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UNITED STATES GOVERNMENT

# Memorandum

TO : Mr. Cochran

DATE: 1/11/79

FROM : W. D. Campbell

SUBJECT: TESTIMONY OF ACOUSTICS EXPERTS BEFORE THE HOUSE SELECT COMMITTEE ON ASSASSINATIONS

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PURPOSE:

To respond to the Director's inquiry concerning "What do we know about the accuracy of this method of tracing?" used by the House Select Committee on Assassinations.

SYNOPSIS:

This document presents a preliminary discussion and evaluation of the acoustic tests performed on a recording believed by the House Select Committee on Assassinations to be that of the sequence of gunshots associated with the assassination of President John F. Kennedy in Dallas on November 22, 1963. Contained herein is a description, to the extent possible in lay terms, of the acoustic tests performed, the nature of the material upon which the tests were performed, estimations of the validity and accuracy of the tests, where possible, and observations by the Engineering Section concerning the strengths and weaknesses of the analyses. In addition, the prospect and impact associated with extending these tests to validate or refute, if such is possible, the opinions rendered in testimony before the House Select Committee on Assassinations are discussed.

DE-70 62-117290-1432X1

RECOMMENDATION:

ST-117 X-1 REC-5 23 APR 18 1980

None. For information.

1 - Mr. Adams
1 - Mr. McDermott
1 - Mr. Bassett
1 - Mr. Herndon
1 - Mr. Mintz
1 - Mr. Moore
1 - Mr. Cochran
1 - Mr. Campbell
1 - Mr. Killion

APPROVED: Director, Assoc. Dir., Dep. AD Adm., Dep. AD Inv., Adm. Serv., Crim. Inv., Ident., Intell., Laboratory, Legal Coun., Plan. & Insp., Rec. Mgnt., Tech. Servs., Training, Public Affs. Off.

JBK:JBK:dkc

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DETAILS:

Overview:

On September 11, 1978, and again on December 29, 1978, the House Select Committee on Assassinations (HSCA) met in public session to hear expert testimony relative to scientific acoustic analyses performed on an audio recording, believed by the Committee to contain the sequence of gunshots associated with the assassination of President John F. Kennedy in Dealy Plaza, Dallas, Texas, on November 22, 1963. Initial analyses were performed by a team of scientists employed by Bolt, Beranek, and Newman, Incorporated, Cambridge, Massachusetts. The team leader and expert, who first testified on September 11, 1978, was Dr. James E. Barger.

Based upon inconclusive results reached by Dr. Barger in certain critical areas of the analyses, particularly the "50-50" conclusion regarding the "third shot from the grassy knoll," Dr. Barger's results were referred for further analysis to Mr. Mark Weiss and Mr. Ernest Aschkenasy, both professors in the Computer Science Department, Queens College, Flushing, New York. It is understood that both Weiss and Asckenasy also provided some assistance and suggestions during the initial analysis of the Dealy Plaza gunshot recording by Bolt, Beranek, and Newman, Inc. According to the testimony of Dr. Barger, after Bolt, Beranek, and Newman, Inc., reached its inconclusive results regarding the third "shot," Weiss suggested to Barger a technique which Weiss felt could improve upon and extend the analysis. Weiss was instructed to proceed by the Committee. On December 29, 1978, he and Aschkenasy testified before the Committee that with a certainty of 95% or better the third sound on the Dealy Plaza recording was a rifle shot and that it originated from a specific point on the grassy

knoll. They further testified that this determination could be made with great positional accuracy, that is, within approximately 5 feet. Dr. Barger later testified that he agreed with the assertion of Weiss that the third sound originated from the grassy knoll but Barger could only ascribe an approximately 78% certainty that the sound was a rifle shot.

The following is a discussion of the analyses performed and the data which these experts believe supports their conclusions. It should be emphasized that the information upon which this discussion is based is derived only from the oral testimony offered in public hearings on September 11, and December 29, 1978, and in the case of the testimony of Weiss and Aschkenasy, also upon visual inspection of exhibits by Engineering Section personnel who observed the testimony on December 29.

The Engineering Section does not presently possess written reports or raw data pertaining to these analyses. Many questions raised in this analysis may in fact be covered in the written reports of the experts.

The Experts:

Dr. James E. Barger is chief scientist for Bolt, Beranek, and Newman, Inc., a major acoustic consulting firm headquartered in Cambridge, Massachusetts. Dr. Barger possesses a PhD in Applied Physics from Harvard, is a Fellow of the Acoustical Society of America and has performed extensive work in sonar and underwater acoustics. He supervised, under the direction of Dr. Richard Bolt, the Bolt, Beranek, and Newman, Inc., effort in the analysis of the 18 1/2 minute gap in the Watergate tapes and was project leader in the Bolt, Beranek, and Newman, Inc., analysis of the recorded gunfire in the Kent State incident.

Dr. Barger identified his team members in the gunshot analysis as Dr. Jerry Wolf, Dr. Dan Calico, Dr. Ted Rine, Mr. Scott Robinson, Mr. Leo Slajeski, Miss Nancy McMahon, Mr. Joe Coleratello, and Mr. Ed Schmidt (phonetic spelling). The Engineering Section has no biographic information on these individuals other than it is believed Dr. Wolf and Mr. Robinson also worked on the Kent State analysis performed by Bolt, Beranek, and Newman, Inc.

Mr. Mark Weiss possesses a M.S. degree in Electrical Engineering, was a past vice president of Federal Scientific Corporation, a signal analysis and equipment manufacturing firm, and is presently a professor in the Department of Computer Science, Queens College, New York. He served as a member of a panel of experts appointed by Judge John J. Sirica to examine the White House tape recordings in connection with the Watergate investigations. He is a Fellow of the Acoustical Society of America and a member of the Institute of Electrical and Electronics Engineering.

Mr. Ernest Aschkenasy possesses a M.S. Degree in Electrical Engineering and is a research associate for the Department of Computer Science at Queens College where he presently serves as Mr. Weiss's assistant.

As the above biographies illustrate, the individuals who conducted the acoustical analyses of the Dealy Plaza recording possess considerable technical knowledge and experience in diverse areas of physics, acoustics and electrical engineering. So far as is known, they are highly regarded scientists in these diciplines.

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Origin and Chain of Custody of the Recording:

Committee Chief Counsel G. Robert Blakey testified that in September of 1977, the committee staff learned of the existence of a Dallas Police Department dispatch recording of the Dallas police transmissions covering the time period before, during and after the Kennedy Assassination. It is believed that the information which led the Committee staff to the recording was obtained from one Paul McCaren (phonetic spelling), retired Assistant Police Chief, who had been assigned to a Special Dallas Police Assassination investigation squad. The recording in question, a Dictaphone "dictabelt," described by Dr. Barger as a blue-colored continuous plastic belt, was a recording of a portion of the Dallas Police Department transmissions on Dallas Police channel 1.

It should be noted that the report of the Warren Commission made reference to this recording. Specifically, a Letterhead Memorandum dated August 11, 1964, Commission Exhibit Number 1974, contained in Volume 23 of the Report, describes the fact that an Agent of the Federal Bureau of Investigation at Dallas reviewed dictabelts containing recordings of the Dallas Police radio transmissions on channel 1 from the period 10:00 AM to 3:00 PM, November 22, 1963. The stated purpose of the review was that the Warren Commission, by letter dated July 16, 1964, referred to the transcripts of Dallas Police Department radio transmissions covering November 22, 1963, and advised that in view of the importance of these transcripts, it was desired that the Federal Bureau of Investigation obtain the original recordings and prepare new transcripts. The letter requested that the name of the reporting police officer be listed alongside each message. The new transcript, included as a part of the Letterhead Memorandum, noted sometime after 12:26 PM the

This fails to report that the FBI had both the original recordings and its own types of them & transcribed for the W.C.

following: "(Transmitters stuck on one of the mobile units; nothing readable for sometime after 38's (WOODROW) last transmission. Sirens audible. Garbled transmissions) (12:34)"

Later in the transcript, sometime between 12:35 and 12:36 PM the following occurs: "4 (Fisher), we have a mike button stuck open. We can't hear anything. (Garbled transmission)."

There is no indication in the transcript that the reviewer had detected noises which sounded like shots. If such noises were present, they were probably substantially masked by other audio noise and radio interference. In fact, Dr. Barger stated in his testimony that the recording had a good deal of crowd and motorcycle noise and the sounds of interest were not clearly audible. There is no indication that the recordings of the Dallas Police radio transmissions were ever sent to the FBI Laboratory for review or analysis.

Acoustic Analysis Performed by Dr. Barger and Bolt, Beranek and Newman, Inc.:

Dr. Barger's testimony on September 11, 1978, described the objectives and methods used by the Bolt, Beranek, and Newman Inc., team to analyze the Dealy Plaza recording. He discussed 6 questions the team addressed:

1) Was the motorcycle in Dealy Plaza?

2) Were the sounds of shots detectable?

3) How many shots?

4) What was the timing of the shots?

5) From what location were the shots fired?

6) What weapon or weapons fired the shots?

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The approach utilized by the team in an attempt to answer the above questions was a detailed analysis of the pattern of the shot-like sounds on the recording in question, an analysis of the echo characteristics of such sounds in Dealy Plaza and a comparison of the patterns in question to known shot and echo patterns recorded from test shots fired by different weapons from the positions of the School Book Depository Building and the grassy knoll.

At the outset Bolt, Beranek, and Newman, Inc., had little substantive information upon which to base any conclusion as to where the sounds recorded on the dictabelt originated. It was assumed, based upon the nature and loudness of the noise on the recording that the open microphone was on a motorcycle. It was assumed that due to the presence of impulsive type sounds that might be gunshots, the motorcycle was somewhere in the vicinity of Dealy Plaza. It was not known which police motorcycle it was, whether the motorcycle was in the Presidential motorcade or whether in fact the motorcycle was definitely in or near Dealy Plaza at the time of the shooting. It was hoped by Bolt, Beranek, and Newman, Inc., that a series of test recordings made in Dealy Plaza would resolve these and other questions.

In August, 1978, the Bolt, Beranek, and Newman, Inc., team went to Dealy Plaza to conduct and record a series of test shots from the School Book Depository Building and from the grassy knoll. An array of microphones and recorders adjusted to laboratory standards was positioned at 36 locations along the motorcade route, beginning at the turn onto Houston Street, turning the corner onto Elm Street and continuing down Elm Street past the spot where the Zapruder film of the motorcade showed Kennedy being struck by the fatal head shot. Sand-bagged targets were placed on the street at locations believed or known to be the impact points of the shots and these targets were fired at by

shooters using 3 weapons, a Mannlicher Carcano rifle similar to the Oswald weapon, an M1 rifle and a pistol. The first 2 weapons were fired to obtain sounds of weapons firing supersonic projectiles, the last weapon was fired for the purposes of obtaining sounds of a weapon firing a subsonic projectile. The significance of the projectile speed will be discussed later. In all, 432 test "events" were recorded, a test event being a shot fired at a particular target using a particular weapon from a particular location and picked up and recorded by one of the 36 microphone positions.

The rationale behind all this testing was as follows: The muzzle blast of a weapon when fired produces a very loud, very brief (commonly called "impulsive") sound which radiates outward in all directions and due to its loudness carries for considerable distances. The muzzle blast impulsive noise travels at the speed of sound essentially in straight lines past an observer, for example a person or a microphone, which detects or "hears" the sound. This is called the "direct" sound. The sound also travels until it meets a hard surface which reflects the sound off in some other direction. The reflected sound may then continue on past the observer, where it is also "heard," or it may reflect off another surface and then past the observer, etc. The reflected sounds, because they always have to travel farther than the direct sound, always arrive some time after the direct sound, resulting in the condition we call echoes.

If the reflecting surfaces are far apart, for example, on the order of thousands of feet, the observer will hear a series of well defined, individual echoes. If, as was the case in Dealy Plaza, the reflecting surfaces, namely the building, signs, bridge abutments, etc., are spaced apart on the order of a few hundred feet, the echoes

usually arrive too quickly after the direct sound to be discerned by the listener as individual echoes. Instead of the listener hearing a series of brief impulsive sounds, he hears one sound which seems to be drawn out in duration. However, the individual echoes are still present and through proper analytical techniques and under appropriate conditions, can be detected. The statement "appropriate conditions" is significant from the standpoint that this detection is fairly easy and straightforward to do when the original sound is brief and loud, the reflecting surfaces are substantial and spaced far enough apart, and there is little other noise interference which masks the direct sound and echoes. As transmission and recording characteristics deteriorate, and other noise begins to mask the impulsive sounds the task becomes increasingly difficult. Evidently the Bolt, Beranek, and Newman, Inc., analysts encountered a poor quality recording in the original, for Dr. Barger described two techniques which Bolt, Beranek, and Newman, Inc., employed to assist in the analysis of the noises. These techniques were the "adaptive filter" and the "matched filter."

The adaptive filter is technically too complex a device to describe in any detail in this document. In brief, it is a method used to reduce the loudness of repetitive noise interference such as the engine noise from a motorcycle. It is a relatively recent development, having been described in principle in the literature about 10 years ago, and applied on a practical basis only in the last few years. Evidently Bolt, Beranek, and Newman, Inc., were somewhat successful in reducing the motorcycle noise interference using the adaptive filter technique.

The second method used by Bolt, Beranek, and Newman, Inc., the "matched filter," may be described more easily and is a straightforward scheme for detecting the presence of signals buried in interference. The matched filter concept has been used for years in radar, sonar, and

other signal detection applications. However, in order for it to work, the characteristics of the signal being looked for must be well known. In the analysis of the Dealy Plaza Recording, the matched filters used were the various direct sound and echo pattern test shots recorded in Dealy Plaza in August, 1978. In other words, Bolt, Beranek, and Newman, Inc., recorded a known series of direct sound and echo patterns representing different test circumstances and they compared the patterns to those patterns on the motorcycle recording to determine whether any shots "matched". The comparison was done by computer as it would have been extremely difficult, if not impossible, to make all the comparisons by hand in a reasonable period of time. What constituted a "match" in the opinion of the analysts was based upon a statistical determination of the presence or absence of impulsive sounds corresponding to what might be echoes at the correct points in time. The process is somewhat akin to aligning the pickets on two picket fences when the pickets are spaced according to some pattern. If the patterns are different, the fences will not line up.

Dr. Barger testified that based upon the above analysis and comparison process, the analysis team had determined that the recording had come from the open microphone of a motorcycle which was a part of the Presidential motorcade and they had established the position of the motorcycle on Elm Street to an error radius of 9 feet (1/2 the distance of the 18 foot spacing of the microphones). Further, they had established that the motorcycle was moving at a speed of about 11 miles per hour and that it's position changed with each shot. Dr. Barger testified they had accurately measured the timing between the shots and if there were 4 shots, the time between the first and second was 1.6 seconds, between the second and the third 5.9 seconds and between the third and fourth 0.5 seconds. He

testified that there was a high probability that there were two shots, both from the School Book Depository Building, a slightly lesser probability that there was a 3rd shot (the fourth sound in the sequence), also from the School Book Depository, and a lesser still probability that there was a 4th shot from the grassy knoll (the third sound in the sequence). When pressed on this issue, he stated he could reach only a "50-50" decision on the third "shot" in the sequence. It is noteworthy that Chairman Stokes asked Dr. Barger in cross-examination "Can I come to a conclusion from what I appear to be hearing?" To this question, Dr. Barger responded, "I think not."

ACOUSTIC ANALYSIS PERFORMED BY MR. MARK WEISS AND MR. ERNEST ASCHKENASY

As previously set forth, Dr. Barger's acoustic analysis resulted in a 50-50 possibility that the third sound on the Dealy Plaza recording was a shot fired from the grassy knoll. After the September, 1978, public hearing where Dr. Barger set forth these results, the Committee contacted Mr. Weiss and Mr. Aschkenasy in an attempt to refine Dr. Barger's test results, and to establish with greater certainty whether or not a shot had been fired from the grassy knoll. On December 29, 1978, Mr. Weiss and Mr. Aschkenasy appeared before the Committee and publicly testified to the results of their study pertaining to the alleged shot from the grassy knoll. Mr. Weiss testified that after careful analysis he had determined with an accuracy of 95% or better, that a gun shot was fired from the grassy knoll in the direction of the Presidential motorcade on November 22, 1963. To reach this conclusion, Mr. Weiss analyzed a copy of the dictabelt recorded by the Dallas Police Department using an oscilloscope, a plotter, a hand calculator, a long graduated scale and a large survey

map of Dealy Plaza. Mr. Weiss justified his analysis based on what he claimed were three (3) well established principals of physics:

1. Sound from a point source radiates in all directions

2. When radiating sound waves encounter reflecting surfaces, echoes occur

3. The speed of sound is constant at a given atmospheric temperature and can be accurately determined.

Mr. Weiss assumed that Dr. Barger's tests had determined the approximate location of the sound source on the grassy knoll and the approximate location of the transmitting motorcycle in the Presidential motorcade. Mr. Weiss utilized the principal that the microphone on the motorcycle would receive the direct impulse sound followed by a series of echoes created by this original impulse reflecting off the nearby buildings and structures.

To perform this analysis, Mr. Weiss played a copy of the Dallas Police Department radio recording into an oscilloscope which produced a visual graph depicting loudness variations of this suspected gunshot sound. Using the plotter he made a hard copy graph of these loudness variations for further study. He assumed that the first high level impulse sound was generated by the original sound wave traveling directly to the microphone. He measured and catalogued the 14 short time lapses between this first impulse signal and each successive high level impulse (assumed to be echoes). Knowing the time interval between the first impulse sound and each successive impulse and the speed of sound, Mr. Weiss calculated the distance a sound (echo) would travel during each of these time intervals.

Knowing the exact distance traveled by each echo he constructed what he described as a unique acoustic pattern for this set of impulse sounds (echoes). He manually attempted to match this set of distances traveled by each echo to the predicted set of distances the sounds would travel in Dealy Plaza by changing the position of the sound source (gunshot) and the motorcycle along the parade route. Using this procedure, Mr. Weiss matched 10 known echo paths on the survey map to the measured distances of the echoes plotted from the copy of the recording of the Dallas Police Department radio transmissions. It should be noted that Mr. Weiss could not match 4 of the 14 impulse sounds recorded on the Dallas police department tape to his predicted echo paths. In addition, Mr. Weiss predicted there would be 12 echo impulse reflection echoes and only ten were found on the plotted graph of the Dallas Police Department tape recording. Statistically, according to Mr. Weiss, this translates into a 95% or better probability that an impulse sound originated on the grassy knoll and was received by the motorcycle in the Presidential motorcade. Then by examining signals buried in the noise, Mr. Weiss believed he could see an "N" wave generated by a supersonic projectile (whenever an object exceeds the speed of sound it generates a shock wave, known as an "N" wave). Rifle bullets usually exceed the speed of sound and therefore generate these "N" waves. Mr. Weiss believes that since an "N" wave was present, the sound from the grassy knoll was generated by a supersonic bullet.

After Mr. Weiss and Mr. Aschkenasy completed their testimony, Dr. Barger was recalled before the HSCA. Dr. Barger testified he agreed with the refinement made in his data by Mr. Weiss and that he would agree that the possibility that the third impulsive sound came from the grassy knoll was better than 95%. However, he stated in his opinion,

the possibility that the sound was a supersonic gunshot was 78%. This was because the recording had numerous other random impulses which had the characteristics of "N" waves, yet could not possibly be supersonic shock waves.

Observations by the Engineering Section:

At the present time there has been little precedent for the kinds of application of acoustic analysis to forensic situations as described by Dr. Barger, Mr. Weiss, and Mr. Aschkenasy. Specifically those applications are to determine, given a sound recording of a shooting incident, the location from which the shots originated and the type of weapons fired. In fact, the work done by Bolt, Beranek, and Newman, Inc., on the recordings of the Kent State incident was the first significant application in this area, with the recent work on the Kennedy Assassination being only the second to our knowledge. This apparent lack of foundation has been simply due to the lack of demand for this kind of service. Consequently, it is easier to comment upon the basic scientific principles involved than it is to determine whether those principles were correctly applied and the proper conclusions were drawn. It is, however, fundamental that the real forensic environment is often very different from the controlled situation of a laboratory.

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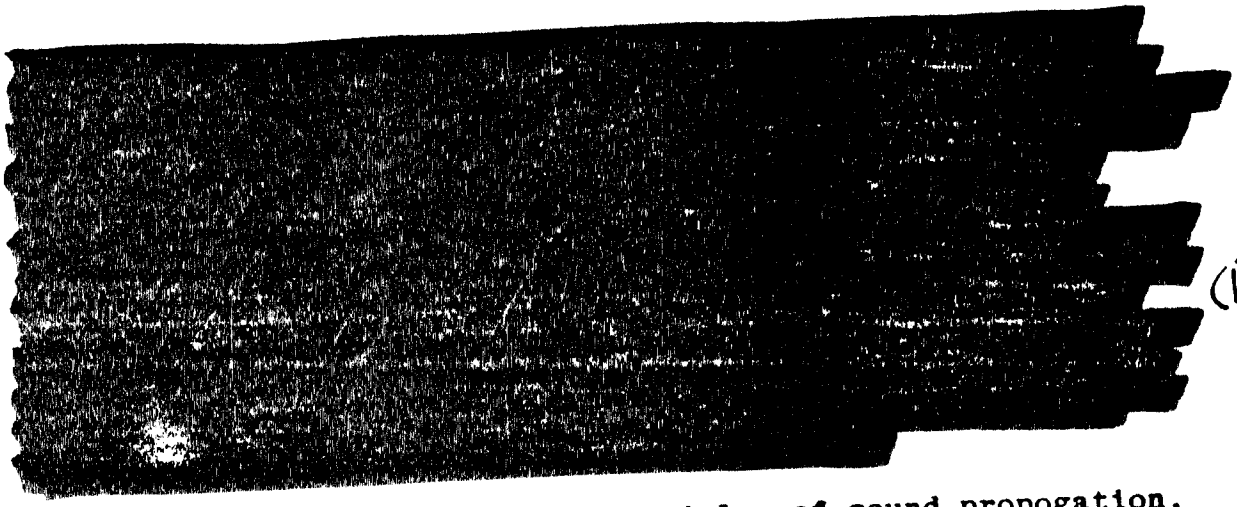
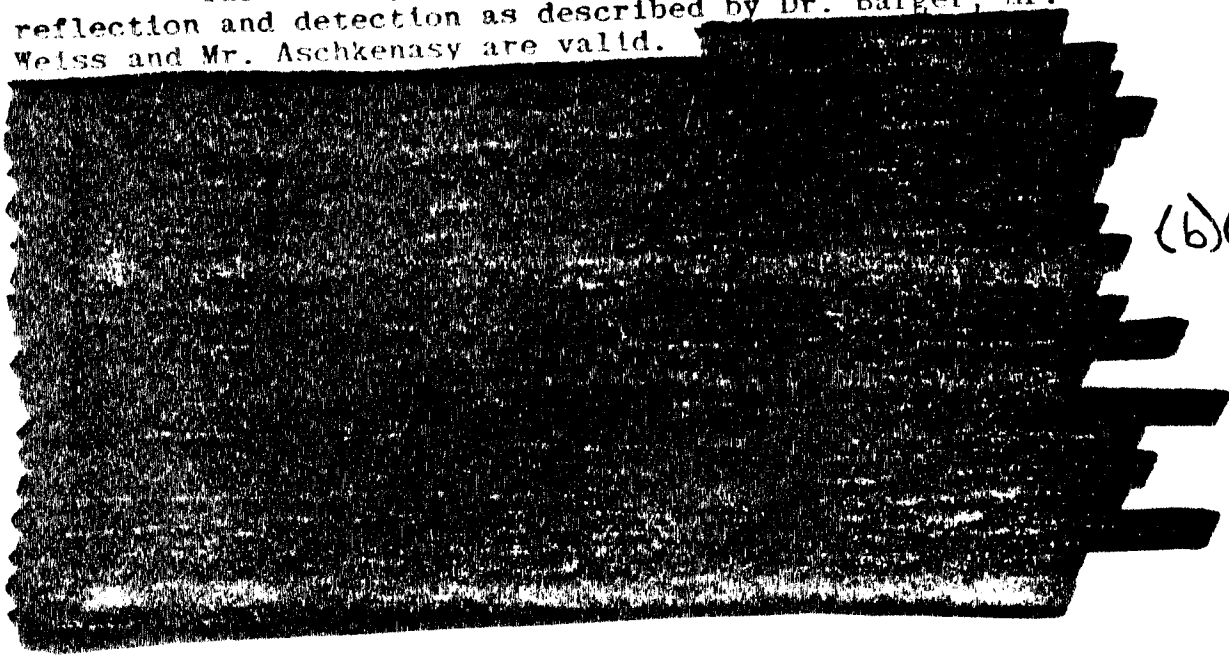


(b)(5)

The basic physical principles of sound propogation, reflection and detection as described by Dr. Barger, Mr. Weiss and Mr. Aschkenasy are valid.



(b)(5)

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[redacted] (b)(5)

When questioned regarding why the "N" wave, the supersonic shock wave which indicates a rifle has been fired, was not observable on the graphs of the first two shots fired from the School Book Depository Building, yet was observed on the last shot, Dr. Barger stated he would not have expected to have seen the "N" wave on the first two shots because the motorcycle was not in the proper position.

[redacted] (b)(5)

The test recordings conducted by Bolt, Beranek, and Newman, Inc., were made using very high quality, calibrated equipment and not using the same kind of equipment-radios, microphones, repeaters, receivers, and dictabelt recorders-used by the Dallas Police Department in 1963. The reasons given by Bolt, Beranek, and Newman, Inc., that they were only interested in the time spacing of the echo pattern which would be represented on either system and therefore, they required a more reliable system [redacted] (b)(5)

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[redacted] (b)(5)

Both Dr. Barger and Mr. Weiss described that the dictabelt recording speed was off by approximately 5% and that they were able to translate their calculations to account for this speed discrepancy.

[redacted] (b)(5)

[redacted] (b)(5)

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[redacted]

Mr. Weiss and Mr. Aschkenasy concluded that the sound from the grassy knoll was a rifle shot. According to Mr. Weiss, this conclusion was drawn because the sound was very loud (although he did not describe how loud it was) and also because they observed an "N" wave type sound which seemed to have the right shape and was about at the right spot in the graph. [redacted] (b)(5)

[redacted]

Further, Dr. Barger had earlier described that numerous impulsive events on the tape had characteristics of "N" waves, yet they were not supersonic shock waves. [redacted] Dr. Barger concluded that the observed wave was probably an "N" wave and not noise because - simply put - it was in the right place on the graph.

Mr. Weiss' statement that his work was based upon simple physical principles taught at the high school or freshman college level and that his calculations were based on simple mathematic and geometry performed by hand belies the real complexity of the task. [redacted]

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(b)(5)

[redacted] Bolt, Beranek, and Newman, Inc., applied a number of powerful analytical techniques, not all of which were available in 1963, to sift through a prodigious amount of data.

The Prospect of Additional Analysis:

[redacted]

(b)(5)