

---

---

**FILE M**  
**PROJECT MOGUL**

---

---

<u>TITLE</u>	<u>TAB</u>
MEMO, CAPT TRAKOWSKI TO COL DUFFY, REVIEW OF PROJECTS MX 968 AND MOGUL, 10 DEC 1948	M 1
CORRESPONDENCE FROM/TO WOODS HOLE OCEANOGRAPHIC INSTITUTION REGARDING MOGUL	M 2
ASSORTED MOGUL PAPERS	M 3
CORRESPONDENCE REGARDING THE RELIEF OF MAJ ROBERT CRANE	M 4
MOGUL- ALASKA OPERATIONS	M 5
REVIEW OF AMC GEOPHYSICAL ACTIVITIES BY B/G D. N. YATES, AND STAFF, OF THE AIR WEATHER SERVICE, 10 FEB 1949	M 6
CONTRACT STATUS REPORT, GEOPHYSICAL RESEARCH DIRECTORATE, CAMBRIDGE FIELD STATION	M 7
CONTRACT STATUS REPORT, WATSON LAB, CAMBRIDGE FIELD STATION, GEOPHYSICAL DIRECTORATE	M 8
EMPTY	M 9
TRANSCRIPTION OF A.P. CRARY'S DIARY	M 10

TITLE

TAB

JOURNAL OF A.P. CRARY, APRIL 1946 - FEB  
1948

M 11

LETTER, COL DUFFY TO COMMANDING  
GENERAL ARMY AIR FORCES, REQUEST FOR  
ENROUTE WEATHER ANALYSES, 8 MAY 1946

M 12

MEMO, WEATHER RESEARCH  
ORGANIZATION, 24 JAN 47

M 13

MOGUL FILES- C/O PROF MOORE

M 14

OPERATION FITZWILLIAM

M 15

FINAL REPORT, ACOUSTIC DETECTION IN  
RTHE TROPOPAUSE FOR SANDSTONE  
NUCLEAR TEST, WRITTEN BY PEOPLES AND  
CRARY

M 16

FINAL REPORT ON PROJECT BIRTHROOT

M 17



USAF Program for Long Range Detection -- Seismic and Acoustic -- FY 1949.  
Declassified. Authority: NND 813070, NARA, 5/5/89.

AIR MATERIEL COMMAND  
3160TH ELECTRONICS STATION  
CAMBRIDGE FIELD STATION  
230 Albany St., Cambridge 39, Mass.

ACT/bs

FRGD

10 Dec 48

MEMORANDUM FOR: Col. M. Duffy

S U B J E C T : Review of Projects "MX-968" and "MOGUL".

I Project MX-968

1. All activity on data gathered last spring is now complete. All reports have been completed and turned in directly to Hq. USAF, AFOTAT (Gen. Hagenberger's office)

2. General review of results on atmospheric radiology:

a. Tracer Lab Corp. completed its analysis of filter paper data. They obtained decay curves and characteristics of gathered fission products which will be of great future use in identifying air contamination. Examples of facts determined:

(1) Background count in filters is very high within first day or so after gathering due to the daughter products of natural earth contained Radon and Thoron. Filters must be aged to eliminate these.

(2) Natural Radon and Thoron decay products were found as high as 10,000 ft. Indicates that the filter technique is far more efficient than first expected.

(3) The expected high concentration of Xenon was actually very low and Krypton was high. There is apparently some adsorptive action which eliminates Xenon and allows Krypton to go free. Future gas sampling should be concentrated on Krypton.

b. Air Reduction Co. completed development of a super concentrator for Xenon of phenomenal efficiency (99 + %). The technique will be adapted to Krypton and made into a package unit which can be used for continuous sampling in scheduled air traffic.

c. Waite and Gish Air Conductivity tests proved that the active clouds were not uniform, but definitely stratified

MEMO for Col. M. Duffy, Subj: Review of Projects "IX-968" and "MOGUL"

and stringy. The air conductivity system has low efficiency for use in analysis but appears as an ideal pilot indicator toward areas where the filter technique comes into its own.

- d. Armour Research Institute attempted a general survey for background information and recommendations on radiological analysis. Slow security clearances crippled their overall effort. Their report is in, but is poor. Request has been made for a clarifying report. This contract was, in general, a flop.

3. On seismology, the Beers and Heroy work is complete. Their report came in this past week. It is not yet evaluated. They went into a survey on the use of seismology for this purpose and recommended a system and service sources to do the job. They have lined up oil prospecting companies for participation and have outlined a possible surveillance network. In general they think seismic surveying is practical but not infalible, because there is no way to separate out natural background noise.

4. Airborne sonic work (done in our own house- Cray and Peoples) showed air detection as no significant improvement over ground pick up. No positive results were obtained farther than 600 mi. Many signals were received at ranges up to 6000 mi. which could have been (and first appeared as) "it". However, complete analysis showed unstable equipment performance, wide deviations in propagation velocity and simultaneous natural disturbances, which allowed only indefinite conclusions and uncertainty. Report on this has been completed and turned in.

5. Present and Future IX-968 work.

- a. Radiology - dormant. This work (on contract) has been taken under the direct supervision of Hq. USAF, AFOAT. Future work by GRD is indeterminant.
- b. Air Conductivity. Directive for GRB now being prepared by AFOAT. Project is to devise means for determining ionizing source background levels under all atmospheric conditions and overcome present sharp limitations imposed by haze, fog and clouds. Procedure will be to determine the natural levels of these adverse conditions and use this information as discrimination factors.
- c. A project is under consideration by AFOAT for GRD to

determine the settling rate in the atmosphere of particles from 1 to 10 microns in diameter, and the adsorptive action of this material to water drops. There is apparently a transition case here between Stokes law settling and Brownian movement. This information is vital to predicting stratification levels and quantities lost by rain-out.

- d. Seismology - plans await committee evaluation of Beers and Heroy work.
- e. Airborne sonic - we are expecting a directive from AFOPAT (coordinated, and we are ready) to participate in an investigation of noise from large scale explosions to be set off at a now indefinite location in the spring of 1949. We will use our balloon borne detectors to give 3rd dimension data to ground arrays. We plan to put in and operate three widely separated balloonlaunching and tracking systems.

## II MOGUL

1. Research on the acoustical transmission characteristics of the stratosphere has been going on over the past 2 years by observing ground to ground sound propagation via refraction within altitudes up to 50 km. Airplane bombing runs as signals observed by ground microphone arrays have been made off East Coast of U.S., Bermuda, Alaska, New Mexico and Panama. Results have been published on the East Coast and Bermuda work. Alaska and New Mexico results are ready for the printer, and Panama data is still being analyzed. Cardinal points in the results are:

- a. There are definite variations in channel height with respect to season and latitude.
- b. There are no identifiable diurnal variations.
- c. Ground to ground propagation east to west is generally successful.
- d. Upper level westerly winds make west to east propagation generally unsuccessful.
- e. Mean upper winds (to 50 km) can be determined by azimuth shift of a wave received at stations placed at right angles to the signal source.

2. Rocket sounds. Records have been made at one or more ground microphone arrays on each V-2 fired from Jan. 1947 to April 1948. The aim was to determine the nature of acoustic disturbances created by rockets and as a by-product, to get added information on the sound velocity structure of the air. General results:

- a. All rockets produce large pulses of sound - not continuous - both on ascent and descent.
- b. The number and character of the signals indicate that the propagation mechanism cannot be explained by simple shock wave theory.
- c. Usability of this data for velocity structure has been limited by indefinite data on rocket trajectories, accuracy of measured angles of approach of the sound rays and accuracy of meteorological correction data up to 18 km, or so.

3. Instrument program. Aim was to develop a system for acoustical detection stably located within the stratospheric channel. Results:

- a. A satisfactory constant level balloon instrument carrier has been developed and tested.
- b. An acoustical pick-up has been developed and proved to be satisfactory.
- c. An interim telemetering and position finding system has been developed and used. The principle deficiency in the entire system is in the reliability and range of the telemetering instruments. Developments are presently under way which indicate that telemetering can be substantially improved.

4. Overall results.

- a. 500 lb. bombs air burst at 20,000 ft. have been detected at ranges up to 300 miles by balloon borne apparatus floating at about 50,000 ft. The decrease of signal intensity with respect to range is greater than expected (greater than inverse square law). This may be due to null point effects which come into play at about 300 mi. Additional range may show stronger signal returns.
- b. Very strong signals from V-2's have been picked up by

balloon detectors at from 25 to over 100 mile ranges. A number of attempts have been made to detect at 1,000 to 2,000 mile ranges. Results are inconclusive due to chronic technical difficulties. One try recorded a signal at 1200 miles which was possibly a "success". The propagation velocity of this wave was excessively high.

- c. Much information has been obtained on acoustic background noise level in the 40,000 ft. to 60,000 ft. altitude region. Noise is generally below 1 dyne/cm<sup>2</sup>. Barograph records on balloons in flight show low frequency high altitude vertical motions of the atmosphere. These natural disturbances mean positive identification of any signal can only be obtained by detection at two or more locations.

5. Although at this point the original purpose of project MOGUL has been neither proved nor disproved, it is now possible to forecast operational necessities and logistic problems which will have to be met in case the final phase of the project turns out positive and field use is imminent. Wide operational experience under <sup>many</sup> conditions has been obtained by those working on this research and development. Questions have arisen in the minds of those on intimate terms with the work. Will the MOGUL system ever be economically practical in consideration of the value of results which might be obtained, and the possibility of getting similar results by other methods? In view of the limitations of the system, can its use be of any strategic value? Some limitations we recognize are:

- a. The operations cannot be kept secure. They are too big; too many people; they must be carried on in the open and are obvious as to purpose. **Balloons cannot be subjected to controlled recovery.** These things can only be overcome by complete disregard of cost. Is it worth it?
- b. Because operations are insecure, countermeasures are possible which could easily destroy all significance of data.
- c. Equipment of MOGUL is inherently complex. Failure will always be frequent without exceptional care. "Routine operation" attitude of personnel will never produce reliable records.
- d. There is no foreseeable way to get interpretation of records out of the semi-research stage.

Memo for Col. M. Duffy, Subj: Review of Projects "MX-968" and "MOGUL"

- c. The system is very expensive in terms of manpower, permanent equipment and expendable equipment.

Even though the principle is sound, it is possible that the system will never be justified for its intended use. Because of this we propose a general evaluation of results to date and re-determination of the course of this project.

We propose a meeting of all AMC personnel, legitimately concerned with this project, to evaluate it and come to agreement on its value and the direction the project should take from here on. Minutes of this meeting should constitute an official report on the project. A suggested agenda is as follows:

- a. Technical review of progress and results.

- (1) Research
- (2) Operations
- (3) Equipment
- (4) Movies of balloon methods

- b. Discussion of foreseeable improvements and agreement as to their influence on the practicality of the system.

Then, under the assumption that the principle of the system will be successful for its intended purpose:

- c. Discussion and agreement on logistic requirements for field use.
- d. Discussion of overall system limitations and agreement on those which are of definite concern.
- e. Discussion of other methods which may produce similar results and agreement as to value relative to MOGUL.

The results of this meeting should bring all AMC thinking on this project into line. The conclusions should be placed before the intelligence and strategic authorities of Hq. USAF and a definite decision obtained from them as to whether MOGUL is desired or not.

If it is desired, the project must be re-chartered, more definite objectives established, and security revised.

If it is not desired, the project can be broken up and all

Memo for Col. M. Duffy, Subj: Review of Projects "MX-968" and "MOGUL"

parts rechannelled into other research work. In this case nothing will be lost. We feel that the project has more than paid its way in knowledge gained and techniques developed.



A. C. TRAKOWSKI, JR.  
Captain, USAF  
Director, Base Directorate, for  
Geophysical Research



168,64-29

1945-1947

RETURN TO DIRECTOR FEDERAL BUREAU OF INVESTIGATION WASHINGTON, D.C. 20535
--

CATALOGUED

00124400

DECLASSIFIED  
EO 11652

LONG RANGE SOUND TRANSMISSION IN THE ATMOSPHERE

A Report for General Carl Spaatz

prepared by Maurice Ewing

I THE SOUND CHANNEL IN THE OCEAN

Under a contract with the Bureau of Ships, we have proved that there is a sound channel in the ocean with its axis at a depth of about 4000 feet. Confirming a prediction made by the writer, a four pound bomb fired at this depth has been heard at a distance of 2300 miles, using a hydrophone at the same depth as a receiver. This range enormously exceeds anything before achieved, and is possible primarily because the source and the receiver are placed at the most advantageous depth. The signal strength indicates that far greater ranges can be obtained without change of equipment.

At a typical place in the ocean, the speed of sound at the surface is 5001 ft/sec. It decreases to 4888 ft/sec at a depth of 4000 feet, and then increases to 5065 ft/sec at a depth of 16,200 feet. This situation is described as a sound channel with its axis at 4000 feet, because all sound rays are deflected downward at points above the axis and upward at points below it. Detailed calculation of the bending of the ray paths due to pressure and temperature shows that all rays leaving a sound source on the axis in directions within 12° of the horizontal are refracted back and forth across the axis and can travel unlimited distances without contact with surface or bottom, hence the long ranges. A similar calculation for a sound source near the surface shows that all rays must be reflected at surface and bottom many times in the course of a few hundred miles, hence the limited range of detection of ordinary shallow explosions, and the occurrence of skip distances.

The sound from an explosion at the axis of the sound channel has a duration of about 12 seconds per thousand miles of travel, and an unmistakable pattern of a gradual building up to maximum intensity with a very sharp cut-off. This last feature is of great importance because it permits accurate triangulation with a network of three listening stations, the rate of transmission being about one mile per second.

(Reference 1)

## II EXISTENCE OF A SOUND CHANNEL IN THE ATMOSPHERE

In September, 1944, it occurred to me that there is a similar sound channel in the atmosphere with the axis at a height of about 45,000 feet, and that, with source and receiver placed at this height, we might exceed the accepted ranges as enormously as we had in the ocean. In other words, it might be possible to detect sound half way around the world.

The fundamental data on this subject as revealed during a hurried search of the literature (mostly prior to 1930), show that, for a typical large explosion, there is audibility from 0 to 25 miles and from 90 to 125 miles, with a zone of silence from 25 to 90 miles. The accepted explanation of the total collection of these data is that the speed of sound decreases from about 1090 ft/sec at the surface to about 970 ft/sec at about 45,000 feet, and then increases to about 1165 ft/sec at about 130,000 feet. (Reference 2)

Thus there is a sound channel in the atmosphere with its axis at a height of about 45,000 feet, and if both sound source and receiver are located at this height, we may expect extraordinary ranges and all the other useful phenomena which have been found in the sound channel in the ocean. This means that the signals will have highly characteristic identifying features and that they will permit accurate triangulation.

## III PROBABLE MAXIMUM RANGE

The maximum range for sonic signalling in the atmospheric sound channel will depend primarily on the absorption coefficient, which is the rate at which the acoustical energy is converted into heat by frictional losses. Following Rayleigh (Reference 3, p. 316), it may be calculated that the distance at which sound of frequency 50 cycles per second would be reduced in intensity by the factor 7.5 by the effect of friction alone is about 24,000 miles at sea level, and about 4500 miles at 45,000 feet. As these distances are inversely proportional to the square of the frequency, they would be one hundred times greater for sounds of frequency 5 cycles per second, which have often been observed when large explosions were studied.

It is impossible to make really detailed calculations of the maximum range without better information about temperature and sound velocity in locations from 45,000 to 90,000 feet, for it is there that the greatest frictional losses will occur. However, it is safe to predict that a bomb containing a few pounds of TNT can be heard from 4000 to 5000 miles. The chance that it could be heard to the farthest point on earth is worth consideration.

#### IV PROPOSED MILITARY USE OF ATMOSPHERIC SOUND CHANNEL

It is my belief that a large rocket or jet propulsion motor passing the axis of the sound channel would also be detectable by listening at several thousand miles, and subject to location by triangulation if heard by three suitably chosen stations. In time of war this triangulation could locate the launching sites of the enemy, and in peace time it is conceivable that suitably chosen listening stations could monitor the entire world to detect and locate any unusual rocket or jet propulsion experiments, thus minimizing the danger of surprise attacks with secret weapons.

#### V TYPES OF LISTENING STATION

The most promising types of listening station according to my present knowledge would make use either of the higher mountains of the world or of free balloons to gain adequate height. It is unknown at present by how far the receiver may be removed from the preferred height without prohibitive sacrifice of sound channel properties. However, in the submarine sound channel we have had fairly good reception with the hydrophone at 2000 feet when the axis of the channel was at 4000 feet. Hence, it is not beyond reason that the taller mountains might provide sufficient altitude of themselves.

Small stratosphere balloons provided with radio means for transmission of sound impulses to a receiving station either fixed or mobile, probably provide the most readily available listening arrangement.

VI PRELIMINARY INVESTIGATIONS RECOMMENDED

a) Canvas published literature for such further information as can be gleaned from sound transmission between source and receiver at the earth's surface about variation of sound velocity and sound absorption with altitude. Also canvas meteorological literature for better information about the stratosphere.

b) Assign an officer to search confidential publications on sound ranging and other related subjects for relevant information. This officer should also collect data on sound ranging equipment and personnel in the army which could be assembled for a preliminary test.

c) Make a preliminary measurement using about three sound ranging units on ground as receivers, and bombs dropped or rockets fired upward from a high flying plane, or anti-aircraft shells sent as high as possible as sources. This will not be true sound channel transmission, but rather a refinement of the data collected from audibility of large explosions. By proper interpretation of records from bombs exploded at intervals of a few miles out to 400 or 500 miles, all of the basic information will be made available. By use of techniques which I have used for years on sound transmission through ground and through water, it is possible to calculate the path followed by each sound ray, to find its highest ascent into the stratosphere, and to determine the coefficient of sound absorption.

d) A study of existing publications should be made to determine the sound production of typical rocket and jet propulsion units in order to have data about the intensity and the frequency distribution of these sources for ultimate estimates of sound channel range.

If these data do not exist, experiments should be made to produce them, for they would certainly be of use in other connections.

e) An estimate of the background noise to be expected at the axis of the sound channel should be made. In my opinion, the principal contributors will be meteors, possibly high-flying normal air traffic, lightning, and anti-aircraft type artillery fire. A considerable body of information could be collected on this subject without experimentation.

My opinion is that the background noise will not be seriously high unless normal traffic begins to reach such heights that it will create the same type of disturbance as the projectiles which we are considering.

f) Measurements of actual sound channel transmission using a small stratosphere balloon carrying sound receivers and a radio for transmission of sound signals to a recording station should be the next step in this investigation.

## VII CONCLUSIONS

It is my opinion that the stratosphere sound channel should be investigated, for it has the potentiality of military importance. I believe that its military importance depends greatly upon secrecy and that the investigation should be started in a quiet way, restricting knowledge of the purpose of the work to the smallest possible group.

## VIII REFERENCES

1. Interfix Report No. 1 Long Range Sound Transmission, by Maurice Ewing and J. L. Worzel, Contract WObs-2083, Bureau of Ships, Navy Department, 1945.
2. Handbuch der Experimentalphysik, by C. Meisser, pp 211-251, XXV, 3 Teil Luftseismik, Wien & Harms, Leipzig, 1930.
3. Theory of Sound, by Lord Rayleigh, vol. II, pp. 316-17, Macmillan & Co., London, 1926.

Co<sup>r</sup> Wilson/fj/6742

13 September 1946

Mr. H. R. Seiwell  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Mr. Seiwell:

In reply to your letter of 4 September 1946, the following is the status of the project.

Two officers have been selected as suitably qualified for assignment to Woods Hole; and we have been notified that two additional officers will be selected prior to 13 September. Wright Field will be notified of the availability of these people, as soon as their names have been determined, and will be directed to negotiate with Woods Hole on such matters as time arrangements, starting dates, contracts, etc.

You will see from the above, that the matter is now well underway and that the greatest difficulty — that of obtaining the proper student material — has been overcome. I hope that this will answer your immediate question. You should hear from the Air Materiel Command, Wright Field, within a very few days.

Sincerely,

R. C. WILSON,  
Colonel, G. S. C.,  
Vice-Deputy Chief of Air Staff  
for Research & Development.

*Margaret G. Seiwell*

SEP 12 1946

MEMORANDUM FOR DEPUTY CHIEF OF AIR STAFF, RESEARCH AND DEVELOPMENT  
ATTENTION: Colonel Wilson

SUBJECT: Woods Hole Oceanographic Institution

1. The following information is provided as a basis for your reply to Mr. Seiwel, whose letter to you of 4 September 1946, on this subject is returned herewith. This, as you requested in your undated Buck Slip addressed to this office:

a. An R&R was forwarded to Air Weather Service, ATC (Attention Col. Stone, Ext. 6442) by AC/AS-1 on 26 August 1946, requesting four officers for training in oceanography.

b. On 9 September 1946, ATC advised that they had two qualified applicants and expect to have two more by 13 September, the closing date for receipt of applications for such training.

c. It is planned that on 17 September 1946, AC/AS-1 will notify Wright Field of the availability of subject officers and will suggest that negotiations be started between Wright Field and Woods Hole Institute on time arrangements, starting dates, letting of contracts, etc.

2. Colonel Garland, Acting Chief of this Division, received a similar inquiry, same date, from Mr. Seiwel and copy of reply is attached for your information.

WILLIAM M. GARLAND  
Colonel, Air Corps  
Deputy, Training Division  
Assistant Chief of Air Staff-3

11 September 1946

Mr. H. R. Seiwell  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Mr. Seiwell:

Colonel Garland has passed your letter to him of 4 September 1946 relating to detail of Army Air Forces officers to your institution, to the undersigned for reply.

Information as a basis for reply has, this date, been transmitted to Colonel Roscoe C. Wilson of this headquarters, to whom you addressed a similar letter. I believe that you will receive further word from Colonel Wilson in the near future and trust that it will satisfactorily answer your inquiry.

Very truly yours,

GEORGE W. PARDY  
Colonel, Air Corps  
Acting Deputy, Training Division  
Assistant Chief of Air Staff-3

WOODS HOLE OCEANOGRAPHIC INSTITUTION  
WOODS HOLE, MASSACHUSETTS

September 4, 1946

Colonel Roscoe C. Wilson  
Headquarters, Army Air Forces  
Room 3D1071, Pentagon Building  
Washington 25, D. C.

Dear Colonel Wilson:

With reference to our discussion on 14 of August concerning the training program for Army Air Force personnel at this institution, I would appreciate learning of its present status.

It so happens that I am making plans to undertake certain experimental work in the vicinity of Bermuda early next month and do not wish to be away from Woods Hole during the time arrangements for this program might be under discussion. Hence, it will certainly help out a lot if you can tell us anything about what we might expect.

With kindest regards.

Very truly yours,

/s/ H. R. Seiwell

WOODS HOLE OCEANOGRAPHIC INSTITUTION  
WOODS HOLE, MASSACHUSETTS

*Law*

September 17, 1946

Colonel R. C. Wilson  
Vice Deputy, Chief of Air Staff for Research and Development  
Headquarters, Army Air Forces  
Washington, D. C.

Dear Colonel Wilson:

Thank you for your letter of 13 September. It  
gave us the information needed.

Very truly yours,

*H. R. Seiwell*

H. R. Seiwell

HRS/rw

*Mogel & Tord*

Woods Hole Oceanographic Institution

Deputy Chief of Air Staff for Research and Development

9 SEP 1946

AC/AS-3

7  
Lt Col Wetzel/gel/3517

1. Reference is made to paragraph 2, Comment #6. The Commanding General, Air Materiel Command, is being requested to establish quotas in civilian universities for training AAF personnel in the physics and phenomena of the upper atmosphere. Provided comparable or similar instruction is not being conducted, it is further being requested that the Air Materiel Command initiate such a program for at least two qualified officers.

2. Information regarding progress on subject training will be forwarded upon receipt.

6 Incl  
w/d

**KENNETH P. BERGQUIST**  
Colonel, Air Corps  
Deputy Asst. Chief of Air Staff-3

AFDRD  
Col. Buller - 61444  
"Morgan & Smith"

7 AUG 1946

Mr. C. C'D. Inslin  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Mr. Inslin:

In my letter to you of July 18, 1946, I stated that the details of the Army Air Forces' participation in the research projects of the Woods Hole Oceanographic Institution had not then been determined. At a recent conference at headquarters, which was attended by representatives of the Air Materiel Command, it was brought out that the Army Air Forces is committed to the support of the Oceanography Division of the Hydrographic Office of the Navy.

It therefore appears that, in view of our respective limitations, the Army Air Forces would not undertake the training of personnel in oceanography, but should support Woods Hole through its liaison capacity with the Oceanography Division of the Navy.

I greatly appreciate your interest and cooperation in this matter.

Very truly yours,

1946  
1946

Return to 3D-1067

1946 AUG 7 AM 10 27

AIR ADJUTANT GENERAL

Gen. G. H. ...  
Commander, Army Air Forces.

COMEBACK COPY

AED RD  
Co: Sullivan - 6144

1 August 1946

MEMORANDUM FOR GENERAL SPAATZ:

SUBJECT: Woods Hole Oceanographic Institution.

1. The attached letter is somewhat of a withdrawal of our implied support of the Woods Hole Oceanographic Institution. It seems necessary to me for the AAF to take this stand for the following reasons.

(a) There is no relation between oceanography and project "Mogul", except that Dr. Ewing, who is associated with Woods Hole Oceanographic Institution, suggested project "Mogul".

(b) At the working level on underwater projects in which the AAF is interested very close coordination with the Navy is being effected.

(c) The Air Staff, particularly AC/AS-3, feels that our assignment of personnel to Woods Hole Oceanographic Institution, which is what Woods Hole is seeking under the guise of on-the-job training, is a dissipation of our manpower resources not justified.

(d) AAF indecision in this matter can be attributed to the now-relieved project officer, Major Crans, who through Dr. Ewing, was seeking to elevate the priority and AAF direct participation in underwater sound projects to the level of project Mogul. It has been determined that his action was completely unjustified.

(e) I am directing AC/AS-3 to see that a limited number of officers are trained in the phenomena of the upper atmosphere.

CURTIS E. LOWMY  
Major General, USA  
Deputy Chief of Air Staff for  
Research and Development

1 Incl  
Ltr for Sig. to  
Mr. Iselin

Mogul + Loring

1 August 1946

MEMORANDUM FOR GENERAL SPAATZ:

SUBJECT: Woods Hole Oceanographic Institution.

1. The attached letter is somewhat of a withdrawal of our implied support of the Woods Hole Oceanographic Institution. It seems necessary to me for the AAF to take this stand for the following reasons.

(a) There is no relation between oceanography and project "Mogul", except that Dr. Ewing, who is associated with Woods Hole Oceanographic Institution, suggested project "Mogul".

(b) At the working level on underwater projects in which the AAF is interested very close coordination with the Navy is being effected.

(c) The Air Staff, particularly AC/AS-3, feels that our assignment of personnel to Woods Hole Oceanographic Institution, which is what Woods Hole is seeking under the guise of on-the-job training, is a dissipation of our manpower resources not justified.

(d) AAF indecision in this matter can be attributed to the now-relieved project officer, Major Crane, who through Dr. Ewing, was seeking to elevate the priority and AAF direct participation in underwater sound projects to the level of project Mogul. It has been determined that his action was completely unjustified.

(e) I am directing AC/AS-3 to see that a limited number of officers are trained in the phenomena of the upper atmosphere.

CURTIS E. LEWIS  
Major General, USA  
Deputy Chief of Air Staff for  
Research and Development

1 Incl  
Ltr for Sig. to  
Mr. Iselin

Mr. C. O'D. Iselin  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Mr. Iselin:

In my letter to you of July 12, 1946, I stated that the details of the Army Air Forces' participation in the research projects of the Woods Hole Oceanographic Institution had not then been determined. At a recent conference at Headquarters, which was attended by representatives of the Air Materiel Command, it was brought out that the Army Air Forces is committed to the support of the Oceanography Division of the Hydrographic Office of the Navy.

It therefore appears that, in view of our manpower limitations, the Army Air Forces would not undertake the training of personnel in oceanography, but should support Woods Hole through its liaison capacity with the Oceanography Division of the Navy.

I greatly appreciate your interest and cooperation in this matter.

Very truly yours,

1/4

*Ed. Emuck (H)*

*File*

12 July 1946

Mr. C. O'D. Iselin  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Mr. Iselin:

As a result of the recent visit of my representatives with you at Woods Hole, as suggested by you in your letter of 12 June 1946, the Army Air Force is now planning for limited participation in the research projects of the Woods Hole Oceanographic Institution. The exact number of AAF personnel who will be detailed for duty and participation with the Institution has not yet been determined.

It is my desire to acknowledge your invitation to the Army Air Force to participate in the research activities of Woods Hole. You may expect representatives of the Air Materiel Command, with Headquarters at Wright Field, Dayton, Ohio, to contact the Institution in the near future to actually set up formal contractual relations.

Very truly yours,

*Question -  
see attached copy -*

00124409

Woods Hole Oceanographic Institution

AC/AS-3

1 August 1946

6

Deputy Chief of Air Staff for Research & Development

Col Sullivan/br/6144

1. Further developments in the analysis of the relation of the Woods Hole Oceanographic Institution to AAF problems, resulting from a conference of Air Materiel Command representatives in the office of the Deputy Chief of Air Staff for R & D, on 29 July 1946, brought out the following:

(a) That AAF support of the Woods Hole Oceanographic Institution is not necessary for the successful prosecution of project "Mogul" as previously implied.

(b) That the AAF is presently adequately represented in the problems of oceanography through its liaison with the Oceanography Division of the Hydrographic Office of the Navy.

(c) That, at the working level, underwater sound projects in which the AAF is interested are being closely coordinated with the Navy which is most effective as long as the Navy continues its interest in underwater sound projects.


(d) That the phenomena of the upper atmosphere is of increasing importance to the AAF and that steps should be taken to insure adequately trained officer personnel in this field.

(e) That the AAF should not become an active participant in oceanography unless it should develop that the Navy was not sufficiently active in the fields to meet AAF requirements.

2. It is desired that AC/AS-3 undertake to establish post-graduate training in the physics and phenomena of the upper atmosphere for a minimum of two officers who have had previous meteorological training and are otherwise qualified for this training.

CURTIS E. LEMAY  
Major General, USA  
Deputy Chief of Air Staff for  
Research and Development

6 Incl  
n/c

  
Woods Hole Oceanographic Institution

Deputy Chief of Air Staff for Research & Development.  
Attention: Colonel H. R. Sullivan.

30 July 46

5

Research and Engineering Division, AC/AS-4.

Maj. Brown/ect/73610

Returned as requested in telephone conversation with Colonel H. R. Sullivan  
this date.

E. H. WYNN,  
Lt. Colonel, Air Corps,  
Assistant to the Chief,  
Research & Engineering Div.

6 Incl: n/c



Woods Hole Oceanographic Institution

Asst Chief of Air Staff-4

27 July 1946

Asst Chief of Air Staff-3

4  
Lt. Col Taylor/vml/74811

1. This office concurs in the necessity of establishing AAF participation in the Woods Hole Oceanographic Institution.

2. Inasmuch as oceanography is a relatively new science, it is believed that the Air Forces would benefit by having a nucleus of military personnel with a basic knowledge of this subject. Hqs, AAF has previously been approached by the U. S. Navy in the matters of oceanography and an invitation extended from the Navy for the Air Forces to participate in the study of oceanography. At the present time, Colonel D. N. Yates, Hqs, Air Transport Command (Air Weather Service), is the principle AAF representative on the Governmental Advisory Committee on Oceanography. The attached correspondence, relative to oceanography, between the War and Navy Departments is submitted for your information.

E. E. PARTRIDGE  
Major General, USA  
AC/AS-3

AFC TG COL. GARLAND  
ADREQ PETERSON  
AFREP L. G. FIEGLE

AFCGM BROWN

AFCWO MOORMAN

6 Incl  
Correspondance on oceanography

Education  
2. A.M. C.

Woods Hole Oceanographic Institution

AC/AS-4 - THRU: AC/AS-3

12 July 1946

Deputy Chief of Air Staff for Research & Development

Col Sullivan/bjr/6144

1. It is directed that AC/AS-4 take the necessary action to establish AAF participation in the Woods Hole Oceanographic Institution for the purpose of liaison and training in the research of earth sciences and the application to the AAF problems.

2. For your information, there is attached a copy of Suggested Oceanographic Program for AAF personnel, which was submitted to General Spaatz by Mr. C. O'D. Iselin, Director, Woods Hole Oceanographic Institution. In addition there is attached a copy of a report made by investigating personnel of AC/AS-3 and AC/AS-4.

3. A study of the attachments referred to in paragraph 2, and the results of a conference held in the office of the Deputy Chief of Air Staff for Research and Development, indicates that AAF participation in oceanography is primarily a research project rather than a field for training. It is therefore desired that AC/AS-3 forward this R & R with their comments to AC/AS-4.

2 Incl  
Cpy ltr fr Mr. Iselin  
with attachd program

Rept made by A-3 & A-4  
with incl R & R from  
DC/AS R&D to A-4

CURTIS E. LEMAY  
Major General, USA  
Deputy Chief of Air Staff for  
Research and Development



IN REPLY REFER TO:

AFDRE-3/C

HEADQUARTERS, ARMY AIR FORCES  
WASHINGTON



26 June 1946

MEMORANDUM FOR: Assistant Chief of Air Staff - 3

SUBJECT: Woods Hole Oceanographic Institution.

1. It is directed that you take necessary action to establish a course at the Woods Hole Oceanographic Institution for the training of a limited number of Army Air Forces personnel, in the research of earth sciences and their application to the Army Air Forces problems.

2. For your information, there is attached a copy of Suggested Oceanographic Training Program for Army Air Forces Personnel, which was submitted to General Spaatz by Mr. C. O'D. Iselin, Director, Woods Hole Oceanographic Institution. In addition there is attached a copy of report made by investigating personnel of AC/AS-3 and AC/AS-4.

BY COMMAND OF GENERAL SPAATZ:

CURTIS E. LEMAY  
Major General, USA  
Deputy Chief of Air Staff for  
Research and Development

2 Incls:

- 1 - Suggested Program  
as cited abv
- 2 - Cy RR-2 to Dep Chf  
A/S dtd 26 Jun 46

*Received 12/20  
R+R by Col Sullivan*

Woods Hole Oceanographic Institution.

Deputy Chief of Air Staff for Research and Development

26 June 1946

AC/AS-4

Col. Cooper/vt/<sup>2</sup>2100

1. As requested in comment 1, a visit was made to the Woods Hole Oceanographic Institution on 25 June 1946. Personnel making this trip were Colonel W. M. Garland and Lt. Col. H. O. McTague of AC/AS-3 and Col. M. F. Cooper of AC/AS-4.

2. In the discussion with Mr. C. O'D. Iselin, Director of Woods Hole Oceanographic Institution, it was determined that during the war the Woods Hole Oceanographic Institution developed for the Navy the Sofar Project which is the long range location of aircraft crewmen at sea by use of exploding a small charge of TNT at the optimum depth such that the sound will travel in a sound axis in the water to great distances. The accuracy of spotting has been found to be one mile in one thousand miles. Another project developed by these people was called the Sonar, which was the accurate spotting of small TNT charges and bomb impacts in shallow water. The maximum distance useable for this type spotting was forty to fifty miles.

3. In addition to the above specific projects, the Woods Hole Oceanographic Institution has done considerable research in the physics of explosion in water, determination of underwater terrain features by a study of surface waves, correlation of sound travel in water with changes in temperature, salinity and current flow in water. Out of these developed operational procedures for detection of submarines and means whereby submarine commanders could take evasive action to prevent being detected. During their fundamental research over the past several years information has been obtained which indicates a possible correlation between long range weather forecasting and temperature gradients of the sea, also predicting the direction and intensity of storm areas by a study of wave formation on the surface of the sea.

4. At the present time Woods Hole Oceanographic Institution has sixty-five men working for the Navy on the atomic bomb test. Their work consists chiefly of setting up subsurface and air-sounding stations to detect propagation of sound and pressure waves from the atomic bomb blast.

5. Possible application of the research capabilities of the Woods Hole Oceanographic Institution to the problems of the Army Air Forces are as follows:

- a. Anti-submarine detection and bombing.
- b. Research into means of more advanced weather forecasting by correlation of ocean temperatures and surface wave formations.
- c. Spotting practice bombing at short range.
- d. Spotting of long range bombing, particularly as applied to accurate determination of impact points of long range guided missiles.
- e. Navigation of both surface craft and aircraft by accurate position

7/12



[REDACTED]

Woods Hole Oceanographic Institution.

2 (Cont'd)

determination through detection of sound travel in water.

f. Improvement in techniques of radio and radar transmission by a study of water condition as it affects adjacent air conditions.

6. The Woods Hole Oceanographic Institution is a non-profit organization, privately endowed. Their interest in contacting the Army Air Forces appears to be purely in the interest of furthering the earth sciences. They feel that their organization would benefit by having several Army Air Forces students assigned temporarily for the purpose of assisting and furthering research in earth sciences. Also, by such an arrangement the AAF personnel would become indoctrinated in the possibilities of application of the earth sciences to the AAF problems. In addition, by having certain AAF personnel working with them, the Woods Hole Oceanographic Institution would be in a better position to appreciate the AAF problems, thereby enabling them to direct their research in the earth sciences along paths which will be beneficial to the Armed Services and particularly the AAF.

7. It is recommended that the AAF establish a small group of personnel to work with the Woods Hole Oceanographic Institution. This group should be composed of two electronic personnel, two weather observers, two navigators, two bombardiers, two air sea rescue officers and two Wright Field officers from Equipment Laboratory. It is preferable that all these officers have technical degrees. The details of this program should be worked out between AAF Technical Institute and Woods Hole Oceanographic Institution. In this connection there is attached a directive to AC/AS-3 asking that they take necessary action with the AAF Technical Institute to establish a suitable course acceptable to both the AAF and the Woods Hole Oceanographic Institution.

2 Incls:

1 - n/c

2 - Memo to A-3, abv subj  
dtd 26 Jun 46

15/  
N. G. Bunker  
Colonel, U.S.  
Deputy Chief, Research  
Office, Staff 4

Woods Hole Oceanographic Institution

AC/AS-4

21 June 1946

1

Deputy Chief of Air Staff for Research and Development

Col. Wilson/fj/6742

1. Dr. Ewing discussed this matter with General Spaatz and Major General Lemay. It appears that a certain number of oceanographers and associated scientists is necessary for proper progress in physics. It further appears that such highly specialized work cannot be depended upon by an individual to provide full-time occupation or to pay an annual living wage.

2. General Spaatz requested the Woods Hole Institution to furnish the Army Air Forces with a plan to supply the present deficiency in personnel and to overcome the objection raised by the failure of oceanographers as a whole to make a living wage. The attached paper is the result of this request.

3. It is desired that you analyze the proposal to determine the degree to which it meets Army Air Forces needs. It is further requested that you furnish this office with a report on your analysis together with your proposed action.

4. Direct correspondence with Woods Hole Institution is authorized.

1 Incl:

-Ltr dtd 6/12/46, to Gen. Spaatz  
fr C. O'D. Iselin, w/incl.

CURTIS E. LEMAY,  
Major General, U. S. Army,  
Deputy Chief of Air Staff for  
Research and Development.

7/12/46

WOODS HOLE OCEANOGRAPHIC INSTITUTION  
Woods Hole, Massachusetts

June 12, 1946

General Carl Spaatz  
Headquarters, Army Air Forces  
The Pentagon Building  
Washington 25, D. C.

Dear General Spaatz:

In accordance with established policy of this Institution to make available its specialized facilities for National Defense, the attached document outlining a suggested training program in Oceanography for Army Air Force Officers is submitted for your consideration. It has been drawn up after discussions with Army Air Force personnel as well as on informal inquiries reaching this Institution. We are now prepared to undertake a program along the lines indicated.

The Woods Hole Oceanographic Institution is privately endowed. It maintains a permanent scientific staff and supporting technicians engaged in investigation of the Physics, Chemistry, Geology and Biology of the oceans. It is also continuing certain phases of oceanographic research under post war contract with other Government Bureaus.

If the attached very tentative proposal is considered worthy, it is requested that your representatives meet with those of this Institution.

Very truly yours,

C. O'D. ISELIN

CI?b

Encl.

C O P Y

## SUGGESTED OCEANOGRAPHIC TRAINING PROGRAM FOR ARMY AIR FORCE PERSONNEL.

### I. General Purpose

1. The purpose of this tentative project is to provide the Army Air Forces with a nucleus of military personnel trained to recognize and formulate oceanographic problems, usually overlooked, in connection with the Air Force post war activities. Oceanographic training is not now included in the curricula of Military personnel and since the subject is a new one, there are no adequate textbooks available.
2. Throughout the war, the Army Air Force was often called upon to procure information on the physical properties of the sea and on adjacent enemy held coastal regions for large scale military operations. They also cooperated in the improvement of photo reconnaissance methods and interpretation techniques designed to provide this important information as well as data on other oceanic phenomena which restrict the use of complicated instrument techniques in the air over the sea. The methods developed under the duress of war often lacked the essential theoretical background and as a result they were at best not too efficient or accurate. However, this war research produced new important ideas which should now be reexamined, studied and recorded in forms suitable for future use. (Appendix II). The most practical means of doing this appears to be by training a small group of Air Force Officers in practical oceanography at an Oceanographic Institution of military experience. This will provide a background of principles underlying the war oceanographic problems with which the Air Force will be confronted in its post war program. In this manner, the Army Air Forces will be provided with an economical means of recognizing and formulating new oceanographic problems which may otherwise be overlooked. The present need to record and appraise war time aerial photographic techniques for oceanic surveys and to develop methods of target scoring for practice bombing over oceanic areas will undoubtedly be supplemented by other requirements not yet recognized.
3. Oceanography is a relatively new science and its role in military operations is frequently overlooked. During the war the few professional oceanographers were engaged in oceanographic work for either the Army or the Navy and now are concentrated at two American Oceanographic Institutions. The Woods Hole Oceanographic Institution is prepared to provide specialized training of the type indicated to a limited number of military personnel.

### II Facilities Available at Woods Hole.

1. The Woods Hole Oceanographic Institution is a private scientific institution endowed by the Rockefeller Foundation for the scientific study of the sea. It maintains a permanent staff of scientists and supporting technicians, engaged in fundamental investigations of the physics, chemistry and biology of the sea. Members of the scientific staff are available for consultation purposes as well as for special instruction and they also direct and organize specific research projects contracted for by Government Bureaus. For this purpose additional skilled personnel may be hired for the duration of a contract. The permanent staff have no fixed teaching responsibilities. This Institution is not Government operated.

2. Throughout the war period, the Woods Hole Oceanographic Institution played a part in research on many oceanographic problems for Military and Naval operations. Some of its permanent staff gained practical operating experience as commissioned Military and Naval personnel in the applications of oceanography to strategical and tactical problems, and now hold Reserve commissions in the services. The Institution is acquainted with military requirements and military administrative policy, as well as with the purely scientific aspects of problems. It has adequate facilities of handling classified materials, and its key personnel are cognizant of military security regulations. At the present time, contracts with the Navy have laid out a continuing program of Naval oceanographic research. It would therefore seem that our staff is in a favorable position to help in the interchange of ideas between Army, Navy and Air Forces.

3. The present physical facilities of the Institution are that during the winter months, adequate laboratory space, the services of an instrument shop and technicians and the use of such ships and boats as may be required are assured. During the summer, with the influx of university people, the living accommodations and the laboratory facilities may be somewhat taxed until additional building is possible.

### III. The Training Program...

1. The Program is divided as follows: (detailed in Appendix I)

- a. Lectures and seminars.
- b. Procurement of experimental data.
- c. Reduction, analysis and reports of data.

2. The objectives are to accomplish with a limited number of qualified officers, the following:

- a. Instruction in the theory and practical applications of Oceanography, in the methods of conducting oceanographic field research and in the scope of oceanographic materials.
- b. Study of the oceanographic problems associated with the techniques of aerial photo procurement and interpretation and of oceanographic and beach characteristics of coastal regions.
- c. Study of physical oceanographic principles in state of the sea forecasting, in sound transmission in sea water and in other techniques relevant to Air Force operations over the oceans.
- d. Directed investigation of important oceanographic problems from World War II operations.
- e. Establishment of round-table discussions to assist students with perplexing oceanographic problems and to develop other marine problems significant to the Air Force post war program.
- f. Directed investigation of new oceanographic problems significant to Air Force operations.

### 3. Benefits to be derived by the Army Air Forces

- a. The provision of a nucleus of Officers with oceanographic training who will be able to recognize and to formulate oceanographic problems with which the Air Forces will be confronted, and who can serve as a liaison group for oceanographic research. No such qualified group or individual is now in the Army Air Forces.
- b. Continuing information on new developments in physical oceanography of interest to the Air Forces.
- c. Established liaison with Oceanographic scientists who are cognizant of military problems and who will assist in the military interpretation of oceanographic data and in the development of new methods.
- d. Provision of controlled field observations bearing on problems in aerial photographic reconnaissance of oceanic areas, analyzed jointly by Air Force Officers and members of this staff.
- e. Preparation of a Manual of interpretation of hydrographic factors from aerial reconnaissance for use in post war activities and in event of future wars.
- f. Preparation of a training film showing technique of obtaining oceanographic data and its analysis and reduction as is pertinent to Air Force problems.
- g. Preparation of short term reports on progress of new relevant information.

### IV. Requirements of Students

1. It is suggested the course be limited to not more than twenty Army Air Force Officers, a reasonable proportion of whom have had operational experience as reconnaissance pilots, aerial photographers and aerial photo interpreters. They should be graduates of accredited Scientific or Engineering schools with a Bachelor's Degree, or its equivalent.

### V. Recommendations

1. If this very tentative proposal is considered to have merit, it is recommended that representatives of the Army Air Forces meet with representatives from the Woods Hole Oceanographic Institution for its development.

## Appendix I

1. The following schedule, covering the principal topics in oceanography significant to the Air Forces, is tentative. The primary objective is to acquaint the student with the basic principles and after a short series of lectures on selected topics, the course may develop in a direction different from that outlined, if the interest of the students should so determine. As the schedule now stands, it is to a large extent concerned with oceanographic phenomena in aerial photographic reconnaissance techniques which were used during the recent war. Flexibility of the schedule will permit study and investigation of subjects of timely interest, as for instance those dealing with locations of oceanic target practice areas and the associated scoring techniques. It is the desire of this Institution that the training program be of directed research rather than follow a formal pattern of instruction.

2. The following division of total time is estimated.

- A. Lectures and seminars - 9 weeks
- B. Procurement of experimental field data - 10 weeks.
- C. Reduction and analysis of data - 13 weeks

Total - 32 weeks

3. Lectures and seminars will be grouped into four main categories of oceanographic subjects as follows:

a. Formal lectures and Oceanographic topics

- 1. Physical and chemical properties of the sea.
- 2. The character of ocean currents.
- 3. Dynamics of ocean currents.
- 4. The tides.
- 5. Oceanography of the continental shelf.
- 6. Surface waves and related phenomena.
- 7. Beaches.
- 8. Oceanic sediments.
- 9. Transparency of sea water.
- 10. Transmission of sound in sea water.
- 11. The sea surface and the air.
- 12. Sea level variations.
- 13. Principles of hydrographic surveying.
- 14. The biological properties of the sea.
- 15. Oceanographic instruments.

b. Informal discussions of above.

c. Seminars on applications of oceanography to aerial reconnaissance methods for determination of coastal waters and beach characteristics.

d. Seminars for discussions of applications of oceanography to target scoring and other post war Air Force activities.

4. Procurement of experimental field data will be arranged as follows:
  - a. Coordinated aerial and sea surface observations for:
    1. Measurement of surface wave characteristics
    2. Measurement of light penetration in the sea and visibility characteristics
    3. Observations on beach characteristics (sediments gradients, etc.)
    4. Reserved for other observations
5. Reduction and analysis of experimental observations.
  - a. Analysis of coordinated air and sea surface observations with reference to wave theory and local oceanographic factors.
  - b. Application of above to practical Air Force reconnaissance problems.
  - c. Analysis of observations for other Air Force problems.
  - d. Preparation of progress reports on new results.
  - e. Preparation of training film.
  - f. Preparation of a manual on methods.

## Appendix II

1. A coordinated program of training and research in oceanography applied to techniques of aerial photographic surveying and its interpretation, was undertaken by the Army Air Forces School of Applied Tactics and the 6211 Beach Intelligence Team (assigned Pacific ocean areas Theater) during May and June, 1945, at Orlando, Florida. After the 6211 Unit moved into the Pacific Theater, a photographically equipped B-25 aircraft was assigned to it for experimental work in connection with the procurement of oceanographic and beach data from the Japanese coastal areas. A summary of this activity is contained in the following three reports.

- a. "Study and Recommendations for an Army Forces Beach Intelligence Service in Pacific Ocean Areas". April 1945.
- b. "The Procurement, Training and Organization of the 6211 Beach Intelligence Unit". August 1945.
- c. "Final Report on Activities of 6211 Beach Intelligence Unit, Pacific Ocean Areas". November 1945.

2. The above reports were distributed to War Department through Intelligence channels.

Magy + torid

Waiver to Clearance Restrictions in New York Control Area.

Deputy Chief of Air Staff for Research and Development

22 AUG 1946

3

AC/AS-3

1. Inclosure has been withdrawn and returned by 2d indorsement to Commanding Officer, 4149th AAF Base Unit, Electronics Experimental Squadron, Olmsted Field, Middletown, Pennsylvania.

2. Inclosed is a copy of our reply.

Incl  
Listed above

SIGNED

WM. A. MATHENY  
Brigadier General, U. S. A.  
Deputy Asst. Chief of Air Staff-8

Room 3-D-1000

20 November 1945

Dr. Maurice Ewing  
Woods Hole Oceanographic Institution  
Woods Hole, Massachusetts

Dear Dr. Ewing:

For my long delay in answering your letter of 24 October I must apologize. Numerous trips have cut almost to nothing the time I am allowed to spend in the office, but your report on "Long Range Sound Transmission in the Atmosphere" has been given distribution to various members of the Air Force staff. They all agree with you that the existence of an atmospheric sound axis is of great military importance.

It is believed that experiments are premature at this time, but that after a thorough study of existing information a program of experimental procedure can be devised. Therefore, it is not possible for me at this time to give you definite word in answer to your desire to direct a preliminary investigation through the facilities of Columbia University.

However, if the outcome of research by our Air Technical Service Command should prove favorable, it is hoped that an experimental project be established both to determine the characteristics of the atmospheric sound axis and to devise equipment for the military utilization of this phenomenon. At this time I should certainly count on you.

It was most enjoyable lunching and talking with you. I hope we may have another meeting in the not too far distant future, and that in the meantime keep in touch with each other through letters.

Best regards.

Sincerely

Carl Spaatz  
General, USA

[REDACTED]

2 November 1945

MEMORANDUM FOR GENERAL CARL SPAATZ

SUBJECT: Atmospheric Sound Axis

1. The attached correspondence was handed to me personally by Brig. General W. E. Todd for comment and recommendation directly to General Spaatz.

2. From study of the attached, it is concluded that Mr. Ewing has a firm scientific basis for his belief that a "sound axis" exists in the atmosphere. The general idea presented is not new to aerologists who concede a lower boundary of such an axis. The existence of an upper refracting layer, however, many require proof by experiment.

3. There is a large literature in existence in the United States which bears directly on the problem but is widely scattered. There is evidence that the Germans have made recent elaborate studies which alone may confirm or refute Mr. Ewing's assumptions.

4. If Mr. Ewing is correct in his belief, the existence of an atmospheric sound axis is of great military importance; and in view of this importance and the data tending to support Mr. Ewing's belief, the subject should be examined by the Army Air Forces.

5. It is believed that experiments are premature at this time, but that an effort should be made to collect and correlate all existing data necessary to prove or disapprove the idea. After study of existing information a program of experimental procedure can be devised; and, if findings warrant, an experimental equipment program should be established at the same time.

6. It is recommended, therefore, that the Air Technical Service Command be directed to establish a project and appoint a project officer to conduct a research of United States and foreign information pertaining to Mr. Ewing's proposal. And it is recommended further, that should the outcome of this research prove favorable an experimental project be established both to determine the characteristics of the atmospheric sound axis and to devise equipment for the military utilization of this phenomenon.

For the Commanding General, Army Air Forces:

R. C. WILSON  
Colonel, Air Corps

[REDACTED]

Incl.

WOODS HOLE OCEANOGRAPHIC INSTITUTION

WOODS HOLE, MASSACHUSETTS

October 24, 1945

General Carl Spaatz  
Headquarter Army Air Forces  
3D-1000 Pentagon Building  
Washington 25, D. C.

Sir:

Enclosed is a brief memorandum on the subject we discussed in your office last week. I shall be pleased to have your opinion of it and to learn whether you think further work on it justified.

I will give you a general idea of my own plans and obligations so you can make an estimate of the extent to which I might be able to participate in any investigation which might be undertaken.

I have been on leave of absence from Columbia University continuously since accepting a position there about 16 months ago. I will probably commence my work therein February, 1946, retaining general supervision of my three Navy projects but gradually passing the detailed work to other hands. The three Navy projects are under contract between the Bureau of Ships and the Woods Hole Oceanographic Institution. I expect to retain my connection with this Institution and to make it the headquarters of my normal research in summers.

The Director of this Institution has naturally been informed of my idea about the stratosphere sound channel. He believes that the matter is a very important one, but that it is too far from Oceanography to be a proper project for the Institution. He does not know of my contact with you as he is beyond reach of the telephone on a vacation which started about a month ago. I believe that any work you may wish me to undertake on this problem should be set up through Columbia University.

I shall have my hands full at Columbia, digging into a new job and still not able to turn loose of the old one, but my interest in the stratosphere sound channel is so great and my conviction that I can contribute very substantially to the problem is so firm, that I am compelled to request the privilege of directing the pre-

liminary investigation if one is undertaken. I feel capable of doing justice to this in addition to the other problems if provision can be made for a suitable project officer and for qualified assistance.

I have had much experience with project officers in the past five years and know well what type of person is most helpful. If this project is undertaken, I shall make the strongest possible request that Major R. T. Crane be assigned as project officer. He has excellent over all qualifications for the job, he knows about the project and has great interest in it, and there would be no uncertainty in my mind about what could be entrusted to him.

Very truly yours,

Maurice Ewing

ME/mke  
enc.

P. S. I have just received by telephone word that the classification on the submarine sound channel work has been removed by C.N.O.

M. E.



Ltr Watson Labs. 14 Jun 46, subj: "Change in Class. of 'Mogul,' Item 188-5."

1st Ind.

TSELT-2/WHD/mch

Hq., Air Materiel Command, Wright Field, Dayton, Ohio. 8 July 1946.

TO: Commanding General, Army Air Forces, Washington 25, D.C.

THRU: (AC/AS-4)

1. To amplify the information given in the basic letter it is desired by Electronic Subdivision that the following information and scientific data pertaining to project "Mogul" be classified "TOP SECRET:"

a. Precise data as to the exact placement of measuring instruments.

b. Scientific observations and measurements that have military application.

c. Detailed methods of measuring results.

2. Engineering preparations for the final test that are not in conflict with the above will be classified "Confidential."

3. Contractual documents will be classified the same as the security classification of the equipments involved. Equipments used in project "Mogul" are common to other systems or sets that are now classified "Confidential," "Restricted," or "Unclassified;" contractual documents should be classified accordingly.

4. Authorization is requested to observe the security classifications proposed herein.

FOR THE COMMANDING GENERAL:

E. O'DONNELL  
Brig.Gen., U.S.A.  
Deputy Chief  
Engineering Division

Ltr Watson Labs. Lt Jun 46, subj: "Change in Class. of 'Mogul,' Item 188-5."

1st Ind.

TSELT-2/WHD/mch

Hq., Air Materiel Command, Wright Field, Dayton, Ohio. 8 July 1946.

TO: Commanding General, Army Air Forces, Washington 25, D.C.

THRU: (AC/AS-4)

1. To amplify the information given in the basic letter it is desired by Electronic Subdivision that the following information and scientific data pertaining to project "Mogul" be classified "TOP SECRET:"

a. Precise data as to the exact placement of measuring instruments.

b. Scientific observations and measurements that have military application.

c. Detailed methods of measuring results.

2. Engineering preparations for the final test that are not in conflict with the above will be classified "Confidential."

3. Contractual documents will be classified the same as the security classification of the equipments involved. Equipments used in project "Mogul" are common to other systems or sets that are now classified "Confidential," "Restricted," or "Unclassified;" contractual documents should be classified accordingly.

4. Authorization is requested to observe the security classifications proposed herein.

FOR THE COMMANDING GENERAL:

E. O'DONNELL  
Brig.Gen., U.S.A.  
Deputy Chief  
Engineering Division

SUBJECT: Waiver to Clearance Restrictions in N. Y. Control Area

*File  
"Torrid" & "Mogul"  
File*

TO: AC/AS-3

DATE 29 July 1946

FROM: Deputy Chief of Air Staff for Research and Development

COMMENT NO. 2  
Col Wilson/fj/6742

1. Forwarded for necessary action.
2. This office recommends approval of the requested waiver with the definite understanding that it applies only to the aircraft when actually engaged on projects "Torrid" and "Mogul."

Incl:  
n/c.

CURTIS E. LEMAY,  
Major General, U. S. Army,  
Deputy Chief of Air Staff for  
Research and Development.

**Waiver to Clearance Restrictions in New York Control Area.**

Office, Deputy Chief of Air Staff for Research and  
Development. Attention: Col. Wilson  
AC/AS-3, Guided Missiles Division. Attention: Col. Brown  
AC/AS-4, Research and Engineering Division

24 July 1946

1

Mr. Roddy/vt/2100

1. The attached correspondence covering clearance of aircraft on projects "Torrid" and "Mogul" into the New York Control Zone is forwarded for consideration.

2. It is recommended that the request be granted, in view of the fact that qualifications of the pilots of the 4149th AAF Base Unit who will do the flying on these projects will be comparable with the qualifications of the Air Transport Command pilots for whom waiver has already been granted. It is believed that the waiver requested will not violate the interests of safety, which was the basis of the original order.

Copy for AFDRD

Incl:  
Ltr 4149 AAF BU 8 Jul 46, abv subj  
w/1 ind and 2 incls

ALDEN R. CRAWFORD  
Brigadier General, USA  
Chief, Research and Engineering Division

Basic Ltr fr 4149th AAFBU, Middletown, Pa., to CG, AAF,  
Wash., D.C., Thru: CG, AMC, W/P, dtd. 8 July 1946.  
Subj: Waiver to Clearance Restrictions in New York  
Control Area.

1st Ind.

TSBLS/HWM:sg

Headquarters, Air Materiel Command, Wright Field, Dayton,  
Ohio. 12 July 1946.

To: Commanding General, Army Air Forces, Washington, D. C.

1. Recommend approval of request in basic letter.
2. The authority contained in Inclosure 1, subject:  
"Special Authorization for Projects Torrid and Mogul", does  
not contain permission for flight into the New York Control  
Zone below contact flight rules.
3. Due to the frequency of the high priority flights  
these aircraft must make into the New York Control Zone and  
the many times the projects are delayed due to conditions  
below contact flight rules, it is deemed advisable to give  
the necessary waivers.

FOR THE COMMANDING GENERAL:

TOM C. DIVES  
Brig. General, U. S. A.,  
Chief, Electronic Subdivision,  
Engineering Division.

Incl: n/c

4149TH AAF BASE UNIT  
ELECTRONICS EXPERIMENTAL SQUADRON  
OLMSTED FIELD, MIDDLETOWN, PA.

8 July 1946

SUBJECT: Waiver to Clearance Restrictions in New York Control Area

THRU: COMMANDING GENERAL  
Engineering Division  
Air Materiel Command  
Wright Field, Dayton, Ohio  
ATTENTION: Col. Lingard

TO: COMMANDING GENERAL  
AAF  
Washington, D. C.

1. It is requested by this headquarters that a waiver be granted for the three aircraft assigned to Projects Mogul 188-5 and Torrid 189-7-1 (see inclosure number one) similar to that granted the Air Transport Command for operating in the New York Control Area below contact flying rules.

2. All three aircraft assigned to these Projects indicated in the inclosure are especially equipped for bad weather flying.

3. The Pilots assigned to these specially equipped aircraft all hold current white instrument cards and shortly will have green cards. The Navigators are thoroughly qualified for all weather flying.

4. The restriction mentioned in paragraph one is based on AAF Letter AF COP-L-296, teletype notification to Newark AAB TSPFL 1-6-54 dated 7 June 1946 states that no aircraft will be cleared to or from an Army Installation in the New York Control Zone except Mitchel Field, Hemsted, N. Y. if weather conditions are below allowable contact flight rules of 2500 feet and 3 miles.

5. It is of the utmost importance in connection with these Projects, both Army Air Force 1-B priority, that these waivers be granted because of the necessity of carrying personnel and cargo for these Projects in and out of the N. Y. Control Zone.

/s/ DONALD E. MATTHEWS  
Major, Air Corps  
Commanding

Incl - 2

1 Incl: Ltr to CO Watson Labs., Red Bank, N. J. subj: "Sp Authorization for Projects Torrid and Mogul" with 3 ltrs inclosed.

2 Incl: Teletype

RESTRICTED

Ltr AMC Watson Lab Red Bank NJ  
14 Jun 46 Subj: Change in Classification  
of Proj "Mogul" Item 188-5. to CGAMC

Hq Army Air Forces, Washington 25, D.C.

2d Ind

17 July 1946

To: Commanding General, Air Materiel Command, Wright Field, Dayton,  
Ohio Attention: WLRL-4

1. It was intended, when project Mogul was initiated, that the military purpose, the existence of technical means of achieving this purpose, and the fact that the Army Air Forces is working toward this purpose, be classified "Top Secret". There is no objection to lower classification of those phases of the work or those equipments which will not in any way compromise this stated policy. When development is complete, classification of the final instrumentation, site locations and other operational and technical features will be established on the basis of conditions then existing.

2. It must be understood, however, that the policy stated in paragraph 1 above is not compatible with the proposal of paragraph 1 of the basic letter, or with paragraph 1 of the 2d indorsement, but is considerably broader.

3. Lower classification for contractual documents, common equipments, and other items not in conflict with paragraph 1 above is concurred in.

BY COMMAND OF GENERAL SPAATZ:

ALDEN R. CRAWFORD  
Brigadier General, USA  
Chief, Research and Engineering Div  
Office, Asst Chief of Air Staff -4

RESTRICTED

R E S T R I C T E D

AIR MATERIEL COMMAND  
WATSON LABORATORIES  
RED BANK, NEW JERSEY

PSD/df

Item 188-5

14 JUN 1946

WLERI-4

SUBJECT: Change in Classification of Project "Mogul," Item 188-5.

TO: Commanding General  
Air Materiel Command  
Wright Field, Dayton, Ohio  
ATTN: TSELT

1. It is recommended that the present classification for project "Mogul," Item 188-5, be retained for the military purpose, the final instrumentation and site locations only, and that the phase of preliminary work including field testing, instrumentation, scientific and general engineering work be classified as "Confidential" and the contractual work as "Restricted".

2. This change in classification will eliminate certain complications in correspondence and procedures, and is justified in view of the publication of articles in the press, magazines, and books on the phenomena of sound wave propagation in the stratosphere in connection with the Siberian meteor and the eruption of the island of Krakatoa.

D. P. GRAUL  
Colonel, Air Corps  
Commanding

R E S T R I C T E D

Ltr Watson Labs. 14 Jun 46, subj: "Change in Class. of 'Mogul,' Item 188-5."

1st Ind.

TSELT-2/WHD/mch

Hq., Air Materiel Command, Wright Field, Dayton, Ohio. 8 July 1946.

TO: Commanding General, Army Air Forces, Washington 25, D.C.

THRU: (AC/AS-4)

1. To amplify the information given in the basic letter it is desired by Electronic Subdivision that the following information and scientific data pertaining to project "Mogul" be classified "TOP SECRET:"

a. Precise data as to the exact placement of measuring instruments.

b. Scientific observations and measurements that have military application.

c. Detailed methods of measuring results.

2. Engineering preparations for the final test that are not in conflict with the above will be classified "Confidential."

3. Contractual documents will be classified the same as the security classification of the equipments involved. Equipments used in project "Mogul" are common to other systems or sets that are now classified "Confidential," "Restricted," or "Unclassified;" contractual documents should be classified accordingly.

4. Authorization is requested to observe the security classifications proposed herein.

FOR THE COMMANDING GENERAL:

E. O'DONNELL  
Brig.Gen., U.S.A.  
Deputy Chief  
Engineering Division

RESTRICTED

*amc*

Ltr AMC Watson Lab Red Bank NJ  
14 Jun 46 Subj: Change in Classification  
of Proj "Mogul" Item 188-5. to CGAMC

Hq Army Air Forces, Washington 25, D.C.

2d Ind

17 July 1946

To: Commanding General, Air Materiel Command, Wright Field, Dayton,  
Ohio Attention: WLERL-4

1. It was intended, when project Mogul was initiated, that the military purpose, the existence of technical means of achieving this purpose, and the fact that the Army Air Forces is working toward this purpose, be classified "Top Secret". There is no objection to lower classification of those phases of the work or those equipments which will not in any way compromise this stated policy. When development is complete, classification of the final instrumentation, site locations and other operational and technical features will be established on the basis of conditions then existing.

2. It must be understood, however, that the policy stated in paragraph 1 above is not compatible with the proposal of paragraph 1 of the basic letter, or with paragraph 1 of the 2d indorsement, but is considerably broader.

3. Lower classification for contractual documents, common equipments, and other items not in conflict with paragraph 1 above is concurred in.

BY COMMAND OF GENERAL SPAATZ:

ALDEN R. CRAWFORD  
Brigadier General, USA  
Chief, Research and Engineering Div  
Office, Asst Chief of Air Staff -4

RESTRICTED

R E S T R I C T E D

AIR MATERIEL COMMAND  
WATSON LABORATORIES  
RED BANK, NEW JERSEY

PSD/df

Item 188-5

14 JUN 1946

WLERL-4

SUBJECT: Change in Classification of Project "Mogul," Item 188-5.

TO: Commanding General  
Air Materiel Command  
Wright Field, Dayton, Ohio  
ATTN: TSELT

1. It is recommended that the present classification for project "Mogul," Item 188-5, be retained for the military purpose, the final instrumentation and site locations only, and that the phase of preliminary work including field testing, instrumentation, scientific and general engineering work be classified as "Confidential" and the contractual work as "Restricted".

2. This change in classification will eliminate certain complications in correspondence and procedures, and is justified in view of the publication of articles in the press, magazines, and books on the phenomena of sound wave propagation in the stratosphere in connection with the Siberian meteor and the eruption of the island of Krakatoa.

D. P. GRAUL  
Colonel, Air Corps  
Commanding

R E S T R I C T E D

Memorandum on  
"Mogul & Torrid" File

12 June 1946

My impression on first reading this file is that the projects are fanning out into a complete investigation of all the properties of the oceans and the atmosphere.  
(see memo to Major Cramm, 11 May 1946)

In view of the earlier documents (report from Ewing to Spaatz, 24 October 1945), I expected that this file would by now contain

- a) a summary of the experimental evidence for existence of a layer, and a summary of what can be inferred about its properties.
- b) a program of research toward the immediate end of using this layer (if it exists), for military purposes.

RPJ

PRIORITY

24 MAY 46

CG WATSON LABS

CG AMC WRIGHTFLD OHIO

*A. ...  
L. ...*

RALPH I COLE  
LT COL AC  
CHIEF ENGINEERING DIVISION

WLERL-5-7

ATTN TSELT IT IS REQUESTED THAT ONE EACH

ADDITIONAL B-25J STRIPPED PAREN WEATHER RECONNAISSANCE AIRCRAFT PAREN ONE B-29 STRIPPED WITH FUEL INJECTION ENGINES AND CURTIS REVERSIBLE PROPELLERS ONE C-54G ALL RADAR AND C-1 AUTO-PILOT EQUIPPED BE ASSIGNED TO THE 4149TH AAF BASE UNIT IN CONNECTION WITH PROJECTS MOGUL AND TORRID PRIORITY 1B PD THE THREE AIRCRAFT ALREADY ASSIGNED OF THIS TYPE WILL BE GROUNDED FROM TIME TO TIME BECAUSE OF MAINTENANCE CMA OVERHAUL OR WEATHER THEREFORE THIS IS REQUIRED TO ACCOMPLISH NECESSARY FLIGHTS PD IN THIS CONNECTION LOCATION AND DELIVERY DATES ARE IMPORTANT SO THAT PLANS FOR MODIFICATIONS MAY BE ACCOMPLISHED PD FURTHER THAT

THE FOLLOWING CREWS BE ASSIGNED WITH THE AIRCRAFT PD B-25 TWO PILOTS MOS 1081 TWO NAVIGATORS MOS 1037 ON APQ 13 AND APA 36 PD TWO RADIO OPERATORS MOS 757 TWO FLIGHT ENGINEERS PAREN CREW CHIEF MOS 750 PAREN PD B-29 TWO PILOTS MOS 1093 TWO NAVIGATORS

		Item Nos. 188-5 and 189-7-1		
WLCOL	WLENG	WLEDE	WLERL	WLERL4
24May46	24May46	24May46	24May46	24May46

ec

MOS 1037 FOR APQ 13 AND APA 36 TWO RADIO OPERATORS MOS 757 TWO RADAR OPERATORS MOS 866  
ONE FLIGHT ENGINEER OFFICER PILOT MOS 1028 ONE FLIGHT ENGINEER MOS 737 PD C-54 TWO  
PILOTS MOS 1024 TWO NAVIGATORS MOS 1037 ON APS 10 AND APN 9 TWO FLIGHT ENGINEERS PAREN  
CREW CHIEF MOS 750 PAREN TWO RADIO OPERATORS MOS 757 PAREN IT IS FURTHER REQUESTED  
THAT HOMESTEAD FIELD FLA ARMY AIRLINE SCHOOL C-54 GRADUATES BE FURNISHED PAREN PD ALL  
PILOTS TO HAVE GREEN INSTRUMENT CARDS PD ALL NAVIGATORS MUST BE TRAINED IN MET  
OBSERVATION AND BE FAMILIAR WITH THE OPERATION OF PSYCHROMETERS AND AEROGRAPHS PD  
INFORMATION COPY TO CG AAF AFDRD SIGNED ENGINEERING DIVISION

*Transmitted  
Sound Copy*

MEMORANDUM A, MAY 14, 1946

1. Introduction

It is believed that immediate action is imperative if projects MOGUL and TORRID are to be in any degree successful, also if Science is to be expected to give its full cooperation in the future ~~On this~~ subject and <sup>in</sup> allied fields.

2. Situation

There exists at present a lack of:

- a. basic understanding of the programs
- b. clarity as to what is expected
- c. cooperation indicated by petty jealousies inside and out of the project
- d. directed and defined authority and responsibility
- e. helpful attitude of organization and personnel both in and out of the project
- f. opportunity for scientific personnel inside and outside of the project to do the jobs they want to do. (This means dissatisfaction and possible severance of their present intense desire to work and be helpful, caused by red tape and other routine matters and channels which are unnecessarily burdensome for fundamental research programs.)

3. Conclusions

In view of the above, the following is submitted as a solution, and not necessarily the only solution.

- a. Separate Geophysical Laboratories under the D.C./S. Research and Development HQ AAF.
- b. Separate Geophysical Laboratory at Watson Laboratories, but only attached for administration and supply, and responsible to D.C.S. Research and Development HQ AAF.
- c. Change present name to Geophysical Branch.

#### 4. Recommendations

- a. A directive outlining, irrespective of which of the above is decided upon, the following:
  1. authority
  2. responsibility
  3. what is expected of the unit
  4. security procedure
  5. supply procedure (expedite)
  6. cooperation (internal)
  7. cooperation (external), Navy, civil, and government agencies.
  8. test units boats, under direct control (part of unit)
  9. test units A. C. under direct control (part of unit)
  10. commitments to Institution for long term research programs so they know where they stand.
  11. ~~date~~ to military and civilian personnel on project.
- b. A long range program to be submitted for approval direct to the Commanding General Army Air Forces, through D.C.S. Research and Development, but that action be taken later on paragraphs 3 and 4.

MEMORANDUM B, MAY 14, 1946

1. Balloons

a. 1 each, manned, 100,000 - 125,000 ft., upper atmosphere data, and ranging.

b. 4 each, manned, 40,000 - 60,000 ft., upper atmosphere data and ranging.

c. Develop <sup>improved</sup> free Radiosonde. *constant altitude 40-60,000 ft.*  
*and max altitude 125,000 ft.*

2. Blimps,

a. Develop a test craft for operation in the sound channel, fuel only for manoeuvring ~~at~~, take-off and landing, plus marginal amount at altitude.

3. Aircraft

a. 10,000 - 20,000 ft. C or B type aircraft, 30,000 - 40,000 lbs., 1500 - 2500 miles.

b. 20,000 - 30,000 ft. C or B type aircraft, 60,000 - 100,000 lbs., 3000 - 4000 miles.

c. 40,000 - 60,000 ft. C. or B type aircraft, 100,000 - 150,000 lbs., 4000 - 6000 miles.

Note: a and b to carry  $1\frac{1}{2}$  and  $2\frac{1}{2}$  tons trucks and trailers, plus balloon, gas bag, and gondola.

4. Boats

a. 1000 - 1500 tons, 90 days supplies and water, complete oceanographic.

5. Large charges to simulate "A" test.

6. Special Instrumentation for aircraft and boats.

Special scientific instrumentation for test programs.

MEMORANDUM C, MAY 14, 1946

1. That 2 each Army F. S. boats be made available immediately for modification pending the construction of specialized vessels for the long range program.
2. That 1 more each B-25, B-29, C-54 be made available to insure continuous operation without interruptions due to weather, maintenance, and overhaul.

[REDACTED]

Atmospheric Sound Axis

TO: Deputy Chief of Air Staff for Research & Development

DATE: 11 Mar 46

FROM: Research & Engineering Division, AC/AS-4

COMMENT NO 2  
Mr Mulkey/hs/6826

1. ATSC has been directed to submit to this headquarters a brief report on the progress of the investigation, made to date, into the possibility of the existence of an atmospheric sound axis.

2. The report will be promptly forwarded when received in this office.

AFDRE-2 \_\_\_\_\_

2F \_\_\_\_\_  
\_\_\_\_\_

ALDEN R. CRAWFORD  
Brig General, U. S. A.  
Chief, Research & Engineering Div

[REDACTED]

[REDACTED]

SECRET  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

Atmospheric Sound Axis

AC/AS-4

4 March 1946

1

Deputy Chief of Air Staff for Research and Development

Col Wilson/fj/6742

1. The Commanding General has expressed his personal interest in the investigation into the possibility of the existence of an atmospheric sound axis. It is understood that this matter was referred to ATSC by AC/AS-4 in November 1945.
2. It is requested that a brief report on the progress of this project be furnished this office.

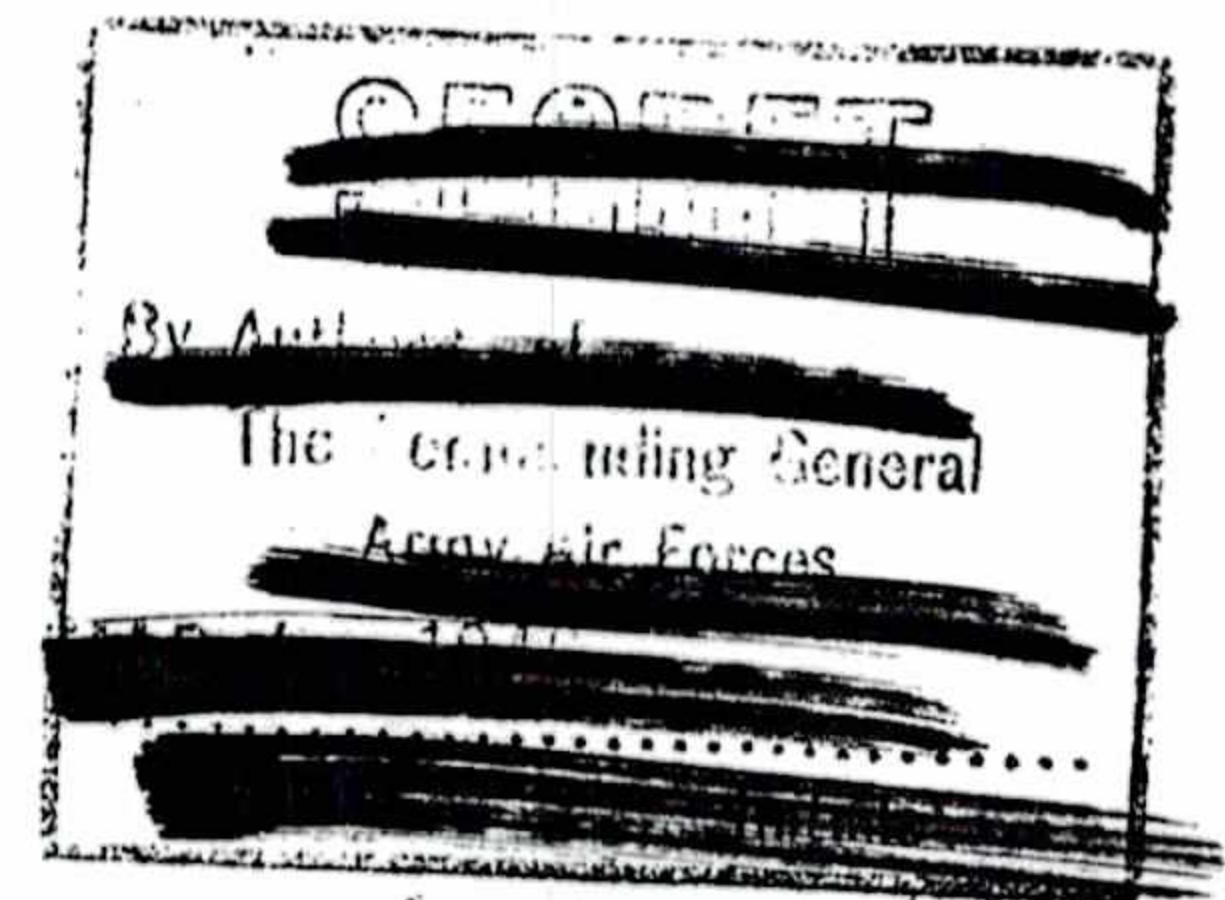
CURTIS E. LOMAY,  
Major General, U. S. Army,  
Deputy Chief of Air Staff for  
Research and Development.

[REDACTED]

**Atmospheric Sound Axis**

AC/AS-4

Deputy Chief of Air Staff for Research and Development



4 March 1946

1

Col Wilson/fj/6742

1. The Commanding General has expressed his personal interest in the investigation into the possibility of the existence of an atmospheric sound axis. It is understood that this matter was referred to ATSC by AC/AS-4 in November 1945.

2. It is requested that a brief report on the progress of this project be furnished this office.

CURTIS E. LEMAY,  
Major General, U. S. Army,  
Deputy Chief of Air Staff for  
Research and Development.

D22.2C  
Serial C-850-106

U. S. NAVY ELECTRONICS LABORATORY  
SAN DIEGO 52, CALIFORNIA

February 4, 1947

*Moguel +  
Torrin*

**FROM:** The Director.  
**To:** The Commanding General, Air Materiel Command,  
Wright Field, Dayton, Ohio.  
Attention: Communications Section, Supply Division.  
**Subject:** AN/CPN-2 and AN/APN-3 Shoran Equipments - Spare Parts -  
Request For.

**References:**

- (a) USNEL ltr S68(D16.2) Ser 850-315 of 13 July 1946 to CG, AMC, Wright Field, cc to BuShips Codes 938, 940 and 951A
- (b) BuShips secret ltr S68 Ser. 005654(40) of 19 Dec 1946 to Asst Chief of Air Staff - 4, cc with Encl (A) to AMC, Wright Field, BuAer, BuOrd, USNEL, and Watson Labs.
- (c) USNEL conf spdltr D16.2(SOFAR) Ser 500A-C16 dtd 14 Jan 1947 to BuShips Code 951 (Army Liaison), cc to BuShips (40), to AMC, Wright Field, Asst Chief of Air Staff - 4, AMC, Wright Field.

**Enclosure:** (A) BuShips spdltr 951A-1696 of 11 June 1946 to USNEL.

1. As indicated in enclosure (a) this Laboratory has been authorized to place requisitions for spare parts for the subject equipments direct with the AAF. Inquiry at local AAF depot reveals that these parts must be requisitioned from AMC, Wright Field.

2. In reference (a) this Laboratory submitted a 32-page list of spare parts for the AN/CPN-2 Shoran shore gear and requested that the items listed therein and a similar series of spare parts for the AN/APN-3 airborne Shoran equipments be furnished this laboratory for the purpose of maintaining the Shoran stations used in connection with the installation of the Pacific SOFAR network.

3. These spare parts have not yet been received.

4. Enclosure (A) of reference (b) is a report of an AAF-Bureau of Ships conference held at the Bureau of Ships 10 December 1946 for the purpose of discussing arrangements for the transfer of the AAF Project TORRID to the Navy. As a result of this conference, the Navy's SOFAR project has been greatly accelerated, involving simultaneous survey and

D22.2C  
Serial C-850-106

---

installation procedures at several stations in the Pacific. The AAF has been requested in reference (c) to provide additional Shoran equipments to this Laboratory in order to carry out this program.

5. In view of this situation, and because of the remoteness of most of the SOFAR stations, an adequate stock of spare Shoran parts is considered absolutely essential.

6. It is therefore requested that the items requisitioned in reference (b) be doubled in quantity, that the cost thereof be charged as indicated in enclosure (A), and that this material be shipped at the earliest practicable date to:

The Supply Officer  
U. S. Naval Shipyard, Mare Island  
Vallejo, California  
Electronics Officer (SOFAR Project)

R. BENNETT

I. W. MARTIN  
By direction

cc: (w/c encl (A))  
BuShips (Code 951) (Army Liaison)  
BuShips (Code 910B)  
BuShips (Code 940)  
CG, AAF, Attn. AFDRD  
MINSY (SOFAR Project) (Code 128)



HEADQUARTERS

**CONFIDENTIAL**

AFBEX-CI  
Lt Col Craig/obh/72307  
27 May 46

RECORD SHEET

DECLASSIFIED

760168

5/12/99

AFBEX-CI

29 MAY 1946

**SUBJECT:** Counterintelligence Investigation at Watson Laboratory, Red Bank, New Jersey

DATE: 6/3/46

**TO:** Commanding General, Air Materiel Command, Wright Field Dayton, Ohio (Att: Security Section, Base Services Division)

COMMENT No. 1

Col Millard/LA/6742

1. From discussion with Major Crane, Air Materiel Command Project Officer at the subject laboratory, this office concludes that there is sufficient evidence to warrant a counterintelligence investigation.

2. The report emphasizes that failure to safeguard highly classified projects or the employment of disloyal or affected personnel on these projects could result in disclosures adversely affecting plans for national security.

3. No direct charges are made by Major Crane against any individual at the Watson Laboratory. The basis of his complaint is that there appears to be a "slow-down" and obstruction in the progress of the projects under his jurisdiction. He allows for the possibility that either management personnel or workmen in the shop may be responsible.

4. It is desired that a thorough investigation of conditions at Watson Laboratory be conducted by your command with a view toward resolving the allegations as made and insuring that appropriate safeguards exist for the highly classified projects involved. It is further desired that this headquarters be kept advised of the progress of the investigation.

5. Confirming arrangements made in a discussion of the subject matter at this headquarters on 25 May 1946 between Majors James H. Gardner and George B. Fall of your command and Lieut. Colonels Thomas D. Craig and John R. Fuller and other officers of this headquarters, two special agents of the AAF Counter Intelligence Corps will be assigned on temporary duty to Headquarters, Air Materiel Command, to assist in the prosecution of the requested investigation.

BY COMMAND OF GENERAL SPAATZ:

P 84006  
29 MAY 1946

Central File

1. AFBEX-CI	2. AFACB	3. MILLARD LEWIS	4. [Signature]
[Signature]	[Signature]	Colonel, G. S. C.	
		Executive	
		Asst. Chief of Air Staff-2	

**CONFIDENTIAL**

1906-7

1906-7

VOL 6

EXHIBIT NO. 50422R

EXHIBIT NO. 50422R

<b>DECLASSIFIED</b>		
DECLASSIFICATION REVIEW PROJECT		
<i>NND</i>		760168
RECORD GROUP	ENTRY	BOX
18	1	612

GSA FORM 6801-C (REV. 1-73)

RG 18 (Army Air Forces)

AIR ADJUTANT GENERAL  
 Mail & Records Division  
 Classified Records Section  
 Decimal File  
 1946-47

333.5 Vol 4 to 7

Box No. 612 *WASHNAT'l Archives*

HEADQUARTERS ARMY AIR FORCES

## ROUTING AND RECORD SHEET

TALLY NO.	
FILE NO.	

ECT: Request for Investigation at Watson Laboratory, Red Bank, New Jersey

AC/AS-2

DATE 20 May 1946

Deputy Chief of Air Staff for Research and Development

COMMENT No. 1  
Col Wilson/fj/6742

1. From discussion with Major Crane, Air Materiel Command Project Officer at the subject laboratory, this office concludes that there is sufficient evidence of disaffection at Watson to warrant an investigation by A-2.
2. The Watson Laboratory is working upon at least one Top Secret project and upon a number of secret projects. Failure on their part to safeguard their classified material properly — or the presence of disloyal or disaffected persons on those projects — could lead to unfortunate disclosure affecting plans for national security.
3. Whereas no direct charges can be leveled at any individual at Watson, it is believed that sufficient "smoke" has developed to draw the attention of A-2. This matter is called to your attention for whatever action you deem advisable.

*Curtis E. Lemay*  
for  
CURTIS E. LEMAY,  
Major General, U. S. Army,  
Deputy Chief of Air Staff for  
Research and Development

OFFICERS

~~CONFIDENTIAL~~PAGE 1

3-1109, AF (REV 20 MAY 44)

XXXXXXXXXXXXXXXXXXXX  
MATERIEL

TSELT/TCR/gen

18 June 1946

TSELT

MEMORANDUM FOR: Major General Curtis LeMay

SUBJECT: Relief of Major R. T. Crane as Project Officer for  
MOGUL and TORRID

1. In compliance with General Spaatz' directive, I contacted Dr. M. Ewing at Columbia University on 15 June 1946 and discussed the proposed relief of Major R. T. Crane as project officer on projects MOGUL and TORRID.

2. Dr. Ewing was exceedingly pleasant and agreed to the relief of Major Crane, asking only that it be done in such a way as to cause as little embarrassment to any of the parties concerned as possible. I advised him that the matter would be handled diplomatically.

3. I then discussed with Dr. Ewing the subject of a successor to Major Crane and suggested to him that Colonel Marcellus Duffy, a Regular Army officer and well-qualified on meteorological research and development work, might be made available for this duty. Dr. Ewing advised that he believed that he could work well with Colonel Duffy if he is assigned to this work. It was further agreed that as soon as a project officer is finally selected, a conference would be held with Dr. Ewing and the new project officer and Colonel Maier and Colonel Graul in order that there will be a clear understanding as to the objectives to be accomplished.

TOM C. RIVES  
Brig. General, USA  
Chief, Electronic Subdivision  
Engineering Division

*Noted by General Spaatz.*

Ltr from 4149th AAFBU, Olmsted Fld, Middletown, Pa., 8 July 46, Subj: Waiver to Clearance Restrictions in New York Control Area.

AFCOP-0

2d Ind

21 8 AUG 1946

Capt Barry/hw/71475  
Wrtn 15 Aug 46

Hq, AAF, Washington 25, D. C.

THRU: Commanding General, Air Materiel Command, Wright Field, Dayton, Ohio.

TO: Commanding Officer, 4149th AAF Base Unit, Electronics Experimental Squadron, Olmsted Field, Middletown, Pennsylvania.

The request for waiver to the restrictions on flight in the New York area for the 4149th AAF Base Unit is not favorably considered.

BY COMMAND OF GENERAL SPAATZ:

SIGNED,

2 Incls  
n/c

G. W. CHAUNCEY  
Major General, U. S. Army  
Deputy Chief of Air Staff

1946 AUG 23 PM 1 23

AIR ADJUTANT GENERAL

AFCOP-0

AFCOP

AFACC

HEADQUARTERS, ARMY AIR FORCES  
OFFICE OF THE COMMANDING GENERAL

DATE

6/12

MEMORANDUM FOR:

Le May

See me re this

6-12-46

Gen Spaatz says to relieve  
Maj. Crane. To have Tom  
Rives do it personally  
& to talk it over with  
Dr. Ewing so Ewing will  
be happy. (DUC)

Duffy =

CARL SPAATZ

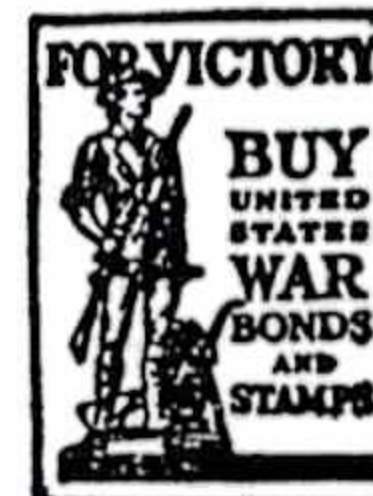
Commanding General, Army Air Forces



IN REPLY REFER TO:

[REDACTED]

HEADQUARTERS, ARMY AIR FORCES  
WASHINGTON



11 June 1946

MEMORANDUM FOR GENERAL CARL SPAATZ:

1. In connection with Dr. Ewing's reported difficulties with projects MOGUL and TORRID, Colonel Canterbury of my staff and Colonel Doubleday of AC/AS-4 have completed a thorough investigation of the technical and operational aspects of the projects. The following key people involved in the project were interviewed:

Dr. M. Ewing, scientist and technical supervisor  
Dr. A. P. Crary, assistant to Dr. Ewing  
Major R. T. Crane, project officer, Watson Laboratories, AMC  
Dr. Paul Dove, civilian engineer of project, Watson Laboratories, AMC.  
Colonel Don Graul, Commanding Officer, Watson Laboratories, AMC  
Colonel O. C. Maier, Chief of Plans, Electronics Subdivision, AMC  
Colonel J. K. DeArmond, Deputy Chief Electronics Subdivision, AMC  
Lt Colonel T. D. Craig, OIC Counter-Intelligence, AC/AS-2, AAF

2. The following is a summary of findings:

a. Technical Progress

The progress in most instances has been on schedule. The projects have, until now, carried 1-B priority (has this week been raised to 1-A). The rail strike injected a four-day delay in certain parts delivery. The major delays, have, almost without exception, been occasioned by lack of proper planning and indecision on the part of Dr. Ewing and Major Crane, the project officer. Major Crane, "by order of General Spaatz" has confused depot work on the airplanes by ordering last-minute and unforeseen changes--this is obviously intolerable with depots now pushed to the limit by manpower problems and re-adjustment.

b. Administration

The administration on the part of the project officer has been entirely unsatisfactory. Major Crane has stated time and again to various people and agencies that he is "General Spaatz' man" and this, in his words, produces "divided loyalty". He has a penchant

7 Counter Intelligence. A.A.F.

The following was dictated by Robert A. Starr who for the past week has been assigned to the Mogul Project at Redbank for the purpose of checking security of the project. Major Crane had requested that this investigation be made.

"No sabotage of an intelligence nature has been discovered and the security of Redbank appears excellent. However, there is another type of sabotage which is caused chiefly by confusion of opinions as to WHO is responsible for the project.

"Major Crane appears to have run into a great many difficulties in securing fullest cooperation. Most of the details are insignificant in themselves, but have accumulated to the point where they are presenting a serious handicap to the development of this project.

"Major Crane had one letter of instructions signed "By Command of General Spaatz" and one officer of field grade said that this letter meant nothing because the Watson Laboratories (in the midst of which is Dr. Ewing's project) had no connection with and do not work for General Spaatz.

"Of course, it must be understood that I was not sent to make an administrative investigation, but because the security angle is so excellent and the administration so poor, I feel it necessary to make this report."

Mr. Starr went on to say that unless something is set up for administrative control of this project, he feels that many of the scientists connected with this work will resign - as some have already done. Dr. Ewing is becoming very dissatisfied himself. Major Crane is doing an excellent job, according to Starr, but is hampered by the fact that he can act and request with no authority to back him up. He is at present under administrative control of the Post Commander (who will not recognize him) and is getting excellent cooperation from the Post Security Officer. Starr went on to say that there is nothing definite on which to put your finger, just underlying current of jealousy and sometimes seemingly malicious contradictions of orders.

Ewing to  
Spaatz

Mr. P. Cray (Rev. from Ewing) petty(?) grievances

File: Mogul - Torrid  
AMC

[REDACTED]

for "cutting across channels" and in each instance using General Spaatz' name as authority--this is evidenced by numerous visits to Dep Ch/AS, R&D, AC/AS-2 and AC/AS-4 with no knowledge of his Commanding Officer. No blame should attach to AMC nor to the Watson Laboratories as it is normal and proper for them to place confidence in their project officers and to grant them considerable liberty of action.

To quote Dr. Ewing, "I am not a good manager; I am not a good planner--just a scientist who knows well just one little corner of science." This is, we believe, quite true, and the more reason why a tactful and intelligent project officer is needed.

There is every evidence to indicate that the AMC is leaning over backwards to give Dr. Ewing every possible help in his project. In the discussion it was brought out that Dr. Ewing and his colleagues had few if any specific complaints of non-cooperation--their complaints were of the most general form, such as Dr. Ewing's statements that, "most of the trouble is part and parcel of the Civil Service way of doing things" and that in his talk with General Spaatz, "lack of support was not the condition that he desired to report".

The AMC is fully appreciative of the high priority of the project, and following the request of Dr. Ewing, procured Major Crane from another command to act as project officer even though other tried and proven officers in AMC were available. Dr. Ewing agreed that could he have foreseen the organization and detailed work his project would necessitate, he would have been glad to confer with AMC on a more suitable project officer. Major Crane has an Efficiency Index of 35.07, only seven-hundredths of one point above the "Must go" index ("May go" is 44.00).

AMC and Watson Laboratories fully realize that in such a research project complete planning cannot be done, but that except for details, a phase-system master-plan can and must be made and adhered to.

c. Security

These projects have been classified TOP SECRET. Clearance request for top secret information in the case of Major Crane was submitted on or about 19 March. Information from Counter-Intelligence, AC/AS-2 indicates that the Federal Bureau of Investigation has rendered an unfavorable loyalty check in the case of Major Crane due to a possible connection with an espionage agent of a foreign country. This investigation may drag on for a protracted period. For reasons unknown, Major Crane made a direct request to A-2 that a security investigation be made at Watson Laboratories--this check indicates that the security is excellent.

3. Recommendations

It is the considered opinion of those officers of Army Air Forces and Air Materiel Command, who have conducted this investigation that the majority of the trouble encountered to date has been due to an incompetent project officer. It is therefore recommended that the Air Materiel Command be directed to relieve Major R. T. Crane from this project and appoint a suitable officer in his stead.

*Curtis E. LeMay*

CURTIS E. LEMAY

Major General, U.S.A.

Deputy Chief of Air Staff for  
Research and Development

1 cc for CIC, AC/AS-2

2 cc for AC/AS-4 (Col Doubleday)

11 June 1946

MEMORANDUM FOR GENERAL CARL SPAATZ:

1. In connection with Dr. Ewing's reported difficulties with projects MOGUL and TORRID, Colonel Canterbury of my staff and Colonel Doubleday of AC/AS-4 have completed a thorough investigation of the technical and operational aspects of the projects. The following key people involved in the project were interviewed:

- Dr. M. Ewing, scientist and technical supervisor
- Dr. A. P. Crary, assistant to Dr. Ewing
- Major R. T. Crane, project officer, Watson Laboratories, AMC
- Dr. Paul Dove, civilian engineer of project, Watson Laboratories, AMC.
- Colonel Don Graul, Commanding Officer, Watson Laboratories, AMC
- Colonel O. C. Maier, Chief of Plans, Electronics Subdivision, AMC
- Colonel J. K. DeArmond, Deputy Chief Electronics Subdivision, AMC
- Lt Colonel T. D. Craig, OIC Counter-Intelligence, AC/AS-2, AAF

2. The following is a summary of findings:

a. Technical Progress

The progress in most instances has been on schedule. The projects have, until now, carried 1-B priority (has this week been raised to 1-A). The rail strike injected a four-day delay in certain parts delivery. The major delays, have, almost without exception, been occasioned by lack of proper planning and indecision on the part of Dr. Ewing and Major Crane, the project officer. Major Crane, "by order of General Spaatz" has confused depot work on the airplanes by ordering last-minute and unforeseen changes--this is obviously intolerable with depots now pushed to the limit by manpower problems and re-adjustment.

b. Administration

The administration on the part of the project officer has been entirely unsatisfactory. Major Crane has stated time and again to various people and agencies that he is "General Spaatz' man" and this, in his words, produces "divided loyalty". He has a penchant

OFFICE SYMBOL	1. AFDRD	2.	3.	4.	5.
GRADE AND SURNAME OF COORDINATING OFFICERS	<i>Colonel Canterbury</i>				
	<i>Colonel Doubleday</i>				



for "cutting across channels" and in each instance using General Spats' name as authority--this is evidenced by numerous visits to Top Ch/AS, SAC, AC/AS-2 and AC/AS-4 with no knowledge of his Commanding Officer. No blame should attach to ALC nor to the Watson Laboratories as it is normal and proper for them to place confidence in their project officers and to grant them considerable liberty of action.

To quote Dr. Swing, "I am not a good manager; I am not a good planner--just a scientist who knows well just one little corner of science." This is, we believe, quite true, and the more reason why a tactful and intelligent project officer is needed.

There is every evidence to indicate that the ALC is leaning over backwards to give Dr. Swing every possible help in his project. In the discussion it was brought out that Dr. Swing and his colleagues had few if any specific complaints of non-cooperation--their complaints were of the most general form, such as Dr. Swing's statements that, "most of the trouble is part and parcel of the Civil Service way of doing things" and that in his talk with General Spats, "lack of support was not the condition that he desired to report".

The ALC is fully appreciative of the high priority of the project, and following the request of Dr. Swing, procured Major Crane from another command to act as project officer even though other tried and proven officers in ALC were available. Dr. Swing agreed that could he have foreseen the organization and detailed work his project would necessitate, he would have been glad to confer with ALC on a more suitable project officer. Major Crane has an efficiency index of 35.07, only seven-hundredths of one point above the "just go" index ("May go" is 44.40).

ALC and Watson Laboratories fully realize that in such a research project complete planning cannot be done, but that except for details, a phase-system master-plan can and must be made and adhered to.

c. Security

These projects have been classified TOP SECRET. Clearance request for top secret information in the case of Major Crane was submitted on or about 19 March. Information from Counter-Intelligence, AC/AS-2 indicated that the Federal Bureau of Investigation has rendered an unfavorable loyalty check in the case of Major Crane due to a possible connection with an espionage agent of a foreign country. This investigation may drag on for a protracted period. For reasons unknown, Major Crane made a direct request to A-2 that a security investigation be made at Watson Laboratories--this check indicates that the security is excellent.

OFFICE SYMBOL	1.	2.	3.	4.	5.
GRADE AND SURNAME OF COORDINATING OFFICERS					





3. Recommendations

It is the considered opinion of those officers of Army Air Forces and Air Materiel Command, who have conducted this investigation that the majority of the trouble encountered to date has been due to an incompetent project officer. It is therefore recommended that the Air Materiel Command be directed to relieve Major R. T. Crane from this project and appoint a suitable officer in his stead.

CURTIS E. LEMAY  
Major General, U.S.A.  
Deputy Chief of Air Staff for  
Research and Development

1 cc for CIC, AC/AS-2  
2 cc for AC/AS-4 (Col. Doubleday)

OFFICE SYMBOL	1.	2.	3.	4.	5.
GRADE AND SURNAME OF COORDINATING OFFICERS			3		

11 June 1946

MEMORANDUM FOR GENERAL CARL SPAATZ:

1. In connection with Dr. Ewing's reported difficulties with projects MOGUL and TORRID, Colonel Canterbury of my staff and Colonel Doubleday of AC/AS-4 have completed a thorough investigation of the technical and operational aspects of the projects. The following key people involved in the project were interviewed:

Dr. M. Ewing, scientist and technical supervisor  
Dr. A. P. Crary, assistant to Dr. Ewing  
Major R. T. Crane, project officer, Watson Laboratories, AMC  
Dr. Paul Dove, civilian engineer of project, Watson Laboratories, AMC.  
Colonel Don Graul, Commanding Officer, Watson Laboratories, AMC  
Colonel O. C. Maier, Chief of Plans, Electronics Subdivision, AMC  
Colonel J. K. Dearmond, Deputy Chief Electronics Subdivision, AMC  
Lt Colonel T. D. Craig, OIC Counter-Intelligence, AC/AS-2, AAF

2. The following is a summary of findings:

a. Technical Progress

The progress in most instances has been on schedule. The projects have, until now, carried 1-B priority (has this week been raised to 1-A). The rail strike injected a four-day delay in certain parts delivery. The major delays, have, almost without exception, been occasioned by lack of proper planning and indecision on the part of Dr. Ewing and Major Crane, the project officer. Major Crane, "by order of General Spaatz" has confused depot work on the airplanes by ordering last-minute and unforeseen changes--this is obviously intolerable with depots now pushed to the limit by manpower problems and re-adjustment.

b. Administration

The administration on the part of the project officer has been entirely unsatisfactory. Major Crane has stated time and again to various people and agencies that he is "General Spaatz' man" and this, in his words, produces "divided loyalty". He has a penchant

for "cutting across channels" and in each instance using General Spaatz' name as authority--this is evidenced by numerous visits to Dep Ch/AS, R&D, AC/AS-2 and AC/AS-4 with no knowledge of his Commanding Officer. No blame should attach to AMC nor to the Watson Laboratories as it is normal and proper for them to place confidence in their project officers and to grant them considerable liberty of action.

To quote Dr. Ewing, "I am not a good manager; I am not a good planner--just a scientist who knows well just one little corner of science." This is, we believe, quite true, and the more reason why a tactful and intelligent project officer is needed.

There is every evidence to indicate that the AMC is leaning over backwards to give Dr. Ewing every possible help in his project. In the discussion it was brought out that Dr. Ewing and his colleagues had few if any specific complaints of non-cooperation--their complaints were of the most general form, such as Dr. Ewing's statements that, "most of the trouble is part and parcel of the Civil Service way of doing things" and that in his talk with General Spaatz, "lack of support was not the condition that he desired to report".

The AMC is fully appreciative of the high priority of the project, and following the request of Dr. Ewing, procured Major Crane from another command to act as project officer even though other tried and proven officers in AMC were available. Dr. Ewing agreed that could he have foreseen the organization and detailed work his project would necessitate, he would have been glad to confer with AMC on a more suitable project officer. Major Crane has an Efficiency Index of 35.07, only seven-hundredths of one point above the "Must go" index ("May go" is 44.00).

AMC and Watson Laboratories fully realize that in such a research project complete planning cannot be done, but that except for details, a phase-system master-plan can and must be made and adhered to.

#### c. Security

These projects have been classified TOP SECRET. Clearance request for top secret information in the case of Major Crane was submitted on or about 19 March. Information from Counter-Intelligence, AC/AS-2 indicates that the Federal Bureau of Investigation has rendered an unfavorable loyalty check in the case of Major Crane due to a possible connection with an espionage agent of a foreign country. This investigation may drag on for a protracted period. For reasons unknown, Major Crane made a direct request to A-2 that a security investigation be made at Watson Laboratories--this check indicates that the security is excellent.

### 3. Recommendations

It is the considered opinion of those officers of Army Air Forces and Air Materiel Command, who have conducted this investigation that the majority of the trouble encountered to date has been due to an incompetent project officer. It is therefore recommended that the Air Materiel Command be directed to relieve Major R. T. Crane from this project and appoint a suitable officer in his stead.

CURTIS E. LEMAY  
Major General, U.S.A.  
Deputy Chief of Air Staff for  
Research and Development

1 cc for CIC, AC/AS-2  
2 cc for AC/AS-4 (Col Doubleday)

11 June 1946

MEMORANDUM FOR GENERAL CARL SPAATZ:

1. In connection with Dr. Ewing's reported difficulties with projects HOCUL and TORPED, Colonel Canterbury of my staff and Colonel Doubleday of AC/AS-4 have completed a thorough investigation of the technical and operational aspects of the projects. The following key people involved in the project were interviewed:

Dr. M. Ewing, scientist and technical supervisor  
Dr. A. P. Crary, assistant to Dr. Ewing  
Major R. T. Crane, project officer, Watson Laboratories, AMC  
Dr. Paul Dove, civilian engineer of project, Watson Laboratories, AMC.  
Colonel Don Graul, Commanding Officer, Watson Laboratories, AMC  
Colonel D. C. Maier, Chief of Plans, Electronics Subdivision, AMC  
Colonel J. K. Dearmond, Deputy Chief Electronics Subdivision, AMC  
Lt Colonel T. D. Craig, OIC Counter-Intelligence, AC/AS-2, AAF

2. The following is a summary of findings:

a. Technical Progress

The progress in most instances has been on schedule. The projects have, until now, carried 1-B priority (has this week been raised to 1-A). The rail strike injected a four-day delay in certain parts delivery. The major delays, have, almost without exception, been occasioned by lack of proper planning and indecision on the part of Dr. Ewing and Major Crane, the project officer. Major Crane, "by order of General Spaatz" has confused depot work on the airplanes by ordering last-minute and unforeseen changes--this is obviously intolerable with depots now pushed to the limit by manpower problems and re-adjustment.

b. Administration

The administration on the part of the project officer has been entirely unsatisfactory. Major Crane has stated time and again to various people and agencies that he is "General Spaatz' man" and this, in his words, produces "divided loyalty". He has a penchant

[REDACTED]

[REDACTED]

for "cutting across channels" and in each instance using General Spaatz' name as authority--this is evidenced by numerous visits to Dep Ch/AS, R&D, AC/AS-2 and AC/AS-4 with no knowledge of his Commanding Officer. No blame should attach to AMC nor to the Watson Laboratories as it is normal and proper for them to place confidence in their project officers and to grant them considerable liberty of action.

To quote Dr. Ewing, "I am not a good manager; I am not a good planner--just a scientist who knows well just one little corner of science." This is, we believe, quite true, and the more reason why a tactful and intelligent project officer is needed.

There is every evidence to indicate that the AMC is leaning over backwards to give Dr. Ewing every possible help in his project. In the discussion it was brought out that Dr. Ewing and his colleagues had few if any specific complaints of non-cooperation--their complaints were of the most general form, such as Dr. Ewing's statements that, "most of the trouble is part and parcel of the Civil Service way of doing things" and that in his talk with General Spaatz, "lack of support was not the condition that he desired to report".

The AMC is fully appreciative of the high priority of the project, and following the request of Dr. Ewing, procured Major Crane from another command to act as project officer even though other tried and proven officers in AMC were available. Dr. Ewing agreed that could he have foreseen the organization and detailed work his project would necessitate, he would have been glad to confer with AMC on a more suitable project officer. Major Crane has an Efficiency Index of 35.07, only seven-hundredths of one point above the "Must go" index ("May go" is 44.00).

AMC and Watson Laboratories fully realize that in such a research project complete planning cannot be done, but that except for details, a phase-system master-plan can and must be made and adhered to.

#### c. Security

These projects have been classified TOP SECRET. Clearance request for top secret information in the case of Major Crane was submitted on or abt 19 March. Information from Counter-Intelligence, AC/AS-2 indicates that the Federal Bureau of Investigation has rendered an unfavorable loyalty check in the case of Major Crane due to a possible connection with an espionage agent of a foreign country. This investigation may drag on for a protracted period. For reasons unknown, Major Crane made a direct request to A-2 that a security investigation be made at Watson Laboratories--this check indicates that the security is excellent.



3. Recommendations

It is the considered opinion of those officers of Army Air Forces and Air Materiel Command, who have conducted this investigation that the majority of the trouble encountered to date has been due to an incompetent project officer. It is therefore recommended that the Air Materiel Command be directed to relieve Major R. T. Crane from this project and appoint a suitable officer in his stead.

CURTIS E. LOWMY  
Major General, U.S.A.  
Deputy Chief of Air Staff for  
Research and Development

1 cc for CIC, AC/AS-2  
2 cc for AC/AS-4, (Col Doubleday)



AIR MATERIEL COMMAND  
WATSON LABORATORIES  
Red Bank, New Jersey

188-5

ACT/mw

WLEAT

SUBJECT: Research Operations in Alaska

TO: Commanding General  
Air Materiel Command  
Wright Field  
Dayton 2, Ohio  
ATTN: TSELT

1. Plans for research on Project "Logul," E. O. 188-11, priority 1A, include determination of compressional wave velocity in the upper atmosphere in regions of high latitude. This information is vital to the completion of the project and as far as is known, no previous work has been done in this field. These Laboratories are now planning to begin the first phase of this research in Alaska between 15 October and 15 December 1947. Completion of this first phase will require about six weeks at the test site.


2. The method of determining acoustic velocity fields in the upper atmosphere will be similar to that which has been done off the New Jersey coast and in New Mexico throughout this year. Explosives are set off at or near the earth's surface and the resulting compressional waves refracted through the upper atmosphere are recorded at sites up to 300 miles distant. One method consists of cropping airburst bombs from airplanes flying a course in various directions from the recording sites, 50 to 300 miles away. Another method involves firing charges of explosives on the ground at fixed distances from the recording sites. Whichever method is used will depend upon available conditions and the granting of clearances to do the work. Both methods have been successfully used for over a year. Techniques are well established and the engineering personnel are well experienced on all phases of the operations.

3. A previous survey of facilities in Alaska by personnel of these Laboratories indicates that all requirements may be fulfilled at Ladd Field, Fairbanks. The following requirements are necessary to conduct either or both types of tests:

a. Facilities for landing and servicing a C-54 airplane and either a B-17 or a B-29 airplane.

b. Housing and messing facilities for three civilian technicians from the Watson Laboratories and the military aircraft crews for a period of six weeks.

U-37827



Ltr, WLAMC, to CG, AMC, Subj: Research Operations in Alaska

9 Sep 1947

c. Heated and lighted storage and workshop space for scientific equipment (approximately 400 sq. ft.).

d. Upper air meteorological data from the surface to maximum obtainable altitudes for establishing test conditions and evaluating test data.

e. Ground vehicles for transporting test crew and up to one ton of test equipment to recording stations, up to 50 miles from the base.

f. Storage of explosives, both and/or TNT demolition charges, is required conveniently available to the base and aircraft.

g. Six thousand (6000) pounds of tetratol (2-1/2 lb. demolition charges) or one hundred (100) each 100-lb. to 500-lb. bombs are required to carry out the experimental work.

4. It is requested that the Watson Laboratories be granted permission to conduct the above outlined tests within the Territory of Alaska, preferably in the vicinity of Fairbanks, beginning between the dates of 15 October and 15 December 1947 for a period of six weeks. In addition, it is requested that the following clearances and authorities be established in connection with the carrying out of this work.

a. Permission to install and operate recording stations at convenient points between Fairbanks and Point Barrow.


b. Permission to drop airburst bombs over at least a 150 mile straight-line course from Fairbanks.

c. If airburst bombing is not possible or proves unsatisfactory, it will be necessary to obtain permission to detonate up to 500 lbs. of TNT on the ground within 50 miles of the operating base. A vehicle will be required for carrying up to 1000 lbs. of explosives, and the assistance of two Corps of Engineers or Ordnance Department enlisted personnel will be required in firing the charges.

d. Authority is required for these Laboratories to draw upon any available supply of explosives in Alaska, requirements as indicated in paragraph 3 (g). If explosives are unavailable in Alaska, these Laboratories will make arrangements for obtaining explosives within the United States and transporting them to the point of the test.

5. If overall approval is granted to conduct this work as outlined, it is requested that these Laboratories be notified immediately, even though detailed arrangements are incomplete, so that aircraft clearances and personnel orders may be initiated.

/s/ W. H. Congdon, Lt. Col., AC

  
D. P. GAUL  
Colonel, Air Corps  
Commanding

C

0

P  
y

[REDACTED]

Basic ltr WLAMC, 9 Sep 47, to CG AMC, subj: "Research Oprs in Alaska."

1st Ind TSELT(TSELO)/JGR/ia

Hq AMC, Wright Field, Dayton, Ohio. 10 Sept 47

To: Commanding General, Army Air Forces, Washington 25, D. C.  
ATTN: AC/AS-4

1. The proposed operation outlined in the basic correspondence is concurred in by this command.

2. In view of the high priority carried by this project, request that necessary action be taken to have the Alaskan Department provide the necessary facilities.

FOR THE COMMANDING GENERAL:

/s/ Tom C. Rives

TOM C. RIVES, Brig Gen, USA  
Chief, Electronic Subdivision  
Engineering Division

C  
O  
P  
Y

WAR DEPARTMENT  
STAFF MESSAGE CENTER  
OUTGOING CLASSIFIED MESSAGE

PARAPHRASE NOT REQUIRED. HANDLE AS SECRET CORRESPONDENCE  
PER PARAS 51i and 60a (4) AR 380-5

Hq U.S.A.F., AFACD, Wash 25,  
D.C. Mr Roddy 2100

30 September 1947

Alaskan Air Command Fort Richardson Alaska

INFORMATION:

CG Alaska Fort Richardson Alaska

Nr: WARX 87413

From AFACD signed CSAP

Barrow facilities in your AX 17299 of 27 September 1947  
is subject. Will require 100 square feet housing and oper-  
ating space for instruments plus rations and quarters for  
2 men for 3 weeks. Expect to base aircraft at Ladd Field.  
Food can be flown from Ladd by project aircraft if necessary.

End  
AF 371

NOTE: AX-17299 is CM IN 5207 (27 Sept 47)

ORIGINATOR: AF

CM OUT 87413

(Oct 47)

DTG 010025Z

fg

AF  
DISA  
INFO  
DRE  
DRD  
ACC  
COP  
ACB

COPY NO. 4

WAR DEPARTMENT  
CLASSIFIED MESSAGE CENTER  
INCOMING CLASSIFIED MESSAGE

*Mogul*

SECRET "IVI"  
PRIORITY

PARAPHRASE NOT REQUIRED HANDLE AS SECRET CORRESPONDENCE  
PER PARAS 511 and 60a (4) AR 380-5

From: Alaskan Air Command, Ft. Richardson, Alaska  
To: COMGENAF for Deputy Chief of Air Staff R&D  
Info: CINCAL, Ft. Richardson, Alaska  
Nr: AX 17299 27 September 1947

Reference letter Air Material Command Watson Laboratories subject research operations in Alaska dated 9 Sep 1947 and your second indorsement thereto. AAPLN 4257 before Navy clearance can be obtained for the Barrow installation required is information as to how many personnel to be accommodated for how long and how much equipment will be used. Barrow facilities extremely limited.

End.

AF

DIST

ACTION

DRD

INFO

ACC

COP

ACB

ACTION: AF

CM IN 5207 ( 28 Sep 47 ) DTG 270316Z sej

SECRET

**ACTION COPY**

3

COPY NO.

THE MAKING OF AN EXACT COPY OF THIS MESSAGE IS FORBIDDEN

[REDACTED]

w/Mr. Roddy/pmo/73481

AFDRE-3

w/11 Sep 47

Ltr fr AEC Watson Laboratories, Red Bank, N. J., subj: "Research Operations in Alaska, 9 Sep 47, w/1st Ind.

2nd Ind.

Hq, Army Air Forces, Washington 25, D. C.

SEP 12 1947

TO: Commanding General, Alaskan Air Command, Fort Richardson, Alaska

1. This Headquarters concurs in the proposed Alaskan operation outlined in the basic correspondence.

2. It is requested that the Alaskan Air Command obtain the concurrence of the Alaska Department for the complete operation and of the local Navy Commander for the location of a listening station at Point Barrow.

3. This project was initiated personally by General Spaatz and is considered very important to the National Defense. Expedited action is therefore requested.

BY COMMAND OF GENERAL SPAATZ:

CURTIS E. LEMAY  
Major General, U. S. Army  
Deputy Chief of Air Staff for  
Research and Development

AFDRE-3

AFDRE

AFDRD

[REDACTED]

COPY FOR AFDRD

AIR MATERIEL COMMAND  
WATSON LABORATORIES  
Red Bank, New Jersey

188-5

ACT/DM

WLEAT

SUBJECT: Research Operations in Alaska

TO: Commanding General  
Air Materiel Command  
Wright Field  
Dayton 2, Ohio  
ATTN: TSELT

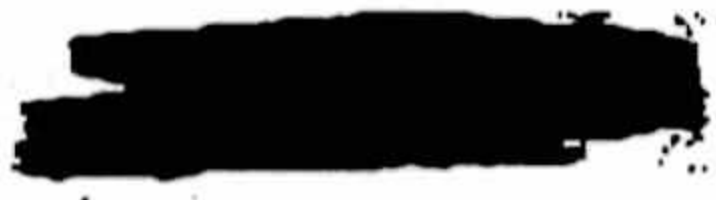
1. Plans for research on Project "Logul," E. O. 188-11, priority 1A, include determination of compressional wave velocity in the upper atmosphere in regions of high latitude. This information is vital to the completion of the project and as far as is known, no previous work has been done in this field. These Laboratories are now planning to begin the first phase of this research in Alaska between 15 October and 15 December 1947. Completion of this first phase will require about six weeks at the test site.

2. The method of determining acoustic velocity fields in the upper atmosphere will be similar to that which has been done off the New Jersey coast and in New Mexico throughout this year. Explosives are set off at or near the earth's surface and the resulting compressional waves refracted through the upper atmosphere are recorded at sites up to 300 miles distant. One method consists of cropping airburst bombs from airplanes flying a course in various directions from the recording sites, 50 to 300 miles away. Another method involves firing charges of explosives on the ground at fixed distances from the recording sites. Whichever method is used will depend upon available conditions and the granting of clearances to do the work. Both methods have been successfully used for over a year. Techniques are well established and the engineering personnel are well experienced on all phases of the operations.

3. A previous survey of facilities in Alaska by personnel of these Laboratories indicates that all requirements may be fulfilled at Ladd Field, Fairbanks. The following requirements are necessary to conduct either or both types of tests:

a. Facilities for landing and servicing a C-54 airplane and either a B-17 or a B-29 airplane.

b. Housing and messing facilities for three civilian technicians from the Watson Laboratories and the military aircraft crews for a period of six weeks.



Ltr, WLAC, to CG, AC, Subj: Research Operations in Alaska 9 Sep 1947

c. Heated and lighted storage and workshop space for scientific equipment (approximately 400 sq. ft.).

d. Upper air meteorological data from the surface to maximum obtainable altitudes for establishing test conditions and evaluating test data.

e. Ground vehicles for transporting test crew and up to one ton of test equipment to recording stations, up to 50 miles from the base.

f. Storage of explosives, bombs and/or TNT demolition charges, is required conveniently available to the base and aircraft.

g. Six thousand (6000) pounds of tetratol (2-1/2 lb. demolition charges) or one hundred (100) each 100-lb. to 500-lb. bombs are required to carry out the experimental work.

4. It is requested that the Watson Laboratories be granted permission to conduct the above outlined tests within the Territory of Alaska, preferably in the vicinity of Fairbanks, beginning between the dates of 15 October and 15 December 1947 for a period of six weeks. In addition, it is requested that the following clearances and authorities be established in connection with the carrying out of this work.

a. Permission to install and operate recording stations at convenient points between Fairbanks and Point Barrow.


b. Permission to drop airburst bombs over at least a 150 mile straight-line course from Fairbanks.

c. If airburst bombing is not possible or proves unsatisfactory, it will be necessary to obtain permission to detonate up to 500 lbs. of TNT on the ground within 50 miles of the operating base. A vehicle will be required for carrying up to 1000 lbs. of explosives, and the assistance of two Corps of Engineers or Ordnance Department enlisted personnel will be required in firing the charges.

d. Authority is required for these Laboratories to draw upon any available supply of explosives in Alaska, requirements as indicated in paragraph 3 (g). If explosives are unavailable in Alaska, these Laboratories will make arrangements for obtaining explosives within the United States and transporting them to the point of the test.

5. If overall approval is granted to conduct this work as outlined, it is requested that these Laboratories be notified immediately, even though detailed arrangements are incomplete, so that aircraft clearances and personnel orders may be initiated.

/s/ W. H. Congdon, Lt. Col., AC

  
D. P. GRAUL  
Colonel, Air Corps  
Commanding

C  
O  
P  
Y



Research Library  
Phillips Lab

UNITED STATES AIR FORCE  
CAMBRIDGE RESEARCH CENTER  
DOCUMENTS UNIT  
GEOPHYSICS

*copy*

r Force Camb. Res. Ctr. Geophys. Res. Dir.]  
bridge Field Station, Air Materiel Cmd  
VIEW OF AIR MATERIEL COMMAND GEOPHYSI-  
ACTIVITIES by D.N. Yates, and Staff.  
Feb. 1949.  
SECRET

DECLASSIFIED AT 12 YEAR  
INTERVALS NOT AUTOMATICALLY  
DECLASSIFIED. DOD DIR. 5209.10

DOWNGRADE TO:  
SECRET ON \_\_\_\_\_  
CONFIDENTIAL ON 31 Dec 61  
DECLASSIFY ON 31 Dec 79  
CLASSIFIED BY \_\_\_\_\_

~~EXCLUDED FROM GENERAL DECLASSIFICATION SCHEDULE~~

*10 Dec 79*

~~SECRET~~

~~CONFIDENTIAL~~

47

copy 36

Review of Air Materiel Command Geophysical Activities by  
Brigadier General D. N. Yates, and Staff, of the Air Weather Service

Cambridge Field Station  
Air Materiel Command  
Cambridge 39, Massachusetts

~~23~~

PROGRAM

10 Feb. 1949

- I. Introduction
- II. Tour of Geophysical Research Laboratories
  - a. Review of facilities
  - b. Project presentations
- III. Discussion

DOWNGRADED AT 12 YEAR  
INTERVALS; NOT AUTOMATICALLY  
DECLASSIFIED. DOD DIR. 5200.10

~~EXCLUDED FROM GENERAL DECLASSIFICATION SCHEDULE~~

~~SECRET~~

~~CONFIDENTIAL~~

I. TERRESTRIAL SCIENCES LABORATORY

Chief: Dr. James A. Peoples, Jr.

1. Project title: Acoustic Sounding of the Atmosphere

Project scientists: Dr. J. A. Peoples, Jr., Dr. Norman Haskell

Summary of In-Laboratory work:

When large explosions have occurred, it has been observed that the sound was heard locally, say up to 25 miles, and also at distances of 100 to 200 miles, but that nothing was heard at intermediate distances. This phenomenon can only be explained by assuming that the sound is refracted into the atmosphere over the intermediate observers and then is bent back down to the more distant areas. For this to occur the velocity of propagation must first decrease with altitude and then increase again to a value at least as large as ground velocity. This is due to a decrease of temperature up to the tropopause followed by an increase in temperature above that level. Winds also have an appreciable effect which can be determined from asymmetrical propagation.

Up to about 1946 most data on this phenomenon had been obtained by taking polls after accidental explosions had occurred. Zones of audibility were mapped out and general conclusions then drawn. Very little systematic work was done in which accurate travel times and other factors were obtained. Beginning in 1946 at these laboratories, a systematic study of these propagation anomalies were started. Sound ranging detectors were set up in arrays, so that the direction and time of arrival of compressional waves could be determined. Explosions were set off on or near the ground at ranges varying from 25 to 200 miles. Data has been taken which has resulted in the indirect determination of the temperature (sound velocity) structure of the atmosphere up to the stratospheric level. East-west propagation was first studied off the New Jersey coast. These tests show there is little or no regular diurnal variation, and that some annual variation in the temperature structure exists. High level winds are shown to be generally easterly. Additional tests have been made in New Mexico to determine the diurnal and annual variations of the temperature structure at that latitude. Some accurate observations of wind velocity are indicated by observations taken along a north-south line as well as an east-west line. Winter observations have been taken in the vicinity of Fairbanks, Alaska for information at very high latitudes. Observations have been taken near the Panama Canal Zone for additional information in the tropics.

The sounds produced by rockets launched at Alamogordo have been recorded with acoustic detector arrays located on the ground near the rocket trajectory. From data gathered in this manner, some indications of upper air temperature and winds have been obtained and much more accurate determinations could be made if the rocket trajectories were more accurately known.

[REDACTED]

Additional details of the atmospheric temperature and wind structure can be obtained by placing microphones near the tropopause where the velocity of sound is at a minimum. To our knowledge, no one has ever tried such an experiment, and in order to do this new equipment had to be developed, since wind produces strong noise in any microphone it was obvious that the detectors could not be used on an aircraft. It was further believed that the noise level of an instrument placed on a constant level balloon would be far below that generally observed on ground equipment. Both a satisfactory constant level balloon and a light weight microphone and telemetering system has been developed in this laboratory.

Basic acoustic propagation information is now being accumulated from equipments launched at Eglin Field Florida. The sound for these experiments is obtained from high altitude (20,000 to 25,000 feet) bomb bursts. Sufficient data have not yet been obtained to justify complete analysis, but it can be stated that observed results generally agree with predictions based upon theory.

Observations of the travel times of waves from an explosive source has yielded a considerable amount of data on the temperature and wind structure of the atmosphere up to altitude of about 50 km (160,000 feet). The interpretation of the data has so far been based on geometrical wave theory, and leads to a variation of propagation velocity with altitude which is in reasonable agreement with other lines of evidence. There are, however, several observed facts which cannot be explained on the basis of the elementary geometrical ray theory, and require a more complete analysis in terms of wave theory. They are: --(1) the "zones of silence", that follow according to geometrical ray theory from the initial decrease of velocity with altitude, which do not have sharply defined boundaries; (2) the same apparent angle of arrival is often observed over a considerable range of distance from the source, whereas on the ray theory a given angle of arrival was associated with one particular distance only; (3) at large distances, the total duration of the signals received is very much greater than can be explained by ray theory, and the character of the signal received is that of a long train of waves of varying amplitude and frequency rather than a limited number of well defined transient pulses.

Preliminary studies indicate that all of these facts may be explained qualitatively by more complete wave theoretical analysis of the diffraction of wave energy into the regions that are zones of silence in the elementary ray theory, and further work, aimed at quantitative treatment is in progress. Until an analysis of this kind has been carried through, one can not feel too much confidence in attempts that have been made to use long distance sonic and microbarometric wave propagation data to deduce atmospheric temperatures at levels above the second inversion.

In addition to the theoretical approach to this problem, consideration is being given to the use of surface waves on shallow water as a model of wave propagation in the atmosphere. The velocity of surface waves whose wave length is greater than the depth of the water is a function of the depth, so that the variation of velocity with altitude in the atmosphere can be simulated on a thin sheet of water by suitable contouring of the bottom. Surface tension and viscosity set at a lower limit of about 4 cm. to the wave lengths that can be used in such a model. With a water table about four feet wide simulating the atmosphere up to 50 km. a four centimeter wave length would represent a wave length in the atmosphere of about 1 mile, or a period of about five seconds.

Complementary Contracts:

- a. Columbia University  
No. W28-099-ac-82
- b. University of California at Los Angeles  
No. W28-099-ac-228
- c. Woods Hole Oceanographic Institution  
No. W28-099-ac-227

All contracts on: "Consultation and Assistance in Research  
on Atmospheric Acoustical Wave Propagation."

2: Project title: Development of Constant Level Balloons

Project scientist: Dr. James A. Peoples, Jr.

Summary of In-Laboratory work:

The development of a constant level balloon was at first motivated by the needs of the acoustic upper air sounding program. As it has developed, this balloon is now a principal atmospheric probing tool in its own right. In order to develop this balloon several special devices have been invented. An Olland cycle pressure indicator, accurate to better than one millibar, has been developed. A device has been constructed which will deflate and bring down balloons in flight either by timing or by pressure activated mechanisms. A balanced flow control valve has been made which gives a constant flow of ballast material proportional to pressure change. Other accessories include a telemetering device to indicate the rate of ballast flow; minimum ballast flow, minimum pressure switches, barographs, and balloon tracking radio transmitters which can be picked up by an aircraft radio compass at a range of 100 miles or more. A sensitive integrating vertical anemometer is now being developed which will aid in the interpretation of atmospheric oscillations.

A thorough investigation of balloon materials and fabrication methods has been conducted, and balloons have been designed suitable for use with the ballasting mechanisms developed. Launching and operational techniques have been developed which permit the launching of balloons in winds up to 20 per hour. Good control of ascent rate and ceiling altitude has been obtained. Constant level flights of several hours duration are now routine and flights lasting up to 5 hours with pressure variations not greater than one or two milibars have been obtained. Simplified control which operate satisfactorily during the day or night are not adequate when sunset occurs during a flight. A system for maintaining constant level thru sunset has been devised and tested in a bell jar, but in actual flight tests have not yet been made. Temperature measurements have been made both inside and outside of balloons to show the affects of super-heat. Temperature measurements have also been made in instrument and battery cases during flight. Measurements to show the actual characteristics of control devices have been made on balloons in flight and simulated in the laboratory. This

includes rate of ballast expenditure, diffusion, leakage, and stability of control.

By-product information of importance to meteorology or balloon flying techniques includes the following: Observation, measurement and theoretical analysis of high altitude atmospheric oscillations has been accomplished. These oscillations are several milibars in amplitude (as indicated on balloon barograph traces) and the period of oscillation varies between 4 and 10 minutes. Air mass trajectories have been measured over ranges up to about 400 miles and have been indicated by the recovery of gear up to 2,000 miles from the launching point. Additional field tests on air mass trajectories are now being made.

Complementary Contracts:

- a. New York University  
No. W28-099-ac-241  
"Development of Constant Level Balloon"
- b. Melpar, Inc.  
No. W28-099-ac-429  
"Development of Balloon Telemetering System"

3. Project title: Seismic Investigations

Project scientists: Dr. J. A. Peoples, Jr., Dr. Norman Haskell

Project summary:

Over the past few years a definite correlation has been established between tropical storms at sea and microseisms with periods in the range from 3 to 10 seconds. Microseisms of shorter periods (down to .02 sec.) are also recorded on seismometers having sufficient high-frequency response. Although it is very probable that these higher frequency components are also of atmospheric origin, little work has been done on their correlation with meteorological phenomena. A start in this direction is being made under contract at the California Institute of Technology.

Other seismic studies aimed at a better understanding of wave propagation and energy exchange between the earth, ocean, and atmosphere are being carried on under contract at Columbia University. One product of this research has been the identification on the records of high-frequency seismographs located near the sea-coast of a phase, called the T-wave, with a period of about 0.5 second, propagated with the velocity of sound in sea water over the oceanic portion of its path. This wave occurs only in connection with shallow-focus submarine earthquakes, particularly those originating on the slope of an oceanic deep. Such earthquakes often give rise to sea waves, or tsunamis, of

destructive amplitude, and a high degree of correlation has been found between the occurrence of tsunami and the appearance of the T-wave on seismograms from coastal stations. Since the tsunami travels with the much lower velocity of gravity surface waves, it is possible that seismometers or hydrophones designed for ready identification of the T-wave could be used as a tsunami warning system. The warning time would amount to about one hour for every 480 nautical miles from the earthquake epicenter to the point of reception.

Another seismic project that is under consideration is a study of explosion-excited vibrations of the ice of the Arctic Ocean. Small scale experiments on lake ice by Weing and Crary a number of years ago showed that certain flexural modes of vibration are transmitted with low attenuation in a floating ice sheet, and can be used to estimate the stiffness of the ice sheet. On this basis it is thought that larger scale experiments might lead to a practicable seismic method for determining the ability of the Arctic ice to support vehicles or landing aircraft.

Complementary Contracts:

- a. California Institute of Technology  
No. W28-099-ac-426  
"Microseisms Connected with Storms other than  
Hurricanes Detected at Single Stations."
- b. Columbia University  
No. W28-099-ac-396  
"Seismic Wave Propagation"

Project title:

4. Research in Geodetics and Isostasy

Project scientists: Dr. James A. Peoples, Jr., Dr. Norman Haskell

Summary of In-Laboratory work:

Active consideration is being given, and background research is in progress on a program in geodetics and isostasy. The program is intended to be directed toward determining the gravitational anomalies which affect precise location of points upon the surface of earth. The necessity for this work is evident in application to precise navigation and guiding of unmanned vehicles. As yet there is no action on this research other than compilation of background material and formulation of a program of activity.

Complementary Contracts : None



II. ELECTROMAGNETIC PROPAGATION LABORATORY

Chief: Mr. H. C. Gerson

1. Project title: Nocturnal Ionization Levels in the Ionosphere

Project scientist: Mr. H. C. Gerson

Summary of In-Laboratory work:

Conventional theories regarding the ionosphere ascribe the production of electrons to photoionization by solar radiation and the removal of free electrons by recombination or attachment mechanisms.

During darkness, when the source of ionizing radiation is removed, the height of the surface of maximum electron concentration and the electron density will be determined by the rate of removal of electrons. The rate of destruction proposed by present theory for the F<sub>2</sub> region should practically dissipate this region prior to sunset. Observation, however, reveals that the electron density in the F<sub>2</sub> layer remains fairly constant from shortly after sunset to almost sunrise. Of the various nocturnal ionization sources which might cause this residual ionization, all including meteors during non-shower periods, seem insufficient to maintain the observed ion density.

A diurnal temperature variation was postulated for the upper atmosphere with a maximum daylight temperature of 2000° K and a presunrise temperature of 300° K. It was then possible to define an influx function representing the increased ionization which enters a unit volume under the influence of atmospheric contraction. The equations derived give the observed ionic densities, clarify the maintenance of nocturnal ionization and give some indication regarding the diurnal temperature change.

Complementary Contracts: None

2. Project title: Research on the Ionosphere D and E layers

Project scientist: Dr. Wolfgang Pfister

Summary of In-Laboratory work:

Observations of an absorption maximum at frequencies near 45 kc/s made in long distance propagation indicate that a low ionospheric layer is effective. Reasonable assumptions for that layer have been made and

a detailed calculation of the reflection and transmission through that layer can explain very well the experimental data as far as such have been made on the very low frequencies. The studies have been brought to a form ready for publishing.

The E-layer is not a simple layer which can be explained satisfactorily by an ion distribution according to Chapman as it generally is assumed. To fit the experimental data made at Washington on the absorption by the E-layer a tentative curve for the variation of the ion density with height has been developed. This curve shows the character of a double layer probably caused by the dissociation of oxygen situated at that level. The explanation of the details of that curve involves mathematical difficulties and requires the ionization of both molecular and atomic oxygen. It is hoped to get valuable information about the basic reactions of the atmosphere in the E-layer level.

**Complementary Contracts:**

- a. Pennsylvania State College  
No. 428-081-ac-143  
"Critical Refraction by the Ionosphere"
- b. Radio Magazines Inc.  
No. PR 95084  
"Gathering of Data Regarding Sporadic E Ionization."
- c. Project title: Research on Frontal System Development by Synoptic Radar Observation.

Project scientist: Dr. David Atlas

Summary of In-Laboratory work:

As part of the overall program to investigate the full capabilities and limitations of radar as a meteorological tool and the applications of this new tool in probing the atmosphere, a pilot research project is now under way to study the relations of the large scale pattern of weather echoes to the genesis and development of the associated frontal systems.

Although it is not practical with the radar frequencies generally in use to detect the actual genesis of a cyclone, its later development and deterioration possible may be indicated on a composite synoptic radar weather chart once precipitation has begun. More specifically, it is desired to determine:

- (1) at what stage in the development of a cyclone the radar observations become significant;

(2) whether or not model patterns of weather echoes exist for the various model frontal systems

(3) the possibility of compiling a "weather echo atlas" indicating either the typical relation of the echoing area to the remainder of the frontal system, the air mass characteristics most frequently associated with that type of echoing area, the relation of the isobaric pattern thereto, or the usual sequence of meteorological events associated therewith.

(4) the complete life cycle of the echo system as related to that of the frontal system

(5) whether or not the development or deterioration of a frontal system could not have been forecast more accurately having observed the continuous development of the radar echo patterns rather than with the use of the discontinuous and delayed information of the synoptic charts.

A project to investigate the feasibility of radar in attaining the above objectives is now currently in operation. Four instruments, located at Bedford, Mass., Militon, Ohio, Washington, D. C., and New Jersey, will provide synoptic radar information over northeastern United States.

Complementary Contracts:

a. University of Florida  
No. AFOS(000)-2

(c) "Investigation of Radio Wave Absorption  
by Atmospheric Hydrogen Molecules"

Monitored Contractual Research:

Contract No.: 42-000-ac-172

Organization: New York University, Institute  
for Mathematics and Mechanics.

(a) Title: "Basic Mathematical Studies in the  
Field of Electrodynamics"

Monitored Contractual Research:

Contract No.: 42-000-ac-175

Organization: Georgia School of Technology

Title: "Atmospheric Effects on Electromagnetic  
Waves"

6. Monitored Contractual Research:

Contract No.: 423-059-ac-204

Organization: Pennsylvania State College

Title: "Electromagnetic Wave Propagation Research"

7. Monitored Contractual Research:

Contract No.: 423-069-ac-323

Organization: Rutgers University

Title: "Dependence of Index of Refraction upon Meteorological Factors and Frequency"

8. Monitored Contractual Research:

Contract No.: 423-099-ac-414

Organization: University of Alaska

Title: "Tropospheric Propagation in the Arctic"

III. ATMOSPHERIC PHYSICS LABORATORY

Chief: Mr. P. M. Lyckoff

1. Project title: Research on Atmospheric Ozone

Project scientists: Mr. P. M. Lyckoff, Mr. Louis Niterman

Project Summary:

The ultra violet portion of the sun's radiation falling upon the earth falls off sharply under  $3000\text{\AA}$  due to absorption in the ozone layer approximately 22 kilometers above the earth. The absorption of this energy by the ozone layer is proposed as an influence of weather to a considerable extent, and it is important to know the height, thickness, and variations in this layer. A two man scientific team of this laboratory is now located at Albuquerque, New Mexico, attempting to determine the height and thickness of the ozone layer by means of a modulated

ultra violet searchlight beam at night. Dr. Rejener of the University of New Mexico at Albuquerque is monitoring surface ozone by chemical methods and obtaining vertical sections by day by use of balloon borne spectrographs. The University of Alaska is duplicating the modulated searchlight equipment for similar ozone measurements at high latitude.

Complementary Contracts:

- a. University of New Mexico  
No. W28-099-ac-379  
"Research in Atmospheric Ozone"
- b. University of Alaska  
No. W28-099-ac-445  
"Research into the Atmosphere of the Arctic"

2. Project title: Air Conductivity Research

Project Scientists: Mr. P. M. Wyckoff, Mr. S. Coroniti

Summary of In-Laboratory work:

This project has been initiated at the request of General Negeberger's group; however, it will be carried over after this special project is ended to attempt to study the problem of electric charge separation in the atmosphere. There is a distinct possibility of using this equipment as a measure of mixing at heights of 2 or 3 miles above ground by measuring the amount of ground radioactive contamination thrown into the upper air by turbulence or advection currents.

Complementary Contracts:

- Wait & Gish  
No. W28-099-ac-418  
"Research in Atmospheric Electrical  
Conductivity"

3. Project title: Atmospheric Effects on Cosmic Rays

Project Scientist: Mr. P. M. Wyckoff

Project Summary:

There is some reason to suspect that cosmic ray particles reaching the earth are considerably influenced by the state of the upper air. A B-25 cosmic ray aircraft has been equipped jointly by the Geophysical Research Division and Brookhaven National Laboratories to make flights up to 35,000 feet to investigate meson production, slow neutrons and fast

electrons at these altitudes. New York University is flying high altitude constant level balloons equipped with neutron counters and the University of Denver is making meson and neutron measurements on top of Mt. Evans, Colorado in order to determine whether cosmic ray counts on the ground can be used as an indication of upper air density, pressure, and water vapor content.

Complementary Contracts:

- a. New York University  
No. AF28(033)-10  
"Research in the Determination of Neutron Maximum at High Altitude."
- b. University of Denver  
No. P.S. 35083  
"Correlation of Meteorological Parameters with Cosmic Ray Energies"

4. Project title: High Altitude Dust Diffusion Measurements

Project scientist: Mr. P. S. Nyckoff

Summary of In-Laboratory work:

This project was initiated at the request of project Rand to determine rates of diffusion in the stratosphere. Balloons carrying containers of titanium dioxide dust will be carried to heights between 30,000 feet and 50,000 feet and the dust dispersed by means of an explosive charge. Ground theodolites will photograph the spread and movement of the cloud. The primary purpose of this study is to determine the height at which molecular diffusion becomes more important than eddy diffusion.

Complementary Contracts: None

a. Project title: Analytical Meteorology of the Upper Atmosphere

Project scientists: Dr. R. Penzance, Mr. J. Prassman,  
Mr. A. Nazarek

Summary of In-Laboratory work:

The study of the structure and behavior of the upper atmosphere is being attacked from various aspects, i.e., astrophysics, radio propagation, aerodynamics, ballistics, etc. It is intended to study here specifically the meteorology of the Upper Atmosphere. The term meteorology is used in its broadest sense.

SECRET

A suitable nomenclature for atmospheric strata, as well as a clear definition of the boundaries, has been proposed.

The composition of the upper atmosphere is the basic problem for all research. It is definitely different from that on the ground because neutral and ionized atoms and molecules occur. The dissociation of oxygen molecules has been calculated, with the result, that a transition from all molecular to all atomic oxygen occurs within a small transition layer of about 8 - 10 km at a height of about 100 km. The same will be calculated for nitrogen.

The relationship between ozone and tropospheric weather, already studied in Europe, will be examined.

Using the pressure data obtained by V-2 ascents, the temperature distribution has been carefully recalculated up to 120 km. More reliable data have been obtained. Moreover the controversy about the various temperatures, calculated for the upper atmosphere, is studied from fundamental viewpoints.

It is hoped to calculate wind direction and velocity from the temperature and pressure data. They are the basis for the general circulation of the upper atmosphere, which as yet is unknown.

Complementary Contracts: None

6. Project title: Research in Cloud Physics

Project scientist: Dr. G. W. Anderson

Summary of In-Laboratory work:

The field of cloud physics embraces all questions related to the physical-chemical consequences of the existence of water vapor in the atmosphere. As such, this research activity is interested in those primary processes of evaporation, condensation and precipitation in the free atmosphere. The first specific objective is to re-investigate the formation of hydro-nuclei and the roles played by condensation, sublimation and freezing nuclei. The results of this program should give answers to the questions: are nuclei necessary for phase transition and, if so, what are their physical and chemical characteristics and methods of action? To provide an answer to the first question, a study of the kinetics of phase transition is being undertaken in which such topics as activation energies for nucleation, surface energies and critical particle size, influence of sorption and electric effects will be considered. At the same time, a program to determine the characteristics and properties of impurities in the atmosphere is in operation. The laboratory is being

SECRET

equipped with a unique adiabatic expansion chamber to study vapor-liquid phase transitions and in some cases liquid-solid changes. An electron microscope, microchemical, and mass spectrometer will be utilized to analyze samples of atmospheric impurities. Methods are being devised to collect samples for analysis. In this connection, some phases of the nuclei distribution problem and the rate of growth of droplets is being carried on for this laboratory by the Mt. Washington Observatory under Dr. Howell. Close contact is maintained with other groups engaged in cloud physics research.

Complementary Contract:

a. Mt. Washington Observatory  
No. AF28(099)-25  
"Research in Cloud Physics"

7. Project title: Chemical Constitution of the Atmosphere

Project Scientists: Dr. A. O. Mirarchi, Mr. A. Reich

Summary of In-Laboratory work:

The chemical composition of the atmosphere is important since it furnishes a basis for understanding the physical processes taking place in the upper air. This problem will be studied experimentally in two ways. The first method will be to obtain samples of atmosphere by means of sampling bottles carried up to 100,000 ft. region by balloons. The contents of these bottles will be examined by chemical gas analysis, mass spectrograph, emission spectrograph, and all other physical and chemical means possible. The second method of study will be an attempt to synthesize upper air dissociation by means of strong ultra-violet light. Rates of dissociation and recombination of oxygen and nitrogen will be studied as a function of the energies and frequencies required to reproduce upper air conditions.

Complementary Contracts: None

8. Monitored Contractual Research:

Contract No: W28-099-ac-405  
" " W28-099-ac-407

Organization: Tracerlab Inc.

Title: "Services in collection of Data and Analysis of Atmospheric Radio-Active Contamination."

SECRET

9. Monitored Contractual Research:

Contract No: W28-09-ac-456

Organization: Air Reduction Research Corporation

Title: "Reduction and Analysis of Atmospheric  
Rare Gases."

10. Monitored Contractual Research:

Contract No.: W28-099-ac-457

Organization: Beers & Heroy Inc.

Title: "Survey in Detection Techniques."

11. Monitored Contractual Research:

Contract No.: W28-099-ac-457

Organization: Armour Research Foundation

Title: "Survey in Detection Techniques."

SECRET

## IV. ATMOSPHERIC ANALYSIS LABORATORY

Chief: Lt. P. D. Thompson

1. Project title: Objective Terminal ForecastingProject scientist: Mr. I. GringortenSummary of In-Laboratory work:

An objective method, based on the statistical theory of attributes, has already been applied to forecasting fog and stratus at Randolph Field, Texas and is at present being systematically tested for its applicability at other large terminals. In brief, the method is this. Certain initially known and forecast parameters, which we might call predictors and predictands respectively, are considered as numerical attributes of terminal weather. About 20 predictors have been selected as having suspected relevance to the predictands in question, and each combination of predictors occurring at a particular time has been recorded on standard punch cards to facilitate handling by "business machines." The frequency of simultaneous occurrence of each predictand with various subuniverses of predictors, formed by combining the universes corresponding to particular values of the predictors, has been computed with a Remington Rand Card-Sorter. The computed frequencies have been assembled in forecasting manuals, which enable one to state the relative probabilities of occurrence of all values of the predictand. This technique has thus far shown marked improvement in accuracy over subjective methods.

Complementary Contracts: None2. Project title: Tropical Weather AnalysisProject scientist: Mr. D. BarberProject summary:

The laboratory's current researches in tropical meteorology are directed toward improved techniques for predicting weather in the Southwest Pacific area. In view of extant theories of the propagation of disturbances in the equatorial regions, special emphasis is placed on the "jumps" (or shock waves) recently proposed by Freeman, as well as analysis of the very long period circulations in those regions. Specifically, the characteristic features of perturbations in the southeast trade and northwest monsoon flows in the Northern New Guinea area will be reconstructed from data collected during the warty years. Before undertaking any extensive

SECRET

theoretical treatment of the propagation and stability of migratory disturbances in the tropics, the following approaches are to be explored first since they are already well developed:

- (a) Empirical forecasting techniques tried with success in the tropical Atlantic and other areas.
- (b) The "easterly wave" theory of Riehl and Bonnot.
- (c) The internal "shock wave" theory of Freeman.

As a necessary adjunct of the program outlined above, the weather patterns normally associated with the travelling disturbances must be reconstructed, in order that any results of propagation studies may be utilized in the field. Finally, some effort will be directed toward establishing the relation between the movement of migratory disturbances and the structure of the intertropical front.

Complementary Contracts:

a. Contract No. W2R-099-ac-385

Organization: University of California

Title: "Synoptic Meteorology of the Tropical Pacific Ocean"

b. Project title: Anisotropic Turbulence and Micrometeorology

Project scientists: Dr. H. Lettau, Mr. H. Lake

Summary of In-Laboratory work:

The program of micrometeorological research is designed to provide techniques for predicting the spatial distribution of the following parameters throughout the atmospheric layer most affected by contact with the ground:

- (a) wind
- (b) Temperature
- (c) Humidity
- (d) Foreign matter (e.g., aerosols)

A theoretical analysis of turbulence in the surface layer has revealed that the assumption of isotropicity, as adopted in previous

SECRET

investigations, is not only unrealistic, but unnecessary. The fundamental differential equations for anisotropic turbulent flow have been integrated, and the solutions thus obtained may be applied to predicting the turbulent transfer of any property. In particular, the theory has been applied to the modification of a warm air mass passing over a cold water surface. These results and others have been checked against data already published in the literature and with data collected under contract with Johns Hopkins University. All these results, theoretical and experimental, have been incorporated in a paper on the role of turbulence in the diurnal and day-to-day variations of micrometeorological parameters. This work will serve as the basis for a system of micrometeorological forecasting.

Further theoretical research, to extend the solutions for eddy transfer to the "geostrophic wind" level, is contemplated for the immediate future. Supporting data on the wind distribution up to the "geostrophic wind" level will be furnished by contracting agencies.

Complementary Contracts:

- a. Johns-Hopkins University  
W28-099-ac-378  
"Investigations of Micrometeorological Parameters"
- b. Massachusetts Institute of Technology  
AF28(099)-7  
"Research on Turbulence and Diffusion of Particulate matter in the Lower Layers of the Atmosphere."

4. Project Title: Convective Circulation Due to Non-Uniform Distribution of Heat Sources Concentrated Near the Ground

Project scientist: Lt. F. D. Thompson

Summary of In-Laboratory work:

Some numerical calculations, based on a simple theoretical model investigated by Lt. Thompson in 1948, have been recently completed. Those results suggest the existence of critical distances between adjacent areas of intense heating for which the vertical motions thus generated are particularly violent. It has been shown that the critical distance depends on the temperature lapse rate.

It is expected that these results, which are founded on hydrodynamically more realistic models than the usual hydraulic analogues, will give greater insight into the genesis and development of intense vertical circulations and, properly interpreted, will serve as a means for predicting their occurrence.

Complementary Contracts: None

5. Project title: Thunderstorms and Associated Electrical ActivityProject scientist: Dr. J. KuettnnerSummary of In-Laboratory work:

Observations of the electrical and meteorological conditions inside 125 thunder storms and shower clouds were made at the Zugspitze Observatory (10,000 ft.) from 1945 to 1948. This investigation has been compared with others from the United States and England. The conclusions concern:

- (a) the role of precipitation in thunder storms
- (b) the generation of electric charges

The following results are significant:

- (1) The formation of solid precipitation (snow pellets and hail) is connected with the production of intense electric fields, the electrostatic charges being borne not by the precipitation particles, but suspended in the cloud air.
- (2) The freezing level is particularly significant in determining the distribution of charge.

Complementary Contracts: None

6. Project title: Air Flow Over an Irregular Ground SurfaceProject scientist: Dr. J. KuettnnerSummary of In-Laboratory work:

Ten years ago, the formation of atmospheric waves at high altitudes over mountain ridges was discovered by glider pilots. In the meantime, many theories have been published explaining this phenomenon, some of which lead to special consequences relevant to cyclogenesis. There is an area of disagreement between these theories, but a decision by experiment could not be given, since investigations by gliders were interrupted in nearly all countries during the war.

It is now necessary to (a) make a summary of the present theoretical and experimental status of this field and (b) determine by experiment whether or not the theory is in accordance with experience.

Observations of the upper atmosphere ("mother-of-pearl clouds") and theoretical conclusions lead to the result that, if the wind velocity is high enough, the influence of a terrestrial obstruction may be effective up to 100,000 ft.

Complementary Contracts: None

7. Project title: Application of Mathematical-Physical Methods to Forecasting  
Project scientist: Lt. F. D. Thompson

Summary of In-Laboratory work:

To continue theoretical investigations originally begun at the Meteorology Project of the Institute for Advanced Study, Princeton, N.J., and to complement the present researches of that Project, this Laboratory is planning computational routines for predicting the day-to-day changes in large scale, one-dimensional, "quasi-barotropic" flow. Preliminary calculations of the Princeton group, with whom this Laboratory is in close contact, show unusual promise, inasmuch as the predicted dispersion and stability, as well as speed of propagations, were of the correct sign and magnitude. Anticipating that high-speed computing machines will soon be available for numerical weather prediction, the Laboratory will also undertake to tabulate the "Green's Functions" which occur in the Fourier Integral solutions corresponding to small arbitrary initial disturbances in large scale, three-dimensional, "quasi-barotropic" flow.

In connection with the program outlined above, the stability of arbitrarily non-uniform laminar flows to small pulses will be studied in an attempt to account for the concentration of atmospheric wave energy within a few, relatively narrow bands of the spectrum.

Complementary Contracts: None

(It is proposed that support be extended to the Institute for advanced study)

8. Project title: The Research Weather Station

Project scientist: Mr. P. L. Frank

Summary of In-Laboratory work:

Owing to slow supply schedules and the shortage of adequately

trained research personnel, this Laboratory has undertaken relatively little purely "synoptic" meteorological research since its recent move from Red Bank, N.J. It is anticipated, however, that roughly one half of the Laboratory's future work will soon fall to the Research Weather Station, a section given over to empirical -- and immediately useable -- weather studies. The functions of that section are three-fold:

1. Designing and carrying out objective tests of empirical "rules of thumb", suggested either by common experience and/or by theoretical results.
2. Devising methods of data representation specially adapted to the most accurate forecasting techniques available.
3. Dissemination of results which will serve as the rational basis for operational forecasting techniques, by vis-a-vis contact with visiting meteorologists who will relay the information to forecasters in the field, and by publishing those results as a sequence of well defined operations in terms familiar to the using agencies.

The present activities of the Research weather Station and its plans for the immediate future are centered around the following subsidiary objectives:

1. Investigations of the movement of large scale pressure systems relative to very large scale flow -- i.e., to test and extend the "steering" methods which are, consciously or unwittingly, the stock-in-trade of most field forecasters.
  - (a) Specifically, the Research weather Station will make objective estimates of the methods used by the European weather Central during the war. This involves historical reconstruction of the steering paths of isallobaric centers and correlation of these movements with the very large scale flow.
2. Instantaneous correlations (as opposed to time-lag correlations) between large scale systems aloft and low level terminal weather.
3. Objective studies of the "thickness-advection" methods developed by Bundgaard.
4. Sampling popular reaction to and evaluation of the scheme of graphical representation recently proposed by John C. Bellamy as a result of reasearches carried out under contract with this Laboratory. This system of data representation

SECRET

includes a method of automatic plotting by transmission of frequency-modulated code signals corresponding to previously scanned data.

Complementary Contracts:

- a. No. W28-099-ac-394  
Cook Research Laboratories  
"Research in Graphical Representation of Meteorological Observations"

9. Monitored Contractual Research:

Contract No.: W28-099-ac-399  
Organization: American Meteorological Society  
Title: "Compendium on the Science of Meteorology"

10. Monitored Contractual Research:

Contract No.: W28-099-ac-398  
Organization: Mass. Institute of Technology  
Title: "Research in Extended Weather Forecasting"

11. Monitored Contractual Research:

Contract No.: W28-099-ac-403  
Organization: University of California  
Title: "Research in Forecasting of Upper-Level Winds"

12. Monitored Contractual Research:

Contract No.: W28-099-ac-406  
Organization: Mass. Institute of Technology  
Title: "Research in General Circulation of the Atmosphere"

13. Monitored Contractual Research:

Contract No. AF28(099)-1  
Organization: American Institute of Aerological Research  
Title: "World-wide weather Relationships"

14. Monitored Contractual Research

Contract No.: W28-099-ac-439  
Organization: University of California  
Title: "Diffusion in the Free Atmosphere"

SECRET

15. Monitored Contractual Research:

Contract No.: PR 57150  
Organization: University of California  
Title: "Investigation of the General Circulation of the Atmosphere"

16. Monitored Contractual Research:

Contract No.: PR 95077  
Organization: NYU  
Title: "Collection and Analysis of High-Altitude Balloon Trajectory Data"

17. Monitored Contractual Research:

Contract NO.: PR 95082  
Organization: NYU  
Title: "Investigation of Atmospheric Oscillations"

18. Monitored Contractual Research:

Contract No. PR 95080  
Organization: U.S. Weather Bureau  
Title: Northern Hemisphere Weather Maps

SECRET

V. UPPER AIR LABORATORY

Chief: Dr. M. O'Day

1. Project Title: Radiation Studies

a. Sky Brightness, Infra-red, Visible and Ultra-violet.

Project Scientists: Dr. Heinz Fischer, Dr. H.A. Miley, Dr. P.R. Gast.

Summary of In-Laboratory Work:

The intensity of solar radiation in the ultra-violet, visible and infra-red, and its depletion as it passes through the atmosphere, are important physical data which are only imperfectly known. The amount of this radiation which is scattered, and may be studied as sky brightness, is of great scientific and military interest.

The development of radiometric equipment with appropriate characteristics, and the standardization of this equipment so that the data shall be stated in absolute units is necessary. To this end all reasonable efforts to procure or develop equipment with optimum characteristics shall be taken.

Since these data must be studied with reference to direction (as well as altitude and wavelength of the radiation band), it is recognized that the astronomical orientation of the radiometers should be known to a high degree of precision. With a stabilized platform, such as may be provided by the Airborne Coronagraph, discussed below, it should be possible to utilize several types of carriers for obtaining data at different altitudes. This information is of interest to various agencies and groups of scientists, and will be used in studying the phenomenon of the scattering of light by small particles and in the design of equipment for civilian and military uses.

Plans are being made for studying scattered radiation in the ultra-violet range. Phototubes and other types of detectors will be used to measure the radiation selected by special filters.

Photoelectric methods of measuring sky brightness can be adapted more easily than others to the requirements imposed by rocket-borne equipment. Multiplier phototubes are used with interference filters for measuring the sky light at various heights and for narrow bands at different wave lengths. Equipment has been sent into the upper atmosphere three times by means of V-2 rockets. The output of each phototube is commutated at a voltage divider to obtain four ranges of sensitivity. Cathode followers match the output impedance to that of the respective telemetering channels, and limiting tubes hold the voltages of the higher ranges within telemetering requirements. By this means a broad range of light values can be measured automatically. The results indicate that it is relatively dark at a height of 25 kilometers, the brightness values being about 3 to 7 per cent of those measured near the ground for the respective chosen directions. The near-the-ground values are larger than might be expected from molecular scattering alone. This may indicate that weather conditions, dust, smoke, etc., are liberal contributors to skylight.

SECRET

**SECRET**

Lead sulphide phototube and other types of detectors will be used to study sky infra-red radiation at various altitudes, directions and wave lengths. The infra-red radiation resulting from the rocket skin and boundary layers will be studied also.

b. Composition of Upper Air by Rocket Borne Spectrographs

Project Scientist: Mr. M. B. Marshall

Summary of In-Laboratory Work:

This experiment was planned for the purpose of gathering data on the composition of the upper air using spectrographic techniques. The data will be in the form of radiation spectra and the excitation source will be the Luxembourg antenna probe. Due to the high voltage gradient at the probe, it will serve as a suitable source for producing molecular excitation and causing a gaseous discharge. The light from the gaseous discharge will be directed in the optical system of the spectrograph by means of a mirror located on an arm. At a predetermined height, this mirror will be extended to a distance of about six inches outside the skin of the rocket.

c. Soft X-Ray Radiation.

Project Scientist: Mr. M. B. Marshall

Summary of In-Laboratory Work:

The purpose of this project is to determine the presence or absence of soft x-rays in the upper atmosphere. Their characteristics will be studied by a method which uses the effect of soft x-rays on photographic film. The measurements will be made by employing a step-wedge type aluminum filter. The five to eight steps are proportional in thickness to give indication of small amounts of radiation between eight and twelve angstrom units, approximately, and to exclude all energy at wave lengths above the pass band due to radiation from the sun.

The assembled packet will consist of a sandwich made up of sensitive film, the filter, and the protective screen which will be enclosed in the metal housing behind the window, or opening.

Radiation Studies Complementary Contracts:

- a. Baird Associates, Inc.  
No. W19-122 ac-50  
No. W19-122 ac-26  
"Design and Construction of Spectrographs, Optical Filters and X-Ray Detection Packets."
- b. Rhode Island State College  
No. W28-099 ac-377  
"Insolation of the Upper Atmosphere."
- c. Harvard University  
No. W19-122 ac-17  
"Site Evaluation for High Altitude Observatory."

**SECRET**

24

d. University of Denver  
No. W19-122 ac-16  
"Daylight Luminescence and Infra-Red Absorption."

e. Colorado University  
No. W19-122 ac-9  
"Design and Construction of Rocket Borne Coronograph."

4. Project Title: Laboratory Studies of Upper Atmospheric Gases.

Project Scientist: Mr. O.T. Fendingsland.

Summary of In-Laboratory Work:

The objectives of this research are to accomplish controlled laboratory experiments for: (1) A study of fundamental mechanisms of ion production and removal processes which are believed to occur in the ionosphere. (2) A study of certain electromagnetic phenomena under simulated ionospheric conditions, and (3) A study of molecular structure and absorption bands of ozone by microwave spectroscopy.

Difficulties encountered in trying to simulate ionospheric conditions in the laboratory are first, a lack of experimental data on gases at low pressures. The walls of the container cause diffusion and three-body combination to be predominate over volume recombination. Also, the walls of the container cause photo-emission and secondary electron emission.

This laboratory study is being attacked from three standpoints: (1) a study of electrodeless discharges and afterglows with the aid of a constant magnetic field to control diffusion, (2) Measurement of relative ion concentrations with the aid of an ion discriminator, operating on the gyro-magnetic resonance principle, and (3) Development of a novel microwave spectrograph technique for measurement of rotational absorption spectra of ozone.

Complementary Contracts:

a. Lehigh University  
No. W28-099 ac-129  
"Microwave Absorption in Ionized Gases"

b. University of California at Los Angeles.  
No. W19-122 ac-19  
"Photo-Electric Analysis and Ion Spectrometer"

c. University of Michigan  
No. W33-038 ac-14050  
"Ambient Temperature and Pressure and Probe Measurements of Ion Density."

SECRET

d. Ohio State University  
No. AF 19(122) - 13  
"Microwave Techniques"

e. Duke University  
No. W28-099 ac-35  
"Microwave Spectroscopy"

3. Project Title: Ionospheric Research.

a. Electron Density Studies and Propagation of Electromagnetic Waves  
Between Ground and Missile.

Project Scientist: Mr. J. C. Reed

Project Summary:

Travel time of low frequency pulse minus travel time of high frequency pulse measured. Allows conclusions about equivalent electron density; modified experiments may also give other information.

b. Oblique Incidence Studies.

Project Scientist: Captain G. E. Austin

Project Summary:

Description: Pulses transmitted at Sterling, Va.; received both on ground at White Sands, N. M., and in rocket; reception by the latter relayed to ground.

c. Luxembourg Effect.

Project Scientist: Mr. P. A. De Paolo

Project Summary:

Alternating field at gyre frequency (cyclotron frequency) produced by flying oscillator with field creating probe; effect on the amplitude of a wave of another not too high frequency studied.

d. Artificial Excitation of Atmospheric Light Emission.

Project Scientist: Mr. P. A. De Paolo

Project Summary:

Used in night rocket firing. Electrons in the ionosphere will take energy out of the created alternating field. Then they will hit molecules,

atoms, etc., and sometimes will excite them. Some of the excited molecules, atoms, etc. will emit radiation. Some of the radiation will be visible. Observation of emitted spectrum planned both in missile and on ground.

Ionospheric Research Complementary Contracts:

- a. University of Utah  
No. W19-122 ac-15
- b. Boston University  
No. W28-099 ac-305

4. Project Title: Ambient Pressure and Temperature.

Project Scientist: Dr. M. O'Day

Project Summary:

Pressure and temperature of the air is wanted as functions of altitude. Pressure measurements during flights must be corrected for effects of the rocket. Temperature so far has been obtained by this project by determining the quotient of temperature and mean molecular weight from pressure data. New measurements are started which should allow greater accuracy, namely measurements of shock wave angles; they will give the mentioned quotient multiplied by the quotient of the specific heats.

Complementary Contract:

University of Michigan  
No. W33-038 ac-14050

5. Project Title: Ultrasonic Studies

Project Scientist: Dr. M. O'Day

Project Summary:

Propagation of ultrasonic acoustic waves in the upper atmosphere and generation of ultrasonic waves on the missile during flight to be studied. For this purpose a body, called Tagalong, to be ejected from the missile. It will detect ultrasonic waves; especially wanted are those which come from the missile. The results of the detection transmitted from the Tagalong to ground by radio. From the speed of propagation of the (ultrasonic) acoustic waves one can obtain the quantity mentioned last under (3), namely the quotient of temperature and mean molecular weight multiplied by the quotient of the specific heats.

Complementary Contract:

Temple University  
No. W19-122 ac-12

5. Project Title: Rocket Tracking by Beacon Triangulation.

Project Scientist: C. S. Tilton

Project Summary:

It is of primary importance to the successful completion of experiments performed in the Upper Air Research Program that the position in space of missiles carrying such experiments be known to a high degree of accuracy. A highly reliable tracking device was required which would provide such data for the missile and be capable of instant shift to track assemblies carrying experiments which would be ejected from the missile during flight. The system chosen would be experimental with emphasis pointed toward research in extreme accuracy and applications to the Upper Air experiments to be performed.

A beacon triangulation system was established in the White Sands area early in 1947. Advantage was taken of a beacon already carried by V-2 missiles allotted to AMC for another experiment (ionosphere density) to establish the system for obtaining the required trajectory information. A point is fixed in space by the measurements of simultaneous ranges to the missile from three or more ground stations of known location. Thus no angles are measured and range data only, the most accurate feature of a beacon-radar system is utilized. Each point, thus obtained, is independent and thus interference at any instant cannot impair the accuracy of succeeding points. The system is readily adaptable for use with a variety of beacons packaged for use in other type missiles. The system has been used during four V-2 flights which have been allotted to AMC for Upper Air experimentation.

The research and development on this project have been utilized in the design of the routine range instrumentation system to be installed by HAFB. Research is continuing at CFS to provide even greater accuracy and broader applications of the system.

Complementary Contract:

Oklahoma A & M Research Foundation  
No. W28-099 ac-377

"Services in Connection with Flight Operation, and Evaluation of Results."

6. Monitored Contractual Research:

Contract No. W19-122 ac-51  
Organization: Cornell University.

Title: "To Study Solar Radiation Noises in the r/f Ranges."

7. Monitored Contractual Research:

Contract No. W28-099 ac-293  
Organization: Tufts College

Title: "To Measure Intensity and Direction of the Earth's Magnetic Field in the Upper Atmosphere and to Develop a Light-Weight Recording Device for Missile Flights."

8. Monitored Contractual Research:

Contract No.: W28-099 ac-277  
Organization: Wentworth Institute  
Title: "To Edit and Prepare Technical Reports for the Upper Atmosphere Research Program."

9. Monitored Contractual Research:

Contract No.: W19-122 ac-52  
Organization: Franklin Institute  
Title: "Provision of Engineering Service on Special Instrument Assemblies for Rockets."

10. Monitored Contractual Research:

Contract No.: W19-122 ac-19  
Organization: University of California at Los Angeles.  
Title: "Photoelectric Analysis from Luxembourg Gyrofrequency Excitation to Determine Upper Atmosphere Composition."