Form AEC-313
(5-58)

ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

Form approved.
Budget Bureau No. 38-R027.4

INSTRUCTIONS.–Complete Items 1 through 16 if this is an initial application. If application is for renewal of a license, complete only Items 1 through 7 and indicate new information or changes in the program as requested in Items 8 through 15. Use supplemental sheets where necessary. Item 16 must be completed on all applications. Mail three copies to: U. S. Atomic Energy Commission, Washington 25, D. C. Attention: Isotopes Branch, Division of Licensing and Regulation. Upon approval of this application, the applicant will receive an AEC Byproduct Material License. An AEC Byproduct Material License is issued in accordance with the general requirements contained in Title 10, Code of Federal Regulations, Part 30 and the Licensee is subject to Title 10, Code of Federal Regulations, Part 20.

1. (a) NAME AND STREET ADDRESS OF APPLICANT. *(Institution, firm, hospital, person, etc.)*

Department of the Army, Fitzsimons General Hospital and U. S. Army Medical Research and Nutrition Laboratory
Denver, Colorado 80240

(b) STREET ADDRESS(ES) AT WHICH BYPRODUCT MATERIAL WILL BE USED. *(If different from 1 (a).)*

1. Fort Devens, Massachusetts

2. Summit of Pikes Peak, Colorado

2. DEPARTMENT TO USE BYPRODUCT MATERIAL

U. S. Army Medical Research and Nutrition Laboratory, Fitzsimons General Hospital
Denver, Colorado

3. PREVIOUS LICENSE NUMBER(S). *(If this is an application for renewal of a license, please indicate and give number.)*

License No. 5-46-13 (A66)
and Amendment No. 1

4. INDIVIDUAL USER(S). *(Name and title of individual(s) who will use or directly supervise use of byproduct material. Give training and experience in Items 8 and 9.)*

As specified in License No. 5-46-13 (A66) Condition 12 and Amendment No. 1

5. RADIATION PROTECTION OFFICER *(Name of person designated as radiation protection officer if other than individual user. Attach resume of his training and experience as in Items 8 and 9.)*

As specified in application(dated Dec 6, '63)for License No. 5-46-13 (A66) and application dtd March 12, '64 and Amendment No. 1

6. (a) BYPRODUCT MATERIAL. *(Elements and mass number of each.)*

A. Carbon-14

(b) CHEMICAL AND/OR PHYSICAL FORM AND MAXIMUM NUMBER OF MILLICURIES OF EACH CHEMICAL AND/OR PHYSICAL FORM THAT YOU WILL POSSESS AT ANY ONE TIME. *(If sealed source(s), also state name of manufacturer, model number, number of sources and maximum activity per source.)*

A. Ascorbic acid — A. 0.5 mc

7. DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED. *(If byproduct material is for "human use," supplement A (Form AEC-313a) must be completed in lieu of this item. If byproduct material is in the form of a sealed source, include the make and model number of the storage container and/or device in which the source will be stored and/or used.)*

See attached Appendices Nos. 1 and 2

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(Continued on reverse side)

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TRAINING AND EXPERIENCE OF EACH INDIVIDUAL NAMED IN ITEM 4 *(Use supplemental sheets if necessary)*

8. TYPE OF TRAINING	WHERE TRAINED	DURATION OF TRAINING	ON THE JOB (Circle answer)	FORMAL COURSE (Circle answer)
a. Principles and practices of radiation protection	NA		Yes No	Yes No
b. Radioactivity measurement standardization and monitoring techniques and instruments	NA		Yes No	Yes No
c. Mathematics and calculations basic to the use and measurement of radioactivity	NA		Yes No	Yes No
d. Biological effects of radiation	NA		Yes No	Yes No

9. EXPERIENCE WITH RADIATION. *(Actual use of radioisotopes or equivalent experience.)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
		NA		

10. RADIATION DETECTION INSTRUMENTS. *(Use supplemental sheets if necessary.)*

TYPE OF INSTRUMENTS (Include make and model number of each)	NUMBER AVAILABLE	RADIATION DETECTED	SENSITIVITY RANGE (mr/hr)	WINDOW THICKNESS (mg/cm²)	USE (Monitoring, surveying, measuring)
As specified in application (dtd Dec. 6, '63) for License No. 5-46-13 (A66) and application dated March 12, '64 for Amendment No. 1					

11. METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED ABOVE.
As specified in application (dtd Dec. 6, '63) for License No. 5-46-13 (A66) and application dated March 12, '64 for Amendment No. 1

12. FILM BADGES, DOSIMETERS, AND BIO-ASSAY PROCEDURES USED. *(For film badges, specify method of calibrating and processing, or name of supplier.)*
As specified in application (dtd Dec. 6, '63) for License No. 5-46-13 (A66) and application dated March 12, '64 for Amendment No. 1

INFORMATION TO BE SUBMITTED ON ADDITIONAL SHEETS

13. FACILITIES AND EQUIPMENT. Describe laboratory facilities and remote handling equipment, storage containers, shielding, fume hoods, etc. Explanatory sketch of facility is attached. (Circle answer) Yes No As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13(A66) and Amend. No. 1. Also see Appendices 1 and 2.

14. RADIATION PROTECTION PROGRAM. Describe the radiation protection program including control measures. If application covers sealed sources, submit leak testing procedures where applicable, name, training, and experience of person to perform leak tests, and arrangements for performing initial radiation survey, servicing, maintenance and repair of the source. As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13(A66) and Amend. No. 1. Also see Appendices 1 and 2.

15. WASTE DISPOSAL. If a commercial waste disposal service is employed, specify name of company. Otherwise, submit detailed description of methods which will be used for disposing of radioactive wastes and estimates of the type and amount of activity involved. As specified in Applications dtd 6 Dec. '63 & 12 Mar. '64 for Lic. No. 5-46-13(A66) & Amend. No. 1. Also see Appendices 1 and 2.

CERTIFICATE (This item must be completed by applicant)

16. THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE APPLICANT NAMED IN ITEM 1, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PART 30, AND THAT ALL INFORMATION CONTAINED HEREIN, INCLUDING ANY SUPPLEMENTS ATTACHED HERETO, IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF.

Dept of Army, FGH, and U.S. Army Med. Rsch. & Nutr. Lab., Denver, Colorado
Applicant named in item 1

Date

By: Edwin L. Overholt
Edwin L. Overholt, Col, MC
Chairman, Radioisotope Committee
Title of certifying official

RECEIVED SEP 2 1964

WARNING.—18 U. S. C., Section 1001, Act of June 25, 1948; 62 Stat. 749, makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

U.S. GOVERNMENT PRINTING OFFICE : 1961 O—615965

Form AEC-313 a (10-61) PAGE 1

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE

SUPPLEMENT A—HUMAN USE

Form approved. Budget Bureau No. 38-R080.1

If byproduct material is for "human use" (internal administration of byproduct material, or the radiation therefrom to human beings), complete this supplement and attach to the application for byproduct material license.

1. (a) USING PHYSICIAN'S NAME

As specified in License No. 5-46-13 (A66) Condition 12 and Amend. No. 1

(b) NAME AND ADDRESS OF APPLICANT (If different from 1(a))

2. THE USING PHYSICIAN INDICATED ABOVE IS LICENSED TO DISPENSE DRUGS IN THE PRACTICE OF MEDICINE BY A STATE OR TERRITORY OF THE UNITED STATES, THE DISTRICT OF COLUMBIA, OR THE COMMONWEALTH OF PUERTO RICO.

NA

CIRCLE ANSWER — YES — NO

3. A STATEMENT OF USING PHYSICIAN'S CLINICAL RADIOISOTOPE EXPERIENCE (PAGE 3 OF THIS SUPPLEMENT) IS SUBMITTED IN SUPPORT OF THIS APPLICATION. IF ANSWER IS NO, USE PAGE 2 OF THIS SUPPLEMENT TO EXPLAIN OR REFER TO OTHER APPLICATION OR RELATED DOCUMENTS ON WHICH THIS INFORMATION APPEARS.

NA

CIRCLE ANSWER — YES — NO

PROPOSED DIAGNOSIS OR TREATMENT

4. (a) DESCRIBE PURPOSE FOR WHICH BYPRODUCT MATERIAL WILL BE USED INCLUDING SPECIFIC CONDITIONS OR DISEASES TO BE DIAGNOSED OR TREATED (Use page 2 if necessary):

As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amendment No. 1. Also see Appendices 1 and 2.

(b) CHEMICAL FORM ADMINISTERED:

Ascorbic acid (Carbon-14)
(As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amend. No. 1. Also see Appendices 1 and 2.

(c) DESCRIBE PROCEDURES WHICH WILL BE OBSERVED TO MINIMIZE HAZARD FROM HANDLING, STORAGE, AND DISPOSAL OF THE BYPRODUCT MATERIAL:

As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amendment No. 1. Also see Appendices 1 and 2.

(d) DESCRIPTION AND SKETCHES OF SPECIAL DEVICES TO BE USED FOR ADMINISTERING BYPRODUCT MATERIAL TO HUMAN BEINGS ARE

(1) ATTACHED (LITERATURE REFERENCES WILL SUFFICE) As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13(A66) and Amend. No. 1. Also see Appendices 1 and 2. — CIRCLE ANSWER — YES — NO

(2) ON FILE WITH THE ISOTOPES EXTENSION — REFER TO APPLICATION NO. _____ — CIRCLE ANSWER — YES — NO

5. (a) PROPOSED DOSAGE SCHEDULE.—In millicuries for internally administered byproduct material other than discrete fixed sources; and in roentgens or rads, as appropriate, for internal or external irradiation from discrete fixed sources (gold seeds, cobalt needles, etc.) state separately for each condition or disease (use page 2 if necessary):

As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amendment No. 1. Also see Appendices 1 and 2.

(b) INVESTIGATIVE PROPOSAL FOR EXPERIMENTAL, NEW OR UNUSUAL HUMAN USES IS ATTACHED. (Attachment should include outline of conditions to be evaluated, including data from animal studies and/or abstract of literature reference if any, number and type of patients (i. e. age group, moribund, etc.)) — CIRCLE ANSWER — YES — NO

As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amendment No. 1. Also see Appendices 1 and 2.

6. IF BYPRODUCT MATERIAL WILL NOT BE OBTAINED IN PRECALIBRATED FORM FOR ORAL ADMINISTRATION OR IN PRECALIBRATED AND STERILIZED FORM FOR PARENTERAL ADMINISTRATION, DESCRIBE IDENTIFICATION, PROCESSING, AND STANDARDIZATION PROCEDURES:

As specified in Applications dtd 6 Dec. '63 and 12 Mar. '64 for Lic. No. 5-46-13 (A66) and Amendment No. 1. Also see Appendices 1 and 2.

7. THE PROPOSED USE OF BYPRODUCT MATERIAL HAS BEEN, OR WILL BE, APPROVED BY THE MEDICAL ISOTOPE COMMITTEE. — CIRCLE ANSWER — (YES) — NO

HOSPITAL FACILITIES FOR INDIVIDUAL PRACTICE USE ONLY

8. (a) THE APPLICANT HAS COMPLETED ARRANGEMENTS FOR A HOSPITAL TO ADMIT RADIOACTIVE PATIENTS WHENEVER ADVISABLE. — CIRCLE ANSWER — YES — NO

(b) A COPY OF INSTRUCTIONS TO BE FURNISHED TO THE HOSPITAL AS TO RADIOLOGICAL SAFETY PRECAUTIONS TO BE TAKEN AND AVAILABLE RADIATION INSTRUMENTATION IS ATTACHED. — CIRCLE ANSWER — YES — NO

Form AEC-313 a (10-61) PAGE 2	UNITED STATES ATOMIC ENERGY COMMISSION **APPLICATION FOR BYPRODUCT MATERIAL LICENSE** SUPPLEMENT A — HUMAN USE	Form approved. Budget Bureau No. 38-R080.1

This page may be used for providing additional information. Please cross reference to specific items.

See Appendices 1 and 2 for additional information.

U.S. GOVERNMENT PRINTING OFFICE : 1961 OF—615965

APPENDIX #1

Ascorbic Acid Requirements of Men Exposed to High Altitude Stress

Arutyunov (1) has previously reported that vitamin C requirement is increased in pilots subjected to high altitude stress. Since a method to approximate the actual utilization of ascorbic acid, by the use of C^{14} labeled ascorbic acid, in man has been developed by this laboratory (2), it is requested that permission be granted to label human volunteers with L-ascorbic-1-C^{14} acid at Ft. Devens, Massachusetts and at the research site on the summit of Pikes Peak, Colorado. The subjects to be used are the same ones who will be used for the high altitude study described in Appendix #2. The object of this experiment is to determine whether or not there is any actual change in vitamin C pool size and rate of utilization in subjects subjected to high altitude stress. Only those volunteer subjects over 21 years of age will be employed in these studies.

Experimental Design

Four groups of subjects, consisting of 2-3 subjects per group will be labeled with 20 μc of L-ascorbic-1-C^{14} acid at the start and at the end of the high altitude study. The subjects will receive the labeled ascorbic acid orally under the direction of Lt. Col. J. E. Hanson, MC. The subjects will be broken down into 4 groups as follows:

Conditioned

Group Ia (sea level)

Ft. Devens (1) 20 μc dose at start of 14,000 ft. study
(2) 20 μc dose at end of study (after 3 weeks)

Group IIIa (14,000 ft.)

Pikes Peak (1) 20 μc dose at time of arrival at 14,000 ft.
(2) 20 μc dose at end of study (after 3 weeks)

Non-Conditioned

Group Ib (sea level)

Ft. Devens (1) 20 μc dose at start of study
(2) 20 μc dose at end of study

Group IIIb (14,000 ft.)

Pikes Peak (1) 20 μc dose at time of arrival at 14,000 ft.
(2) 20 μc dose at end of study (after 3 weeks)

The subjects will receive the 20 μc of L-ascorbic acid at 0800 in the morning. After this, they will be required to collect a complete 24-hour urine sample. A 300 ml aliquot will be taken for the isolation of the labeled ascorbic acid and total oxalic acid C^{14} activity. Whole blood and urinary ascorbic acid determinations will be made on the day that the subjects are labeled, then only urinary excretion of ascorbic acid will be determined for a 4 to 5-day period following the ingestion of the labeled ascorbate.

As noted previously, each subject will be labeled twice, once at the start of the study and then again at the end of the study. The total dose of L-ascorbic-1-C^{14} acid will not exceed 40 μc in any subject.

Facilities

There are excellent facilities available at both Ft. Devens, Massachusetts and at the summit of Pikes Peak, Colorado. These facilities are described in detail in Appendix #2. The C^{14} labeled ascorbic acid will be kept in sealed glass containers until it is to be administered and then only a sufficient amount needed to label the subjects will be opened.

Transportation, Waste Products and Monitoring

All materials will be transported together with the investigators by automobile or airplane. The isotope will be contained in a sealed glass container (each vial will contain a total of 50 μc). These, in turn, will be placed in a sealed plastic container when transported. Unused portions of the isotope will be returned to the laboratory in the same fashion at the conclusion of the study. All radioactive urine samples collected from the subjects will be transported back to the main Denver laboratory in proper containers. Further, all transportation of the isotope or specimens will be properly monitored. Other materials such as glassware, pipettes, etc. will be returned to the main laboratory in Denver for disposal or decontamination as specified in Application for License No. 5-46-13(A66). There will be no disposal of radioactivity or decontamination of any equipment at either Ft. Devens or at the summit of Pikes Peak. Further, the experimental areas at both Ft. Devens and at Pikes Peak will be continuously monitored for radioactivity.

Further, it should be pointed out that there is no other route of excretion of C^{14} activity other than the urine excreted by the subjects since no $C^{14}O_2$ is formed from the labeled ascorbate.

REFERENCES

1. Arutyunov, G. A., et al. Intern. Z. Vitaminforsch. 33: 129-130, 1963.

2. Baker, E. M., et al. Proc. Soc. Exp. Biol. Med. 109: 737, 1962.

Project No. 3A012501A8 MILITARY ENVIRONMENTAL MEDICI
Task No. 01 Military Environmental Medicine
Sub-task No. 70 High Altitude Studies

Appendix # 2

USAMRNL

REVISED PROTOCOL 31 AUGUST 1964

High Altitude Studies

Study No. 4 Physiologic and Biochemical Studies Related to Performance in Healthy Sea Level Soldiers at 14,000 feet as Affected by Physical Conditioning, Transient Intermediate Altitude Exposure and Acclimatization

Authors: Consolazio, C. F., J. E. Hansen, and others

I. Background:

The military need for further studies at altitude is apparent (1). Such studies cannot be done using gas mixtures; large altitude chambers are unavailable to us. It appears as if a militarily and scientifically worthwhile study can be accomplished this year at 14,100 feet on the summit of Pikes Peak, Colorado, by this Laboratory with the necessary assistance of many individuals and agencies.

A pilot study in early 1964 from this Laboratory (2), as yet incompletely analyzed, showed many interesting findings:

a. The reduction in maximal physical performance at 11,400 feet was approximately equal in subjects brought from sea level or 5,200 feet and was greater than in staff members who were generally older and less fit.

b. Subjects brought from sea level had significantly more symptomatology for several days.

c. Maximal pulse rates were slightly lower and resting pulse rates gradually higher during three weeks at altitude.

d. Maximal performance was significantly higher after return to sea level.

e. The QRS complex of the electrocardiogram shifted rapidly with altitude changes.

f. Dietary changes were minimal.

g. Closed circuit basal oxygen consumption was slightly increased at altitude.

h. Maximal breathing capacity (BTPS) is 27% higher at altitude than sea level.

We also observed in some subjects persistent fingernail cyanosis for as long as 20 minutes after maximal performance testing and in several individuals more subjective dyspnea during performance testing after several days at altitude. We made no measurements of resting or exercise arterial oxygen saturation, partial pressures of CO_2 or O_2, pH, lactate, or pyruvate. We had no estimate of maximal aerobic work. Recent observations at 14,100 feet show a decreased percentage of oxygen extraction during heavy exercise - falling below resting levels.

A major controversy concerns the alveolar-arterial oxygen gradient at altitude. Reduction in the gradient would be of value to the altitude resident. Lilienthal et al. (3) found no difference between altitude and sea level; Houston and Riley (4) and several others found a decreased gradient at altitude. Most recently Terman and Newton (5) found a variable but usual decrease in the same subjects whereas Kreuzer, Tenney, Mithoefer, and Remmers (6) found a higher gradient in Andean natives than sea level residents.

Many attempts have been made to estimate maximal oxygen consumption without the actual performance of maximal work and to estimate maximal aerobic work capacity. Wells, Balke, and Van Fossan (7), using rapidly increasing exercise and venous lactic acid values, found a substantial rise in lactic acid when the pulse reached 160; with a striking rise in lactic acid, RQ over 1.0 and no further rise in "oxygen pulse" with a pulse of 180. Wyndham, Strydom, and Williams (8), using six repetitive exercise levels and arterial or "arteriolized" lactate and pyruvate values found anaerobic metabolism (e.g. excess lactate) recurring in well-trained individuals at 55-60% of maximal oxygen intake and 45-50% of less fit individuals. Strydom (9) states that a 15% increase in aerobic metabolism occurred with only ten days of extensive physical conditioning. Arterial or arteriolized lactate and pyruvate measurements have not been reported with simultaneous continuous oxygen consumption and carbon dioxide output during rapidly exhausting exercise.

II. Questions to Answer:

1. Are the symptoms and performance equal in conditioned and unconditioned subjects brought rapidly (seven hours) or gradually (two weeks) to 14,100 feet from sea level?

2. Is maximum performance measured at sea level in conditioned or unconditioned subjects remaining at sea level for four weeks equal to performance in subjects living at 14,100 feet for four weeks or subjects living at 5,200 feet for one week, 10-11,500 feet for one week, and 14,100 feet for four weeks?

3. Can we estimate accurately maximal aerobic work capacity from our present or modified maximal performance test?

4. Is open circuit basal oxygen consumption equal at sea level and 14,100 feet?

5. What is the A-a gradient for oxygen at sea level and 14,100 feet at rest and during exercise?

6. Does arterial desaturation persist after maximal exercise after the subject is comfortable? If so, does voluntary hyperventilation or leg movement reduce it?

7. How long does it take after maximal performance for pulse, ventilation, oxygen consumption and carbon dioxide output to return to basal levels at sea level and 14,100 feet?

8. Are EKG axis shifts equal in conditioned and unconditioned subjects at 14,100 feet and sea level?

9. Are there changes in the serum electrophoretic or fat patterns with acclamatization?

III. Experimental Design:

A. Subject selection

1. Subjects will be non-obese, Caucasian males, ages 17-25, residents of less than 1,000 feet altitude and in good physical and mental health.

2. Fifty potential subjects will be oriented and screened by altitude and medical history questionnaires. After explanation, subjects must sign statement of desire to volunteer.

3. Each volunteer remaining will be given a brief physical examination, chest X-ray and electrocardiogram. Anyone with significant cardiovascular, pulmonary or neurological disease or defect will be excluded. Screening will preferably be done at 2 or 3 posts in the eastern United States. If this is not feasible 50 subjects will be sent to Fort Devens, Massachusetts for screening. Twenty four subjects will be retained for study.

B. Grouping

1. Subjects will be divided into 2 sections on 30 August, one of which will undergo conditioning and one of which will not undergo conditioning. On 15 September each section will be divided into 3 subsections, each as similar as possible. The six subsections of 4 volunteers each will become groups

Ia, Ib, IIa, IIb, IIIa, or IIIb on the basis of the flip of coins.

No. Subjects	Group	Conditioning	Locale after 20 September
4	Ia	yes	remain at sea level
4	Ib	no	remain at sea level
4	IIa	yes	1 wk 5,200'; 1 wk 10-11,500';
4	IIb	no	4 wks at 14,100' & return to sea level
4	IIIa	yes	4 wks at 14,100' & return to sea level
4	IIIb	no	4 wks at 14,100' & return to sea level

C. **Conditioning program and field condition and aptitude testing:**

1. All subjects will leave weekly measurement by field testing of their condition and aptitude from 27 August until 10 November. After division into groups a and b on 30 August, all group a subjects will undergo intensive conditioning on a daily basis (excluding Saturdays and Sundays) from 8 September to 10 November. No subject will have practice for aptitude testing. Group b subjects will not be allowed to participate in vigorous physical exercise or vigorous competitive sports except as necessary to measure their condition and aptitude weekly.

2. From 10 November until 29 November it is recommended that all subjects be on convalescent leave. During this time they will be free to exercise as much or as little as they desire.

D. Critical measurements

1. Open circuit basal oxygen consumption and pulses will be performed several times at sea level and Pikes Peak in groups II and III subjects.

2. Maximal performance testing with the bicycle ergometer and accessories, to include arterial and venous catheters will measure continuously or at selected times the pulse, blood pressure, electrocardiogram, cardiac output by dye dilution, temperature, ventilation, oxygen consumption, carbon dioxide output, and arterial oxygen saturation, pO_2, pCO_2, total carbonate, pH, hemotocrit, lactate and pyruvate. Subjects will go to bed before 2000 hours the nite before testing and remain fasting until completion of the study. Subjects will become basal and rest one hour supine after catheters are inserted. After 10 minutes measurement sitting on the bicycle, subject will pedal at 60 watts resistance for 15 minutes, 90-120 watts (to approximate 50% maximal sea level oxygen consumption) for 10 minutes and 140-250 watts (single level selected to cause

exhaustion in 5-12 minutes at sea level). Measurements will be made for 75 minutes after the end of exercise. Blood loss will approximate 150 ml per run. This test will be done initially and finally at sea level on all volunteers and twice while at altitude on groups II and III subjects.

3. Maximal performance testing with the bicycle ergometer without blood sampling will be done approximately 8 times on each volunteer. After resting for 5 minutes on the bicycle, subject begins pedalling with wattage at 60. Wattage is increased by 10 watts every 30 seconds until the subject stops pedalling from exhaustion or medical interventions. Pulse, ventilation, oxygen consumption, carbon dioxide output are measured before and during exercise and for 20 minutes after.

4. All blood specimens required for other analyses (protein, fat, endocrine) will be taken thru catheters, thus avoiding any other venipunctures.

5. Vital capacity, 1 second vital capacity and maximal voluntary ventilation will be measured before each maximal performance test without blood sampling.

6. The Harvard step test with measurement of time up to 5 minutes and pulse 1-1½, 2-2½ and 4-4½ minutes after exercise will be done weekly on all subjects.

7. The alveolar CO_2 will be determined twice daily with changes in altitude and as necessary to determine the change thereafter. Expired (Haldane-Priestly) and rebreathing (Campbell-Howell) methods will be used to indirectly measure arterial and mixed venous pCO_2.

8. All subjects will fill out standard symptomatology questionnaires nightly after supper.

9. Nude body weights will be measured every morning before breakfast.

10. EKGs will be done before altitude exposure, early and late in altitude exposure and 3x after return to sea level.

E. Other desireable measurements

1. If a standard ration can be furnished, food and fluid intake will be recorded and complete stool and urine collections will be made. Volume of urine will be measured and an aliquot measured for pH, total CO_2 and specific gravity from 14 September to 10 November. If a standard ration cannot be furnished these measurements will not be made.

2. Psychometric testing as determined by Dr. Wayne Evans.

3. Tilt table studies by Dr. Loren Carlson, University of Kentucky.

F. Staff augmentation required

1. Company grade Army officer with Ranger training, physically fit, to administer and supervise a vigorous physical conditioning program for subjects.

2. Three non-commissioned officers or specialists selected or approved by officer above, each one capable of supervising 8-12 subjects and administering vigorous conditioning program to half of their subjects.

G. Precautions

All subjects will be volunteers and will be able to terminate their participation in this study at any time without prejudice. No subjects with known significant cardiovascular, pulmonary, or neurologic disease or deficit will be accepted. A physician will be present at all times during maximal performance testing and will have the authority and responsibility to terminate any portion of the study at any time he considers any unnecessary or significant danger to exist. Oxygen and resuscitative drugs will be available at all times.

H. Discipline

Discipline necessary to accomplish the objectives of the study and consistent with proper military behavior will be maintained.

I. Dates

Participation in the Fort Bragg study by many members of USAMRNL in August and early September prevents initial performance measurements before 31 August 1964. Because of the uncertainties of the autumn weather on the summit of Pikes Peak, all measurements on Pikes Peak should be completed by 30 October 1964.

1. Interview and select company grade officer as soon as possible - before 15 August. Presence required 24 August - 13 November 1964.

2. Interview and select three NCO's. Presence required 24 August - 13 November 1964.

3. Notification to one or more sea level posts in early August 1964 requesting volunteers.

4. On 24-26 August interview and screen 50 volunteers.

5. On 27 August measure on all remaining volunteers field test condition and aptitude and on 28-29 August maximal performance on bicycle ergometer without oxygen consumption or blood sampling.

6. On 30 August select 24-26 volunteers and divide into sections.

7. On 3 September and weekly thereafter until 10 November (Fridays or Saturdays) measure field test condition and aptitude on all subjects. In addition test will be run one extra time on the Monday or Tuesday immediately after groups II and III arrive at Pikes Peak. (Concomitantly once extra for group I at Devens)

8. On 31 August to 5 September measure one bicycle ergometer performance test with arterial and venous catheters and one maximum bicycle ergometer performance test without blood sampling on 12 volunteers undergoing conditioning.

9. On 8 September begin the daily conditioning program.

10. On 8-15 September measure one bicycle ergometer performance test with arterial and venous catheters and one maximum bicycle ergometer performance test without blood sampling on 12 volunteers not undergoing conditioning.

11. On 14 September begin balance study on all volunteers. Balance terminates approximately 10 November.

12. On 17-18 September measure one bicycle maximum ergometer performance test without blood sampling on all volunteers.

13. On 20 September fly group IIa and IIb subjects to Denver to stay at USAMRNC.

14. On 27 September drive group IIa and IIb subjects to Camp Hale.

15. On 27 September fly and drive groups IIIa and IIIb subjects to Pikes Peak.

16. On 28 September to 2 October measure one bicycle ergometer performance test with arterial and venous catheters and two tests without blood sampling on groups IIIa and IIIb subjects.

17. On 4 October drive groups IIa and IIb subjects to Pikes Peak.

18. On 5-9 October measure one bicycle ergometer performance test with arterial and venous catherters and two tests without blood sampling on groups IIa and IIb subjects.

19. On 12-16 October repeat #16.

20. On 19-23 October repeat #18.

21. From 28 September to 23 October do six bicycle ergometer performance tests on group I subjects. Length of ride and end of exercise and recovery pulse will be recorded.

22. On 26 October drive and fly groups IIIa and IIIb subjects to Fort Devens.

23. On 27-31 October measure one bicycle ergometer performance test with arterial and venous catheters and one test without blood sampling on groups IIIa and IIIb subjects.

24. On 1 November drive and fly groups IIa and IIb subjects to Fort Devens.

25. On 2-10 November measure one bicycle ergometer performance test with arterial and venous catheters and one test without blood sampling on groups Ia, Ib, IIa and IIb subjects.

26. On 10 November terminate balance study and recommend sending volunteer subjects on convalescent leave until 29 November.

27. On 30 November to 2 December measure field test condition and aptitude and a single bicycle ergometry without blood sampling on all volunteers.

IV. Logistics:

A. Fort Devens, Massachusetts (sea level). Arrangements are to be made with Col. Moring, the C.O. of the USA Hospital at Fort Devens, Massachusetts with the assistance and support of Lt. Col. Hall, the C.O. of USARIEM, Natick, Massachusetts.

1. Housing and food is necessary for up to 50 volunteers 24-29 August; 24-26 on 31 August to 20 September, 16 on 21-27 September, 8 on 28 September to 25 October, 16 on 26-31 October, 24 on 1-10 November and 24 on 29 November to 2 December. Housing should include beds, mattresses, blankets, sheets, pillowcases, wall lockers, tables and chairs.

2. Housing and food is necessary for enlisted staff men varying from one to nine in number from 24 August to 12 November.

3. Housing (BOQ or civilian motels) are needed for civilian and officer investigators varying from one to seven in number from 24 August to 12 November.

4. Laboratory space of approximately 1000 square feet is needed. An area of 300-400 square feet must be air conditioned to 20-24 degrees centigrade for maximal performance testing. Also necessary in this area are a latrine, hot and cold water, showers, sinks for washing glassware and surgical equipment, 110 and 220 volt outlets and reasonable light. Ten 4'x8' tables, 20 chairs, 30 cubic feet of refrigerator space, 12 cubic feet of freezer space, 2 wheeled litters, intravenous stands (2), 4 table lamps, 2-4 waste barrels, cleaning equipment (brooms, mops, pails), 1 portable surgical operating room light, two surgical stands (Mayo) are needed.

5. Expendable supplies desirable are 5 gallons of 95% ethanol, 2 gallons of Westcodyne and 60 liters of normal intravenous saline.

6. Laundry facilities are necessary for EM whites and so that we can have 2 clean blankets and 10 clean scrub suits per day, 3 arterial packs per day, 10 pairs of size 7½ surgical, and other surgical supplies - the latter items requiring auto-claving. (We can bring 100 clean scrub suits, 30 pairs of gloves, 100 towels, 1 dozen blankets if necessary).

7. Five type E tanks of standardizing gas are needed: one water pumped nitrogen, one 5% CO_2 in air, one compressed air, and two still to be specified. One large tank of medical oxygen is needed.

8. An area of several acres only for field conditioning and condition and aptitude testing is needed. Three telephone poles, 4 saw horses and rope only are necessary.

9. Chest X-rays will be needed on all volunteers 24-27 August and again 27 October or 2 November.

B. Denver (USAMRNL)(5200 feet). Food and housing is required for 8 subjects 20-27 September. Space and supplies for conditioning and aptitude testing are necessary.

C. Camp Hale (9800 feet). Food and housing is required for 8 subjects and 2 enlisted man 27 September to 4 October. Space and supplies for conditioning and aptitude testing are necessary.

D. Pikes Peak summit (14,150 feet)

1. Arrangements are being finalized with Mr. Roan Anderson, District Ranger, Pike National Forest, Forestry Service, U. S. Department of Agriculture; Mr. Jack Sullivan and Mr. C. L. Henderson, officials of the city of Colorado Springs which operates and maintains the toll road to Pikes Peak and owns the new summit house; Mrs. Marther Dobbie who controls the wooden cabin on Pikes Peak summit; and Mr. William Carle, who operates the new summit house as a concession. All are aware of our plans and have been most cooperative.

2. The summit of Pikes Peak, 4 acres in area, is reached by a toll road and cog railway, both of which will be open until the end of October. Mr. Sullivan will definitely keep the road open, although early storms may cause temporary closure. There will be no toll charged members of this study. There are three major buildings on the summit: the old summit house which is being razed; the new summit house, a magnificant one story stone structure 55' x 110', built at a cost of over $400,000.00, unequalled anywhere in the U. S. above 12,000 feet, with excellent heat, water, sewage, and electricity; and a very sturdy one story wood cabin, 20' x 30' with heat and electricity.

3. Communications and transportation to Denver - two-way radio communications will be used. Supplies and specimens will be transported 3-7 times weekly (2-3 hours from summit to USAMRNL).

4. Mr. Carle will furnish messing, sleeping and laboratory facilities for 16 subjects and 15 staff members if we supplement space with one or two additional rented trailers. There is no space for indoor recreational activities except for sedentary games. The cost of room and board and a few necessary utility alterations on Pikes Peak has not been finalized.

E. Transportation

1. There is frequent, rapid air transportation for subjects, staff and equipment between Denver and Boston by United and Trans World Airlines.

2. Vehicle rental is necessary in Boston.

3. Motor pool support perhaps supplemented by vehicle rental is necessary at Denver.

4. Helicopter service for emergency use only will be requested from Fort Carson.

F. Religious Services

1. Subjects may attend religious services in Boston, Denver and Camp Hale.

2. At Pikes Peak, subjects will be allowed to go to Colorado Springs on Sunday mornings for religious services.

V. Bibliography:

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