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QUARANTINE SCHEMES FOR MANNED LUNAR MISSIONS

BY: INTERAGENCY COMMITTEE
ON BACK CONTAMINATION

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QUARANTINE SCHEMES FOR MANNED LUNAR MISSIONS

Introduction

Presented herein are the fundamental quarantine and sample release plans for manned lunar missions as established by the Interagency Committee on Back Contamination. Obviously, the scheme does not contain all possible finite technical details about quarantine test methods and containment provisions, but it provides the necessary framework for action by the Interagency Committee on Back Contamination and substantive methods for satisfying the quarantine requirements of the Regulatory Agencies.*

It is, of course, impossible in any set of quarantine plans to anticipate every eventuality. Therefore, it is necessary that the schemes include a contingency provision that gives the Interagency Committee and the Regulatory Agencies adequate opportunity to provide requirements and suggestions for situations not covered in the formal plans. It is likewise necessary to emphasize that in spite of efforts being made to assure aseptic collection and return of lunar samples, there is no certainty of the complete absence of earth microbial contaminants. And certainly, the potential of earth contaminants in returned lunar samples will be significantly greater after the first Apollo mission.

Astronaut Release Scheme

Table I provides the general scheme for the quarantine and release of the astronauts and medical support personnel in the Crew Reception Area (CRA) of the Lunar Receiving Laboratory (LRL). The scheme covers three possible results and indicates the course of action for each. Implicit in each is an appropriate review by the Interagency Committee and the accomplishment of any formal action and recommendation that might be required.

Proposition I is the most likely with release of the astronauts and medical support personnel from the CRA after approximately 21 days. This action will accrue if there are no alterations in the general health of the quarantined people and no other indications of infectious disease due to lunar exposure.

*In this document the U. S. Department of Health, Education and Welfare, the U. S. Department of Agriculture, and the U. S. Department of the Interior are referred to as the Regulatory Agencies.

Should a definite alteration in the health of one or more persons in the CRA occur (Proposition II), release of the people would probably not be delayed if the alteration is diagnosed as non infectious or is of terrestrial origin. If the source of the alteration cannot be readily diagnosed, however, some prolongation of the quarantine may be necessary. In either case, under Proposition II, review of the data and recommendations by the Interagency Committee are required.

Proposition III establishes the requirement that laboratory personnel from the sample laboratory of the LRL be housed in the CRA following a severe rupture of a cabinet system containing lunar material suspected of containing harmful or infectious materials. While precise specification of events for Proposition III are not outlined in Table I, the NASA medical team should consider all available information and make recommendations concerning release of the laboratory people. These recommendations should be reviewed and approved by the Interagency Committee. If it is decided that the laboratory personnel must undergo quarantine, the medical observations would identify Propositions I or II in Table I. It must be recognized that this situation could result in prolonged quarantine of the astronauts.

Phase I Sample Release Scheme

The scheme outlined in Table II provides a general plan for each of three sets of circumstances resulting from quarantine testing of lunar samples. Examination and review of the quarantine data by the Interagency Committee before release or non release of the sample is provided in each case. In other words, in each case the Interagency Committee would have identified an appropriate time for coordinating their position and making their recommendations to the National Aeronautics and Space Administration.

Proposition I of Table II shows the course of action for what should be the most probable result of sample quarantine testing, the situation in which the protocol is carried out in the LRL with completely negative results: no viable organisms being isolated and no pathogenic effects being noted in the animals and plant systems tested. For this eventuality, Proposition I calls for the Interagency Committee to meet, examine, and review the quarantine data, and if satisfied as to its validity and reliability, recommend to NASA the release of samples from that returned mission. Formal clearance by the Regulatory Agencies is effected as a part of this plan.

Proposition II of Table II prescribes the course of action to be followed in the event that a replicating organism is detected in the lunar sample without any deleterious effects being noted on the life systems or terrestrial niches tested in the LRL. Should this result materialize, the aim of the flow chart under Proposition II is to

determine: (1) if the organism isolated is of terrestrial origin, unmodified by any lunar exposure and generally considered as "non pathogenic", or (2) if the organism is not readily classified as being of terrestrial origin and therefore of potential hazard to terrestrial ecology.

In regard to statement (1) above, demonstration that the organism in question is identical with organisms collected from the spacecraft, from spacecraft equipment, or from the astronauts during preflight sampling, or classification of the organism as a harmless terrestrial microbe would be adequate reason for neither extending nor expanding the quarantine. The inability to recover a common, identifiable, and non pathogenic organism a second time from a duplicate lunar sample would further indicate that an earth contaminant rather than an organism indigenous to the lunar sample was involved. In this same regard, lunar sample contamination could result following a break in the primary barrier of the LRL. If the organism isolated cannot be readily classified or otherwise shown to be of terrestrial origin, there then would be the need for initiation of a contingency quarantine plan.

Under Proposition II, Table II, the scheme requires review by the Interagency Committee at the points indicated. Adequate demonstration that the organisms are terrestrial, unchanged, and usually regarded as "non pathogenic" would be considered by the Interagency Committee as sufficient reason for not requiring challenge of additional terrestrial niches before sample release. Failure of the protocol tests to provide this information about organisms isolated from the lunar sample, however, would signal the need for further quarantine testing (indicated as Phase II quarantine) and/or release of sample according to conditions* then specified by the Regulatory Agencies, and/or release of samples after sterilization.

Proposition III of Table II covers the situation where definite deleterious effects are noted on one or more of the life systems tested in the LRL. Should this occur, the effects observed may be due to chemical toxicity rather than to invasion by a replicating organism. This would be indicated if sterilized lunar material (the control) produced the same deleterious effects and if no replicating organisms were found. It is always possible, however, that replicating contaminants will be uncovered along with a toxic chemical. In such cases,

*Release to certain specified laboratories for further study; or sterilization before release, but only after consultation with investigators to determine if this is satisfactory to their specific experiment; or release to the LRL so that visiting scientists (Principal Investigators) can work in the LRL under containment conditions to carry out early experiments.

it will be necessary to identify the organisms as of terrestrial origin and to classify them as "harmless" in order to avoid testing additional terrestrial niches or life systems.

Finally, if replicating organisms are indicated as the cause of definite deleterious effects on tested life systems, Phase II quarantine will be indicated with the possibility of a subsequent conditional release and/or only sterilized samples will be released. Under Proposition III appropriate places for review and action by the Inter-agency Committee are indicated.

Phase II Sample Release Scheme

The probability is very remote of a contingency quarantine of a lunar sample due to the presence of unidentified replicating organisms or because of non-explained deleterious effects on life systems that are not due to chemical toxicity. Nevertheless, it is necessary that the prevention of possible terrestrial back contamination be specific with regard to these remote probabilities in order that the intent of the Interagency Committee on Back Contamination Terms of Reference* be fulfilled and that the legal requirements of the Regulatory Agencies be satisfied. The Phase II quarantine scheme for these eventualities is specified in Table III.

Phase II requires a prolongation of the quarantine for an unspecified time interval. However, even at the outset of Phase II, the Interagency Committee could recommend release of some portions of the lunar samples to non-biological institutions under specific conditions of handling. The conditions would, for the most part, relate to the use of the sample inside biological barriers.

Otherwise, Phase II quarantine involves continued testing of animal and plant species in the LRL. As indicated in Table III, the scheme could also provide for conditional release of cultures isolated in the LRL or specimens to certain biological laboratory institutions in the United States for more detailed study of possible pathogenic effects. These laboratories, however, must meet existing specifications of the Regulatory Agencies for handling potentially virulent pathogens.

*Interagency Agreement between the National Aeronautics and Space Administration, the Department of Agriculture, the Department of Health, Education and Welfare, the Department of the Interior, and the National Academy of Sciences on the protection of the Earth's biosphere from lunar sources of contamination: Attachment A: Interagency Committee on Back Contamination Terms of Reference.

(Phase II quarantine could take advantage of visiting scientists in the LRL as bioscience specialists to carry out specific tests for pathogenicity, should such talents be available.)

Contingency Landings

The release schemes outlined above assume that a nominal or near nominal landing of the crew, spacecraft, and related equipment has been achieved. In the event of a contingency landing -- off nominal -- the details and method of quarantine must be adapted to the exigencies of the situation. Immediate authoritative decisions must be made as they apply to quarantine and back contamination as well as other time critical problems.

For such cases, the quarantine aspects will be represented by a Quarantine Control Officer.* To the extent possible during a disaster, he will obtain direction from the Regulatory members of the Interagency Committee before initiating disaster control procedures. Prior to the first returned lunar mission it will be the responsibility of the Quarantine Control Officer to prepare and have approved by the NASA medical team and the Science and Applications Director (Manned Spacecraft Center), and the Regulatory Agencies a document outlining typical courses of action for several types of contingency landings.

Release of Film and Data Tapes

The film and data tapes will be returned to the LRL in the same manner as the lunar samples, admitted to quarantine, and maintained behind a biological barrier. The data tapes will then be played through the biological barrier for outside processing.

The film will be processed inside the quarantine facility and printed through the biological barrier with an optical printer for outside use.

If current studies indicate that ethylene-oxide sterilization of the film is possible when the film is contaminated with bacterial spores and that no degradation of the film occurs, there is the possibility that immediate release of sterilized film will be allowed without printing through the barrier. The statistical reliability of the ethylene-oxide process should be such that the treatment will fail to give sterility no more than 1 in 10,000 times ($P=1 \times 10^{-4}$).

*Manned Spacecraft Center Management Instruction 8030.1, dated January 9, 1967: Assignment of Responsibility for the Prevention of Contamination of the Biosphere by Extraterrestrial Life.

Spacecraft Release

The spacecraft will enter the LRL in a sealed configuration and be placed in isolation near the CRA (this area can become a part of the quarantine facility if necessary). It will follow the same time constraints as the sample -- 30 days -- prior to release if all results are negative. It will, however, be available for additional bio-sampling if deemed necessary by the Quarantine Control Officer. At his discretion, it may also be entered for technical inspection provided that it is placed inside the biological barrier and the personnel and spacecraft become an integral part of the quarantine facility and scheme of release at that time.

Summary

The Interagency Committee has prepared this document in order that all agencies and persons involved in returned lunar samples may have a clear understanding of the procedures the Interagency Committee feels are necessary for the realistic program to protect this planet from possible back contamination. Moreover, the Interagency Committee presents this document as one that will satisfy the requirements of the Regulatory Agencies of Government without undue hardship on NASA. Although the Interagency Committee feels that very few alternates to this plan are possible, it wishes to acknowledge a speedy and unconditional release of the sample; a minimum of expense and delay is highly advantageous to the scientific community.

The schemes proposed may be summarized as follows:

1. Astronauts and Medical Support Personnel

a. Release after 21 days if no alterations in general health are observed and in the absence of an infectious disease attributable to lunar exposure.

b. If significant alterations in general health occur, release is still indicated if alterations are diagnosed as of terrestrial origin or as non communicable.

c. If alterations are apparent and not diagnosed, some delay in release would be indicated with the final action to be recommended by the NASA medical team.

2. Conditions for Lunar Sample Release

a. It is expected that prompt release of lunar samples after completion of the protocol tests can be recommended by the Interagency Committee to the Administrator of NASA or NASA's designated representative. The nominal results expected would obviously not impose any unusual conditions upon the release.

b. Interagency Committee conditional release could result if there is sufficient doubt regarding the presence of pathogenic organisms in the lunar samples. In this instance, release of sterilized samples would be possible, or some samples might be released providing they are used only behind a suitable biological barrier. In the case of a conditional release, Phase II quarantine testing will proceed as rapidly as possible in an attempt to clarify the data regarding possible pathogenic effects.

3. Validity Constraints for Sample Release

It is in the interest of all concerned that the quarantine testing procedures be designed to avoid events that would produce invalid results. To insure that "lunar pathogens" will not be falsely detected, the sample release scheme contains the following constraints.

a. If replicating organisms are found in the sample and no deleterious effects are noted in any of the terrestrial niches tested in the LRL, release will not be delayed beyond the time needed to identify the organisms as terrestrial contaminants.

b. If deleterious effects from lunar material are noted with the terrestrial life systems tested in the LRL, release will not be delayed beyond the time needed to show that the effects were due to chemical toxicity and that any replicating organisms isolated from the sample were of terrestrial origin, harmless, and not responsible for the effects.

c. Should Phase I quarantine procedures indicate the presence of a substance pathogenic to terrestrial life, Phase II procedures will be initiated to verify or more adequately explain the Phase I results.

INTERAGENCY COMMITTEE ON BACK CONTAMINATION

Membership

Primary

Alternate

David J. Sencer, M. D. (Chairman)
National Communicable Disease Center
U. S. Public Health Service

Dr. John Bagby, Jr. (Co-Chairman)
National Communicable Disease Center
U. S. Public Health Service

Dr. Wolf Vishniac
University of Rochester
(National Academy of Sciences
representative)

Dr. Allan Brown
University of Pennsylvania

Dr. Ernest Saulmon
Department of Agriculture

Dr. A. B. Park
Department of Agriculture

Mr. Howard H. Eckles
Department of the Interior

Dr. John Buckley
Department of the Interior

Dr. Harold P. Klein
Ames Research Center, NASA

Dr. Adrian Mandel
Ames Research Center, NASA

Charles A. Berry, M. D.
Manned Spacecraft Center, NASA

Walter W. Kemmerer, M. D.
Manned Spacecraft Center, NASA

Dr. Wilmot N. Hess
Manned Spacecraft Center, NASA

Mr. Joseph V. Piland
Manned Spacecraft Center, NASA

Mr. Lawrence B. Hall
Office of Space Science and
Applications, NASA

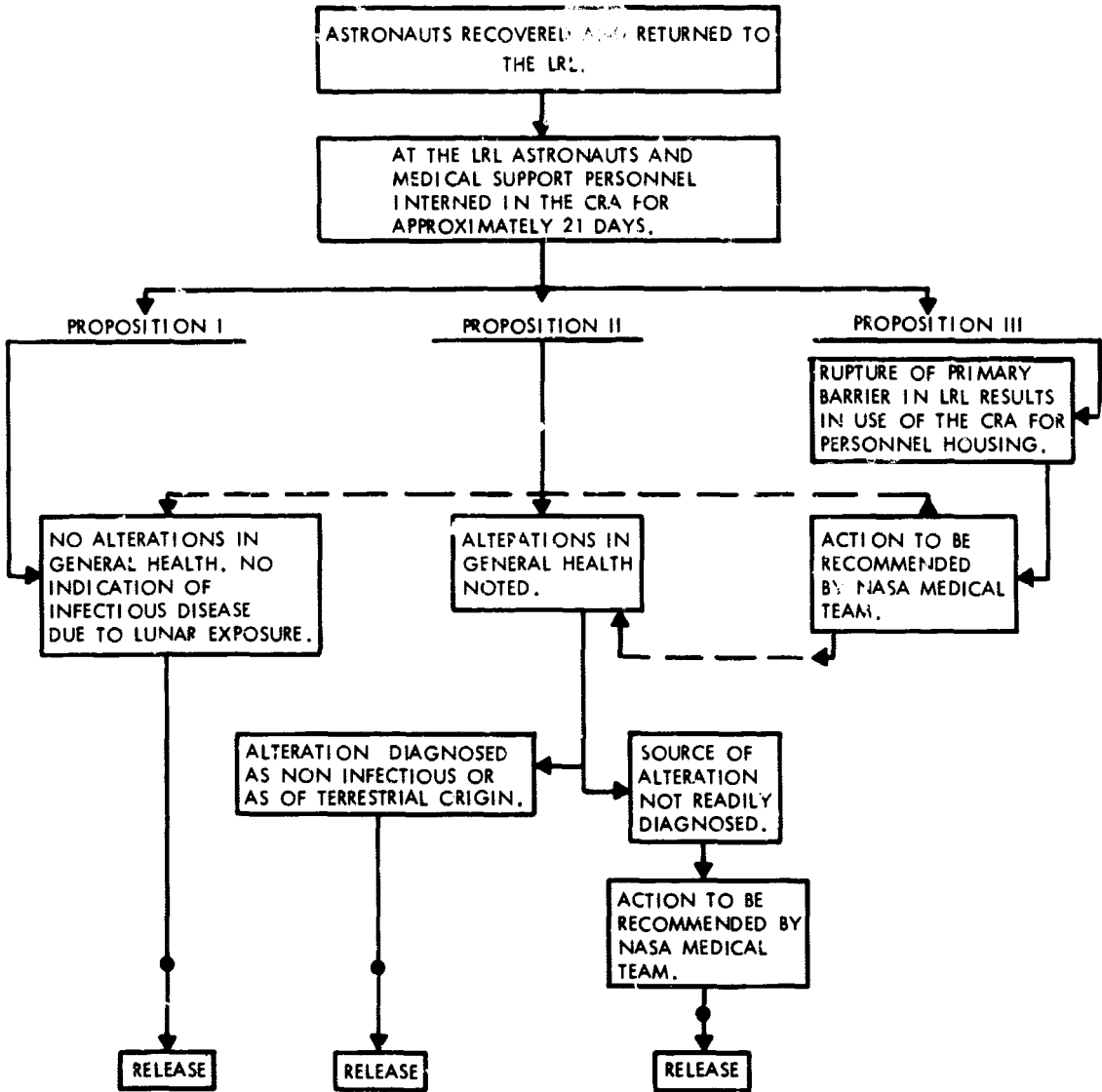
Captain Arthur H. Neill
Office of Space Science and
Applications, NASA

Dr. James Turnock
Office of Manned Space Flight, NASA

Colonel John E. Pickering
(Executive Secretary)
Office of Manned Space Flight, NASA

Dr. G. Briggs Phillips
U. S. Public Health Service Consultant

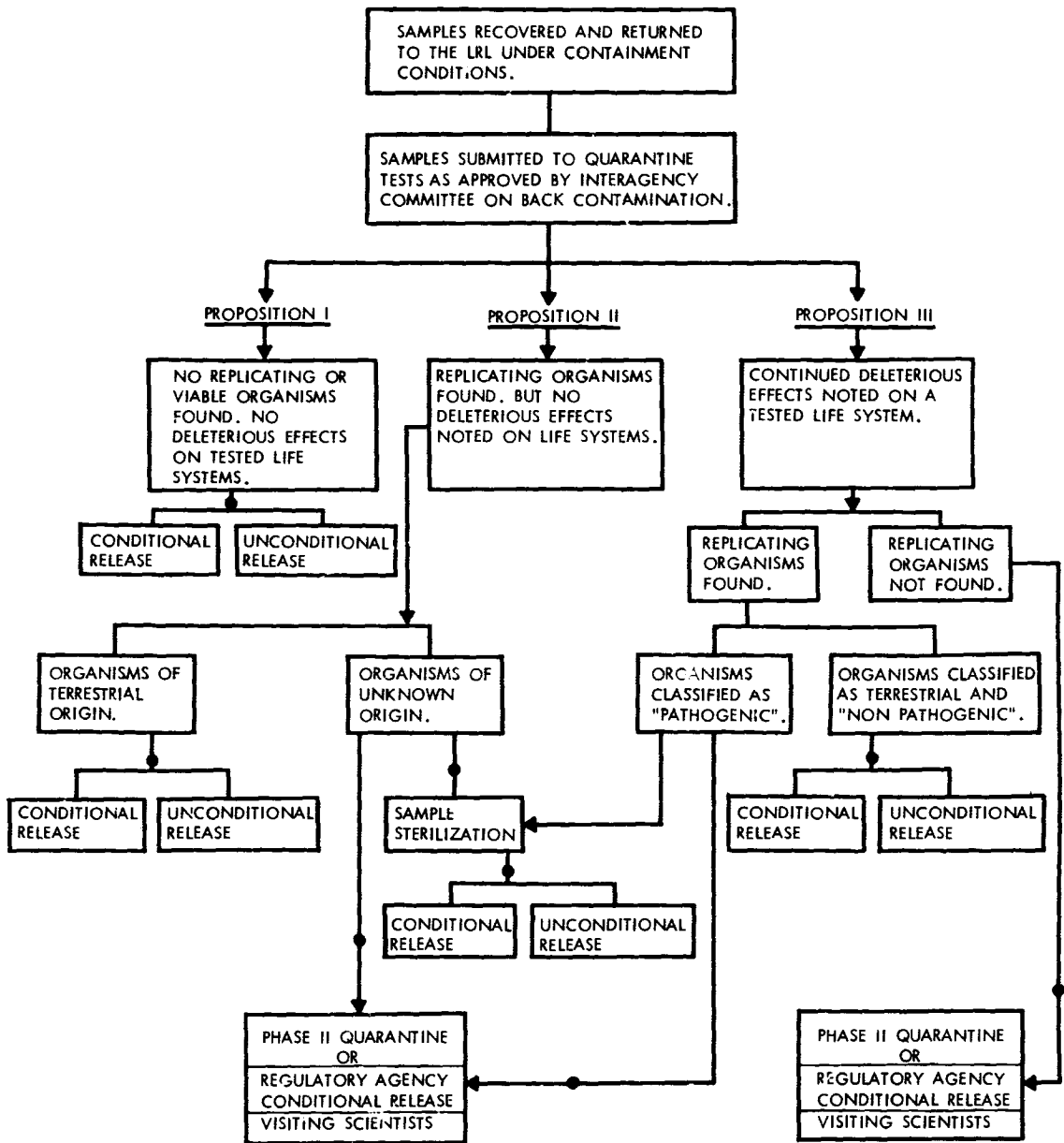
TABLE I. ASTRONAUT QUARANTINE SCHEME FOR MANNED LUNAR MISSIONS



● INDICATES:

- (A) REVIEW OF DATA AND PROPOSED ACTION BY THE INTERAGENCY COMMITTEE ON BACK CONTAMINATION, AND
- (B) FORMAL CLEARANCE BY THE REGULATORY AGENCIES, WHEN NECESSARY.

TABLE II. QUARANTINE SCHEME FOR RETURNED LUNAR SAMPLES (PHASE I)



● INDICATES:

- (A) REVIEW OF DATA AND PROPOSED ACTION BY THE INTERAGENCY COMMITTEE ON BACK CONTAMINATION, AND
- (B) FORMAL CLEARANCE BY THE REGULATORY AGENCIES, WHEN NECESSARY.

TABLE III. QUARANTINE SCHEME FOR RETURNED LUNAR SAMPLES (PHASE II)

