The effort took from September until the end of November. They are available to testify here this morning.

Professor Weiss received a B.E.E. degree from the City College of New York in 1952, and an M.S. in electrical engineering from Columbia University in 1957. From 1957 until 1964, he worked as a project engineer for the Federal Scientific Corp., and from 1965 until 1974 he was vice president of that corporation for acoustical research. He is presently a professor in the Department of Computer Science of Queens College of the City University of New York, a position he assumed in 1974.

Professor Weiss is the author of over 30 articles and technical reports concerning electronics for acoustical engineering. He has worked on projects such as the development of instruments for real-time spectrum analysis of audio signals; development of the first real-time system for extraction of vocal pitch using the cepstrum approach; and he is currently involved in development of techniques for reducing wide band noise and other interference on speech recordings to increase the detectability and intelligibility of speech.

From November 1973 until June 1974, Professor Weiss was a member of a panel of technical experts appointed by Chief Judge John J. Sirica to examine the White House tape recordings in connection with the Watergate grand jury investigation.

He is a fellow of the Acoustical Society of America and a member of the Institute of Electrical & Electronics Engineering.

Mr. Ernest Aschkenasy received a B.E.E. from the City College of New York in 1967, and his M.S. from the City College of New York in 1972. From 1967 until 1974, he worked as an engineer with the Federal Scientific Corp., where he had primary responsibility for the development of computer programs for analysis and reduction of large volumes of acoustic data. In 1974, Mr. Aschkenasy also assisted in the Watergate tape analysis and began his present work as a research associate for the Department of Computer Science at Queens College of the City University of New York, where he is presently acting as Prof. Mark Weiss' assistant.

It would be appropriate at this time, Mr. Chairman, to call as witnesses Professor Weiss and his associate, Mr. Aschkenasy.

Chairman STOKES. The committee calls Professor Weiss and Mr. Aschkenasy. May I ask both of you to stand, raise your right hand and be sworn? Do you solemnly swear the testimony you give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Mr. WEISS. I do.

Mr. ASCHKENASY. I do.

Chairman STOKES. Thank you. You may be seated. The committee recognizes deputy chief counsel Gary Cornwell.

TESTIMONY OF PROF. MARK WEISS AND MR. ERNEST ASCHKENASY

Mr. CORNWELL. Thank you, Mr. Chairman. Professor Weiss and Mr. Aschkenasy, are you familiar with the work of Dr. Barger and his team of scientists at Bolt Beranek & Newman, which led to Dr. Barger's testimony in September of this year before the committee?

Mr. WEISS. Yes; we are.

Mr. CORNWELL. When did you first have the opportunity to review that work?

Mr. WEISS. In August of this year we examined the results of Dr. Barger's analysis up to that time, and also reviewed the plan for the reconstruction experiment to be conducted in Dallas and judged whether the experiment was necessary to be performed. We did visit Dr. Barger at his lab in Cambridge, Mass., and had a lengthy discussion with him, saw his result, and reported back to the committee that in our opinion the reconstruction experiment was not only fully justified but also necessary for the continuance of his analysis.

Mr. CORNWELL. So at that time you simply reviewed the processes and techniques that Dr. Barger was using and specifically you did so for the purpose of rendering an independent opinion to the committee as to the necessity of going to Dallas and conducting the lab test; is that correct?

Mr. WEISS. That is correct.

Mr. CORNWELL. After the hearings of September were concluded, were you again asked to look at the work of the team of Bolt, Beranek & Newman in more detail?

Mr. WEISS. That is correct. We were asked to take a more detailed look at not only their work, but also at the Dallas police tape recording.

Mr. CORNWELL. What was the purpose of that request? What were you asked to do on this occasion?

Mr. WEISS. The object there was to perform a refined analysis of the data relating to the presumed shot occurring, the third possible shot that was examined by Dr. Barger, the one that was thought to have been the result of a gun firing at the grassy knoll.

Mr. CORNWELL. And you began that work in early October?

Mr. WEISS. That is correct.

Mr. CORNWELL. And you just very recently concluded the work; is that correct?

Mr. WEISS. Yes, sir.

Mr. CORNWELL. Based upon the work, were you able to reach a conclusion with any greater degree of certainty as to whether or not that shot did or did not occur?

Mr. WEISS. Yes, sir, we did.

Mr. CORNWELL. And what was your conclusion?

Mr. WEISS. It is our conclusion that as a result of very careful analysis, it appears that with a probability of 95 percent or better, there was indeed a shot fired from the grassy knoll.

Mr. CORNWELL. Let me ask you—just very, very recently you reached that conclusion—would you tell us why it was that it took from early October until just very recently to complete your work?

Mr. WEISS. Yes, sir, our problem was that we had other obligations in addition to working on this problem. We have a major contract with the Air Force for development of some special purpose speech processing equipment, and in order to both work on that and work on this problem, we could not work on this problem fulltime.

Mr. CORNWELL. Would you very generally describe for us what the scientific principles are that you utilized in your work?

Mr. WEISS. Well, the principles are basically the fundamental principles in acoustics, namely, that if someone makes a loud noise somewhere, like here [witness claps his hands], that sort of thing, everybody in this room can hear that noise, which means that sound moves out in all possible directions. A second principle is that that sound which they hear directly also will bounce off walls and be reflected. So they will hear not only the direct sound but also sounds called echoes bouncing from walls, corners, and other surfaces. The third principle, also very fundamental, is that the speed of sound is constant in whatever direction it may go. So that the farther you are from the source of the sound, the longer it will take for that sound to reach you, whether that source is, in fact, the original source of the sound or a reflecting surface which would cause an echo. I would like to illustrate basically what is meant by echoes at this point here. I think everybody is pretty much aware of what happens if you stand at a canyon and holler something like "Hello" and you get back a series of "Hello, hello, hello," that sort of thing. You can hear each of these echoes in such a circumstance because the reflecting surfaces are quite far apart from you and from each other. In a situation such as an echo generated in Dealey Plaza, you have reflecting surfaces, also the walls and corners of the buildings there. They, too, will generate echoes, but they will tend to come in very much more closely in sequence so that even if you have a very short, sharp sound such as a rifle firing, OK, or again a clap of the hands, you will get back what to an observer or many observers will sound like a single, loud bang-type thing. But if you were to record that and play it back at one-quarter or one-eighth the speed you recorded it, you will be able to hear something like the independent echoes coming back, in fact what you would hear would be something like bang-bang-bang-bang, and diminishing in amplitude as you get echoes over longer periods. To the human ear you don't hear that because the first loud sound partially deafens the ear, and it decreases your sensitivity to the later arriving sounds. What you hear is a single loud sound with a diminishing intensity.

Mr. CORNWELL. In what we might describe as a complex urban type of environment with a number of different solid structures in it such as you might find in any city or in Dealey Plaza, do I understand, then, that the echoes would arrive back at a varied spacing in time; they would not all arrive back at the evenly spaced intervals?

Mr. WEISS. That is correct. They will arrive back at spacings which depend entirely on where the listener is relative to the surfaces that produce the reflections that generate the echo paths and also it will depend on where the source of the sound is.

Mr. CORNWELL. So if then you were given one location for the listener and one location for the sound source, would you get the same type of pattern time after time if you reproduce the sounds from that location?

Mr. WEISS. Yes. In fact, if you had to listen, as in the specific case of Dealey Plaza, if you had a listener standing someplace in the Plaza, say on the sidewalk near the depository building, and he stood still and a rifle was exactly held in another place, as the rifle fired, he would hear a succession of echoes. If it was fired again, he would hear identically the same succession of echoes if nobody moved. If he came back 15 years later and the buildings were the same, as they are in this case, and he stood in the same spot and a rifle was fired from exactly the same spot and the temperature of the air was the same he would, in fact, even then hear exactly the same sequence of echoes. If somebody is standing close by, but not in exactly the same place, he will hear a similar succession of echoes but not identically the same. There will be small measurable differences. The farther away the other listener gets from the first person, the greater the difference will be in the pattern of echoes that he hears.

Mr. CORNWELL. And likewise, I take it if you were to move the location of a sound source, whether it is someone clapping their hands or rifle fire, you also, by moving it a few feet, would get a different echo pattern?

Mr. WEISS. You would get a different echo pattern.

Mr. CORNWELL. How well established are these acoustics principles you have been describing?

Mr. WEISS. These have been established a very long time. They have been known for several hundred years. These are fundamental things in acoustics, the things taught in high school or college undergraduate level physics.

Mr. CORNWELL. Were there other more complex or more sophisticated principles that you were required to use in your analysis which were not so well established, which were newer or less well established?

Mr. WEISS. No, sir. We only needed to apply these basic well-tested, well-established principles; nothing more.

Mr. CORNWELL. In your analysis, what equipment were you required to use?

Mr. WEISS. Basically we used a large plan map of Dealey Plaza.

Mr. CORNWELL. A survey map?

Mr. WEISS. A survey map; that is correct. The scale was 1 inch corresponding to 10 feet in Dealey Plaza. We used a long graduated ruler that could be extended to measure long distances on the map. We used a hand calculator for computing some very simple things, and we used a device, an electric device called an oscilloscope, for observing the wave shapes of the sounds that we got when we played back tape recordings, and also a device that enabled us to plot these patterns on paper so that we could examine them in very fine detail.

Mr. CORNWELL. Were you required to use anything sophisticated such as a computer or anything beyond what you have mentioned?

Mr. WEISS. No, sir. This is the only equipment that we used.

Mr. CORNWELL. Would you very generally describe what the basic process was that you went through in applying these principles to the available data?

Mr. WEISS. Well, basically the idea was this. As I indicated, each position in the plaza would have a unique set of echoes associated with it. If a sound heard on the police tape was, in fact, the sound of gunfire heard by a microphone—and a microphone, remember, is kind of an electronic ear—it hears the same as an ear will hear—if that indeed was the case, then I ought to be able to find a position for that microphone and a position for the gun such that I could predict a pattern of echoes that would match the sounds heard on the police tape to a high degree of accuracy. I could then say that this kind of match of a predicted pattern with the observed pattern is so close that the probability that what I am really looking at on the Dallas police tape is noise becomes very small. So we set out to be able to predict what the echo structures would be at various locations in Dealey Plaza. This was the whole art of it. As I say, it was done by using the simple concept that sound would travel in all directions from a source and that it will reflect off surfaces and travel back.

Mr. CORNWELL. In your attempt then to calculate various echo patterns and find out if they precisely matched or relatively precisely matched what is on the Dallas police tape, did you or were you required to use in any way the test that Dr. Barger conducted with his team from B.B. & N.?

Mr. WEISS. Yes, sir, that set of test data, in fact, proved to be invaluable in this case. It was by analysis of a number of these firings that Dr. Barger and his associates recorded in, I guess it was, August of this year that we got to become familiar with the acoustical structure of Dealey Plaza. By using these recordings in conjunction with this map of Dealey Plaza, we got to know where the buildings—where were the reflecting surfaces that gave rise to the echoes that could be heard.

Mr. CORNWELL. In addition to the tests that Dr. Barger conducted, did you need anything else, any other information in order to follow this process?

Mr. WEISS. Well, yes. We needed, in order to perform this prediction process, we needed to know a number of things. First, we needed to know where the sources of sound were.

Now, of course, that means we had to have some idea of where a shooter might have been, and by all indications, he had to be someplace up on the grassy knoll, and we had that area taken care of.

We had to know, of course, also where the reflecting surfaces were. That is for a particular assumed position of the microphone, where the major reflecting surfaces were. So we had to refine our understanding of how the echoes were produced in that case. We had to know approximately where the motorcycle was, because although this technique is simple and straightforward, it can become pretty tedious if you don't know approximately where or reasonably well where the motorcycle is, and you can assume it to be anywhere in the Plaza. So we had to have some idea where it was. And what we assumed was that it was approximately in the neighborhood of that microphone that gave the strongest matching pattern in Dr. Barger's experiment between a shot from the knoll and the impulses audible on the police tape recordings.

Furthermore, in order to calculate the echo times, the time of arrival at each of these echoes, we had to know what the velocity of sound was in the air. As I said before, the velocity of sound is constant in all directions. However, it is not always the same value. In particular, it is a function of the temperature of the air. So we had to find out what was the temperature of the air at the time of the assassination. And that was about all we really had to know in order to perform the prediction.

Mr. CORNWELL. Would you have an opinion to know what speed the tape recorder ran at that recorded the initial sounds?

Mr. WEISS. Yes. We had an estimate from Dr. Barger that the speed of the tape recorder was about 5 or so percent slow from a normal, nominal speed, and we had to build this factor into the correction of time observed on the tape so we could get a time interval for the echoes, if, indeed, these impulses are echoes, that would be true for a correctly running tape.

Mr. CORNWELL. Just to be sure I understood one statement you made, you said you needed to know the source of the sound, the location of the source of the sound, and the location or approximate location of the motorcycle.

Do I understand from that that what you are saying is you need to know a general area in which to begin making your calculations?

Mr. WEISS. That is correct, that is what I meant. As I said, I assumed that the motorcycle would have been somewhere in the vicinity of microphone 4, for example, which was down on Elm Street in the experiment performed by Dr. Barger.

Mr. CORNWELL. So you didn't take as a given that the motorcycle was in that location, and you simply began to look in that general area.

Mr. WEISS. That is correct, and if we had not found it, we would have looked in a wider and wider zone.

Mr. CORNWELL. Ultimately you may have found it was not even in the Plaza.

Mr. WEISS. That is correct. In fact, this brings up another point. If, in fact, after diligent searching we could not get a pattern of echoes, a predicted pattern of echoes, that would sufficiently closely match the impulses visible on the police tape recording, then we would have to conclude either that we did not have a shot recorded there, or that if we did have a shot recorded, then the motorcycle was not anywhere near the position we had assumed it to be, or the shooter was not anywhere near the position we assumed to be, or both conditions.

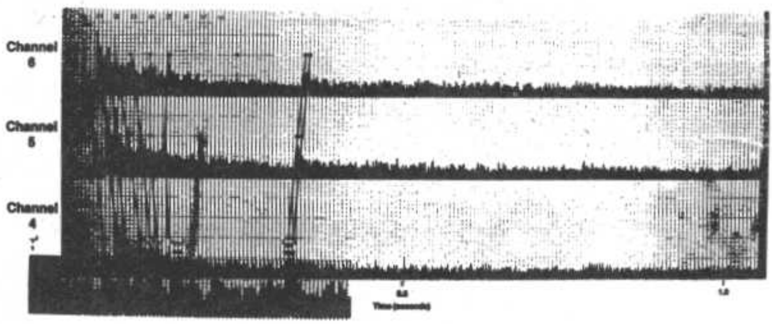
Mr. CORNWELL. Mr. Chairman, I would ask at this time that we leave exhibit F-361, which has previously been admitted, on the easel, and also add to it, the exhibit F-349, which was previously admitted in these hearings in September, and, in addition, I would request that exhibits F-672 and F-667 be admitted into evidence and displayed so that all four exhibits are displayed simultaneously.

Chairman STOKES. Without objection, they may be entered into the record and displayed appropriately.

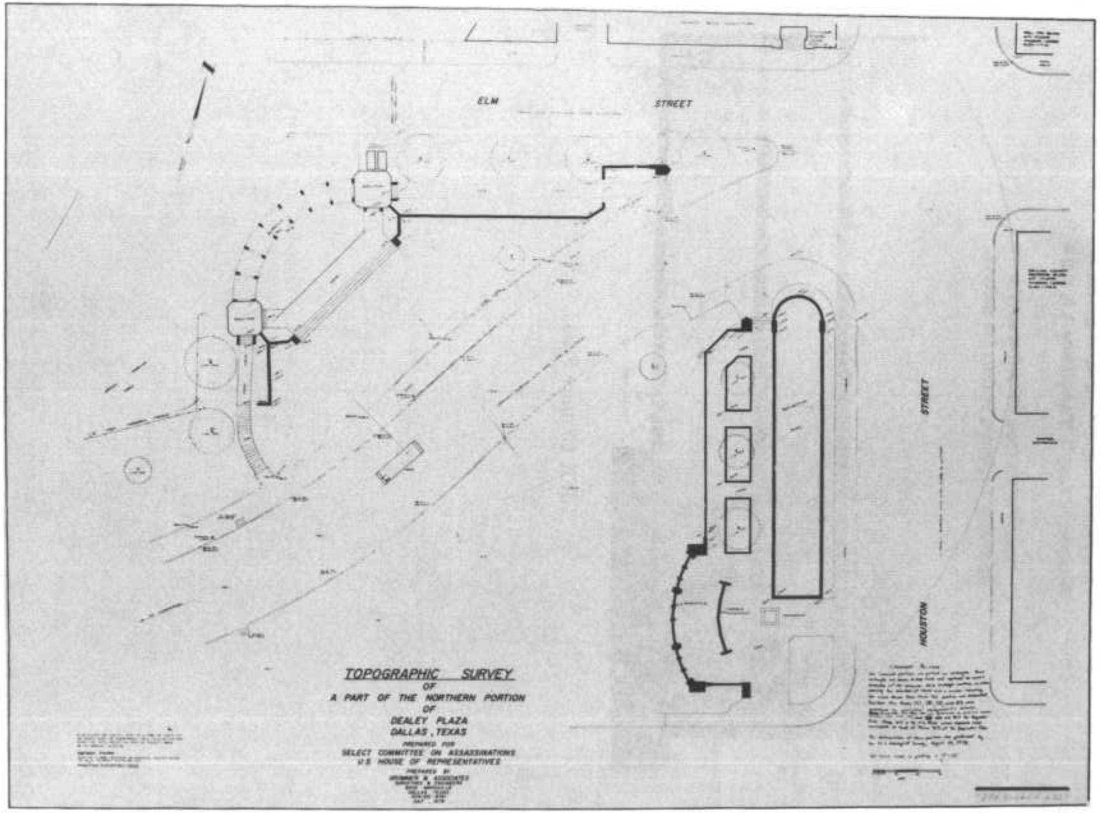
[The exhibits follow:]

Test Pattern for Shot 8 (Knoll, Target No. 3)
Received at Array 3, Microphones 4, 5, and 6

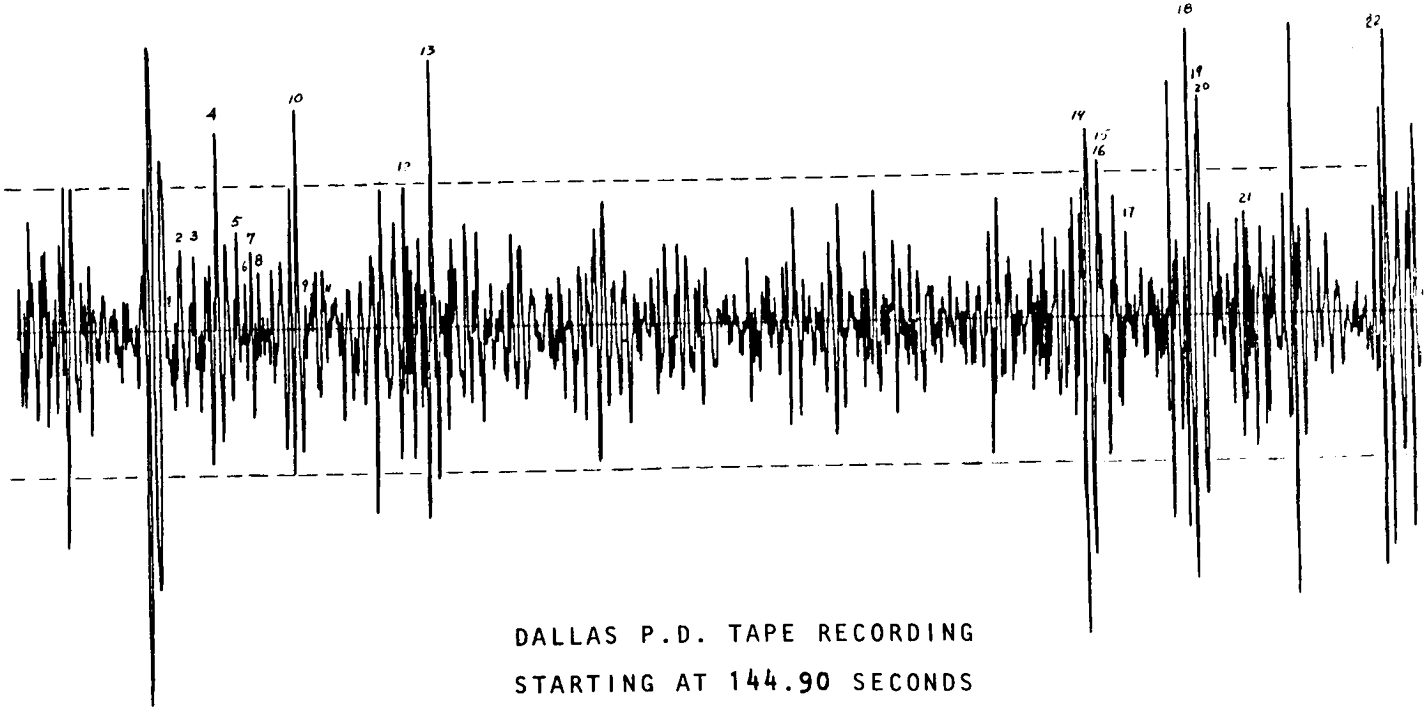
Echo Pattern From Stuck-Transmitter
Recording Beginning at Time 145 Seconds.



JFK Exhibit F-349



JFK EXHIBIT 672



DALLAS P.D. TAPE RECORDING

STARTING AT 144.90 SECONDS

JFK EXHIBIT F-667

Mr. CORNWELL. Professor Weiss, I would ask, if you would be able to, utilizing those exhibits, to actually illustrate for us the process that you employed in reaching your final conclusion.

Mr. WEISS. Sure.

Just to illustrate briefly what I was saying before, here is a photograph of Dealey Plaza, and let's assume for a moment that you have an observer standing right around over here, sort of visible on the street between these two trees, and then you have a source of sound in this area here, which would be behind the wooden stockade fence on the grassy knoll.

Now, if he fires a rifle at this point, the sound of that firing will go directly to the observer over here. It will also go to this building over here, the so-called DCRB, Dallas County Records Building, and bounce back to the observer. It will also go to the corner of these buildings here, and each of these corners' reflections will then bounce back.

Now the time taken for the sound, the original sound to reach the observer depends, of course, upon how far the observer is from the rifle—and by the "observer" here, it could be an individual or it could be a microphone—and this time is the distance the sound travels divided by the velocity of sound, which is approximately, say, 1,100 feet per second.

Now, the time taken for this echo here to come back to the observer will be the total distance taken going from the rifle to the building and then back to the observer, also divided by the velocity of sound. As you can see, each of these echo paths will have a different length. Therefore, there will be a different travel time for each echo. What that means is that you will hear first the one sound and then a whole series of them coming in, each of these coming in after the first sound you hear.

Now, this exhibit illustration here shows the intensity of the sounds that were received by microphone No. 4 in the Dallas reconstruction experiment for a shot fired from the grassy knoll area. Microphone 4 was in fact approximately over here.

This first rather tall, dark line, which I hope is visible to everyone, is, in fact, the intensity of the sound received for the direct muzzle blast, the first sound. Following that, there are a series of dark lines which are, in fact, the echoes coming into the microphone following its receiving the muzzle blast sound. Way out over here, about three-tenths of a second after the first one, is another sound, and there are some others that are further out and sort of getting smaller and smaller and so on.

Now, the way you use this information in identifying the echo-generating sources is as follows. Here is a topographic survey map of Dealey Plaza which gives us a better view of where things are, it is turned around from the way that one is. Here is Elm Street. This is Houston Street. Elm Street. Here is the grassy knoll area. Here is the position of microphone No. 4. The shooter is here. The sound goes from here directly to here. It also goes to this building, bounces off it, goes back to the microphone. It goes to various corners represented over here for various other structures and buildings. And all is recorded.

Now, supposing we want to know what was the echo producing surface that gave rise to this echo in the recording. Well——

Mr. CORNWELL. Professor, excuse me one more time.

Mr. WEISS. Sure.

Mr. CORNWELL. The wiring is having trouble picking up your voice. Could we move the mike up perhaps to your tie or lapel?

Mr. WEISS. OK.

Now we know what the time taken for the direct sound to reach the microphone was, because we know the distance precisely from the rifle to the microphone.

Mr. CORNWELL. And again you are still now talking about on the test?

Mr. WEISS. Yes, this is simply for the purpose of confirming our understanding of exactly where, and it is important to know exactly where, the echo-generating surfaces are.

Mr. CORNWELL. So you, in other words——

Mr. WEISS. So this location is approximately in Dealey Plaza.

Mr. CORNWELL. So, in other words, you are using Dr. Barger's test waves, which are the exhibits you have been referring to, and when those were generated, of course we were all standing there watching, and we know exactly where the shooter was located and exactly where the microphone was. Is that correct?

Mr. WEISS. That is correct. We had good information as to where both of these points were so we could know in advance what the distance was from the shooter to the microphone, and we knew what the time would be that it took for the sound to go directly from the rifle to the microphone.

Now, we also know what the additional time was from the time that the first sound of the rifle was received to the time this echo here that we are interested in was received. If you add this amount of time to the direct time, you have a total time taken to go from here to some echo-generating surface and to the microphone. All right? If you know what that total time is, you can, therefore, predict what the total path length was. OK? Because you now take that total time, now you multiply it by the velocity of sound, and you can compute how many feet, in fact, that sound traveled before it came back and was recorded as this highest peak at this point.

Fine. What you do is the following: Knowing the length of that path—and this is scaled, as I said, approximately at 1 inch equals 10 feet—you can find out the length of that path in inches; you simply cut a piece of string to that length—and I just happen to have some string here pre-cut.

Now I am going to put a pin in here at the position of the rifle. I am going to put another pin in at the known position of the microphone.

Now this piece of string, the length of this corresponds, in fact, to the distance the sound must have traveled in order to have produced this echo. And I sort of now loop it between here and here.

Now sound travels in straight lines so that this string if—I hope it is visible—now if I pull tight on it, it forms two straight lines. It will form a line going from the rifle to some reflecting surface and then bouncing from that surface back to the microphone.

OK. Well, so we start looking—well, there is nothing out here, over here—and what you do is move the string along here over until it intercepts a surface. Well, in passing through here, has to go further, so this can't be it. And you keep on trying, and because it is easier to do with a pencil, OK, so we can now sort of see the arc formed, the possible positions for a reflecting—a surface that will generate an echo.

And as I bring it along, you can see that it just touches this building over here. If I proceed on, it moves away from it, and, in fact, this is the only point at which this line will just touch the surface. It can't go beyond it, and can't fall in front of it. It just, just touches it in order to be considered to be a surface that generated that echo. And so we have now the location of the surface that produced this echo over here. And it is, in fact, the wall of the Dallas County Records Building.

Now we can take another echo, just to illustrate the process again. We take one that's closer in; we pull out this string; and for that one, again, the same calculation. We know what the time to get from the rifle to the microphone is. We know what the time, later, that we hear this additional echo is, so we know how long that echo actually traveled from the rifle to some surface back to the microphone. And we do the same thing: We compute that in terms of real distance, and then we cut a string according to that distance, scaled to this map. I hook one end of it around the position of the rifle.

As one can see, one does not need a large digital computer to do this kind of thing. Put one end where the microphone or observer is, and we start again doing this business of stretching, and, as again you can see, there is really nothing in here that just touches anything.

So we try the other side here and, lo and behold, we hit this corner over here. There's a wall that is apparently about 4 or 5 feet high at this point, and this string has now just touched this point, so that for this instance the echo traveled from the rifle to this corner of the wall, and now back up to the microphone.

So that's how we identified or confirmed these two points as echo-generating surfaces.

Well, we picked out, in fact, a total of some 20 or so, or 22 actually, echo paths that we were able to determine by analysis of exactly this sort, just continuing on down the line, picking up these echoes as they can be seen on here and using this technique to actually find where they were generated.

Mr. CORNWELL. Then from that process, as I understand, you were able to sort of confirm what the real echo structure of Dealey Plaza was?

Mr. WEISS. Yes, sir.

Mr. CORNWELL. Which surfaces in it generated echoes from roughly the area of the grassy knoll and being received roughly in the area of the second pin?

Mr. WEISS. That is correct. These surfaces would be correct for that set of conditions for something out here and for something in around here. For something elsewhere it would have been perhaps a different set of echo-generating surfaces.

Mr. CORNWELL. So after you had made that determination, what use did you make of what you had learned?

Mr. WEISS. OK. As I said earlier, the objective was to be able to see if we could, in fact, predict a set of echoes that would closely match the impulses that we could hear and observe on the Dallas police tape recording.

Now this is a wave form chart of the Dallas police tape recording. Here is actually what you hear, but this is what it looks like in terms of the variations of electrical signals as times goes on. Here is time moving along in this direction, and here's how the signal strength varies. It's a big bang here and here and here (indicating).

These are primarily the impulses I am talking about in this set of data.

Mr. CORNWELL. Let me ask you, before you begin to describe that exhibit: Why is it that the wave form which you have printed there from the Dallas P.D. tape appears to us to look absolutely nothing like the test tape wave forms that Dr. Barger created?

Mr. WEISS. Dr. Barger's wave form here represents the total power or strength of the signal as we see it.

The problem here was to actually be able to look, indicate points where that energy level was significantly above the background noise level, which was relatively quiet here, but also to get some sense of the relative strengths of these echoes coming back. This is different because we were interested in very precise measures of time elapsed from any point to any other point in this pattern.

Mr. CORNWELL. In other words, it's simply a different way of displaying——

Mr. WEISS. That's all it is.

Mr. CORNWELL [continuing]. The sound?

Mr. WEISS. The same information is displayed in both of them; yes, sir.

Mr. CORNWELL. In other words, it is the space between the peaks, and not whether they go up or below the line, that is important?

Mr. WEISS. That is correct.

Mr. CORNWELL. OK. Would you proceed?

Mr. WEISS. Now what we did, very simply, was, we put a shooter someplace on the knoll over here, we put a microphone someplace in the plaza over here, and then we started the prediction process.

Now the prediction process is sort of the reverse of the process we had used before.

Could I have the scale? Thank you.

In the prediction process, you don't know, of course, where the shooter is, and you don't know where the microphone is. You make an assumption. You say, "Well, I am going to put him down over here somewhere, let's say the corner of the fence, and I am going to put the microphone over here, let's say somewhere on to the right side, closer to the north side of Elm Street here," and, OK, fine.

So now I have this position here; I can measure off on here what the total path length is, and I can convert that into the time it would take for the sound to travel directly from here to here. Fine.

Now I know where my echo-generating surfaces are, so I now can measure from the rifle to an echo-generating surface to a point; and then I can measure from that point, let's say, back to the microphone. I have a total path length; I can convert that into the total time it took for this echo to travel from here to this position here.

Now I know that original direct travel travel time; I know the echo time. The difference between these two corresponds to the time spacing—say, in this case—between this large bang of the muzzle blast, and some echo time.

Now I believe there is a blackboard here that I can use. Is there chalk?

Let me just sort of represent things this way here.

Chairman STOKES. Professor, can you turn the blackboard just a little bit so the committee can see it?

Mr. WEISS. Surely. We will move this back again later on.

OK. Supposing that, in fact, this represents time running along here, and this is the time at which you received the muzzle bang itself, OK, which would correspond to this again, this first large dark mark on the exhibit there, and I have computed now for this first position echo a time that that echo would arrive, which might be, let's say, over here. OK, that's one echo.

Now I go ahead and I say, OK, that's one surface. I know there are other surfaces here, and I start computing the echos that would be received at that position of the microphone for that position of the shooter, I have assumed when echoes would come in from other surfaces that are known to be echo generators for this set of positions, and I might get some kind of pattern, OK, like this, and I would want to compare that with, in fact, the pattern for the Dallas police tape recording.

And so I line up what looks like the muzzle blast, the sound, which is this very first, very large peak over here, and I say, all right, that one corresponds to this over here, so let's put this one in over here; and now I have a set of sounds which sort of looks like this.

And then there are a few things out further here, and then maybe something else out over here.

Well, you crank this all through, and you find it doesn't match at all. This is nowhere near it, so what you do is, you start moving the microphone around and/or moving the motorcycle—pardon me, the rifle—around.

Mr. CORNWELL. In other words, what you have concluded by the very first choice, arbitrary choice, is that the shooter was not in the location you chose, or the microphone was not in the location, or both?

Mr. WEISS. That is correct, or both—you don't really know—both are variables. So we start moving them around. The whole process is one of experimentation, trial and error, until finally you begin to get some set of data that begins to look reasonable, and then you can close in on a set of positions that will give a reasonably good and accurate match.

Well, this is, in fact, what happened. I got a set of positions which gave an extremely good match to this early set of echoes. This is the Dallas Police Department tape; these are the predictions. OK, here's what is actually being matched to, the observed data, and this is the predicted data.

Now after a while we got some very good agreements with this set of data here that was not as good for the echoes that were out at a distance there. All right, so we started adjusting again until, in fact, we got excellent agreement for here. Only what happened now was, we didn't get such good agreement as we had before for the early echoes.

And after doing this enough times, the light finally dawned, and it occurred to us that the concept wasn't complete. We weren't dealing with a shooter here and a microphone here. We were dealing with a shooter here all right, but with a microphone that wasn't just here; it was in motion; it was going down the street. If it was a motorcycle in the motorcade, it had to have been in motion; it couldn't just be standing there in the middle of the street; and, in fact, if it was going down the street it was probably going at about the speed of the motorcade, which was supposed to be about 11 miles an hour.

So we started moving the microphone down the street at 11 miles an hour, and for this set of moved positions—now predicting what the echo pattern would be at every position as it comes on down—let's say, at what time it would receive each of these echoes. This is a somewhat more complicated process. It is the same process; it just takes a lot longer because you have to do a lot more calculations.

As soon as we started doing that, it became immediately obvious we could quite easily find positions for the rifle and for the motorcycle, such that the match at both the early and the late echoes was getting increasingly close; and, in fact, once we were there, we were practically in the ballpark. It was a little more work, and we closed on a set of echoes that we could predict that matched the observed impulses on this pattern with an accuracy of approximately one-thousandth of a second.

Mr. CORNWELL. So you found that by moving the microphone at approximately 11 miles an hour, the peaks that you predicted the wave form would look like were correct all the way through from the beginning to the end of particular parts of a tape?

Mr. WEISS. That's correct. That's correct.

Mr. CORNWELL. And each of those peaks fell exactly where you would expect them to fall within one-thousandth of a second?

Mr. WEISS. That is correct. In fact, I have on here numbered some 22 peaks for which I can predict an echo path that will match it to within one-thousandth of a second.

Mr. CORNWELL. Are you able to quantify in some fashion the probability that results from the ability to identify a large number of peaks, as you did, to that degree of precision?

Mr. WEISS. Yes, if you have a fit of some 22 points, you have a terrific fit to begin with. It really is hard to imagine this could be an accident, but you can't express it in those terms. You have to reduce it to some formal number that you can actually show is reasonable.

Now some of these echoes, and particularly the early ones coming from surfaces such as doorways over here and some corners over here, come in small. In fact, they come in below the noise level of impulse peaks in the general area of the recording where this is heard.

There is noise that is heard; there is the motorcycle noises; there is electrical noise; static is coming in. All of this is approximately at the level shown by these dashed lines on this exhibit.

Now we didn't want to include anything that might be noise in this comparison; we wanted to deal only with things of which we could be reasonably certain. So we excluded from the consideration anything which was at the noise level itself. If we knew it was below that level, then it was more probably noise than anything else, we excluded it. We wanted to know do those things that excessed this noise level match? Well, if so, how many are there, how many do we expect to find, and how many are matched?

The answer to those three points is that there are a total of some 14 of these greater-than-noise-level peaks observed; there are a total of 10 of them that, in fact, correspond very closely to echo paths that we have been able to predict.

Now our predictions also show that we should have had 12 larger-than-noise-level peaks present; but if you take these numbers and put it in an equation or formula known as the binary correlation formula, you get a number, known as a binary correlation coefficient, of .77, which says, in effect, that this pattern matches, is matched by a corresponding pattern of strong echoes with a coefficient of .77.

If you take that now and you say, well, what is the probability that this is noise, that it is just an accident that these impulses happened to fall into this sequence of spacings, the answer that you get then is that the probability that this is noise is less than 5 percent.

In fact, putting it in a slightly different way, if I may, if I were a betting man, I would say that the odds are 20 to 1 that this is not noise; and I would take 20-to-1 odds.

Mr. CORNWELL. Just to be sure that it is clear, could you have put the microphone at where—I mean, the shooter—at where you ultimately located it and moved the microphone alone and compensated for the error?

Let's suppose you erroneously placed the shooter.

Mr. WEISS. OK. In fact, we performed experiments along that line. Once we knew where everything was, we then tried to adjust positions, and we found that if you move the shooter by perhaps 5 feet on here, you could compensate in a sense for that by moving the initial position of the microphone by about 1 foot, but that when you did that, the compensation was never going to be perfect and, in fact, the range of fit of prediction to observed peak was now somewhat greater than 1 millisecond; it ran to about 1.5 milliseconds.

If you started moving the shooter much more than 5 feet away, you really could not find a position of the microphone that would give any kind of decent fit anymore.

Mr. CORNWELL. So the only two locations in Dealey Plaza which would produce this echo pattern would be the shooter as you have located it on the grassy knoll within the 5 feet circumference?

Mr. WEISS. That is correct.

Mr. CORNWELL. And likewise, a microphone location within about a foot and one-half?

Mr. WEISS. That is correct. We tried numerous positions for the shooter on the grassy knoll area and, of course, many positions for the microphone, and these are the two that yield the tightest and best fit.

Mr. CORNWELL. From that, I take it that you have established to a very high confidence level that it is a shot from some sort of firearm.

Let me ask you if you were able to tell from the wave forms what kind of firearm it was, whether it was supersonic or subsonic, or a rifle or a pistol?

Mr. WEISS. Right. Of course, we have been dealing, up until now, with the question of the sounds of the muzzle blast, which this is identified as, and of all the different echoes that come in later on.

Now if—if this was a rifle firing a supersonic bullet, then we would expect that immediately preceding the sound of the muzzle blast we would find the sound of the shockwave generated by the bullet while it is in flight that always precedes the muzzle blast; and, of course, it precedes it because the bullet is flying at a speed much greater than the speed of sound.

And if we look in the data, we, in fact, do find a very strong impulse preceding the muzzle blast by a reasonable distance that is not so close so that it could not possibly be it, nor is it too far away. It is pretty much in the right position to be considered to be a probable shockwave sound, recorded just before the recording of the direct muzzle blast sound.

You can see similar such events, of course, over there on the recording of the test firings in Dealey Plaza.

Over here I have been pointing previously to the muzzle blast sound arriving. Well, just before it, over here, there is a dark line which, in fact, is the sound of the shockwave that arrives at the microphone before the muzzle blast.

Mr. CORNWELL. So are you telling us that the indications are that it was a supersonic bullet and, therefore, probably a rifle?

Mr. WEISS. That is correct.

Mr. CORNWELL. And would you also be able to tell us from the wave form what direction the rifle was pointed, what its target was, and whether or not it hit its target?

Mr. WEISS. Well, to deal with the first question, it is quite difficult to say exactly where the rifle would have to have been pointing. It could have been pointing—now, it could have been pointing approximately in a zone, let's say, this wide, so that it could have included the last position of the limousine at frame 312 of the Zapruder film, but, of course, it could have been firing off elsewhere. It couldn't have been firing, for example, straight up in the air. You would never have observed the shockwave for such a condition, nor for that matter could he have been firing off toward, let's say, the underpass region, because again you would simply not have observed it. There are other positions where in all likelihood you would have observed it, but it would have come in at drastically different times than it does here.

If you figure out what the region is for the rifle to have been aimed at, it does include this sort of a region along here [indicating].

Mr. CORNWELL. And if that's the direction it was aimed, can you tell us how far out the bullet went before it terminated?

Mr. WEISS. No, I cannot, because in order to know that, you have to know both precisely where the rifle was fired—and, as I indicated, you cannot know that really—and you must know exactly what the muzzle velocity of the bullet was, and there is no way of determining that from these data.

Mr. CORNWELL. You said you cannot know precisely where the rifle was fired; you mean at what target?

Mr. WEISS. In what direction it was fired, exactly at what target it was aimed at the time it was fired.

Mr. CORNWELL. And if you were to vary the velocity of the rifle bullet from, say, what you might expect to be a normal rifle velocity, somewhere in the 2,000-foot-per-second range up to something considerably higher, up to the upper 3,000 or perhaps 4,000-foot-per-second range, I take it that every time you would vary any assumption like that you would also conclude that there would be a different assumption about where the bullet struck?

Mr. WEISS. That is correct. Even if one makes the assumption that it was aimed directly at the head of the President, you could, for a range of such velocities, assume that it fell short of the target, that it fell at the target, that it went well beyond the target. There is simply no way of knowing.

Mr. CORNWELL. With respect to the last point, Mr. Chairman, I might suggest that we admit as an exhibit, F-673, which is simply a Xerox copy of a 1963 Gun Digest which has the number of velocities of rifles that were available at that time period ranging from everything from just above supersonic speed, all the way up to above 4,000 feet per second.

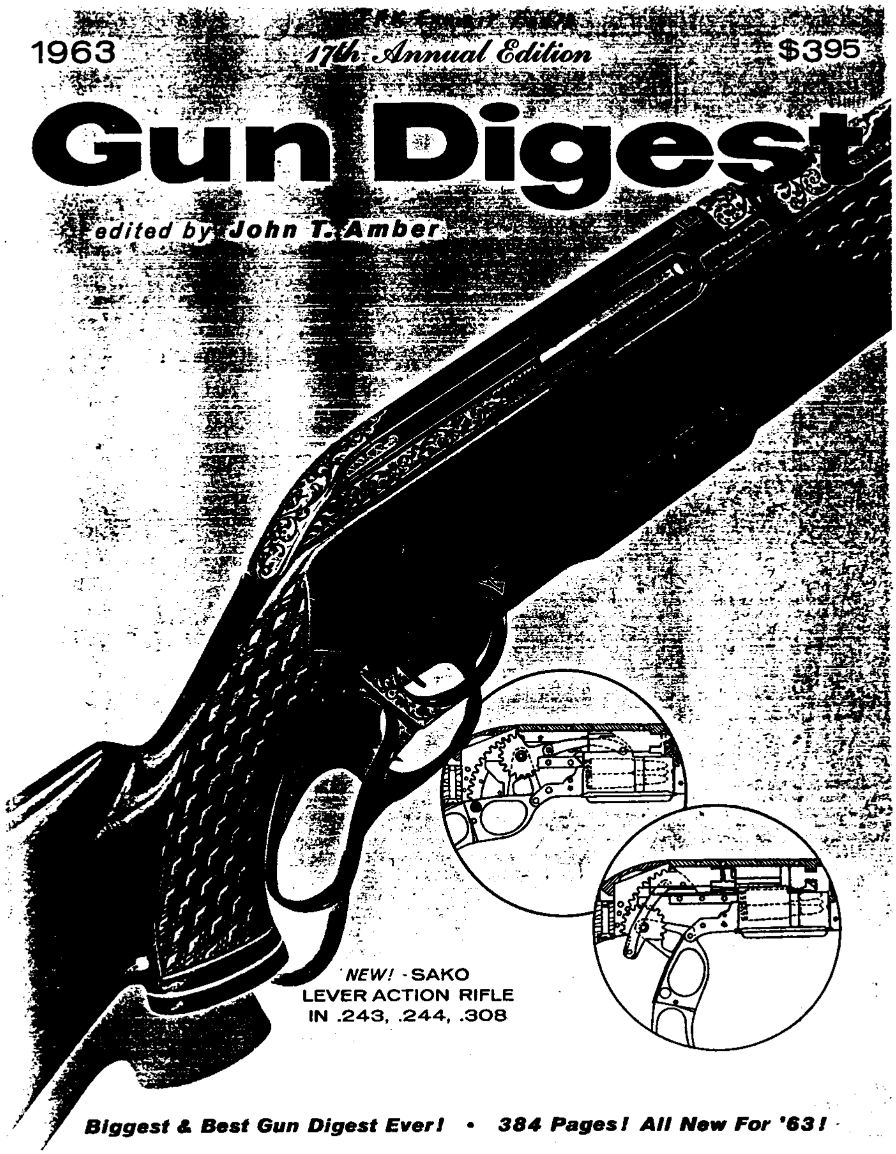
Chairman Stokes. Has it been marked as an exhibit, counsel?

Mr. CORNWELL. Yes, it has.

Chairman Stokes. All right. Without objection, it may be entered.

[The exhibit follows:]

JFK EXHIBIT F-673



WINCHESTER C.F. PISTOL & REVOLVER CARTRIDGES—BALLISTICS AND PRICES

Western cartridges are identical with Winchester loads having the same basic caliber designation, hence the ballistics given will serve for both brands. Western cartridges not duplicated by Winchester are listed in boldface type. The foregoing also holds true for Remington and Peters loads. Peters cartridges not duplicated by Remington are listed in boldface type.

CARTRIDGE	WT. GRS.	BULLET TYPE	BARREL LENGTH	MUZZLE VELOCITY FT. PER SEC.	MUZZLE ENERGY FT. LBS.	PENE-TRATION ⅞" SOFT PIN BOARDS AT 15 FT.	PRICE FOR 50
25 Automatic (Oilproof)	50	F.P.	2"	810	73	3	$4.20
256 Winchester Magnum	60	S.P.	8"	2200	650	—	N.A.
30 Mauser (7.63m/m) (Oilproof)	86	F.P.	5½"	1410	380	11	5.75
30 Luger (7.65 m/m) (Oilproof)	93	F.P.	4½"	1220	307	11	5.75
32 Automatic (Oilproof)	71	F.P.	4"	960	145	5	4.80
32 Smith & Wesson Blank	No Bullet		—	—	—	—	3.25
32 Smith & Wesson Blank (Black powder)	No Bullet		—	—	—	—	3.25
32 Smith & Wesson (Oilproof) Inside Lubricated	85	Lead	3"	680	87	3	3.65
32 Smith & Wesson Long (Oilproof) Inside Lubricated	98	Lead	4"	705	115	4	3.85
32 Short Colt (Oilproof) Greased	80	Lub.	4"	745	100	3	3.65
32 Long Colt (Oilproof) Inside Lubricated	82	Lub.	4"	755	104	3	3.85
32 Colt New Police (Oilproof) Inside Lubricated	98	Lead	4"	680	100	3	3.85
32-20 Winchester (Oilproof) Inside Lubricated	100	Lead	6"	1030	271	6	5.35
32-20 Winchester (Oilproof)	100	S.P.	6"	1030	271	6	6.60
357 Magnum Super-X (Oilproof) Inside Lubricated	158	Lub.	8⅜"	1410	695	12	5.45
357 Magnum Metal Piercing Super-X (Oilproof) Inside Lubricated Lead Bearing	158	Met. Pt.	8⅜"	1410	695	12	6.20
9 m/m Luger (Parabellum) (Oilproof)	115	F.P.	4"	1140	332	10	6.00
38 Smith & Wesson Blank	No Bullet		—	—	—	—	3.35
38 Special Blank	No Bullet		—	—	—	—	4.60
38 Smith & Wesson (Oilproof) Inside Lubricated	145	Lead	4"	685	151	—	4.50
38 Special Super-X (Oilproof) Inside Lubricated	150	Lub.	6"	1065	377	9	4.90
38 Special Metal Piercing Super-X (Oilproof) Inside Lubricated Lead Bearing	150	Met. Pt.	6"	1065	377	11	5.85
38 Special (Oilproof) Inside Lubricated	158	Lead	6"	855	256	7	4.60
38 Special (Oilproof) Inside Lubricated Lead Bearing	158	Met. Pt.	6"	855	256	7.5	5.70
38 Special Mid-Range Match Sharp Corner Clean Cutting (Oilproof) Inside Lubricated	148	Lead	6"	770	195	—	4.80
38 Special Super Match (Oilproof) Inside Lubricated	158	Lead	6"	855	256	—	4.70
38 Special (Oilproof) Inside Lubricated	200	Lead	6"	730	236	7.5	4.80
38 Short Colt (Oilproof) Greased	130	Lub.	6"	730	155	4	4.05
38 Long Colt (Oilproof) Inside Lubricated	150	Lub.	6"	730	175	6	4.50
38 Colt New Police (Oilproof) Inside Lubricated	150	Lead	4"	680	154	4	4.50
38 Automatic Super-Speed. For use in 38 Colt Super Automatic Pistols (Oilproof)	130	F.P.	5"	1280	475	10	5.10
38 Automatic. For all 38 Colt Automatic Pistols (Oilproof)	130	F.P.	4½"	1040	312	9	5.10
380 Automatic (Oilproof)	95	F.P.	3¾"	955	192	5.5	4.90
38-40 Winchester (Oilproof)	180	S.P.	5"	975	380	6	7.85
41 Long Colt (Oilproof) Inside Lubricated	200	Lub.	6"	730	237	3	5.25
44 Smith & Wesson Special (Oilproof) Inside Lubricated	246	Lead	6½"	755	311	4	6.15
44 Magnum	240	Lub.	6½"	1470	1150	—	8.10
44 40 Winchester (Oilproof)	200	S.P.	7½"	975	422	6	8.25
45 Colt (Oilproof) Inside Lubricated	255	Lead	5½"	860	420	6	6.15
45 Automatic (Oilproof)	230	F.P.	5"	850	369	6	6.55
45 Automatic Super Match Clean Cutting	185	M.C.	5"	775	247	—	6.80
45 Automatic Super Match (Oilproof) Clean-Cutting	210	Lead	5"	710	235	—	6.80
45 Automatic Metal Piercing Super-X (Oilproof)	230	M.C.	5"	945	456	11	7.10

American—European Caliber Equivalents

Rifle Cartridges

American	European
22 Hornet	5.6 x 35R
22 Savage	5.6 x 52R
25 Remington	6.5 x 52
25-35 Winchester	6.5 x 52R
7 m/m Mauser	7 x 57
30-30 Winchester	7.62 x 51R
7.62 Russian	7.62 x 53R
30-06 Springfield	7.62 x 63
303 British	.303 Inch Mark VI or VII
8 m/m Mannlicher-Schoenauer (M/1908)	8 x 56
8 m/m Mauser	8 x 57

Pistol Cartridges

American	European
25 Automatic	6.35 Browning
30 Luger	7.65 m/m (Parabellum)
30 Mauser	7.63 m/m Militaire
32 Automatic	7.65 m/m Browning
38 Automatic	9 m/m Browning
380 Automatic	9 m/m Browning Short (Corto, Kurz)
9 m/m Luger	9 m/m Luger (Parabellum)

WINCHESTER R.F. CARTRIDGES—BALLISTICS AND PRICES

CARTRIDGE	WT. GRS.	BULLET TYPE	VELOCITY FT. PER SEC. MUZZLE	VELOCITY FT. PER SEC. 100 YDS.	ENERGY FT. LBS. MUZZLE	ENERGY FT. LBS. 100 YDS.	MID-RANGE TRAJECTORY 100 YDS.	PISTOL-REVOLVER BALLISTICS BARREL LENGTH	PISTOL-REVOLVER BALLISTICS M. V. FT. PER SEC.	PISTOL-REVOLVER BALLISTICS M. E. FT. LBS.	PRICE FOR 50
22 Short Super Speed†	29	K	1125	920	81	54	4.3	6"	1035	69	$ .65
22 Short H.P. Super Speed†	27	K	1155	920	80	51	4.2				.75
22 Long Super Speed†	29	K	1240	965	99	60	3.8	6"	1095	77	.70
22 Long Rifle Super Speed†	40	K	1335	1045	158	97	3.3	6"	1125	112	.80
22 Long Rifle H.P. Super Speed†	37	K	1365	1040	149	86	3.3				.90
22 Long Rifle Shot Super Speed	No. 12		—	—	—	—	—				1.50
22 W.R.F. (22 Rem. Spl.) Sup. Sp. Inside Lub.	45	K	1450	1110	210	123	2.7				2.00
22 W.R.F. Magnum H.P.	40	K	2000	1390	355	170	1.6	6½"	1550	210	2.60
22 W.R.F. Magnum	40	M.C.	2000	1390	355	170	1.6	6½"	1550	210	2.60
22 Short Leader	29	L*	1045	—	70	—	5.6	6"	865	48	.65
22 Long Rifle Leader	40	L*	1145	975	116	84	4.0	6"	950	80	.80
22 Long Rifle, Improved L. V. EZXS, Smokeless Staynless, lead, lub	40	L*	1120	950	111	80	4.2				1 25
22 Long Rifle Super-Match Mark III	40	Lead	1120	950	111	80	4.2				1.25
22 Long Rifle Super-Match Mark IV	40	Lead						6¾"	1060	100	1.25
22 Short Super Match For Pistols	29	Lead						6¾"	1020	67	1.00
22 Short Spotterpruf (Gallery Pack)	29	D*	1045	—	70	—	—			Box of 500	6.50
22 Short Spotterpruf (Gallery Pack)	15	D*	1710	—	97	—	—			Box of 500	6.50
22 Winchester Automatic Inside Lubricated	45	K	1055	930	111	86	4.6				2.00

†Wax Coated M.C.—Metal Case L*—Lead, lubricated K—Kopperclad Lub—Lubaloy D*—Disintegrating *Courtesy Western-Winchester*

Western cartridges are identical with Winchester loads having the same basic caliber designation, hence the ballistics given will serve for both brands. Western cartridges not duplicated by Winchester are listed in boldface type. The foregoing also holds true for Remington and Peters loads. Peters cartridges not duplicated by Remington are listed in boldface type.

WINCHESTER C.F. RIFLE CARTRIDGES—BALLISTICS AND PRICES

CARTRIDGE	BULLET Wt. Grs.	BULLET Type	VELOCITY—FT. PER SEC. Muzzle	VELOCITY 100 yds.	VELOCITY 200 yds.	VELOCITY 300 yds.	ENERGY—FT. LBS. Muzzle	ENERGY 100 yds.	ENERGY 200 yds.	ENERGY 300 yds.	MID-RANGE TRAJECTORY 100 yds.	MID-RANGE TRAJECTORY 200 yds.	MID-RANGE TRAJECTORY 300 yds.	PRICE For 20
218 Bee Super Speed*	46	H.P.	2860	2160	1610	1200	835	475	265	145	0.7	3.8	11.5	$6.90
219 Zipper Super Speed	56	H.P.	3110	2440	1940	1550	1200	740	465	300	0.6	2.9	8.3	3.60
22 Hornet Super Speed*	45	S.P.	2690	2030	1510	1150	720	410	230	130	0.8	4.3	13.0	6.70
22 Hornet Super Speed*	46	H.P.	2690	2030	1510	1150	740	420	235	135	0.8	4.3	13.0	6.70
220 Swift Super Speed	48	P.S.P.	4110	3490	2930	2440	1800	1300	915	635	0.3	1.4	3.8	3.85
222 Remington	50	S.P.	3200	2660	2170	1750	1140	785	520	340	0.5	2.5	7.0	3.15
243 Winchester Super Speed	80	S.P.	3500	3080	2720	2410	2180	1690	1320	1030	0.4	1.8	4.7	4.30
243 Winchester Super Speed	100	Power Pt.	3070	2790	2540	2320	2090	1730	1430	1190	0.5	2.2	5.5	4.30
25-20 Winchester High Velocity Super Speed*	60	H.P.	2250	1660	1240	1030	675	365	205	140	1.2	6.3	21.0	6.20
25-20 Winchester†*	86	Lead	1460	1180	1030	940	405	265	200	170	2.6	12.5	32.0	5.35
25-20 Winchester*	86	S.P.	1460	1180	1030	940	405	265	200	170	2.6	12.5	32.0	5.90
25-35 Winchester Super Speed	117	S.P.	2300	1910	1600	1340	1370	945	665	465	1.0	4.6	12.5	3.70
250 Savage Super Speed	87	P.S.P.	3030	2660	2330	2060	1770	1370	1050	820	0.6	2.5	6.4	4.00
250 Savage Super Speed	100	S.T.Exp.	2820	2460	2140	1870	1760	1340	1020	775	0.6	2.9	7.4	4.00
257 Roberts Super Speed	87	S.P.	3200	2840	2500	2190	1980	1560	1210	925	0.5	2.2	5.7	4.45
257 Roberts Super Speed	100	S.T.Exp.	2900	2540	2210	1920	1870	1430	1080	820	0.6	2.7	7.0	4.45
257 Roberts Super-X	117	S.P.	2650	2280	1950	1690	1820	1350	985	740	0.7	3.4	8.8	4.45
264 Winchester Magnum	100	S.P.	3700	3260	2880	2550	3040	2360	1840	1440	0.4	1.6	4.2	5.85
264 Winchester Magnum	140	Power Pt.	3200	2940	2700	2480	3180	2690	2270	1910	0.5	2.0	4.9	5.85
270 Winchester Super Speed	100	S.P.	3480	3070	2690	2340	2690	2090	1600	1215	0.4	1.8	4.8	4.75
270 Winchester Super Speed	130	S.T.Exp.	3140	2850	2580	2320	2840	2340	1920	1550	0.5	2.1	5.3	4.75
270 Winchester Super Speed	150	Power Pt.	2900	2620	2380	2160	2800	2290	1890	1550	0.6	2.5	6.3	4.75
7x57 m/m Mauser Super Speed	175	S.P.	2490	2170	1900	1680	2410	1830	1400	1100	0.8	3.7	9.5	4.75
30-30 Winchester Super Speed	150	H.P.	2410	2020	1700	1430	1930	1360	960	680	0.9	4.2	11.0	3.75
30-30 Winchester Super Speed	150	Power Pt.	2410	2020	1700	1430	1930	1360	960	680	0.9	4.2	11.0	3.75
30-30 Winchester Super Speed	170	Power Pt.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30-30 Winchester Super Speed	170	S.T.Exp.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30-30 Winchester Super Speed	170	F.P.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30 Remington Super Speed	170	S.T.Exp.	2120	1820	1560	1350	1590	1180	870	645	1.1	5.3	14.0	3.75
308 Winchester Super Speed	110	S.P.	3340	2810	2340	1920	2730	1930	1340	900	0.5	2.2	6.0	4.75
308 Winchester Super Speed	125	P.S.P.	3100	2740	2430	2160	2670	2080	1640	1300	0.5	2.3	5.9	4.75
308 Winchester Super Speed	150	Power Pt.	2860	2520	2210	1930	2730	2120	1630	1240	0.6	2.7	7.0	4.75
308 Winchester Super Speed	150	S.T.Exp.	2860	2570	2300	2050	2730	2200	1760	1400	0.6	2.6	6.5	4.75
308 Winchester Super Speed	180	Power Pt.	2610	2250	1940	1680	2720	2020	1500	1130	0.7	3.4	8.9	4.75
308 Winchester Super Speed	180	S.T.Exp.	2610	2390	2170	1970	2720	2280	1870	1540	0.8	3.1	7.4	4.75
308 Winchester Super Speed	200	S.T.Exp.	2450	2210	1980	1770	2670	2170	1750	1400	0.8	3.6	9.0	4.75
30-40 Krag Super Speed	180	Power Pt.	2470	2120	1830	1590	2440	1790	1340	1010	0.8	3.8	9.9	4.75
30-40 Krag Super Speed	180	S.T.Exp.	2470	2250	2040	1850	2440	2020	1660	1370	0.8	3.5	8.5	4.75
30-40 Krag Super Speed	220	S.T.Exp.	2200	1990	1800	1630	2360	1930	1580	1300	1.0	4.4	11.0	4.75
30-06 Springfield Super Speed	110	S.P.	3370	2830	2350	1970	2770	1960	1350	900	0.5	2.2	6.0	4.75
30-06 Springfield Super Speed	125	Power Pt.	3200	2810	2480	2200	2840	2190	1710	1340	0.5	2.2	5.6	4.75
30-06 Springfield Super Speed	150	Power Pt.	2970	2620	2300	2010	2930	2280	1760	1340	0.6	2.5	6.5	4.75
30-06 Springfield Super Speed	150	S.T.Exp.	2970	2670	2400	2130	2930	2370	1920	1510	0.6	2.4	6.1	4.75
30-06 Springfield Super Speed	180	Power Pt.	2700	2330	2010	1740	2910	2170	1610	1210	0.7	3.1	8.3	4.75
30-06 Springfield Super Speed	180	S.T.Exp.	2700	2470	2250	2040	2910	2440	2020	1660	0.7	2.9	7.0	4.75
30-06 Springfield Wimbledon Cup	180	F.P.B.T.	2700	2520	2350	2190	2910	2540	2200	1900	0.6	2.8	6.7	6.05
30-06 Springfield Super-X	180	M.C.B.T.	2700	2520	2350	2190	2910	2540	2200	1900	0.6	2.8	6.7	6.05
30-06 Springfield Super-Speed	220	Power Pt.	2410	2120	1870	1670	2830	2190	1710	1360	0.8	3.9	9.8	4.75
30-06 Springfield Super-Speed	220	S.T.Exp.	2410	2180	1980	1790	2830	2320	1910	1560	0.8	3.7	9.2	4.75
300 Savage Super Speed	150	Power Pt.	2670	2350	2060	1800	2370	1840	1410	1080	0.7	3.2	8.0	4.40
300 Savage Super Speed	150	S.T.Exp.	2670	2390	2130	1890	2370	1900	1510	1190	0.7	3.0	7.6	4.40
300 Savage Super Speed	180	Power Pt.	2370	2040	1760	1520	2240	1660	1240	920	0.9	4.1	10.5	4.40
300 Savage Super Speed	180	S.T.Exp.	2370	2160	1960	1770	2240	1860	1530	1250	0.9	3.7	9.2	4.40
300 H. & H. Magnum Super Speed	150	S.T.Exp.	3190	2870	2580	2300	3390	2740	2220	1760	0.5	2.1	5.2	6.00
300 H. & H. Magnum Super Speed	180	S.T.Exp.	2920	2670	2440	2220	3400	2850	2380	1970	0.6	2.4	5.8	6.00
300 H. & H. Magnum Super Speed	220	S.T.Exp.	2620	2370	2150	1940	3350	2740	2260	1840	0.7	3.1	7.7	6.00
303 Savage Super Speed	190	S.T.Exp.	1980	1680	1440	1250	1650	1190	875	660	1.3	6.2	15.5	4.05
303 British Super Speed	180	Power Pt.	2540	2300	2090	1900	2580	2120	1750	1440	0.7	3.3	8.2	4.75
303 British Super Speed	215	S.P.	2180	1900	1660	1460	2270	1720	1310	1020	1.1	4.9	12.5	4.75
32-20 Winchester High Velocity Super Speed*	80	H.P.	2100	1430	1090	950	780	365	210	160	1.5	8.5	24.5	7.10
32-20 Winchester (Oilproof)†*	100	Lead	1290	1060	940	840	370	250	195	155	3.3	15.5	38.0	5.35
32-20 Winchester (Oilproof)*	100	S.P.	1290	1060	940	840	370	250	195	155	3.3	15.5	38.0	6.60
32 Winchester Special Super Speed	170	Power Pt.	2280	1870	1560	1330	1960	1320	920	665	1.0	4.8	13.0	3.85
32 Winchester Special Super Speed	170	S.T.Exp.	2280	1870	1560	1330	1960	1320	920	665	1.0	4.8	13.0	3.85
32 Remington Super Speed	170	S.T.Exp.	2120	1760	1460	1220	1700	1170	805	560	1.1	5.3	14.5	3.85
32-40 Winchester	165	P.S.	1440	1250	1100	1030	760	570	445	390	2.4	11.0	28.0	3.70
8x57 m/m Mauser Super Speed	200	Power Pt.	2320	1990	1720	1500	2390	1760	1310	1000	0.9	4.4	11.5	4.75
338 Winchester Magnum	200	Power Pt.	3000	2690	2410	2170	4000	3210	2580	2090	0.5	2.4	6.0	6.30
338 Winchester Magnum	250	S.T.	2700	2430	2180	1940	4050	3280	2640	2090	0.7	3.0	7.4	6.30
338 Winchester Magnum	300	Power Pt	2450	2160	1910	1690	4000	3110	2430	1900	0.8	3.7	9.5	6.30
348 Winchester Super Speed	150	S.T.Exp.	2890	2460	2060	1710	2780	2020	1410	975	0.6	2.9	7.9	5.65
348 Winchester Super Speed	200	S.T.Exp.	2530	2220	1940	1680	2840	2190	1670	1250	0.9	3.6	9.0	5.65
348 Winchester Super Speed	250	S.T.Exp.	2350	1970	1660	1410	3060	2150	1530	1100	0.9	4.4	11.5	5.65
35 Remington Super Speed	200	Power Pt.	2100	1710	1390	1160	1950	1300	860	605	1.2	6.0	16.5	4.30
35 Remington Super Speed	200	S.T.Exp.	2100	1710	1390	1160	1950	1290	865	605	1.2	6.0	16.5	4.30
351 Winchester Self-Loading (Oilproof)*	180	S.P.	1850	1560	1310	1140	1370	975	685	520	1.5	7.8	21.5	8.05
351 Winchester Self-Loading (Oilproof)*	180	F.P.	1850	1560	1310	1140	1370	975	685	520	1.5	7.8	21.5	8.05
358 Winchester Super-Speed	200	S.T.	2530	2210	1910	1640	2840	2160	1610	1190	0.8	3.6	9.4	4.95
358 Winchester Super Speed	250	S.T.	2250	2010	1780	1570	2810	2230	1760	1370	1.0	4.4	11.0	4.95
375 H. & H. Magnum Super Speed	270	Power Pt.	2740	2460	2210	1990	4500	3620	2920	2370	0.7	2.9	7.1	6.50
375 H. & H. Magnum Super Speed	300	S.T.Exp.	2550	2280	2040	1830	4330	3460	2770	2230	0.7	3.3	8.3	6.50
375 H. & H. Magnum Super Speed	300	F.P.	2550	2180	1860	1590	4330	3160	2300	1680	0.7	3.6	9.3	6.50
38-40 Winchester (Oilproof)*	180	S.P.	1330	1070	960	850	705	455	370	290	3.2	15.0	36.5	7.85
38-55 Winchester	255	S.P.	1320	1160	1050	1000	985	760	625	565	2.9	13.0	32.0	3.75
44 Magnum Super-X	240	H.S.P.	1750	1350	1090	950	1630	970	635	480	1.8	9.4	26.0	3.35
44-40 Winchester (Oilproof)*	200	S.P.	1310	1050	940	830	760	490	390	305	3.3	15.0	36.5	8.25
45-70 Government	405	S.P.	1320	1160	1050	990	1570	1210	990	880	2.9	13.0	32.5	5.00
458 Winchester Magnum Super Speed	500	F.P.	2130	1910	1700	1520	5040	4050	3210	2570	1.1	4.8	12	12.15
458 Winchester Magnum Super Speed	510	S.P.	2130	1840	1600	1400	5140	3830	2900	2220	1.1	5.1	13.5	7.95

†Inside Lubricated H.P.—Hollow Point O.P.E.—Open Point Expanding S.P.—Soft Point P.S.P.—Pointed Soft Point F.P.—Full Patch S.T.—Silvertip M.C.B.T.—Metal Case Boat Tail
*50 per box F.P.B.T.—Full Patch Boat Tail H.C.P.—Hollow Copper Point

Courtesy Western-Winchester

REMINGTON C.F. RIFLE CARTRIDGES—BALLISTICS AND PRICES

CARTRIDGE	BULLET Wt. Grs.	BULLET Style	VELOCITY—FEET PER SECOND Muzzle	100 yds.	200 yds.	300 yds.	ENERGY—FOOT POUNDS Muzzle	100 yds.	200 yds.	300 yds.	MID-RANGE TRAJECTORY 100 yds.	200 yds.	300 yds.	PRICE For 20
218 Bee Hi-Speed*	46	Mush.	2860	2160	1610	1200	835	475	265	145	0.7	3.8	11.5	$6.90
219 Zipper Hi-Speed	56	Mush.	3110	2440	1940	1550	1200	740	465	300	0.6	2.9	8.3	3.60
22 Hornet Hi-Speed*	45	Mush.	2690	2030	1510	1150	720	410	230	130	0.8	4.3	13.0	6.70
22 Hornet Hi-Speed*	45	S.P.	2690	2030	1510	1150	720	410	230	130	0.8	4.3	13.0	6.70
220 Swift Hi-Speed	48	S.P.	4110	3490	2930	2440	1800	1300	915	635	0.3	1.4	3.8	2.85
222 Remington Hi-Speed	50	S.P.	3200	2650	2170	1750	1140	780	520	340	0.5	2.5	7.0	3.15
222 Remington Hi-Speed	50	M.C.	3200	2650	2170	1750	1140	780	520	340	0.5	2.5	7.0	3.15
222 Remington Magnum Hi-Speed	55	S.P.	3300	2800	2340	1930	1330	955	670	455	0.5	2.3	6.1	3.45
243 Winchester Hi-Speed	80	Pt.S.P.	3500	3080	2720	2410	2280	1690	1320	1030	0.4	1.8	4.7	4.30
243 Winchester Hi-Speed	100	Pt.S.P.C.L.	3070	2790	2540	2320	2090	1730	1430	1190	0.5	2.2	5.5	4.30
244 Remington	75	Ptd.S.P.	3500	3070	2660	2290	2040	1570	1180	875	0.4	1.9	4.9	4.30
244 Remington	90	Ptd.S.P.	3200	2850	2530	2230	2050	1630	1280	995	0.5	2.1	5.5	4.30
244 Remington	90	Br.P.	3200	2850	2530	2230	2050	1630	1280	995	0.5	2.1	5.5	4.30
25-20 Winchester Hi-Speed*	60	Mush.	2250	1660	1240	1030	675	365	205	140	1.2	6.3	21.0	6.25
25-20 Winchester*	86	Lead	1440	1180	1030	940	405	265	200	170	2.6	12.5	32.0	5.35
25-20 Winchester*	86	S.P.	1440	1180	1030	940	405	265	200	170	2.6	12.5	32.0	5.90
250 Savage Hi-Speed	87	S.P.	3030	2660	2330	2060	1770	1370	1050	820	0.6	2.5	6.4	4.00
250 Savage Hi-Speed	100	Ptd.S.P.C.L.	2820	2500	2210	1940	1760	1390	1080	835	0.6	2.8	7.1	4.00
250 Savage Hi-Speed	100	S.P.C.L.	2820	2350	1970	1670	1760	1220	860	620	0.6	3.1	8.4	4.00
25-35 Winchester	117	M.C.	2300	1950	1680	1460	1370	985	730	555	1.0	4.6	12.0	3.70
25-35 Winchester Express	117	S.P.C.L.	2300	1910	1600	1340	1370	945	665	465	1.0	4.6	12.5	3.70
257 Roberts Hi-Speed	100	Ptd.S.P.C.L.	2900	2580	2280	2000	1870	1480	1150	885	0.6	2.7	6.7	4.45
257 Roberts Express	117	S.P.C.L.	2650	2280	1950	1690	1820	1350	985	740	0.7	3.4	8.8	4.45
264 Winchester Magnum	100	Ptd.S.P.C.L.	3700	3260	2880	2550	3040	2360	1840	1440	0.4	1.6	4.2	5.85
264 Winchester Magnum	140	Ptd.S.P.C.L.	3200	2940	2700	2480	3180	2690	2270	1910	0.5	2.1	4.9	5.85
270 Winchester Hi-Speed	100	Ptd.S.P.	3480	3070	2690	2340	2690	2090	1600	1220	0.4	1.8	4.8	4.75
270 Winchester Hi-Speed	130	Ptd.S.P.C.L.	3140	2850	2580	2320	2840	2340	1920	1550	0.5	2.1	5.3	4.75
270 Winchester Hi-Speed	130	Br.P.	3140	2880	2630	2400	2840	2390	1990	1660	0.5	2.1	5.1	4.75
270 Winchester Hi-Speed	150	S.P.C.L.	2800	2440	2140	1870	2610	1980	1520	1160	0.6	2.9	7.6	4.75
280 Remington	100	Br.P.	3570	3160	2770	2420	2830	2220	1700	1300	.4	1.8	4.5	4.75
280 Remington	125	Ptd.S.P.C.L.	3190	2880	2590	2320	2820	2300	1860	1490	.5	2.1	5.3	4.75
280 Remington	150	Ptd.S.P.C.L.	2890	2660	2440	2210	2780	2360	1980	1630	.6	2.5	6.1	4.75
280 Remington	165	S.P.C.L.	2820	2510	2220	1970	2910	2310	1810	1420	.6	2.8	7.2	4.75
7mm Remington Magnum	150	Ptd.S.P.C.L.	3260	3040	2820	2600	3540	3140	2760	2410	.5	1.8	4.7	5.85
7mm Remington Magnum	175	S.P.C.L.	3020	2650	2310	2010	3540	2750	2130	1630	.7	2.5	6.2	5.85
30-30 Winchester Express	150	S.P.C.L.	2410	1960	1620	1360	1930	1280	875	615	0.9	4.5	12.5	3.75
30-30 Winchester Express	160	M.C.	2220	1870	1600	1370	1750	1240	910	665	1.0	5.0	13.0	3.75
30-30 Winchester Express	170	M.C.L.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30-30 Winchester Express	170	S.P.C.L.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30 Remington Express	170	M.C.L.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30 Remington High Velocity	170	I.B.S.P.	2220	1890	1630	1410	1860	1350	1000	750	1.2	4.6	12.5	3.75
30-40 Krag Hi-Speed	180	S.P.C.L.	2470	2120	1830	1590	2440	1790	1340	1010	0.8	3.8	9.9	4.75
30-40 Krag Hi-Speed	180	Ptd.S.P.C.L.	2470	2250	2040	1850	2440	2020	1660	1370	0.8	3.5	8.5	4.75
30-40 Krag High Velocity	220	I.B.H.P.	2200	1930	1700	1510	2360	1820	1410	1110	1.0	4.6	12.0	4.75
30-40 Krag Express	220	S.P.C.L.	2200	1930	1700	1510	2360	1820	1410	1110	1.0	4.6	12.0	4.75
30-06 Springfield Hi-Speed	110	Ptd.S.P.	3420	2940	2490	2090	2850	2110	1510	1070	0.4	2.1	5.6	4.75
30-06 Springfield Hi-Speed	150	Br.P.	2970	2710	2470	2240	2930	2440	2030	1670	0.5	2.4	6.0	4.75
30-06 Springfield Hi-Speed	150	Ptd.S.P.C.L.	2970	2670	2400	2130	2930	2370	1920	1510	0.6	2.4	6.1	4.75
30-06 Springfield Hi-Speed	125	Ptd.S.P.	3200	2810	2480	2200	2840	2190	1710	1340	.5	2.2	5.6	4.75
30-06 Springfield Hi-Speed	180	S.P.C.L.	2700	2330	2010	1740	2910	2170	1610	1210	0.7	3.1	8.3	4.75
30-06 Springfield Hi-Speed	180	Ptd.S.P.C.L.	2700	2470	2250	2040	2910	2440	2020	1660	0.7	2.9	7.0	4.75
30-06 Springfield Hi-Speed	180	Br.P.	2700	2480	2280	2080	2910	2460	2080	1730	0.7	2.9	6.9	4.75
30-06 Springfield Palma Match	180	M.C.T.H.	2700	2520	2350	2190	2910	2540	2200	1900	0.6	2.8	6.7	6.05
30-06 Springfield Express	220	M.C.L.	2410	2120	1870	1670	2830	2190	1710	1360	0.8	3.9	9.8	4.75
30-06 Springfield Express	220	S.P.C.L.	2410	2120	1870	1670	2830	2190	1710	1360	0.8	3.9	9.8	4.75
300 H. & H. Magnum Hi-Speed	180	Ptd.S.P.C.L.	2920	2670	2440	2220	3400	2850	2380	1970	0.6	2.4	5.9	6.00
300 H. & H. Magnum Match	180	M.C.T.H.	2920	2740	2550	2380	3400	3000	2600	2260	0.6	2.4	5.7	7.45
300 H. & H. Magnum Express	220	M.C.L.	2620	2320	2050	1830	3350	2630	2050	1630	0.7	3.2	8.2	6.00
300 Savage Hi-Speed	150	S.P.C.L.	2670	2270	1930	1660	2370	1710	1240	915	0.7	3.3	9.3	4.60
300 Savage Hi-Speed	150	Br.P.	2670	2410	2170	1950	2370	1930	1570	1270	0.7	3.0	7.5	4.60
300 Savage Hi-Speed	150	Ptd.S.P.C.L.	2670	2390	2130	1890	2370	1900	1510	1190	0.7	3.0	7.6	4.60
300 Savage Express	180	S.P.C.L.	2370	2040	1760	1520	2240	1660	1240	920	0.9	4.1	10.5	4.60
300 Savage Express	180	Ptd.S.P.C.L.	2370	2160	1960	1770	2240	1860	1530	1250	0.9	3.7	9.2	4.60
303 British Express	215	S.P.	2180	1900	1660	1460	2270	1720	1310	1020	1.1	4.9	12.5	4.75
303 Savage High Velocity	180	I.B.H.P.	2140	1810	1550	1340	1830	1310	960	715	1.1	5.4	14.0	4.05
303 Savage Express	180	S.P.C.L.	2140	1810	1550	1340	1830	1310	960	715	1.1	5.4	14.0	4.05
308 Win. Hi-Speed	110	Ptd.S.P.	3340	2810	2340	1920	2730	1930	1340	900	0.5	2.2	6.0	4.75
308 Win. Hi-Speed	150	Ptd.S.P.C.L.	2860	2570	2300	2050	2730	2200	1760	1400	0.6	2.6	6.5	4.75
308 Win. Hi-Speed	180	Ptd.S.P.C.L.	2610	2390	2170	1970	2720	2280	1870	1540	0.8	3.1	7.4	4.75
32 Remington Express	170	S.P.C.L.	2220	1890	1610	1400	1860	1350	975	740	1.0	4.9	13.0	3.85
32 Winchester Special Express	170	M.C.L.	2280	1920	1630	1410	1960	1390	1000	750	1.0	4.8	12.5	3.85
32 Winchester Special Express	170	S.P.C.L.	2280	1920	1630	1410	1960	1390	1000	750	1.0	4.8	12.5	3.85
32-20 Winchester Hi-Speed*	80	Mush.	2100	1430	1090	950	780	365	210	160	1.5	8.5	24.5	7.15
32-20 Winchester*	100	Lead	1290	1060	940	840	370	250	195	155	3.3	15.5	38.0	5.35
32-20 Winchester*	100	S.P.	1290	1060	940	840	370	250	195	155	3.3	15.5	38.0	6.60
32-40 Winchester	165	S.P.	1440	1250	1100	1030	760	570	445	390	2.4	11.0	28.0	3.70
348 Winchester Hi-Speed	150	S.P.	2890	2360	1860	1420	2780	1850	1150	670	0.6	3.2	9.0	5.45
348 Winchester High Velocity	200	I.B.H.P.	2530	2140	1820	1570	2840	2030	1470	1090	0.8	3.8	10.0	5.65
348 Winchester Express	200	S.P.C.L.	2530	2140	1820	1570	2840	2030	1470	1090	0.8	3.8	10.0	5.65
35 Remington Hi-Speed	150	Ptd.S.P.C.L.	2400	1960	1580	1280	1920	1280	835	545	0.9	4.6	13.0	4.30
35 Remington Express	200	M.C.L.	2210	1830	1540	1310	2170	1490	1050	760	1.1	5.2	14.0	4.30
35 Remington Express	200	S.P.C.L.	2210	1830	1540	1310	2170	1490	1050	760	1.1	5.2	14.0	4.30
351 Winchester Self-Loading*	180	S.P.	1850	1560	1310	1140	1370	975	685	520	1.5	7.8	21.5	8.05
351 Winchester Self-Loading*	177	M.C.	1850	1560	1310	1140	1370	975	685	520	1.5	7.8	21.5	8.05
375 H. & H. Magnum	270	S.P.	2740	2460	2210	1990	4500	3620	2920	2370	0.7	2.9	7.1	6.50
375 H. & H. Magnum	300	M.C.	2550	2280	2040	1830	4330	3460	2770	2230	0.7	3.6	9.3	6.50
38-40 Winchester*	180	S.P.	1330	1070	960	850	705	455	370	290	3.2	15.0	36.5	7.85
38-55 Winchester	255	S.P.	1320	1160	1050	1000	985	760	625	565	2.9	13.0	32.0	4.20
44 Magnum Carbine*	240	S.P.	1850	1450	1150		1820	1120	705		1.6	8.4		8.30
44-40 Winchester*	200	S.P.	1310	1050	940	830	760	490	390	305	3.3	15.0	36.5	8.25
45-70 Government	405	S.P.	1320	1160	1050	990	1570	1210	990	880	2.9	13.0	32.5	5.00
458 Winchester Magnum	510	S.P.	2130	1840	1600	1400	5140	3830	2900	2220	1.1	5.1	13.5	7.95
458 Winchester Magnum	500	M.C.	2130	1910	1700	1520	5040	4050	3210	2570	1.1	4.8	12.0	12.15
7 mm. Mauser Express	175	S.P.	2490	2170	1900	1680	2410	1830	1400	1100	0.8	3.7	9.5	4.75
8 mm. Mauser Hi-Speed	170	S.P.C.L.	2570	2140	1790	1520	2490	1730	1210	870	0.8	3.9	10.5	4.75
8 mm. Lebel Hi-Speed	170	S.P.	2640	2260	1960	1700	2630	1930	1450	1090	0.7	3.4	8.9	5.40

*50 per Box Mush.—Mushroom S.P.—Soft Point Br.P.—Bronze Point C.L.—Core-Lokt M.C.—Metal Cased T.H.—Tapered Heel M.C.L.—Mushroom Core-Lokt Ptd.—Pointed H.P.—Hollow Point I.B.—Inner Belted P.P.Exp.—Protected Point Expanding

REMINGTON R.F. CARTRIDGES—BALLISTICS AND PRICES

CARTRIDGE ‡250 per Box *28 per Box	BULLET Weight Grains	BULLET Style	VELOCITY—FEET PER SECOND Muzzle	VELOCITY—FEET PER SECOND 100 Yards	ENERGY—FOOT POUNDS Muzzle	ENERGY—FOOT POUNDS 100 Yards	M.R. TRAJECTORY Inches—100 Yds.	PRICE Per 50
REMINGTON "HI-SPEED"								
22 Short	29	Lead	1125	920	81	54	4.3	$ .65
22 Short	27	Hollow Point	1155	920	80	51	4.2	.75
22 Short Hi-Speed Rocket*	15	—	1710	—	97	—	—	.37
22 Long	29	Lead	1240	965	99	60	3.8	.70
22 Long Rifle	40	Lead	1335	1045	158	97	3.3	.80
22 Long Rifle	36	Hollow Point	1365	1040	149	86	3.3	.90
22 W.R.F. (Remington Special)	45	Lead	1450	1110	210	123	2.7	2.00
REMINGTON—STANDARD VELOCITY								
22 Short	29	Lead	1045	810	70	—	—	.65
22 Short Gallery Special Spatter-Less‡	29	Lead	1045	—	70	—	—	3.25
22 Short Spatter-Less	29	Lead	1045	—	70	—	—	.65
22 Short New and Improved Spatter-Less‡	15	—	1710	—	97	—	—	3.25
22 Long Rifle	40	Lead	1145	975	116	84	4.0	.80
22 Winchester Automatic	45	Lead	1055	930	111	86	4.6	2.00
REMINGTON—SPECIAL MATCH CARTRIDGES								
22 Long Rifle—Remington Match	40	Lead	1145	975	116	84	4.0	1.25

REMINGTON SHOT SHELLS

Gauge and Brand	Length Shell Ins.	Powder Equiv. Drams	Shot Oz.	Size Shot	RETAIL PER BOX ZONES 1-2-3-4	RETAIL PER BOX ZONE 5
EXTRA LONG RANGE—Flat-Top Crimp						
10 Ga. Remington Exp.	2⅞	4¾	1⅝	2, 4	$4.25	$4.30
12 Ga. Remington Exp.	2¾	3¾	1¼	BB, 2, 4, 5, 6, 7½	3.50	3.55
12 Ga. Remington "SP"	2¾	3¾	1¼	BB, 2, 4, 5, 6, 7½, 9	3.65	3.70
*16 Ga. Remington "SP"	2¾	3	1⅛	2, 4, 5, 6, 7½, 9	3.20	3.25
16 Ga. Remington Exp.	2 9/16	3	1⅛	2, 4, 5, 6, 7½		
*16 Ga. Remington "SP"	2¾	3¼	1⅛	2, 4, 5, 6, 7½	3.25	3.30
*20 Ga. Remington "SP"	2¾	2¾	1	2, 4, 5, 6, 7½	3.05	3.10
28 Ga. Remington Exp.	2¾	2¼	¾	4, 6, 7½, 9	3.15	3.20
410 Ga. Remington Exp.	2½	...	½	4, 5, 6, 7½, 9	2.35	2.40
410 Ga. Remington Exp.	3	...	¾	4, 5, 6, 7½, 9	2.75	2.80
MAGNUM LOADS						
10 Ga. Remington Exp.	3½	5	2	BB, 2, 4	7.25	7.30
12 Ga. Remington Exp.	2¾	4	1½	2, 4, 6	4.00	4.05
12 Ga. Remington "SP"	2¾	4	1½	BB, 2, 4, 5, 6	4.15	4.20
12 Ga. Remington Exp.	3	4½	1⅞	BB, 2, 4	4.75	4.80
12 Ga. Remington "SP"	3	4½	1⅞	BB, 2, 4	4.90	4.95
12 Ga. Remington Exp.	3	4¼	1⅝	BB, 2, 4, 5, 6	4.40	4.45
12 Ga. Remington "SP"	3	4¼	1⅝	BB, 2, 4, 5, 6	4.55	4.60
*16 Ga. Remington "SP"	2¾	3½	1¼	2, 4, 6	3.50	3.55
*20 Ga. Remington "SP"	2¾	3	1⅛	2, 4, 6, 7½	3.20	3.25
*20 Ga. Remington "SP"	3	3¼	1¼	2, 4, 6, 7½	3.55	3.60
BUCKSHOT—Roll Crimp						
12 Ga. Remington Mag.	2¾	4	...	00 Buck—12 Pellets	4.75	4.80
12 Ga. Remington "SP"	2¾	4	...	00 Buck—12 Pellets	4.90	4.95
12 Ga. Remington Mag.	3	4½	...	00 Buck—15 Pellets	5.45	5.50
12 Ga. Remington "SP"	3	4½	...	00 Buck—15 Pellets	5.60	5.65
12 Ga. Remington "SP"	3	4½	...	4 Buck—41 Pellets	5.45	5.50
12 Ga. Remington Exp.	2¾	3¾	...	00 Buck— 9 Pellets	4.20	4.25
12 Ga. Remington "SP"	2¾	3¾	...	00 Buck— 9 Pellets	4.35	4.40
12 Ga. Remington Exp.	2¾	3¾	...	0 Buck—12 Pellets	4.20	4.25
12 Ga. Remington "SP"	2¾	3¾	...	0 Buck—12 Pellets	4.35	4.40
12 Ga. Remington Exp.	2¾	3¾	...	1 Buck—16 Pellets	4.20	4.25
12 Ga. Remington "SP"	2¾	3¾	...	1 Buck—16 Pellets	4.35	4.40
12 Ga. Remington Exp.	2¾	3¾	...	4 Buck—27 Pellets	4.20	4.25
12 Ga. Remington "SP"	2¾	3¾	...	4 Buck—27 Pellets	4.35	4.40
16 Ga. Remington "SP"	2¾	3	...	1 Buck—12 Pellets	4.20	4.25
16 Ga. Remington Exp.	2 9/16	3	...	1 Buck—12 Pellets	4.20	4.25
*20 Ga. Remington "SP"	2¾	2¾	...	3 Buck—20 Pellets		
RIFLED SLUG—Roll Crimp						
12 Ga. Remington Exp.	2¾	3¾	1	Rifled Slug	5.25	5.30
12 Ga. Remington "SP"	2¾	3¾	1	Rifled Slug	5.40	5.45
16 Ga. Remington "SP"	2¾	3	⅞	Rifled Slug	5.00	5.05
20 Ga. Remington "SP"	2¾	2¾	⅝	Rifled Slug	4.80	4.85
28 Ga. Remington Exp.	2¾	2¼	½	Rifled Slug	4.90	4.95
410 Ga. Remington Exp.	2½	...	1/5	Rifled Slug	4.50	4.55
FIELD LOADS—Flat-Top Crimp						
12 Ga. Shur Shot	2¾	3	1	4, 5, 6, 8	2.75	2.80
12 Ga. Shur Shot	2¾	3	1⅛	4, 5, 6, 8, 9	2.90	2.95
12 Ga. Shur Shot	2¾	3¼	1⅛	4, 5, 6, 8	2.95	3.00
12 Ga. Shur Shot	2¾	3¼	1¼	7½, 8	3.10	3.15
16 Ga. Shur Shot	2 9/16	2½	1	4, 5, 6, 8, 9	2.60	2.65
16 Ga. Shur Shot	2¾	2¾	1⅛	4, 6, 8	2.75	2.80
20 Ga. Shur Shot	2¾	2¼	⅞	4, 5, 6, 8, 9	2.45	2.50
20 Ga. Shur Shot	2¾	2½	1	4, 6, 8	2.65	2.70
SCATTER LOADS—Roll Crimp						
12 Ga. Shur Shot	2⅝	3	1⅛	8	3.05	3.10
16 Ga. Shur Shot	2 9/16	2½	1	8	2.75	2.80
20 Ga. Shur Shot	2½	2¼	⅞	8	2.60	2.65
TARGET LOADS—Flat-Top Crimp						
12 Ga. Shur Shot	2¾	3	1⅛	7½, 8, 9 New Load	2.90	2.95
12 Ga. Shur Shot	2¾	2¾	1⅛	7½, 8 New Load	2.90	2.95
16 Ga. Shur Shot	2¾	2½	1	9	2.60	2.65
20 Ga. Shur Shot	2¾	2¼	⅞	9	2.45	2.50
28 Ga. Remington Exp.	2¾	2¼	¾	9	3.15	3.20
410 Ga. Remington Exp.	2½	...	½	9	2.35	2.40
410 Ga. Remington Exp.	3	...	¾	9	2.75	2.80

*Paper shells in these loads available only while stock lasts.

Courtesy Remington Arms Co.

FEDERAL SHOT SHELLS

Load No.	Length Shell Ins.	Gauge	Powder Drams Equiv.	Ounces Shot	SHOT SIZES Standard Shot	RETAIL PER BOX ZONES 1-2-3-4	RETAIL PER BOX ZONE 5
HI-POWER Brand							
HP127	2¾	12	3¾	1¼	BB, 2, 4, 5, 6, 7½, 9	$3.50	$3.55
HP163	2 9/16	16	3	1⅛	2, 4, 5, 6, 7½, 9	$3.20	3.25
HP164	2¾	16	3¼	1⅛	2, 4, 5, 6, 7½	3.25	3.30
HP203	2¾	20	2¾	1	2, 4, 5, 6, 7½, 9	3.05	3.10
HP281	2¾	28	2¼	¾	4, 6, 7½	3.15	3.20
HP412	2½	410	Max	½	4, 5, 6, 7½	2.35	2.40
HP413	3	410	Max	¾	4, 5, 6, 7½	2.75	2.80
MAGNUM LOADS							
HP130	2¾	12	4	1½	2, 4, 5, 6	4.00	4.05
HP131	3	12	4½	1⅞	BB, 2, 4, 5	4.75	4.80
HP129	3	12	4¼	1⅝	BB, 2, 4, 5, 6	4.40	4.45
HP165	2¾	16	3½	1¼	2, 4, 6	3.50	3.55
HP205	2¾	20	3	1⅛	2, 4, 6, 7½	3.20	3.25
HP207	3	20	3¼	1¼	2, 4, 6, 7½	3.50	3.55
HP282	2¾	28	2¾	1	6, 7½, 8	3.40	3.45
BUCKSHOT—Rifled Slugs							
HP131	3	12	Sup-Mag		00 Buck—15 Pellets	5.45	5.50
HP130	2¾	12	Mag		00 Buck—12 Pellets	4.75	4.80
HP127	2¾	12	Max		00 Buck— 9 Pellets	4.20	4.25
HP127	2¾	12	Max		0 Buck—12 Pellets	4.20	4.25
HP127	2¾	12	Max		1 Buck—16 Pellets	4.20	4.25
HP127	2¾	12	Max		4 Buck—27 Pellets	4.20	4.25
HP163	2 9/16	16	Max		1 Buck—12 Pellets	4.20	4.25
HP203	2¾	20	Max		3 Buck—20 Pellets	4.20	4.25
HP127	2¾	12	Max	1	Rifled Slug	5.25	5.30
HP163	2 9/16	16	Max	⅞	Rifled Slug	5.00	5.05
HP203	2¾	20	Max	⅝	Rifled Slug	4.80	4.85
HP412	2½	410	Max	1/5	Rifled Slug	4.50	4.55
MONARK Brand							
M120	2¾	12	3	1	4, 5, 6, 8	2.75	2.80
M121	2¾	12	3	1⅛	4, 5, 6, 8, 9	2.90	2.95
M123	2¾	12	3¼	1⅛	4, 5, 6, 7½, 8, 9	2.95	3.00
M124	2¾	12	3¼	1¼	7½, 8	3.10	3.15
M161	2 9/16	16	2½	1	4, 5, 6, 8, 9	2.60	2.65
M162	2 9/16	16	2¾	1⅛	4, 5, 6, 7½, 8, 9	2.75	2.80
M201	2¾	20	2¼	⅞	4, 5, 6, 8, 9	2.45	2.50
M202	2¾	20	2½	1	4, 5, 6, 7½, 8, 9	2.65	2.70
OPEN LOADS							
M125	2¾	12	3	1⅛	8	3.05	3.10
M160	2 9/16	16	2½	1	8	2.75	2.80
M200	2¾	20	2¼	⅞	8	2.60	2.65
TARGET LOADS							
M119	2¾	12	2¾	1⅛	7½, 8, 9	2.90	2.95
T122	2¾	12	3	1⅛	7½, 8, 9	2.90	2.95
S166	2¾	16	2½	1	8, 9	2.60	2.65
S206	2¾	20	2¼	⅞	8, 9	2.45	2.50
S280	2¾	28	2¼	¾	9	3.15	3.20
S412	2½	410	Max	½	9	2.35	2.40
S413	3	410	Max	¾	9	2.75	2.80

BALLISTIC DATA FOR WEATHERBY MAGNUM CALIBERS

Bullets		Velocity				Foot-Pounds of Energy				Trajectory*		
Weight	Type	Muzzle	100 yds.	200 yds.	300 yds.	Muzzle	100 yds.	200 yds.	300 yds.	200 yds.	300 yds.	400 yds.
257 Weatherby Magnum: Price, $6.60												
87	SpP	3930	3575	3195	2850	2984	2471	1974	1569	0.5	2.9	6.5
100	SpP	3700	3400	3100	2810	3040	2562	2129	1753	0.7	3.3	7.5
117	RN	3320	2950	2675	2380	2858	2260	1867	1472	1.4	4.4	8.5
270 Weatherby Magnum: Price, $6.60												
100	SpP	3900	3545	3180	2820	3378	2794	2241	1766	0.8	2.7	6.5
130	SpP	3450	3185	2920	2680	3429	2931	2461	2075	1.0	3.6	7.1
150	RN	3240	2905	2590	2300	3489	2820	2234	1761	1.3	5.0	10.1
150	SpP	3240	3010	2800	2600	3489	3018	2612	2252	1.1	3.9	8.3
7mm Weatherby Magnum: Price, $6.60												
139	SpP	3465	3195	2930	2685	3709	3153	2649	2233	1.0	3.3	7.1
154	SpP	3260	3035	2820	2605	3627	3160	2720	2330	1.2	3.8	8.3
175	RN	3067	2790	2500	2270	3662	3024	2429	2002	1.4	5.0	11.5
300 Weatherby Magnum: Price, $7.70												
110	SpP	4050	3625	3230	2835	4007	3218	2543	1970	0.7	2.7	6.6
150	SpP	3630	3360	3095	2850	4389	3753	3193	2706	0.8	3.0	6.7
180	SpP	3350	3115	2895	2685	4477	3882	3361	2892	1.0	3.9	7.5
220	RN	3000	2740	2475	2230	4400	3667	3005	2429	1.5	4.9	11.5
375 Weatherby Magnum: Price, $8.80												
270	RN	2940	2680	2420	2175	5181	4309	3510	2835	1.9	5.5	11.1
300	RN	2800	2510	2270	2025	5223	4197	3432	2745	2.3	6.4	12.5
378 Weatherby Magnum: Price, $15.00												
270	RN	3212	2910	2650	2390	6201	5076	4209	3424	1.4	4.2	8.9
300	RN	3022	2725	2460	2200	6075	4965	4032	3222	1.5	4.7	11.0
460 Weatherby Magnum: Price, $17.50												
500	RN	2725	2480	2240	2025	8245	6830	5570	4550	2.0	7.0	13.3

*Mid-range, with telescope sights.
Bullets—SpP: Spire Point; RN: Round Nose. All cartridges 20 per box.

REMINGTON C.F. PISTOL AND REVOLVER CARTRIDGES—BALLISTICS AND PRICES

CARTRIDGE	BULLET Wt. Grs.	BULLET Style	Muzzle Velocity Feet per Second	Muzzle Energy Ft. Lbs.	Barrel Inches	PRICE Per 50
22 Jet	40	S.P.	2460	535	8⅜	$4.50
25 (6.35 mm.) Automatic	50	M.C.	810	73	2	4.20
30 (7.65 mm.) Luger	93	M.C.	1220	307	4½	5.75
30 (7.63 mm.) Mauser Automatic	85	M.C.	1410	375	5½	5.75
32 Short Colt	80	Lead	795	112	4	3.45
32 Long Colt	80	Lead	790	111	4	3.85
32 Colt New Police	100	Lead	785	137	4	3.85
32 (7.65 mm.) Automatic Pistol	71	M.C.	960	145	4	4.80
32 Smith & Wesson	88	Lead	705	97	3	3.65
32 Smith & Wesson Long	98	Lead	780	132	4	3.85
357 Magnum Hi-Speed	158	M.P.	1430	717	8⅜	6.20
357 Magnum Hi-Speed	158	Lead	1430	717	8⅜	5.45
9 mm. Luger	124	M.C.	1120	345	4	6.00
38 Smith & Wesson	146	Lead	730	173	4	4.50
38 Special	158	Lead	855	256	6	4.60
38 Special	200	Lead	730	236	6	4.80
38 Special	158	M.P.	855	256	6	5.70
38 Special Wad Cutter Targetmaster	148	Lead	770	195	6	4.80
38 Special Metal Penetrating Hi-Way Master	110	Special	1330	433	5	5.85
38 Special Hi-Speed	158	Lead	1085	413	5	5.10
38 Colt New Police	150	Lead	680	154	4	4.50
38 Short Colt	125	Lead	760	160	6	4.05
38 Long Colt	150	Lead	770	197	6	4.50
38 Super Automatic Hi-Speed	130	M.C.	1275	469	5	5.10
38 Automatic	130	M.C.	1040	312	4½	5.10
380 Automatic	95	M.C.	955	192	3¾	4.90
41 Long Colt	195	Lead	730	231	6	5.25
44 Smith & Wesson Special	246	Lead	755	311	6½	6.15
44 Remington Magnum Hi-Speed	240	Ld. G.C.	1470	1150	6½	8.10
44 Remington Magnum	240	S.P.	1470	1150	6½	8.35
45 Colt	250	Lead	855	405	5½	6.15
45 Automatic	230	M.C.	850	369	5	6.55
45 Automatic Wad Cutter Targetmaster	185	M.C.	775	245	5	6.80
45 Automatic Rim	230	Lead	805	331	5½	6.55

norma Ballistics

Index no.	Cartridge	Bullet Weight grs.	Velocity, feet per sec.				Energy, foot pounds				Max. height of trajectory, inches		
			V Muzzle	V 100 yds.	V 200 yds.	V 300 yds.	E Muzzle	E 100 yds.	E 200 yds.	E 300 yds.	Tr. 100 yds.	Tr. 200 yds.	Tr. 300 yds.
	.220 Swift												
1	Soft point pointed	50	4111	3611	3133	2681	1877	1448	1090	799	-.2	.9	3.0
2	Full jacket semi pointed	50	4111	3460	2850	2295	1877	1329	902	585	-.2	.9	3.7
	.222 Rem.												
3	Soft point pointed	50	3200	2660	2170	1750	1137	786	523	340	.0	2.0	6.2
4	Full jacket semi pointed	50	3200	2610	2080	1630	1137	756	480	295	.0	2.1	7.1
	.243 Win.												
5	Hollow point	75	3500	3070	2660	2290	2041	1570	1179	873	.0	1.4	4.1
151	Soft point pointed	100	3070	2790	2540	2320	2093	1729	1433	1195	.1	1.8	5.0
148	Full jacket semi pointed	100	3070	2790	2540	2320	2093	1729	1433	1195	.1	1.8	5.0
	.244 Rem.												
7	Hollow point	75	3500	3070	2660	2290	2041	1570	1179	873	.0	1.4	4.1
8	Soft point pointed	90	3200	2850	2530	2230	2047	1624	1279	994	.1	1.6	4.9
	.250 Savage												
9	Soft point pointed	87	3032	2685	2357	2054	1776	1393	1074	815	.0	1.9	5.8
10	Soft point pointed	100	2822	2514	2223	1956	1769	1404	1098	850	.1	2.2	6.6
101	Soft point pointed	120	2645	2405	2177	1964	1865	1542	1263	1028	.2	2.5	7.0
	.257 Roberts												
11	Soft point pointed	100	2900	2588	2291	2020	1868	1488	1166	906	.1	2.1	6.2
12	Soft point pointed	120	2645	2405	2177	1964	1865	1542	1263	1028	.2	2.5	7.0
	6,5 Jap.												
13	Soft point pointed boattail	139	2428	2280	2130	1990	1820	1605	1401	1223	.3	2.8	7.7
14	Soft point round nose	156	2067	1871	1692	1529	1481	1213	992	810	.6	4.4	11.9
	6,5 x 54 MS												
15	Soft point pointed	77	3117	2731	2369	2036	1662	1274	960	710	.0	1.9	5.6
16	Soft point pointed boattail	139	2580	2420	2270	2120	2056	1808	1591	1388	.2	2.4	6.5
163	Full jacket boattail	139	2580	2420	2270	2120	2056	1808	1591	1388	.2	2.4	6.5
17	Soft point round nose	156	2461	2240	2033	1840	2098	1738	1432	1173	.3	3.0	8.2
164	Full jacket round nose	156	2461	2240	2033	1840	2098	1738	1432	1173	.3	3.0	8.2
	6,5 x 55												
105	Soft point pointed	77	3120	2730	2370	2040	1664	1275	961	712	.0	1.9	5.6
19	Full jacket pointed	93	3150	2705	2292	1920	2050	1512	1085	762	.0	1.9	6.0
20	Soft point pointed boattail	139	2789	2630	2470	2320	2402	2136	1883	1662	.1	2.0	5.6
21	Full jacket boattail	139	2789	2630	2470	2320	2402	2136	1883	1662	.1	2.0	5.6
22	Soft point round nose	156	2493	2271	2062	1867	2153	1787	1473	1208	.3	2.9	7.9
23	Full jacket round nose	156	2493	2271	2062	1867	2153	1787	1473	1208	.3	2.9	7.9
	.270 Win.												
24	Soft point pointed	110	3248	2966	2694	2435	2578	2150	1773	1448	.1	1.4	4.3
25	Soft point pointed boattail	130	3140	2884	2639	2404	2847	2401	2011	1669	.0	1.6	4.7
26	Hollow point boattail	130	3140	2860	2593	2338	2847	2362	1941	1578	.0	1.6	4.8
27	Full jacket boattail	130	3140	2944	2753	2568	2847	2502	2188	1904	.0	1.4	4.3
28	Soft point pointed boattail	150	2802	2616	2436	2262	2616	2280	1977	1705	.1	2.0	5.7
161	Full jacket pointed	150	2802	2616	2436	2262	2616	2280	1977	1705	.1	2.0	5.7

6,5 x 55

norma —Continued

Index no.	Cartridge	Bullet Weight grs.	Velocity, feet per sec. V Muzzle	V 100 yds.	V 200 yds.	V 300 yds.	Energy, foot pounds E Muzzle	E 100 yds.	E 200 yds.	E 300 yds.	Max. height of trajectory, inches Tr. 100 yds.	Tr. 200 yds.	Tr. 300 yds.
	7 x 57												
29	Soft point pointed	110	3068	2792	2528	2277	2300	1904	1561	1267	.0	1.6	5.0
30	Soft point pointed boattail	150	2756	2539	2331	2133	2530	2148	1810	1516	.1	2.2	6.2
31	Full jacket boattail	150	2756	2539	2331	2133	2530	2148	1810	1516	.1	2.2	6.2
32	Soft point round nose	175	2490	2170	1900	1680	2410	1830	1403	1097	.4	3.3	9.0
	7 x 61 S & H (26 in.)												
33	Soft point pointed boattail	160	3100	2927	2757	2595	3415	3045	2701	2393	.0	1.5	4.3
	.30 US Carb.												
35	Soft point round nose	110	1970	1595	1300	1090	948	622	413	290	.8	6.4	19.0
34	Full jacket round nose	110	1970	1595	1300	1090	948	622	413	290	.8	6.4	19.0
	.30 - 30 Win.												
37	Soft point flat nose	170	2220	1890	1630	1410	1861	1349	1003	750	.7	4.1	11.9
	.308 Win.												
143	Soft point pointed boattail	130	2900	2590	2300	2030	2428	1937	1527	1190	.1	2.1	6.2
38	Soft point pointed boattail	150	2860	2570	2300	2050	2725	2200	1762	1400	.1	2.0	5.9
39	Soft point pointed boattail	180	2610	2400	2210	2020	2725	2303	1952	1631	.2	2.5	6.6
	.308 Norma Magnum												
179	Norma "Dual Core"	180	3100	2881	2668	2464	3842	3318	2846	2427	.0	1.6	4.6
	.30 - 06												
40	Soft point pointed boattail	130	3281	2951	2636	2338	3108	2514	2006	1578	.1	1.5	4.6
42	Full jacket boattail	130	3281	2951	2636	2338	3108	2514	2006	1578	.1	1.5	4.6
43	Soft point pointed boattail	150	2972	2680	2402	2141	2943	2393	1922	1527	.0	1.9	5.7
44	Full jacket boattail	150	2972	2680	2402	2141	2943	2393	1922	1527	.0	1.9	5.7
45	Soft point pointed boattail	180	2700	2494	2296	2109	2914	2487	2107	1778	.1	2.3	6.4
46	Hollow point boattail	180	2700	2494	2296	2109	2914	2487	2107	1778	.1	2.3	6.4
47	Full jacket boattail	180	2700	2530	2365	2206	2914	2559	2236	1944	.1	2.2	6.1
48	Soft point round nose	220	2411	2197	1996	1809	2840	2358	1947	1599	.3	3.1	8.5
49	Full jacket round nose	220	2411	2197	1996	1809	2840	2358	1947	1599	.3	3.1	8.5
	.300 H & H												
50	Soft point pointed boattail	180	2920	2706	2500	2297	3409	2927	2499	2109	.0	1.9	5.3
51	Hollow point boattail	180	2920	2704	2500	2297	3409	2927	2499	2109	.0	1.9	5.3
53	Soft point round nose	220	2625	2400	2170	1986	3367	2814	2301	1927	.2	2.5	7.0
54	Full jacket round boattail	220	2625	2400	2170	1986	3367	2814	2301	1927	.2	2.5	7.0
	7.65 Argentine												
187	Soft point pointed	150	2920	2630	2355	2105	2841	2304	1843	1476	.1	2.0	5.8
	.303 Brit.												
55	Soft point pointed	130	2789	2483	2195	1929	2246	1780	1391	1075	.1	2.3	6.7
147	Soft point pointed	150	2720	2440	2170	1930	2465	1983	1569	1241	.1	2.2	6.5
56	Soft point pointed boattail	180	2540	2340	2147	1965	2579	2189	1843	1544	.2	2.7	7.3
57	Soft point round nose	215	2182	1947	1733	1541	2273	1810	1434	1134	.5	4.1	11.2
	7,7 Jap.												
110	Soft point pointed	130	2950	2635	2340	2065	2513	2004	1581	1231	.1	2.0	5.9
58	Soft point pointed boattail	180	2493	2292	2101	1922	2484	2100	1765	1477	.3	2.3	7.7
59	Soft point round nose	215	2264	2023	1802	1603	2448	1954	1550	1227	.5	3.3	10.4
	8 x 57 JR												
61	Soft point round nose	196	2362	2045	1761	1513	2428	1820	1530	996	.4	3.7	10.6
	8 x 57 JRS												
62	Soft point round nose	196	2395	2074	1795	1535	2497	1873	1402	1026	.4	3.5	10.3
	8 x 57 J												
112	Soft point round nose	159	2723	2362	2030	1734	2618	1970	1455	1052	.2	2.6	7.9
113	Full jacket round nose	159	2723	2362	2030	1734	2618	1970	1455	1052	.2	2.6	7.9
60	Soft point round nose	196	2526	2195	1894	1627	2778	2097	1562	1152	.3	3.1	9.1
114	Full jacket round nose	196	2526	2195	1894	1627	2778	2097	1562	1152	.3	3.1	9.1
	8 x 57 JS												
63	Soft point pointed	123	2887	2515	2170	1857	2277	1728	1286	942	.1	2.3	6.8
64	Soft point round nose	159	2723	2362	2030	1734	2618	1970	1455	1062	.2	2.5	7.9
65	Soft point round nose	196	2526	2195	1894	1627	2778	2097	1562	1152	.3	3.1	9.1
67	Hollow point boattail	198	2625	2416	2216	2028	3031	2567	2160	1808	.2	2.5	6.9
68	Full jacket boattail	198	2625	2456	2294	2139	3031	2653	2314	2012	.2	2.4	6.5
69	Soft point round nose	227	2330	2085	1855	1650	2737	2192	1735	1373	.4	3.4	9.5
	.358 Win.												
71	Soft point semi pointed	200	2530	2210	1910	1640	2843	2170	1621	1195	.4	3.1	8.8
72	Soft point semi pointed	250	2250	2010	1780	1570	2811	2243	1759	1369	.6	3.9	10.4
	.358 NORMA MAGNUM												
152	Soft point semi pointed	250	2790	2493	2231	2001	4322	3451	2764	2223	.2	2.4	6.6
	9,3 x 57												
73	Hollow point boattail	232	2329	2032	1763	1527	2795	2127	1602	1202	.4	3.7	10.6
74	Soft point round nose	286	2067	1818	1595	1404	2714	2099	1616	1252	.6	4.8	13.2
	9,3 x 62												
75	Hollow point boattail	232	2625	2304	2009	1742	3551	2735	2080	1564	.2	2.8	8.1
76	Full jacket pointed	232	2625	2350	2092	1855	3551	2846	2255	1773	.2	2.7	7.6
77	Soft point round nose	286	2362	2088	1837	1612	3544	2769	2144	1651	.4	3.5	9.8
78	Full jacket round nose	286	2362	2088	1837	1612	3544	2769	2144	1651	.4	3.5	9.8
	9,3 x 74 R												
80	Hollow point boattail	232	2625	2304	2009	1742	3551	2735	2080	1554	.2	2.8	8.1
81	Full jacket pointed	232	2625	2350	2092	1855	3551	2846	2255	1773	.2	2.7	7.6
82	Soft point round nose	286	2362	2088	1837	1612	3544	2769	2144	1651	.4	3.5	9.8
83	Full jacket round nose	286	2362	2088	1837	1612	3544	2769	2144	1651	.4	3.5	9.8
	.375 H & H												
84	Soft point semi pointed	270	2740	2460	2210	1990	4502	3629	2929	2375	.2	2.4	6.5
85	Soft point semi pointed	300	2550	2280	2040	1830	4333	3464	2773	2231	.3	2.8	7.6

.308 Norma Magnum

.358 Norma Magnum

Trajectory is given in relation to line of sight 1" above center of bore at muzzle.

Exterior Ballistic Data for British Centerfire Rifle Cartridges

Cartridge	Case length inches	Bullet weight (grs.)	Powder weight (grs.)	Velocity (ft./sec.)			Energy (ft./lb.)			Drop (in.)†	
				Muzzle	100 yd.	200 yd.	Muzzle	100 yd.	200 yd.	100 yd.	200 yd.
*297/230 (Morris) Short	9/16	37L	1¼ RN	875	720		63	43		15.0	
*297/230 (Morris) Long	⅞	37L	2¾ CN	1200	920	760	120	70	48	15.0	71.0
*p240 H&H Apex Flanged	2½	100CP	38½ NC	2800	2570	2355	1740	1470	1230	2.3	10.0
240 Belted Rimless	2½	100CP	40½ NC	2900	2665	2445	1870	1580	1330	2.2	9.2
*242 Rimless Nitro Exp.	2⅜	100CP	42 NC	3000	2740	2490	1970	1635	1355	2.0	8.6
244 H&H Magnum (Belted)	2¾	100CP		3500	3230	2970	2725	2320	1980	1.6	5.1
297/250 Rook Rifle	13/16	56L	3 CN	1150	940	805	165	110	80	15.5	70.0
256 (6.5mm) Mannlicher	2⅛	160SN	36 NC	2350	2045	1765	1960	1490	1110	3.4	15.5
6.5mm Mann.-Schon.	2⅛	160SN	36 NC	2300	2000	1725	1880	1420	1060	3.6	16.0
275 H&H Magnum (Belted)	2½	160CP	52 NC	2700	2505	2320	2600	2230	1920	2.5	10.5
275 High Velocity (7mm)	2¼	140CP	48 NC	2900	2705	2515	2620	2280	1970	2.2	9.0
276 (7mm) Mauser	2¼	173SN	38 NC	2300	2015	1765	2040	1560	1200	3.9	16.0
p7mm H&H Magnum Flanged	2½	140CP		2650	2450		2184	1867			
*280 Flanged Nitro Exp.	2⅝	140CP	52 NC	2800	2570	2355	2440	2060	1730	2.3	10.0
*280 Flanged Nitro Exp.	2⅝	160HP	52 NC	2600	2300	2020	2400	1880	1450	2.8	12.0
280 Ross Rimless Nitro	2⅝	140CP	54 NC	2900	2665	2445	2620	2210	1860	2.2	9.0
280 Ross Rimless Nitro		160HP	54 NC	2700	2395	2110	2600	2040	1580	2.6	11.5
*280 Jeffery Rimless	2½	140CP	57 NC	3000	2870	2735	2800	2555	2390	2.1	10.0
300 (.295) Rook Rifle	1⅛	80L	4½ CN	1100	915	785	215	150	110	16.5	75.0
300 Sherwood	1½	140L	8½ CN	1400	1195	1060	610	445	350	9.9	44.0
300 H&H Magnum Belted	2⅞	150SN	58 C	3000	2660	2350	3000	2360	1835	2.2	9.8
or (30 Super Magnum)		180SN	55 C	2750	2430	2130	3020	2360	1815	2.8	12.5
or (30 Super Magnum)		220SN	49 C	2300	2045	1810	2115	1675	1305	3.9	17.0
p30 Super Flanged H&H	2⅞	150SN	55 C	2875	2581		2755	2225			
p30 Super Flanged H&H		180SN	50 C	2575	2309		2653	2131			
p30 Super Flanged H&H		220SN	46 C	2250	2045		2475	2045			
*30 Purdey Flanged Nitro	2⅝	150SN		2700	2385	2090	2430	1900	1460	2.6	11.5
303 British (Mark 6)	2⅛	215S	31 C	2050	1855	1670	2010	1650	1330	4.4	19.0
303 British (Mark 7)	2⅛	174S	37 C	2450	2250	2055	2320	1960	1640	3.0	13.0
303 British	2⅛	150CP	38 C	2700	2465	2240	2440	2030	1680	2.5	11.0
303 British	2⅛	174SN	41 NC	2450	2195	1955	2315	1870	1480	3.1	13.5
303 British	2⅛	215SN	31 C	2050	1790	1555	2010	1530	1160	4.6	20.0
310 Cadet	1⅛	120L	6 CN	1200	1010	890	385	270	210	14.0	62.0
318 Rimless Nitro Exp.	2⅜	180CP	55 NC	2700	2395	2110	2920	2300	1780	2.6	11.5
318 Rimless Nitro Exp.		250SN	52 NC	2400	2040	1715	3200	2320	1640	3.3	15.0
333 Rimless Nitro Exp.	2⅜	300SN	65 NC	2200	1950	1720	3230	2540	1980	3.9	17.0
*400/350 Nitro Exp.	2¾	310SN	43 NC	2000	1795	1610	2760	2220	1790	4.7	20.0
350 Rigby Magnum Rimless	2¾	225SN	65 NC	2625	2307		3440	2657			
350 No. 2 Rigby Flanged	2¾	225SN		2600			3400				
*360 Nitro Exp. Flanged	2¼	300SN	30 C	1650	1490	1355	1820	1480	1210	6.9	29.0
*360 Nitro for Black Powd.	2¼	190CT	22 C	1650	1285	1070	1150	700	485	7.6	36.0
o400/360 Purdey Flanged	2¾	300SN	40 C	1950	1776		2537	2102			
o400/360 Westley Richards	2¾	314SN	41 C	1900	1724		2520	2072			
o360 No. 2 Nitro Exp.	3	320SN	55 C	2200	1999		3442	2845			
*369 Purdey Nitro Exp.	2⅝	270SN	64½ NC	2500	2135	1800	3760	2740	1950	3.1	14.0
375 Flanged Nitro Exp.	2½	270SN	40 C	2000	1735	1405	2400	1810	1190	4.9	22.0
o375 Rimless W.R. Nitro	2¼	270SN	43 C	2100	1870		2640	2100			
375 Flanged Magnum Nitro	2½	270SN	59 C	2600	2280	1980	4060	3120	2360	2.8	12.5
375 Flanged Magnum Nitro		300SN	56 C	2400	2105	1825	3850	2960	2220	3.3	14.5
375 Belted H&H Magnum	2⅞	235CP	62 C	2800	2495	2215	4100	3260	2560	2.4	10.5
375 Belted H&H Magnum		270SN	61 C	2650	2325	2020	4220	3250	2450	2.9	12.0
375 Belted H&H Magnum		300SN	58 C	2500	2200	1915	4170	3230	2450	3.0	13.5
450/400 Nitro Exp.	3	400SN	60 C	2100	1845	1610	3920	3030	2310	4.3	19.0
450/400 Magnum Nitro Exp.	3¼	400SN	60 C	2150	1890	1650	4110	3180	2420	4.1	18.0
404 Jeffery Rimless	2⅞	400SN	60 C	2125	1885	1670	4020	3160	2480	4.2	18.0
p416 Rigby Magnum	2⅞	410SN	71 C	2371	2110		5100				
p425 Westley Richards	2⅝	410SN		2350			5010				
450 Nitro Exp.	3¼	480SN	70 C	2150	1900	1665	4930	3860	2960	4.1	18.0
*500/450 Magnum Nitro Exp.	3¼	480SN	75 C	2175	1987		5050	4220			
*450 No. 2 Nitro Exp.	3½	480SN	80 C	2175	1904		5050	3900			
o450 Black Powder Exp.	3¼	310L	120Blk	1800	1510		2240	1570			
o450 Nitro for B.P. Exp.	3¼	365CT	52 C	2100	1809		3578	2655			
577/450 Martini-Henry	2⅜	480L	38½ C	1350	1210	1110	1950	1560	1320	10.0	44.0
577/450 Martini-Henry B.P.	2⅜	480L	85 Blk	1350	1210	1110	1950	1560	1320	10.0	44.0
465 H&H Nitro Exp.	3¼	480SN	73 C	2150	1830	1620	4930	3580	2800	4.1	18.5
470 Nitro Exp.	3¼	500SN	75 C	2150	1890	1650	5140	3980	3030	4.1	18.0
*475 Nitro Exp.	3¼	480SN	75 C	2175	2000	1830	5040	4260	3580	4.2	18.0
r475 No. 2 Nitro Exp.	3½	480SN	85 C	2200	1925	1680	5170	3960	3020	3.9	17.0
*475 No. 2 Jeffery	3½	500SN	85 C	2150	1880	1635	5140	3930	2970	4.1	18.0
*476 Nitro Exp.	3	520SN	75 C	2100	1925	1760	5085	4295	3585	4.6	20.0
500 Nitro Exp.	3	570SN	80 C	2150	1890	1650	5850	4530	3450	4.1	18.0
*500 Nitro for B.P. Exp.	3	440CT	55 C	1900	1570	1290	3530	2410	1630	5.5	25.0
o500 Black Powder Exp.	3	340CT	136 Blk	1925	1585		2800	1900			
p500 Jeffery Rimless		535SN	95 C	2400			6800				
p505 Gibbs Rimless Magnum		525SN	90 C	2300			6180				
577 Solid Snider	1¾	480L	70 Blk	1250	1055	940	1670	1190	940	13.0	57.0
r577 Nitro Exp.	3	750SN	100 C	2050	1795	1570	7010	5380	4110	4.5	20.0
o600 Nitro Exp.	3	900S	110 C	1950	1650	1390	7600	5450	3870	5.1	23.0

ABBREVIATIONS

† — Drop is computed from horizontal line of departure for the bullet.
* — Available while stocks last; will then become obsolete.
o — Obsolete; no longer available.
r — Re-introduced and again available.
p — Proprietary Cartridge; available only from specific maker.

SN — Soft Nose
CP — Copper Point
CT — Copper Tube
L — Lead
HP — Hollow Point
S — Solid (Jacketed)

BP or Blk — Black Powder
C — Cordite
NC — Nitro-Cellulose
CN — Cadet Neonite
RN — Revolver Neonite

Mr. CORNWELL. In addition to the characteristics of the form which you have just described as indicating that the weapon fired a supersonic bullet, was there anything else about the waveforms that you discovered in your analysis?

Mr. WEISS. Yes; there are perhaps two things that are relevant to confirming that what we are dealing with here is not noise but is in fact a sound recording of a bullet, of a gunshot by equipment such as was used by the Dallas police motorcycle men. First and simplest is the following: that if, in fact, this was—no, let me put it differently.

You can in, as part of the prediction, you can determine what the general pattern of the shape will be at the microphone as you receive it. Now, for example, if at the microphone, as you receive it, you expect that—well, let me go back to the blackboard here, if I may.

Now if the muzzle blast came in looking something like this, it goes up, it goes down, and then it sort of settles back, then from some of these surfaces you can quite accurately predict that it will do exactly the same sort of thing, let us say that the echo shape will be simply a mirror image replica of the muzzle blast.

Now if this is noise, then there is nothing which says that it has to start out going positive. It could equally, let us say, going upwards, the sound could equally, with equal probability, start out going this way and come back this way. But in every one of these instances where we identified an echo as coming back from a flat reflecting surface, it has precisely the correct replication quality when compared to the pattern of the muzzle blast.

As I say, for noise, you have no right to expect that sort of thing will happen. It is like saying I have a coin which is going to flip once, and the first time it comes up heads, and thereafter every time it is going to come up heads. It doesn't happen that way.

The second thing is, if you look at these patterns in somewhat more expanded detail than perhaps is visible here, you will see in the case of the muzzle blast there is a very sharp, short, initial, positive, upward going spike or peak, then it goes strongly down, and then it comes up again, and so on.

Now, in fact, as recorded through a high-fidelity system and an open microphone, it really does this, it is very sharply upward first, then it goes down and so on.

Well, something must have happened to this upward, strong one to make it seem much smaller. It now is just a little bitty one over here. It goes down, and now it comes up afterwards, and does that sort of thing. And we considered why that is so, and thought that it is probable that if this is a microphone on the motorcycle, and the motorcycle, in fact, is over here in Dealey Plaza, facing in this direction, and if there is a rifle over here, that the windshield of the motorcycle is sort of between the sound that comes directly at it from the muzzle blast and the microphone, so the windshield is screening the microphone to some degree.

Well, the effect of that can be predicted. But to confirm our understanding of this, we arranged with the New York City Police Department to perform some experiments at their shooting range in the Bronx. We went out there, and they trotted out an old Harley-Davidson motorcycle and put a transmitter on it, vintage

1963 or 1964, and an old microphone pretty much the same kind as was used by the Dallas Police Department, and we performed some experiments with people firing rifles at various locations, sometimes with the motorcycle facing the shooter, sometimes with the motorcycle crosswise to the shooter. At the same time we made recordings using high fidelity equipment of the sounds of the shots.

Now there were two kinds of recordings made. The first, as I say, was high fidelity equipment, good microphone, good recorder on the spot. The second was through the microphone which was on the motorbike, which was a microphone of the type used in Dallas, through the transmitter, and recorded downtown at the police communications laboratory. And we compared the results of these two recordings, and what we found was exactly what we had thought we would find, that is, that in the case of the high fidelity recording, we got that kind of big, first spike upward and downward, and so on. In the case of the recording made through the police microphone, that first spike was greatly attenuated and it went negative and came back up and so on. This was true, however, only in the case where the motorcycle was facing the rifle. When the motorcycle was crosswise to the rifle, the recording made by the police microphone fairly closely matched, looks, looked pretty much like, with some distortions, but looked pretty much like the recording made using the high fidelity equipment. So it was essentially confirmed that the windshield really does have this effect on reducing the strength of that initial, very sharp spike received, and, of course, this is what we have over here. It is consistent with the assumption that this is a microphone behind the windshield facing a rifle.

Mr. CORNWELL. Thank you, I have no further questions.

Chairman STOKES. Professor, you may resume your seat at the witness table.

The committee will now operate under the 5-minute rule.

Professor Weiss, I guess I am sort of reminded this morning of how, some months ago, when several members of this committee and I appeared before the House Administration Committee, which is the committee of the Congress that recommends funding for all of the committees in Congress, and one of the distinguished members of the committee posed the question to me, he said, "Stokes, has your investigation revealed anything that would change the course of history?" And I said to that Member of Congress that nothing that we had uncovered thus far would, in my opinion, change the course of history.

I am sure that as a scientist that you are aware of the enormous impact that your testimony has here today, because if the committee accepts your testimony, the committee then, in effect, accepts the fact that on that particular day in 1963 when the President was assassinated, there were two shooters in Dealey Plaza.

From that premise, one can further assume association, and then from association there can be the further legal asssumption, the possibility of a conspiracy. So I am sure that you are aware of the enormous impact of your testimony here today in terms of history.

Mr. WEISS. I am, sir; yes, sir.

Chairman STOKES. For that reason, I would assume that you realize that for many years to come your work will be scrutinized extremely carefully by persons who are interested in this fascinating aspect of evidentiary material.

I would, therefore, at this point ask you the question I asked you in executive session. I would ask you to play the devil's advocate for us for a moment. Obviously there are other scientists in your field, men who are, or women perhaps, who are as eminently qualified as you and your associate are.

Would you, for this committee, then tell us what type of criticisms could other members of your field have of your work here?

Mr. WEISS. Well, a few things. I would, of course, assume that other researchers would read our written report before volunteering criticisms of what we have presented here today. But if I were a critic of this work, I would look to see if, in fact, it left out of these considerations any important parameters of the situation that existed in Dealey Plaza on November 22, 1963, that could affect the predicted positions of echoes, as I have done.

Now, when we did this work, we tried very hard to take into account every possible thing that might affect the accuracy of our predictions. We took into account, for example, the fact that the map itself is probably accurate to only about 1 foot, so we knew that there was no point in attempting to push for accuracies greater than that quoted, approximately 1 millisecond.

We took into account the temperature as given to us by staff members of this committee. We investigated the question, the fact of whether humidity might have any affect on the velocity of sound. We considered the question of whether there had been any significant changes in the architecture in Dealey Plaza area for those structures that could have given rise to echoes. We considered the question of waveshape, and of distortion of microphone, and of the transmitter, and tried to take into account additional distortions that probably would have been produced by the receiver and the Dictabelt recorder.

Now, if there is any weakness in the results of our analysis, it has to be in some consideration that has escaped us entirely, and that, contrary to anything I can imagine, would have significant impact on the measurements we have made.

We, in fact, in performing this work, made every single measurement there many times, each of us made the measurements on the map, checked the results of the other fellow's measurement, checked the calculations out many times, and just to be sure that there were no errors that had crept in and then propagated through this analysis. Otherwise, I really cannot see a basis for finding significant fault with the acoustical analysis as described.

Chairman STOKES. Then as a scientist, you are comfortable with the statement to this committee that beyond a reasonable doubt, and to a degree of 95 percent or better, there were four shots in Dealey Plaza?

Mr. WEISS. Well, I would agree with that, with the somewhat clarification, that since our work concentrated primarily on the third shot, the one from the grassy knoll area, I would imply for the moment, limit the statement to that, with a, again, a confidence level of 95 percent or higher, which I guess if I were a lawyer, I might well express as beyond a reasonable doubt, that shot took place. And then relying upon the corresponding confidence expressed by Dr. Barger about the other shots, I would agree with the statement that there is an overall probability of 95 percent or better that there were four shots fired in Dealey Plaza.

Chairman STOKES. Let me ask you this. This is 1978, this tape existed in 1963. Had this tape been given, let's say, to you or other scientists who specialized in this particular area, have you done anything new that could not have been done in 1963 with this tape?

Mr. WEISS. No, sir; the only thing that is new—this is an old technology that we are dealing with—the application is new, insofar as the use of the physics and science of acoustics for predicting the position of a microphone and/or a gun. I believe that the first application of it was only several years ago, and by Dr. Barger, in the case of the Kent State shootings. But other than that, there is nothing new in this at all.

Chairman STOKES. I recall at the executive session, I believe Professor Blakey asked you, for purposes of clarifying it for the committee, whether what you were basically using was high school physics and geometry principles, and that basically that is what you have done here.

Mr. WEISS. That is correct, sir.

Chairman STOKES. Now, what about the work of Dr. Barger? When Dr. Barger testified before our committee on September 11, based upon the work that he had done, he said to us at that time that there were definitely three shots, but would not commit himself to more than a possibility of a fourth shot. And, of course, we have now heard Dr. Barger's testimony in executive session, and we will hear it here later today.

Tell the committee whether or not, if he has now changed his opinion to agree with yours, whether such a conservative estimate on his part at that time and his unwillingness to say that, in fact, there was beyond a reasonable doubt a fourth shot, is the proper type of analysis that a scientist should have made at that time, prior to additional work being performed on his work.

Mr. WEISS. Yes, sir; Dr. Barger's analysis was exactly right, as a matter of fact. The difference between his analysis and ours, which is, in fact, might be considered to be a kind of extension by analysis, by mathematical analysis, of what he had done, or a refinement, if you will, of what he did, is the following: that in our matching of the pattern, by being able to predict precisely for a precise location of a microphone in the plaza what the echo pattern would have been, I was able to use an uncertainty window of about plus or minus 1/1,000 of a second at each of the echo points that I had predicted when I made the comparison to the peaks on the waveform of the Dallas Police tape recording.

Now, in Dr. Barger's work, because his data were based on an array of microphones that were strung out in Dealey Plaza, microphones spaced, as I recall, 18 feet apart, he could not be sure where the presumed motorcycle microphone was in relationship to any one of those microphones, so he had to use an uncertainty window which was wider. The microphone on the motorcycle, for example, could have been halfway between two of his microphones, or closer to one, or closer to another.

Because he could not know precisely where it was, he had to use a window which was about plus or minus 6 milliseconds wide, total width of about 12 milliseconds, compared to a total width here of about 2.

Now, that difference is very significant in the, insofar as it affects the degree of confidence that you can express in whether or not the patterns that is observed there that matches a prediction or an observed set of data is, in fact, perhaps noise and not meaningful data.

And his number is a very reasonable one. Fifty percent is what I, myself, would have quoted under those circumstances.

Chairman STOKES. Thank you, Professor.

My time has expired.

The gentleman from North Carolina, Mr. Preyer.

Mr. PREYER. Thank you, Mr. Chairman.

Thank you, Dr. Weiss. I think that many of us who aren't scientists, when we first heard of the acoustics test, tended to think of it as some sort of arcane science, perhaps like a polygraph test, which my former colleague, Senator Erwin, once called modern witchcraft. But I gather you are telling us that this is not like a polygraph test or modern, electronic witchcraft. It doesn't involve any subjective judgment; it is based on everlasting and relative simple mathematical principles.

It was interesting to me to see you use pen and string and thread, that you can physically maneuver and physically see until you come out with the kind of match which would not happen in the nature of things otherwise.

Mr. WEISS. That is correct. The differentiation is even greater than a matter of interpretation, as one would have to do in case of polygraph. You have to recall that polygraphs and other such devices are based on assumed physiological responses of the human being to some set of conditions or stimuli.

This has nothing to do with human responses or to interpretation, which may vary from one observer of results of a test to another observer. This is simple, pure, basic physics and geometry.

Mr. PREYER. I might say, the committee's experience with polygraphs, our expert panel, looking at various polygraphs that Jack Ruby, James Earl Ray, Nosenko and others have taken, hasn't been very encouraging as to the scientific accuracy of it; but it does seem to me that you pointed out this is quite a different situation.

We all know as human beings that sound plays tricks on our ears when we hear it. We had Dr. Green, a professor at MIT, a psychoacoustics expert, testify in connection with the witnesses that Professor Blakey mentioned earlier who testified as to where the sound came from, and he pointed out that the shockwave of a bullet causes a confusion of the direction of the sound, and it would make a spectator point to the direction from which the sound came that was actually being perpendicular from the area in which the sound came.

While I am sure your kind of equipment doesn't play the sort of tricks that sound plays on the human ear, a layman like me would wonder if other sounds had played tricks.

For example, what is the possibility of the backfire on a motorcycle making this sort of waves and spikes?

Mr. WEISS. Well, the answer to that question is, first, I haven't had the opportunity to examine the waveshape of a backfire of a motorcycle, so I cannot say absolutely that this might not resemble it in some way, but if there was a motorcycle backfiring in this instance, that motorcycle was up there behind the stockade fence in Dealey Plaza.

Mr. PREYER. You mentioned—and we will all be looking for possible flaws in your analysis in view of the importance of it, as Chairman Stokes pointed out—you mentioned that you excluded in your calculations anything at the noise level, and you matched peaks above the noise levels. You then said something like there are 10 such peaks, and I understood you to say there should have been 12. What was the meaning of that?

Mr. WEISS. Well, in fact, there are those 12 that were predicted, are actually there. Just two of them, for reasons that I am not sure of, came in somewhat smaller than I expected them to be, and indeed fell below the noise level. Because they fell below the noise level, although I was confident that I had actually confirmed their identification, I did not include them in the correlation equation. Had I done so, it would only have strengthened the equation, and quite significantly strengthened it. But in order to be conservative in this calculation, I had to simply reject them from consideration. In fact, in the act of rejecting them I simply—in computing the equation, the fact that I expected 12 but found only 10—I actually weakened the correlation.

Mr. PREYER. So you did not exclude two, which did not confirm your analysis?

Mr. WEISS. No, sir.

Mr. PREYER. But you had two which would have further corroborated——

Mr. WEISS. That is correct.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Ohio, Mr. Devine.

Mr. DEVINE. Thank you, Mr. Chairman.

Dr. Weiss, we appreciate your contribution to the record now in public session.

Do you consider your profession pretty much of an exact science?

Mr. WEISS. Yes, sir.

Mr. DEVINE. Much more so, I take it, than you feel in the polygraph field, because the human factor is not as prevalent?

Mr. WEISS. That is correct.

Mr. DEVINE. Do you consider Dr. James Barger an expert?

Mr. WEISS. Yes, sir, I do.

Mr. DEVINE. And do you respect his opinion very much?

Mr. WEISS. I do.

Mr. DEVINE. Do you think that he made an incomplete study, inasmuch as his conclusions, when he testified here, I think on September 11, suggested that there was about a 50-50 chance that a shot was fired from the grassy knoll?

Mr. WEISS. No, sir. That study, as it was being performed, was moving exactly along the path that any study of this sort ought to move.

Mr. DEVINE. Yet you saw fit to supplement his study by a number of things—and I have outlined them here—by seeking to determine where the source of the sounds were, where reflection surfaces were, where the motorcycle was—you assumed it was in the neighborhood of the strongest impulses from the grassy knoll—the velocity of sound at the temperture given on November 22, 1963, as well as the time intervals and the echoes.

Now did Dr. Barger fail to take these important things into consideration in his study, or are these things that you found necessary in order to arrive at a different conclusion?

Mr. WEISS. No; as a matter of fact, Dr. Barger actually intrinsically used all of his information in his study and, in fact, it really was as a result of his study that we were able in the first place to say that the motorcycle was there in Dealey Plaza. It was because of his study that we were able to say that at the time of shot No. 3 it was, in fact, in the vicinity of the microphone No. 4 position in the array when the experiment was performed in Dealey Plaza.

All of the things that Dr. Barger did were natural steps along this kind of investigation. I am sure that had it been continued, or had there been more time available to Dr. Barger, this further result would have been the natural evolution of that process.

Mr. DEVINE. Thank you.

Going into a different direction, I assume you were not present when Dr. Barger testified on the previous occasion; however, if I am not mistaken, at that time they played a recording of the sounds, and I think, inferentially, although you suggested that all of these tests may have been available to the Warren Commission had they sought them, that under the more sophisticated electronic sound selection, to use an expression, that you are able to pretty well remove the motorcycle noise, remove the street noise and still have the blips left on the tape.

As I recall, when those tapes were played before this committee, one, two and four sounded quite alike, but the third blip, which from your testimony would suggest the one from the grassy knoll, was of a different sound, at least to a layman's ear. You have probably heard those statements since that time.

Have you come to any conclusions that the sounds were identical or that there was a difference?

Mr. WEISS. No. As a matter of fact, I did not hear that tape.

Mr. DEVINE. You did not hear it?

Mr. WEISS. No, sir.

Mr. DEVINE. Do you have an opinion as to whether, if in fact there was a shot from the grassy knoll, whether it hit anything in the motorcade?

Mr. WEISS. I have no way of knowing that, sir. There is no way of predicting or determining that from the data that are available.

Mr. DEVINE. Did you not try to coordinate the tapes with the Zapruder films and come to conclusions?

Mr. WEISS. Well, we had tried some matching, but now we are sort of out of the area of pure acoustics and getting into other areas, and there are various matters that in fact can be raised, but since that is not an area of my expertise, I really would rather not comment on that.

Mr. DEVINE. Thank you very much.

You, of course, understand the very difficult position that this committee finds itself in. I think it was pretty well put in an editorial by a local paper here, how much weight in an evidentiary study, whether by a court or a congressional committee, should be assigned to an arcane science understood only by the same experts who draw the conclusions?

Mr. WEISS. Well, I beg to disagree with the phrasing, as elegant as it is. This is not an arcane science insofar as it is taught in high school and college level physics, to begin with, and it can be explained and demonstrated in the manner in which I attempted to, and I think can be understood by anybody who has ever heard an echo.

Mr. DEVINE. Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from the District of Columbia, Mr. Fauntroy.

Mr. FAUNTROY. Thank you, Mr. Chairman.

Mr. Weiss, you have cleared up for us the question as to whether you employed the marvels and refinements of computerized electronics to reach your conclusion about the 95 percent chance of a shot from the grassy knoll. You have also dealt with noises which are indistinguishable to the unaided ear. And is it your testimony that the shots that you have distinguished were not backfires?

Mr. WEISS. Not exactly so, sir. In the case of shot No. 3, since there is evidence of a shockwave preceding the muzzle blast, then it would have to be concluded that this was not a backfire, since backfires are not known to produce shockwave sounds.

Mr. FAUNTROY. Then your answer is yes, that the shot which you examined, the noise that you examined, was not in fact a backfire?

Mr. WEISS. That is correct, sir.

Mr. FAUNTROY. If it had been a backfire, you testified it would have had to come from the grassy knoll?

Mr. WEISS. That is correct, since I did not concern myself with the nature of the sound, only the location at which it originated.

Mr. FAUNTROY. But from your knowledge of sound and the velocity of a missile traveling at that speed, it would not have been a backfire?

Mr. WEISS. That is correct.

Mr. FAUNTROY. All right. Thank you.

Second, the problem that we have is that nobody saw anyone with a rifle in that area. My question is: Could a shot from a pistol have created the same noise, shockwaves and echoes?

Mr. WEISS. In order to do so, the bullet fired from such a pistol would have had to have left the muzzle at supersonic speed, and so, if indeed there are pistols that fire supersonic bullets, the answer would be yes in such a circumstance. However, to my understanding, most pistols do not fire supersonic bullets.

Mr. FAUNTROY. So that on the basis of your knowledge we would have to identify a pistol that fired that fast before you could conclude that it was probably a pistol or could have been a pistol?

Mr. WEISS. Could have been; that is correct.

Mr. FAUNTROY. I guess my question, Mr. Chairman, now goes to staff, Mr. Cornwell or Mr. Blakey, and that is, what do we know about the alleged encounter with a person bearing Secret Service credentials in the area of the grassy knoll?

Mr. BLAKEY. Mr. Fauntroy, the committee did look into that incident and did what it could 15 years later to determine whether it occurred and, if it occurred, could we identify the individual.

The testimony in essence is that an individual identified himself by showing what he said to be Secret Service credentials behind the picket fence, and based on that was allowed to continue.

A careful examination of where all of the Secret Service agents were that day, and their duty assignments, indicates that no Secret Service agent was in that area. And that is about as far as we have been able to carry it.

Mr. FAUNTROY. But who had the encounter?

Mr. BLAKEY. My memory is, a policeman, one of the first to come up over the fence, ironically, with a gun drawn, encountered an individual who, seeing the gun, identified himself as a Secret Service agent and was thus able to pass on.

Mr. FAUNTROY. Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

Mr. FAUNTROY. I yield back the balance of my time.

Chairman STOKES. The gentleman yields back the balance of his time.

The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Thank you, Mr. Chairman.

Thank you, Dr. Weiss, for your testimony this morning.

In responding to Judge Preyer's question about the degree of exactitude in your science of acoustics, has the science progressed to such a significant note in the past 15 years that what you have done could also have been done by the Warren Commission?

Mr. WEISS. Well, as a matter of fact, the science, insofar as what I needed to know in order to do what I have done, was known long before 15 years ago, so that it could have been done at that time, yes, sir.

Mr. DODD. What about the tests of Dr. Barger?

Mr. WEISS. Yes, those also.

Mr. DODD. So there has been no appreciable improvement in the science in 15 years that what you did or what Dr. Barger did would have precluded the Warren Commission or someone conducting a similar test in 1963 from reaching the same conclusions that you have?

Mr. WEISS. Nothing that I know of. The only difference that I recall is that in part of the work that Dr. Barger did, in order to establish that there were no indications of shots earlier than the timeframe indicated, he used a novel type of filtering technique to remove the sound, to reduce the sound level of the motorcycle and thereby hopefully expose impulse sounds similar to those that we have observed in the region of the shot here.

That technique has been developed only in the last 15 years.

Mr. DODD. You, in responding to Chairman Stokes and Mr. Fauntroy, indicated that as a result of your assessment of these wave forms you rule out the possibility of backfire as causing a similar echo pattern. Is that correct?

Mr. WEISS. Well, not so much the echo pattern as the evidence of a shockwave present, but also, as I indicated, that if there was backfire it had to have been from the same location that I place the shooter of the rifle.

Mr. DODD. My point is this: Are you excluding all other possible noise patterns that could have produced a similar kind of wave form that we see on your predicted response tape or that was evident on the Dallas Police Department tape?

Mr. WEISS. If there are other kinds of sounds which resemble sounds produced by a bullet in supersonic flight followed by the sound of a muzzle blast, then they must, of course, be considered, but I don't know that there is.

Mr. DODD. Could you share with this committee what other possible noises could produce that sort of thing, other than a rifle or a pistol?

Mr. WEISS. I don't know—that is the point I was trying to reach—can I think of any that might resemble it.

Mr. DODD. Was there any assessment made of other things that might have been occurring at that time at Dealey Plaza which could have produced that kind of noise pattern?

Mr. WEISS. I think somebody had once suggested a firecracker being thrown, or something like that.

Mr. DODD. Well, there was a train. I think we had evidence that there was a freight train that was moving or present at the time in Dealey Plaza. Could a train have done anything, cars backing into each other?

Mr. WEISS. No, sir, they would not have produced this kind of pattern.

Mr. DODD. Let me ask you something and see if I have, after listening to you—this is my third or fourth time, I think I am beginning to understand some of the terminology.

Is this statement correct? Would the absence of any identifiable pattern in the predicted response from the Dallas Police Department tape, would that raise a serious question as to the authenticity of the test, the absence of an identifiable pattern, and one from the other?

Mr. WEISS. Well, the test is authentic, regardless. If I could not find a pattern that matched sufficiently closely, I would only have been able to conclude that we have not found proof either that this is a shot that was recorded or that there was a microphone at that location in Dealey Plaza.

Mr. DODD. So it would raise questions, anyway, as not necessarily to the authenticity of the test, but rather whether or not your predicted response compared favorably to a certain degree of probability with the original tape?

Mr. WEISS. That is correct. We could not make a statement that there was a 95-percent probability of having identified a shot.

Mr. DODD. Conversely, could we also say that the inclusion of a wave form in the Dallas Police Department tape that it would have been impossible to record on the predicted response recording, would also raise serious questions?

Mr. WEISS. I'm not quite sure what you are asking.

Mr. DODD. We have evidence that there was a Dallas Police Department tape under, I guess it is exhibit F-355, the carillon bell going off in Dealey Plaza. That is on the Dallas Police Department tape.

To the best of our knowledge, there were no bells ringing in Dealey Plaza at that time, November 22, 1963. How do we explain the ringing of a carillon bell that would be impossible to record at Dealey Plaza?

Mr. WEISS. Offhand, I really can't address that question, since I didn't consider it in any detail when I was examining these data.

Mr. DODD. As someone who is trained and provides expertise in this area, my point is, can you have the sound of something that could be impossible to be heard on a tape-recording and somehow that be picked up some other place? Was it possible for another policeman to have had his tape-recorder on at some other location?

Mr. WEISS. Yes; that is a possibility. I think Mr. Aschkenasy wants to say something.

Mr. ASCHKENASY. You are making an assumption that there was a source of a bell in Dealey Plaza, but that is your assumption. However, you have to look at the tape and the data on the tape a little more carefully, and one can see there an indication of a keying-on-transient which means that someone else tried to get onto the channel at that very time. He may have been in position to be close to a source of a carillon bell rather than anyone in Dealey Plaza, because there is associated with that carillon bell some indication of somebody else transmitting at the same time, which puts it just equally as well outside of Dealey Plaza.

Chairman STOKES. The time of the gentleman has expired.

Mr. DODD. Mr. Chairman, could I ask for unanimous consent just to proceed for a couple of additional minutes?

Chairman STOKES. Without objection, the gentleman is recognized for 2 additional minutes.

Mr. DODD. I realize that you are not an expert on police transmitters, motorcycle transmitters, but to my knowledge, anyway, having looked into this a little bit, it would be impossible for—and you correct me if I am wrong—but I am led to believe it would be impossible for someone else to interrupt a transmission once there is a transmission occurring.

Do you understand what I am saying?

Mr. ASCHKENASY. Yes. What you mean to say is, if one guy has the channel——

Mr. DODD. Has the channel open, it is impossible to break in?

Mr. ASCHKENASY. It is not impossible to break. It is a question of the strength of each individual transmitter and its relation to the antenna that is receiving the transmission.

The one who has the stronger signal is the one who grabs the channel, notwithstanding whether someone else is on the channel at that time.

If I am coming in with a big 20-kilowatt signal, I will swamp everybody else in sight.

Mr. DODD. Then you are telling me it would be impossible to record two sounds at the same time?

Mr. ASCHKENASY. No.

Mr. DODD. Or is it?

Mr. WEISS. No. As a matter of fact—let me respond to that one. We sort of play ping-pong here. In fact, if you listen to the police tape recording during the entire period of the so-called—the 5 minutes when the microphone on this motorcycle was accidentally on, you can in fact hear other transmitters coming on. Most of them failed insofar as all you hear is the microphone click and you hear a kind of a chirp as they try to capture the channel.

But there are a number of times where you do hear other voices coming on, other people communicating, sometimes very distorted sounds of the voices, sometimes quite clear and intelligible; and it is all during the time that this one transmitter has been on. In fact, as you go on in time past the point at which the shots occur, the ability of other transmitters to come into the channel becomes increasingly—it occurs more frequently. You hear more people coming in. You hear comments to the effect that somebody has his microphone button stuck, and it is all audible and understandable, so there are indeed several transmitters being received simultaneously during that period, and therefore it could very well have been that there was another motorcycle who happened to key on at just that point in time and picked up the sound of a bell somewhere.

Mr. DODD. Let me try to conclude this, by asking you this, though. Having said that, and using the expertise that you have in acoustics, you, I think, said, Dr. Aschkenasy, that to have found a sound that you developed in your predicted response in some place other than Dealey Plaza, it would have been necessary to reconstruct, in effect, Dealey Plaza in some other place?

Mr. ASCHKENASY. Correct.

Mr. DODD. So that even if that sound that we hear is the third or fourth response, that would have only been able to have come, based on your expertise and your tests, only could have come from Dealey Plaza, unless you could have recreated Dealey Plaza?

Mr. ASCHKENASY. Yes. Congressman Sawyer at that time asked the question, if somebody were to tell me that the motorcycle was not at Dealey Plaza—and he was in fact somewhere else and he was transmitting from another location—my response to him at that time was that I would ask to be told where that location is, and once told where it is, I would go there, and one thing I would expect to find is a replica of Dealey Plaza at that location. That is the only way it can come out.

Chairman Stokes. The time of the gentleman has again expired.

The gentleman from Indiana, Mr. Fithian.

Mr. FITHIAN. Thank you, Mr. Chairman.

Mr. Weiss, Chairman Stokes alluded earlier to some of the problems that your analysis will undoubtedly cause this committee, and indeed cause history and people who look at this on down the way. We may, in fact, be in the position of finally having raised more serious questions than we answered as a committee.

We are particularly aware of the lateness in the life of this committee, matched up with your findings. I suppose we could take some comfort in the fact that you came up with your findings 3 weeks before, rather than 3 weeks after, we rendered our findings, but I must, without being personal, now pursue some lines of questioning which I think will be asked of us, and of you and of your professional characteristics and findings, so please don't take the initial questions at least, personally, but I think that they must be asked.

When you and Mr. Aschkenasy entered into this series of mathematical and geometrical computations, did you set out with any particular result desired?

Mr. WEISS. No, sir.

Mr. ASCHKENASY. No, sir.

Mr. WEISS. We had no preconception as to what we were going to find. If anything, when we first heard the tape recording and first began to examine the data, our initial reaction was, somebody has got to be kidding; this can't be gunshots. But as we examined the data more carefully, subjected it to all the tests that we have described, the procedures that we have described, the results of the analyses themselves convinced us of where we were heading.

Obviously, we did not have any plan or any objective other than to do the best we could to find out what really these data represent.

Mr. ASCHKENASY. If I may——

Mr. FITHIAN. Yes, sir; go ahead.

Mr. ASCHKENASY. If I may say just one line, it's that the numbers could not be refuted. That was our problem. The numbers just came back again and again the same way, pointing only in one direction, as to what these findings were. There just didn't seem to be any way to make those numbers go away, no matter how hard we tried. It was not a question of interpretation of the numbers; it was a question of what the analysis yielded, the mechanical analysis, because it was just a hand calculator and a piece of string, as you saw it, a tape measure, and it all just came out the same way.

Mr. FITHIAN. What were your instructions from the committee staff when you set out to extend or refine Dr. Barger's work?

Mr. ASCHKENASY. Is there any way to take Dr. Barger's statement of 50-50 percent and move it off center either way?

Mr. FITHIAN. And so you are telling me that it really didn't matter to you which way it moved, that you were trying to get at more certainty than a probability of 50–50?

Mr. ASCHKENASY. That is correct, sir.

Mr. FITHIAN. Did you have any instructions from any member of the committee, any suggestions, any recommended lines of pursuit, that you should follow?

Mr. ASCHKENASY. We were totally independent of the committee.

Mr. FITHIAN. Now during your testimony, Dr. Weiss, you stated that the principles you employ are really basically very simple; they are mathematical; they are a part of the physical sciences. Has this technique been commonly employed in criminal investigations in recent years?

Mr. WEISS. I think, as I stated earlier, the only application of this technique that comes to mind is the one in the instance of the shootings at Kent State College, and in that analysis and investigation the technique was developed originally by Dr. Barger.

Mr. FITHIAN. Then we are in a pretty small circle, the two of you and Dr. Barger and his firm, in what must be a much larger field, that is, the field of acoustics.

Are we saying, then, that this whole thing is really rather novel, that is, the application of acoustical principles to criminalistics, if you will?

Mr. WEISS. Yes, sir; the application is novel in this area, perhaps because these are first times that questions of this sort have been raised, that is, "Given sounds on a tape which may or may not be a gunshot, can you identify what it was, and if so, can you tell where the gun was fired from or where the microphone was listening?"

I don't know if that question had ever been raised before Kent State, and for that matter how many times it has been raised since then.

Mr. FITHIAN. I realize criminalistics and so forth is not your profession, but as far as you know this is the first application of the principles of acoustics to ascertain the precise origin of a gunshot?

Mr. WEISS. That is correct.

Mr. ASCHKENASY. Congressman, if I may give you an analogy to that, it is almost like taking a wheel and putting it either on a bicycle, or on something newer than that, on a car. It is the same wheel. Principles of a pneumatic wheel of a tire, are the same for both, and they are basically simple and basically straightforward and incontrovertible, those principles, and yet there was one application before, and now you have another application which is new; but the results of the game are the same.

Mr. FITHIAN. Now I want to clarify in my own mind the distinction between your work and Dr. Barger's, and I have some additional questions on that which will come a little later; but if I understand you correctly, you did not, in fact, analyze the nature of the impulses, that is, you weren't working with filtering systems and the like to get rid of the extra noise. You were only working with the output of Dr. Barger's work in that area; is that correct?

Chairman STOKES. The time of the gentleman has expired.

Is the gentleman seeking additional time?

Mr. FITHIAN. I seek additional recognition for two additional minutes.

Chairman STOKES. Without objection, the gentleman is recognized for two additional minutes.

Mr. ASCHKENASY. Congressman, our input to this process were two tapes, basically, the tape of the test shots in Dallas in August and the other one was a high quality copy of the Dallas police tape recording in its pristine, natural form, without any filtering whatsoever, and that is what you actually see on that exhibit. That is from the Dallas police tape recording.

Mr. FITHIAN. To refine my question somewhat, as I understand, Dr. Weiss, the only additional analysis you made other than the mathematical computations with measurements and moving those around until you got a match was the possibility of sound alteration by the windshield of the bicycle or the motorbike?

Mr. WEISS. Yes, sir; that is correct.

Mr. FITHIAN. So that that was the limited area of your analysis of the impulse or impulses on the Dallas P.D. tape; is that correct?

Mr. WEISS. That is right, sir.

Mr. FITHIAN. Mr. Chairman, I think my other questions can be grouped together a little later.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Pennsylvania, Mr. Edgar.

Mr. EDGAR. Thank you, Mr. Chairman.

Mr. Chairman, before I begin my questioning I would like to simply state that the questions that I am about to ask have been shaped and assisted by several people who have come and attempted to help me with this. The first is Dr. Arthur Lord, who is sitting behind me, who is a professor at Drexel University and has extensive background in ultrasonics and acoustics. And also in the audience we have Dr. Francis Davis, who is the dean of science at Drexel University, and a fellow in the American Meteorological Society; and also Dr. Marvin Wolfgang, who is a criminologist and a professor at the University of Pennsylvania.

These three gentlemen, at my request, came and reviewed the testimony which you gave a week ago, as well as the testimony that was presented to the committee back in September by Dr. Barger; and they have assisted me in asking, I think, some questions that are a little bit more technical and perhaps different from the questions previously asked; and they start with the whole question of temperature.

When asked about this previously this morning, you had indicated, I believe, that you received the temperature data that you took into consideration from the committee staff; is that correct?

Mr. WEISS. That is correct.

Mr. EDGAR. Did you feel that the use of temperature was not that important to the findings of this particular study?

Mr. WEISS. No; it was important to know approximately what the temperature was. The precise knowledge is not that important because the effect is not that great. We, for example, took into account the temperature of Dealey Plaza at the time that Dr. Barger's experiment was being performed and particularly at the time the shot was fired from the grassy knoll that was recorded by microphone 4, and that was known to be about 90° F. at that time. It was very near at the end of his tests and they had been noticing what the temperature was as the tests progressed.

Now at that temperature the velocity of sound in air is about 1,150 feet per second. By contrast, the temperature on November 22, 1963, was given to me as 65°, and the velocity of sound in air corresponding to that temperature is 1,123 feet per second; therefore, there is approximately a 27-feet-per-second increment over a roughly 25° F. change, or approximately 1 foot per second per degree.

Had there been a, say, 5° or so difference from the 65° I was quoted, it would have affected the calculations slightly, but not seriously, and certainly not affected them significantly for the earliest arriving or the earlier arriving set of echoes, but only for the really late echoes.

Mr. EDGAR. The temperature that you determined in November of 1963, you said was 65°?

Mr. WEISS. That is what I was told, yes.

Mr. EDGAR. Do you know where they determined that temperature?

Mr. WEISS. No, sir; I do not.

Mr. EDGAR. So there really was no accurate way of determining the exact temperature in Dealey Plaza at the time of the assassination, other than statements that were given to you; is that correct?

Mr. WEISS. That is correct. I would again, however, assume that if the temperature were quoted as 65°, measured at one place, then it would not be likely to be more than, say, 5° higher at another place in the immediate vicinity.

Mr. EDGAR. Well, let's make the assumption that they called the Weather Bureau and asked what's the exact weather on that particular day; the Weather Bureau presumably would have taken a look at their records, taken at a temperature gauge somewhere near the airport where their findings would have been taken, and if we just have that as an average temperature for the city of Dallas at that time, you drew on the map with your string and pins straight lines from the point of the presumed shot to the point of the microphone, and also straight lines to the point of the echoes. That was assuming that at the muzzleblast sound, concentric circles went out similar to throwing a rock or a pebble into a creek or pond, and those ripples went out in even circles.

Couldn't temperature have affected the time it took for the sound to have in fact reached the microphone or to have in fact hit the corner of a building and bounced back to the microphone where it was being received?

Mr. ASCHKENASY. Well, as we mentioned earlier, Congressman, we had received this temperature of 65° from the committee staff. We assumed that they had done their homework as to getting the temperature that was actually measured on that day. However, as Professor Weiss also just pointed out, is that the difference of temperature—it does, of course—it does affect, because we see that on the day of the experiment the temperature was 90°, and at the day of—on November 22, 1963—was 65°, and the tables give you two different speeds for the velocity of sound, one 1,123 at the lower temperature, and 1,150.

If we just take a linear extrapolation between those two numbers and we say that instead of being 65° on November 22, maybe close to 70°, so instead of 1,123, we have measured 1,128 feet per second.

Now what does that mean? A change of 5 over 1,100 approximately, a change of a half a percent. Now half a percent change would not affect our measurements because we did not know the accuracy of the map that we have. Was it accurate to a half percent? As a matter of fact, we discovered in looking at photographs and looking at the map that some of the details there were actually not correct.

So this is why we assumed that the 65° was a good, reasonable, ballpark figure, since, No. 1, it was given by the committee staff, and No. 2, distances over which we were measuring echoes, the distances are not miles; the distances are only hundreds of feet, and in 100 feet, half a percent of error is hardly measurable in terms of our measurement; and this is basically the thought processes that we followed.

Mr. EDGAR. In the first part of your comment you said it affected the later echoes; is that correct?

Mr. ASCHKENASY. It may have affected the later echoes, but the measurement of those later echoes is not that much later in relation to the earlier echoes. Everything occurs here within approximately three-tenths of a second, the whole echo pattern.

Mr. EDGAR. But how would that have affected your 95 percent certainty that you have just talked about?

Mr. ASCHKENASY. We said 95 percent or better; so it would have made the "better" a little bit smaller.

Chairman STOKES. The time of the gentleman has expired.

Mr. EDGAR. Mr. Chairman, I will not ask unanimous consent for 5 additional minutes if it is understood that we are going to a second and a third round of questions at this time.

Chairman STOKES. We will continue as long as the committee has questions.

Mr. EDGAR. I will come back to this question.

Chairman STOKES. Professor Weiss, let me ask you this: The bullet from the grassy knoll, do we know where it went?

Mr. WEISS. No, sir, we do not.

Chairman STOKES. And do we know the speed of the bullet?

Mr. WEISS. No, we do not know that either.

Chairman STOKES. Can you tell us, then, why we do not know those things about the bullet from grassy knoll?

Mr. WEISS. Well, because the data won't permit us to determine it. All we know from the data is that there appears to be a shockwave impulse that precedes a muzzle blast sound by some number of milliseconds. I believe the number is actually 24 milliseconds.

Now if you knew—you have to know two things in order to find a third in this sort of situation—you have to know the direction in which the bullet was fired, and you need to know the muzzle velocity in order to be able to determine where the bullet's flight terminated.

Alternatively, if you knew where it terminated and knew where it was aimed, you could determine its velocity. Or, if you knew where it terminated and you knew what its velocity was, you could then determine where it was aimed.

But, you see, there are three unknowns that we are dealing with, and we only have one fact, and there is simply no way to be able to resolve the ambiguity here.

Chairman STOKES. So, for our purposes, we would be in the position of not knowing whether the bullet was fired straight up in the air or toward the limousine, or back away from——

Mr. WEISS. That is not quite correct, sir. We can say that the bullet was not fired straight up in the air because had it been, you would not have received a shockwave impulse at that microphone position; and, indeed, if it had been fired in a direction reverse to that of the limousine, you also would not have received a shockwave impulse.

Chairman STOKES. Then you are able to say, then, that the bullet would have been fired in the vicinity of the limousine?

Mr. WEISS. Well, one could say it was fired in the general direction of it. That could mean something well in front of it and something well behind it, as well as right at it.

Chairman STOKES. What happened to it after that we have no way of knowing?

Mr. WEISS. No, sir, we do not.

Chairman STOKES. Thank you.

The gentleman from North Carolina, Mr. Preyer.

Mr. PREYER. Thank you, Mr. Chairman.

Along the lines that Mr. Edgar was questioning you concerning assumptions that may have been made about the scene and how they may affect your calculations, you mentioned when you were discussing the original assumptions you made that the tape recorder on the Dallas police vehicle was 5 percent slow. I wonder if you could discuss that a little bit and tell us, one, how do you know it was 5 percent slow, and, two, how important is it, what difference does it make, that we be accurate about that?

Mr. WEISS. As a matter of fact, we know that it is 5 percent or approximately 5 percent slow from the time analysis done by Dr. Barger, these data having been presented to the committee during the open hearing in September when he discussed this factor. He did this by extrapolating a straight line to fit the time announcements made by the dispatcher on channel 1, which is the channel on which these data were recorded, and found that its slope was about 5 percent or something in that vicinity.

Now this affects measurements in the following way: If the tape was, in fact, recorded slowly, then it would be played back—and we played it back on equipment that we believe plays at true tape speed as indicated—then if it was recorded slowly, events occurring, let us say, 1 second apart, when you play it back on a machine that plays a tape more quickly, will occur in an interval of less than 1 second. If you then make a measurement and forget that the tape may not have been recorded at the correct speed, you are in error; so you have to adjust the observed spacing between events, the events being impulses, for example, that you correct them to determine what they really should be or in fact were at the time that the recording was made.

Now this adjustment of 5 percent is only an approximate one. In fact, it was altered slightly during our analyses as we found it necessary to alter it, so that the data fell in a little bit better and a little bit more meaningfully. We checked with Dr. Barger on the validity of doing this, and his opinion was there is absolutely no reason that it could not have been done that way, that in fact the fit that he had was over an average of a number of minutes, and that the Dictabelt itself was not notorious for holding constant speed, so that its speed could have been varying by a minute amount during this period of time, so a small upward or downward adjustment was perfectly valid.

It therefore was necessary to make such an adjustment in order to find what the correct interval spacing was, or our best guess at what it was.

Mr. PREYER. I get the impression that the fit, the match, determined the tape speed, rather than the tape speed having much effect or influence on the match?

Mr. WEISS. No, because the adjustment that is necessary is only a small one. If it were a matter of saying, well, I have to slow this tape, or I have to speed this tape up, by, say, 20 percent, or slow it down by 25 percent, then it would have been a situation of that sort.

The trim was a very small amount around the estimate that had been made by Dr. Barger in the first place. For that matter—

actually, the adjustment was—instead of using 5 percent, we used 4.3 percent.

Mr. PREYER. If I might just ask one other question, Mr. Chairman, in another area.

You mentioned that this involves a new application of old and incontrovertible principles, and that the Kent State was the first application of the new techniques; and I gather it was the first application of the new technique which would rule out low level sound so that you would be able to hear the higher level sound?

Mr. WEISS. Not in the work that we did. We did not actually use any technique for suppressing low-level sounds. We just took the tape exactly as it had been recorded and analyzed it that way.

Mr. PREYER. My question that I wanted to get at was: Was your analysis, or any acoustic analysis from experts, admitted into evidence at any of the Kent State hearings or trials?

Mr. WEISS. I'm not sure what the results of that analysis were. I think Dr. Barger would be better able to answer that question.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Ohio, Mr. Devine.

Mr. DEVINE. Thank you, Mr. Chairman.

Dr. Weiss, I don't know how closely related are the science of acoustics and ballistics, but wouldn't it be a fact that muzzle velocity from a rifle would exceed the speed of sound?

Mr. WEISS. For most rifle bullets I believe that is true, yes.

Mr. DEVINE. Therefore, the bullet or the projectile would probably arrive at the target before the sound would be heard by people at the target area?

Mr. WEISS. That is correct.

Mr. DEVINE. Therefore, in order to coordinate the Zapruder film with the dispatcher's tape of the broadcast on the motorcycle and the Dr. Barger acoustics studies, you would have to take into consideration the sound-impact lag, would it not?

Mr. WEISS. That is correct. It would depend entirely upon what you were trying to relate. If you wish to relate the moment at which an impact might have occurred, you might get one set of relationships or adjustments. If you wanted to, however, synchronize—if that is the idea—sound and film to what would have been heard in the automobile, then you might get a slightly different, but only a slightly different, set of synchronizations.

Mr. DEVINE. Of course, the picking up of the sound from different areas would be different than at the target area itself?

Mr. WEISS. That is correct, absolutely correct.

Mr. DEVINE. Let me just finally comment that I have had some experience with expert witnesses in the medical field and psychiatric field and the ballistics field and the fingerprint field and so forth. Wouldn't you agree, those of you that are engaged in expert opinion testimony, that reasonable minds can reach different conclusions from the same set of facts?

Mr. WEISS. Well, if the facts can bear alternative interpretations, yes, that would be true, they can. The only question, I think, would be relating to the premises on which the facts may have been based.

Mr. DEVINE. Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from the District of Columbia, Mr. Fauntroy.

Mr. FAUNTROY. Mr. Weiss, you have on several occasions indicated that there was, in fact, no new electronic equipment utilized by you to establish these facts?

Mr. WEISS. That is fundamentally true; yes, sir.

Mr. FAUNTROY. Therefore, we need not look for an analysis of how reliable the new equipment you used is, because you didn't use any?

Mr. WEISS. That is correct, sir.

Mr. FAUNTROY. Mr. Chairman, I just have one question, and that question is of staff; therefore, I would like staff to tell us the source of the 65-degree temperature determination which was provided the team here.

Chairman STOKES. Professor Blakey, do you want to reply to that?

Mr. BLAKEY. Mr. Chairman, I obviously would be corrected by the record and if my memory today is like it is normally, it is probably in error. My memory is that we got it from the Weather Bureau, which, of course, keeps relatively accurate temperatures; and they differentiated the temperature in various areas, and we took the one that was the closest to Dealey Plaza.

If that is wrong, I will stand corrected and bring it to the attention of the committee as soon as possible and insert it in the record.

I might add just a comment, and perhaps I could do it in the form of a question so that I am not in the position of inserting something in the record:

Professor Weiss, if you would comment on the following hypothetical: If you knew where the gun was, if you knew the muzzle velocity of the gun, and you knew where it hit, and you had a recording, could you determine the temperature of the air?

Mr. WEISS. Yes, sir.

Mr. ASCHKENASY. Yes, sir.

Mr. BLAKEY. If it is true from extrinsic data, apart from the acoustic study, that we know those factors about, one, the first shot, the second shot and the fourth shot, then the temperature in the air at Dealey Plaza could be determined by the known shots that had been related by the medical and ballistics neutron activation analysis of Lee Harvey Oswald's gun, couldn't we? It is a possibility; is that correct?

Mr. ASCHKENASY. That is correct, except that you have to remember that when you hypothesize you are hypothesizing laboratory-ideal conditions which do not exist in the real world.

Mr. BLAKEY. Did you gentlemen make that determination?

Mr. WEISS. No, sir, we did not.

Mr. BLAKEY. How difficult would it be to do so?

Mr. WEISS. From the data that are available, I don't know.

Mr. BLAKEY. I wonder if you could supplement your testimony at this point with a letter telling us what mathematically the temperature of the air had to have been at Dealey Plaza based on an analysis of shots one, two, and four?

Mr. WEISS. That would require, for example, redetermining the locations of the echo-generating surfaces for the position from the sixth floor window of the depository building, and that will take some time to do.

Mr. ASCHKENASY. It isn't easy.

Mr. BLAKEY. But it is a mechanical possibility?

Mr. WEISS. It is a doable thing.

Mr. BLAKEY. Thank you.

Mr. FAUNTROY. Mr. Chairman, I want to be sure that I understand the answer to counsel's question. We know that the second shot struck President Kennedy somewhere behind the sign on the film. You can determine the distance roughly between the middle of that sign and the sixth floor window, can you not?

Mr. ASCHKENASY. Those who are expert at doing that sort of thing can.

Mr. FAUNTROY. You drew me a line a minute ago.

Mr. WEISS. One can determine the distance, yes.

Mr. FAUNTROY. The question, therefore, is, if you know where the shot emanated and where it struck, if you took the time, could you determine the temperature? And the answer is?

Mr. WEISS. Yes, you could.

Mr. FAUNTROY. Thank you.

Mr. WEISS. I was going to add another comment apropos of the precision of knowing the temperature. Since the effect of a variation in the temperature is slight, is that its only primary effect in fact in this set of calculations, will be to move the position, the initial position, of the motorcycle at the start of, relative to the point at which it is now, too, so that it might be either a little bit closer or a little bit further from the rifle at the time it first receives the muzzleblast sound? For example, if the temperature is, say, 5 degrees warmer, then as Mr. Aschkenasy pointed out, the effect will be a one-half of 1 percent adjustment. In fact, that adjustment can be applied quite easily to the position of the motorcycle. The motorcycle in that estimation is something like 200 feet away from the grassy knoll area, which would mean moving it by 1 additional foot forward or backward, whichever way.

Mr. EDGAR. Would the gentleman yield?

Chairman STOKES. The time of the gentleman has expired.

Mr. EDGAR. I ask unanimous consent that the gentleman have 1 additional minute.

Mr. FAUNTROY. I ask it, too, and I yield that minute to the gentleman from Pennsylvania.

Chairman STOKES. Without objection, the gentleman may have 1 additional minute.

Mr. EDGAR. What is the statistical evidence that atmospherically your temperature is not off by more than 5?

Mr. WEISS. I have no idea, sir.

Mr. EDGAR. If it is off by 10 percent, doesn't that affect——

Mr. WEISS. Then there would be a net 1-percent change in the velocity of sound, and I have to move the motorcycle not by 1 foot but by 2 feet to compensate. That is the total effect, sir.

Mr. EDGAR. But doesn't that affect the number of millisecond signals that you use?

Mr. WEISS. No, sir. It simply means that the starting position of the motorcycle has been moved. If I had to move him 10 feet forward, then I probably could not get a decent match anymore. But that would probably be a 100-percent error in the temperature.

Mr. EDGAR. Are you 95 percent sure that the temperature was within the 5- to 10-percent difference that we are talking about, 5- to 10-degree difference?

Mr. ASCHKENASY. We had no reason to doubt the committee staff in getting the correct answer to the question that we put to them. We explained to them that it was important to know what the temperature was on November 22, 1963, in Dealey Plaza. This is the number that they came back with. Now whether there was any error intentional or unintentional on their part, right now we have to make the statement that it was never taken into consideration that there may be an error in that number.

Mr. EDGAR. I yield back.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Thank you, Mr. Chairman.

Just following up on this point because, as I understood it, you made adjustments not just for temperature but you made them as well for the location of the receiver, the location of the alleged fire of the gun. Apparently, and I may have misheard you, but you also discovered some incorrect location in the map, itself, that apparently you had to make some adjustments for as well; is that correct?

Mr. ASCHKENASY. We did not make any adjustments. We just noticed that the map was not an exact survey. For example, the vertical, as is shown there in the lower right-hand corner in the photograph, shows evenly spaced columns. The map we were given by committee staff did not show evenly spaced columns. Columns could be echo sources. In this case they were not, but this came to our attention. We want to point out it was not perfect.

Mr. DODD. What I'm getting at is this. Assuming that any error that may have existed in temperature would be minimal, do you believe that a reenactment of it, of what occurred in Dealey Plaza, placing a person firing a rifle at exactly the location that you adjusted for, having a tape recorder going at exactly the same speed that the recorder was allegedly going on November 22, 1963, and exactly accounting for the adjustments that were made in the motorcycle, do you think that would in any way possibly narrow your prediction down even further? Would it be worthwhile, in other words?

Mr. WEISS. No; I believe all that would happen if you trotted a motorcycle down the street with a microphone receiving the sounds, that you would, in fact, come up with a set of echoes that would very closely match the set that has been predicted.

Mr. DODD. With regard to the placement of the firing person on the grassy knoll, to what degree of error do you allow? We have discussed this before in executive session, and I tried to recall your response. It seems to me you talked about 5 feet, a radius of 5 feet.

Mr. WEISS. Yes.

Mr. DODD. Are you suggesting that if we, one, move that firer by 10 feet or more from where you placed him, that that would throw off the pattern significantly, that the probability that you have arrived at here would diminish significantly?

Mr. WEISS. Depending upon how you moved the shooter, you would affect one or another or several of the predicted echoes and, of course, depending upon how far you moved him. Now, if the movement is a small amount, let's say 5 feet along the line of the fence, then you can compensate for that adequately by moving the motorcycle a little bit and still get a pattern that will match. It may not match as close as plus or minus one one-thousandth of a second. It might be 1½ thousandths of a second. If you start moving the shooter significantly greater distances——

Mr. DODD. What do you mean by significantly?

Mr. WEISS. Ten to 20 feet from where I have it now; then the likelihood is that one after another of these echoes will fail to be matched by any reasonable pattern.

Mr. DODD. Mr. Blakey, do we have a graph of the grassy knoll at all? Do we have any evidence that blows that up at all? Could you explain on the blackboard and draw a little picture of the area in which we placed the fireman, the rifleman, in the grassy knoll?

Mr. WEISS. You mean in terms of what you would see if you were standing there, actually a photograph sort of thing?

Mr. BLAKEY. I didn't understand the question. There is an exhibit already in the record. I believe it is No. 155 that shows the fence from the ground level. He would be able to indicate from there.

Mr. DODD. Is it from behind the fence?

Mr. BLAKEY. In front of the fence.

Mr. DODD. Maybe the blackboard would be better, it might be more graphic, and you can place it more clearly. Could you draw the fence as you would perceive it, looking out onto Dealey Plaza, and then place the rifleman in a spot where you think he would have had to fire from?

Mr. ASCHKENASY. Just to refer you to this map here, here is what is shown as the 5-foot high wooden fence. It runs in this direction approximately north-south and approximately east-west. I will just reproduce it larger.

Mr. DODD. That would be helpful.

Mr. ASCHKENASY. This is what I pointed out before, and we show, if we take a scale of 1 inch—let's say this is 10 feet—1 inch equals 10 feet. This piece of chalk equals 10 feet, and we originally placed him here, 8 feet from the corner.

Mr. DODD. Going along the fence.

Mr. ASCHKENASY. Running along the fence, since this represents 8 feet, we say we could move him within 5 feet of this location, from here to here, and get a reasonable match, still.

Mr. DODD. Where would be the direction of the highway or the motorcade?

Mr. ASCHKENASY. The motorcade is coming down here on Elm Street, right here.

Mr. DODD. And your margin of error would be anything beyond 10 feet you start having difficulties?

Mr. ASCHKENASY. Yes; then you put him already on the other side of the crux and the position begins to change, or you put him further out here. We certainly would have to exclude this region here because he would not want to be visible. If we put him too far back here, he would not be able to see down to the limousine, which is below his level.

Mr. DODD. I am talking just from an acoustical assessment. Then you would have difficulty with the degree of probability?

Mr. ASCHKENASY. That is right.

Mr. DODD. Thank you, Mr. Chairman.

Thank you.

Chairman STOKES. The time of the gentleman has expired. The gentleman from Indiana, Mr. Fithian.

Mr. FITHIAN. I was about to ask chief counsel or one of the members of the staff, as I recall way back when we had a photograph that the photographic panel was working with and there was a linear object behind the wall. I was wondering if, though that is not very conclusive evidence, if that linear object and that undefined object is roughly what we are talking about here.

Mr. BLAKEY. Mr. Fithian, again the record will correct me if my memory is wrong—we analyzed two places, photographed to determine if something could be seen. The photographic panel indicated that the area on the fence, which was one possible one, was not profitable. We could not get anything out of it. Consequently, additional work was not done on it. The photograph we analyzed in some detail in the hearing was of a possible person and a linear object behind the concrete abutment and not behind the picket fence. I might ask, Mr. Chairman, that exhibit F-155 be displayed at this point, and this is just moments before the assassination, and I would direct the committee's attention to the arrow pointing at the President's head. If the committee would look up and slightly to the left, you will see the cement colored area and above it, you will see the outlines of the picket fence. This is the concrete abutment, and this is the approximate area where an analysis was made previously. This is the line of the wooden picket fence. It extends in this direction back, and this is the area that is shown from the other side if we would refer again to the larger aerial photograph of Dealey Plaza; this is the picket fence coming this way and back over; and the line of fire, assuming a shot did occur from the grassy knoll, would be down in this direction. As in this situation, it would be down in this direction, coming from the picket fence down toward the car. So this could give you a visual image of what happened.

Mr. FITHIAN. The picket fence is some feet behind the concrete wall?

Mr. BLAKEY. That is correct.

Mr. FITHIAN. Thank you. Dr. Weiss, I want to pursue in this particular round of questioning the nature of the receiver and its ability to determine and therefore turn out the kind of shape that you worked with. If I remember Dr. Barger's testimony correctly before the committee in September, I was just going back through the documents, and I can find several references to it which I could read to you if you would like, but basically what he said was that given the limited nature or capacity of the motorcycle radio, that it did not indeed transmit the full picture of a very, very loud sound, that is, it attenuated or modified that sound simply because it could not accommodate that much of an impulse. Are you familiar with that particular problem that we ran into?

Mr. WEISS. Yes, I am.

Mr. FITHIAN. Now, does that problem pose any significance for you in the kind of mathematical extension that you made on shot No. 3?

Mr. WEISS. No, it does not affect the time at which an impulse will occur, only the amplitude or strength with which it is observed.

Mr. FITHIAN. Well, then, let me ask it another way. You were concerned about the alteration of the nature of the impulse by the windshield of the motorcycle?

Mr. WEISS. That is correct, only insofar as it is another means of observing a consistency between what is seen in the pattern and what is expected to be seen based upon both theory and experiment, that is, that the leading edge is much smaller than the cycle that immediately follows it. In reality, when a muzzle blast occurs, that leading edge is very much larger than the cycle that will follow it. There are two things that are reducing it as we observe it here. The first is the effect of the windshield, and the second is the effect of the compression caused by limiting action in the microphone and transmitter and almost certainly in the receiver and recorder as well.

Mr. FITHIAN. Does that in any way call into question the identification of the sound, itself, as that which reflects a gunshot from a rifle?

Mr. WEISS. Not seriously. Well, in effect, actually, rather than contradicting it, in a sense it supports it because all we see is all explainable and consistent with what we should expect to see if we take into account all the factors of the situation.

Mr. FITHIAN. Thank you. One other area that I am concerned about, as I was concerned in September in my own questioning of Dr. Barger, and that had to do with what he called false alarms. Is that term familiar to you?

Mr. WEISS. Yes, sir.

Mr. FITHIAN. As I understand it, to go back again and find some indications of this in Dr. Barger's testimony, but as I understand it, the reason he could not come up with a greater probability that there was a fourth shot was in part, at least, due to the possibility of false alarms being generated in the various noises. I guess what I am curious to know is how you eliminated those false alarms that were reducing Dr. Barger's probability estimate?

Mr. WEISS. The elimination, in fact, is a byproduct of the ability to narrow the window down from 12 milliseconds wide to only 2 milliseconds wide. By so doing, it is possible to now predict that the probability of a noise occurrence matching this closely is significantly reduced and indeed reduced below the 5 percent level that I have mentioned.

Chairman STOKES. The time of the gentleman has expired.

Mr. FITHIAN. Let me just for the record, Mr. Chairman, well perhaps more properly pursue this with Dr. Barger, but on page 68-69 of the transcript, Dr. Barger answers in part:

> Therefore it would not be unreasonable to expect that approximately 5 of the remaining 10 correlations were also false alarms. That would indicate that about one-half of the detections that I did not previously indicate to be false alarms, about one-half of the remaining 10, are false alarms. This would indicate that the probability that each one is a correct detection is about one-half.

From that he went on to the 50-50 probability. Now, do I understand you correctly in that you are saying that simply by narrowing down the window, as you use the term, narrowing down the area——

Mr. ASCHKENASY. It is the uncertainty window.

Mr. FITHIAN. The uncertainty window to a very narrow space in numbers of feet and whatever other uncertainties you went into, that it is in that process that you reduce the probability of false alarm?

Mr. WEISS. That is correct, sir.

Chairman STOKES. The time of the gentleman has expired. The gentleman from Pennsylvania, Mr. Edgar.

Mr. EDGAR. Thank you, Mr. Chairman. Just for a moment, I would like to go back to one of your previous answers in reference to the temperature. You had indicated that if the temperature was off by 10°, that that would necessitate your simply moving the motorcycle plus or minus 2 feet; is that correct?

Mr. WEISS. I believe so. I really would want to do the calculation before answering that firmly, but it is probably correct.

Mr. EDGAR. Isn't that somewhat of an oversimplification of the process? Wouldn't you also have to go back and redo the calculations of all the echoes that are coming off of the buildings?

Mr. WEISS. That is correct; for a 1-foot movement it would shift the other echoes, but, remember, it would also shift the time of the travel of sound from the source to those points. For example, supposing that the temperature was warmer by some number of degrees, which means the sound would travel faster and all sounds would be received at the microphone sooner, well, the echoes would come in sooner, for sure, but so would the direct muzzle blast come in sooner. This is a kind of self-compensating process. It doesn't compensate exactly and in order to find the correct compensation, you have to move the motorcycle a little bit. Remember, we are dealing with a difference in time of arrival between the direct muzzle blast and the echo, not the absolute time of arrival of these events. This difference becomes somewhat less sensitive to temperatures than each of the events, themselves.

Mr. EDGAR. I have been given a piece of paper that indicates that on November 22, 1963, at the tower of the Texas Book Depository, they actually had a temperature of 68° signaled at the top of it. Evidently this is backed up by some pictures. It has not been determined where that particular temperature had been derived from or determined in order to put it up on the tower. It also does not take into account the differing temperatures that might occur at the ground level or toward the tree area as opposed to next to a building where temperatures could vary. Is it your experience that in situations like this that temperature just doesn't vary that much?

Mr. WEISS. If we are dealing with a temperature variation of only 3°, for example, from what I have reported, the effect on the calculations would be negligible. As far as experience of temperature variations of a grassy area as opposed to a building, I have no experience there. But if we are dealing with temperature variations that are not of a large range, then the chances are it would have negligible effect. The sound goes to the building and then comes away from the building again, so it is affected only as it approaches the building closely and as it leaves the building closely. Once it's out in the street, if we are out of the building range, in a normal temperature range it's going to be, in the main, near the average temperature of the area.

Mr. EDGAR. As I listened to your testimony this morning, it occurs to me that what you are sharing with us is a very well done analysis that is, in a sense, done in a test tube; that is, your calculations are made with basic science tools, basic skills that have been known for a long period of time. You were given by Dr. Barger the set of parameters around which you were to look, and that namely the third shot, and you have been able to calculate in an office, apart from Dealey Plaza, the echo pattern off of buildings that you had some approximate knowledge of where they were. You don't have the exact knowledge of the exact angle at which the echoes are leaving the building; is that correct?

Mr. WEISS. If one makes an assumption as to where the motorcycle is, you have an exact knowledge of what the angle is, if you can believe the topographic survey map. You can easily calculate the angle, if that is necessary, but the angle is not an important consideration because it does not affect the time of travel of sound. It will affect, to some degree, the strength of the echo as we see at a particular point, but not its time of travel.

Mr. EDGAR. But essentially you were using a test-tube setting in order to come up with the calculations. While temperature was important, it was not that important. I would assume that you would say while wind might be a factor, it was not that important. Aren't there a number of variables like wind, temperature, number of people, number of cars, number of objects in Dealey Plaza that might have some effect on your calculations?

Mr. WEISS. In answering that, I would like to start with a quote that we have pasted to the wall in our office to the effect that the only difference between theory and practice is that in practice you can ignore nothing, you can leave out nothing. This is what we very strenuously tried to do in performing this calculation, recognizing that one could easily get into a test-tube situation by forgetting effects or by not estimating what these effects are going to be or can be. This is why we did take the trouble of taking into account the temperature, as a matter of fact, and to be concerned about other effects as well. It is our belief that we have, in fact, accounted for all of the things that can really significantly—and by significantly, I mean can affect the accuracy of the prediction, by significantly, I mean prevent us from finding a pattern that matches it within the kind of window we are talking about. As far as the effect of other people are concerned, and there certainly were plenty of people in the street at the time, they are not going to particularly affect the time of arrival of echoes received from the hard surfaces in the environment there. The walls of the building will still receive and reflect sounds. The people there can perhaps affect the strength of some of these sounds, but they are not going to greatly alter the time of arrival. Now, this understanding is not only ours. We, in fact, corroborated it by talking with other acoustics experts, and they agreed on this.

Mr. EDGAR. It is my understanding that due to the short time interval between shot No. 3 and shot No. 4, approximately 0.5 to 0.7 seconds, the possibility of an acoustical mirage should be considered as a possible explanation. Perhaps the most common illustration of the effect of an acoustical mirage is the optical mirage we see riding along a highway, and we look on the distance and see wet pavement, and when we get to the spot, we find it is not wet pavement, but a trick on our eyes. The phenomenon of an acoustical mirage, which I believe is called refraction or bending, is it possible that the closeness of the two shots, No. 3 and No. 4, could have, in fact, come from the same muzzle blast and could, in fact, be an acoustical mirage, a reflection, a bending off of the sound patterns, or a different approach of the sound to the microphone?

Mr. WEISS. No, sir; because in order for that to be true, you would have to, in effect, have had the sound of the muzzle blast transported by some means to the location of the grassy knoll area, and there emitted as if it had originated from that point. Since every echo that was predicted corresponded to an echo arising from a sound rising from that location, what you would have required is that echoes otherwise generated from a shot fired, say, from the depository window, would each have had its own peculiar distortion, transmission, characteristics such that by some marvelous process it occurred at the microphone, intact, and at the correct position. Second: As far as I understand acoustical ducting, which is what you are referring to, these things occur over very much greater distances than a few hundred feet as we are observing here. So I don't think that sort of phenomenon could have accounted for these two shots.

Chairman STOKES. The time of the gentleman has expired. Are there further members seeking further recognition?

The gentleman from Indiana, Mr. Fithian.

Mr. FITHIAN. Thank you, Mr. Chairman.

Dr. Weiss, when you performed the test on the Harley Davidson with the New York Police Department, did you discover any characteristics that might help us understand why the officer inadvertently had the microphone on?

Mr. WEISS. Yes. I think Mr. Aschkenasy can answer.

Mr. ASCHKENASY. I am certainly glad you asked that question. At the time we conducted those tests, there was an officer who had been a member of the motorcycle police force in New York City for quite awhile. Once he saw we were playing around with the microphone and radio, and he was assisting in turning on the motorcycle and turning it off at our directions, he let on as to how many times that stupid microphone would go on every time he pulled the brake cable because the brake cable passed within a half inch of the microphone button that activates the microphone button, enabling it to transmit. That was a totally voluntary comment on his part which indicated to us that indeed it is possible inadvertently for a microphone to transmit without the rider being aware of it.

Mr. FITHIAN. The second question: Were there any changes in Dealey Plaza between 1963 and 1978 which altered the echo pattern?

Mr. WEISS. Not that I know of. We compared photographs and maps, aerial photographs, land maps, et cetera. All of the surfaces that we have considered are intact since 1963.

Mr. FITHIAN. The reason I ask the question is that if I remember Dr. Barger's testimony, they had to move one of the targets a bit because of the new freeway sign that does appear very, very close——

Mr. WEISS. That is correct, but, in fact, none of the echoes—well, insofar as that overhead sign, since it was not there in 1963, it could not have caused an echo in 1963.

Mr. FITHIAN. What I was getting at was, did you get some extra echoes that you could not account for?

Mr. WEISS. As a matter of fact, we found echoes in Dr. Barger's experiment not from the overhead sign for microphone position No. 4, but actually from the supporting columns that hold the overhead sign up, these cylindrical columns about 14 or so feet high. There were some very small echoes that bounced off there and could be related to those posts, but they were very weak compared to the other echoes.

Mr. DODD. If you will yield, it has been asked in the past, and I think you responded to it already, but the construction of the Hyatt Hotel is a rather significant addition in the vicinity. Did that make any difference whatsoever?

Mr. WEISS. No; because echoes from that structure would have come in much, much beyond the three-tenths of 1 second or half second that we have been considering.

Mr. DODD. Thank you.

Mr. FITHIAN. I yield back the balance of my time.

Chairman STOKES. The gentleman yields back the balance of his time.

The gentleman from Pennsylvania, Mr. Edgar.

Mr. EDGAR. Thank you, Mr. Chairman. Dr. Weiss, are you aware of the phenomenon that exists out on the open sea when ships are trying to locate the port and they hear a foghorn in the distance? Are you aware of the phenomenon that occasionally the sound from that foghorn directs the ship in a false direction, as opposed to the accurate direction of seeking a safe harbor, and, in fact, in some instances those ships wind up on the rocks and go in exactly the opposite direction of where they should go?

Mr. WEISS. No, sir; I am not.

Mr. EDGAR. I would like to congratulate you for what I think is a refreshingly good answer. Let me ask you if you are aware of the fact that on radar scopes, sometimes the blips that occur on radar scopes are not accurate?

Mr. WEISS. That I am not aware of. I have some knowledge of radar, and I am not sure of quite what you mean by not accurate in this instance. If you could define the condition that might produce the inaccuracy, I could respond to it, but I have some knowledge of radar, having spent some years working with it.

Mr. EDGAR. How do you know that the squiggly lines you are looking at are really supersonic?

Mr. WEISS. We do not know it at all.

Mr. ASCHKENASY. They are not supersonic. Those are sound waves. Those are presentations of sound waves. The question, what you might want to ask, is about whether we can tell a bullet was there, namely, was it creating a supersonic shock wave. That is what you are questioning. And those are not supersonic sound waves. Those are sound waves as recorded by a microphone, and put into electrical form by the equipment that was used to transmit it and record it, and there is nothing supersonic in those squiggles that we have up there on that board.

Mr. EDGAR. Would you answer the question I wanted to ask?

Mr. ASCHKENASY. Well, because you have a bullet that travels faster than sound, it will get to someplace faster than the sound reaching that same point. We are talking about two components, the bullet and the muzzle blast. The bullet flies, let's just pick a number, at 2,220 feet per second, so that it travels at twice the speed of sound for this particular example, when you fire the gun.

And it flies, let's say for 200 feet. It will get at the target 200 feet away in a certain period of time. Just like a boat pushes the water ahead of it creating the V-shape wake behind the boat, that is similar to what you see in a shock wave from a bullet. And that shock wave is what is recorded by the microphone that is right next to the target. Sometime later, finally the sound catches up to it and gets to the target, and the muzzle blast is recorded. That interval of time is fixed, by the fact that you have a certain muzzle velocity and you have a certain distance, they occur in a fixed time relationship. We have also the first, it's covered by the photograph—could somebody remove that photograph, please. If I may point something out there.

Mr. EDGAR. Yes.

Mr. ASCHKENASY. I can point out here also these first impulses before the muzzle blast, those are the shock waves, and if you look carefully—I am sure you cannot look that carefully at that distance—but if you look at these graphs, because these microphones are located at different positions on the street, the relationship between the shock wave and the muzzle blast changes, and it changes in a predictable manner because the manner in which you expect them to change is related to where the observer, or the microphone is picking up both the shock waves and the muzzle blast.

Now, you measure here about on the average of about 14 milliseconds, 14 thousandths of a second delay between the shock wave and the muzzle blast. We go now here to the police tape and the measurement that we found was around 24 milliseconds here. It is now reasonable to assume because of the measured time interval that the impulse may have attributes of a shock wave.

If you expand the experiment tape and take an even better look at it, you find there is a little shock wave echo right in between the shock wave and the muzzle blast, and if you expand the police tape properly, you find similar patterns, implying to us that this impulse has the qualities, attributes of a shock wave.

Mr. EDGAR. Two further questions relating to that. Your length of little squiggly lines which represent this particular shot, does that impinge on the next shot?

Mr. ASCHKENASY. No, no; this point right here in time is approximately seven-tenths of a second before the beginning of the next shot, and this whole display here is approximately three-tenths of a second.

Mr. EDGAR. I know this was not part of your scientific work, but when you look at the whole tape played out, how many muzzle blasts did you see?

Mr. ASCHKENASY. We did not look at the whole tape as you describe it, laid out. We saw, we examined this one in very great detail, and we examined the other candidates that we had been asked when we reviewed the first approach and before the experiment that Dr. Barger performed.

Mr. EDGAR. But would it be your expert opinion that Dr. Barger would be able to have described and looked at the number of muzzle blasts?

Mr. ASCHKENASY. I am sure that he looked—I don't understand what you mean. When, muzzle blast relating to the Dallas police tape?

Mr. EDGAR. It seems to me if you have large lines indicating when the muzzle blast occurred, that if you looked at the total tape played out across the room, that we would see four things that would look like four muzzle blasts.

Mr. ASCHKENASY. However, they will not look the same, because at the locations where they were picked up the motorcycle was in different orientation relative to the sound source, and as was discussed earlier, the windshield has an effect, the position of the microphone, which we suspect was on the left side of the motorcycle, those all would affect the quality, if I can call it that you know, the shape of the received muzzle blast.

Chairman STOKES. Time of the gentleman has expired.

Mr. FITHIAN. Mr. Chairman, I have just one question of Mr. Aschkenasy before he steps down.

Chairman STOKES. Mr. Fithian is recognized.

Mr. FITHIAN. I did not quite understand what you said. Would the shock wave produce the same echo pattern as the muzzle blast?

Mr. ASCHKENASY. No, no; the shock wave produces its own echo pattern. I do not know exactly what it is, but this sure does look like one. It is a qualitative statement rather than a quantitative statement.

Mr. FITHIAN. Thank you.

Chairman STOKES. Mr. Edgar.

Mr. EDGAR. Mr. Chairman, I just have one additional question and that is the question of probability. The thing we have been reading about in the newspaper and what you have testified this morning is you are 95 percent sure that what we are seeing is a fourth shot. And if I understand the use of the word probability, it is based on some history. I wonder if you could describe the history around which your 95-percent probability is based.

Mr. WEISS. Well, the probability we are talking about here is simply that sort of calculation that says well, look, let us not talk in terms of echoes and so forth. We have a range here of about 300 milliseconds, and let us divide it up into 2-millisecond intervals, giving 150 intervals. Now suppose that we are dealing with a deck of 150 cards, and I tell you that in this deck there are only 12 spades. All right, if I give you 14 chances to deal cards from the deck, what are the chances that you are going to deal out 10 spades? The probability of that is less than 5 percent. In other words, the probability of something happening by a random process, that would have generated, in fact, a set of data that closely matches a known set of events, that is to say a predicted set of echoes, they are the knowns, the chances of that occurring is less than 5 percent.

Mr. EDGAR. So what you are saying is if we would go back to Dallas, and have a gunman perched on top of the railroad overpass shooting at a target, that there would be only a 5 percent chance.

Mr. WEISS. No; that is different situation entirely. That is not a random event. That is a systematical one. You are describing a specific process.

Mr. EDGAR. What I am suggesting is 100 different locations in Dealey Plaza where you could shoot a rifle and get echo patterns.

Mr. WEISS. No; again we are dealing with generative processes, not one of them will match exactly, unless he is merely within a few feet. If you pick the microphone where it was and move it at the right rate, and now we have all of these people spread all over Dealey Plaza shooting wherever they want, then not one of them is going to match as well as this does here.

If, however, you have a radio receiving signals, and everybody has heard radios that receive signals, there is a lot of static, and a lot of crackling noises going on, and some of those noises are people turning microphones on and off. These are random events, there is nothing systematic about it. It can occur at any time. There is nothing which forces a crackle to occur at any one particular time. That is the sort of thing we are talking about. Is this noise, or is this something that occurred through a systematic process? The chances of this being noise is less than 5 percent.

Mr. EDGAR. But, what experience do we base that on?

Mr. WEISS. Oh, long theoretical experience in probability studies of exactly this sort. This has been proven time and time and time again over many years, this sort of analysis.

Chairman STOKES. The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Just going a step further, as I understood your response to Mr. Edgar's question and, in fact, your response earlier to the chairman's question with regard to the degree of probability, you are 95 percent sure that there was a noise emanating from the grassy knoll. To what extent are you sure, based on your responses to questions I raised with you, with like sounds that could create that pattern, to what degree are you sure that this was a rifle that was fired from the grassy knoll?

Mr. WEISS. Well, I never, I have not done any kind of consideration of certainty there. I cannot, in fact, say I am sure at all, all I can again do is point to the evidence of a shock wave preceding the muzzle blast, and, in fact, as Mr. Aschkenasy pointed out, there is even a kind of early shock wave echo.

Mr. DODD. But you were fairly, in response to my questions about similar things that could occur that would create a sound, you said to me that you did not know of anything else that could create a pattern such as we have seen here other than a rifle.

Mr. ASCHKENASY. Well, the question that you posed to us just a few seconds ago is what kind of a probability did we assign to the question of whether there was a rifle there or not; correct?

Mr. DODD. Correct.

Mr. ASCHKENASY. Now, how we did the analysis was to locate the source and the receiver, namely, the motorcycle. And the detail of analysis that we applied to that process was not applied to the question of whether it was a rifle or not. To us, we were satisfied enough that there were indications of a rifle, but we did not proceed to the extent that we did with locating the source and in locating the motorcycle. The question of whether it was a rifle or not is equally important and must be addressed with the same degree of refinement that we applied to that one.

Mr. DODD. Are there acoustical tests that could be performed that would provide us with some degree of probability as to whether or not that, in fact, was a rifle?

Mr. ASCHKENASY. I would take 10 minutes to think it.

Mr. DODD. I am sorry?

Mr. ASCHKENASY. I would need 10 minutes to think some tests up.

Mr. DODD. But there are tests——

Mr. ASCHKENASY. Oh, sure.

Mr. DODD. That could be performed?

Mr. ASCHKENASY. Oh, sure.

Mr. WEISS. By the way, for clarification of those listening who may be wondering what a shock wave is, that is the well-known crack sound that you hear when a rifle is fired that precedes the muzzle blast. It is normally almost simultaneous with the bang or muzzle blast, itself. It is similar to the sort of thing you hear when someone cracks a whip and, of course, a very louder and deeper toned example is the sound you hear when an airplane goes by overhead at a greater speed than the speed of sound. It is a sharp, very brief, but very intense sound.

Mr. DODD. May I address this to Mr. Blakey. I am curious as to why we did not ask for an acoustical analysis of that which created the sound in addition to its location.

Mr. BLAKEY. We began with oral testimony, an eyewitness testimony that heard rifle fire from that direction. We began with oral testimony of people seeing smoke from that direction. And the question was, was there scientific corroboration for what the people heard and saw in Dealey Plaza: That is, gunmen shooting from different directions.

When we asked Dr. Barger to determine whether he could detect gunfire on the tape, we asked him literally to do that. He did, and what he found on the tape apparently was gunfire that we had substantial corroboration for on shots 1, 2, and 4 from the depository in the ballistic and neutron activation analysis, and in the other areas. The material that they looked at for a possible shot from the grassy knoll on 3 looked like the other patterns, and the question that was asked of us was not did a rifle fire from that direction, but did a shot fire from that direction. And consequently what we have, what we were concerned with was the direction of the shot.

Mr. DODD. We made an assumption that it was a shot?

Mr. BLAKEY. No; I think that the match between the known shot in Barger's test and the possible shot in the 1963 tape was sufficiently clear on a 50–50 probability that it was 50–50 that it was rifle. Now, the next question was, could we carry that direction further, and we did. I don't know if it is fair to say we assumed it was a rifle. But what it corresponded to was a rifle shot. To the degree that it had a supersonic wave preceding it, one would suppose it was a rifle. In the original test shots it ought to be appropriate to note that we fired a pistol from the grassy knoll and we did not assume that it was either a rifle or a pistol on it. We fired both, and the correspondence was to the rifle, not the pistol.

Mr. DODD. You fired both the pistol and rifle?

Mr. BLAKEY. We fired both a pistol and rifle from the grassy knoll, and the correspondence was to the rifle. Mr. Cornwell has something to add to that, Mr. Dodd.

Mr. CORNWELL. I might note just for the committee's interest that marksmen with the Dallas Police Department that fired the pistol hit in an area after several shots, I did not check it all the way to the end, but after several shots you could cover all of their pistol shots with a quarter, so even though they were obviously excellent shots, the distances involved are not lengthy, so that, roughly speaking, the ability to hit a target at those distances would be somewhat comparable whether you used a pistol or a rifle.

Mr. FAUNTROY. Mr. Chairman.

Chairman STOKES. The gentleman from the District of Columbia, Mr. Fauntroy.

Mr. FAUNTROY. That raises the question in my mind as to whether in fact, there were at that time pistols that could create the impulse of a rifle in terms of the speed of the muzzle blast, and I have the feeling that we do not have that information available to us now. In short, you recall my question earlier.

Mr. BLAKEY. Mr. Fauntroy, I think we may.

Mr. FAUNTROY. I would like to know about the pistols fired.

Mr. BLAKEY. Mr. Cornwell is looking at a Gun Digest that may have that data in it.

Mr. FAUNTROY. Very good. Mr. Chairman, I will yield at this point.

Mr. CORNWELL. Mr. Chairman, the Gun Digest which we have previously admitted as JFK exhibit F-673 does reflect that there were pistols available on the market in 1963 which fired ammunition supersonically, above the speed of sound.

Mr. FAUNTROY. Thank you, Mr. Chairman.

Chairman STOKES. Any members seeking further recognition.

Mr. Cornwell, do you have a further request of the Chair?

Mr. CORNWELL. Yes, Mr. Chairman. I might request that you consider asking Mr. Aschkenasy and Professor Weiss if they could provide us in some written form a supplement for this record which would correspond to the diagrams they previously drew on the blackboard and, of course, which we lost in the process of erasing and creating subsequent diagrams.

Mr. WEISS. Yes, we can.

Mr. DODD. Mr. Chairman, may I make an additional request. We are going to have Dr. Barger on this afternoon, and I think it would be highly appropriate if we had both of our present witnesses with him at the time so that if there are questions that would be asked of Dr. Barger that he may want to refer to either

Dr. Weiss or Dr. Aschkenasy, they would be right there so we would have some consistency in the questioning.

Chairman STOKES. As long as the gentlemen can be available to us, the committee would appreciate it.

Professor Weiss, Mr. Aschkenasy, at the conclusion of witnesses testimony before our committee——

Mr. BLAKEY. Excuse me, Mr. Chairman. I would note Mr. Aschkenasy has a religious obligation that will prevent him from being here this afternoon. And I think Mr. Weiss could make it.

Mr. WEISS. Yes.

Chairman STOKES. Professor Weiss, Mr. Aschkenasy, at the conclusion of a witness testimony before our committee, the witness has 5 minutes during which time they may in any way explain or amplify their testimony before this committee. I would extend to the two of you at this time 5 minutes for that purpose, if you so desire.

Mr. WEISS. Thank you, Mr. Chairman. I will not take very much time at all. I simply would like to take this opportunity, as I did in the executive session, to put on the record my appreciation for the great work of the committee staff in getting information to us that we had requested that was important in our analysis.

I also would like to express my deep appreciation for the fine cooperation of the New York City Police Department in arranging for and performing for us the various experiments that were conducted at their firing range and that really greatly helped us to understand better what we were looking at.

Thank you, Mr. Chairman.

Chairman STOKES. Well, thank you, and on behalf of the committee I certainly want to thank both of you for the time you expended, the cooperation you have given to both the staff and this committee, and for the testimony that you have rendered here in this hearing room today. We are indebted to both of you and thank you very much.

Mr. WEISS. Thank you, Mr. Chairman.

Mr. ASCHKENASY. Thank you.

Chairman STOKES. The Chair recognizes Professor Blakey.

Mr. BLAKEY. Thank you, Mr. Chairman.

As you will recall, the time span between the shots allegedly fired by Oswald from the Texas School Book Depository itself potentially raises the specter of a conspiracy. FBI expert testimony to the Warren Commission indicated that Oswald's rifle could not be aimed and fired in less than 2.25 to 2.3 seconds. Consequently, for the Commission to conclude that Oswald fired two or more shots, there had to be at least that time interval between them.

The acoustics project has now made available to the committee evidence indicating that shots 1 and 2 from the depository were 1.59 seconds apart. If the FBI expert testimony is correct, Oswald could not have been firing alone from the Texas School Book Depository building—there had to be another gunman.

As you will also recall, Mr. Chairman, I reported to the committee on September 11 the results of preliminary tests conducted by the staff at the Metropolitan Police Department firing range in Lorton, Va, under the general supervision of Sgt. Cecil Kirk. Those tests established that a Mannlicher-Carcano could be operated accurately in considerably less time than had been indicated by the FBI.

I indicated in September that these were preliminary tests and that more refined tests would be subsequently performed. They had been scheduled for the early part of December. Unfortunately, Sergeant Kirk had to undergo surgery, delaying the test results. Delayed test results are, therefore, not expected until the first of the year. Nevertheless, the preliminary tests are sufficient to cast into serious doubt the previously established FBI time intervals.

The difference between the two sets of tests may be accounted for by the simple fact that a telescopic sight was used by the FBI, while the open iron sights of the Mannlicher-Carcano were used by committee staff marksmen. It is the view of the committee's expert firearms panel that the open sights on Oswald's Mannlicher-Carcano would have been preferred, given the conditions in Dealey Plaza in 1963. It is worth noting that in firing tests for the committee in Dealey Plaza in August 1978, Dallas Police Department marksmen, using open iron sights, had no difficulty hitting their targets.

The results of the acoustics project not only led the committee to reexamine the FBI firing data, it also led the committee to look for a policeman on a motorcycle. The acoustics experts had predicted that the motorcycle with the stuck microphone was located in an area where neither they nor the committee had seen a motorcycle. If it could be proved that no motorcycle was in the predicted location at the time of the shots, then serious doubt would be raised about the reliability of the acoustics project. Similarly, when Professor Weiss and Mr. Aschkenasy later told the committee that their analysis of the waveforms indicated that the microphone was probably located on the left side of the motorcycle, no one knew the identity of the officer, or if, in fact, his microphone was mounted on the left.

The committee then began a review of the available documentation and film coverage of the motorcade to see if the acoustics predictions could be verified. It was a classic, scientific experiment. Our first efforts were disappointing. We found a picture of a DPD motorcycle parked in front of the Texas School Book Depository, showing its microphone mounted on the right side, not the left, and we could not find a motorcycle that appeared to be in the right location in Dealey Plaza.

Nevertheless, the investigation continued. The initial plans of the Dallas Police Department specified that the motorcade would be led by five motorcycles, followed closely by the lead car containing Chief Curry, and then the Presidential limousine. Eight motorcycles were to flank the Presidential limousine, four to its left and four to the right rear side. Motion pictures of the actual motorcade reflect that the initial plans were altered slightly on the morning of November 22, and only four motorcycles remained close to the Presidential limousine during the motorcade, two on each side. The other four, ridden by Officers McLain and Courson on the left and Baker and Haygood on the right, were spaced throughout the parade route at varying distances, but generally several car lengths separated them and they were behind the Presidential limousine.

Ultimately, the committee found film coverage, however, of the motorcycle in Dealey Plaza showing a bikeman on Houston Street several car lengths behind the Presidential limousine as it turned in front of the Texas School Book Depository from Houston onto Elm, the place that the acoustics project suggested it would be. The officer riding that motorcycle has been identified as Officer H. B. McLain.

It would be appropriate now, Mr. Chairman, to call Officer McLain.

Chairman STOKES. The committee calls Officer McLain.

Mr. McLain, may I ask you to raise your right hand, please, and be sworn?

Do you solemnly swear the testimony you are about to give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Mr. MCLAIN. I do.

Chairman STOKES. Thank you. You may be seated.

The Chair recognizes counsel, Gary Cornwell.

TESTIMONY OF POLICE OFFICER H. B. McLAIN, DALLAS POLICE DEPARTMENT, DALLAS, TEX.

Mr. CORNWELL. Thank you, Mr. Chairman.

Mr. McLain, what is your present occupation?

Mr. MCLAIN. Police officer, city of Dallas.

Mr. CORNWELL. How long have you been so employed?

Mr. MCLAIN. I am working on my 26th year.

Mr. CORNWELL. What is the nature of your present assignment with the Dallas Police Department?

Mr. MCLAIN. At the present, an accident investigator.

Chairman STOKES. Would the witness please pull the microphone a little closer to him?

Mr. CORNWELL. Directing your attention to 1963, what was the nature of your assignment during that year?

Mr. MCLAIN. I was assigned to ride a solo motorcycle.

Mr. CORNWELL. And how long had you been riding a solo motorcycle?

Mr. MCLAIN. Approximately 8 years.

Mr. CORNWELL. If I could direct your attention to November 22, 1963, the day that President Kennedy came to Dallas, were you part of the motorcade escort for the motorcade on that day?

Mr. MCLAIN. Yes, sir.

Mr. CORNWELL. Mr. Chairman, may I have marked and admitted as JFK exhibit F-679, a memorandum of the Dallas Police Department, dated November 21, 1963?

Chairman STOKES. Without objection.

[The information follows:]