COMMITTEE PRINT

MICROWAVE IRRADIATION OF THE U.S. EMBASSY IN MOSCOW

(REVIEW OF ITS HISTORY AND STUDIES TO DETERMINE WHETHER OR NOT RELATED HEALTH DEFECTS WERE EXPERIENCED BY EMPLOYEES ASSIGNED IN THE PERIOD 1953–1977)

PREPARED AT THE REQUEST OF

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COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

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LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
May 1, 1979.

DEAR COLLEAGUE: It was indicated in the Report on Radiation Health and Safety, released as a staff report in December 1978, that a separate report would be prepared on microwave irradiation of the U.S. Embassy in Moscow. I am pleased now, on behalf of the Committee on Commerce, Science, and Transportation, to release this staff report covering study of that matter.

Persons reading this report may know that the U.S. Embassy in Moscow was subjected over a period of approximately 25 years to microwave radiation. The intensity of that radiation was within the levels permissible in the Soviet Union for public exposure, and far below the levels considered acceptable in the United States. Nevertheless, committee members, as well as present and former employees assigned to the Embassy, and many other persons, were concerned as to whether any adverse health effects were encountered by people so exposed, and whether Government agencies involved, particularly the Department of State, provided adequate measures to assure the health and safety of personnel involved.

This staff report reviews the history of that irradiation of the U.S. Embassy including actions taken and studies conducted to determine whether or not the health and safety of U.S. personnel were in any way jeopardized. It also examines the question as to the adequacy of the information provided by the Department of State to employees assigned.

Although it has not been officially approved by the Committee on Commerce, Science, and Transportation, I believe this staff report will answer for many persons their questions concerning this unfortunate episode.

Sincerely,

HOWARD W. CANNON
Chairman.

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INTRODUCTION

Approximately 6 years ago it became known to the public and the Congress that the U.S. Embassy in Moscow—the chancery and its occupants—had been irradiated over a long calendar period dating back perhaps to 1953 by microwaves of variable, but low intensity, from different directions, and for purposes unknown. A number of media accounts in recent years have implied with varying degrees of conviction that the health of a number of Embassy employees had been injured or threatened by this radiation. Some of those accounts implied that the Government agencies involved appeared either indifferent to those health hazards or unwilling or unable to remedy the situation.

All the known facts relating to this matter were sought during public hearings conducted in June 1977, by the Committee on Commerce, Science, and Transportation, supplemented by a classified briefing of the Committee and professional staff members by the Departments of State and Defense.

This report is issued to summarize and present the history and nature of this irradiation activity and of the action taken by Government agencies for the health and safety of U.S. personnel involved.

Nature and History of the Radiation Activity

STATE DEPARTMENT DISCOVERY

Initial discovery by the State Department of the existence of such microwave irradiation dates back to approximately 1953. At that time and for a number of years thereafter, neither the public nor the scientific community nor Government agencies responsible for public health were generally aware of or concerned about the possible, but undetermined, health hazards of low-intensity microwaves. Military systems (e.g., radar surveillance) and commercial systems (e.g., VHF broadcasting) which emit such radiation had been in widespread use for a number of years.

Little was done or recorded by the State Department concerning this irradiation activity until the early sixties at which time appropriate equipment was made available for on-site measurement of the microwave characteristics. The measured characteristics included primarily intensity, frequency and duration of the radiation. By early 1963 this monitoring included recorders capable of continuous and permanent recording of the radiation characteristics in the chancery.

Embassy employees were not informed by the State Department of the presence of this radiation throughout the period from its initial discovery until early 1976 when a decision to install protective screening over the chancery was made. However, media reports in 1972 did disclose presence of this radiation.

DESCRIPTION OF THE MICROWAVE RADIATION

The following abbreviated summary of the principal characteristics of the radiation is based upon testimony submitted to the Committee by witnesses appearing during its Oversight Hearings on Public Health and Safety in June 1977. More complete details will be found in the hearing record identified as publication Serial No. 95–49.

The originally measured radiation, from August 1963 until May 1975, consisted of microwaves in the frequency range from 2.56 to 4.1 gigahertz,[1] with occasional variations. Each variation or mode was on the air no more than about 6 hours, and the total continuous duration, including several modes in sequence, was never transmitted for more than about 48 hours. The radiation intensity remained at approximately 5 microwatts per square centimeter[2] at the strongest point of the beam on the west face of the Embassy building In any or all of its modes, the radiation was on the air about one-third of the time.

In January 1973, an additional signal was detected which was discontinued in March 1973, and reappeared briefly in February 1974 and more permanently in May 1975. This signal originated from the east, replacing the first signal which was from the west. The newer signal was an unevenly distributed, wideband, noise-moduated, microwave transmission which expanded the frequency coverage from approximately 0.6 to 9.5 gigahertz. In August 1975, another signal originating from the south was detected. These two signals displayed equivalent frequency modes and continued almost daily from that time until January 1979, when all radiation ceased entirely (reportedly as a result of a fire in one or more buildings from which the radiation originated).

To monitor those signals and determine trends in microwave frequency, power levels, and activity patterns, both signals were continually recorded and results telegraphed daily from the Embassy to the Medical Services Office of the State Department. The activity level ranged over the years from a low of about 8.5 hours per day to a high of about 20 hours per day, with minimal activity on weekends. When the source of the radiation shifted from the west to the east and was supplemented in August 1975 by another signal from the south, the resultant maximum radiation intensity was measured to be as high as 18 microwatts per square centimeter at times, Pulsing of the signal appeared, in contrast to the continuous wave originally coming from the west. By February 1976, protective screening was installed at the chancery. At about that time the radiation intensity striking the chancery had been reduced to about 2 microwatts per square centimeter. The effect of the screening was to reduce it to levels below 0.2 microwatts per square centimeter within the chancery. It remained at those levels until its cessation in January 1979.

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[1] This is a measure of the frequency of the microwaves. One hertz is one cycle per second. One kilohertz is 1,000 cycles per second. One megahertz is one million cycles per second. One gigahertz is one billion cycles per second. Microwave ovens typically operate at 2.45 gigahertz.

[2] Microwave intensity is generally measured in microwatts or milliwatts per square centimeter. A milliwatt is 1,000 microwatts. The maximum permissible intensity in the Soviet Union for worker exposure is 10 microwatts per square centimeter. The corresponding *recommended* limit in the United States and Canada is 10 milliwatts per square centimeter (10,000 microwatts per square centimeter).

"Moscow Viral Study"

PURPOSE AND SCOPE

By the midsixties there was sufficient awareness of the concern among a growing number of medical scientists as to the possibility of biological effects of microwaves to prompt the Medical Services Office to conduct an internal survey in 1965 of the medical records of 139 employees and 268 dependents assigned to the Moscow Embassy. The results of that survey are quoted below.

No recognizable patterns of disease or evidence of recurring problems were noted. The incidence of abnormalities does not appear significantly unusual. It is recognized that a retrospective study such as this (in contrast to a prospective study where a specific examination proforma is followed) is of limited value:

1. Statistical significance of findings cannot be determined.
2. No control group is available.
3. Examinations were conducted at varying intervals, at different facilities, and without consistency as to thoroughness, type of examination, or recording of findings.
4. Listing of interval illnesses often is incomplete.
5. Examination of children under age of 12 usually consists only of a statement of present health. No record of prior illnesses is submitted.

The inconclusive findings of that internal survey led to a contract study performed by the George Washington University School of Medicine for the Department of State. It was initiated on March 29, 1966, under Contract No. SCC-31252 and completed on June 30, 1969, under Contract No. SCC-31759.

The ambiguous project indentification "Moscow Viral Study" was adopted for general internal reference within the State Department to avoid employee concern which might be precipitated by the more definitive official title of the study "Cytogenic Evaluation of Mutagenic Exposure".[3] The program involved analysis and study of coded blood samples provided by employees before, during, and after exposure to microwave radiation at the Moscow Embassy. It was under the direction of Dr. Cecil Jacobson, Assistant Professor and then Chief of the Reproductive Genetics Unit at the George Washington University School of Medicine.

During the period of this study, in particular during calendar years 1967 and 1968, approximately 250 samples were provided from more than 71 State Department employees and family members. A number of these samples were taken from 13 personnel before assignment to the Moscow Embassy. These provided a control reference. The others were taken during the period of their assignment and at various periods after completion.

This program constituted an objective effort by the Medical Services Office of the Department of State to determine whether, in fact, employees subject to this irradiation were experiencing any health hazards attributable to it. It was recognized that other characteristics of the environment in the City of Moscow and at the Moscow Embassy could be causal factors of certain health defects which would

[3] In lay terms this would mean an evaluation of the effect on cell structure of exposure capable of causing a change in hereditary material.

considerably complicate the problem of analysis. As a step toward isolating the radiation factor, a record was developed showing the approximate actual exposure to the Embassy irradiation of each individual in the study. This was done by classifying each individual in accordance with his place of residency, whether within or outside the Embassy, in which wing, on which floor of the Embassy he or she normally worked, and the duration of such assignments. These data were available for subsequent evaluation of the findings of the study.

FINDINGS

The final report of the study was issued in August 1969. The principal investigator directing the study cited important limitations inherent in the techniques then available for the study which, combined with the limited state of knowledge of that branch of scientific investigation, appeared to impair the reliability of his findings and conclusions. The following statements from his final report illustrate the nature of his concerns in this area.

At present, the degree of clinical importance of chromosomal breakage is a debatable issue.[4] The contractor accepted these contracts in order to investigate this area.***

However, in the absence of serial samples, the contractor has been forced to make a judgment on a single sample and thus, it was necessary to attribute significance to chromatid and chromosome breaks when present in high frequency (even in the absence of definitive markers).***

In the absence of consensus in the literature on these findings a cautious attitude was adopted which may result in an overestimate of the patients mutagenic risks.***

The attempt to establish a more quantifiable method of estimating clinical risks was beset with numerous difficulties. A major concern was the relative risks attributable to both the percent of cells showing aberrations and the number and type of aberrations per cell. The numerical average often does not reflect the variation between cells. The *occasional* presence of structural rearrangements such as dicentrics and exchanges seen in a sample perplex the investigator due to their rarity in controls.

It was felt by the contractor that by rigidly adhering to the techniques utilized at the inception of this contract, both evaluation of patient exposure and technical methodology could be ascertained.

To the extent tempered by such expressions of uncertainty on the part of the principal investigator, his principal findings and judgments can be summarized as follows.

Potentially significant chromosomal anomalies were recorded and classified into five types:

Chromatid: post DNA replication, pre-division;
Chromosome: pre DNA replication, pre-division;
Marker: post division with replicating error;
Aneuploidy: chromosomal count other than 46; and
Clonal: an aberrant cell population with the same abnormality

The individual blood samples were then analyzed for frequency of occurrence of such anomalies and aberrations. On the basis of those counts, the principal investigator and study director reported findings indicating that 43 percent of the subjects exposed to the Moscow Embassy irradiation should be classified as either having actually

[4] This uncertainty is again reflected in a technical paper published in 1975. As co-author, Dr. Jacobson stated, "In most cases, the consequences of induced chromosome breakage are yet to be determined. We hope that responsible cytogenetic studies of suitable industrial populations will be a significant force in the development of this urgently needed knowledge." See Annals of the New York Academy of Sciences, Volume 269, p. 10, December 31, 1975.

experienced high risk of mutagenic exposure or were highly suspect, thereof. However, the study also showed that 38 percent of the control subjects (based on corresponding analysis of blood samples taken before assignment of those subjects to the Moscow Embassy) fell into that risk classification. The uncertainties of the laboratory methodology and the statistical limitations of the data appear to eliminate any significance in the difference between those two numbers. Of at least equal importance was the inability of the analysis to account for extraneous factors, such as caffeine, which can also contribute to such anomalies.

PEER REVIEW OF METHODOLOGY AND FINDINGS

For 6 months preceding issuance of that report, the State Department's Medical Services Office sought and obtained several independent reviews of the emerging results of the study conveyed through earlier progress reports. These judgments were from experts in the field of cytogenetics and medical genetics. One of these experts was recommended by the principal investigator of the study and two were independently selected. These specialists were:

Dr. David A. Hungerford, The Institute for Cancer Research, Fox-Chase, Philadelphia, Pa.

Dr. Kurt Hirschhorn, Professor of Pediatrics and Genetics, Chief, Division of Medical Genetics, Mount Sinai School of Medicine, City University of New York.

Dr. J. H. Tjio, Chief, Section on Cytogenetics, National Institutes of Health.

These specialists independently examined representative portions of the slides and data developed in the study, a number of them selected by the study director. Each of these specialists independently rejected the judgments and conclusions of the study director. Their reasons for such rejection were varied.

In one case the reviewer's remarks concerning the slides and related data included the following: "Poor Quality; Can't draw conclusions; Can't classify for clinical point."

Another reviewer commented as follows:

All of these counts derive from the examination of 50 metaphases by two independent observers, one of which is me; in terms of severity of aberrations, these all fall into the normal range in our laboratory. The only case which might be considered borderline is X–53, but we have seen this much in normals as well. We consider gap as meaningless and would tend to ignore all of our findings in view of the absence of chromosomal rearrangements such as dicentrics, rings, or exchange figures. I would, therefore, say from a chromosomal point of view that the clinical impression is of no risk.

Another reviewer stated:

Before commenting further, it is necessary for me to say something concerning the generally poor quality of the preparations. Many of the metaphases are over colchimized, such that the chromosomes are super condensed. In addition, the preparations are often over or understained, and there is a good deal of artifact present. To sum up, unless the quality of work can be immediately and drastically improved, I would recommend, in view of the seriousness of the matter and the difficulties inherent in the project, that it be done elsewhere.

CONCLUSIONS OF THE STATE DEPARTMENT

On the basis of these negative assessments, both of the methodology and the conclusions drawn from this study, the Medical Services

Office of the Department of State decided in June of 1969 against renewal and extension of that study. The State Department also accepted at that time the judgment and conclusions of the previously identified independent specialists to the effect that the "Moscow Viral Study" had not established any genetic or other adverse biological effect on employees and dependents attributable to microwave irradiation of the Moscow Embassy. It should be noted that the study was also unable conclusively to establish that no adverse effect could be present.

Project Pandora

PURPOSE

This project was initiated in early 1965 through funding to the Walter Reed Army Institute of Research (WRAIR) provided by the Advanced Research Projects Agency (ARPA). It's mission was to investigate possible behavioral and bioeffects (primarily the former) on primates when the latter were irradiated with microwave signals simulating the exposure of Embassy employees in Moscow. Toward that end, a "special" signal was established which contained, as far as it was then believed practical, the structure of the actual Moscow signal with respect to such parameters as frequency, modulation, and continuity. In order to accelerate potential conclusions, the *intensity* of the signal was set to the maximum useful capability of the laboratory equipment then available, which yielded an exposure intensity of between 4 and 5 milliwatts per square centimeter compared to the average intensity of a Moscow signal which generally measured between 2 and 18 microwatts per square centimeter. The program was classified, according to the record more to avoid publicity as to the purpose of the investigation than to protect the research or scientific values that might emerge.

Included in the ARPA funding was a contract with Allied Research to perform a comprehensive survey of East European scientific literature detailing experimental work containing indications of behavioral effects on animals attributable to microwave irradiation. That effort produced a complete bibliography of such work dating back to the early 1930's and nearly up to the date of its publication in December 1969. Both the State Department and the Institute for Defense Analysis considered it important to know whether or not the Moscow Embassy irradiation was able to influence in any way the behavior of persons subjected to it. Even as this report is prepared, there is little scientific evidence of such effects, although a number of investigators are performing research in this field with small laboratory animals. In the midsixties, virtually nothing was known about such possible effects, except that East European studies had reported such indications. These had not been verified by U.S. scientists. In that period there was hardly any open scientific interchange among U.S. and Russian scientists, and little of the work published in the Eastern European countries had been translated or abstracted in English.

INITIAL ACTIVITY

The record of what was done during the course of this program is scattered and incomplete. The experimental program was severely

hampered by the absence of established laboratory techniques and procedures for such experiments at WRAIR. There existed no comprehensive protocol for the conduct of the experimental program. The principal investigator, Maj. Joseph Sharp, viewed it as an exploratory study to identify effects that might justify experimental research thereafter.

The results of these studies were ambiguous and controversial. The experimental methodology led to inconclusive results. No comprehensive project report was ever prepared. Portions of the project record consisting of certain classified documents were destroyed in September of 1973, about 2 years after the project was terminated. Efforts by the Committee during the hearing in June 1977, and in subsequent briefings by the Departments of State and Defense were unable to ascertain any reason other than routine disposal of records which had no further value. Remaining unclassified notebooks, graphs, and material pertaining to animal acquisition, feed purchases, etc., devoid of useful scientific significance were turned over to the Committee in January 1978. Copies of remaining classified documents (records of what had been destroyed) were provided on June 29, 1978, at the request of the Committee.

PROJECT MONITORING

In 1968 a designated Pandora Science Advisory Committee was established to guide and advise on the continued conduct of the Pandora Project. This Science Advisory Committee (SAC) was made up of a number of scientists from a broad spectrum of activities and involvement in the field, the majority of them from outside the Government. This Advisory Committee included:

Dr. Joseph E. Barmack, Professor of Psychology, Fordham University;

Dr. James N. Brown, Electrical Engineer, Wright-Patterson Air Force Base;

Dr. H. Allen Ecker, Electrical Engineer, Georgia Institute of Technology;

Dr. Joseph Kubis, Behavioral Psychologist, Chief, Department of Psychology, City College of New York;

Dr. Lawrence Sher, Associate Professor, Bio-Physics, University of Pennsylvania;

Gen. Carl Hughes, Commanding General, Walter Reed Army Medical Center;

Dr. Lysle H. Peterson (Chairman), Professor of Physiology, University of Pennsylvania and President, University City Science Center; and

Dr. Herbert Pollack, Professor of Medicine, George Washington University; Medical Consultant, Department of Defense; Senior Staff Member, Institute for Defense Analysis.

The principal findings of the project thereafter are contained in the minutes of the SAC project review meetings, commencing December 20, 1968 through January 12, 1970, involving WRAIR project staff, representatives of the sponsoring agencies and SAC. Highlights from those meetings follow. More complete details are available in the published record.[5]

[5] The minutes of these meetings are included in the published record (Serial No. 95–49) of the Committee Oversight Hearings on Radiation, Health, and Safety, June 1977.

FINDINGS OF THE INITIAL PRINCIPAL INVESTIGATOR

In the December 20, 1968 meeting, the WRAIR project staff presented a summary of the experimental procedures and selected findings of the work accomplished up to that time on primates. The findings reflected the principal investigator's (Major Sharp's) interpretation of the experiments to the effect that learning behavior was impaired by extended exposure to microwaves. He cited results with two monkeys exposed to the "Special" Moscow signal at intensities from 1 to 4.6 milliwatts per square centimeter. They showed degradation in previously learned work performance after 11 to 21 days of such exposure at 10 hours per day. This behavioral degradation was reversible. However, the calendar time to achieve such degradation decreased somewhat with repeated series of exposures which would suggest some cumulative effect. The foregoing findings were not supported by subsequent experiments. Further discussion of these contradictory results is provided in a following section which reviews project work at WRAIR.

NEED FOR HUMAN SUBJECTS—PROJECT "BIG BOY"

Discussion of the project goals led the Pandora Science Advisory Committee (SAC) to conclude that experimentation with human subjects was essential due to fundamental limitations in any animal studies relating especially to behavior.

A key limitation was recognized by the SAC: Although alteration in learning and performance capability might indeed be detectable and even measurable in a properly conducted experimental program with animals, it might forever be impossible to detect and measure significant subjective effects relating to feelings, attitudes, moods, etc., which have such a dominant effect on human behavior. Obviously, it would require human subjects to help identify, describe, and characterize such possible effects which could then be correlated to the intensity, duration, and other parameters of the radiation to which they had been exposed. Accordingly, the general outline of, and criteria for, a study protocol was suggested based on utilization of human subjects.

During the following Pandora meeting of January 17, 1969, the SAC reviewed what was then known about the effects of microwave radiation on the physiological and psychological functions of humans. This led to selection of criteria applicable to both physiological and psychological effects to be observed and measured in an experimental program involving crew members from the *U.S.S. Saratoga*. This proposed study would involve two groups of Navy crewmen from this ship, of which one group was regularly exposed above deck to ship's radar and the other group regularly assigned below deck and effectively isolated from any significant microwave exposure. Responsibility for direction of the experimental study was assigned to Dr. Kubis and his team with the support of Commander Pratt and his staff from the *Saratoga*. The program would include recurring physical examinations, as well as psychological examinations of the various crewmen in the two groups. The study was named "Big Boy."

FINDINGS OF "BIG BOY"

During the review meeting of April 21, 1969, the activities and findings of the foregoing study were evaluated. Crewmen from the *Saratoga* had been selected and classified into three groups: Those with the highest levels of expected exposure, those with low expected levels, and those with no expected exposure. Dockside control tests, as well as seagoing tests, were conducted with the subjects in the three categories indicated. In spite of the difficulty of conducting tests under actual operational conditions compared to tests conducted under laboratory conditions, the testing was regarded by Dr. Kubis as satisfactory. The key findings were these:

(1) There were no significant differences discernible among the three groups, either in the dockside or underway tests with respect either to task performance, psychological effects, or biological effects.

(2) Although it was initially expected that maximum microwave exposure intensity would be as high as 10 milliwatts per square centimeter over 80 percent of the carrier deck, measurements in fact disclosed a maximum of 1 milliwatt per square centimeter, and generally less than one-third of that maximum.

(3) Blood studies revealed two conditions requiring further analysis which were subsequently determined to fall within the normal range.

PLANNING FOR LABORATORY STUDIES WITH HUMANS

The results of the experiment with crewmen aboard the *Saratoga* led to refocusing of the attention of the SAC on the experimental work underway at WRAIR and at other laboratories and universities dealing with microwave radiation. This included a review of the findings from WRAIR's work with primates, the findings then reported from the George Washington University "Moscow Viral Study", and an earlier Johns Hopkins study of Mongoloid children born to veterans exposed to radar. Review of all these studies confirmed to the SAC the impossibility of drawing any reliable conclusions without additional scientific study. WRAIR was requested to develop a protocol for an expanded study based on human subjects.

In its meeting of May 12, 1969, SAC reviewed WRAIR's proposed protocol for a classified study involving eight human subjects to be exposed to the same synthetic "Moscow" signal previously established for the WRAIR primate study. This protocol provided for special protective measures to be applied to safeguard the health of the subjects. Included would be an independent medical function to monitor the physical condition of the subjects and to provide regular psychiatric screening. This responsibility would be executed independent of the research project with medical personnel having no involvement in the experimental program and no commitment to its findings. In addition, the protocol provided an array of safeguards established to correct previous experimental deficiencies in the primate studies.

In the SAC meeting of June 18, 1969, the urgency of proceeding with the experimental program was reaffirmed by ARPA. Emphasis

was again placed by ARPA on the need to know whether or not the Moscow radiation could significantly affect personnel behavior, and if so, what characteristics of the signal, e.g., intensity, modulation, etc., were the most significant parameters in affecting such behavior.

In the July 16, 1969 meeting, SAC concentrated on a review of the required facilities and resources for the proposed WRAIR program. These included anechoic chambers, computer software and hardware, etc. In addition, the proposed program schedule for implementation was reviewed. SAC also requested early preparation of a complete summary of the WRAIR studies to date.

REEXAMINATION AND REVIEW OF ALL PROJECT WORK AT WRAIR

The August 12 and 13, 1969 meetings of the SAC were devoted to a complete review of the earlier WRAIR primate work previously deferred to allow the second principal investigator, Maj. James T. McIlwain, to study and assess earlier laboratory records, and to conduct additional tests. One series of experiments involved two monkeys which were subjected to signals of 4.6 mW/cm^2 and 20 mW/cm^2, respectively. Neither of the primates showed any discernible effect of exposure or nonexposure during 250 to 500 simple learning tests performed each day. Another phase of the experiment expanded the study to four monkeys subjected to 4.6 mW/cm^2 and included a multiple schedule of learning tests and rewards, Again, no significant effects could be identified which could confirm earlier findings. In general, these findings and assessments presented by Major McIlwain differed markedly from those reported in the December 1968 meeting by Major Sharp,

During the December 4, 1969 meeting of SAC, a detailed report was given by Dr. Kubis who had been requested, subsequent to the previous SAC meeting, to conduct a detailed personal study of the Pandora project effort. In particular, he was asked to reconcile the difference in interpretation of those earlier results by Dr. Sharp, the initial principal investigator, and Dr. McIlwain, the second principal investigator.

The essence of Dr. Kubis' report was this: Dr. Sharp interpreted the initial assignment as being exploratory in nature. It was a pilot experiment seeking leads of possible significance which would warrant experimental research. The most one can draw from such experiments are suggestions, not scientific conclusions. The base line data from which to assess changes in animal behavior was weak because no control animals were employed. The sample was too small to permit delineation of effects attributable to external factors versus effects that might be attributable to changes in radiation exposure. The experimental work was hampered by excessive mechanical equipment failures involving laboratory equipment which could have had more effect on animals' learning patterns than the radiation.

CONCLUSIONS OF THE SCIENCE ADVISORY COMMITTEE

In the January 12, 1970 meeting of the SAC, the Kubis report as above summarized was reviewed and discussed in detail. The SAC came to the following conclusions.

(*a*) The Pandora primate study did not provide an acceptable answer to the question as to whether or not *any* effects, either behavioral or biological, could be caused by microwave radiation of the intensity and characteristics contained in the synthetic "Moscow" signal. This failure to provide an answer was due to:

(1) Assumptions and criteria underlying the experiments were appropriate to an exploratory study to define appropriate research experiments, not to provide scientific results.

(2) Contamination of control conditions precluded establishment of acceptable base lines from which to judge departures in behavior of the subjects.

(3) Contamination of experimental conditions by equipment malfunctionings and variations in procedure precluded assignment of any observed effect to such conditions or to changes in radiation exposure.

(*b*) Reliance would have to be placed on future experimental work to be done at WRAIR and elsewhere, primarily with human subjects, even though grave questions as to the ethical acceptability of such studies were still unanswered.

Project Pandora was terminated on March 20, 1970 without further investigation. Its extension to proposed experimentation with humans was never carried out because of the DOD's concern about ill-defined requirements then emerging for fully informed and consenting subjects for human experimentation.

Study of Lymphocyte Counts

SCOPE AND DURATION

This study was undertaken by Dr. Thomas P. Stossel, Chief Medical Oncology Unit of the Massachusetts General Hospital, and Associate Professor of Medicine at Harvard University. It was authorized by the Medical Services Office of the Department of State and initiated in February 1976 and completed in June 1978. Blood counts taken by the Embassy resident medical officer as part of a general health survey on Moscow Embassy personnel had indicated a higher than average lymphocyte count. It was the purpose of this study to determine the health implications, and in particular, whether or not this higher than normal count could be attributed to the irradiation of Embassy personnel. Since it was well known that children have higher lymphocyte counts than adults, and the counts observed in children associated with the Moscow Embassy were not statistically significant from those generally published for children in the United States, it was decided to limit the detailed scope of the study to adult employees of the Embassy, including dependents to the extent possible.

CHARACTERISTICS OF LYMPHOCYTES

Lymphocytes are a class of white blood cells capable of recognizing and destroying various types of foreign matter within cells such as viruses, fungi, protozoa, and bacteria. The lymphocyte count in peripheral blood samples is variable because it is in dynamic equilibrium with other body lymphocyte compartments, any of which may encounter varying intensities of foreign matter. It is, therefore,

important that studies deal with large enough population groups wherein count distribution among the various subjects in the group could have statistical significance.

The principal causes for elevated lymphocyte counts are these.

(1) Reaction to infection or invasion by foreign materials. This count is reversible; that is, the count drops when the cause has been removed or cured.

(2) Lymphocyte transformations characteristic of the so-called neo-plastic state. These are generally not reversible. One major subclassification is referred to as acute lymphatic leukemia in which rapid accumulation of lymphocytes in the bone marrow occurs and will generally be fatal if untreated. Chronic lymphatic leukemia corresponds to a gradual accumulation in the blood, bone marrow, or lymphoid organs. Generally, this condition is treatable, but can become fatal.

STUDY POPULATION

Approximately 350 adult males and females who were Embassy employees or dependents during the time of the study constituted the study population. Of these, approximately two-thirds were male. A control group of approximately 1,000 foreign service personnel present in the United States was included in the survey as a comparison group. Included in the Moscow study group were personnel who had arrived in Moscow prior to February of 1976 and a number who arrived thereafter. The potential significance of that date derives from the fact that protective screening had been installed at the Embassy by that time which reduced the intensity of microwave radiation measurable to miniscule levels, i.e., well below one microwatt per square centimeter. Therefore, personnel assigned after that date were not subject to significant microwave radiation.

PRINCIPAL FINDINGS

(1) Blood counts from Moscow Embassy subjects showed mean lymphocyte counts among those personnel approximately 41 percent higher than those of the control group of foreign service personnel.

(2) Such higher lymphocyte counts were present equally among those employees in the test group who arrived prior to February of 1976 and those who arrived after that date when the exposure intensity had been reduced to insignificant levels.

(3) The lymphocyte count was equally high among subgroups divided by work location at the chancery, that is, regardless of whether they worked on floor levels and office locations where the relative intensity was highest or whether they worked in chancery locations where the intensity was lowest.

(4) The lymphocyte count exhibited a sharp and sustained dropoff after August, 1977, for reasons not determined. The elevated counts were reversible; that is, they were reduced to the level of the control group both for persons remaining in Moscow after August 1977, and for those leaving Moscow prior to that date.

CONCLUSIONS OF THE STUDY DIRECTOR

Quoted below is the text of the principal conclusions from this study as it pertains to the possible relationship of lymphocyte counts to microwave radiation exposure at the Moscow Embassy.

The changes in the average lymphocyte count in the Moscow population did not correlate either in time or space with the exposure of individuals within the population to microwave irradiation in the embassy, i.e., the level of lymphocyte counts did not change when microwave irradiation within the embassy was reduced, did not differ among individuals arriving before or after the reduction in radiation, or did not differ among persons likely to be maximally exposed versus those minimally exposed to the radiation.

The spontaneous remission in the lymphocyte blood count identified it as a reactive state to some foreign intrusion of the body cells attributable to some environmental condition or exposure encountered by the Moscow Embassy employees and residents. An attempt was made to obtain corresponding blood count data from the U.S.S.R. Ministry of Health for the general population level of Moscow. This request was rejected.

The study group was left then to speculate that the high lymphocyte count may have been attributable to a mild infestation of a parasite associated with the Giardia infection. Giardia epidemics have occurred in various parts of the world, including the U.S.S.R. An outbreak had occurred among tourists returning from Leningrad in 1976. Since such an infection is liable to leave no detectable traces through any routine tests available, there was no way to confirm or deny the validity of such speculation. During the period of the study, there was no overt Giardia epidemic reported in Moscow, nor among Moscow Embassy personnel.

The substantial variation in lymphocyte counts among individuals is such that very few individuals in the population study would have raised the concern of private physicians confronted with those persons' lymphocyte counts. The lack of any symptoms of hematologic disease among the subjects confirms a finding that the lymphocyte counts contained no implication with respect to the general health of the population studied.

The principal investigator on this study summarized his opinion as to the results as follows:

(1) The U.S. Embassy personnel in Moscow had a higher population average lymphocyte count because there is a mild reaction to an unknown environmental agent.

(2) Although it is probably not feasible to determine the nature of this agent, it is probably microbial.

(3) This reaction began at an unknown date and persisted until August of 1977.

(4) This reaction disappeared in persons who left Moscow.

(5) This reaction has no connection with exposure to microwave irradiation in the U.S. Embassy.

(6) This reaction has no importance with respect to the general health of persons associated with the U.S. Embassy.

Johns Hopkins Foreign Service Health Status Study

PURPOSE AND SCOPE

This study was initiated on June 21, 1976, and was completed with the issuance of a report on November 20, 1978. It was conducted by the School of Hygiene and Public Health of Johns Hopkins University, authorized and funded by Study Contract 6025–619073, granted by the Office of Medical Services of the Department of State. The

principal investigator and study director was Dr. Abraham Lilienfeld, Distinguished Service Professor of Epidemiology at Johns Hopkins University.

The objective of the study was to conduct a complete mortality and morbidity analysis of Moscow Embassy employees and dependents assigned there during the period from 1953 to 1976. Included in that group would be employees from all agencies of the Government there assigned, not only State Department employees. The analysis would include a comparison of the mortality and morbidity experience of the foregoing study group with a control group [6] from the other East European embassies in Budapest, Leningrad, Prague, Warsaw, Belgrade, Bucharest, Sophia, and Zagreb. That choice was based upon the desire to have a control group that was as much like the Moscow Embassy group as practicable. In particular, the control group would have met the same State Department medical and psychological screening processes applicable to Eastern European assignments and would have been subject during those assignments to comparable tensions attributable to political climate, communications barriers, consumer goods scarcities, social and cultural activities, etc. Of critical importance, of course, was the reported freedom of any of those embassies from microwave irradiation.

BASIC DATA SOURCES

There were four primary sources of input data for the statistical analysis performed. These were:

(1) the State Department and other Government agency medical records;
(2) individual health history questionnaries;
(3) death certificates; and
(4) telephone interviews.

A major and time-consuming effort was expended in identifying the persons actually involved. This effort included, for example, screening approximately 150,000 service record cards. Other sources of data included:

State Department computer printout of current personnel.
United States Information Agency.
Foreign Agriculture Service.
Abstracts of various Foreign Service lists by State Department personnel.
Staffing Patterns, June 1976.
Who's Who in Moscow, August 1976.
Marine Security Guards, Eastern Europe.
Department of Defense (Army, Navy, Air Force, Marines, civilians).
Department of State personnel, Warsaw, 1954–76.
Retired Department of State Foreign Service Officers.
Listings of dependents of State Department personnel found in Archives in St. Louis.
Directory of Moscow Embassy—1967.
Tracing questionnaires.
Lists and directories mailed in from study participants.

[6] Any person serving tours both at Moscow and any other embassy post was included in the Moscow group.

After the names of the persons encompassed by the two population groups were determined there followed the major task of obtaining individual medical histories. The following table shows the principal sources for those records.

Employer	Current employees and dependents	Retired employees and dependents
State Department	Medical Record Division, State Department, Washington, D.C.	Federal Record Center, Civilian Record Branch, St. Louis.
Defense Department (military).	At employee's present post, United States and foreign countries.	Military Record Center, St. Louis.
Defense Department (civilian)	Dispensary of present post, all over United States and foreign countries.	Federal Record Center, Civilian Record Branch, St. Louis.
U.S. Information Agency	Medical Record Division, State Department, Washington, D.C.	Do.
Foreign Agriculture Service	do	Do.

Medical records for current military personnel formerly assigned to the Moscow Embassy were particularly difficult to obtain as they are located with the individual at his current post, wherever that may be. Indeed, the study deadline forced curtailment of the search for a number of these records.

Quality control procedures were designed and applied to assure thorough abstracting of the desired data from the medical records. Monitoring of those procedures was accomplished by a sustained program of 10 percent sampling by independent abstractors. Training sessions were conducted to assure standardization in the coding of information extracted for subsequent data processing and analysis. For that purpose, 150 computer programs were designed of which 100 were for data processing and 50 for data analysis.

STUDY GROUP COMPOSITION

The potential study population of all persons serving or having served at any of the Eastern European embassies during the period January 1, 1953 through June 30, 1976 totaled 12,671. Of this number about 4,800 employees and dependents had served at Moscow, the remainder at the eight comparison posts.

The massive effort of identifying and tracing the individuals yielded a total of 4,179 employees traced for subsequent analysis. In spite of the difficulties encountered in obtaining histories of the persons traced, completed data covering information on years observed, age at entry into the study, and year of arrival at an embassy post was obtained for 4,033 of these. Medical abstracts adequate for statistical analysis were compiled for 3,094 employees.

The age distribution of Moscow and comparison post employees of the State Department were quite similar. Approximately one-third of the Moscow employees traced yielded histories of 15 to 20 years duration. This provided a base for detecting late eruption of a disease which might possibly have been initiated by early exposure to microwaves at the Moscow Embassy.

In addition to the employee numbers above summarized, the total population included 8,283 dependents, of whom 5,474 were children and 2,809 adults. Approximately 5,000 of these were not known to have lived at any of the embassy posts. Of all the dependents, ade-

quate medical records could be obtained on 3,881. Of those known to have resided at an embassy post, medical records were attainable for 2,336 dependents. Of the latter number 1,468 were children.

PRINCIPAL FINDINGS

Employees

(a) *Mortality comparison*

The data base for the mortality analysis consisted of a total of 4,179 employees in the Moscow and control groups whose histories could be traced. Of these, 1,719 were from the Moscow Embassy group and 2,460 were from the comparison post group. Of the former, 56 had died, and of the latter group, 138 had died. Death certificates or other adequate information for mortality analysis by cause were available for 181 of the deceased subjects.

Based on the total deaths in the two groups an SMR[7] of 0.47 was computed for the Moscow Embassy group versus an SMR of 0.59 for the comparison group from the other Eastern European embassy posts. Mortality experience by sex for all causes and for the two principal causes of death is summarized in the following tables:

MORTALITY COMPARISON (MALE)

Cause of death	Number of deaths (male)		Ratio (actual to expected)	
	Moscow	Comparison	Moscow	Comparison
All causes	45	107	0.73	1.2
Malignant neoplasms	11	33	.63	1.3
Heart disease	17	29	.94	1.0

MORTALITY COMPARISON (FEMALE)

Cause of death	Number of deaths (female)		Ratio (actual to expected)	
	Moscow	Comparison	Moscow	Comparison
All causes	11	31	0.85	1.1
Malignant neoplasms	8	14	1.10	.94
Heart disease	1	3	.81	1.1

The foregoing findings indicate that the overall mortality experience involving all causes of deaths were more favorable for the Moscow Embassy group than for the control group. This was also true for three of the four subgroups formed about the two principal causes of deaths and the subdivision between male and female. The one departure, namely the subgroup involving female death rate from malignant neoplasms shows a higher ratio of actual to expected than the ratio obtained for the control group. The experts conducting this study did not identify this departure as statistically significant. It is recognized that every subgroup reduces the affected population and the number of incidents, and thereby the statistical significance of calculated results. Further analysis disclosed that there were seven different cancer sites involved in those eight cases which virtually eliminates a single causal factor.

[7] This SMR or "standardized mortality ratio" is the ratio of actual results encountered to those expected from general population statistics after adjustment for the age distribution involved.

(b) Morbidity comparison

Numerous health comparisons were derived from statistical analysis of the incidence of each of approximately 70 medical conditions of the two employee groups as indicated by health at time of survey, record of hospitalization or medical evacuation, significant medical problems reported, etc.

Perhaps the most comprehensive of the many comparative analyses completed was that involving 44 standardized medical conditions first occurring after the subject had arrived at an embassy post. The two tables on the following pages summarize those results for male and female members of the comparison groups, based on abstracts from their medical records.

Those tables show that the incidence of these 44 medical conditions is quite similar for the Moscow group and the comparison groups. The Standardized Morbidity Ratios [8] are higher in the Moscow groups for about half the conditions listed and vice versa. Generally, the differences are not statistically significant. In the few cases where they are it was found that Moscow males had higher rates than the comparison males for protozoal intestinal diseases, benign neoplasms, and diseases of nerves and peripheral ganglia. The rate for pneumonia was higher in the comparison group for males and females. Among Moscow females the rates for protozoal intestinal diseases, and complications of pregnancy and childbirth were higher than for comparison group females.

STANDARDIZED MORBIDITY RATIOS (SMBR) FOR MEDICAL CONDITIONS FIRST ENCOUNTERED AFTER FIRST TOUR OF DUTY

Medical condition	Moscow group			Comparison group		
	Number of incidents	Rate per 1,000 PY [1]	SMBR	Number of incidents	Rate per 1,000 PY [1]	SMBR
MALE						
Amebiasis	21	2.0	.86	41	2.5	1.1
Protozoal intestinal disease	21	2.0	1.7	8	.48	.48
Diarrheal disease	58	5.5	.97	95	5.8	1.0
Herpes simplex	8	.76	1.5	5	.30	.65
Measles	2	.19	.50	9	.55	1.3
Infectious hepatitis	7	.66	1.0	11	.67	.97
Mumps	9	.86	.81	19	1.2	1.1
Dermatophytosis	42	4.0	1.0	60	3.6	.99
Helminthiasis	11	1.0	.70	27	1.6	1.2
Malignant skin neoplasm	15	1.4	1.3	15	.90	.80
Malignant neoplasm, excluding skin	13	1.2	.95	24	1.5	1.0
Benign neoplasms	119	11.3	1.2	151	9.2	.90
Diabetes mellitus	22	2.1	1.2	26	1.6	.87
Obesity (nonendocrine)	82	7.8	.98	130	7.9	1.0
Blood diseases	34	3.2	1.2	40	2.4	.87
Neuroses, personality disorders	82	7.8	1.0	122	7.4	.98
Migraine	2	.19	.62	6	.36	1.3
Diseases of nerves and peripheral ganglia	32	3.0	1.3	32	1.9	.80
Inflammatory eye diseases	47	4.5	1.0	70	4.2	1.0
Eye: Refractive errors	178	16.9	1.0	276	16.7	.98
Eye: Other conditions	77	7.3	1.0	128	7.8	1.0
Diseases of ear and mastoid	117	11.1	1.1	149	9.0	.92
Hypertensive disease	61	5.8	1.0	99	6.0	.97
Ischemic heart disease	39	3.7	1.2	59	3.6	.90
Other forms of heart disease	82	7.8	1.0	131	7.9	.96
Diseases of arteries, arterioles, capillaries	33	3.1	1.3	51	3.1	.88
Diseases of veins, lymphatitis	168	16.0	.99	271	16.4	1.0
Acute respiratory infections except influenza	79	7.5	1.2	94	5.7	.90

[8] Ratio of percent of occurrence in the study group to that expected in the general population adjusted for age and calendar year.

STANDARDIZED MORBIDITY RATIOS (SMBR) FOR MEDICAL CONDITIONS FIRST ENCOUNTERED AFTER FIRST TOUR OF DUTY—Continued

Medical condition	Moscow group			Comparison group		
	Number of incidents	Rate per 1,000 PY[1]	SMBR	Number of incidents	Rate per 1,000 PY[1]	SMBR
Influenza	40	3.8	1.2	41	2.5	.8[6]
Pneumonia	14	1.3	.6	42	2.5	1.2
Bronchitis, emphysema, asthma	48	4.6	.95	87	5.3	1.0
Other disease upper respiratory tract	80	7.6	.98	125	7.6	1.0
Other diseases of respiratory system	68	6.5	1.1	90	5.4	.9[3]
Diseases of esophagus, stomach, and duodenum	76	7.2	.93	137	8.3	1.0
Hernia of abdominal cavity	56	5.3	1.1	79	4.8	.92
Other diseases of intestine and peritoneum	71	6.7	.90	137	8.3	1.1
Diseases of liver, gall bladder, pancreas	33	3.1	1.1	50	3.0	.96
Diseases of genitourinary system	162	15.4	1.0	268	16.2	1.0
Diseases of skin and subcutaneous tissue	239	22.7	1.1	331	20.0	.95
Diseases of musculoskeletal system and connective tissue	227	21.6	.99	376	22.8	1.0
Nervousness and debility	59	5.6	.96	100	6.1	1.0
Accidents, poisonings, violence	211	20.0	1.1	288	17.4	.96
Accidents, external cause	86	8.2	1.1	102	6.2	.91
FEMALE						
Amebiasis	11	3.5	1.6	11	1.6	.72
Protozoal intestinal disease	6	1.9	2.1	2	.29	.39
Diarrheal disease	23	7.3	1.1	45	6.5	.95
Herpes simplex	0	0	Und.	3	.43	1.4
Measles	2	.64	1.1	4	.58	.97
Infectious hepatitis	0	0	Und.	3	.43	1.5
Mumps	3	.95	1.2	5	.72	.90
Dermatophytosis	5	1.6	1.0	10	1.4	.99
Helminthiasis	0	0	Und.	4	.58	1.4
Malignant skin neoplasm	1	.32	.85	2	.29	1.1
Malignant neoplasm, excluding skin	17	5.4	1.2	29	4.2	.92
Benign neoplasms	64	20.3	.99	140	20.1	1.0
Diabetes mellitus	2	.64	.4	14	2.0	1.3
Obesity (nonendocrine)	35	11.1	1.2	51	7.3	.89
Blood diseases	19	6.0	1.0	40	5.8	.99
Neuroses, personality disorders	22	7.0	1.0	50	7.2	1.0
Migraine	5	1.6	1.7	5	.72	.71
Diseases of nerves and peripheral ganglia	6	1.9	.80	19	2.7	1.1
Inflammatory eye diseases	11	3.5	1.2	18	2.6	.90
Eye: Refractive errors	56	17.8	1.1	115	16.5	.97
Eye: Other conditions	18	5.7	1.1	33	4.7	.94
Diseases of ear and mastoid	27	8.6	1.0	52	7.5	.98
Hypertensive disease	16	5.1	.94	43	6.2	1.0
Ischemic heart disease	5	1.6	.64	18	2.6	1.2
Other forms of heart disease	26	8.3	1.1	49	7.1	.94
Diseases of arteries, arterioles, capillaries	5	1.6	.67	17	2.4	1.2
Diseases of veins, lymphatitis	59	18.8	1.2	108	15.5	.93
Acute respiratory infections except influenza	19	6.0	.90	46	6.6	1.0
Influenza	11	3.5	1.1	18	2.6	.93
Pneumonia	5	1.6	.63	20	2.9	1.2
Bronchitis, emphysema, asthma	11	3.5	.78	36	5.2	1.1
Other diseases of upper respiratory tract	23	7.3	.82	63	9.1	1.1
Other diseases of respiratory system	19	6.0	1.2	34	4.9	.92
Diseases of esophagus, stomach, and duodenum	16	5.1	.86	44	6.3	1.1
Hernia of abdominal cavity	7	2.2	.84	17	2.4	1.1
Other diseases of intestine and peritoneum	21	6.7	1.0	49	7.1	1.0
Diseases of liver, gallbladder, pancreas	10	3.2	1.4	15	2.2	.84
Diseases of genitourinary system	155	49.3	1.0	291	41.9	0.98
Complications of pregnancy, childbirth, and puerperium.	11	3.5	1.7	9	1.3	.67
Disease of skin and subcutaneous tissue.	65	20.7	1.0	131	18.9	.99
Disease of musculoskeletal system and connective tissue.	81	25.7	1.1	150	21.6	.96
Nervousness and debility	17	5.4	.80	52	7.5	1.1
Accidents, poisonings, violence	51	16.2	1.0	111	16.0	.99
Accidents, external cause	18	5.7	.82	51	7.3	1.1

[1] Person years spent at Embassy posts.

When those same medical conditions were compared within the Moscow group according to the degree of microwave exposure encountered the differences disappeared. On the other hand the latter comparison disclosed that the incidence of respiratory tract problems and nervous debility was higher among the unexposed than among the exposed group at Moscow, whereas the incidence of other than skin cancer was somewhat higher in the exposed group.

Insofar as practical the study examined the possible effect of other factors on health status such as cigarette smoking, exposure to occupational chemical hazards, residence history, etc. Of these, suitable data was obtainable on the most important, cigarette smoking. Smoking habits were so similar between the two comparison groups among men and women in various age brackets that smoking had to be dismissed as a factor in comparative health statistics.

In another comparison of 28 more general medical conditions, three were identified in which the Moscow group showed statistically significant rates that were higher than the comparison group. These were eye problems (primarily common refractive errors), psoriasis and other assorted skin conditions (mostly cysts, dermatitis and eczema). When these were analyzed in terms of comparative incidence within the Moscow groups for persons maximally exposed to microwaves and those unexposed no statistically significant differences could be found.

Another analysis of 20 commonly reported symptoms (many of a subjective nature) showed four with statistically significant higher rates for the Moscow group than for the comparison group. These were depression, irritability, loss of appetite and difficulty concentrating. When these were analyzed within the Moscow group, it was found that the rate of occurrence was higher among those least exposed to microwaves than among those most exposed.

For one important condition, malignant neoplasms other than skin, a statistically significant and much higher SMBR (1.7) was found for females in the Moscow group, versus females in the comparison group (0.6) based on data from Health History Questionnaires. When this condition was compared for females within the Moscow group according to degree of exposure to microwaves, it was found that the rate was highest for those who had minimum exposure to microwaves. Furthermore, 7 different cancer sites were involved in the 10 cases making it extremely difficult to attribute any single cause as a principal factor.

Employee dependents

(*a*) *Mortality*

The following tables summarize and compare mortality experience of dependents who were known to have lived at embassy posts at any time during the span of the study, 1953 to 1976. These tables are limited to principal causes of death, although the study provides data on all causes investigated.

MORTALITY EXPERIENCE—ADULT DEPENDENTS

Cause of death	Moscow group		Comparison group	
	Actual number	Ratio—actual-expected	Actual number	Ratio—actual-expected
All causes	12	0.80	33	1.1
Cancer	5	.75	15	1.1
Heart	2	.75	6	1.1

MORTALITY EXPERIENCE—DEPENDENT CHILDREN

Cause of death	Moscow group		Comparison group	
	Actual	SMR	Actual	SMR
All causes	8	0.83	13	0.66
Cancer	2	.38	1	.79
Accidents	2	.68	3	.56

These data have little statistical significance because of the small numbers involved. More difficulty was encountered ascertaining the residence status of dependents than employees because of uncertainties as to when dependents arrived or left an embassy location. This reduced sharply the number available in the data base for mortality analysis.

(*b*) *Morbidity*

Analysis of the frequency of occurrence of any of 44 medical conditions at any time after arrival of an adult dependent to an embassy location yielded the following results. There were 23 of those medical conditions for which the rate of occurrence for the adult Moscow resident dependents was higher than at comparison posts, 20 for which it was lower, and 1 for which it was the same.

Within the various medical conditions, the differences were not held to be statistically significant. It was noted that for both the Moscow and comparison groups, employee dependents who had never lived at *any* embassy post experienced lower morbidity ratios, i.e., fewer medical conditions, than those who did.

Another comparison was based on the most often recorded medical complaints by dependent adults after arriving at an embassy post. The 20 most frequent complaints among the Moscow resident dependents all were included among the 24 most frequently recorded complaints by dependent adults after arriving at a comparison post. This high degree of commonality is difficult to reconcile with the existence of a significant adverse environmental factor such as microwave exposure. The higher frequency of those complaints reported by the Moscow group is, however, suggestive either of more generally adverse living conditions in Moscow or more intensive health monitoring associated with the resident medical officers' awareness of the microwave irradiation. The foregoing findings were subject to critical evaluation by the study team in the course of coming to that assessment.

The following table presents the results of analysis of the rate of occurrence of 44 medical conditions first observed after a dependent child arrived at an embassy post. The Standardized Morbidity Ratios (SMBR) are compared for the two groups of children, those resident in Moscow versus the comparison posts.

ANALYSIS OF MEDICAL CONDITIONS FIRST ENCOUNTERED AFTER ARRIVAL AT AN EMBASSY POST (DEPENDENT CHILDREN)

Medical condition	Number reported		SMBR	
	Moscow	Comparison	Moscow	Comparison
Amebiasis	3	15	0.59	1.3
Protozoal intestinal disease	2	3	1.1	.84
Diarrheal disease	9	18	.74	.76
Herpes simplex	2	2	2.1	.93
Measles	18	32	1.2	1.0
Infectious hepatitis	0	2	Und.	2.5
Mumps	26	23	1.8	.77
Dermatophytosis	6	9	1.4	1.0
Helminthiasis	11	12	1.4	.73
Malignant skin neoplasms	0	0	Und.	Und.
Malignant neoplasms, except skin	1	1	1.4	.58
Benign neoplasms	11	18	.90	.88
Diabetes mellitus	0	0	Und.	Und.
Obesity (nonendocrine)	13	26	.81	.90
Blood diseases	19	14	1.8	.70
Neuroses, personality disorders	9	33	.64	1.2
Migraine	1	2	1.5	1.2
Diseases of nerves and peripheral ganglia	1	1	1.5	.83
Inflammatory eye diseases	12	17	1.2	.92
Eye: refractive error	61	108	1.1	1.0
Eye: other conditions	12	24	1.1	1.1
Diseases of ear and mastoid process	30	56	.89	.88
Hypertensive disease	0	1	Und.	.29
Ischemic heart disease	0	0	Und.	Und.
Other forms of heart disease	19	15	1.4	.62
Diseases of arteries, arterioles, capillaries	0	0	Und.	Und.
Diseases of veins, lymphatitis	5	12	.89	1.0
Acute respiratory infections except influenza	46	51	1.2	.72
Influenza	5	13	.94	1.5
Pneumonia	7	15	.72	.99
Bronchitis, emphysema, asthma	15	34	.88	1.1
Other diseases of respiratory tract	51	102	.94	1.0
Other diseases of respiratory system	5	8	.82	.70
Diseases of esophagus, stomach and duodenum	5	13	.86	1.1
Hernia of abdominal cavity	9	8	2.1	.92
Other diseases of intestine and peritoneum	3	10	.67	1.1
Diseases of liver, gall bladder, pancreas	2	7	.45	1.3
Diseases of genitourinary system	39	80	1.1	1.2
Complications of pregnancy, childbirth and puerperium	0	1	Und.	.54
Diseases of skin and subcutaneous tissue	63	87	1.2	.85
Diseases of musculoskeletal system and connective tissue	23	66	.96	1.3
Nervousness and debility	4	20	.63	1.3
Accidents, poisonings, violence	73	108	1.2	.97
Accidents, external cause	23	41	1.1	1.1

Of the 44 conditions analyzed, the results for five were considered statistically significant. For four of these (mumps, anemic blood diseases, heart disease, and respiratory infections) the SMBR's were higher for the Moscow than the comparison group. For the other, diseases of the musculoskeletal system, the SMBR was higher for children at comparison posts. However, for three of the five, the SMBR's were highest for children who had never been known to be residents at any embassy post.

One especially important and unique requirement of the study was analysis of congenital defects occurring in 674 children born after one or both parents arrived at an embassy post. Fifty-one of these had congenital anomalies. The analysis is contained in the following table.

CONGENITAL ANOMALIES IN CHILDREN BORN AFTER PARENTS' ARRIVAL AT AN EMBASSY POST

Congenital anomaly class	Observed number of congenital anomalies in children born after embassy tour		Observed to expected raios	
	Moscow parent	Comparison parent	Moscow parent	Comparison parent
All anomalies	[1] 19	[2] 32	0.9	1.1
Spina bifida	1	1	1.2	.8
Nervous system	1	0	2.5	0
Eye	2	4	.8	1.1
Ear	1	0	2.5	0
Heart	0	3	0	1.7
Respiratory system	0	3	0	1.7
Cleft lip and palate	1	0	2.5	0
Upper alimentary tract	2	1	1.7	.6
Other digestive	0	1	0	1.7
Genital organs	2	4	.8	1.1
Clubfoot	4	3	1.4	.7
Other limb	2	8	.5	1.4
Skin	3	4	1.0	.9

[1] 7 percent.
[2] 8 percent.

The table shows a moderately lower rate of occurrence of anomalies of all classes for the Moscow than the comparison group, with both groups about at the expected level for the general population. Of the 13 classes, rates were higher in 7 and lower in 6 for the Moscow group.

CONCLUSIONS OF THE STUDY TEAM

The key conclusions of the team of scientists who conducted this study are as follows:

1. *Mortality.*—There is no evidence that the Moscow group has experienced any higher total mortality or for any specific causes of death up to this time. It should be noted, however, that the population was relatively young, and it is too early to have been able to detect long-term mortality effects except for those who had served in the earliest period of the study.

It is reasonable to conclude from the results of the analysis of the experience of the identified dependents, that no differences in mortality were detected between the Moscow and comparison dependent groups of children or adults.

2. *Morbidity.*—The study group was found to be subject to a large variety of health problems, many of which were serious; but to a great degree, the risks of developing these problems were shared nearly equally by both groups. Only two differences, based on the medical record review, stood out: (1) the Moscow male employees had a threefold higher risk of acquiring protozoal infections between the time of arrival at the post and the time of last observation than did the comparison employees; and (2) both men and women in the Moscow group were found to have slightly higher frequencies of most of the common kinds of health conditions reported. However, these conditions represented a very heterogeneous collection and it is difficult to conclude that they could have been related to exposure to microwave radiation since no consistent pattern of increased frequency in the group exposed to other than background microwave radiation could be found.

A somewhat different indication of the health status of the two employee groups was derived from analysis of the responses to the Health History Questionnaire. While many reported problems were similar in both groups, there were some noteworthy excesses in the Moscow employee group. Both men and women reported more problems with their eyes; however, most of this increase was due to correctable refractive errors. The men reported more problems with psoriasis and women with anemia. The Moscow group, expecially the men, reported a variety of symptoms after their duty tour much more frequently than the comparison group: more depression, more irritability, more difficulty concentrating and more memory loss. Many other symptoms were higher in the Moscow group, but not to the degree as these four. In view of the possibilities which had been publicized of the increased danger to their health and that of their children, it is not at all surprising that the Moscow group might have had an increase in symptoms such as those reported. However, no relationship was found between the occurrence of these symptoms and exposure to microwaves; in fact, the four symptoms mentioned earlier, which showed the strongest difference between the Moscow and comparison groups, were all found to have occurred most frequently in the group with the least exposure to microwaves.

In spite of the problems encountered in enumerating all dependents, the morbidity experience of dependents, both adults and children, was analyzed using available data from the medical record review and from the Health History Questionnaire. No consistent differences were noted among adults taking into account whether or not they had resided at the post at the time of service.

The children studied had experienced many health problems, the vast majority of which were similar in both the Moscow and comparison groups. The only problem definitely present to a greater extent in the children who had lived in Moscow compared with those who had lived in one of the comparison posts was the occurrence of mumps which was more than twice as frequent in the Moscow children during the period from the time of arrival at the Embassy until the time of the last observation.

Congenital anomalies occurring after arrival at the duty posts were studied, and although anomalies had occurred, no difference could be detected between the two study groups in this regard.

3. *Overall.*—To summarize, with very few exceptions, an exhaustive comparison of the health status of the State and non-State Department employees who had served in Moscow with those who had served in other Eastern European posts during the same period of time revealed no differences in health status as indicated by their mortality experience and a variety of morbidity measures. No convincing evidence was discovered that would directly implicate the exposure to microwave radiation experienced by the employees at the Moscow Embassy in the causation of any adverse health effects as of the time of this analysis.

Public Issues, Comments and Conclusions

These center about the following questions.

1. Was the health and safety of U.S. personnel assigned to the U.S. Embassy in Moscow in fact harmed by their exposure to microwave radiation during such assignments?

The four major studies summarized in the preceding sections, extending over a calendar period of about 13 years sought and analyzed all available information in order to answer this question of overriding importance to the employee group and to the Government agencies involved. The first two of those studies were exploratory in nature and were conducted under inadequately established laboratory procedures. Their findings were variously interpreted by different reviewers. Those studies were inconclusive.

The succeeding studies conducted during the calendar years 1976–78 were conducted with sound scientific and analytical methodology directed toward more definitive goals. Those studies indicate that microwave radiation of the nature, duration, and intensity experienced by Moscow Embassy employees and dependents did not cause health defects detectable either through blood cell analysis, morbidity analysis, or mortality analysis.

Questions can, and probably will, be raised about the adequacy or finality of these findings and conclusions. For example, whereas the latter studies conclude correctly that malignant neoplasms (cancer) were less prevalent among the Moscow Embassy personnel exposed to microwaves than among control groups not so exposed, they do not and cannot answer the question as to whether any of those specific incidents were or were not attributable to microwave radiation.

At the present time, there is no known and proven mechanism by which nonionizing (microwave) radiation can cause such a biological effect. This fact supports the validity of the *statistical conclusion* which the studies developed. But that unanswered question also supports the wisdom of a recommendation contained in the Hopkins Foreign Service Health Status Study that health monitoring of certain portions of the study group continue for a number of years. This pertains especially to those assigned at the Moscow Embassy between June 1975 and February 1976 when recorded exposures were at their highest. Persons so exposed may have incurred bioeffects with a prolonged latency period which would not manifest ill effects for a number of years thereafter. It is urged that the State Department pursue this recommendation [9] for continued monitoring of the health of affected persons and to preserve all existing records of their work and residency locations, radiation measurements, etc.

Questions can be raised as to whether health data from the large population of Moscow Embassy employees whose health histories could not be obtained and analyzed would have significantly altered the findings. Although there is no basis for believing the results from that group would be significantly different, the possibility remains.

Questions can also be raised concerning the methodology applied to the interpretation of some of the findings of the Hopkins study. In particular, certain medical conditions which showed a statistically significant higher rate of occurrence in the Moscow group than in the Eastern European comparison embassy group were discounted as of no further importance if it was found that the same condition *within* the Moscow group occurred with equal or higher frequency in those persons receiving minimum exposure in Moscow as in those receiving maximum exposure. In effect, this assigns equal weight to comparative

[9] This recommendation reflects a precautionary attitude rather than one compelled by the facts. The population study included a substantial number with health histories extending 15–20 years after initial exposure. Furthermore, there is no known mechanism by which low-level nonionizing (microwave) radiation can cause permanent cell damage analogous to the known mechanism for ionizing radiation (X-rays and radioactive emissions) wherefrom future disease may evolve.

findings within the Moscow group, based on degree of exposure at Moscow, to comparative findings of the Moscow group as a whole with the Eastern European group as a whole. But the doubtful reliability and accuracy of information as to relative exposure within the Moscow group impairs the validity of this element of the methodology.

An alternative methodology for further evaluation of medical conditions found to be statistically more prevalent in certain Moscow subgroups than in corresponding Eastern European embassy comparison subgroups avoids that uncertain data base. This approach assigns importance to the absence of any pattern of consistency within any of the classes of medical conditions encountered. For example, it was found that the cancer rate for other than skin cancers for females in the Moscow group was almost three times as high as in the comparison group based on Health History Questionnaires. But the 10 Moscow cancer cases were distributed among 7 different types. The study reported it difficult to believe that any single environmental factor (such as microwave radiation) could be the significant factor in so diverse a set of symptoms.

Relative to the female cancer subgroup, it should be noted that the findings based on abstracts from the medical records (as opposed to information on the questionnaires) showed comparable rates for both skin and other than skin cancers among Moscow and comparison post female employees with no statistically significant difference between those rates.

In spite of these elements of recognized uncertainty, the weight of the findings of those studies supports the conclusion that Government employees did not encounter health hazards traceable to their exposure for various periods to microwave radiation levels ranging from 0.2 to 18 microwatts per square centimeter.

2. Does the answer to question No. 1 provide useful information as to the nature and level of microwave radiation that should be permitted throughout the public domain of the United States?

Had the findings and conclusions been opposite to what they were, they would have contributed significantly. The level of exposure measured at the Moscow Embassy never exceeded about 18 microwatts per square centimeter which is far below the U.S. voluntary standard for worker exposure (10,000 microwatts or 10 milliwatts per square centimeter). There are no mandated standards [10] applicable in the United States for either worker or public exposure. Therefore, the Johns Hopkins' conclusions from a study in which the subjects were exposed to no more than 18 microwatts per square centimeter contributes little to answering the question as to the level, if any, for such a standard.

3. Did the State Department diligently seek scientifically and medically sound information bearing on the health of Embassy personnel exposed to the microwaves, or did it adopt a policy of diversion and evasion to camouflage the true dimensions of the potential health hazard involved?

This issue has been framed in those terms because the State Department (and other Government agencies) have been charged in certain media reports with indifference to alleged health hazards and deliberate concealment of such hazards from the public. The record reflects that for over a decade from the time of initial discovery in

[10] See Report on Radiation Health and Safety, dated December 1978, printed for the Committee on Commerce, Science, and Transportation for discussion and recommendations relating to this subject.

1953 of microwave radiation at the Moscow Embassy, nothing of a medical or scientific nature was done to evaluate the potential health hazard to Embassy employees exposed to this radiation. During that period only scant attention was paid by the U.S. scientific community to Soviet and East European animal experiments suggesting effects, particularly behavioral effects, attributable to microwaves below the so-called thermal level of 10 milliwatts per square centimeter. The only linkage generally recognized in the United States involved intensities of exposure above that level which would cause bodily injuries due to overheating. Occurrence of cataracts in laboratory animals exposed to intense microwave fields is an example of such an effect.

In the mid-1960's a comprehensive survey of such East European experiments was initiated by funding from ARPA. It provided a bibliography of such experiments as well as translations and abstracts of many of the reports. A definitive program was initiated by the Medical Services Office of the State Department in 1965 to evaluate what was believed by them to be a highly improbable health hazard. Its efforts, thereafter, to resolve this question were pursued through contracts with independent hospital and university-affiliated contractors. Parallel with the State Department effort in the mid-1960's was a separate experimental effort by the DOD to evaluate possible behavioral effects of microwave radiation using primates as the subjects.

In sum, a comprehensive effort was initiated once a broader awareness of the possibility of injury had been recognized.

4. Was the State Department justified in withholding information from Moscow Embassy employees for about 23 years (1953 to 1976 [11]*) as to the existence of such radiation?*

Throughout that period, the Medical Services Office of the State Department believed that there was no adverse health effects from those low levels of radiation and that knowledge of its existence would unnecessarily add another source of uneasiness or tension to the lives of Moscow Embassy personnel. The State Department, thus, used the analogy of individual physicians withholding medical information from patients when, in their judgment, the well-being of the patient was better protected by so doing. But this substitution of a doctor/patient relationship for an employer/employee relationship is not defensible, regardless of the outcome of the studies. The employees should have been promptly informed of the situation.

5. Were adequate efforts pursued by the Department of State to determine the purpose of the microwave irradiation and to have it stopped?

Requests to the U.S.S.R. to stop the irradiation of the U.S. Embassy were ignored. Such requests by the State Department could not be supported by evidence of health defects incurred, nor by arguments as to the potential for such defects, because the U.S.S.R. was well aware that the maximum levels recorded were hundreds of times less than accepted limits in the United States for worker exposure.

Exploration of the purpose for the irradiation and the nature of any countermeasures by the United States was not included in this study as it has no bearing on the issue of health and safety effects of the radiation actually encountered.

[11] Although the State Department did not inform its employees before 1976, information as to the Embassy microwave irradiation did leak and was reported in the media in 1972.