B. Scientific Acoustical Evidence Establishes a High Probability That Two Gunmen Fired at President John F. Kennedy; Other Scientific Evidence Does Not Preclude the Possibility of Two Gunmen Firing at the President; Scientific Evidence Negates Some Specific Conspiracy Allegations

The committee tried to take optimum advantage of scientific analysis in exploring issues concerning the assassination. In many cases, it was believed that scientific information would be the most reliable information available, since some witnesses had died and the passage of time had caused the memories of remaining witnesses to fail and caused other problems affecting the trustworthiness of their testimony.

As noted in the preceding section of this report, the committee turned to science as a major source of evidence for its conclusion that Lee Harvey Oswald fired three shots from the Texas School Book Depository, two of which hit President Kennedy. The evidence that was most relied upon was developed by committee panels specializing in the fields of forensic pathology, ballistics, neutron activation, analysis, handwriting identification, photography and acoustics. Of these, acoustics—a science that involves analysis of the nature and origin of sound impulses—indicated that the shots from the book depository were not the only ones fired at President Kennedy.

(*a*) *Warren Commission analysis of a tape*

The Warren Commission had also employed scientific analysis in its investigation and had recognized that acoustics might be used to resolve some questions about the shots fired at the President. It had obtained a tape recording, an alleged on-the-scene account of the assassination made by Sam Pate, a Dallas radio newsman, but an FBI examination of the tape "failed to indicate the presence of any sounds which could be interpreted as gunshots."(*1*) The FBI also informed the Commission that the newsman had stated that most of the tape was not recorded in Dealey Plaza at the time of the assassination, but was recorded in a studio several days later after he had been dismissed by his station, KBOX.(*2*)

The Commission independently submitted the tape for analysis to Dr. Lawrence Kersta of Bell Telephone Acoustics & Speech Research Laboratory. As reported in a letter from Kersta to the Commission on July 17, 1964,(*3*) spectograms (visual representations of tonal qualities in the sounds) were made of a key 8-second portion of the tape. The spectograms indicated there were six nonvoiced noises—one nonvoiced "spike" (a scientific term for a graphic display of a noise) followed by three other nonvoiced spikes of different acoustical characteristics occurring .86 seconds, 1.035 seconds and 1.385 seconds after the first. These, in turn, were followed by two events apparently caused by sound and believed to have been related to the previous ones.

Dr. Kersta did not indicate in his letter that he had found shots, and the results of his tests were not mentioned in the Warren Report.

The committee was unable to locate the Kersta spectographs in the National Archives until late 1978 (they had been misfiled), but it did obtain the tape recording made on November 22, 1963, by KBOX reporter Sam Pate. On May 11, 1978, the committee submitted the tape to an acoustical consultant for analysis, with these results: (*4*)

> While a portion of the tape was recorded on November 22, 1963, in the vicinity of Dealey Plaza, it was thought not to be contemporaneous with the assassination. Other portions of the tape, moreover, seemed to have been recorded, at least in large part, in a studio, since appropriate background noise was not present.
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> And even if the tape had been made during the firing of the shots and had recorded them, Kersta's spectographic analysis would not have found them. The committee's consultant advised that spectographic analysis is appropriate only for detecting tonal, or harmonic, sound. To identify a gunshot, the analysis must be able to portray a waveform on an oscilloscope or similar such device.

(*b*) *Dallas Police Department recordings*

To resolve questions concerning the number, timing, and origin of the shots fired in Dealey Plaza, the committee asked its acoustical consultant to examine recordings not analyzed acoustically by the Warren Commission, specifically, Dallas Police Department dispatch transmissions for November 22, 1963.[1]

These transmissions, received over the police radio network from officers in the field, were recorded at Dallas police headquarters. Two recording systems were in use at the time—a Dictabelt for channel 1, and a Gray Audograph disc recording for channel 2.[2] (*5*)

The committee held 2 days of public hearings—on September 11, 1978 and December 29, 1978—in which it attempted to present the essential evidence from the acoustical analysis. Because of time limitations, it was not possible to present all of the evidence in the hearings.

(1) *Analysis by Bolt Beranek and Newman.*—In order to identify the nature and origin of sound impulses in a recording, acoustical analysis may include, among other means of examination, a delineation and study of the shape of its electrical waveforms and a precise measurement and study of the timing of impulses on the recording. In May 1978, the committee contracted with Bolt Beranek and Newman Inc. (BBN) of Cambridge, Mass., to perform this sort of analysis. The study was supervised by Dr. James E. Barger, the firm's chief scientist.

Bolt Beranek and Newman specializes in acoustical analysis and performs such work as locating submarines by analyzing underwater sound impulses. It pioneered the technique of using sound recordings

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[1] Transcripts of the Dallas dispatch transmissions had been provided to the Warren Commission by the FBI and the Dallas Police Department. They were used to resolve issues not related to the number, timing or origin of the shots fired in Dealey Plaza. It did not appear that an acoustical analysis of these tapes or Dictabelts was performed for the Commission by the FBI or any other agency or private organization.

[2] Channel 1 transmissions were a continuous record of Dallas police activity; channel 2 transmissions were voice activated, and therefore an intermittent record of communications, for the most part those of Dallas Police Chief Jesse E. Curry and the headquarters dispatcher.

to determine the timing and direction of gunfire in an analysis of a tape that was recorded during the shootings at Kent State University in 1970. In a criminal case brought against members of the National Guard by the Department of Justice, the analysis of the tape by BBN, combined with photographs taken at the time of the shootings, were used by the prosecution in its presentation to a grand jury to help establish which guardsmen were the first to fire shots. The firm was also selected by Judge John J. Sirica to serve on a panel of technical experts that examined the Watergate tapes in 1973.

The Dallas police dispatch materials given to BBN to analyze in May 1978 were as follows:

The original Dictabelt recordings made on November 22, 1963, of transmissions over channel 1;

A tape recording of channel 1 Dictabelts;

A tape recording of transmissions over channel 2.[3] (*7*)

These materials were obtained by a committee investigator in March 1978, from Paul McCaghren, who in 1963 was a Dallas police lieutenant who had submitted investigative reports and materials on the assassination to Chief Curry. (*8*) In 1969, a newly appointed chief of police had ordered that a locked cabinet outside his office be opened. It contained reports and materials concerning the assassination that had been submitted to Curry; among the items were the Dictabelt recordings and tapes of the November 22, 1963, dispatch transmissions. McCaghren, who in 1969 was director of the Intelligence Division, had then taken custody of the materials and retained them until he gave them to the committee's investigator in 1978. (*9*) There was no evidence that any of the materials had been tampered with while in the police department's or McCaghren's possession.

To the human ear, the tapes and Dictabelts contain no discernible sounds of gunfire. The dispatcher's voice notations of the time of day indicate that channel 2 apparently was not in use during the period when the shots were fired. Channel 1 transmissions, however, were inadvertently being recorded from a motorcycle or other police vehicle whose radio transmission switch was stuck in the "on" position. (*10*)

BBN was asked to examine the channel 1 Dictabelts and the tape that was made of them to see if it could determine: (1) if they were, in fact, recorded transmissions from a motorcycle with a microphone stuck in the "on" position in Dealey Plaza; (2) if the sounds of shots had been, in fact, recorded; (3) the number of shots; (4) the time interval between the shots; (5) the location of the weapon or weapons used to fire the shots; and (6) the type of weapon or weapons used.

BBN converted the sounds on the tape into digitized waveforms and produced a visual representation of the waveforms. (*11*) By employing sophisticated electronic filters, BBN filtered out "repetitive noise," such as repeated firings of the pistons of a motorcycle engine. (*12*) It then examined the tape for "sequences of impulses" that might be significant. (A "sequence of impulses" might be caused by a loud noise—such as gunfire—followed by the echoes from that

[3] Prior to the BBN analysis of the original Dictabelt and tapes, the firm was given a tape that had been supplied to the committee by a Warren Commission critic in the belief that it was an original. BBN determined that this tape was a second generation copy of the original. Because it was an imperfect copy, it was not used in the BBN work. (*6*)

loud noise.) Six sequences of impulses that could have been caused by a noise such as gunfire were initially identified as having been transmitted over channel 1. (*13*) Thus, they warranted further analysis.

These six sequences of impulses, or impulse patterns, were subjected to preliminary screening tests to determine if any could be conclusively determined not to have been caused by gunfire during the assassination. The screening tests were designed to answer the following questions: (*14*)

Do the impulse patterns, in fact, occur during the period of the assassination?

Are the impulse patterns unique to the period of the assassination?

Does the span of time of the impulse patterns approximate the duration of the assassination as indicated by a preliminary analysis of the Zapruder film? (Are there at least 5.6 seconds between the first and last impulse? [4])

Does the shape of the impulse patterns resemble the shape of impulse patterns produced when the sound of gunfire is recorded through a radio transmission system comparable to the one used for the Dallas police dispatch network?

Are the amplitudes of the impulse patterns similar to those produced when the sound of gunfire is recorded through a transmission system comparable to the one used for the Dallas police dispatch network?

All six impulse patterns passed the preliminary screening tests. (*15*)

BBN next recommended that the committee conduct an acoustical reconstruction of the assassination in Dealey Plaza to determine if any of the six impulse patterns on the dispatch tape were caused by shots and, if so, if the shots were fired from the Texas School Book Depository or the grassy knoll. (*16*) The reconstruction would entail firing from two locations in Dealey Plaza—the depository and the knoll—at particular target locations and recording the sounds through numerous microphones. The purpose was to determine if the sequences of impluses recorded during the reconstruction would match any of those on the dispatch tape. If so, it would be possible to determine if the impulse patterns on the dispatch tape were caused by shots fired during the assassination from shooter locations in the depository and on the knoll. (*17*)

The theoretical rationale for the reconstruction was as follows:

The sequence of impulses from a gunshot is caused by the noise of the shot, followed by several echoes. Each combination of shooter location, target location and microphone location produces a sequence of uniquely spaced impulses. At a given microphone location, there would be a unique sequence of impulses, depending on the location of the noise source (gunfire) and the target, and the urban environment of the surrounding area (echo-producing structures in and surrounding Dealey Plaza). The time of arrival of the echoes would be the

[4] The 5.6-second standard was based on a preliminary examination of the Zapruder film that showed evidence of Kennedy and Connally reacting to their wounds. The difference between approximate impact moments was calculated using the 18.3 frame per second rate of the Zapruder camera. This 5.6-second standard was derived before the photographic evidence panel had reported the results of its observations of the Zapruder film.

significant aspect of the sequence of impulses that would be used to compare the 1963 dispatch tape with the sounds recorded during the 1978 reconstruction. (*18*)

The echo patterns in a complex environment such as Dealey Plaza are unique, so by conducting the reconstruction, the committee could obtain unique "acoustical fingerprints" of various combinations of shooter, target and microphone locations. The fingerprint's identifying characteristic would be the unique time-spacing between the echoes. If any of the acoustical fingerprints produced in the 1978 reconstruction matched those on the 1963 Dallas police dispatch tape, it would be a strong indication that the sounds on the 1963 Dallas police dispatch tape were caused by gunfire recorded by a police microphone in Dealey Plaza. (*19*)

At the time of the reconstruction in August 1978, the committee was extremely conscious of the significance of Barger's preliminary work, realizing, as it did, that his analysis indicated that there possibly were too many shots, spaced too closely together,[5] for Lee Harvey Oswald to have fired all of them, and that one of the shots came from the grassy knoll, not the Texas School Book Depository.

The committee's awareness that it might have evidence that Oswald was not a lone assassin affected the manner in which it conducted the subsequent phase of the investigation. For example, it was deemed judicious to seek an independent review of Barger's analysis before proceeding with the acoustical reconstruction. So, in July 1978, the committee contacted the Acoustical Society of America to solicit recommendations for persons qualified to review the BBN analysis and the proposed Dallas reconstruction. The society recommended a number of individuals, and the committee selected Prof. Mark Weiss of Queens College of the City University of New York and his research associate, Ernest Aschkenasy. Professor Weiss had worked on numerous acoustical projects. He had served, for example, on the panel of technical experts appointed by Judge John J. Sirica to examine the White House tape recordings in conjunction with the Watergate grand jury investigation. Aschkenasy had specialized in developing computer programs for analyzing large volumes of acoustical data.

Weiss and Aschkenasy reviewed Barger's analysis and conclusions and concurred with them. In addition, they agreed that the acoustical reconstruction was necessary, (*20*) and they approved Barger's plan for conducting it.

The committee authorized an acoustical reconstruction, to be conducted on August 20, 1978. Four target locations were selected, based on: (*21*)

> The estimated positions of the Presidential limousine according to a correlation of the channel 1 transmissions with the Zapruder film, indicating that the first shot was fired between Zapruder frames 160 and 170 and that the second shot was fired between Zapruder frames 190 and 200; [6]
>
> The position of the President at the time of the fatal head shot (Zapruder frame 312); and

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[5] For example, the time between two of the impulse patterns that might represent gunfire was less than a second, too brief an interval to have permitted Oswald to fire two shots.

[6] The committee ultimately determined that the shots were fired a few Zapruder frames earlier than it believed to be the case in August 1978.

Evidence that a curb in Dealey Plaza may have been struck by a bullet during the assassination.

Two shooter locations were selected for the reconstruction:(*22*)

The sixth floor southeast corner window of the Texas School Book Depository, since substantial physical evidence and witness testimony indicated shots were fired from this location; and

The area behind a picket fence atop the grassy knoll, since there was considerable witness testimony suggesting shots were fired from there.[7]

A Mannlicher-Carcano rifle was fired from the depository, since it was the type of weapon found on the sixth floor on November 22, 1963. (*23*) Both a Mannlicher-Carcano (chosen mainly because it fires a medium velocity supersonic bullet) and a pistol, which fires a subsonic bullet, were fired from the grassy knoll, since there was no evidence in August 1978 as to what type of weapon, if any, may have been fired from there on November 22, 1963.[8](*24*) Microphones to record the test shots were placed every 18 feet in 36 different locations along the motorcade route where a motorcycle could have been transmitting during the assassination.(*25*)

A recording was made of the sounds received at each microphone location during each test shot, making a total of 432 recordings of impulse sequences (36 microphone locations times 12 shots), or "acoustical fingerprints," for various target-shooter-microphone combinations. Each recorded acoustical fingerprint was then compared with each of the six impulse patterns on the channel 1 dispatch tape to see if and how well the significant points in each impulse pattern matched up. The process required a total of 2,592 comparisons (432 recordings of impulse sequences times six impulse patterns), an extensive effort that was not completed until 4 days before Barger was to testify at a committee public hearing on September 11, 1978.(*26*)

The time of the arrival of the impulses, or echoes, in each sequence of impulses was the characteristic being compared, not the shape, amplitude or any other characteristic of the impulses or sequence.(*27*) If a point (representing time of arrival of an echo) in a sequence of the 1963 dispatch tape could be correlated within ±6/1,000 of a second to a point in a sequence of the reconstruction, it was considered a match. (*28*)

A ±6/1,000 of a second "window" was chosen, because the exact location of the motorcycle was not known. Since the microphones were placed 18 feet apart in the 1978 reconstruction, no microphone was expected to be in the exact location of the motorcycle microphone during the assassination in 1963. Since the location was not apt to be exactly the same, and the time of arrival of the echo is unique at each spot, the ±6/1,000 of a second "window" would allow for the contingency that the motorcycle was near, but not exactly at, one of the microphone locations selected for the reconstruction.(*29*)

Those sequences of impulses that had a sufficiently high number of points that matched (a "score" or correlation coefficient of .6 or higher) were considered significant.(*30*) The "score" or correlation

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[7] The committee noted the absence of physical evidence of shots from the grassy knoll.

[8] As is discussed *infra*, there are important differences between the impulse patterns caused by a subsonic bullet, as opposed to a supersonic bullet.

coefficient was set at this level to insure finding all sequences that might represent a true indication that the 1963 dispatch tape contained gunfire. Setting it at this level, however, also allowed a sequence of impulses on the dispatch tape that might have been caused by random noise or other factors to be considered a match and therefore significant.(*31*) Such a match, since it did not in fact represent a true indication of gunfire on the 1963 dispatch tape, would be considered an "invalid match."(*32*)

Of the 2,592 comparisons between the six sequences of impulses on the 1963 police dispatch tape and the sequences obtained during the acoustical reconstruction in August 1978, 15 had a sufficient number of matching points (a correlation coefficient of .6 or higher) to be considered significant.(*33*) The first and sixth sequence of impulses on the dispatch tape had no matches with a correlation coefficient over .5. The second sequence of impulses on the dispatch tape had four significant matches, the third sequence had five, the fourth sequence had three, and the fifth sequence had three.(*34*) Accordingly, impulses one and six on the dispatch tape did not pass the most rigorous acoustical test and were deemed not to have been caused by gunfire from the Texas School Book Depository or grassy knoll.(*35*) Additional analysis of the remaining four impulse sequences was still necessary before any of them could be considered as probably representing gunfire from the Texas School Book Depository or the grassy knoll.

The locations of the microphones that recorded the matches in the 1978 reconstruction were plotted on a graph that depicted time and distance. It was observed that the location of the microphones at which matches were recorded tended to cluster around a line on the graph that was, in fact, consistent with the approximate speed of the motorcade (11 mph), as estimated from the Zapruder film.(*36*) For example, of the 36 microphones placed along the motorcade route, the one that recorded the sequence of impulses that matched the third impulse on the 1963 dispatch tape was farther along the route than the one that recorded the impulses that matched the second impulse on the dispatch tape. The location of the microphones was such, it was further observed, that a motorcycle traveling at approximately 11 miles per hour would cover the distance between two microphones in the elapsed time between impulses on the dispatch tape. This relationship between the location of the microphones and the time between impulses was consistent for the four impulses on the dispatch tape, a very strong indication, the committee found, that the impulses on the 1963 dispatch tape were picked up by a transmitter on a motorcycle or other vehicle as it proceeded along the motorcade route. Applying a statistical formula, Barger estimated that since the microphones clustered around a line representing the speed of the motorcade, there was a 99 percent probability that the Dallas police dispatch tape did, in fact, contain impulses transmitted by a microphone in the motorcade in Dealey Plaza during the assassination.(*37*)

Some of the matches found between the 1978 reconstruction and the dispatch tape were, however, thought to be clearly "invalid," that is, they did not represent a true indication of gunfire from the Texas School Book Depository or the grassy knoll. In one case, for example, there was a match for a shot in the reconstruction that had been aimed

at a target located in a different direction from where the Presidential limousine was located at the moment, the limousine's location having been established by a correlation of the dispatch tape and the Zapruder film. (*38*) Only an unlikely misfire could explain why an assassin would fire in the opposite direction. By applying similar principles of logic, six matches were ruled out. This left three matches for impulse pattern one, three for impulse pattern two, one for impulse pattern three and two for impulse pattern four. (*39*) The remaining matches for impulse patterns one, two and four on the dispatch tape were for rifle firings from the Texas School Book Depository in the 1978 reconstruction, while the match for impulse pattern three was for a rifle firing from the grassy knoll.

These matches did not, however, prove conclusively that the impulses on the 1963 dispatch tape did, in fact, represent gunfire from the book depository or grassy knoll. There still was a chance that random or other noise could have produced the pattern on the dispatch tape that matched the pattern obtained in the reconstruction, therefore being invalid as well. Based on statistical probabilities, including the observation that the locations of the microphones that picked up the matching impulse patterns tended to cluster along a line on the graph that approximated the speed of the motorcycle, Barger estimated there was a 50 percent chance that any one of the matches was invalid. (*40*) Consequently, Barger testified before the committee in September 1978 that the probability of there having been a shot from the grassy knoll was only 50 percent. (*41*) He based this estimate on there being only one match for impulse three, combined with his conclusion that there was a 50–50 chance that any one match, including the one for impulse pattern three, had been caused by random noise and was invalid. (*42*) (Barger was also saying, however, that if the match for impulse pattern three was valid, it meant that a shot was fired at President Kennedy from the grassy knoll.)[9]

(2) *Weiss-Aschkenasy analysis.*—In mid-September 1978, the committee asked Weiss and Aschkenasy, the acoustical analysts who had reviewed Barger's work, if they could go beyond what Barger had done to determine with greater certainty if there had been a shot from the grassy knoll. Weiss and Aschkenasy conceived an analytical extension of Barger's work that might enable them to refine the probability estimate. (*45*) They studied Dealey Plaza to determine which structures were most apt to have caused the echoes received by the microphone in the 1978 acoustical reconstruction that had recorded the match to the shot from the grassy knoll. They verified and refined their identifications of echo-generating structures by examining the results of the reconstruction. And like BBN, since they were analyzing the arrival time of echoes, they made allowances for the temperature differential, because air temperature affects the speed of sound. (*46*) Barger then reviewed and verified the identification of echo-generating sources by Weiss and Aschkenasy. (*47*)

Once they had identified the echo-generating sources for a shot from the vicinity of the grassy knoll and a microphone located near the

[9] With respect to the other shots, Barger estimated there was an 88 percent chance that impulse pattern one represented a shot from the book depository (based on three matches), 88 percent again for impulse pattern two (three matches) and a 75 percent chance that impulse pattern four represented a shot from the depository (two matches). (*43*) At the time of his testimony in September 1978, Barger estimated that the probability of all four impulses actually representing gunshots was only 29 percent. (*44*)

point indicated by Barger's tests, it was possible for Weiss and Aschkenasy to predict precisely what impulse sequences (sound fingerprints) would have been created by various specific shooter and microphone locations in 1963.(*48*) (The major structures in Dealey Plaza in 1978 were located as they had been in 1963.) Weiss and Aschkenasy determined the time of sound travel for a series of sound triangles whose three points were shooter location, microphone location and echo-generating structure location. While the location of the structures would remain constant, the different combinations of shooter and microphone locations would each produce a unique sound travel pattern, or sound fingerprint.(*49*) Using this procedure, Weiss and Aschkenasy could compare acoustical fingerprints for numerous precise points in the grassy knoll area with the segment identified by Barger on the dispatch tape as possibly reflecting a shot fired from the knoll.(*50*) [10]

Because Weiss and Aschkenasy could analytically construct what the impulse sequences would be at numerous specific shooter and microphone locations, they decided to look for a match to the 1963 police dispatch tape that correlated to within ±1/1,000 of a second, as opposed to ±6/1,000 of a second, as Barger had done.(*51*) By looking for a match with such precision, they considerably reduced the possibility that any match they found could have been caused by random or other noise,(*52*) thus substantially reducing the percentage probability of an invalid match.

Weiss and Aschkenasy initially pinpointed a combination of shooter-microphone locations for which the early impulses in pattern three matched those on the dispatch tape quite well, although later impulses in the pattern did not. Similarly, they found other microphone locations for which later impulses matched those on the dispatch tape, while the earlier ones did not. They then realized that a microphone mounted on a motorcycle or other vehicle would not have remained stationary during the period it was receiving the echoes. They computed that the entire impulse pattern or sequence of echoes they were analyzing on the dispatch tape occurred over approximately three-tenths of a second, during which time the motorcycle or other vehicle would have, at 11 miles per hour, traveled about five feet. By taking into account the movement of the vehicle, Weiss and Aschkenasy were able to find a sequence of impulses representing a shot from the grassy knoll in the reconstruction that matched both the early and late impulses on the dispatch tape.(*53*)

Approximately 10 feet from the point on the grassy knoll that was picked as the shooter location in the 1978 reconstruction and four feet from a microphone location which, Barger found, recorded a shot that matched the dispatch tape within ±6/1,000 of a second, Weiss and Aschkenasy found a combination of shooter and microphone locations they needed to solve the problem. It represented the initial position of a microphone that would have received a series of impulses matching those on the dispatch tape to within ±1/1,000 of a second. The microphone would have been mounted on a vehicle that was moving along the motorcade route at 11 miles per hour.(*54*)

Weiss and Aschkenasy also considered the distortion that a windshield might cause to the sound impulses received by a motorcycle

[10] Weiss and Aschkenasy examined only the impulse sequence that Barger indicated had come from the grassy knoll. Due to time constraints, they did not analyze the three impulse sequences indicating shots fired from the Texas School Book Depository.

microphone. They reasoned that the noise from the initial muzzle blast of a shot would be somewhat muted on the tape if it traveled through the windshield to the microphone. Test firings conducted under the auspices of the New York City Police Department confirmed this hypothesis. Further, an examination of the dispatch tape reflected similar distortions on shots one, two, and three, when the indicated positions of the motorcycle would have placed the windshield between the shooter and the microphone.[11] On shot four, Weiss and Aschkenasy found no such distortion.(*55*) The analysts' ability to predict the effect of the windshield on the impulses found on the dispatch tape, and having their predictions confirmed by the tape, indicated further that the microphone was mounted on a motorcycle in Dealey Plaza and that it had transmitted the sounds of the shots fired during the assassination.

Since Weiss and Aschkenasy were able to obtain a match to within ±1/1,000 of a second, the probability that such a match could occur by random chance was slight. Specifically, they mathematically computed that, with a certainty factor of 95 percent or better, there was a shot fired at the Presidential limousine from the grassy knoll.(*56*)

Barger independently reviewed the analysis performed by Weiss and Aschkenasy and concluded that their analytical procedures were correct.(*57*) Barger and the staff at BBN also confirmed that there was a 95 percent chance that at the time of the assassination a noise as loud as a rifle shot was produced at the grassy knoll. When questioned about what could cause such a noise if it were not a shot, Barger noted it had to be something capable of causing a very loud noise—greater than a single firecracker.(*58*) Further, given the echo patterns obtained, the noise had to have originated at the very spot behind the picket fence on the grassy knoll that had been identified,(*59*) indicating that it could not have been a backfire from a motorcycle in the motorcade.(*60*)

In addition, Barger emphasized, the first part of the sequence of impulses identified as a shot from the grassy knoll was marked by an N-wave, a characteristic impulse caused by a supersonic bullet. (*61*) The N-wave, also referred to as a supersonic shock wave, travels faster than the noise of the muzzle blast of a gun and therefore arrives at a listening device such as a microphone ahead of the noise of a muzzle blast. The presence of the N-wave was, therefore, a significant additional indication that the third impulse on the police dispatch tape represented gunfire, and, in particular, a supersonic bullet.(*62*) The weapon may well have been a rifle, since most pistols—except for some, such as a .44 magnum—fire subsonic bullets.

The N-wave was further substantiation for a finding that the third impulse represented a shot fired in the direction of the President. Had the gun been discharged when aimed straight up or down, or away from the motorcade, no N-wave would have appeared.(*63*) Of the impulse patterns on the dispatch tape that indicated shots from the book depository, those that would be expected to contain an N-wave, given the location of the vehicle's microphone, did so, further corroborating the conclusion that these impulses did represent supersonic bullets.(*64*)

[11] The motorcycle was traveling 120 feet behind the Presidential limousine when the shots were fired. This put shots one and two from the book depository, as well as shot three from the grassy knoll, in front of the motorcycle windshield.

When questioned about the probability of the entire third impulse pattern representing a supersonic bullet being fired at the President from the grassy knoll, Barger estimated there was a 20 percent chance that the N–wave, as opposed to the sequence of impulses following it, was actually caused by random noise.(*65*) Accordingly, the mathematical probability of the entire sequence of impulses actually representing a supersonic bullet was 76 percent, the product of a 95 percent chance that the impulse pattern represented noise as loud as a rifle shot from the grassy knoll times an 80 percent chance that the N–wave was caused by a supersonic bullet.(*66*)

The committee found no evidence or indication of any other cause of noise as loud as a rifle shot coming from the grassy knoll at the time the impulse sequence was recorded on the dispatch tape, and therefore concluded that the cause was probably a gunshot fired at the motorcade.

(3) *Search for a motorcycle.*—As the work of Weiss and Aschkenasy produced strong indications of a shot from the grassy knoll, the committee began a search of documentary and photographic evidence to determine if a motorcycle or other vehicle had been in the locations indicated by the acoustical tests.

Earlier in its investigation, the committee had interviewed many Dallas police officers who had ridden in the Presidential motorcade, although the purpose of the interviews was not to determine the location of a motorcycle that might have had its radio transmitting switch stuck in the "on" position. Among the officers who were interviewed, one who subsequently testified in a public hearing was H. B. McLain. In his interview on September 26, 1977, McLain said that he had been riding to the left rear of Vice President Johnson's car and that just as he was completing his turn from Main onto Houston Street, he heard what he believed to have been two shots.(*67*) Sergeant Jimmy Wayne Courson was also interviewed on September 26, 1977. He stated that his assignment in the motorcade was in front of the press bus, approximately six or seven cars to the rear of the Presidential limousine, and that as he turned onto Houston Street, he heard three shots about a second apart.(*68*) Neither officer was asked specifically whether his radio was on channel one or two, or whether his microphone switch might have been stuck in the transmit position.

The committee obtained Dallas Police Department assignment records confirming that McLain and Courson had both been assigned to the left side of the motorcade,(*69*) and it discovered photographic evidence(*70*) that Courson was riding to the rear of McLain, and, as Courson recalled,(*71*) he was in the vicinity of the press bus. The available films revealed that throughout the motorcade the spacing of the motorcycles varied, but that McLain was generally several car lengths ahead of Courson and therefore much closer to the Presidential and Vice Presidential limousines.(*72*) No photographs of the precise locations of the two officers at the moment of the assassination were, at that time, found. Photographs taken shortly before the assassination, however, did indicate that McLain was on Houston Street heading toward Elm as the Presidential limousine was turning onto Elm in front of the Texas School Book Depository.[12](*73*) At the time of the assassina-

[12] Subsequent to the committee's final vote on its findings, additional photographic evidence of the actions of Officer McLain was received by the committee from Robert Groden, a consultant to the committee.(*74*) It supported the committee's conclusion with respect to McLain's testimony, but since it was not received until after the vote, it was not relied upon in this report.

tion, therefore, he would have been in the approximate position of the transmitting microphone, as indicated by the acoustical analysis.

The committee reviewed transcripts of the Dallas police dispatch tapes for both channel one and channel two. It did not find any voice transmissions from McLain on either channel on November 22 1963. (As noted, it was determined that the shots fired during the assassination were recorded over channel one. If it could have been established that McLain was transmitting over channel two, then the gunfire transmissions could not have come from his motorcycle radio.)

McLain was asked by the committee to come to Washington to testify. He was shown all of the photographic evidence that the committee had assembled, as well as the Dallas police records of the motorcade assignments. McLain testified before the committee on December 29, 1978, that he was assigned to ride on the left side of the motorcade; that since he would slow down at corners, often stopping momentarily, and then speed up during straight stretches, his exact position in the motorcade varied; and that he was the first motorcycle to the rear of the Vice Presidential limousine. (*75*)

He further stated that he was the officer in the photographs taken of the motorcade on Main and Houston Streets, and that at the time of the assassination he would have been in the approximate position of the open microphone near the corner of Houston and Elm, indicated by the acoustical analysis.(*76*) He did not recall using his radio during the motorcade nor what channel it was tuned to on that day.(*77*) He stated it usually was tuned to channel one.(*78*) The button on his transmitter receiver, he acknowledged, often got stuck in the "on" position when he was unaware of it, but he did not know if it was stuck during the motorcade.(*79*)

McLain testified before the committee that he recalled hearing only one shot and that he thereafter heard Chief Curry say to go to the hospital.(*80*) McLain testified it was possible that he heard the broadcast of Chief Curry (which would have been on channel two) over the speaker of his own radio, or over the speaker of the radio of another motorcycle.(*81*)

Following the hearing, the committee secured a copy of the daily assignment sheet for motorcycles from the Dallas Police Department and found that McClain had been assigned motorcycle number 352 and call sign 155 on November 22, 1963.(*82*) Preliminary photographic enhancement of the films taken on Houston and Main Streets indicated that the number on the rear of the motorcycle previously identified as having been ridden by McLain was, in fact, 352.(*83*) [13]

[13] During his public testimony, McLain also identified photographs of motorcycles on Elm Street (JFK Exhibit F–675), and at Parkland Hospital (JFK Exhibits 674, 676, 677, and 678) as possibly portraying his motorcycle. One of the pictures at Parkland Hospital (JFK Exhibit F–674) apparently indicates that the microphone button was turned to channel one. With respect to the photograph on Elm Street, McLain stated that the other motorcycle in the picture appeared to be ridden by Sergeant Courson. At that time, counsel cautioned that the photographs were being introduced for a limited purpose, since they had not been analyzed by any photographic experts; it was unclear if the cycle in each photograph was that of McLain; and the channel selector, even if it was on channel one, could have been switched after the shots were fired. Preliminary photographic analysis of those pictures conducted by one expert in the time available after the hearing cast doubt upon the accuracy of at least McLain's identification of Courson in Exhibit F–675, and indicated that the channel selector on the motorcycle in Exhibit F–674 may have been on channel two instead of one. Because the committee was unable to conduct comprehensive and thorough analyses of those photographs, it did not rely on Exhibits F–674, F–675, F–676, F–677 or F–678 in forming any conclusions.

The committee recognized that its acoustical analysis first established and then relied on the fact that a Dictabelt had recorded transmissions from a radio with a stuck microphone switch located in Dealey Plaza. The committee realized that the authenticity of the tape and the location of the stuck microphone were both of great importance to the acoustical analysis. Consequently, it sought to verify that the tape in fact contained a broadcast from an open motorcycle microphone in Dealey Plaza during the assassination.

The findings of the acoustics experts may be challenged by raising a variety of questions, questions prompted, for example, by the sound of sirens on the tape,(*84*) by statements by Officer McLain subsequent to his hearing testimony in which he denied that it was his radio that was transmitting, (*85*) by what appears to be the sound of a carillon bell on the tape,(*86*) and by the apparent absence of crowd noise. The committee carefully considered these questions as they bore on the authenticity of the tape and the location of the stuck microphone.

Approximately 2 minutes after the impulse sequences that, according to the acoustical analysis, represent gunfire, the dispatch tape contains the sound of sirens for approximately 40 seconds. The sirens appear to rise and then recede in intensity, suggesting that the position of the microphone might have been moving closer to and then farther away from the sirens, or that the sirens were approaching the microphone and then moving away from it.(*87*)

If the sirens were approaching the microphone and then moving away from it, it could be suggested that the motorcycle with the stuck transmitter was stationary on the Stemmons Freeway and not in Dealey Plaza. The sirens would appear to increase and then decrease as some vehicles in the motorcade, with their sirens turned on, drove along the freeway on the way to Parkland Hospital, approaching and then passing by the motorcycle with the stuck microphone. According to a transcript of channel two transmissions, approximately 3½ minutes after the assassination Dallas Police Department dispatcher Gerald D. Henslee stated that an unknown motorcycle on Stemmons Freeway appeared to have its microphone switch stuck open on channel one.(*88*) The committee interviewed Henslee on August 12, 1978. He told the committee he had assumed the motorcycle was on the freeway from the noise of the sirens.(*89*) Other Dallas police officers have also speculated that the motorcycle may have been standing near the Trade Mart.

Officer McLain's acknowledged actions subsequent to the assassination might explain the sound of sirens on the tape. McLain was in fact probably on Stemmons Freeway at the time Henslee noted that an unknown motorcycle appeared to have its microphone switch stuck open. McLain himself testified that following the assassination, he sped up to catch the front cars of the motorcade that had entered Stemmons Freeway en route to Parkland Hospital.(*90*) In any event, it is certain he left the plaza shortly after the assassination. The cars in the motorcade had their sirens on, and this could account for the sound of the sirens increasing as McLain drew closer to them, whether he left Dealey Plaza immediately or shortly after the assassination.[14] A

[14] McLain's microphone was so constructed that it would pick up only the siren of the motorcycle on which it was mounted or one of a motorcycle or other vehicle that was no more than 300 feet away.

variety of other actions might also account for the sound appearing to recede. Officer McLain might have fallen back after catching the cars, he might have passed by the cars, or he might have arrived at the hospital shortly after catching up, at a time when the sirens were being turned down as the cars approached the hospital.

Subsequent to his hearing testimony, McLain stated that he believed he turned on his siren as soon as he heard Curry's order to proceed to Parkland Hospital. He said that everyone near him had their sirens on immediately.(*91*) Should his memory be reliable, the broadcast of the shots during the assassination would not have been over his radio, because the sound of sirens on the tape does not come until approximately 2 minutes later. The committee believed that McLain was in error on the point of his use of his siren. Since those riding in the motorcade near Chief Curry had their sirens on, there may have been no particular need for McLain to turn his on, too. The acoustical analysis pinpointing the location of the microphone, the confirmation of the location of the motorcycle by photographs, his own testimony as to his location, and his slowing his motorcycle as it rounded the corner of Houston and Elm (as had been previously indicated by the acoustical analysis),(*92*) and the likelihood that McLain did not leave the plaza immediately, but lagged behind momentarily after the assassination, led the committee to conclude it was Officer McLain whose radio microphone switch was stuck open.

Further, the committee noted, it would have been highly improbable for a motorcycle on Stemmons Freeway to have received the echo patterns for the four impulses that appear on the dispatch tape. As noted in more detail below, to contend that the microphone was elsewhere carries with it the burden of explaining all that appears on the tape. To be sure, those who argue the microphone was in Dealey Plaza must explain the sounds that argue it was not. Similarly, those who contend it was not in Dealey Plaza must explain the sounds that indicate it was. As Aschkenasy testified, the echo patterns on the tape would only have been received by a microphone located in a physical environment with the same acoustical characteristics as Dealey Plaza.(*93*) It is extremely unlikely that the echo patterns on the tape, if received from elsewhere, would so closely parallel the echo patterns characteristic of Dealey Plaza.

The tape contains the faint sound of a carillon-like bell about 7 seconds after the last impulse believed to have been a shot, but no such bell was known to have been in the vicinity of Dealey Plaza. Accordingly, the possibility that the motorcycle with the stuck radio transmitter might not have been in Dealey Plaza was considered. The committee found that the radio system used by the Dallas Police Department permitted more than one transmitter to operate at the same time, and this frequently occurred.(*94*) The motorcycle whose radio transmitted the sound of a bell was apparently not positioned in Dealey Plaza, but this did not mean that the transmissions of gunshots were also from a radio not in Dealey Plaza. The logical explanation was that the dispatch tape contains the transmissions of two or more radios.(*95*)

The absence of identifiable crowd noise on the tape also might raise questions as to whether the motorcycle with the stuck transmitter was in Dealey Plaza. The lack of recognizable crowd noise, however, may be explained by the transmission characteristics of the microphone.

Dallas police motorcycle radios were equipped with a directional microphone and were designed to transmit only very loud sounds. A human voice would transmit only if it originated very close to the front of the mike. The chief objective of this characteristic was to allow a police officer, when speaking directly into the microphone, to be heard over the sound of his motorcycle engine. Background noise, such as that of a crowd, would not exceed the noise level from the much closer motorcycle engine, and it would not be identifiable on a tape of the radio transmission. The sound of a rifle shot is so pronounced, however, that it would be picked up even if it originated considerably farther away from the microphone than other less intense noise sources, such as a crowd.(*96*)

(*c*) *Other evidence with respect to the shots*

To address further the question of whether the dispatch tape contained sounds from a microphone in Dealey Plaza with a stuck transmitting switch, the committee reviewed independent evidence. It reasoned that if the timing, number and location of the shooters, as shown on the tape, were corroborated or independently substantiated in whole or in part by other scientific or physical evidence—that is, the Zapruder film, findings of the forensic pathology and firearms panels, the neutron activation analysis and the trajectory analysis—the validity of the acoustical analysis and the authenticity of the tape could be established. Conversely, any fundamental inconsistency in the evidence would undermine the analysis and the authenticity of the tape.

The tape and acoustical analysis indicated that, in addition to the shot from the knoll, there were three shots fired at President Kennedy from the Texas School Book Depository. This aspect of the analysis was corroborated or independently substantiated by three cartridge cases found on the sixth floor of the Texas School Book Depository on November 22, 1963, cartridge cases that had been fired in Oswald's rifle,(*97*) along with other evidence related to the number of shots fired from Oswald's rifle. This corroboration was considered significant by the committee, since it tended to prove that the tape did indeed record the sounds of shots during the assassination.

Further corroboration or substantiation was sought by correlating the Zapruder film to the acoustical tape. The Zapruder film contains visual evidence that two shots struck the occupants of the Presidential limousine.(*98*) The committee attempted to correlate the observable reactions of President Kennedy and Governor Connally in the film to the time spacing of the four impulses found in the recording of the channel one transmission. The correlation between the film and the recording, however, could only be approximate because it was based on the estimated real-time characteristics of the recording (calculated from the frequent time annotations made by the dispatcher) (*99*) and the average running time of the film (between 18.0 and 18.5, or an average of 18.3 frames per second).[15]

[15] The 18.3 frame per second rate of the Zapruder film was an average of the 18.0 to 18.5 frame per second rate determined in 1964 by the FBI under laboratory conditions in which the camera was set and run in the manner that Zapruder said he had operated it at the time of the assassination. (*100*) Given the 18.0 to 18.5 frame per second average running speed of the film, a differential of four frames is a differential of less than a quarter of a second. For this reason, an absolute correlation between events in the recording and the observable reactions on the film was not expected. If there were no reasonable correlation between the tape and film, however, substantial questions concerning the authenticity of the tape could be raised. (A more detailed explanation of the calculation of Zapruder frames based on the running speeds of the camera is set forth in vol. V of the HSCA–JFK hearings, at pp. 722–724.)

The committee correlated the film to the tape in two ways. The first assumed the fourth shot was the fatal head shot to the President and occurred at frame 312. Its results are as follows:(*101*)

	Channel time	Bullet reached limousine at Zapruder frame No.	Acoustical determination of source of impulse
Impulse pattern I	12:30:47.0	157–161	TSBD.
Impulse pattern II	12:30:48.6	188–191	TSBD.
Impulse pattern III	12:30:54.6	295–296	Grassy knoll.
Impulse pattern IV	12:30:55.3	312	TSBD.

The committee believed that the fourth impulse pattern probably reepresented that fatal head shot to the President that hit at Zapruder frame 312. Nevertheless, the possibility of frame 312 representing the shot fired from the grassy knoll, with the fourth shot consequently occurring at frame 328, was also considered. The problem with this possibility is that it appeared to be inconsistent with other scientific evidence that established that all the shots that struck the President and the Governor came from the Texas School Book Depository.

The forensic pathology panel concluded that there was no evidence that the President or Governor was hit by a bullet fired from the grassy knoll and that only two bullets, each fired from behind, struck them.(*102*) Further, neutron activation analysis indicated that the bullet fragments removed from Governor Connally's wrist during surgery, those removed from the President's brain during the autopsy, and those found in the limousine were all very likely fragments from Mannlicher-Carcano bullets. (*103*) It was also found that there was evidence of only two bullets among all the specimens tested—the fragments removed from Governor Connally's wrist during surgery were very likely from the almost whole bullet found on the stretcher at Parkland Hospital, and the fragments removed from the President's brain during the autopsy very likely matched bullet fragments found in the limousine.(*104*) The neutron activation analysis findings, when combined with the finding of the committee that the almost whole bullet found on the stretcher at Parkland Hospital as well as the larger fragment found in the limousine were fired from Oswald's Mannlicher-Carcano rifle,(*105*) established that only two bullets struck the President and the Governor, and each was fired from the rifle found on the sixth floor of the Texas School Book Depository and owned by Oswald.

The committee considered whether proper synchronization of the tape to the film should assume that the shot from the grassy knoll hit the President at Zapruder from 312. It did so because Dr. Michael Baden, chairman of the committee's forensic pathology panel, acknowledged there was a possibility, although highly remote, that the head wound depicted in Zapruder frame 312 could have been caused by a shot from the grassy knoll, and that medical evidence of it had been destroyed by a shot from the rear a fraction of a second later. (*106*) [16] The

[16] In addition, the blur analysis conducted by the photographic evidence panel appeared to be more consistent with the grassy knoll shot striking the President. The analysis reflected no significant panning errors by Zapruder after frame 296. Such errors would have been expected if the third (grassy knoll) shot occurred 0.7 second before the fatal head shot. Assuming the head shot was the grassy knoll shot, Zapruder made significant panning errors after both the third and fourth shots. (See Blur Analysis, Appendix to the HSCA–JFK hearings, vol. VI, par. 81ff.)

significance of this, the committee reasoned, was the realization that it could mean that the President's fatal head wound was caused by the shooter from the grassy knoll, not Oswald.

Since the medical, ballistics and neutron activation analysis evidence, taken together, established that the President was struck by two bullets fired from Oswald's rifle found on the sixth floor of the Texas School Book Depository, the committee sought to determine if such shots could have struck the President, given the known position of his body, even if the grassy knoll shot struck him at Zapruder frame 312. The results of correlating the acoustical tape to the film, assuming the shot from the knoll was at Zapruder frame 312, are as follows: (*107*)

	Zapruder frame	Acoustical determination of origin
Impulse pattern I	173–177	TSBD.
Impulse pattern II	205–208	TSBD.
Impulse pattern III	312	Grassy knoll.
Impulse pattern IV	328–329	TSBD.

It was determined by medical, ballistics and neutron activation evidence that the President was struck in the head by a bullet fired from a rifle found on the sixth floor of the Texas School Book Depository. For that bullet to have destroyed the medical evidence of the President being hit at Zapruder frame 312, it would have had to have struck at Zapruder frame 328–329. But a preliminary trajectory analysis, based on the President's location and body position at frame 328–329 failed to track to a shooter in the sixth floor southeast corner window of the depository within a minimum margin of error radius, (*108*) thus indicating it was highly unlikely the President was struck in the head at Zapruder frame 328 by a shot fired from the sixth floor southeast corner window of the depository. Further, there is no visual evidence in the Zapruder film of the President being struck in the head at Zapruder frames 173–177 or 205–208, the frames at which shots one and two would have been fired if the shot from the knoll was a hit to the head at frame 312. Accordingly, if the shot from the grassy knoll occurred at frame 312, no shot fired from the Texas School Book Depository would have struck the President in the head at any time. Such a finding is contrary to the weight of the scientific evidence. The committee concluded, therefore, that the shot fired from the grassy knoll was not the shot visually represented at Zapruder frame 312; that the shot from the grassy knoll missed President Kennedy; [17] and that the most accurate synchronization of the tape and the film would be one based on a correlation of impulse pattern four on the tape with the fatal head shot to the President at frame 312 of the Zapruder film. When the tape and film are so synchronized, the sequence on the film corroborated or substantiated the timing of the shots indicated on the 1963 tape.

According to the more logical synchronization, the first shot would have occurred at approximately Zapruder frame 160. This would also

[17] The committee noted there was no physical evidence of where a shot from the grassy knoll might have hit. Since a shot from the Texas School Book Depository hit the President in the head less than one second after the shot from the knoll, there would have been little apparent reason for a gunman on the knoll to fire a second shot.

be consistent with the testimony of Governor Connally, who stated that he heard the first shot and began to turn in response to it. (*109*) His reactions, as shown in Zapruder frames 162–167, reflect the start of a rapid head movement from left to right. (*110*)

The photographic evidence panel's observations were also relevant to the acoustics data that indicated that the second shot hit the limousine's occupants at about Zapruder frames 188–191. The panel noted that at approximately Zapruder frame 200 the President's movements suddenly freeze, as his right hand seemed to stop abruptly in the midst of a waving motion. Then, during frames 200–202, his head moves rapidly from right to left. The sudden interruption of the President's hand-waving motion, coupled with his rapid head movements, was considered by the photographic panel as evidence of President Kennedy's reaction to some "severe external stimulus." (*111*)

Finally, the panel observed that Governor Connally's actions during frames 222–226, as he is seen emerging from behind the sign that obstructed Zapruder's view, indicated he was also reacting to some "severe external stimulus." [18] (*112*) Based upon this observation and upon the positions of President Kennedy and Governor Connally within the limousine, the panel concluded that the relative alinement of the two men was consistent with the theory that they had been struck by the same bullet. (*113*)

The forensic pathology panel, with one member in dissent, stated that the medical evidence was consistent with the hypothesis that a single bullet caused the wounds to the Governor and the President. (*114*)

The committee conducted a trajectory analysis for the shot that it ultimately concluded struck both the Governor and the President. It was based on the location of the limousine and the body positions of President Kennedy and Governor Connally at Zapruder frame 190 and the bullet's course as it could be determined from their wounds.[19] When President Kennedy's entry and exit wounds were used as reference points for the trajectory line, it intersected the Texas School Book Depository within a 13-foot radius of a point approximately 14 feet west of the building's southeast corner and approximately 2 feet below the sixth floor window-sills. (*115*) When President Kennedy's exit wound and Governor Connally's entrance wound were used as the reference points for the trajectory line, it intersected the Texas School Book Depository within a 7-foot radius of a point approximately 2 feet west of the southeast corner and 9 feet above the sixth floor window sills. (*116*)

The committee's examination of the synchronization of the tape to the Zapruder film, therefore, demonstrated that the timing of the impulses on the tape matched the timing of events seen in the film. Further, the other scientific evidence available to the committee was

[18] The panel reached no conclusion concerning Governor Connally's reactions, if any, from Zapruder frame 207 to frame 221, since during this .82-second interval he was behind the sign that obstructed Zapruder's field of view. Connally could conceivably have started his reaction at frames 200–206, but too little of his body is visible during these frames to permit such a finding.

[19] Because the committee concluded that the shot from the grassy knoll did not hit the President at Zapruder frame 312, it did not undertake a trajectory analysis for the second shot from the depository, one that would have occurred in the area of Zapruder frames 205–208 if the shot from the grassy knoll had hit the President at Zapruder frame 312.

consistent with the reactions viewed in the film and the timing of the shots indicated by the acoustical analysis. The synchronization of the 1963 dispatch tape with the film, based on a fatal hit to the President's head at frame 312 having been fired from the Texas School Book Depository, along with related evidence, corroborated or independently substantiated that the tape is one of transmissions from a microphone that recorded the assassination in Dealey Plaza on November 22, 1963.

Despite the existence of adequate corroboration or substantiation of the tape's authenticity, the committee realized that other questions were posed by the timing sequence of the impulses on the tape. The acoustical analysis had indicated both the first and second impulse patterns were shots from the vicinity of Texas School Book Depository, but that there were only 1.66 seconds between the onset of each of these impulse patterns. The committee recognized that 1.66 seconds is too brief a period for both shots to have been fired from Oswald's rifle, given the results of tests performed for the Warren Commission that found that the average minimum firing time between shots was 2.3 seconds.(*117*)

The tests for the Warren Commission, however, were based on an assumption that Oswald used the telescopic sight on the rifle. (*118*) The committee's panel of firearms experts, on the other hand, testified that given the distance and angle from the sixth floor window to the location of the President's limousine, it would have been easier to use the open iron sights.(*119*) During the acoustical reconstruction performed for the committee in August, the Dallas Police Department marksmen in fact used iron sights and had no difficulty hitting the targets.

The committee test fired a Mannlicher-Carcano rifle using the open iron sights. It found that it was possible for two shots to be fired within 1.66 seconds.(*120*) One gunman, therefore, could have fired the shots that caused both impulse pattern 1 and impulse pattern 2 on the dispatch tape. The strongest evidence that one gunman did, in fact, fire the shots that caused both impulse patterns was that all three cartridge cases found on the sixth floor of the Texas School Book Depository came from Oswald's rifle.(*121*) In addition, the fragments from the two bullets that were found were identified as having been fired from Oswald's rifle.(*122*) Accordingly, the 1.66 seconds between the onset of the first and second impulse patterns on the tape are not too brief a period of time for both of these patterns to represent gunfire, and for Oswald to have been the person responsible for firing both shots.

To explore further whether the tape contained sounds transmitted from a microphone in Dealey Plaza, the committee reviewed evidence produced by its photographic evidence panel. The panel conducted a "jiggle analysis" of the Zapruder film on the theory that Zapruder's panning errors, which would be apparent as a blur in the film, might have been caused by his reaction to the sound of gunfire. An original jiggle analysis, performed without knowledge of the results of the acoustical analysis, showed strong indications of shots occurring at about frame 190 and at about frame 310.(*123*) The photographic evidence panel also noted some correlation between the acoustics results and a panning error reaction to the apparent sound of gunfire at about

frame 160. Little evidence of another shot was found in the jiggle analysis,[20] but the expert who performed it testified that since the third and fourth shots occurred within less than a second of each other, it might be difficult to differentiate between them. (*124*)

In summary, the various scientific projects indicated that there was a high probability that two gunmen were firing at the President. Scientifically, the existence of the second gunman was established only by the acoustical study, but its basic validity was corroborated or independently substantiated by the various other scientific projects.

The committee had its photographic evidence panel examine evidence that might also reveal that there was in fact more than one gunman shooting at the President. Each item of relevant photographic evidence available to the committee was evaluated to determine whether image enhancement techniques (digital image processing, photo-optical/chemical enhancement, and autoradiographic enhancement) might show additional gunmen. (*125*) As the use of nonoriginal photographic materials frequently introduces image distortion that precludes accurate photointerpretation, only original photographic materials were subjected to image enhancement techniques. (*126*) Similarly, since opaque film, such as photographic print paper, does not have the dynamic range (of brightness) of properly processed transparent film, it was not as suitable for enhancement. (*127*)

There was considerable witness testimony, as well as a large body of critical literature, that had indicated the grassy knoll as a source of gunshots. Accordingly, this area received particular emphasis in the photographic interpretation analysis. The panel directed its attention to that portion of the knoll that extended from the retaining wall situated by the pergola to the stockade fence to the west of the wall. This analysis included enhancement of photographs taken by Mary Moorman, Philip Willis and Orville Nix, as well as Zapruder.

Mary Moorman, a bystander, had taken a Polaroid photograph of the grassy knoll at approximately the time of Zapruder frame 313. (*128*) As far as the committee knew, it was the one photograph taken at the moment of the fatal head shot that showed the area that the acoustical analysis indicated was the location of the second gunman. Viewing the photograph with the naked eye, one could detect images that might be construed as something significant behind the stockade fence. These images may, however, only represent parts of a tree, or they may be photographic artifacts. Due to the poor quality of the photograph and its deterioration over the years, it was not possible to determine the nature of the images with the naked eye. The photograph, because of this poor quality and because it was taken on opaque film that is less suitable for photographic enhancement, was considered by the photographic evidence panel to be of limited usefulness. (*129*) Prior to the acoustical analysis, it was the subject of only limited clarification efforts, none of which involved computer technology. (*130*) Enhancement attempts in the region of the retaining wall produced no significant increase in detail and no evidence of any human form. (*131*) Because the stockade fence region of the photograph was of even

[20] Indication of a shot from the grassy knoll might have been expected in the jiggle analysis at about frame 295.

poorer quality than the retaining wall area, no enhancement attempts were recommended.(*132*) Subsequent to the acoustical analysis, the author of the section of the photographic evidence panel's report that addressed the question of whether there were other gunmen in Dealey Plaza indicated that the likelihood of successfully enhancing this print was extremely remote.(*133*)

The significance of the Moorman film may, therefore, be largely negative. It was not possible to draw anything positive from the film 15 years after it was taken. Nevertheless, if the film did not contain images that might be construed to be a figure behind the fence, it would be a troubling lack of corroboration for the acoustical analysis. At the same time, the committee noted, the Department of Justice might consider further enhancement, if it is deemed to be feasible.

Zapruder frame 413, showing a bush situated between Zapruder and the Presidential limousine, was also analyzed by the photographic evidence panel. Image enhancement techniques successfully established the presence of a human head visible among the leaves of the bush in Zapruder's field of view.(*134*) Photogrammetric analysis determined that this so-called gunman in the bush was actually located on the other side of the bush from Zapruder.(*135*) It is probably one of the men who can be seen in other photographs standing in the middle of the sidewalk that runs from the top of the grassy knoll down to Elm Street. Consequently, he was not, as had been alleged, in a position to have been a hidden gunman. Further, the linear feature associated with this person, alleged by Warren Commission critics to be a rifle, is actually in front of the leaves on the same side of the bush as Zapruder. (*136*) Analytical photogrammetry and image enhancement with special color analysis attributed this linear feature to natural surroundings. The narrow portion of the linear feature (the alleged rifle barrel) was established to be one of a number of twigs in the bush. (*137*) All of them were characterized by the same general direction and spacing, consistent with the natural growth patterns of the bush. (*138*) The thicker part of the linear feature (the alleged rifle "stock") was a hole in the bushes through which a portion of the Presidential limousine was visible.(*139*)

Willis photograph No. 5 was the third knoll photograph enhanced and evaluated by the panel. The relevant area of analysis was the retaining wall situated approximately 41 feet to the east of the point of the stockade fence that, according to the acoustics analysis, was the source of gunfire. A fleshtone comparison performed by analyzing measurements of color values on an object located behind the west end of the retaining wall confirmed that the image perceived was actually a human being.(*140*) The panel did perceive "a very distinct straight-line feature" near the region of this person's hands, but it was unable to deblur the image sufficiently to reach any conclusion as to whether the feature was, in fact, a weapon.(*141*)

Photographic enhancement of selected portions of a film taken by Orville Nix was also performed by the panel. One object in the vicinity of the retaining wall near the pergola was carefully studied, but the panel could not identify it as a human being and decided that the image was more likely the result of light and shadow patterns.(*142*)

The Nix frames analyzed included those that purportedly depict a gunman in a "classic" firing stance. This "individual" is located by the southwest corner of the pergola beyond the retaining wall, approximately 41 feet north of the point of the stockade fence that, according to the acoustics study, was the source of gunfire. The panel was able to conclude that this image was not, in fact, a human being. Its conclusion was based on both a shadow analysis and its inability to attribute flesh tones or motion to the alleged gunman. (*143*)

None of the photographs of the grassy knoll that were analyzed by the photographic evidence panel revealed any evidence of a puff of smoke or flash of light, (*144*) as reported by several people in the crowd.

The committee's analysis of available photographic evidence, therefore, did not confirm or preclude the presence of a gunman firing at the President from behind the stockade fence on the grassy knoll. In addition to photographs of the knoll area, the committee enhanced photographic materials of the Texas School Book Depository taken by Robert Hughes, Tom Dillard, and James Powell. These were examined for any evidence with respect to the source of the shots fired from the depository, as well as any evidence of conspiratorial activity before or after the assassination. (The committee was not aware of the existence of any photographs of the sixth floor southeast corner window of the depository at the actual moment of the assassination.) The Hughes film, taken moments before the first shot was fired at the President, was enhanced for the purpose of determining whether any motion could be discerned in the sixth floor southeast corner window where Oswald was alleged to have been positioned. Although motion in this window was noted, the panel concluded that it was only apparent rather than real. (*145*) This conclusion was based upon the rapidity of the perceived motion, its lack of consistent direction, and the fact that the object disappears from view during a two-frame (approximately one-ninth of a second) sequence. (*146*) Accordingly, the motion was attributed to photographic artifact. (*147*) An appearance of motion in an adjacent set of windows was also attributed to a photographic artifact. (*148*)

The question of motion in both sets of windows is similarly raised by the film taken by Charles L. Bronson several minutes before the assassination. Because this film was not made available to the committee until December 2, 1978, it was not reviewed by the full panel. In a preliminary examination of the film by several members of the panel, it was observed that the characteristics of the Bronson film were similar to those of the Hughes film that were examined by the entire panel. The apparent motion in the window seemed to be random and therefore not likely to be caused by human motion. (*149*) Because of the high quality of the Bronson film, the panel members recommended it be subjected to computer analysis. (*150*) The committee recommended, in turn, that the Bronson film be subjected to analysis by the Department of Justice.

Enhancement efforts with respect to the Dillard and Powell photographs, taken shortly after the assassination, successfully generated considerable detail within the depository window. (*151*) Based upon its review of these materials, the panel was able to conclude that at

the time these photographs were taken, no human forms were present in the sixth floor southeast corner window of the depository.(*152*)

No photographs of the sixth floor southeast corner window of the Texas School Book Depository were taken at the time of the assassination, photographic evidence did not confirm or preclude a firing by an assassin from the window. Photographs of the sixth floor window taken shortly before and after the assassination did not reveal evidence of human forms. Allegations that these photographs contain evidence of there having been more than one gunman on the sixth floor were not supported by the enhancement efforts. In summary, the photographic evidence with respect to the grassy knoll and the Texas School Book Depository did not confirm or preclude that a gunman fired at the President from either location.

None of the scientific evidence available to the committee—photography, forensic pathology, ballistics, neutron activation analysis—was inconsistent with the acoustical evidence that established a high probability that two gunmen fired at the President.

(*d*) *Witness testimony on the shots.*—The committee, in conjunction with its scientific projects, had a consultant retained by Bolt Beranek and Newman analyze the testimony of witnesses in Dealey Plaza on November 22, 1963, to advise the committee what weight, if any, it should give such testimony, and to relate the testimony to the acoustics evidence the committee had obtained.

The statements of 178 persons who were in Dealey Plaza, all of whom were available to the Warren Commission, were analyzed:(*153*) 49 (27.5 percent) believed the shots had come from the Texas School Book Depository; 21 (11.8 percent) believed the shots had come from the grassy knoll; 30 (16.9 percent) believed the shots had originated elsewhere; and 78 (43.8 percent) were unable to tell which direction the shots were fired from. Only four individuals believed shots had originated from more than one location.(*154*)

Some comment on these statistics is called for. The committee noted that a significant number of witnesses reported that shots originated from the grassy knoll. The small number of those who thought shots originated from both the book depository and grassy knoll might be explained by the fact that the third and fourth shots were only seven-tenths of a second apart. Such a brief interval might have made it difficult for witnesses to differentiate between the two shots, or to distinguish their direction. While recognizing the substantial number of people who reported shots originating from the knoll, the committee also believed the process of collecting witness testimony was such that it would be unwise to place substantial reliance upon it. The witnesses were interviewed over a substantial period of time, some of them several days, even weeks, after the assassination. By that time, numerous accounts of the number and direction of the shots had been published. The committee believed that the witnesses' memories and testimony on the number, direction, and timing of the shots may have been substantially influenced by the intervening publicity concerning the events of November 22, 1963.(*155*) Consequently, standing alone, the statistics are an unreliable foundation upon which to rely with great confidence for any specific finding. It was of obvious im-

portance, however, that some witness testimony would corroborate the acoustical finding of a shot from the grassy knoll. If no testimony indicated shots from the knoll, there would have been a troubling lack of corroboration for the acoustical analysis.

The Warren Commission had available to it the same testimony concerning shots from the knoll, but it believed it should not be credited because of "the difficulty of accurate perception."(*156*) The Commission stated, "* * * the physical and other evidence" only compelled the conclusion that at least two shots were fired.(*157*) The Commission noted, however, that the three cartridge cases that were found, when taken together with the witness testimony, amounted to a preponderance of evidence that three shots were fired.(*158*) Nevertheless, the Commission held, "* * * there is no credible evidence to indicate shots were fired from other than the Texas School Book Depository."(*159*) It therefore discounted the testimony of shots from the grassy knoll.

While recognizing that the Commission was correct in acknowledging the difficulty of accurate witness perception, the committee obtained independent acoustical evidence to support it. Consequently, it was in a position where it had to regard the witness testimony in a different light.

The committee assembled for the purpose of illustration the substance of the testimony of some of the witnesses who believed the shots may have come from somewhere in addition to the depository. A Dallas police officer, Bobby W. Hargis, was riding a motorcycle to the left and slightly to the rear of the limousine. Hargis described the direction of the shots in a deposition given to the Warren Commission on April 8, 1964:

> Well, at the time it sounded like the shots were right next to me. There wasn't any way in the world I could tell where they were coming from, but at the time there was something in my head that said that they probably could have been coming from the railroad overpass, because I thought since I had got splattered * * * I had a feeling that it might have been from the Texas School Book Depository, and these two places was (sic) the primary place that could have been shot from.(*160*)

Hargis stated that after the shooting he saw a man fall to the ground at the base of the incline and cover his child. He also saw other people running. Hargis himself stopped his motorcycle and ran up the incline.(*161*)

The man Officer Hargis saw lying on the ground was probably William Eugene Newman. Newman and his wife and child were observing the motorcade from the curb near the west end of the concrete standard on Elm Street. Newman gave this description of their actions after hearing the shots to the sheriff's department on November 22, 1963:

> Then we fell down on the grass as it seemed that we were in direct path of fire . . . I thought the shots had come from the garden directly behind me, that was on an elevation from

> where I was as I was right on the curb. I do not recall looking toward the Texas School Book Depository. I looked back in the vicinity of the garden. (*162*)

Abraham Zapruder, since deceased, was standing on a concrete abutment on the grassy knoll, just beyond the Stemmons Freeway sign, aiming his 8 millimeter camera at the motorcade. He testified in a deposition given to the Commission on July 22, 1964, that he thought a shot may have come from behind him, but then acknowledged in response to questions from Commission counsel that it could have come from anywhere. He did, however, differentiate among the effects the shots had on him. One shot, he noted, caused reverberations all around him and was much more pronounced than the others. (*163*) Such a difference, the committee noted, would be consistent with the differing effects Zapruder might notice from a shot from the knoll, as opposed to the Texas School Book Depository.

A Secret Service agent, Paul E. Landis, Jr., wrote a statement on the shooting, dated November 30, 1963. Landis was in the follow-up car, behind the Presidential limousine, on the outside running board on the right. He indicated that the first shot "sounded like the report of a high-powered rifle from behind me, over my right shoulder." (*164*) According to his statement, the shot he identified as number two might have come from a different direction. He said:

> I still was not certain from which direction the second shot came, but my reaction at this time was that the shot came from somewhere towards the front, right-hand side of the road. (*165*)

Another witness, S. M. Holland, since deceased, also noted signs of a shot coming from a group of trees on the knoll. Holland was standing on top of the railroad overpass above Elm Street. Testifying in a deposition to the Warren Commission on April 8, 1964, he indicated he heard four shots. After the first, he said, he saw Governor Connally turn around. (*166*) Then there was another report. The first two sounded as if they came from "the upper part of the street." The third was not as loud as the others. Holland said:

> There was a shot, a report. I don't know whether it was a shot. I can't say that. And a puff of smoke came out about 6 or 8 feet above the ground right out from under those trees. And at just about this location from where I was standing, you could see that puff of smoke, like someone had thrown a firecracker, or something out, and that is just about the way it sounded. It wasn't as loud as the previous reports or shots. (*167*)

When counsel for the Warren Commission asked Holland if he had any doubts about the four shots, he said:

> I have no doubt about it. I have no doubt about seeing that puff of smoke come out from those trees either. (*168*)

These witnesses are illustrative of those present in Dealey Plaza on November 22, 1963, who believed a shot came from the grassy knoll.

(1) *Analysis of the reliability of witness testimony.*—The committee also conducted, as part of the acoustical reenactment in Dealey Plaza in August 1978, a test of the capacity of witnesses to locate the direction of shots, hoping the experiment might give the committee an independent basis with which to evaluate what weight, if any, to assign to witness testimony. Two expert witnesses were asked to locate the direction of shots during the test,(*169*) and Dr. David Green, the BBN consultant, supervised the test and prepared a report on the reactions of the expert witnesses. Green concluded in the report, "* * * it is difficult to draw any firm conclusions relative to the reports of witnesses in the plaza as to the possible locus of any assassin." (*170*) Nevertheless, he stated that "it is hard to believe a rifle was fired from the knoll" during the assassination, since such a shot would be easy to "localize." Green cited as support for his conclusion the fact that only four of the 178 Dealey Plaza witnesses pointed to more than one location as the origin of the shots.(*171*)

In its evaluation of Green's conclusions, the committee considered the different circumstances affecting the expert witnesses in the test and the actual witnesses to the assassination. The expert witnesses in August 1978 were expecting the shooting and knew in advance that guns would be fired only from the Texas School Book Depository and the grassy knoll, and they had been told their assignment was to determine the direction of the shots. Further, there was no test in which shots were fired within seven-tenths of a second of each other, so no reliable conclusion could be reached with respect to the possibility that such a brief interval would cause confusion. Dr. Green's report also reflects that even though the two trained observers correctly identified the origin of 90 percent of the shots, their own notes indicated something short of certainty.(*172*) Their comments were phrased with equivocation: "Knoll?;" "Over my head. Not really on knoll or even behind me:" "Knoll/underpass;" and "Knoll? Not really confident." Their comments, in short, frequently reflected ambiguity as to the origin of the shots, indicating that the gunfire from the grassy knoll often did not sound very different from shots fired from the book depository.

An analysis by the committee of the statements of witnesses in Dealey Plaza on November 22, 1963, moreover, showed that about 44 percent were not able to form an opinion about the origin of the shots,(*173*) attesting to the ambiguity showed in the August 1978 experiment. Seventy percent of the witnesses in 1963 who had an opinion as to origin said it was either the book depository or the grassy knoll.[21](*174*) Those witnesses who thought the shots originated from the grassy knoll represented 30 percent of those who chose between the knoll and the book depository and 21 percent of those who made a decision as to origin. Since most of the shots fired on November 22, 1963 (three out of four, the committee determined) came from the book depository, the fact that so many witnesses thought they heard shots from the knoll lent additional weight to a conclusion that a shot came from there.

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[21] The interviews of witnesses to the assassination may have reflected a tendency to make a "forced choice" between the two locations, caused by the actions of police and other spectators in Dealey Plaza indicating the knoll and the depository were the two shooter locations, an attitude that was substantiated by press reports of shooter locations that, in some instances, preceded interviews with witnesses.

The committee, therefore, concluded that the testimony of witnesses in Dealey Plaza on November 22, 1963 supported the finding of the acoustical analysis that there was a high probability that a shot was fired at the President from the grassy knoll. There were also witness reports of suspicious activity in the vicinity of the knoll. (*175*).

(*e*) *Certain conspiracy allegations*

While the committee recognized, as discussed in section C, that a finding that two gunmen fired at the President did not in itself establish that President Kennedy was assassinated as a result of a conspiracy, it did establish, in the context of common experience, the probability that a conspiracy did exist that day. Consequently, the committee sought to employ scientific analysis to examine some conspiracy theories about the assassination. The scientific analysis that could be applied to these conspiracy allegations refuted each one of them.

The committee had its photographic evidence panel investigate allegations concerning certain specific individuals who had been linked to the assassination and were allegedly present in Dealey Plaza. Forensic anthropologists were asked to compare photographs of these known subjects with those of unidentified persons photographed in Dealey Plaza on the day of the assassination. The anthropological studies involved comparisons of morphological traits (wrinkles, scars, and shape of ears, nose, et cetera) and facial dimensions and statural measurements to the extent that these could be derived from the photographs examined and other related documents available to the committee. (*176*)

The first photograph examined contained an individual appearing in a press photograph of motorcade spectators on Houston Street. (*177*) Some critics had contended the individual appeared to be Joseph A. Milteer, a militant conservative who had been secretly recorded on tape by a police informant 2 weeks prior to the assassination as he described a plan to assassinate the President.[22] The anthropologists concluded, however, that based on available photographs and records of Milteer's height, the individual in the photograph could not have been Milteer. (*178*)

Press photographs of three "tramps" apprehended by the Dallas police near Dealey Plaza shortly after the assassination were analyzed and compared with photographs of a number of persons, including E. Howard Hunt,[23] Frank Sturgis, Thomas Vallee, Daniel Carswell, and Fred Lee Chrisman, each of whom had been alleged by critics to be linked to the assassination. Of all the subjects compared, only Fred Lee Chrisman, a conservative active in New Orleans at the time of the assassination, was found to have facial measurements consistent with any of the tramps. (*180*) Anthropologists could not make a positive identification of Chrisman, (*181*) however. The committee could not establish any link between Chrisman and the assassination. In addi-

[22] The committee's analysis of the response by the Secret Service to the threat posed by Milteer's alleged plan is described in section D1 of this report.

[23] During the course of the committee's investigation, a rumor was circulating that the committee had uncovered a memorandum in CIA files indicating Hunt was in Dallas on November 22, 1963. The rumor was not founded on fact. In addition, Hunt gave the committee a sworn deposition (*179*) in which he denied the allegation, and the committee found no evidence that contradicted Hunt's deposition.

tion, the committee independently determined that Chrisman was not in Dealey Plaza on the day of the assassination. (*182*)

The committee sought, by employing scientific analysis, to explore other allegations of conspiratorial activity. Establishing the authenticity of the autopsy photographs and X-rays was of fundamental importance, not only because these evidentiary materials were a primary basis for the committee's findings concerning the nature and causes of the President's head wounds, but because allegations that they had been altered raised implications of a wide-based conspiracy operating at high levels of the U.S. Government. As it has been noted, the committee found that the X-rays and photographs had not been altered.

Another conspiratorial theory that implied there was an extensive and sophisticated conspiracy rested on the allegation that the photographs of Oswald in his backyard holding a rifle were composites. Similar conspiratorial implications were raised by the allegation that the rifle currently in the National Archives was a different rifle than that seen in the backyard photographs of Oswald with the rifle, as well as other photographs of the rifle taken on November 22 and November 23, 1963. As discussed in section A 3, scientific analysis performed by the committee refuted each of these allegations. (*183*)

The final conspiratorial theory the committee investigated by scientific analysis was the so-called "two Oswald theory." This was an assertion by some critics that the Lee Harvey Oswald who returned from Russia in 1962 was a different person than the Lee Harvey Oswald who defected to Russia in 1959. (*184*) Forensic anthropologists analyzed and compared a number of photos of Oswald taken at different times during his life for any indication that they were not photographs of one and the same individual. Based on an analysis of facial dimensions, they found all the photographs consistent with those of a single individual. (*185*)

In addition, the photographic evidence panel conducted height and proportion studies of various Oswald photographs, utilizing test photographs of subjects against a height chart. (*186*) The panel noted that significant variations can arise from this type of measurement due to differences in orientation and distance of the subject from the camera. (*187*) The panel explained, " * * * unless the subject photographed is standing directly with his back against the height chart at a correct distance from a properly positioned camera equipped with an appropriate lens, it is unreasonable to assume that the resulting picture is ever a precisely accurate indicator of both his height and head size." (*188*) The panel noted that because of these impediments to accuracy, the use of height charts in pictures is no longer a common practice in law enforcement or industrial security work. (*189*)

The committee also engaged the services of three handwriting experts to explore the "two Oswald theory." These experts viewed documents purported to have been written by Lee Harvey Oswald. They examined documents from the years 1956 to 1963 to determine if the handwriting of the man who joined the Marines in 1956 was the same as that of the man who had applied for a passport in 1959, tried to revoke his American citizenship in 1959, returned to the United States

in 1962, journeyed to Mexico in late September 1963, and ordered the rifle which was found on the sixth floor of the Texas School Book Depository on November 22, 1963. A careful examination of these documents demonstrated that the man who signed those items was the same man throughout the entire 7-year period.(*190*) Accordingly, on the basis of the committee's scientific analysis, there was no evidence to support the allegation that the Lee Harvey Oswald who returned from Russia in 1962 was a different person than the Lee Harvey Oswald who defected to Russia in 1959.

(*f*) *Summary of the evidence*

Where it was available, the committee extensively employed scientific analysis to assist it in the resolution of numerous issues. The committee considered all the other evidence available to evaluate the scientific analysis. In conclusion, the committee found that the scientific accoustical evidence established a high probability that two gunmen fired at President John F. Kennedy. Other scientific evidence did not preclude the possibility of two gunmen firing at the President, but it did negate some specific conspiracy allegations.