IV. Conspiracy Questions

*A. Alleged Gunmen in Dealey Plaza**

1. INTRODUCTION

(241) A number of commentators and critics of the Warren Commission have asserted that photographic evidence exists which demonstrates that more than one gunman was present in Dealey Plaza. (*79*) The evidence includes an assortment of still- and motion-picture photography taken by the amateur and professional photographers present in the Plaza that day. If these films and pictures were ideal in quality, the questions they have raised might have been answered long ago. Nevertheless, there are limitations inherent in any photographic image,** and many of the issues concerning the number of gunmen in Dealey Plaza have arisen from interpretation of details that approach these inherent limitations. In some, the quality is too poor to allow an unambiguous interpretation of the images, resulting in differences of opinion.

(242) Because of the advances that have been made in the photographic sciences associated with image enhancement, (*80*) an effort was made to resolve the issues raised in photographs of the assassination by applying modern technology. It was understood, however, that because of inherent limitations to this technology not all image enhancement attempts would necessarily be successful and that, even when successful, the clarification obtained might not be sufficient to answer the questions that have been raised. (*81*)

2. ISSUE

(243) Is there any photographic evidence of a gunman or gunmen in Dealey Plaza at the time of the President's assassination?

3. MATERIALS AND PROCEDURES

(244) The available photographic materials were reviewed by the Panel and contractors. Those considered most relevant to the question of gunmen in Dealey Plaza (e.g., materials alleged to show a gunman, weapon, flash of light, puff of smoke) were selected for image

*This section was prepared under the direction of Bob R. Hunt, with the assistance of Harry Andrews, Robert Chiralo, Donald Janney, and Charles Leontis. For related public hearing testimony of Hunt, September 25, 1978. See HSCA–JFK Hearings, vol. IV, pp. 387, 420.

**The limitations inherent to photography can be classified as optical and photochemical, the former referring to the optical components which form an image, the latter to the processes which capture and permanently record the image. *See* J. C. Dainty and R. Shaw, *supra* note 2.

enhancement, provided that they were judged to have sufficient potential for meaningful improvement.[1]

(245) Based upon this review, the following photographic materials were selected for image enhancement.[2]

Dillard—35 millimeter black and white transparencies.
Powell—35 millimeter color transparency.
Hughes—8 millimeter color-motion-picture film.
Willis—35 millimeter color transparency.
Moorman—Polaroid print.
Zapruder—8 millimeter color-motion-picture film.
Nix—8 millimeter color-motion-picture film.

(246) Three different categories of image enhancement technology were available to the Panel: Photo-optical/photo-chemical, digital image processing, and autoradiography.[3] The selection of a particular technology depended upon the nature of the photograph and the type of clarification considered necessary.

4. CONCLUSIONS

(247) *a.* Evidence of changes in the open sixth-floor window of the Texas School Book Depository is visible. The changes are of two types:

(248) (*1*) There is an apparent rearranging of boxes within 2 minutes after the last shot was fired at President Kennedy;

(249) (*2*) There is an appearance or impression of motion in the open sixth-floor window a few seconds prior to the assassination. While the pattern of motion is not necessarily inconsistent with movement by a human being, it was nevertheless considered probably to be photographic artifacts.

(250) *b.* There is no visible evidence of anyone at the closed windows adjacent to the open sixth-floor window of the Texas School Book Depository. Motion in these windows was also attributed to photographic artifact.

(251) *c.* There is no definitive visible evidence of any gunmen in the streets, sidewalks, or areas adjacent to Dealey Plaza. Nor was any evidence discerned of a flash of light or puff of smoke.

5. ANALYSIS

(252) The following section describes the processing and analysis of the Dealey Plaza photographic evidence undertaken by the Photographic Evidence Panel. Each of the major subdivisions of this section contains a synopsis of the issues in question, a summary of the relevant photographic evidence, and a discussion of the special processing operations used to enhance the evidence. The evidence in question is identified by using the photographer's name—for example, a motion picture taken by Orville Nix will be referred to as the Nix film. In the

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[1] In general, a minimum requirement was that the material be original and transparent film. See pars. 39–41, *supra*.

[2] A list of the most important photographic materials reviewed by the Panel is set forth in par. 42, *supra*.

[3] See pars. 9–38, *supra*.

case of multiple pictures by the same photographer, frame numbers are also used.*

(*a*) *The Texas School Book Depository*

(253) Evidence from sources other than phototgraphy led the Warren Commission to conclude that the shots that struck the President had come from an open window on the sixth floor of the Texas School Book Depository. (*82*) Several sources of photography exist that show the window before and after the fatal shots. These were examined for evidence of a gunman.

(254) The following photographs of the Texas School Book Depository were subjected to image enhancement:

(1) The Dillard photographs (2).
(2) The Powell photograph.
(3) The Hughes motion-picture film.

(255) The Dillard and Powell photographs and Hughes film were taken from the region of the intersection of Houston and Elm Streets in Dealey Plaza. Dillard, a professional photographer, was riding in a press car in the Presidential motorcade. At the time he took his pictures of the Depository, the car was approaching Elm and Houston. (*83*) Powell was standing considerably to the right of Dillard, near the southeast corner at Elm and Houston, and his picture therefore shows the window from a much more oblique angle. (*84*) Hughes was standing near the southwest corner of Houston and Main Streets; (*85*) thus, his motion picture film was taken from a much greater distance than the Dillard and Powell photographs.

(256) The time at which the photographs of Dillard and Powell were taken is only approximate. Dillard stated that his second picture was taken a few seconds after the last shot that he heard. (*86*) Powell has estimated that he took his picture about 30 seconds after the last shot. (*87*) A shadow analysis performed by the panel confirmed that these photographs were taken at the same approximate time, with Dillard's first and Powell's second. (*88*) The Hughes film ended 2 to 10 seconds before any shots were fired, as indicated by the position of the Presidential limousine in the film.**

1. DILLARD AND POWELL PHOTOGRAPHS

(257) Examination of both the Dillard and Powell photographs of the sixth floor windows shows an open window with deep shadows in the region behind it. The deep shadows indicate the film was underexposed in these regions; that is, too little light reached the film for a clear recording of any details in the room behind the window.

(258) A number of enhancement processes were applied to the photographs in order to bring out any details obscured within the underexposed regions. They were as follows:

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*This system has been used by others who have analyzed the evidence, including the Warren Commission and the commentators and critics of the Warren Commission.

**The panel did not consider it necessary to refine these estimates of the time of the taking of the photographs because it would not have helped to resolve the issue of whether these photographs depicted any gunmen.

(259) (*1*) Photographic enhancement (using photo-optical and photochemical techniques) of the underexposed regions of the Dillard photograph undertaken at the Rochester Institute of Technology (RIT). (*89*)
(260) (*2*) Autoradiographic enhancement of the underexposed regions of the Dillard photograph at Stanford Research Institute, Inc. (SRI). (*90*)
(261) (*3*) Computer enhancement of the underexposed regions of the Powell photograph at the University of Southern California and the Aerospace Corp. (*91*)
(262) In addition, the Dillard photographs were scanned and digitized for possible computer enhancement. Nevertheless, no such enhancement was performed because the Panel decided that the autoradiographic technique had more potential for success.
(263) The photographic and computer processes made visible details that had been obscured in the underexposed regions of the photographs. Both the photographic enhancement by RIT and the autoradiographic enhancement by SRI revealed a feature in the fifth floor window immediately beneath the sixth floor window. Figure IV–1 (JFK exhibit F–153) shows one of the original Dillard photographs, and figure IV–2 is an autoradiographic enhancement. The detail revealed by the processing appears to be a circular light fixture hanging from the ceiling of the fifth floor room, with a light bulb in the center of the fixture.*

*The Panel observed all enhanced images under optimum viewing conditions. Reproduction of the enhanced images for this report results in a degradation in quality. The Panel's decisions were reached on the basis of the image quality of the original enhanced photographs, and not on the quality of images as reproduced in this report. See par. 28 supra.

FIGURE IV–1.—Dillard photograph (unenhanced).

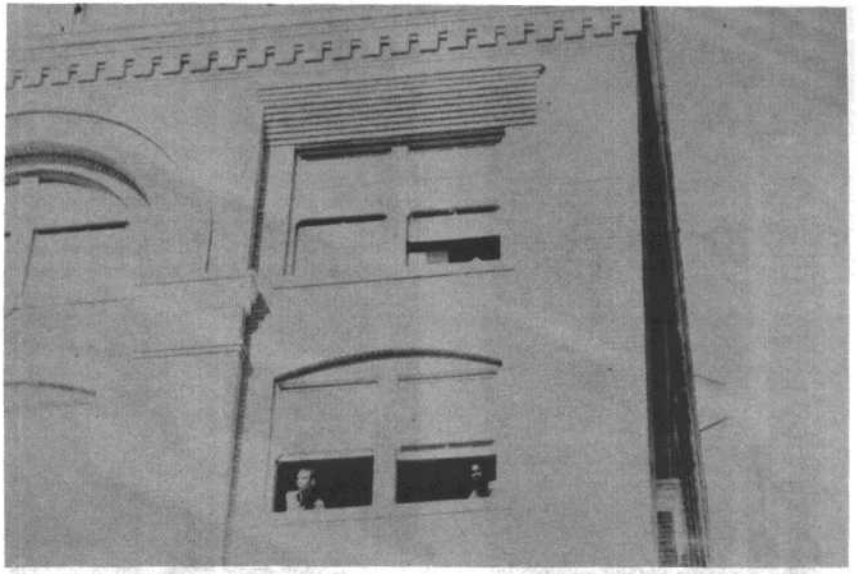

FIGURE IV–2.—Autoradiographic enhancement—Dillard photograph.

(264) In the enhanced Powell photograph additional details became visible on the boxes in the windows. (See figure IV–3, JFK exhibit F–157.) Nevertheless, in neither photograph did the processing operations reveal any sign of a human face or form in the open sixth floor or adjoining windows.

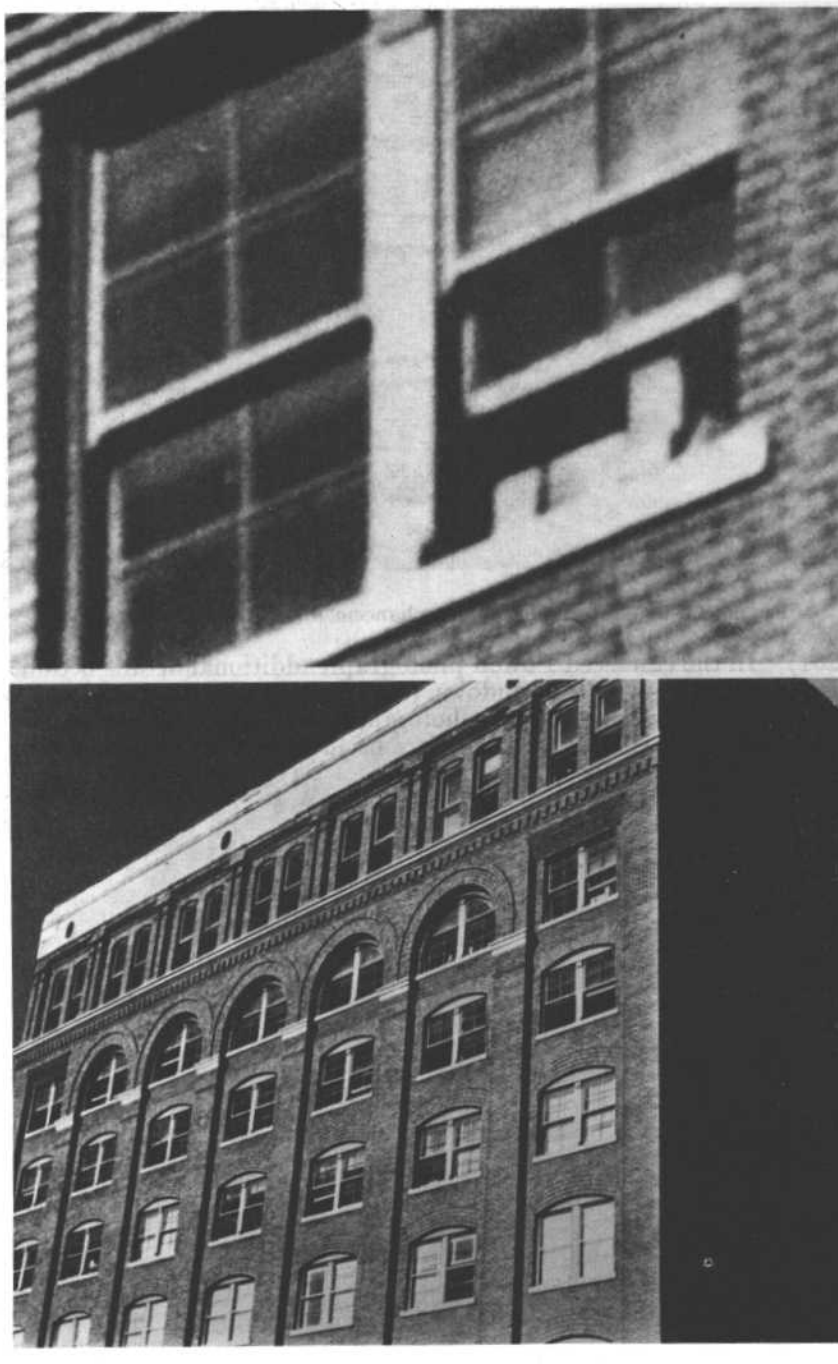

FIGURE IV–3.—Powell photograph. Top: Enhanced window area. Bottom: Unenhanced original.

(265) The Panel concluded that the light fixture revealed in the fifth floor window served as a "benchmark" against which the sixth floor enhancement could be judged. Accordingly, the enhancement of a recognizable object in the fifth floor window gave the Panel confidence in its judgment there were no recognizable human forms in the enhancement of the sixth floor windows.

(266) Although human faces or forms were not visible in the enhanced photographs, inspection of figures IV–2 and IV–3 reveals a difference in the boxes visible through the sixth floor widow. In the Dillard photograph, only two boxes are immediately visible, one each at the left and right of the window frame. Nevertheless, the Powell photograph shows several additional boxes. There are two possible explanations for this difference:

(267) (*1*) The Powell photograph may reflect only an apparent change in the boxes; the different angle from which Powell viewed the depository may have caused a different set of boxes within the room to be framed within the window;

(268) (*2*) The boxes were moved during the time that elapsed between the Dillard and Powell photographs.

(269) Since the precise positions of Dillard and Powell at the time of the photographs were unknown, it was not possible to calculate precisely the region within the sixth floor room that would have been visible to each photographer. In the Dillard photograph, the two boxes at the left and right of the window frame appear to be in the full light of the Sun, with no shadows cast on them by the frame of the partially opened window. In the Powell photograph, it also appears that the boxes are in full sunlight, with no shadow cast on them by the window frame.

(270) A simple trigonometric calculation shows that the two boxes at the left and right lie approximately 6 inches from the plane of the window (see addendum A). If full sunlight is falling on the additional boxes in question in the Powell photograph, they must also lie close to the plane of the window.* For this reason, the Panel concluded that the additional boxes visible in the Powell photograph were moved during the interval between the Dillard and Powell photographs.

(271) An additional issue relating to the sixth floor windows was the possible presence of a human face or form in the adjacent windows. None was found by the Panel.

2. HUGHES MOTION PICTURE FILM

(272) The Hughes film shows the Presidential limousine for a total of 88 frames as it is proceeding down Houston Street toward the Texas School Book Depository. The open sixth floor window of the depository is visible in the upper left corner of the film frames. An object, approximately rectangular in shape, is visible in the open

*If the additional boxes in the Powell photograph were so far back into the room that the difference in viewing angle made them apparent in the Powell photograph and not in Dillard's, then they would not appear to be in full sunlight. Since at the time of the assassination it was late fall, the midday sun was south of directly overhead and therefore would have been entering those windows of the Texas School Book Depository facing directly south.

window. When the film is viewed as a motion picture, the object distinctly appears to be moving.

(273) The 88 frames were processed for computer enhancement and motion analysis at the Aerospace Corp. (*92*) The scans were centered on the portion of the frames that showed the open sixth floor window and the closed windows adjacent to it. After scanning, the images were viewed on a precision television soft-copy video-display computer system that was used to adjust the contrast of the displayed images.

(274) Figure IV–4 (JFK exhibit F–121) shows a single unenhanced frame of the Hughes film. It was the judgment of the Panel that the object in the open window was partially in the Sun and partially in the shadows. This judgment is based upon the enhancement of selected frames of the Hughes film by computer contrast alteration.

(275) As the contrast of any single frame was changed by computer, the shape of the object in the open sixth floor window also changed. When an object is in both Sun and shadow and an exposure is chosen that will record the sunlit features, the shadowed features will be underexposed. A computer can be used to alter the contrast and correct for the underexposure so that the object within the shadows is more directly visible. In this case, however, the processing also changes the shape of the image.

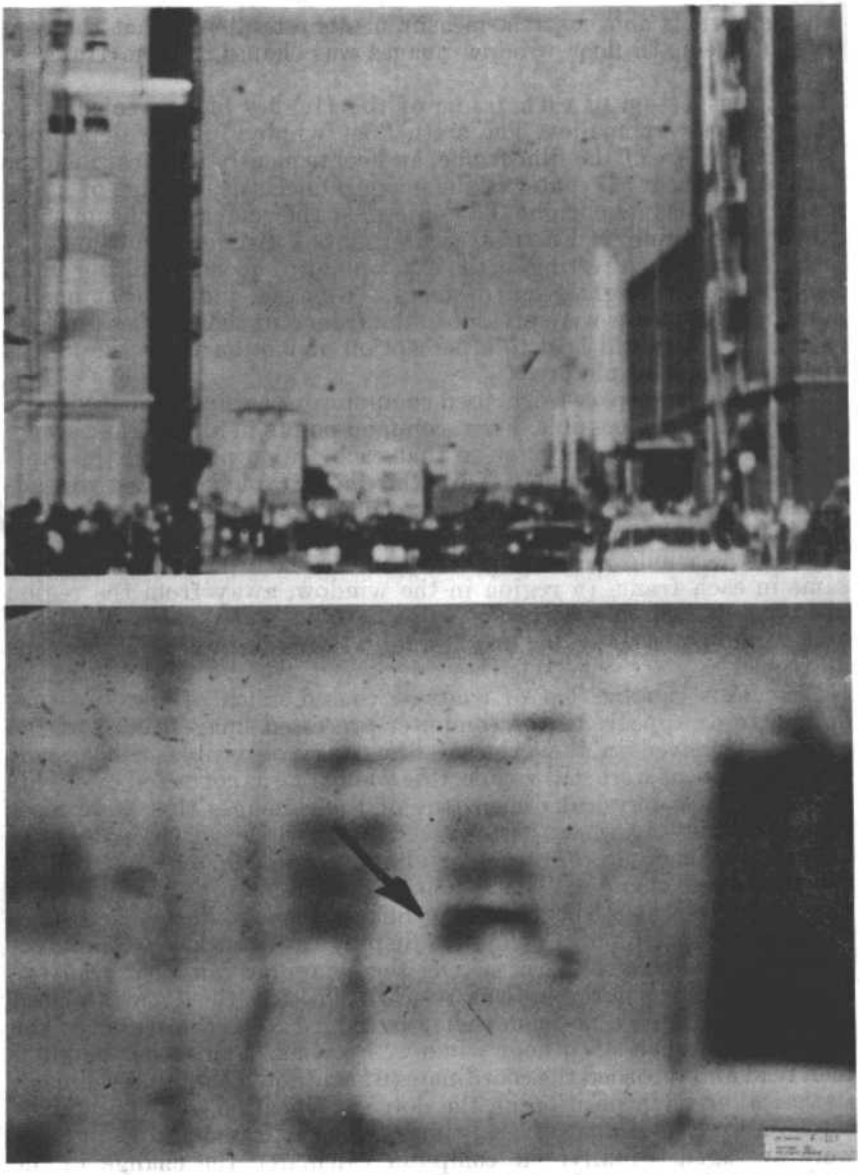

FIGURE IV–4.—Hughes film (unenhanced) Top: Full frame view. Bottom: Enlarged window area.

(276) It was theorized that the contrast of each frame of the unenhanced Hughes film was not constant in the region of the sixth floor window, and that this was causing an apparent change of shape that appeared to be motion in the film sequence. The panel used computer displays to inspect the 88 frames of the Hughes film without enhancement and computer calculations to measure the contrast. Both the vis-

ual inspections and contrast measurements established that the contrast of the sixth floor window images was changing from frame to frame.

(277) Inspection of each frame of the Hughes film revealed other photographic anomalies. The sixth floor window of the depository is near the edge of the film frame, and consequently it is less in focus than objects near the center of the image. Objects at the edge of a film frame were also less bright than objects at the center (a phenomenon called "vignetting"). Further, as film moved through the camera, it may not have been resting at the exact point of focus, resulting in an image that was slightly out of focus. The panel judged that one or more of these effects were present in the frames of the Hughes film and that they, too, could lead to a perception of motion when the film is viewed as a motion picture.

(278) The Aerospace Corp. used computer processing to reduce these effects as much as possible. First, common points in all 88 frames were "registered" in the computer so that each frame possessed the same coordinates in the computer. Next, the photographic contrast was adjusted to be as equal as possible between all frames. This was done by picking a bright point that was the same in each frame (the white edge of the windowsill was picked), and a dark point that was the same in each frame (a region in the window, away from the region of apparent motion, was picked). Each frame was then manipulated by computer so that all the bright and dark regions were the same for all frames.

(279) This equalization of contrast caused much of the apparent motion to disappear. In the computer-processed images, most of the motion perceived in the original film was not visible. Since some changes in focus were still visible, this anomaly was corrected by slightly altering the physical dimensions of those images that were most out of focus.

(280) The computer processing eliminated much, but not all, of the perceived changes. The extent of the remaining changes was quantified by using the computer image display at the Aerospace Corp. The operator of a computer display can position a computer-generated dot on the video screen; the computer can then read the coordinates of the dot onto the screen. In this case, the dot was placed by the operator at a position that was judged to be the center of the object in the open sixth floor window. For each frame, the computer then read and recorded the coordinates of this dot. To minimize human statistical error in positioning the dot, identification of the center of the object was repeated several times for each frame and the results were averaged. Finally, the computer calculated the change in the position of the center of the object from frame to frame.

(281) The results of this motion analysis can be seen in figures IV–5–6 (JFK exhibits F–159 and 159–A). Figure IV–6 shows the center of the object as determined by the motion of the dot. Each arrowhead position on the exhibit indicates the location of the center of the object for the particular frame number designated. The direction of the motion between frames can be discerned by going from each arrowhead to the next sequentially numbered arrowhead. The length of each arrow is proportional to the actual distance the center of the

object moved between frame identifications, and the thickness of each line is proportional to the amount of time (indicated by the decimal number) that it took to move that distance. Figure IV–5 shows the actual change in the shape of the object for frames 55, 56, 59, and 61.

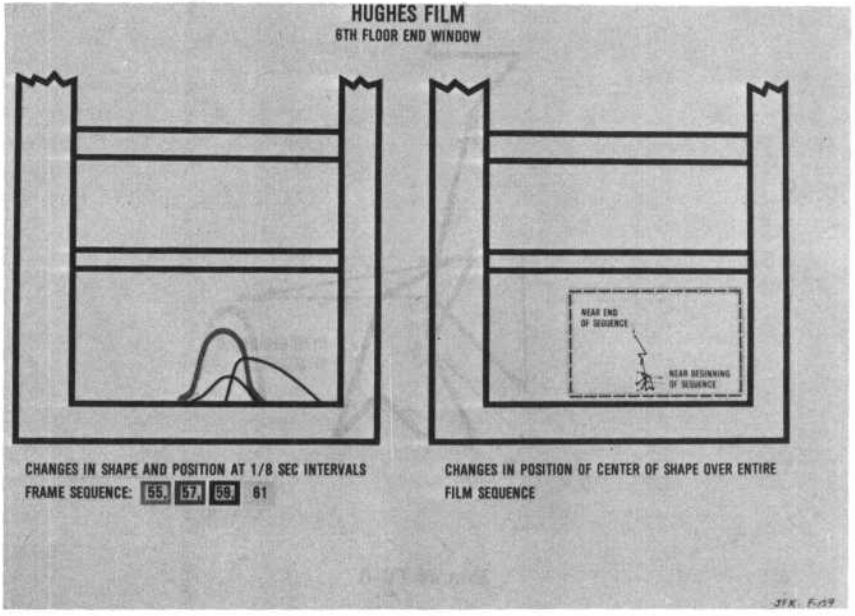

FIGURE IV–5.—Hughes Motion Analysis Diagram.

(282) The Panel interpreted these exhibits as demonstrating that the perceived motion was apparent rather than real. This conclusion was based on the following considerations:

(283) (*1*) The pattern of motion does not display a consistent direction, but appears to be attributable either to random motions or to purposeful, consistent motion of a very complex type;

(284) (*2*) When the time interval between positions is considered, the motions appear to be quite rapid. For example, motions of 18 inches per second can be calculated. While such rapid motions are not impossible, they are considered improbable when considered along with the complexity of the motion as revealed in figure IV–6.

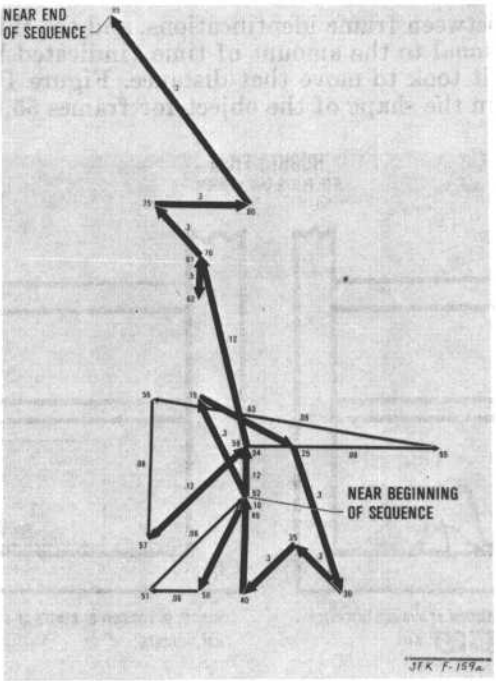

FIGURE IV–6.

(285) (*3*) In one two-frame sequence, the object disappeared: It is present in frame 59, but not in frame 60, and then is visible again in frame 61. This abrupt disappearance and reappearance is not consistent with human motion and can be explained only as a photographic anomaly.

(286) In summary, a pattern of changes in the object in the sixth floor window is visible in the computer processed images of the Hughes film. Nevertheless, the Panel did not attribute this pattern of changes to the motion of any recognizable object such as a person. While the overall pattern of changes is not necessarily inconsistent with human motion, the Panel still concludes that the perceived motions are attributable to photographic artifact.

(287) The closed sixth floor windows adjacent to the open sixth floor window were also examined. The same type of artifacts were present.

BRONSON MOTION PICTURE FILM

(288) The original 8 millimeter movie film of the Texas School Book Depository taken by Charles L. Bronson a few minutes before the assassination was not made available to the committee until December 2, 1978. At that time, it was reviewed by several of the committee's photographic contractors and members of the Photographic Evidence Panel. Based upon this preliminary review, the scientists believe that, as in the Hughes film, the apparent motion in the sixth floor southeast corner windows seems to be random and therefore is not likely to have been caused by humans. Nevertheless, no firm conclusion could be

reached without applying digital image processing, which was not possible because of time and money constraints. The Panel suggests that the good quality of this film makes it advisable that image enhancement be considered (possibly by the Department of Justice) if further investigative efforts are undertaken. (*93*)

(*b*) *The grassy knoll*

(289) To the right of the Presidential limousine as it proceeded down Elm Street in Dealey Plaza is a small knoll. An assortment of trees, bushes, and concrete works is located on it. Several persons present in the plaza at the time of the assassination stated that they thought shots were fired from the region of this knoll, (*94*) and commentators and critics of the Warren Commission have asserted that there is photographic evidence that supports the claims of a gunman firing from the area (*95*).

(290) The following photographic evidence pertaining to the grassy knoll was subjected to enhancement:

(1) Willis No. 5 photograph;
(2) Moorman No. 2 photograph;
(3) Nix motion picture film; and
(4) Zapruder motion picture film.

(291) The Willis No. 5 photograph was taken from the south side of Elm Street, near the intersection of Houston and Elm Streets. (*96*) The Moorman picture was taken from a point on the south curb of Elm Street, midway between Houston Street and the exit from Dealey Plaza. (*97*) The Nix film was taken from the other side of Dealey Plaza near the intersection of Main and Houston Streets. (*98*) Zapruder was standing on a concrete abutment by the retaining wall in the grassy knoll area (*99*).

(292) The Zapruder and Nix films span an interval that includes the fatal shot to the head, and therefore no ambiguity as to the time they were taken exists. The time at which the Willis and Moorman photographs were taken is, however, difficult to establish. From the position of the President and Mrs. Kennedy in the limousine in the Moorman photograph, the Panel believes that the photograph was taken at the time of the fatal head shot, corresponding with frame 313 of the Zapruder film.* The Willis photograph appears to have been taken several seconds earlier, at approximately Zapruder frame 202.

1. THE WILLIS PHOTOGRAPH

(293) Preliminary visual inspection of the Willis photograph showed extensive blurring of all features of the picture near the retaining wall on top of the grassy knoll. The blurring is most clearly seen in the freeway sign, which is in the line of sight between the retaining wall and the Willis camera. (See fig. IV–7, JFK exhibit F–155.) It was caused by motion that was complex and not uniform over the entire image. The Panel judged that the motion was probably a combination of rotation about a point to the lower left of the optical axis, and that a component of linear translation (that is, motion in a straight line) in the motion was also possible.

*Zapruder frame numbers are used as the basic time references because this film spans the most comprehensive interval of time. See par. 146, *supra*.

FIGURE IV–7.—Willis No. 5 photograph (unenhanced).

(294) The Willis photograph was scanned for possible input into a computer. Since it is in color, the scan had to be a full-color scan. Then the knoll area from the scan was presented on a full-color computer video display. The display and manipulation were performed at the University of Southern California. (*100*)

(295) The retaining wall at the top of the knoll was subsequently enlarged by a computer operation similar to enlargement by photo-optical and photo-chemical techniques. This computer display made visible an object whose size and shape were consistent with a human being, positioned just inside the retaining wall. (See fig. IV–8, JFK exhibit F–160.) The object possessed colors with a distinct resemblance to flesh tones, as revealed on the color display. The Panel perceived the object to be that of a badly blurred image of a person, dressed in dark clothing, standing or leaning just inside the retaining wall.

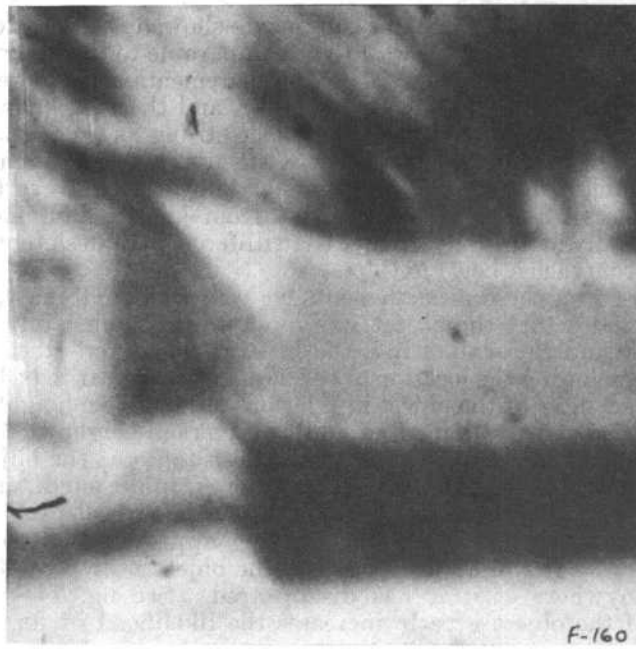

FIGURE IV–8.—Willis No. 5. Wall Image Enhancement.

(296) Since the image was badly blurred, an attempt was made to use the computer to remove the blur. Blur removal can be accomplished if its extent is not too great. (*101*) Unfortunately, the image was so severely degraded in the region of the retaining wall that deblurring efforts were not successful.

(297) The next computer processing step was to make measurements of the color values of the object behind the retaining wall in order to compare the perceived flesh tones with those of a person at another location in the Willis photograph. The photograph was scanned in color: Separate measurements were made of the three primary colors, red, green and blue, from which other colors can be made.

(298) After scanning, an image analyst at the Aerospace Corp. viewed the image on a color video image display and positioned a computer-generated dot at those points where colors were to be measured. The computer then recorded the red, green, and blue values in the image at the dot's positions. A similar analysis was carried out at the University of Southern California.

(299) Regions measured at the Aerospace Corp. included the flesh tones of the object near the retaining wall and of Marilyn Sitzman, the secretary to Abraham Zapruder, who is visible in the Willis photograph. Sitzman's flesh tones were measured both in shadow and sunlight. At the University of Southern California, flesh tones were measured for the object at the retaining wall and for several people: A policeman, a bystander, and a child. In addition, measurements were made of Mrs. Kennedy's hat, which was pink in color and had a flesh tone appearance on the video display. (*102*)

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(300) The Aerospace Corp. measurements showed the flesh tones of the object near the retaining wall to be comparable to the known flesh tones of Zapruder's secretary. USC's measurements also showed similarity between the flesh tones of the object and those of known persons; however, the similarities were not as strong as those found by Aerospace. The measurements of Mrs. Kennedy's hat were found to be distinguishable from the measurements of known flesh. Nevertheless, the differences of Mrs. Kennedy's hat from known flesh measurements were only marginally greater than differences of flesh tone measurements from each other. (*103*)

(301) Based on these measurements, as well as visual analysis, the Panel concludes that the object was most probably an adult person standing behind the wall. First, the general shape and structure of the object, including the location of the flesh tones, appear to be human. Second, the height of the object in relation to the known height of the wall is consistent with that of an adult of average height (5′6″ to 6′ tall). Third, the measured values of the flesh tones of the object are comparable with those of people in the photograph. Fourth, an additional Willis photograph, No. 6, taken after the Presidential limousine had exited Dealey Plaza but showing approximately the same field of view as No. 5, no longer shows the object near the retaining wall, or anywhere else; it has disappeared. (See fig. IV–9.) The mobility of the object greatly increases the likelihood of its being a person.

FIGURE IV–9.—Willis No. 6 photograph.

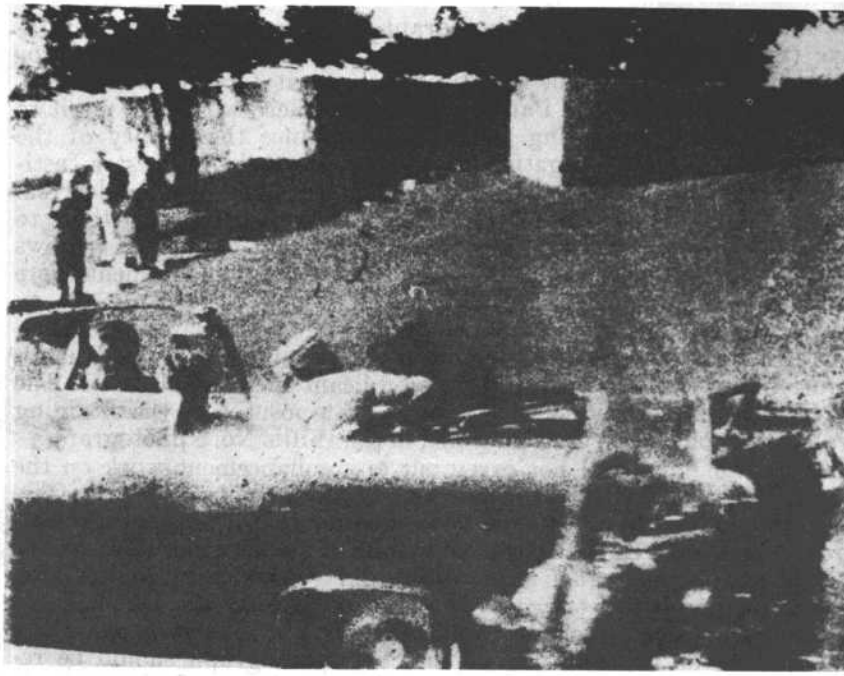

FIGURE IV–10.—(JFK exhibit F–129) Moorman No. 2 photograph.

(302) Since the panel concluded that the object was probably a person, the next question was whether there was any evidence of a weapon associated with this individual. Visible near the region of the hands is a very distinct straight-line feature extending from lower right to upper left. The panel notes, however, that the image is badly blurred in this region and that the direction of the blurring is the same as the southeast-northwest orientation of the linear feature near the hands. The blur would stretch any small point object on the wall into a linear object. As the blur could not be clarified, the panel could reach no conclusion as to the existence of a rifle or any other weapon in relation to the person standing behind the retaining wall.

2. THE MOORMAN PHOTOGRAPH

(303) The Moorman No. 2 photograph is a black and white Polaroid print that has suffered from handling during the intervening years. A number of large and small defects were visible on the photograph when the panel examined it. It, too, shows the grassy knoll and the retaining wall in the same region where the person was identified in Willis No. 5. (See fig. IV–10, JFK exhibit F–129.) It also shows another region of the knoll which critics of the Warren Commission have identified as important: The stockade fence. This fence runs toward the railroad overpass from the region of the retaining wall. Various critics have claimed that gunfire was directed at the President from behind the fence. (*104*) Finally, this is the area from which the committee's acoustics analysis indicates a shot originated. (*105*)

(304) Since the Moorman photograph is opaque rather than a negative transparency, a conventional image scanner (one designed for transparencies) could not be used to sample it for computer input. Given its condition, the Panel judged that there was little merit to using computer processing. Instead, to enhance the quality of the image, a high-quality negative copy was made at the Rochester Institute of Technology. A series of photo enlargements was made from this negative. The contrast and brightness were altered in these to bring out any objects or details that might be visible in the shadows or underexposed regions. (*106*) These photographic enhancements were focused on the region of the retaining wall.

(305) These efforts were not successful. The Moorman photograph was so underexposed in the region of the retaining wall that the alterations in contrast produced no significant increase in detail. The Panel could find no evidence of a person in a position on the retaining wall corresponding to that identified in the Willis No. 5 photograph.

(306) The Panel did not carry out any enhancement work on the Moorman photograph in the area of the stockade fence because this area was judged to be of even lesser quality than the retaining wall area, which had yielded negative results. This decision, however, as well as the decision not to apply digital image processing to this item, was made long before the committee's acoustics analysis was finalized. Although it is extremely unlikely that further enhancement of any kind would be successful, this particular photograph should be reexamined, in light of the findings of the acoustics analysis.

3. THE NIX FILM

(307) The final photographic source relating to the grassy knoll retaining wall is the Nix motion picture film. Several frames coinciding with the fatal head shot frames of the Zapruder film were selected for scanning and input into the computer. The scanning was performed at the Los Alamos Scientific Laboratory; the scanned data was then sent to the Aerospace Corp. for enhancement by computer. The mode of enhancement was an edge and detail sharpening process that has the effect of making the photograph appear more in focus. (*107*) Fig. IV–11 (JFK exhibit F–161) shows both original and enhanced images of the Nix film, centered around the region of the retaining wall.

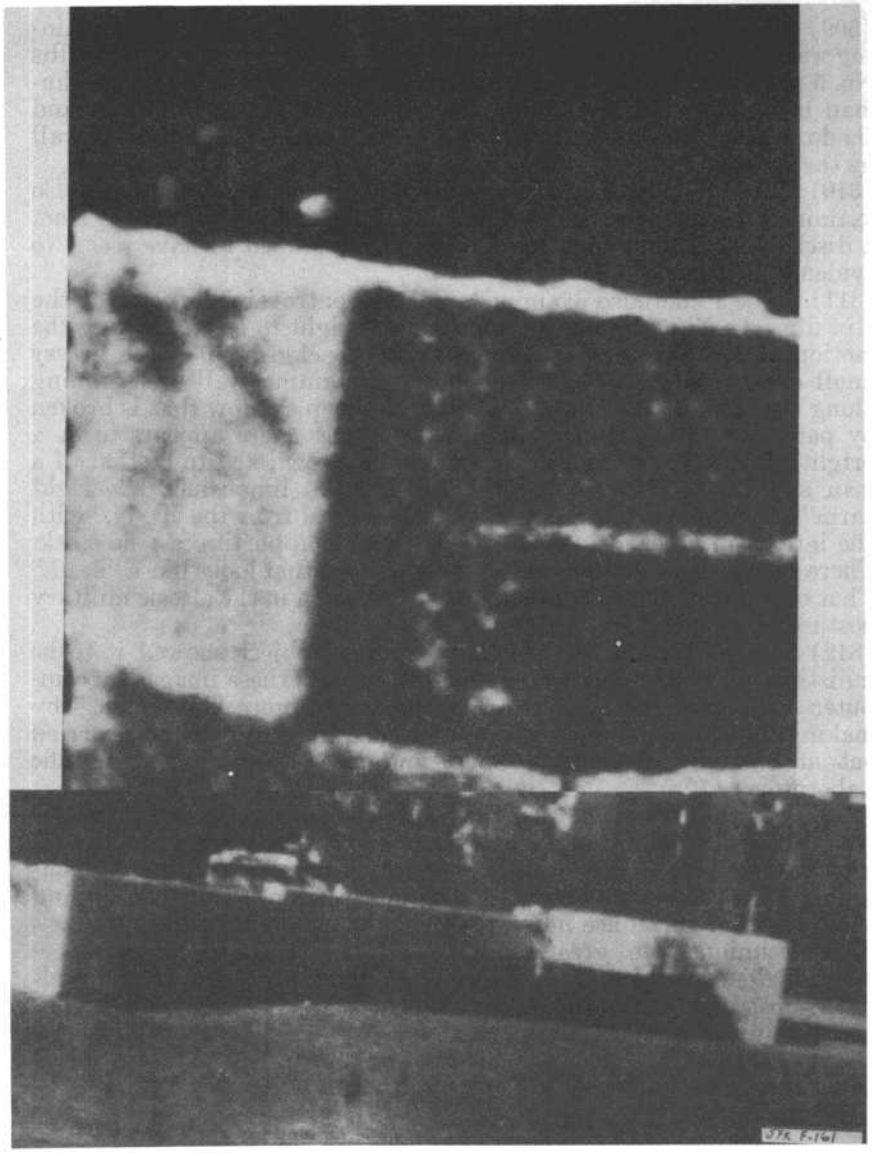

FIGURE IV–11.—Retaining wall image (Nix film) Top: Enhanced. Bottom: Unenhanced.

(308) The enhanced Nix film shows an object that can be construed as having a shape similar to that of a person. It is also possible to interpret this object as being of the same general shape as the person identified at the wall in the Willis No. 5 photograph. Nevertheless, the person in the Willis photograph displayed distinct flesh tones in the computer display of the image. No such pattern of flesh tones is visible in the enhanced (or original) Nix frames.

(309) The Panel could not conclude that the object near the retaining wall in the Nix film was the same as the person visible in the Willis No. 5 photograph. This image was not identified by the Panel as a human being. It was more likely the result of a pattern of light and shadows cast on an object in the background behind the retaining wall by the nearby trees.

(310) The area of the retaining wall image in the Nix frames was also examined for the presence of a flash of light or a puff of smoke from a discharging rifle, which some bystanders claimed to have seen. No evidence of either was found.

(311) The Panel also examined another controversial aspect of the Nix film. As Nix panned his camera from right to left following the motion of the Presidential limousine, the background of the grassy knoll came into view. In it, beyond the retaining wall and running along the crest of the knoll, is a region of deep shadow that is broken by patches of light. For a number of frames there appears to be a brightly lit object whose shape some have interpreted to be that of a man sighting a rifle toward the Presidential limousine. The right "arm" of this object is rigidly extended outward from the "body," with the left "arm" tucked in more tightly, as if supporting a rifle stock. There is, between and above these arms, a shape that looks like a "head." That object has been interpreted to be a rifleman in the classic military posture for firing a rifle. (*108*)

(312) Magnification of the classic gunman object showed it to be indistinct and blurry. It was decided to process these images by computer techniques that would bring the image more "into focus" by making its features sharper. Computer enhancement work was carried out at both the Aerospace Corp. and the Los Alamos Scientific Laboratory. (*109*)

(313) It was recognized that the limitation on improving the images would be the noise in the frames. Since several frames showed the region in question, it was decided to apply a "frame-averaging" technique. This process involves registering the frames and then adding them together to reduce noise, then enhancing the resulting product. This technique can greatly improve the quality of an enhancement. (*110*) Aerospace applied an enhancement process to the individual frames identical to the one applied to the Nix film for the person-at-the-retaining-wall image (see fig. IV–12, JFK exhibit F–163); (*111*) Los Alamos Scientific Laboratory applied a more sophisticated technique known as MAP restoration. (*112*)

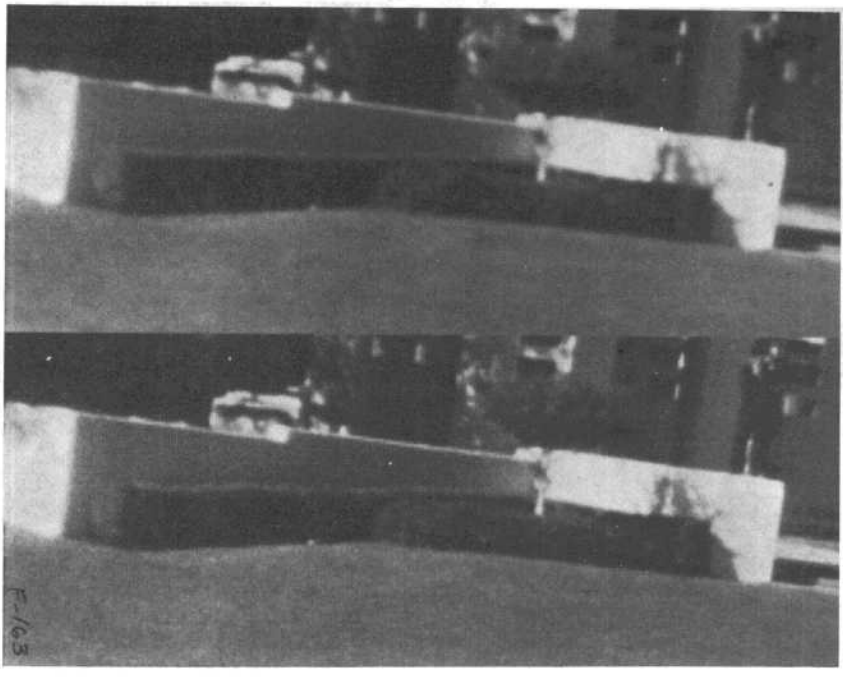

FIGURE IV–12.—Classic gunman image (Nix film) Top: Unenhanced. Bottom: Enhanced.

(314) Figure IV–13 (JFK exhibit F–162) shows the original and enhanced version of one Nix frame as produced at the Los Alamos Scientific Laboratory; the original is shown at the top, the enhanced version at the bottom. A total of eight frames were registered, added and enhanced to produce the lower image. Eight frames, considered to have the least blur or noise, were selected.

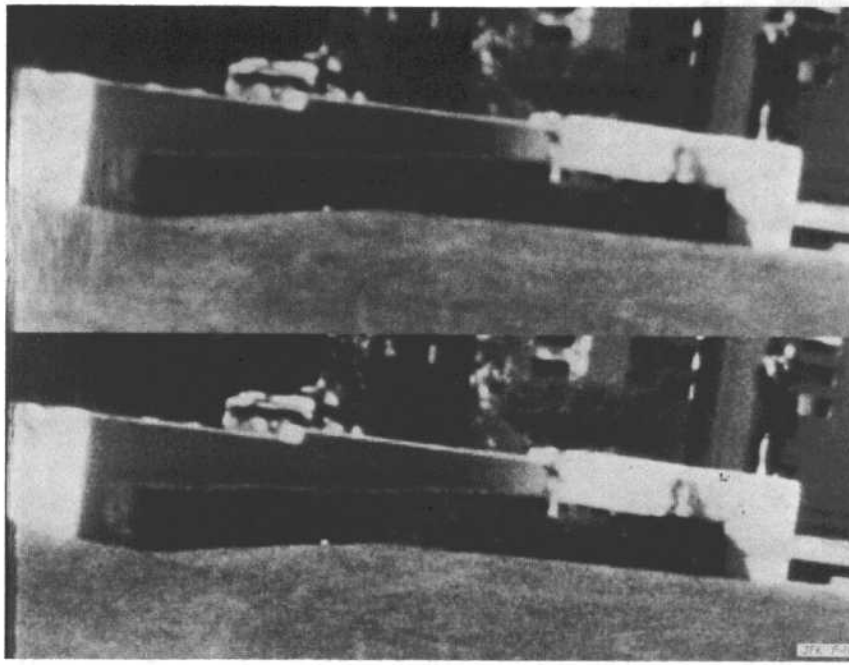

FIGURE IV–13.—Classic gunman image (Nix film) Top: Unenhanced. Bottom: Enhanced.

(315) After examining the enhanced image, the Panel concludes that the so-called classic gunman object was not a gunman. First, there is no evidence of human flesh tones in the "head" and "hands"; whereas the people in the Nix film have distinct flesh tones, the object here is almost uniformly white. Second, the white tones are identical in appearance with the white tones of the light regions of the shadow patterns cast on the wall of the structure behind the retaining wall by sunlight filtering through the nearby trees. Third, in the enhanced image, the shadow pattern above and to the right of the object is seen to be connected to the object itself.

(316) The Panel concludes that the most probable explanation is that the image is a chance pattern of sunlight on the structure behind the retaining wall. The Panel's conclusion was strengthened by an observation at the Aerospace Corp. that in one frame the "right arm" of the object disappears, only to reappear in the next frame. Such behavior would be virtually impossible for a person, but is conceivable for tree branches casting a shadow pattern on a wall.

(317) The Panel also examined the classic gunman object for evidence of a flash of light or puff of smoke. To enhance any phenomena as transient as these, the frames were differenced, that is registered frames were subtracted from each other sequentially in time. This technique makes transient phenomena highly visible. (*113*) No evidence of any flash or smoke was found.

(318) The Panel also reviewed a previous report by the Itek Corp. (*114*) Itek measured the relative displacement of the classic gunman in successive frames of the Nix film as the camera panned

from right to left. The extent to which an object shifts in successive frames can be used to calculate the distance from camera to object by applying the basic principles of photogrammetry. Itek calculated the distance from the camera to the object in this way and found that the calculations placed the object very near shelter 3 of Pergola 2 in Dealey Plaza. (*115*) Further study by Itek of the ground elevation in relation to the retaining wall showed that a line of fire toward Dealey Plaza would require that a rifle near this structure be 9 feet above ground. Itek concluded that the classic gunman object was a pattern of light and shadow on shelter 3. The Panel agrees with these conclusions.

4. ZAPRUDER FRAME 413—PHOTOGRAPHY OF ALLEGED HEAD IN THE BUSH

(319) When the Presidential limousine accelerated and pulled out of Dealey Plaza after the shooting, Zapruder continued to follow it with his camera. As the car passes him, going from left to right in front of him, a bush becomes visible in the lower right of the film frame, moving into the field of view from the right and traveling to the left as Zapruder panned the camera to the right. For a number of frames, an object that resembles a head is visible within the bush. In Zapruder frame 413 the object is very distinct and clear. Extending from the region of the head is a distinct linear feature. Critics have claimed that this linear feature is a rifle and that the head is of a gunman hiding behind the retaining wall and firing into Dealey Plaza. (*116*)

(320) The head in the bush is visible only in a few frames. From Zapruder's position on an abutment, which was connected to the retaining wall that lay to the right of the Presidential limousine (as it proceeded down Elm Street), his camera was the only one positioned so as to look through the bush and to the limousine in a geometry that shows the head, bush and limousine in the same line of sight. Zapruder frame 413, which shows the head object most clearly, was exposed approximately 5½ seconds after the fatal shot to the President's head at frame 313.*

(321) Since the head-like object is visible for several frames coming in from the right and moving to the left as the camera pans right, the Panel concluded that the object was real and not a chance arrangement of leaves. In frame 413, the head appears to be wearing a hat, such as a tennis hat, with a pulled-down brim. The "hat" is not visible in any other frames, however, and the Panel concludes that the "hat-brim" in frame 413 was only a coincidental juxtaposition of leaves near the head.

(322) Frame 413 was scanned for input to a digital computer at the Los Alamos Scientific Laboratory.(*117*) After scanning, the image was presented on a color video image display. The Panel again concluded that the object was a head. Flesh tones were visible on the back of the neck and ears. A hairline at the back of the neck was distinct and visible. The hair appeared to be fair in color; the head was either close-cropped or balding.

(323) Having found the object to be a head, placement of the head and bush in relation to Zapruder became of great importance. Placing the bush was simple because the Nix film shows Zapruder and the bush

*The time elapsed is readily calculated based on the camera framing rate of 18.3 frames per second.

in a series of frames. By using photogrammetric techniques, the USGS was able to place the Presidential limousine at the time of frame 413.(*118*) A line of sight drawn between Zapruder and the Presidential limousine passes directly through the bush, as seen in the survey map of Dealey Plaza (see fig. II–10, JFK exhibit F–133).

(324) To determine where the head lies on the line between Zapruder and the Presidential limousine, computer enhancement of frame 413 was undertaken at the Los Alamos Scientific Laboratory. (*119*) The image was processed by a technique that is designed to bring details into focus, the same technique used on the classic gunman frames of the Nix film. The result of the processing is seen in figure IV–14 (JFK exhibit F–164), where the original and enhanced images are displayed. From the enhanced image, measurements could then be made to determine the head location.

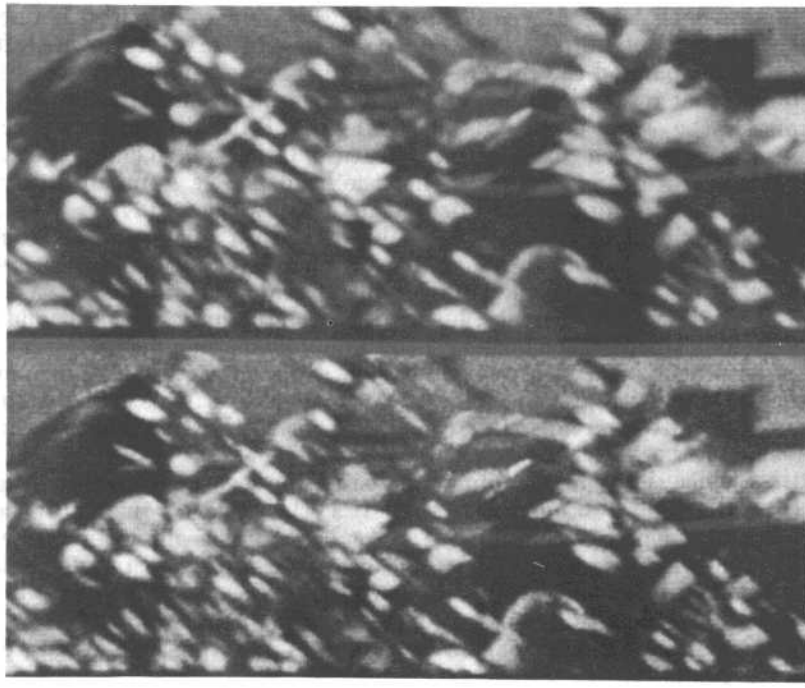

FIGURE IV–14.—Head in bush image. (Zapruder 413) Top: Unenhanced. Bottom: Enhanced.

(325) Accordingly, this photograph was then studied photogrammetrically. A basic principle in optics states that the size of an image is inversely proportional to the distance of the object from the camera that created the image.(*120*) Using this principle, the distance of an object from a camera can be calculated by comparing the size of its image to the image size of a similar object at a known distance. The size of the image of the head in the bush was compared to the size of the image of a head in the Presidential limousine. A simple calculation can determine where the head in the bush was located on the line of sight between Zapruder and the limousine (see addendum B).

(326) The head of the Secret Service agent climbing into the Presidential limousine was used for the calculation. Several measurements were made. The closest to Zapruder that the head in the bush can lie was in the middle of the sidewalk that runs from the top of the grassy knoll down to the street. The farthest away would be 10 to 15 feet beyond the sidewalk.*

(327) Based on this analysis, an inspection of the Dealey Plaza survey map (fig. II–10, JFK exhibit F–133) revealed that the head in the bush was not in the bush at all. The bush lies between Zapruder and head, with the head itself an appreciable distance away from the bush. Accordingly, there was no evidence of a person actually hiding behind the bush.

(328) Having located the head, the linear feature purported to be a rifle was examined. The computer-enhanced image shows a number of linear features similar to the one near the head, all extending in the same general direction as the alleged rifle. Further, close inspection of the enhanced image shows that the narrow part of the linear feature (the alleged "barrel" of the rifle) passes in *front* of leaves in the bush. Since the head lies far on the other side of the bush, it was geometrically impossible for an actual rifle barrel near this head to be situated in front of any leaves in the bush.

(329) The panel concluded that the linear feature was not a rifle barrel; it was only one of a number of twigs in the bush, all characterized by the same general direction and spacing in the natural growth patterns of the bush.

(330) Additional processing work was done at the Los Alamos Scientific Laboratory to study the region of the linear feature. (*121*) This processing, which was based on the knowledge that similar objects reflect light in similar ways, has been applied by NASA in analyzing satellite photographs of the earth for natural resources. (*122*) The technique developed by NASA is known as spectral ratioing and involves a comparison of color measurements by dividing measurements of the color values. (*123*) The objective is to compare the different amounts of red, green, and blue light reflected by an object. This is done by obtaining a computer scan of the photograph's red, green, and blue components and then measuring each one.

(331) When the Los Alamos Scientific Laboratory applied this spectral ratio technique to Zapruder frame 413, it found that the ratios in the region of the thick part of the linear feature (the "rifle stock") were identical to the ratios of the light reflected from the Presidential limousine. (*124*) On the basis, the panel concluded that the "rifle stock" was only a hole in the bushes looking through to the limousine, which, by virtue of being coincident with a twig, created the false impression of a rifle. Thus, no evidence of a gunman was discerned by the panel.

ADDENDUM A

Calculations on the Boxes in the Sixth Floor Window

(332) The boxes visible in the Powell photograph that were not visible in the Dillard photograph** appear to be equally in full Sun as

*See addendum B, par. 340 infra.

**Two relevant photographs were taken by Dillard. This analysis is based upon the closeup view depicted in fig. IV–2.

are those seen in the Dillard photograph.* This suggests that the additional boxes in the Powell photograph lie equally as close to the plane of the window as those visible in the Dillard photograph, ruling out the possibility of boxes very far inside the room being viewed by Powell from a viewpoint that was not available to Dillard. A simple calculation that can be used to place the two boxes visible in both Dillard and Powell shows that these boxes were very close to the plane of the window. This does not prove that the additional boxes in the Powell photograph lie equally close. Nevertheless, the appearance of being fully sunlit, without shadows from the window framing, strengthens the judgment that they do lie close to the plane of the window.

(333) Neither Dillard nor Powell had a camera angle perpendicular to the front of the depository building. Thus, they viewed objects in the windows from two different angles. As a convenient point of reference, the panel chose the triangular-appearing box corner that is visible in both the Dillard and Powell photographs at the lower right window frame. (See figs. IV–2 and IV–3.)

(334) The panel constructed the geometry seen in figure A–1 (infra). The diagram represents viewing angles from above the depository building, looking down, perpendicular to the horizontal plane of the street. The circular point a represents the corner of the box seen at the right of the windows; α and β are the angles made with respect to a perpendicular between point a and the plane of the window. (The plane of the window is assumed to coincide with the outer brick wall of the depository.)

(335) The angles α and β are not known precisely, since the exact positions of Dillard and Powell are unknown. They were crudely estimated in the following way. Dillard was riding in a press car behind the Presidential limousine; the position of the press car was approximately at the intersection of Houston and Elm when the picture was taken. Powell was on the east side of the intersection of Houston and Elm, and farther north than Dillard. Figure A–2 (infra) shows the approximate placement of the two photographers. The angles α and β shown in figure A–1 were measured from A–1 to be approximately 20° and 40°. It is important to note that these are only approximations. The imperfect knowledge of the locations makes it probable that there could be a $\pm 5°$ to $\pm 10°$ error in each angle.

(336) In figure A–1, the distance "d" is the apparent displacement of the corner of the box in position between the Dillard and Powell photographs. The distance x is the distance from true perpendicular (perpendicular is $\alpha = 0°$). The distance h is the distance behind the wall from which the corner of the box lies. It is measured from the box corner to the plane of the window.

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*See par. 269 supra.

(337) From figure A–1, the following two equations can be formed:

$$\tan(\alpha) = \frac{x}{h}$$

$$\tan(\alpha + \beta) = \frac{x + d}{h}$$

Since α and β are known, assignment of a value to d allows the two equations to be solved for the distance h. Solving the equations for $\alpha = 20°$ and $\beta = 40°$ gives:

$$h = d/(\tan(\alpha + \beta) - \tan(\alpha))$$

$$= d/(1.37)$$

(338) The distance d is measurable as a fraction of the window width. The window was known, from the Warren Commission measurements, to be 36 inches wide. The shift d, when converted to a fraction of the width of the window, yielded $d \cong 8$ inches. Thus:

$$h \cong 5.8 \text{ inches},$$

or the box corner lay approximately 6 inches behind the plane of the window.

(339) While there are appreciable uncertainties in these calculations, the location of the boxes within 6 inches of the plane of the window is consistent with their apparent photographic position in full sunlight.

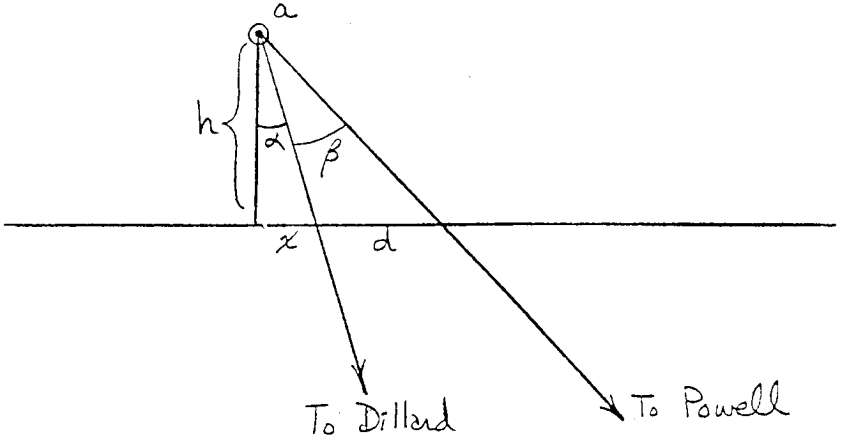
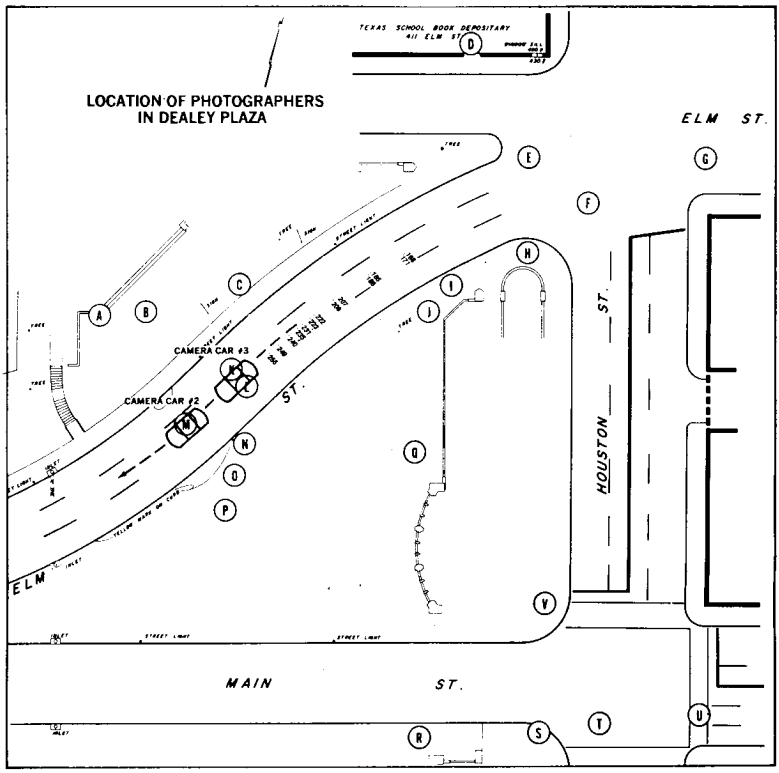


FIGURE A–1.—Viewing angles for Dillard and Powell photographs.



The twenty-two photographers in Dealey Plaza and where they stood.

A
Zapruder (color movie)

B
Cancellare (black & white still)

C
Cablack (black & white still)

D
Dorman (color movie)

E
Weigman (black & white movie)

F
Dillard (black & white still)

G
Powell (color still)

H
Martin (color movie)

I
Willis (color still)

J
Betzner (color still)

K
Underwood (black & white movie)

L
Couch (black & white movie)

M
Rickerby (black & white still)

N
Moorman (black and white Polaroid)

O
Altgens (black & white still)

P
Bothun (black & white still)

Q
Muchmore (color movie)

R
Nix (color movie)

S
Bell (color movie)

T
Hughes (color movie)

U
Weaver (black & white Polaroid

V
Bond (color still)

FIGURE A–2

Source: Courtesy of Josiah Thompson, author of "Six Seconds in Dallas."

ADDENDUM B

CALCULATION OF HEAD SIZES IN ZAPRUDER FRAME 413

(340) Figure B–1 (infra) shows the geometry of the objects and camera focal plane. Head No. 1 is located at distance r_1 and subtends an angle θ_1. Head No. 2 is located at distance r_2 and subtends an angle θ_2.

The common focal length is f. It was assumed that both objects are equally focused (or equally out of focus). The image sizes in the two cases are d_1 and d_2, respectively. It was also assumed that both heads have the same dimension d.

(341) Using the small-angle approximation:

$$r_1\theta_1 = d$$

$$r_2\theta_2 = d$$

Thus:

$$r_1\theta_1 = r_2\theta_2$$

and

$$\frac{r_1}{r_2} = \frac{\theta_2}{\theta_1} \quad (A)$$

(342) In the image plane, however, the same small-angle approximations give:

$$f\theta_1 = d_1$$

$$f\theta_2 = d_2$$

Thus:

$$\frac{\theta_2}{\theta_1} = \frac{d_2}{d_1} \quad (B)$$

Combining equations (A) and (B),

$$r_2 = \frac{d_1}{d_2} r_1.$$

This equation expresses the distance r_2 as a fraction of the distance r_1, the fraction being the ratio of the measured head sizes in the image. Thus, the key to estimating r_2 is to measure the ratio of head sizes.

(343) The measurement of the ratio of the head sizes is not simple because no other head in frame 413 is positioned the same as the "head-in-the-bush." Thus, it was necessary to make estimates of the head size of a person in the limousine. The estimation of head size is totally subjective as there was no analytical procedure to guide the estimates other than the obvious requirement that measurements of features be as comparable as possible for both heads. The width of the upper third of the head in the bush and the Secret Service agent climbing into the back of the limousine were measured because this portion of the head tends to be most spherical in shape, and hence, most invariant in size with respect to the viewing angle.

(344) The head in the bush, being nearest to the camera and largest in size, could be measured without appreciable error. The head of the Secret Service agent is partly obscured by leaves; therefore, three measurements were made corresponding to an estimate of the smallest head, the largest possible dimension, and a "best" guess. The measurements gave the following values for r_2:

$r_2 = .38r_1$, smallest estimate.
$r_2 = .44r_1$, "best" estimate.
$r_2 = .50r_1$, largest estimate.

(345) These figures can be used to place the head on the line of sight. For example, in figure II–10, the distance from Zapruder to the limou-

sine would be multiplied by the fraction 0.38, and the corresponding distance measured along the line from Zapruder. The smallest value places the head in the center of the sidewalk.

(346) There are possible sources of error in these calculations, but it is important to note that any errors would have to be substantial to place the head in the bush. For example, the ratio of head sizes that would place the larger head within the bush would have to be approximately 0.20; that is, nearly 50 percent smaller than recorded for the smallest estimate of the Secret Service agent's head. It is believed that the probability of errors of this magnitude is virtually zero. The placement of the head beyond the bush is a certainty. The placement of the head beyond the retaining wall is almost as certain, since the corner of the retaining wall would correspond to a ratio of head sizes of approximately 0.25.

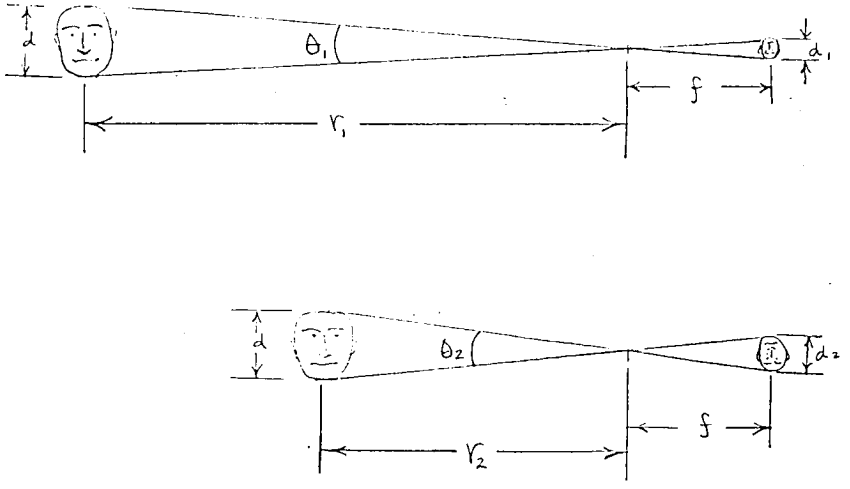


FIGURE B-1.—Head Size Calculation (Zapruder 413).

B. Photograph Authentication

1. THE OSWALD BACKYARD PHOTOGRAPHS*

*(a) Introduction***

(347) One of the most publicized questions to emerge in relation to the Kennedy assassination involves the authenticity of photographs showing Lee Harvey Oswald standing in his backyard, with a holstered pistol strapped to his waist, holding a Mannlicher-Carcano rifle

*This section prepared under the direction of C. S. McCamy and Cecil Kirk. with the assistance of David Eisendrath. For related public hearing testimony of McCamy and Kirk, Sept. 14, 1978, see HSCA–JFK Hearings, vol. II, pp. 349. 397.

**A glossary of terms is available in App. A of "The Backyard Pictures," Report to the House Select Committee on Assassinations by Dr. Leslie Stroebel, Mr. Andrew Davidlazy, and Dr. Ronald Francis, October 1978 (JFK Document No. 12902 [Hereinafter referred to as RIT Technical Report]). See par. 445 *infra*.