OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA GEN. REG. NO. 27
5010-

UNITED STATES GOVERNMENT

# *Memorandum*

: DA/C. A. Berry

**DATE:** December 2, 1967
PA-7-12-9

OM : PA/Manager, Apollo Spacecraft Program

BJECT: Maximum exposure time in pure oxygen atmosphere

During the ORI for manned suit loop testing at Downey, Dr. Hawkins pointed out that we should limit to no more than four hours the time of exposure to a pure oxygen environment at 16 to 19 psia. We accepted this limitation for the test in question with the understanding that the local flight surgeon could extend the time for a short period if required.

This raises a question concerning exposure to this environment on the launch pad. As I recall, we had several instances in Mercury and Gemini where the astronauts were exposed for considerably more than four hours. Present plans for Apollo also allow for countdown plus pad hold times to exceed the four-hour limitation.

May I have your thoughts on this matter? Is there a rational way of arriving at a number greater than four hours?

George M. Low

George M. Low

cc:
PD/O. E. Maynard

PA:GMLow:mb 12/2/67

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UNITED STATES GOVERNMENT

# *Memorandum*

: PA/Manager, Apollo Spacecraft Program

DATE: December 7, 1967

In reply refer to:
DA-67-M587

)M : DA/Director of Medical Research
and Operations

JECT: Maximum Crew Exposure Time in a Pure Oxygen Atmosphere

I have referred your memorandum PA-7-12-9, dated December 2, 1967, to the Medical Directorate staff for an in-depth review of the question posed.

As experience is gained throughout the country with human exposure to relative high concentrations of oxygen at pressures equal to or greater than one atmosphere, more precise understanding is being achieved of the safe exposure envelope in this mildly toxic environment. We will endeavor to collect the most recent firm data relevant to this question and furnish you a position regarding safe exposure limits for the crew during checkout and countdown operations on the launch pad by the end of this month.

Charles A. Berry M.D.

Charles A. Berry, M. D.

DA:ADC:fm 12-6-67

5010-108



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Dr. Berry 1/3 $O_2$ Atmos

PA/Manager, Apollo Spacecraft Program JAN 16 1968

DA/Director of Medical Research & Operations

Human Exposure Limits to a 100% Oxygen Atmosphere at Pressures from 14.7 to 20 psia.

The Medical Operations Office has completed a detailed literature review on human tolerance to 100% oxygen environments. As you might suspect, this literature survey showed that the fundamental factors influencing oxygen toxicity are:

a. Dosage (oxygen partial pressure)

b. Duration

c. Biological variability/susceptibility

Item c above makes the assignment of a specific tolerance time for a well-known and well-defined population such as the astronauts extremely difficult, if not impossible. Hence, it should be understood that certain individuals may be unable to complete a "nominal" exposure time without onset of definite symptomatology.

The literature search also clearly established that there is a void of human data in the area of particular interest to us, i.e., 16-20 psia. However, numerous human research studies are available in the pressure ranges less than or equal to 14.7 psia and equal to or greater than 37 psia. These studies provide a reasonable basis for extrapolating the oxygen tolerance curve through an area presently lacking data points and in predicting the time-dependent physiological effects of such hyperbaric oxygen environments upon man.

Based on the evidence presented in these studies, our medical policy regarding human exposure limits to a 100% oxygen atmosphere at pressures from 14.7 to 20 psia during all space flights and ground tests is as follows:

a. The allowable planned human exposure limit is 4 hours. + 4 hrs prebreathing

b. The maximum contingency human exposure limit is 8 hours.

Only a crew determined to be symptom-free by the flight surgeon and very unusual extenuating circumstances which justify the gain versus risk will be acceptable grounds for exceeding the 4 hour limit given above. It must again be recognized that individual hyperbaric oxygen intolerance and/or a reduced tolerance threshold precipitated by exercise and fatigue could require termination of an exposure prior to attaining the 4 hour limit.

Needless to say, we are investigating the feasibility of implementing a research program designed to more accurately determine the physiological effects and medical risks incurred by exposing man to hyperbaric oxygen environments in the range of 1-2 atmospheres absolute. Such future human studies may hopefully yield data which will allow a change in our medical policy set forth in this memorandum.

Original signed by
Charles A. Berry, M. D.

Charles A. Berry, M.D.

DD:JFZieglschmid:jbr 1/5/68

CCAE

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UNITED STATES GOVERNMENT

DA 2

# *Memorandum*

TO : PD/Aaron Cohen

DATE: February 7, 1968
In reply refer to:
PA-8-2-14

FROM : PA/Manager, Apollo Spacecraft Program

SUBJECT: Spacecraft 101 DCR

I have made a commitment to General Phillips that we would try to wrap up the launch atmosphere selection for Spacecraft 101 at the March 6, 1968, Design Certification Review.

The basic outline for this wrap up should include the following:

a. A discussion by the medical people of the physiological effects of various atmospheres. Dr. Berry should be responsible for this discussion and should have it coordinated with General Humphries and with the various Manned Space Flight Advisory Committees in the Medical Community.

b. A discussion of the operational aspects of various atmospheres. What are the operational advantages and disadvantages of using pure oxygen, enriched air or regular air? Considerations of crew time-lines and of extravehicular activities should be included. Mr. Slayton should be responsible for this portion of the presentation.

c. A discussion of flammability characteristics. What are the results of 1224 mockup testing under the various atmospheres considered?

All of these discussions should then lead to a general programmatic conclusion concerning the atmosphere for launch and for orbital operations. Either you or I should give this wrap up presentation.

In making the commitment to include this on the agenda of the DCR, I am assuming that we will complete BP 1224 testing at 16.2 psi pure oxygen within the next two weeks and will have another meeting of the Flammability Mockup Review Board prior to the 6th of March. With these assumptions would you please pull together the presentations I have mentioned.

George M Low

George M. Low

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FEB 1968

PA:GMLow:lbf 2-7-68