision as to what constitutes "routine instrumentation" will be made by George Gleason of Instrumentation.

R. H. Edgerley
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Approved: J. G. Gaume M.D.
J. G. Gaume, M.D.
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RHE:gdt

Requirements for Sensors in Small Animal Chamber (ESA 516)
(Revised Copy)

Requirements for all sensors:

1. Operating temperature, 15 to 40° C.
2. 0 to 100% oxygen, i.e. 0 to 760 mm.Hg. O_2 partial pressure.
3. Total pressure variation, 0-760 mm.Hg.
4. Humidity, 0 to 100% rel. humidity.
5. Stability over a period of 2 months so far as calibration is concerned.
6. Maximum reliability or life expectancy.
7. Not affected by light.
8. Capability for 2 months permanent recording. (monitoring at preset conditions)
9. Frequency of response.
   a. Chart record once per hour.
   b. Instruments or meters permitting visual measurements anytime. This permits adjustment to required experimental conditions.
10. Laboratory rather than airborne equipment is required for initial installation. (bulk reduction no problem at this stage)
11. Installation by August 1, 1959.

Special Requirements:

1. Total Pressure - overall range 0 - 760 mm.Hg. ±1 mm.Hg. precision. Should be as responsive as an altimeter. For recording purposes,
* we should be able to record in various ranges (X ±10 mm.Hg.). Automatic control to inject [illegible] mixture or operate vacuum pump whenever pressure deviates.

   Number = 2. One for inner and one for outer chamber.

2. Rate of Pressure Change Indicator. This should be equivalent to a rate of climb indicator as used in high performance aircraft.
* No permanent record required.

   Number = 2. One for inner and one for outer chamber.

3. Humidity - Maximum precision at least ±1% Rel. Humidity in temperature range 20° to 25° C. Equilibration time 1 minute if possible
* for any amount of change in range of 0 to 99% relative humidity. Read out units not important.

   Number = 2. One for inlet and one for outlet of inner chamber.

4. Air Flow Meters - We need something to tell us how rapidly the inner chamber "air" is being replaced (volume). Secondly, we
* need information about the velocity (ft./min.) of air over the animals. (not a fixed installation)

   Volume Information

   a. Units - $ft.^3/min.$
   b. Range - 0 - 30 $ft.^3/min.$
   c. Precision 0.25 $ft.^3/min.$ (at least)
   d. Number = 1.

   Velocity Information

   a. Units = cm./sec.
   b. Range - 0 to 25 cm./sec.
   c. Precision - ±0.5 cm./sec. (at lease)
   d. Number = 2.

5. Air Temperature -

* a. Units = degrees C.
   b. Range = +15° to 40° C.
   c. Precision = 0.1° C. (minimum)
   d. Equilibration in 1-2 minutes.
   e. Number = 3. One for inlet and one for outlet of inner chamber. A third sensor is needed to measure air temperature at cooling unit inlet to regulate, in conjunction with chamber inlet sensor, the performance of cooling unit.

6. Gas Sensors -

a. O_2 Sensor

Units - mm.Hg.
Range - 0 to 760 mm.Hg. with capability of selecting a variety of short ranges (±10 mm.Hg.) with a precision of ±1 mm.Hg.
Number = 2. Inlet and outlet of inner chamber.

b. CO_2 Sensor

Units - mm.Hg.
Range - 0 to 100 mm.Hg. with capability of selecting a variety of short ranges (±5 mm.Hg.) with a precision of ±1 mm.Hg.
Number = 2. Inlet and outlet of inner chamber.

c. Nitrogen Sensor

low priority

Units - mm.Hg.
Range - 0 to 760 mm.Hg. with capability of selecting a variety of short ranges (±10 mm.Hg.) with a precision of 1 mm.Hg.
Number = 2. Inlet and outlet of inner chamber.

7. O_2 Consumption -

* a. Regulator to inject O_2 when O_2 pressure falls by 1 mm.Hg.
b. Record injections of O_2 into chamber.

8. Special instruments (low priority) not required for initial installation but for which room should be left on instrument panel, etc.

a. Conductivity of the air in the animal chamber.
b. Special gas detectors such as NH_4, He, O_3, CO, metal vapors, etc.
c. Physiological instrumentation.

* Those items requiring controls; the rest we will control indirectly.

SUBJECT: Requirements for the Atmospheric Conditioning System to be Used in Connection with the Environmental Exposure Chamber, ESA 516

A. General Considerations that Apply to the Entire System.

1. All figures given below are calculated for a maximum requirement of 10 rats maintained for a continuous 2-month period. This means a total absorptive capacity for 44 lbs. of water, 14.2 lbs. of CO_2 and a heat load of .827 BTU/min. from the animals.

2. All atmospheric conditioning devices must be operateable for short periods of time (hours) as well as for periods up to two months, without attention to maintain the atmosphere of the chamber within the specifications originally outlined in:

   a. IDC, dated 1/22/59, ("Statement of Work for the Construction of a Prototype Sealed Cabin for Use with Animal Subjects").

   b. "Requirements for Sensors in Small Animal Chamber, ESA 516".

3. The dead space of the chamber-absorber plumbing should be held to a minimum.

4. All connections are to be made for maximum flexibility. This means standardization of all fittings with a female end on the entry side to all absorbers and devices, and male fittings at all exit ends. (or vice versa over the entire system)

5. All valves (stopcocks) need only be of the on-off type (except where specifically indicated). These valves (stopcocks) must be reliable over long term usage and require no lubrication.

6. The pressure inside the inner chamber and associated plumbing will usually be less than atmospheric.

7. All plumbing and canisters must be leak-proof and corrosion resistant. Canisters are to be reuseable over many experiments (after recharging).

B. A flow diagram attached herewith outlines the initial arrangement of the equipment. Certain components will be described in greater detail below. (Numbers refer to locations in flow chart.)

#2, 20 - Temperature Insulating Gaskets (2)

   a. Purpose: to prevent conductive heat loss.

#3 - Hair and Fecal Material Filter

a. Purpose: to remove airborne animal waste products (hair and fecal material) before air stream reaches water and CO_2 absorbers.

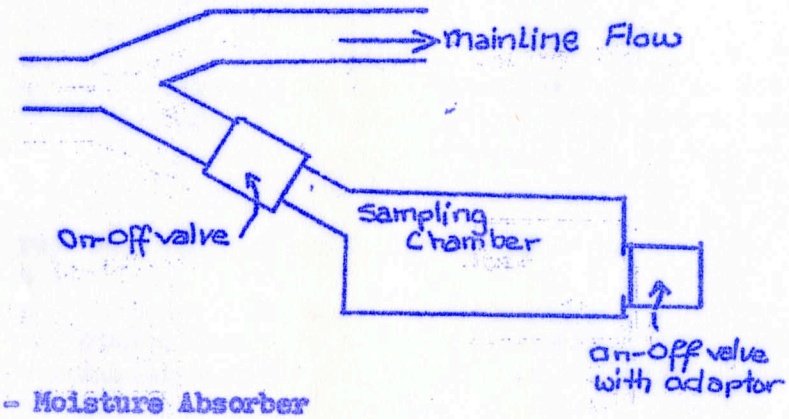
b. A coarse wire screen, followed by a finer wire screen contained in a single cartridge is envisioned.

c. Two alternate units allowing cleaning and replacement without chamber shutdown.

#4, 14 - Gas Sampling Devices (2)

a. Purpose: to withdraw gas samples of 10-100 ml. for special analysis.

b. Possible design:



#5 - Moisture Absorber

a. Purpose: to remove water produced by animals in the chamber and permit the measurement of the amount.

b. Requirements:

1) Over a 2-month period from 10 rats, 44 lbs. of water will be produced.

2) The absorption is to be so arranged that each of 16 canisters can absorb all moisture produced for 4 days (without interruption) or that all 16 units absorb all moisture for the entire period.

3) Size: each canister to contain a charge of 8.3 lbs. of anhydrone or 12.5 lbs. of Zeolite (Linde 4A Molecular Sieves).

4) Absorption should be so arranged that it is possible to maintain the relative humidity from 10 to 99% at any temperature from 15-40° C. in the inner chamber. In the range of from 20-25° C., it is desired to maintain the humidity at any preset level with an accuracy of ±1%.

#6 - CO_2 Absorber

a. Purpose: to remove CO_2 produced by the animals in the chamber and to measure the quantities produced at various experimental intervals.

b. Requirements:

1) Over a 2-month period from 10 rats, 14.2 lbs. CO_2 will be produced.

2) The absorption is to be so arranged that each of 16 canisters can absorb all CO_2 produced for 4 days (without interruption) or that the combined capacity of all 16 units can satisfy the needs over the entire 2-month period.

3) Size: each canister to contain 1.27 lbs. (0.05333 ft.^{3}) of lithium hydroxide (Maywood) or 2.572 lbs. of Baralyme (0.0442 ft.^{3}).

4) Absorption should be so arranged that it is possible to maintain CO_2 concentration from 0 to 100 mm.Hg. partial pressure in the inner chamber, and to regulate this at any preset level within ± 1 mm. of Hg. partial pressure.

#7, 19 - Special Purpose Manifolding

a. Purpose: to introduce into the circulating air stream special devices, i.e., ion generators, ion counters, special gas analysis instrumentation, air humidity regulators, special gas absorbers, etc.

b. Requirements:

1) The units to be introduced will vary in size and use and have to be engineered specially for each purpose.

#8 - Charcoal Absorber

a. Purpose: to remove noxious gases from the circulating air system.

b. Requirements:

1) Each canister unit should contain 2 lbs. of activated charcoal (density 30 lbs./ft.^{3}).

#9 - Particle Filter

a. Purpose: to remove chemical dust that was carried by air stream from water and CO_2 absorbers and charcoal (charcoal, LiOH, $Mg(ClO_4)_2$, etc.).

b. Requirements: a self-cleaning device is desirable.

#10 - Catalytic Burner

a. Purpose: to remove noxious gases not absorbed by the charcoal.

b. Requirements: satisfactory operation without attention over a 2-month period.

#11, 12, 13 - Gas Addition Manifold

a. Purpose: to supply O_2 to the atmosphere as used by the animal and to initially charge and maintain the gas atmosphere in the system.

b. Requirements:

1) In response to pO_2 sensor at inlet of chamber add automatically small amounts of O_2 and to record the volume (mass) of gas injected.

2) In response to the total pressure sensor, to inject automatically more of the atmospheric gas mixture when level drops below preset level. (low priority)

3) The controls in this manifold must also be operateable manually.

4) A third position for the purpose of gas mixing and the changing of tanks is needed.

#15 - Air Transport Pump

a. Purpose: to move air in chamber and associated plumbing. Air movement is being depended on for the removal of water and renewal of the atmosphere in the chamber.

b. Requirements:

1) Performance of air transport to be regulated within at least ± 0.25 ft.^{3}/min. at any given level. The level of air transport to be determined by the humidity sensor at chamber outlet within the range of 0-30 ft.^{3}/min. (automatically).

2) To also be manually adjustable.

#17 - Air Cooling System

a. Purpose: to condition the air to a preset chamber entry temperature.

1) To remove from the air, heat added by the air circulation pump, catalytic burner, CO_2 and water absorbers, the animals and instrumentation within the chamber.

b. Requirements:

1) To hold the air temperature of the inner chamber at any level in the range 15 to 40° C. in a laboratory of the usual temperature range. It is desired to control and record the temperature with a precision of 0.1° C.

#23 - Vacuum Pump

a. Purpose: to reduce the total pressure and maintain it automatically at any preset level in the vacuum chamber.

b. Requirements:

1) Must be operateable by manual means.

2) Appropriate valving to permit it's serviceability for both chambers.

3) Capable of reducing chamber pressure from ambient to 10 mm. Hg. in 60 minutes.

#26 - Heat Removal from Inner Chamber

a. Purpose: the illumination, instrumentation and animals produce heat which will accumulate unless removed and raise in-chamber temperature.

b. Requirements:

1) It is estimated that up to 4.36535 BTU have to be removed each minute.

Expected Time Schedule

a. Completion of basic chamber unit (no plumbing), July 25, 1959.
b. Installation of all of above components, the control systems, and instrumentation required, July 25, 1959 to August 10, 1959.
c. Chamber operation testing, August 10 to August 25, 1959.
d. Transfer of chamber unit from Space Medicine Laboratory (Ranch House Area) to new laboratory in research building now under construction.
e. Physiological experimentation to start September 1, 1959.

Prepared by Manfred M. Hein

MMH:gdt