DID THE EARTH SHAKE BEFORE THE SOUTH TOWER HIT THE GROUND?

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Abstract

In the debate over the collapses of the Twin Towers on 9/11, the shaking of the earth that accompanied these collapses has played an important role. This shaking registered clearly on seismographs. Less clear, however, are its causes and the times it began. The National Institute of Standards and Technology emphasizes the role of the debris from the collapsing buildings in producing the seismic signals. In assessing NIST's hypothesis I focus on the collapse of the South Tower and attempt to determine the time the collapse began, the time the debris from the Tower struck the ground, and the temporal relation of these events to the shaking of the earth that accompanied the collapse. I consider both the Lamont-Doherty Earth Observatory's seismic evidence and the evidence provided by a less studied form of seismic instrument, the video camera. I also draw on witness testimony. I conclude that key statements by NIST are false. Major shaking of the earth, and corresponding seismic signals, started well before the debris hit the ground. In fact, it seems certain that the shaking of the earth started before visible signs of building collapse. This evidence is incompatible with the official NIST hypothesis of the cause of the collapse of the Towers.

Introduction

In debates over the collapses of the Twin Towers on 9/11, the shaking of the earth that accompanied these collapses has played a significant role. The collapse of the North Tower is associated with a seismic disturbance with a local magnitude of 2.3 and the collapse of the South Tower, which will be the main focus of this paper, registered 2.1. [1] But the questions remain: when did this shaking begin, and what caused it? While it may seem intuitively plausible that the rapid disintegration of such enormous buildings would produce seismic signals, it is likely that understanding the nature and times of the signals will give us more insight into the destruction of these buildings.

In 2006 the National Institute of Standards and Technology, which had produced a lengthy report in 2005 on the demise of the Twin Towers, attempted to answer a number of questions about the collapses. Here are two of the questions and answers as found in NIST's 2006 publication:

> **5. Why were two distinct spikes—one for each tower—seen in seismic records before the towers collapsed? Isn't this indicative of an explosion occurring in each tower?**
>
> The seismic spikes for the collapse of the WTC Towers are the result of debris from the collapsing towers impacting the ground. The spikes began approximately 10 seconds after the times for the start of each building's collapse and continued for approximately 15 seconds. There were no seismic signals that occurred prior to the initiation of the collapse of either tower. The seismic record contains no evidence that would indicate explosions occurring prior to the collapse of the towers.
>
> **6. How could the WTC towers collapse in only 11 seconds (WTC 1) and 9 seconds (WTC 2)—speeds that approximate that of a ball dropped from similar height in a vacuum (with no air resistance)?**
>
> NIST estimated the elapsed times for the first exterior panels to strike the ground after the collapse initiated in each of the towers to be approximately 11 seconds for WTC 1 and approximately 9 seconds for WTC 2. These elapsed times were based on: (1) precise timing of the initiation of collapse from video evidence, and (2) ground motion (seismic) signals recorded at Palisades, N.Y., that also were precisely time-calibrated for wave transmission times from lower Manhattan (see NCSTAR 1-5A)... [2]

Question 5 posits seismic "spikes" that precede the collapses of the Towers. [3] NIST replies that there are no such spikes preceding collapse initiation and therefore there is no evidence of pre-collapse explosions in the seismic record. The seismic spikes, says NIST, indicate activity that occurred well after the beginning of the collapses and were caused by debris striking the ground.

NIST's statement is not free of ambiguity. NIST does not actually say there were no relevant seismic signals at all produced as the buildings came down, but it appears to be using the term "seismic spikes" to refer quite generally to the major seismic signal produced in association with the collapses of the Towers. In saying that the spikes were caused by debris hitting the ground, it apparently wishes to imply that there were no significant seismic signals produced prior to debris strike.

As for Question 6, NIST again deals in ambiguity. It does not say what it means by "collapse," but merely affirms that the first impacts of major debris from the Towers occurred at the estimated times (9 and 11 seconds).

In this paper, I will explain what I mean by "collapse initiation" in the case of the South Tower and will try to reach clarity on the time of this event. Then I will establish the time of debris strike. Next, after establishing the context of our investigation into seismic evidence, I will make a plea for a broad understanding of the seismic record, setting forth the case for the use of video cameras as crude seismographs. Then I will examine the video record of a camera by broadcaster NY1 that recorded the collapse of the South Tower, and following this I will set forth a hypothesis that I believe can explain the anomalies and difficulties that surround the issue of the shaking of the earth. In support of my hypothesis I will present corroborating testimony from witnesses. Finally, I will summarize the conclusions of the research.

I shall argue that key claims by NIST as given above are false. And although the issue of explosions will not be central to this article, I will suggest that the evidence presented in this paper is incompatible with NIST's collapse hypothesis.

Timeline

The main time estimates associated with the collapse of the South Tower as given in official reports are listed in the following table (times in all cases are Eastern Daylight Time): [4]

TIMES ASSOCIATED WITH COLLAPSE OF SOUTH TOWER

VISUAL	SEISMIC	SEISMIC REVISED
9:58:59 a.m.	9:59:04 a.m.	9:59:07 a.m.
NIST "Adjusted Time from Television Broadcasts" NIST Progress Report (2004, Appendix H, H-15) NIST Final Report 1-5A (2005, p. 22)	Time Reported in FEMA Study FEMA Report (2002, 1-10) NIST Final Report 1-5A (2005, p. 22)	NIST "Time Based on LDEO Recent Analysis" NIST Final Report 1-5A (2005, p. 22)

The 9/11 Commission report also gives a time of 9:58:59 a.m. for collapse initiation but this is not an independent estimate, having been taken from NIST ("Adjusted Time from Television Broadcasts" as given in NIST's 2004 Progress Report.) [5]

In its early reports NIST gives a time of 9:58:54 a.m. based on visual records ("Relative Time from Visual Analysis"), but it later rejects this as inaccurate and as superseded by the 9:58:59 a.m. time ("Adjusted Time from Television Broadcasts"), which is its final and best visually determined estimate. [6] We need not get into the issue of what led to the five seconds being added to the earlier estimate.

So the final visually determined estimate of collapse initiation—in other words, the time when the video records indicate collapse begins—9:58:59 a.m..

The two further times in the table above (9:59:04 a.m. and 9:59:07 a.m.) are both based on seismic evidence as distinct from video-based visual evidence. NIST asserts that seismic times are later than the visually determined times because they refer to the moment when debris strikes the ground. The first of the seismic estimates (9:59:04 a.m.) is the time originally given by Columbia University's Lamont-Doherty Earth Observatory (LDEO) in Palisades, New York and thereafter included in the 2002 report of the Federal Emergency Management Agency (FEMA). [7] This time estimate and the rationale behind it have been available since 2001 and have been corroborated, apparently, by other seismic stations. [8] But the final NIST report accepts a revised seismic time of 9:59:07 a.m. ("Time Based on LDEO Recent Analysis") and takes this as superseding the time of 9:59:04 a.m.**.** [9] How could LDEO have been off by three seconds in the earlier estimate? What is the rationale for the three second revision? NIST does not tell us, and the LDEO report that NIST refers to when justifying this change has apparently not been made public. [10]

There is reason to be cautious about the revised seismic time. Notice the difficulty NIST found itself in prior to the discovery by LDEO that it had been off by three seconds. NIST was committed to a collapse initiation time of 9:58:59 a.m. There was not much room to maneuver with this figure since television broadcasts with appropriate time-stamps were publicly available—two of them will be used in this paper. But LDEO had reported that the seismic signal began at 9:59:04 a.m. Since NIST wished to claim that the seismic signal was caused by debris hitting the earth it found itself in trouble. If the seismic signal that began at 9:59:04 was caused by debris striking the ground this left only five seconds for the debris to make it to the ground—utterly impossible without a violation of the laws of physics.

So NIST apparently sent LDEO back to the drawing board and LDEO returned with an extra three seconds. As can be seen in NIST's 2006 Question 6 and response as given above, NIST settled on nine seconds as the time in which sufficient debris hit the ground to cause a seismic spike. NIST got eight seconds as the difference between the two times (9:58:59 a.m. as collapse initiation time and the revised LDEO seismic time of 9:59:07 a.m.) and had no difficulty coming up with an extra second by referring to margin of uncertainty in measurement (one second for network time-stamps and one second for the

seismic times referring to the South Tower's collapse). [11] NIST has tried to find a way to create sufficient time between collapse initiation and debris strike to make it plausible that the LDEO-recorded seismic signal began when debris struck the ground.

What did LDEO do to come up with three extra seconds?

First, recall that although the times recorded for the arrival of seismic waves are extremely accurate these recorded arrival times are not at the centre of the controversy. At the centre of the controversy are "origin times," the times when the seismologists estimate the seismic waves were produced. These origin times are not directly recorded but computed. In order to compute them it is necessary to know the type of seismic wave being dealt with and, from this, the expected speed of the waves; the distance of the point of origin from the seismometer where the waves' arrival is recorded; and the medium (type of rock, and so on) through which the waves have traveled to get from their point of origin to the seismometer, since this medium will affect the speed.

In the present case the LDEO seismologists determined that the waves in question were predominantly short-period Rayleigh waves. Rayleigh waves are a form of "surface wave." They travel near the surface of the earth, as distinct from seismic "body waves" that travel more deeply in the earth. The seismologists estimated that these short-period Rayleigh waves would be traveling an average of 2 kilometers per second from the World Trade Center to the seismic station in Palisades, New York. Since the distance between the two points is 34 kilometers, they gave 17 seconds as the time it would take the seismic waves to make their journey. It was on this basis that the time of 9:59:04 a.m. EDT was initially established as the *origin time* for the South Tower's seismic signal. The arrival time of the seismic waves was, therefore, 9:59:21 a.m. EDT. [12]

It seems unlikely that the time of 9:59:21 a.m. was changed by LDEO. I assume that what was changed was the estimate of the speed of the Rayleigh waves. If the waves were assumed to be traveling 2.4 km/s instead of 2 km/s NIST would have its extra three seconds. But did LDEO have good scientific reasons to make this change or was the change made because NIST requested a few extra seconds? Until NIST and LDEO tell us how they got the three seconds and what their justification of the procedure is, I do not see how we can accept the revised figures.

What do we do in the meantime? Unwilling to take LDEO-NIST's new figures on faith, we are stuck in NIST's earlier dilemma: we have only five seconds between collapse initiation and seismic signal, and no matter how we twist and turn and juggle the figures this gap is too narrow.

Toward Reliable Times for Collapse Initiation and Debris Strike

(i) Collapse Initiation:

What should we accept as indicators of the beginning of the collapse of the South Tower? How shall we get a precise time for this event? How shall we corroborate our time?

While I do not favour the term “collapse” as descriptive of what happened to the Towers—I prefer “destruction”— I will accept the use of the term in this paper without debate. But this concession does not solve the problem of what we should mean by “collapse initiation.” To what event does this refer in the case of the South Tower? We could use the expression to refer to the first downward movement of the building but there is another obvious possibility. The top of the South Tower underwent a number of quite rapid changes. The earliest and most visible change that we could reasonably associate with collapse is the deformation of the top of the building—often referred to as a “leaning” or “tilt” of the top portion. This “tilt” toward the east and south can be seen quite distinctly in surviving videos, and with the help of selected video evidence we can make a fairly good estimate as to when it began. *In this paper, I shall take the beginning of this tilt as collapse initiation.*

Although a judgment is called for when determining the beginning of the tilt (the distortion of the building is gradual; the event is not clean or sharp), I estimate that frame 61 in a video clip from NBC is the first frame in which the tilt can confidently be ascertained. [13] Frame 61 is located at 2.035 seconds into this video clip.

Collapse Initiation:
NBC video, frame 61

Unfortunately, the NBC video, despite its clarity, has no time-stamp, so we must find a way to coordinate events in it with events in videos that do have time-stamps. (For a discussion of time-stamps and related method, see Appendix A.)

It is possible to discover what I shall call “distinctive transient events” (DTE) in the video footage we possess, which allow us to match frames quite accurately between two or more videos. Two such DTEs suffice to allow us to place the NBC video, with its clear view of collapse initiation, on a time-line.

A frame showing three ejections from the northeast corner of the South Tower gives us our first DTE. We can find this event in the NBC video and on a time-stamped ABC video. [14] Although the perspectives differ (the NBC video has been shot from the northeast, whereas the ABC perspective is from the north) the match is quite precise, because this configuration of ejections lasts for only about one tenth of a second. [15] The matching frames recording this DTE are:

NBC 196 (6.540) = ABC 108389 (1:00:16.580).

NBC: three ejections at 6.540 in video clip

ABC: three ejections at 1:00:16.580 in video clip

The real time of this DTE, as determined through the use of the correct ABC time-stamp (see note 14) is: 9:59:04.092 a.m. EDT.

Carrying out the required calculations, we arrive at a collapse initiation time of (6.540 – 2.035 = 4.505, and 9:59:04.092 – 4.505 =)

9:58:59.587 a.m. EDT.

To seek correction or corroboration we need to find another DTE that will allow us to use a separate and independent broadcaster time-stamp to determine the time of collapse initiation. We discover that a line of "puffs" or ejections on the east face of the South Tower are visible on both the NBC video and a video of the South Tower's collapse by broadcaster NY1. [16]

To compare the two video clips, which capture the South Tower from different directions (NBC from the northeast and NYI from the south), it is necessary to look at a series of frames. Appendix B gives 6 frames from each video clip. We then choose, with some confidence, the first frame in each series (frame 75 in the NBC clip and frame 1470 in the NY1 clip) as matching or near-matching frames.

NBC frame 75 (2.503 sec. into clip)

NY1 fr. 1470 (49.049 sec. into clip)

Frame 1470 in the NY1 video clip represents a time of 49.049 seconds into the clip. Since the NY1 time-stamp flips to 9:59 at 48.315 seconds into the clip (frame 1448), we can determine that the real time represented by frame 1470 is (49.049 - 48.315 = 0.734, and 9:59:00.000 + 0.734 =) 9:59:00.734 a.m. We now bring in the NBC times and calculate that collapse initiation must be at (2.503 – 2.035 = 0.468, and 9:59:00.734 - 0.468 =)

9:59:00.266 a.m. EDT.

Using ABC-NBC matching frames we derived a collapse initiation time of 9:58:59.587. The two collapse initiation figures differ by only 0.679 seconds, so, assuming we have been correct in our choice of the first frame in which collapse initiation is represented, we can be quite confident in our estimate of collapse initiation time.

NIST's figure of 9:58:59 a.m. EDT for collapse initiation is surprisingly close to the range of times I have calculated, especially since NIST has not been as forthcoming as it should have been about its method of reaching its figure. Although my times are slightly later than NIST's I will not quibble over the differences but will, for the purposes of this paper, take NIST's estimate of collapse initiation as accurate. The differences at issue are too small to affect the conclusions reached in this paper.

What have we gained from this procedure? We have a transparent, replicable method for determining the time of collapse initiation, with details NIST has not given. We can now

have confidence in NIST's collapse initiation time for the South Tower (similar research shows NIST to be equally accurate for the collapse initiation time of the North Tower), [17] *and we have a method that we can extend to other events and video clips*.

(ii) Debris Strike:

We can now ask if NIST has been as careful in determining the time of debris strike as it has been in estimating the time of collapse initiation.

There are several ways to pursue this investigation, but let us begin by taking NIST's own figures and estimates and asking how well they stand up when we bring new video evidence to bear.

There is a well known video clip, the provenance of which is unknown to me, in which the South Tower's collapse is recorded from a position on the ground quite close to the Tower. [18] Firefighters are seen in the foreground at the beginning of this clip, and I shall therefore refer to this as the "Firefighter video." There is a very interesting soundtrack accompanying the recording, which confirms that the video is playing in real time. [19] This video will help us with our next DTE.

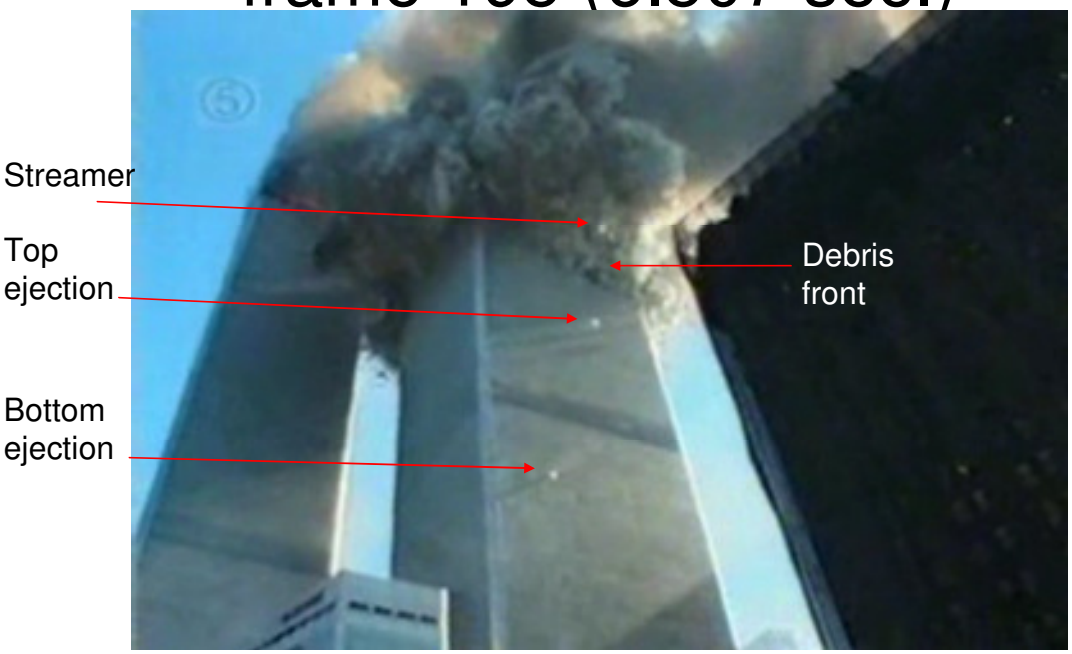
But first let us look at a frame from a CBS helicopter video clip that NIST offers us in its report. [20] The frame shows two focused ejections on the south face of the South Tower, and NIST has attached to this frame a time of 9:59:06 a.m. (Black arrows with accompanying black text have been added by me.)

NIST CBS frame: 9:59:06 a.m.

The two ejections are ahead of the collapse front but one is much lower than the other. We can also see a "streamer" moving down the south face. These, as well as relative positions and distances and the configuration of the collapse front, give us our DTE.

The Firefighter video has a frame that closely matches this, recording the same DTE. It is frame 195 (6.507 seconds into the clip). The streamer appears in the CBS frame to be lower than the top ejection and appears in the Firefighter video to be higher than the top ejection, but I believe from other elements in the frames that this is a result of radical difference in perspective.

Firefighter video: frame 195 (6.507 sec.)



Now that we have coordinated these clips, we can make a time estimate for debris strike. One of the great advantages of the Firefighter video is that it shows the debris wave very clearly as it plunges to the ground, and it also records the sound of the debris wave striking the earth.

Frame 345 (11.512 seconds into the clip) shows the debris front descending on the Marriott Hotel, also known as WTC 3, and poised to strike the ground.

Firefighter video: the debris front

I believe that the first main debris strike took place less than a second after this frame. I say this on the basis of measurements of the debris front and of its speed as it passes the 242 foot tall Marriott Hotel. [21]

Let us suppose that the debris front struck the ground 0.5 seconds after this frame. In this case, debris strike occurred at 11.512 + 0.5 = 12.012 seconds in the clip. But we have determined, using NIST's time estimate and our matching frames, that 6.507 in the clip = 9:59:06 a.m. Therefore, the debris strike must have occurred at (12.012 – 6.507 = 5.505, and 9:59:06 + 5.505 =)

9:59:11.505 a.m. EDT.

But if collapse initiation occurred at 9:58:59 a.m. as NIST says, the time it took for the debris to strike the ground after collapse initiation was (9:59:11.505 – 9:58:59 =) 12.505 seconds.

We recall that NIST has said:

"NIST estimated the elapsed times for the first exterior panels to strike the ground after the collapse initiated in each of the towers to be approximately 11 seconds for WTC 1 and

approximately 9 seconds for WTC 2. These elapsed times were based on: (1) precise timing of the initiation of collapse from video evidence, and (2) ground motion (seismic) signals recorded at Palisades, N.Y., that also were precisely time-calibrated for wave transmission times from lower Manhattan (see NCSTAR 1-5A)..." (my emphasis)

NIST is wrong by more than three seconds, a surprisingly large figure under the circumstances and given the importance of these matters.

But is it not possible that "the first exterior panels" preceded the debris wave seen in our video clip? We have no reason to be interested in this or that particular panel. NIST has made its estimate on the basis of seismic signals, so the debris of interest to us must be sufficiently massive to create seismic waves. We have every reason to believe the first significant wave of debris has been captured in the relevant frames of the Firefighter video.

Now we must consider the seismic evidence. NIST says that while it estimated collapse initiation from visual evidence, as we have also done in this essay, it estimated debris strike from seismic evidence obtained from the Lamont-Doherty Earth Observatory in Palisades, N.Y., 34 km from the WTC. Why NIST would choose to use this seismic evidence instead of visual evidence obtained close to the WTC (as in the Firefighter video) is not clear. But let us now turn to NIST's seismic evidence to see how convincing it is.

Seismic Evidence

(i) NIST, FEMA and LDEO Establish the Context:

In its 2005 report, NIST glosses over a serious difficulty. It says:

> Times listed in Table 3-1 for the collapses of the two towers based on the television records and the revised LDEO analysis appear to differ significantly. These differences are likely due to different definitions used for the collapse times. The times based on visual analysis refer to the time when the collapse of a tower first became evident, while the times based on seismic records likely indicate the time when the falling debris first struck the ground. [22]

Notice the repeated use of the term "likely." As seen in the Questions and Answers quoted earlier, by 2006 NIST was speaking with confidence about the cause of seismic signals, yet scarcely a year earlier it had been using the word "likely." What was NIST trying to say here? Was it saying it had to guess the intentions of LDEO experts or the authors of the FEMA report? No guesswork should have been necessary: NIST is given by U.S. law the power to subpoena witnesses. [23] Or was it saying the seismic signal might have been caused by something other than debris strike? If so, this would be an important admission, quite at odds with the confident assertions of 2006.

If we consult the 2002 FEMA report and study its collapse times we will find that FEMA, basing itself on the LDEO seismic study, does not say that the debris hit the ground at 9:59:04 a.m. but that the South Tower *began to collapse* at 9:59:04 a.m. [24] According to FEMA, the start of the South Tower's collapse and the start of the seismic signal were simultaneous.

To put it differently, FEMA thought that the seismic signal started at the beginning of the collapse of the South Tower and lasted until debris strike, while NIST appears to have decided that the seismic signal started at the beginning of debris strike and lasted during the time it took for all of the debris to rain down. Why has NIST obscured this very important difference of interpretation of the seismic signal?

As for the Lamont-Doherty Earth Observatory, I see nothing in its report to indicate how its seismologists interpreted the figure of 9:59:04. [25] It is their estimate of the time of origin of the seismic signal from the collapse—but whether the signal started at the beginning or the middle or the end of the collapse they do not say. And why should they? They have no particular expertise in what was happening at the World Trade Center and there is no reason to look to them for a detailed interpretation of the figures they came up with. That has been the duty of FEMA and of NIST. But the FEMA report and the NIST report disagree fundamentally.

If this uncertainty hangs over the figure of 9:59:04 a.m., then it also hangs over the revised figure of 9:59:07 a.m. NIST apparently wants us to accept that the figure refers to debris striking the ground. But it has given us no reason to believe that this is LDEO's interpretation and, more importantly, no convincing reason to believe it is the truth.

(ii) Accidental Seismometers:

The LDEO report, "Seismic Waves Generated by Aircraft Impacts and Building Collapses at World Trade Center, New York City" says: "Unfortunately, no seismic recordings of ground motion are currently known to exist at or very close to the WTC." [26]

If by seismic recordings we refer to products of official seismic stations, the statement is correct. But we should bear in mind that seismic waves may be recorded in unofficial, informal or accidental ways. There may have been no formal recordings of seismic waves "at or very close to the WTC" by instruments designed for that purpose, and for this reason it may be possible to speak of the Palisades, New York seismic station 34 km from the WTC as the closest station. But there were instruments much closer to the WTC that recorded earth vibrations produced by the various events of 9/11. I refer to video cameras on tripods.

There has been some attention in the 9/11 truth movement to the trembling of video cameras and its significance, but many researchers have steered clear of the discussion. Whatever the reason for this timidity, there is no justification for ignoring this fascinating and important form of evidence.[27]

In this article I am interested in the overall pattern of perturbations associated with the collapse of the South Tower, and I will concentrate on a very important record left by a camera belonging to network station New York 1 (NY1).

But first a few words are in order about this general source and form of evidence.

The most obvious weakness and dangers of relying on the movements of video cameras are the following:

- There will be cases where the camera trembles but where we have no simple way of knowing what caused the trembling and whether it has anything to do with the Towers. It might be caused by a minor, irrelevant event such as the rumbling of a subway train or a simple jostling of the camera.
- Video cameras will, in many cases, record no reliable time, unlike a seismic station, which will have very accurate times.
- There may be little uniformity in the record produced by the trembling of multiple video cameras. Different cameras and different tripods may produce different records. The structure of camera and tripod, the terrain, the distance from the source of the signal—all these may be impossible to determine with accuracy. There may also be no easy way to match the records of one camera with those of another camera or to match any given camera with official seismic records.

Despite these difficulties, there are three obvious advantages of these sources of evidence:

- The instruments (the video cameras) may be much closer to the source of the seismic waves than any available seismic stations.
- The records, which in some cases include quite precise times via time-stamps, may be open to public scrutiny and interpretation.
- The perturbations recorded may be accompanied by simultaneous recording, by the same instrument, of visual and auditory events, which may provide various sorts of correction or corroboration.

Let me expand on the third advantage. The official seismic records tell us of vibrations in the earth that are obviously related in some way to the collapses of the Towers—but in what precise way they are related neither the records themselves nor the seismologists studying them can tell us. We have video records of the initiation and progress of the collapse, and we have separate seismic evidence: the challenge is to connect the two. It is an enormous advantage to have a recording device that records perturbations at the same time as it records visual and auditory material directly relating to the Towers.

But do we have reason to believe that trembling video cameras on 9/11 *ever* produced evidence directly connected to objective events in the Towers, as opposed to various irrelevant local events? Certainly, we do. There are, for example, five main camera perturbations recorded by Etienne Sauret's camera or cameras on 9/11, and there are good reasons to believe that most if not all were caused by objective events in the Towers. These perturbations are discussed in Appendix C.

The perturbations in Sauret's footage that are most directly relevant to this essay are those associated with the South Tower's collapse.

If we examine this sequence, the first clear evidence of camera trembling appears to come at frame 2605 (clip time 1:26.920). The perturbation has tapered off by about frame 2860 (clip time 1:35.429). This means the perturbation lasts for about 8.509 seconds.

But when does collapse initiation occur in this clip?

The South Tower is obscured by clouds of smoke, and only sporadically can we get a clear view of the perimeter columns with their aluminum cladding. The first frame in which I can definitely say that these vertical columns are beginning to lean is frame 2252, which represents a time of 1:15.142 in the Sauret film. The sequence is shot from the north and we observe the building lean toward the east.

But a closer time for collapse initiation can be gained by finding a DTE that ties the Sauret video to one of the other videos for which we have a secure timeline. As it happens, we can observe the vertical fall of the roof of the South Tower. We can watch as the slanted white section of roof falls past the airplane damage on the north face of the North Tower. We discover that this event is also clearly visible in the NBC video clip.

There are uncertainties in the matching of the two clips (Sauret and NBC) due to the quite different angles and distances from which the shots have been taken, but we are able to make a reasonably confident match.

The point at which the lower portion of the slanting white roof of the South Tower falls past the lower portion of the plane damage on the north face of the North Tower (not discernable, unfortunately, in the copy of the frame below, but discernable in the video) can be taken as corresponding to frame 2345 in the Sauret clip, which occurs at 1:18.245 in the film.

Sauret Matching Frame (2345)

I estimate that 196 is the frame in the NBC clip that most closely matches the above frame. It occurs 6.540 seconds into the clip.

NBC Matching Frame (196)

So our matching frames are:

Sauret Frame 2345 (1:18.245) = NBC Frame 196 (6.540)

Collapse initiation occurs at NBC frame 61 (2.035), which is therefore (6.540 – 2.035 = 4.505, and 1:18.245 – 4.505 =) frame 2210 (1:13.740) in the Sauret clip. This suggests that the shaking of the earth begins in the Sauret clip (1:26.920 - 1:13.740 =) 13.180 seconds after collapse initiation. But we need to subtract the time it takes for the seismic waves to reach the camera, which we shall take to be 0.8 seconds. [28] This means that the seismic event at its source begins (13.180 - 0.8 =) 12.380 seconds after collapse initiation.

We arrived at a figure of 12.505 seconds for debris strike based on a DTE in the Firefighter video and a NIST-dated CBS frame. The figures are very close and allow us to feel quite confident that the perturbations evident in the Sauret video clip are caused by debris strike and that the interval between collapse initiation and debris strike is approximately 12.5 seconds.

These results seem both to affirm and disconfirm NIST's conclusions. On the one hand, the Sauret camera's behaviour seems to support NIST's assertion that significant shaking of the earth began with debris strike, not before. On the other hand, the Sauret camera's behaviour suggests that NIST is in error by at least three seconds when it estimates the time of debris strike.

I shall suggest shortly a means of resolving this conundrum, at least as far as the South Tower is concerned.

In the meantime, I believe it is clear from the data presented in this section and in Appendix C that the shaking of video cameras recording the events of 9/11 cannot be dismissed as irrelevant but must be taken seriously as a source of evidence.

The Case of the NY1 Video Camera

We now turn to the instance of camera shake that is at the heart of this paper and of my analysis. The sequence of interest is the second in this video clip from broadcaster New York 1 (NY1). It is shot from a video camera apparently set up on a tripod on the ground to the south of the Twin Towers. The camera is pointed up at the Towers at a fairly steep angle and visibility is generally good, although copious black smoke obscures the top of the South Tower and does not permit a clear view of collapse initiation.

As of the time of writing of this article, the clip can be found here:

http://www.youtube.com/watch?v=srBvZE-i-vQ&feature=channel_page

and here:

http://ca.video.yahoo.com/watch/5477202/14412896

During this sequence we hear an exchange between anchor Pat Kiernan and Kristen Shaughnessy, a reporter on the scene. Shaughnessy is not with the camera nor can she see the image being broadcast. She is at a different location using a pay phone during this exchange. [29] But she has a clear view of the South Tower and is close enough that she will soon have to run for her life.

Shaughnessy asks, "Do you have...any shots right now of it?" Kiernan replies, "You know...we've got a shot looking up from the ground at the Tower there."

A few moments later Shaughnessy interrupts Kiernan:

"Oh! It's just coming down, Pat! It is just coming down! It's exploding! It is billowing! Pat, the debris is flying--I'm gonna run."

That is the last we hear of Shaughnessy on the tape. Kiernan, obviously stunned, continues as best he can.

When watching this sequence, note:

- There are early ejections of matter from the east side of the South Tower. These turn into great clouds descending evenly and at speed down the south (near) side of the building.

- As the Tower comes down, it gives off a roar, which changes in tone and increases its volume as the first wave of debris hits the ground.

- The camera shakes.

There is nothing subtle about the shaking of this camera. It has been commented upon by several viewers of the sequence on YouTube. [30] In fact, viewers have noted two separate phenomena. First, there is a very brief jiggle of the camera a few seconds before any sign of collapse. Second, there is a more dramatic trembling of the camera that is in progress by the time Shaughnessy finishes her sentence, "It is just coming down" and that continues without interruption through the rest of the sequence.

By simply pressing the pause button we can discern the main points in this sequence. The initial, sharp jiggle of the camera appears to happen at 45-46 seconds into the NY1 clip. Shaughnessy's "Oh!" and the first ejections of matter from the east side of the building appear to occur at 49-50 seconds. The first major and continuing shake of the camera seems to take place at 52-53 seconds. The increased sound of the collapse that appears to signal the debris striking the ground is heard at 1:02 – 1:03 into the clip.

To achieve more accuracy we will want to examine individual frames and make appropriate measurements. Then we can convert the times on the video clip to real times via the time-stamp. But the challenge this clip presents to NIST is already clear. The

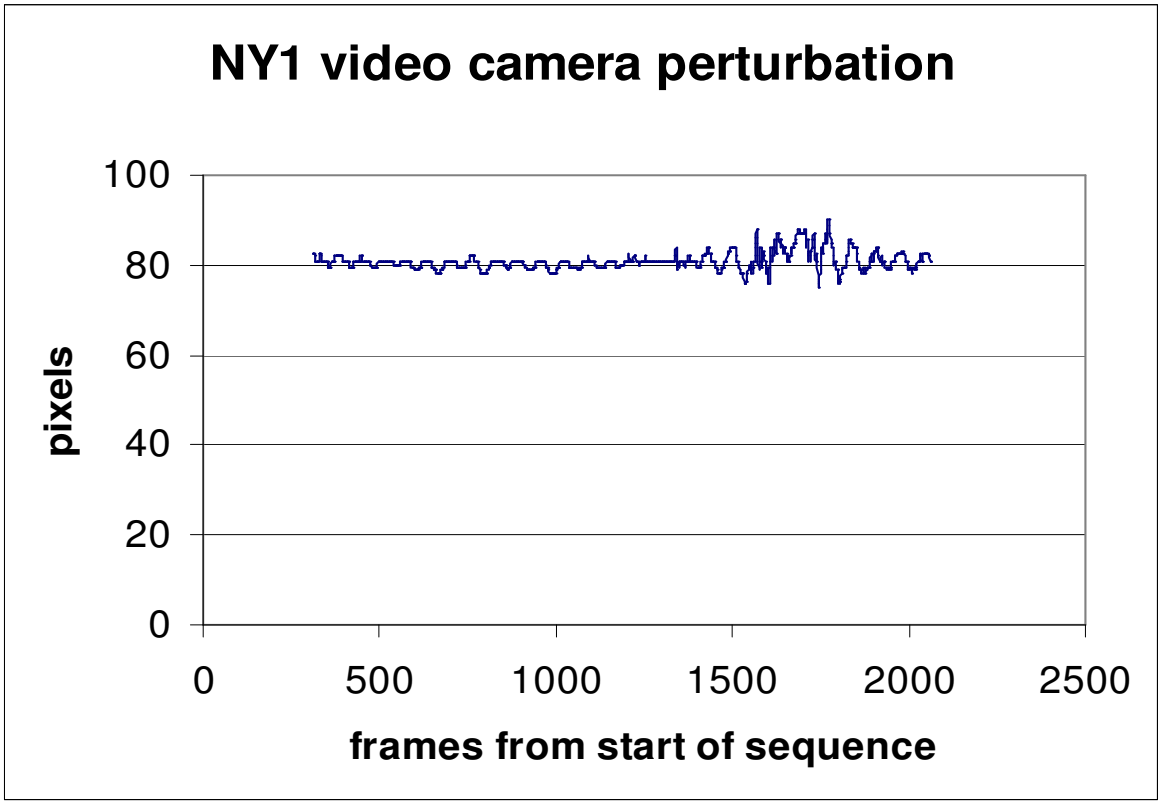
shaking of the earth may increase in severity as the debris hits the ground, but it starts well before this.

Has the camera, so much closer to the action than the Palisades seismometer, caught a shaking that the official seismometer has missed? Or has NIST misinterpreted the seismic signal from Palisades?

To answer these questions, our first task is to plot the shaking of the NY1 video camera. Having downloaded the clip to our hard drive, and having used VirtualDub to break it into frames of approximately 33 milliseconds each, we choose a point on a building visible in the frame and plot the movement of that point relative to the bottom edge of the picture frame during the sequence. We are not, of course, plotting the movement of the building but of the camera. In order to make sure we do not miss crucial information, we take one measurement of the point, using Screen Calipers, for each frame in the sequence. We nominate frame 310, during the fade-in, as the starting point of the sequence and frame 2063 as the end point. This gives us 1753 frames with as many separate measurements.

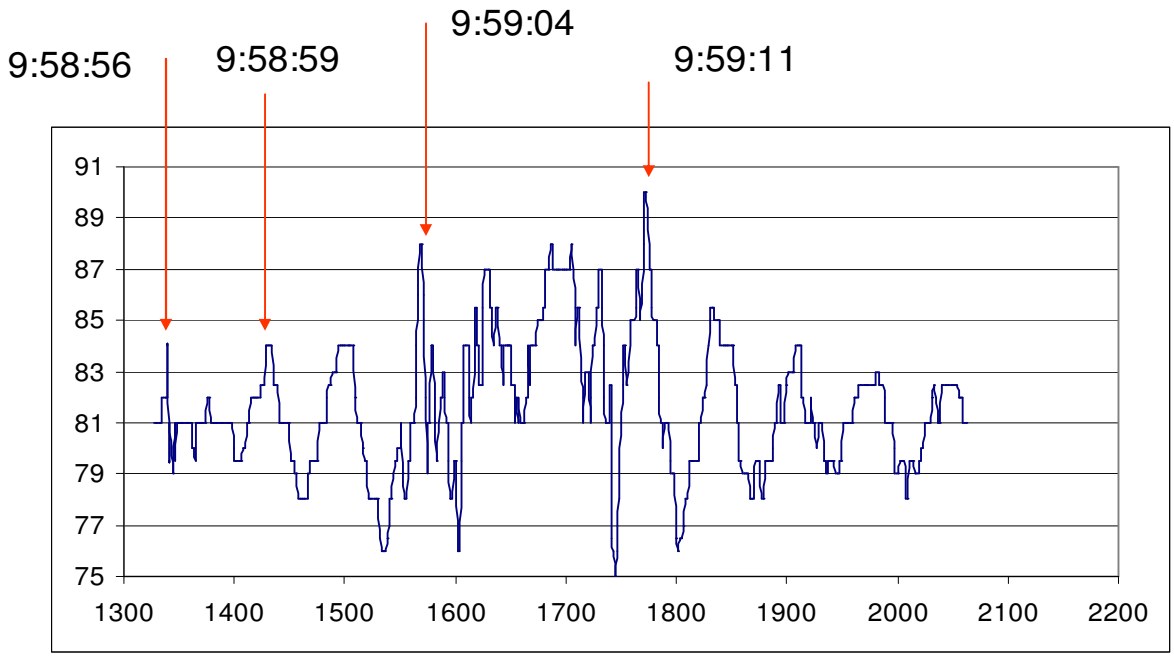
NY1: Distance Measured

When we enter the data on Excel, the following graph is produced:



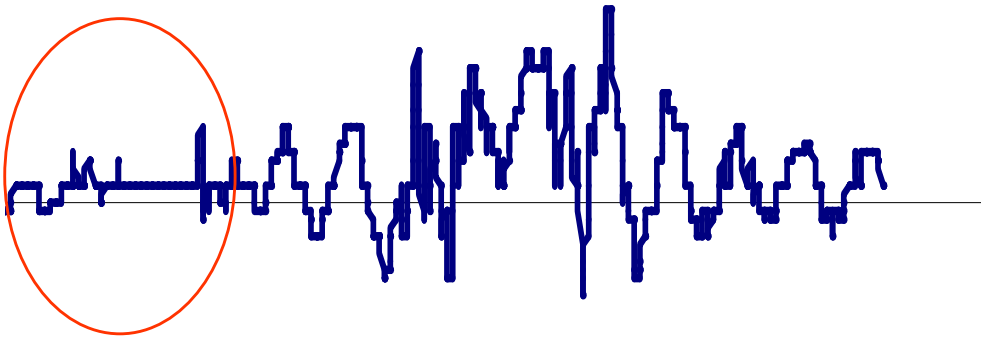
Let us now add four key times, concentrating on the portion of the sequence in which perturbation is greatest. [31] Bear in mind that this NY1 video clip has a time-stamp and that we have corroborated it through cross-referencing to the ABC time-stamp.

NY1 video camera perturbation: close-up



We can now make a few observations.

(1) The camera movement at 9:58:56 a.m. EDT, which shows up as a jiggle of the camera, is extremely sudden and brief, and it occurs about three seconds before collapse initiation. On close inspection, it appears likely that the movement at 9:58:56 is part of a series of less dramatic disruptions beginning several seconds earlier still:



(2) The prolonged bout of camera-shaking begins after the brief event just discussed and directly before collapse initiation as visually determined.
(3) The original LDEO estimate of the beginning of the seismic signal, accepted by FEMA, does not correspond either to the first brief camera shake or the beginning of the sustained sequence, but it does appear to correspond closely to a major spike (9:59:04).
(4) The largest spike in the series (9:59:11) appears to correspond to debris strike.

Since the Sauret camera began shaking 12.380 seconds after collapse initiation, we may hypothesize that the trembling of this particular camera was not triggered until the largest seismic spike (9:59:11), caused by debris strike and occurring approximately 12 seconds after collapse initiation. The times are not perfect because, not knowing the distance of the NY1 camera from the South Tower, I have not taken account of the time required for the travel of seismic waves. But, bearing in mind the differences in camera site, apparatus, and so on, and keeping in mind that the Tower did not hit the ground as a discrete and rigid body, our results are probably within a reasonable margin of error.

The real times given in the above NY1 chart will require adjustment if and when it is possible to determine the location of the camera and, from this, the distance of the camera from the South Tower.

Preliminary Conclusions:

I began this paper by noting NIST's claims that "there were no seismic signals that occurred prior to the initiation of the collapse of either tower," that the seismic spikes recorded by the Palisades seismic station occurred about 9 seconds after the beginning of the South Tower collapse, and that these spikes were the result of debris impacting the ground. We can now evaluate these statements. Although LDEO presumably recorded no relevant seismic signal prior to collapse initiation, we have certainly found one on the

NY1 video clip. And although debris impacting the ground did cause a seismic spike, it now seems that the seismic spikes recorded by the Palisades seismic station began well before debris struck the ground (probably between six and eight seconds before debris strike) and considerably less than nine seconds after the beginning of collapse.

Direct Corroboration

I have argued that the earth shook well before the South Tower hit the ground and, indeed, before visible collapse initiation. But the next question must be: Is there corroborating evidence? It may seem, after all, that I am allowing a great deal to depend on a single source, the NY1 video clip.

One of the richest forms of information about the WTC on 9/11 is witness testimony, so let us turn to this. Witness testimony tends to be qualitatively thick but quantitatively thin. We may get accurate and vivid descriptions of key events but we will seldom be able to measure quantities and will in most cases be unable, on this basis alone, to construct a detailed time-line. But let us see what we can learn.

I shall restrict myself to two sources of witness testimony, the oral histories collected by the Fire Department of New York (FDNY) and the written accounts of the Port Authority Police Department (PAPD). [32] Although I will concentrate on accounts of the South Tower's collapse, I will begin with four accounts of the North Tower coming down.

(1)

> *"As we approached Chambers Street, kept walking, still no one had told us about the total collapse [of the South Tower]. We get down to about Barclay and Vesey Street, which is a block away from the overpass, the bridge overpass that goes across the West Side Highway.*
>
> *All you hear is a rumbling in the street. It sounded like an earthquake. When I was a younger kid, I was in an earthquake and it felt like the same exact feeling. I looked, and I could see the antenna on the top of the roof coming straight down.*
>
> *We all turned and just threw our rollups down and started running as fast as we could."*
>
> John Amato (9110421), FDNY, p. 3-4.

Notice in this account the close connection between feeling and sound. Connecting the experience to an earthquake, he says, "It *felt* like the same exact feeling," but he also says, "It *sounded* like an earthquake" (my emphasis). It seems that the "rumbling" he experienced ("rumbling" is an extremely common term in the oral histories to describe the Towers coming down) refers simultaneously to sound and feeling.

The other thing that is helpful about the above account of the North Tower's collapse is the reference to an event with a known time. Amato hears and feels the rumbling, then

looks up and sees the antenna coming down. From videos of the North Tower's collapse, we know that the antenna became lost to sight well before debris struck the ground. [33] So we know that the shaking he is describing could not possibly have been caused by debris striking the ground. This is an example of how witness testimony, although not as precise as we might wish, may be precise enough to establish a very important point.

Three PAPD accounts, also referring to the North Tower, will be useful to look at next since each corroborates the above account.

(2)

> *"Someone said, 'Duck!' Captain Anthony Whitaker grabbed me and threw me behind the truck. We huddled behind the truck as the building came down. The sound was deafening. The street was bouncing like a trampoline."*
>
> Michael Shuhala, Part 2, p. 60

It is impossible to determine precise times from the Shuhala account, but we note again *the close connection of sound and shaking*. They are simultaneous. It is possible that the shaking did not begin until debris struck the ground, but there is nothing in this account to suggest it.

(3)

> *"We regrouped and started back to help the injuried [sic] as we went back towards Building #1. After walking two blocks the ground shook and I saw the top of Building #1 start to collapse--everyone started to leave the area for safety."*
>
> Gary Gersitz, Part 3, p. 40

This witness suggests that the shaking of the earth began at least as early as collapse initiation.

(4)

> *"I was standing there about 15-20 seconds when Inspector Fields ran up to me and said the building was going to come down. The ground started to shake, I looked up and saw the top of 1 WTC start to collapse. I started to run..."*
>
> B. Pikaard Part 2, p. 17

This account suggests the shaking of the earth preceded collapse initiation.

Since we are concentrating on the South Tower in this investigation, let us now turn to FDNY and PAPD accounts of the South Tower's collapse.

(5)

"I lost track of time. You start to hear this rumble. You hear this rumble. Everything is shaking. Now I'm like, what the hell could that be. I'm thinking we're going to get bombed. This is an air raid.

You hear this thunder, this rumbling. Then you see the building start to come down. Everybody's like, 'Run for your lives! The building is coming down!'"

Jody Bell (9110335), FDNY, p. 9-11

Again we have "rumbling," and again it is associated not only with hearing but with feeling ("shaking"). Bell guesses that planes are in the sky ("This is an air raid.") This disturbance precedes visual signs of collapse ("Then you see the building start to come down").

(6)

"-- at that time, I heard a rumble, you know, and then it was, you know, really like, almost like an earthquake.

Then what happened was I heard people screaming and running and then it seemed like they were going to -- it was like going to be a trampling. It was just like bedlam...Then I started to run for safety too, because I looked up and I saw that the building was going to come down. We were right across the street from it...suddenly, I was near that garage area, the sky as it blacks out, and then all of a sudden, it just came down."

Alexander Loutsky (9110151), FDNY, p. 10, 11

Again we have a reference to a rumble, and by now we suspect both feeling and hearing are involved when he makes the comparison to an earthquake. Once again, this disturbance begins very early: "I looked up and I saw that the building was going to come down." He does not say how he knew it was going to come down, but perhaps he saw the tilting of the top portion of the building.

(7)

"We went approximately one or two blocks when all of a sudden heard this big roar. It sounded like another plane coming in or it sounded like an earthquake, but it just didn't sound right. So we all started running, my partner and I, and we had the commissioner with us also. The next thing I know we were engulfed in this black cloud of smoke..."

Richard McCurry (9110371), FDNY, p. 5

Fire Marshal McCurry's account does not allow a precise time estimate. We cannot rule out the possibility that debris was striking the ground as this disturbance began. But I want to draw attention to the word "roar," which is probably second in frequency only to "rumble" in the FDNY collapse descriptions. Note that we also have another comparison

to the sound of a plane, a comparison which, as Appendix D at the end of this article makes clear, is extremely common.

(8)

> *"I was in back of the vehicle and I heard, it sounded like I thought another plane had struck the building. This loud bang and then it sounded like a locomotive, or like when I used to live in Howard Beach, when the planes used to come in at night, flying right over the house. Everything started shaking and I heard like a thunderstorm. Somebody screamed it's coming down. I don't remember if it was on the radio, because the side door of the bus was open. The back door of the truck--I could see out of. I looked, and I bent all the way down to look up as far as I could, and I could see the cloud coming. I thought the building was actually falling over. I didn't know it was pancaking."*
>
> Eric Rodriguez (9110094), FDNY, p. 7

Although we cannot make a precise time estimate from this account, the time of the disturbance seems early. There are the familiar references to planes, thunder and shaking, and only after this do we have someone scream "it's coming down." When he speaks of the cloud coming we do not know if he is referring to the flow of pulverized material that spread through the streets after collapse or if he is referring to the vertical descent of the pulverization wave. His final comments suggest the latter. The account certainly suggests that the earth shook before debris hit the ground.

(9)

> *"At that time we were looking at the top of the towers and all the rubble and people coming off, and all of a sudden you heard -- it sounded like another airplane, or a missile. It was like a slow shake. The whole ground just vibrated and shook. We just told everybody to run, run into a building, let's go, run, run, run..."*
>
> John Rothmund (9110112), FDNY, p. 5-6

Rothmund is describing a shaking of the earth that occurred very early, probably prior to any visible sign of building collapse. He sees rubble and people coming off the buildings—this took place over quite a lengthy period and does not suggest building collapse—and then he experiences the hearing and feeling with which we are by now familiar.

(10)

> *"The next thing you know, you hear a loud thundering noise. It sounded like a jet, a big rumble. I start looking around and I'm like, what is that? The next thing I know, I see the cop just take off. I'm like, where's he going?*
>
> *Then I see the things on the floor, like Liberty -- you know, just like the movies, bouncing up and jumping and shaking. I mean, not like an*

earthquake, like a 6 point something or something like that. But you see stuff on the floor shaking from side to side. I'm like, oh, my God. I look up and I was saying, oh, no, the building's going to fall down.

...

Q. "So you had a feeling the building was coming down right away?"

A. "Yeah."

Q. "Is that what you first thought?"

A. "Yeah. The sound, it's just loud. At first it's (sound) and then you feel everything around you -- not around you but the floor. You feel the floor trembling and shaking. You look at the floor, the dirt, the sand and everything on the floor shifting from side to side. I'm like, oh, man..."

Robert Ruiz (9110333), FDNY, p. 10 ff.

Ruiz hears the rumble and thunder, thinks of the jet plane, and clearly experiences the shaking of the ground (FDNY members often talk of the "floor" when many of us would refer to the "ground") before the building has even begun to descend. "I look up and I was saying, oh, no, the building's going to fall down." It is not clear how he knows the South Tower is going to collapse.

(11)

"Shortly before the first tower came down I remember feeling the ground shaking. I heard a terrible noise, and then debris just started flying everywhere. People started running toward the staging area."

"By the time the debris settled from the first collapse, we started to walk back east towards West Street, and a few minutes later -- I really don't remember the time frames because we were so busy in trying to account for who was in the staging area and who wasn't -- we basically had the same thing: The ground shook again, and we heard another terrible noise and the next think [sic] we knew the second tower was coming down."

Bradley Mann (9110194), FDNY, p. 5, 6, 7

Mann is confident about the sequence of events, which he says was the same for both buildings. The shaking came early—either before, or at the same time as, the loud sound. Only then did the wave of debris come down. *The earth began shaking before visible signs of collapse.*

(12)

"...at that exact moment I can feel -- or hear the noise first. I hear a noise. Right after that noise, you could feel the building start to shudder, tremble, under your feet.

Somebody said to me, 'What's going on?' I said, 'What's going on? The fucking building -- the goddamn building is coming down'...I knew what was coming down. The building I was in was coming down...

I remember taking a few steps and trying to run, and you're either thrown or blown off your feet....

It was a terrible noise. Besides the building shuddering, the sound was horrendous. To me it sounded like steel cutting through steel."

Brian O'Flaherty (9110431), FDNY, p. 13-15

Precise times cannot be determined from O'Flaherty's account, but the shuddering and the sound are closely connected and certainly seem to precede debris strike.

(13)

"...we started ahead like halfway across West Street with our stuff, and the ground started shaking like a train was coming... You looked up, and it looked like a ticker tape parade off the back of the building, because all this stuff started coming down...We came halfway across the street, and the building was coming down."

Joseph Fortis (9110200), FDNY, p. 7-8

The earth shake either accompanied, or preceded, collapse initiation.

(14)

"After that, I helped one lady out of the front of the Marriott entrance, I recall. I was on my way back...Then on my way back to the entrance, I felt the ground shake, I turned around and ran for my life.

I made it as far as the Financial Center, like right before it, behind the last Hatzolah ambulance facing the Trade Center, when the collapse happened...

...

I assisted that lady to the Hatzolah ambulance and was on my way back when we felt the rumble. My partner actually came sort of like running up to me but not all the way. What should I do. I just said go get a long board from the ambulance and that was the last I saw of him. We felt the ground shake. You could see the towers sway [tower sway?] and then it just came down..."

Lonnie Penn (9110203), FDNY, p. 2-3, 5

The earth shake seems to have preceded collapse initiation.

(15)

> *"Just at this time, another firefighter began to yell to us from across the street. He was looking up at the Towers and yelled for us to hurry up since he thought the second Tower was about to fall. The two firefighters and myself again picked up the injured man and managed to walk three or four steps when we felt extreme vibration and an incredible noise 'like a thousand freight trains.' I knew instantly that the Tower was falling down."*
>
> Timothy Norris, PAPD, Part 1, p. 34

Vibration and noise are closely connected in this account. The earth shake either accompanied or preceded collapse initiation.

(16)

> *"As I walked to the window I heard this incredible noise. It's difficult to describe what it had sounded or felt like. It was like being in an earthquake and under a thousand "L" trains all at once. The vibration ran thru me with violent ground vibrations. I heard Lt. Kassamatis yelling for me to get out of there....[describes running, thinking] I thought it was another plane crashing into the Plaza. I remember thinking that this was it, I was not going to make it. I heard a loud wind and glass shattering around me. An incredible force of wind and debris crashed thru the mezzanine and knocked me down...*
>
> ...
>
> *We were walking north on West St. and just as we got there I heard that noise again. I remember looking up at the North Tower and saw the corners of the building collapsing straight down."*
>
> Anthony Croce, PAPD, Part 1, p. 64-67

I have left in the second part of this account, dealing with the North Tower, because it is essential to the interpretation of the account as a whole. When discussing the South Tower he links the noise closely to the “violent ground vibrations,” but we do not have enough information to estimate where in the collapse these sounds and vibrations began. When dealing with the North Tower, however, he says he saw the “corners of the building collapsing straight down” after the noise has already begun. This indicates that the noise started early, well before debris strike.

(17)

> *"We then continued walking down the ramp and towards the parking areas, looking for people who may be trying to exit. We felt what I can only describe [as] a shudder in the building and then ran towards the exit. We ran up the Barclay St. ramp and made a right onto Vesey St. I turned to look up at the buildings as Tower #2 began collapsing."*

Robert Greff, PAPD, Part 1, p. 94

It is not clear what building he is referring to as shuddering. It is possible he is referring to the South Tower itself. In any case, several seconds before collapse initiation he felt a building in the vicinity of the South Tower shudder.

What have we learned from these accounts?

- The ground trembled--objects on the ground visibly shifted and shook--well before the debris from the collapsing Tower hit the ground.
- A considerable degree of shaking began not only before debris struck the ground but before the South Tower began to descend.
- The earth shaking was directly associated with an extremely loud noise.

Although it is difficult to determine precise times from the witness testimony, these accounts certainly corroborate in a general way the NY1 video record.

And our third conclusion, having to do with the close association of sound and shaking, allows us to extend our enquiry to include indirect corroboration.

Indirect Corroboration: the Sounds of Collapse

The Twin Towers were huge buildings, and it is not surprising that their rapid destruction generated a great deal of noise. But this observation does not take us very far. We want to know what specific sounds accompanied the collapses and whether these sounds corroborate our findings about the shaking of the earth.

Witness testimony and surviving audio records allow us to distinguish three broad and overlapping sorts of sounds accompanying the collapses (see Appendix D for these and other accounts):

(1) Discrete impulsive sounds typically described as booms, bangs, crashes and explosions.

> "I had heard right before the lights went out, I had heard a distant boom boom boom, sounded like three explosions. I don't know what it was. At the time, I would have said they sounded like bombs, but it was boom boom boom and then the lights all go out..." (Keith Murphy)

I have catalogued reports of explosions elsewhere. [34] I have only two comments on the subject to make in this article. First, since some people seem to think we are faced with a choice between explosions and the well known "rumble" and "roar," it is important to make it clear that these are not competitors. All three sorts of sounds were heard.

Second, I want to mention that “booms” occurring during the South Tower’s collapse are audible on at least two video recordings, one of which is the Firefighter video and one of which is the Sauret video. In the latter, there are eight booms audible, and at least six of them precede debris strike. [35]

(2) A “rumble” that includes both sound and feeling and is characterized both by a deep, continuous noise and a felt vibration.

See the accounts in the previous section, Direct Corroboration, and in Appendix D.

(3) A “roar,” described most commonly as like the roar of a jet plane, and including both a deep sound and a higher sound--a whine or whistle.

> "...all of a sudden I heard this sound. It sounded like a jet, a high, whistling sound. There was like a rumble behind it. It was like a jet with a locomotive behind it.” (Mark Mazur)

The rumble and roar were extremely loud (“It was the loudest noise I've ever heard in my life,” Robert Larocco). They increased in volume in the early stages of collapse (“you heard a roar, some sort of a vibration, like a vrr vrr vrr, getting louder and louder,” Kevin McCabe).

Most importantly, as the two following testimonies show, these sounds began before the descent of the South Tower. (The witnesses hear the sounds, have a series of thoughts, and then look up to see the building beginning to tilt).

> (a) "But immediately once I put the oxygen down, I hear the rumble, and I heard a rumble that we thought was another plane. That's what immediately everyone said, there's a plane coming, there's another plane coming.
>
> So we all looked up and what we saw was tower, I guess, 2, the south tower, begin to do this. The top kind of did this and there was a horrendous rumble.”
>
> Q. “Now, your hand is showing that it's kind of tilted in one direction. What direction did it tilt?”
>
> A. “It was tilting towards us, so it had been to be tilting eastward....At that point we hear the rumble and, you know, this is it. I figure I'm dead. I thought this tower was going to topple. So I start to run." (Manuel Delgado)

> (b) "Then I just remember that, distinct noise like an airplane being on a runway and it's ready to take off. I heard the loud roaring of like the engines, and I thought another plane was hitting the building.

> Someone yelled run. I looked up, and the top of the tower I saw was starting to move over. It was bending like it was going to come down. Everybody started running." (Bruce Medjuck)

The case appears to have been the same with the North Tower: the rumble preceded downward movement:

> "We were probably about a block away when we heard a giant rumbling sound. It sounded like jets were going overhead and then we looked up and we saw the tower start to fall and we just ran." (Michael Morabito)

Appendix D lists further descriptions, in the FDNY oral histories, of sounds accompanying the collapses of the Towers--excluding explosions, which I have dealt with elsewhere, and focusing especially on the curious comparisons to the sounds of jet planes. It is obvious from these accounts that the sounds, and by implication the closely connected vibrations, occur well before debris strike. I therefore regard this witness testimony as indirectly corroborating the main conclusions reached through the NY1 graph and the previously discussed directly corroborating evidence.

Conclusions:

If we simply checked time-stamps and exercised appropriate scepticism toward NIST's revised seismic estimates we would find good reason to reject NIST's position that a significant seismic signal began only when debris hit the earth. Innovation in the use of video cameras would not be necessary. But we have gone further and used video evidence, especially that embodied in the NY1 video, and we have been able put together an intriguing profile of the shaking of the earth and to suggest that:

- The shaking of the earth seems to have reached an early peak at approximately 9:59:04 a.m. This helps us make sense of LDEO's original findings.
- A second and higher peak came much later. Representing the moment when debris hit the ground, it has been mistakenly represented by NIST as corresponding to the start of the LDEO seismic signal.
- The seismic event actually began before both of these points in time and, indeed, before any visible sign of collapse.

Seeking to corroborate the NY1 video evidence, we have looked at witness testimony from the FDNY oral histories and PAPD accounts, and we have found two kinds of corroborating evidence, direct and indirect. The direct evidence has confirmed that a quite intense shaking of the earth began well before debris impact and that some degree of earth shaking took place before collapse initiation. The indirect (auditory) evidence suggests that the distinct sounds associated with shaking of the earth began well before debris impact. Some of these accounts confirm that the sounds, and by implication the vibrations, began before visible collapse of the South Tower.

I do not pretend to have resolved all the anomalies relating to the shaking of the earth at the time of the South Tower's destruction. I do not expect to see these anomalies resolved until seismologists study the WTC events closely. But I believe it is clear that several of NIST's key claims are untenable.

I am especially intrigued by the evidence we now possess that the earth shook before the initiation of each of the three dramatic building collapses of 9/11. This article has touched on some of the evidence relating to the South Tower. In the case of the North Tower we have both witness evidence and video camera perturbation. [36] As for World Trade Center 7, NIST acknowledges the existence of a seismic signal preceding the collapse by ten seconds: "A seismic signal approximately 10 s prior to the onset of collapse was likely due to the falling of debris from the collapse (NIST NCSTAR 1-9 Appendix B)." [37]

The official explanation of the collapses given by NIST is not compatible with these pre-collapse perturbations. For example, although the NIST hypothesis of a gravity-driven "progressive collapse" of the Towers does necessitate major impact between the upper and lower portions of the buildings (such as might, in theory, cause a seismic signal), this impact would have to occur after, not before, collapse initiation. And, in any case, when we take the trouble to study the acceleration of the upper block we find no evidence whatsoever of the major impact NIST's hypothesis requires.[38]

The possibility that explosions caused some or all of the earliest perturbations needs to be investigated. We already possess convincing evidence of critical explosions in these buildings, [39] and we cannot help but notice that video cameras do, in fact, sometimes shake before the visible beginning of collapses in controlled demolitions.[40]

I hope other researchers will take advantage of the methods and materials used in this article to further refine our knowledge of the destruction of the buildings of the World Trade Center on September 11, 2001.

ENDNOTES

1. Local magnitudes were reported by Won-Young Kim, et al, "Seismic Waves Generated by Aircraft Impacts and Building Collapses at World Trade Center, New York City." Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York. Date uncertain.

http://www.ldeo.columbia.edu/~mwest/papers/WTC_LDEO_KIM.pdf

2. National Institute of Standards and Technology (NIST), *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Answers to Frequently Asked Questions (August 30, 2006)*

http://wtc.nist.gov/pubs/factsheets/faqs_8_2006.htm

3. NIST's Question 5 may be based on a 2002 article by Christopher Bollyn, "Seismic Evidence Points to Underground Explosions Causing WTC Collapse." (*American Free Press*).

http://www.serendipity.li/wot/bollyn2.htm

Bollyn did not, to be sure, claim that the main seismic spikes occurred *before* collapse initiation but that they occurred "at the beginning of each collapse." In any case, Bollyn's article has been sharply criticized by Jim Hoffman. See, for example, "Seismic Records of the Twin Towers' Destruction: Clarifying the Relationship Between Seismic Evidence and Controlled Demolition Theories." (Version 0.9, Oct. 31, 2006.)

http://911research.wtc7.net/essays/demolition/seismic.html

My research supports several of Hoffman's points. On the other hand, although I have been greatly influenced by Hoffman's method, my findings on the South Tower's collapse signal are quite different in some respects from his findings on the collapse signal of the North Tower. Perhaps these differences can be reconciled, but at the moment mine are less compatible with NIST's claims.

4. These time estimates can be found in the NIST reports detailed in the table and found at:

http://wtc.nist.gov/

5. *The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States* (New York: W. W. Norton, 2004), p. 305; 550, n. 156.

6. Williams Pitts, et al, *Federal Building and Fire Safety Investigation of the World Trade Center Disaster: Visual Evidence, Damage Estimates, and Timeline Analysis*. (NIST NCSTAR 1-5A), p. 23.

http://wtc.nist.gov/NCSTAR1/PDF/NCSTAR%201-5A%20Ch%201-8.pdf

7. "Seismic Waves Generated by Aircraft Impacts and Building Collapses at World Trade Center." And see *World Trade Center Building Performance Study: Data Collection, Preliminary Observations, and Recommendations*. Federal Emergency Management Agency, 2002, **1**-10.

8. See "Seismic Waves Generated by Aircraft Impacts and Building Collapses at World Trade Center." The report notes that five stations "within the greater Metropolitan New York region" in addition to the Palisades station "recorded the two tower collapses," and it gives the impression that the records of all these stations support the times estimates given in the report.

9. NIST NCSTAR 1-5A, p. 22, 23.

10. NIST NCSTAR 1-5A, p. 23, 24. The paper in question is referred to (p. 24) as:

Kim, W. X., "Analysis of Seismogram Data Recorded on September 11, 2001 during the World Trade Center, New York City Disaster, Final Technical Report to the Building and Fire Research Laboratory," Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, January 31, 2005.

I assumed the author of the report was LDEO's Won-Young Kim so I wrote to Dr. Kim, asking him if I could have a copy of the report. He replied that he did not have a copy but suggested I ask NIST for one. NIST has not responded to my query.

11. NIST NCSTAR 1-5A, p. 23.

12. "Seismic Waves Generated by Aircraft Impacts and Building Collapses at World Trade Center." Cf. Hoffman, "Seismic Records of the Twin Towers' Destruction."

13. As of the time of writing of this article, this NBC video clip may be found at:

http://ishare.rediff.com/filevideo-south_tower_collapse-id-34537.php

Currently, the clip is also available at the Television Archive as part of the NBC 9/11 full day coverage--it is found at about 12 minutes and 16 seconds into the 9:54 a.m. – 10:36 a.m. segment, as a play-back dealing with the earlier collapse of the South Tower.

http://www.archive.org/details/sept_11_tv_archive

14. Various versions of the ABC video clip are available on the internet, some with time-stamps and some without. As of the writing of this article, the ABC full day coverage has, unfortunately, been removed from the Television Archive site and is no longer accessible.

I have chosen a version of the clip that was downloaded from the internet in 2005 as part of complete, full day ABC coverage. This version actually has two time-stamps, which give significantly different times.

As can be seen in the exemplifying frame below, there is one time-stamp at the top of the picture and another at the bottom. Although it cannot be discerned in the single frame below, detailed study of the footage shows that the top time-stamp is 12.729 seconds ahead of the bottom one (discounting the different time zones). Comparing several events in this video with the same events in other videos, we conclude that the lower time-stamp is the correct one. It is the lower time-stamp, therefore, that has been used in my calculations.

15. The twin ejections used here as part of this DTE have been studied, and their velocities measured, by David Chandler.

http://www.youtube.com/watch?v=N_UeLXfI37s

16. The NY1 video clip will be the focus of our attention later in the paper and an internet link to it is provided there.

17. If we take collapse initiation in the case of the North Tower to refer to the first certain downward movement of the roof antenna, and if we check the frame in question against the (lower) time-stamp on the ABC video, we arrive at a collapse initiation time of 10:28:22.176 a.m. EDT. NIST's most recent estimate for the collapse initiation time of the NT is 10:28:22 a.m. EDT.

18. As of the writing of this article the Firefighter video can be found on the Studyof911.com website:

http://www.studyof911.com/video/

There are two main versions of this video available, both found on this website. One has a clearer picture, and it is this one I have used for establishing DTE and taking images and measurements. (But see also the next note.)

This video is said to have been "filmed from West Street between 1 World Financial Center and the Banker's Trust Building." I have tentatively adopted this estimate, although I do not know the date and author of the article in which this estimate is made ("Explosion Sounds and the World Trade Center - Twin Tower Collapses").

Currently, the article can be found at:

http://www.mediumrecords.com/wtc/audio01.html

19. The version of the Firefighter video with the poorer quality image has a superior soundtrack. By this I mean that this soundtrack fits much better than the other one with witness reports of the sounds of the collapse. I accept this soundtrack as the more authentic of the two.

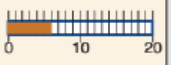
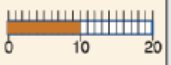
20. NIST NCSTAR 1-5A, p. 233.

21. A good discussion of the Marriott and its dimensions is found in the FEMA report, *World Trade Center Building Performance Study,* chapter 3. We can determine from the Firefighter video that the debris front falls past the full height of the Marriott in a bit more than one second and is accelerating as it falls.

22. NIST NCSTAR 1-5A, p. 23.

23. *May 2003 Progress Report on the Federal Building and Fire Safety Investigation of the World Trade Center Disaster* (NIST Special Publications 1000-3). National Institute of Standards and Technology, U.S. Dept. of Commerce, May 2003, p. 7.

24. In the FEMA report, **1**-10 we find:

9:02:54 EDT (13:02 UTC) 	**6 seconds** 	**0.7**	WTC 2 (the south tower) was hit by United Airlines Flight 175, also a hijacked 767-200ER jet.
9:59:04 EDT (13:59 UTC) 	**10 seconds** 	**2.1**	WTC 2 began collapsing after 56 minutes, 10 seconds. Large debris from the collapse fell on WTC 3 and WTC 4, 130 Cedar Street, 90 West Street, and Bankers Trust. WTC 3 suffered a partial collapse. Fire was initiated in WTC 4 and 90 West Street.

http://www.fema.gov/rebuild/mat/wtcstudy.shtm

The meaning is clear: the South Tower was hit at 9:02:54 and *began* collapsing 56 minutes, 10 seconds later, at 9:59:04. FEMA says this collapse time has been determined from the Lamont-Doherty Earth Observatory seismic record.

25. http://www.ldeo.columbia.edu/~mwest/papers/WTC_LDEO_KIM.pdf

26. P. 4.

27. Most of the discussion of pre-collapse shaking has focused on the North Tower and a well known video clip by Etienne Sauret (from his "WTC: the first 24 hours", available as a DVD). Clips from the Sauret film are gradually being removed from the internet, but as of the time of writing of this article the trembling of the Sauret camera both before and after collapse can be seen here:

http://www.youtube.com/watch?v=2E-tieJFVGY

It is important to realize that the version of the clip on this site does not include the original Sauret audio—the audio here is taken from Rick Siegel's film, "911 Eyewitness." This transposing of sound tracks is legitimate as long as it is made explicit.

The What Really Happened website furnishes an example of an attempt to show, through a study of changing patterns of smoke and debris near the top of the North Tower, that the pre-collapse Sauret camera shake represents a real event in the North Tower.

http://whatreallyhappened.com/WRHARTICLES/shake.html

28. I am depending on the work of a researcher already referred to ("Explosion Sounds and the World Trade Center"):

"Also, a view of the South Tower collapse from the same angle is available. In this clip, the South Tower can be seen shrouded in smoke and standing behind the North Tower. It

was filmed from somewhere off of Varick Street at a distance of approximately 1600 meters

29. http://www.ny1.com/content/about_ny1/staff_profiles/39999/kristen-shaughnessy/Default.aspx

30. YouTube comments tend to be ephemeral, and this is especially true in the study of 9/11 since many of the most important video clips are being removed from the internet. But here are typical comments posted some time ago in relation to the NY1 clip:

Gyphia (2 months ago) Show Hide

-3

Reply | Spam

I noticed that, also heard a small bang in the distance.
the camera was fixed, doesnt wobble at all, except just before the collapse.

Also:

StarryKid06 (3 months ago) Show Hide

0

Reply | Spam

Right at 0:46, the camera shakes very briefly prior to the collapse

...

melb223 (4 months ago) Show Hide

+1

Reply | Spam

See how at 00:45 seconds there is some severe shaking, at 00:48 the clock ticks over to 9.59 am, then a second later at 00:49 the south tower starts to collapse, very interesting. I think it was very well planned.

31. The four times as listed on the graph are approximate. My measurements give the following as the times corresponding to the peaks marked:

9:58:56.396
9:58:59.333
9:59:04.004
9:59:10.777

32.

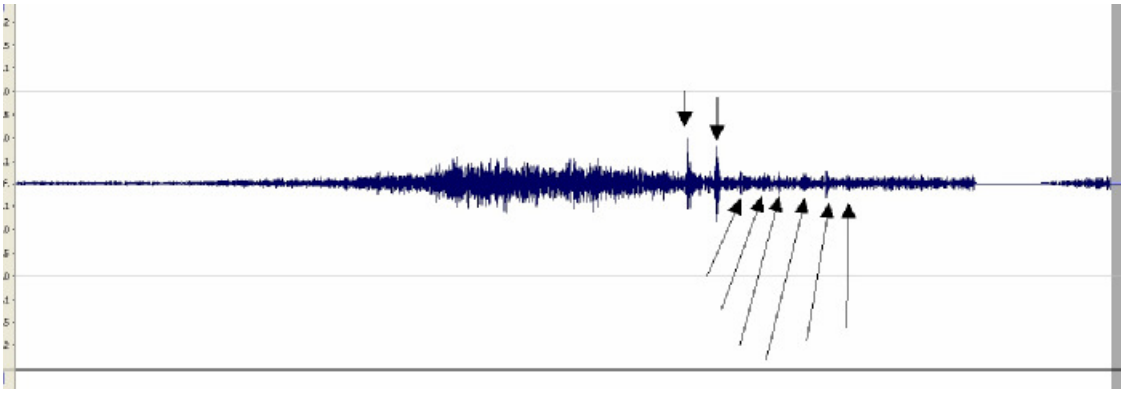
FDNY:
http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met_WTC_histories_full_01.html

PAPD:
http://www.thememoryhole.org/911/pa-transcripts/

33. I have examined five different video clips and have found that the antenna of the North Tower is visible until 4.5 – 7.8 seconds after collapse initiation, depending on the location and perspective.

34. "118 Witnesses: The Firefighters' Testimony to Explosions in the Twin Towers." http://www.journalof911studies.com/articles/Article_5_118Witnesses_WorldTradeCenter.pdf

35. Although eight sounds can distinctly be heard on the DVD ("WTC: the first 24 hours"), the first two are especially prominent, as the following sonogram kindly prepared for me by Joe Terrien shows:



Discussion of these sounds can be found in "Explosion Sounds and the World Trade Center - Twin Tower Collapses:"

http://www.mediumrecords.com/wtc/audio01.html

36. Examples of witness accounts are given on pages 26-28 of the article. The shaking of the Sauret video camera (note 27) is the best known instance of camera shake in relation to the North Tower but it may not be the only one. As of the time of writing of this article, see also:

http://www.youtube.com/watch?v=mHPgLLJfq7s

37. *Final Report on the Collapse of World Trade Center Building 7. NIST NCSTAR 1A: Federal Building and Fire Safety Investigation of the World Trade Center Disaster.* November, 2008. Pp. 42-43. The apparent absurdity of the NIST statement derives from the use of the word "collapse" to refer to two different events. In the first instance "collapse" refers to the visible descent of the building; in the second case it refers to the invisible and hypothetical falling of debris inside the building prior to visible descent.

http://wtc.nist.gov/NCSTAR1/PDF/NCSTAR%201A.pdf

38. See MacQueen and Szamboti, "The Missing Jolt: A Simple Refutation of the NIST-Bazant Collapse Hypothesis," *Journal of 9/11 Studies*, vol. 24, Jan. 2009.

http://www.journalof911studies.com/volume/2008/TheMissingJolt7.pdf

39.There are numerous websites that have assembled evidence of explosions in the WTC. Three of the best known are:

http://www.journalof911studies.com/

(See not only the articles in the *Journal of 9/11 Studies* itself but other peer-reviewed articles mentioned on this site.)

http://911research.wtc7.net/

http://www.ae911truth.org/

40. See, as of the time of writing of this article:

the demolition of the Intel Building in Austin, Texas:

http://www.youtube.com/watch?v=4nm4wVoe6Z8

the demolition of three power station chimneys:

http://www.youtube.com/watch?v=HsWTtw--66M

and the demolition of the Tencza apartments in Virginia:

http://www.youtube.com/watch?v=d-WvQbFMIWU

APPENDIX A

Method: Time-stamps and Graphs

1. NIST uses network time-stamps to establish its timeline for major events at the WTC. It estimates that these time-stamps are generally very accurate and that the margin of error is about one second. (See note 11.) My own use of these time-stamps suggests NIST's estimate is accurate.

2. To the extent that I am able to discern NIST's method, I find that it relies, like my method, on distinctive transient events (although the term is my own). Any rejection of my method as applied in this paper would, therefore, have serious implications for NIST and its own method and time-line.

3. In this paper I shall, as a general rule, give times exactly as they are delivered by the software I am using (VirtualDub), which divides video footage into 33 millisecond frames. We cannot, of course, claim to determine the real times of the events in question to the millisecond, so suitable rounding off can be carried out when we convert VirtualDub times to real times. The claims I make in this paper do not depend on millisecond-level accuracy.

4. Most of the time-stamps found on the network videos give simply hours and minutes. So, for example, a time-stamp might read "9:59". But it is possible to determine very precisely when the number flips from 9:59 to 10:00, and with this information we can determine seconds and fractions of seconds using our software.

5. Creating graphs from camera perturbations is not especially difficult, although it requires patience. A stable point in the picture (typically part of a building) is chosen and its apparent vertical movement recorded by measuring, in each chosen frame, the distance between the point and the fixed border of the picture. I have used the software called Screen Calipers for my measurements.

APPENDIX B
6 NBC Frames and 6 NY1 Frames Showing South Tower East Face Ejections

NBC frame 75 (2.503 sec. into clip)

NBC frame 85 (2.836 sec.)

NBC frame 95 (3.170 sec.)

NBC frame 105 (3.504 sec.)

NBC frame 115 (3.837 sec.)

NBC frame 125 (4.171 sec.)

NY1 fr. 1470 (49.049 sec. into clip)

NY1 fr. 1480 (49.383 sec.)

NY1 fr. 1490 (49.716 sec.)

NY1 fr. 1500 (50.050 sec.)

NY1 fr. 1510 (50.384 sec.)

NY1 fr. 1520 (50.717 sec.)

APPENDIX C

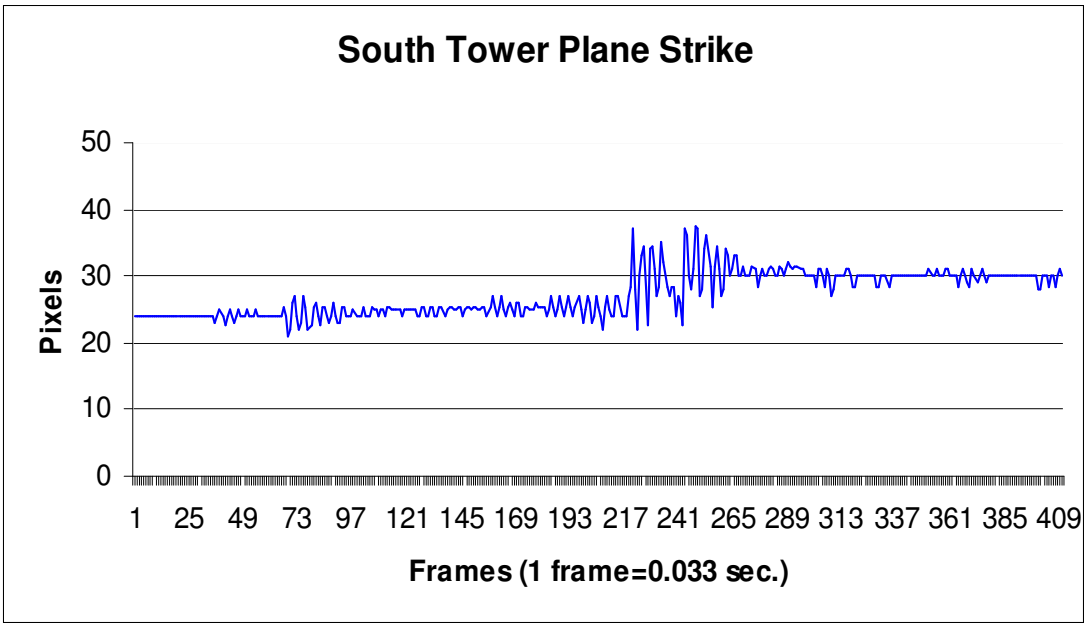
The DVD of Etienne Sauret's "WTC: the first 24 hours" contains a short and a long version of his film. In the longer version there are three separate video sequences (each one shot with a stable camera from a single angle) strung together at the beginning of the film. Within these three sequences are the five perturbations.

(1) The first perturbation begins at approximately frame 429 (14.314 seconds into the clip) of the first sequence and lasts about 2.5 seconds. This puts its initiation at about 18.5 seconds before the beginning of the perturbation associated with the impact of the plane on the South Tower. Furlong and Ross have made a case for an explosion, presumably in the basement, in the South Tower somewhere between 17 and 20 seconds prior to plane impact. It is possible that this first perturbation was caused by that explosion, although this hypothesis would not be without its own challenges. (In this case the seismic signal interpreted by LDEO as the result of the plane strike is actually the result of the explosion. But we then have to explain why the plane strike did not show up on the LDEO record given that it appears to show up clearly in the record of the video camera.)

Craig Furlong and Gordon Ross, "Seismic Proof – 9/11 Was An Inside Job" (Updated Version II). *Journal of 9/11 Studies*, vol. 3, Sept. 2006.

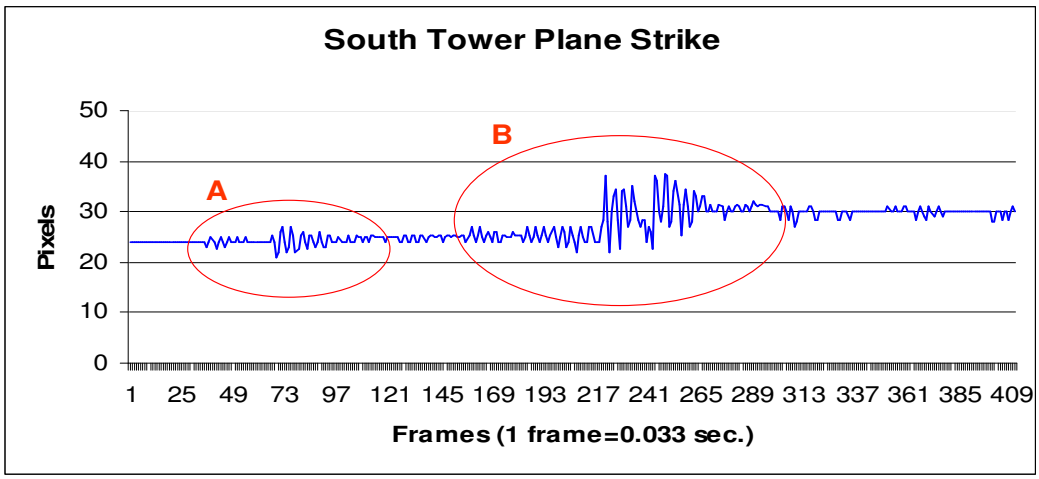
http://www.journalof911studies.com/volume/200609/ExplosionInTowerBeforeJetHitByFurlongAndRoss.pdf

(2) The next perturbation is associated with the impact of the plane on the South Tower and is represented below in graphic form (see Appendix A for the method used to obtain this graph).



There are two phases of disturbance in this perturbation, which can be indicated roughly as follows:

Two phases of disturbance



I assume the first phase of disturbance (A) was caused by seismic waves generated at or around the time of airplane impact and that the second phase (B) was caused by the pressure wave created by the deflagration of the vapour cloud that formed subsequent to the crash. Video cameras may move in response to events in both earth and atmosphere, which is to say that they will at times be both crude seismographs and crude barographs. The accompanying visual and auditory data captured by the camera seem to me to support this interpretation. The same general phenomena—camera perturbations from seismic waves followed by perturbations caused by disturbances in the atmosphere—can be seen in the NY1 video clip discussed in the article.

Note that in the selected frames below the blurring of the image in frame 220 represents one of the moments of extreme camera perturbation that I interpret as caused by the pressure wave from the vapour cloud.

These and other camera perturbations on the Sauret video merit separate and detailed study.

Frame 75

Frame 190

Frame 220

Frame 240

Frame 265

(3) The third perturbation is the one related to the collapse of the South Tower discussed in the body of the article.

(4) In the third video sequence, we find the well known pre-collapse perturbation associated with the North Tower (see Note 27). The tremble lasts about 2.5 seconds. The North Tower begins to descend about 9 seconds after the end of this perturbation.

(5) The next perturbation in the third sequence, also associated with the North Tower, is so delicate that it can easily be missed. But it is undeniably present, as the website referenced in note 27 makes clear:

http://www.youtube.com/watch?v=2E-tieJFVGY

Measuring and interpreting this perturbation are tasks for a separate study. In my view, the largest spikes after collapse initiation are likely caused by debris strike, but there are smaller perturbations preceding these that must have different causes.

APPENDIX D

FDNY ORAL HISTORIES:
THE SOUND OF THE TOWERS' COLLAPSES, WITH A SPECIAL FOCUS ON THE COMPARISON TO JET PLANES

(1) "Next thing you know, you hear another--they had said there were jets out there that day. They were out there. I started to hear another jet, right, it sound like the flush of a jet. What it was was actually the building coming down. I didn't actually see the building coming down but you heard it. Why I didn't see it, I don't know. We were just so busy concentrating on what we are doing. You just heard this thrushing, thrushing noise like a rocket. I thought the building was under attack again.

You just start seeing this smoke coming down. We just took off."

South Tower
Faisel Abed (9110071), p. 6-7

(2) "As we approached Chambers Street, kept walking, still no one had told us about the total collapse. We get down to about Barclay and Vesey Street, which is a block away from the overpass, the bridge overpass that goes across the West Side Highway.

All you hear is a rumbling in the street. It sounded like an earthquake. When I was a younger kid, I was in an earthquake and it felt like the same exact feeling. I looked, and I could see the antenna on the top of the roof coming straight down.

We all turned and just threw our rollups down and started running as fast as we could. I took about five steps, I turned back to look behind me, and the debris was on my heels. Guys were just scrambling through the streets. Finally the debris overcame us, and you couldn't see anymore. It was like pitch-black, total darkness."

North Tower
John Amato (9110421), p. 3-4

(3) "...I heard what I thought was a jet engine plane. In retrospect, it turns out that it was the first tower coming down.
...
and the next thing I noticed, that jet engine sound and then a loud crash and then pitch black."

South Tower
Glenn Asaeda (9110062), p. 17-18

(4) "Approximately 9:50, we heard this loud noise. I looked up and it sounded like another airplane was coming in. That's what it sounded. It sounded like a large engine, like you're

sitting on the seat on the wing of the plane. That's the best way I can describe what it sounded like.

We look up and we saw tower two coming down. We just all ran."

South Tower
Kevin Barrett (9110464), p. 4-5

(5) "We were operating in the lobby, and all of a sudden we heard the roar of a jet engine, is what it sounded like. We thought that there was another plane coming into the building. We went from the lobby area into an elevator bank area--escalators that led into the concourse area...

Not two seconds later debris and dust started to come in, and essentially we were just shut down."

South Tower
James Basile (9110105), p. 5-6

(6) "...we heard this noise. It sounded like a train. I thought it was another jet coming overhead. I thought it was a fighter jet now patrolling or another plane coming. Pretty much everybody started scattering..."

South Tower
Paul Beck (9110326), p. 4

(7) "I lost track of time. You start to hear this rumble. You hear this rumble. Everything is shaking. Now I'm like, what the hell could that be. I'm thinking we're going to get bombed. This is an air raid.

You hear this thunder, this rumbling. Then you see the building start to come down. Everybody's like, 'Run for your lives! The building is coming down!'" [He then describes himself doing several tasks, then says: "Then shortly after that--the building came down."]

[later, p. 16-17:]

"Oh, wait, another major thing. When that second building came down, as we were running, you hear this thunder in the air. This was a scary part. We hear thunder. That's when I'm like, oh, no, now they're going to bomb us. You hear this thunder. You know it's in the air, but you don't see anything. You just hear this loud sound. It's just getting bigger and bigger."

South Tower; North Tower
Jody Bell (9110335), p. 9-11; 16-17

(8) "...I guess a little bit after I got past that point, there was a loud roar....I figured another plane was coming."

South Tower
Thomas Bendick (9110083), p. 3-4

(9) "I looked back because I heard what I thought was another jet, and it was the building on its way down already."

North Tower
Paul Bessler (9110503), p. 6

(10) "I didn't turn around to look. I just heard the noise coming down, and it was like a jet engine, just getting louder and louder."

South Tower
Pedro Carrasquillo (9110089), p. 5-6

(11) "that's when tower one came down, so I was on West Street. I looked up. There was a jet plane. It sounded--I mean it sounded like another plane coming over and I said holy god, I hope it's one of ours. I looked up. It wasn't ours. There was a building coming down."

North Tower
Salvatore Cassano (9110011), p. 11

(12) "As we were doing that, somebody said, there's another plane. That's it, another plane is coming, another plane is gonna crash. We heard this rumble, that's when the building came down. We all thought it was a plane...We actually thought it was another plane. That's right. That's when the other building came down. Because we heard the rumble (BOOM). Just crashing down, I thought it was another plane."

North Tower
Allen Cruz (9110047), p. 10

(13) Q. "You knew the building was coming down?"
A. "No. We were reacting. There was no logical thought. You were reacting to the noise. The noise was getting louder and louder. It was like a jet engine or a train coming at you. So we just ran and ducked."

South Tower
John Culley (9110107), p. 11

(14) "Whatever time it was when that first building started to come down, all we heard was just like a loud thunder that didn't stop. When you looked up you saw the debris starting to fall from the top, and a cloud of smoke on top and it was hard to judge where the debris was going to fall..."

South Tower

Frank D'Amato (9110043), p. 6

(15) "But immediately once I put the oxygen down, I hear the rumble, and I heard a rumble that we thought was another plane. That's what immediately everyone said, there's a plane coming, there's another plane coming.

So we all looked up and what we saw was tower, I guess, 2, the south tower, begin to do this. The top kind of did this and there was a horrendous rumble."

Q. "Now, your hand is showing that it's kind of tilted in one direction. What direction did it tilt?"

A. "It was tilting towards us, so it had been to be tilting eastward....At that point we hear the rumble and, you know, this is it. I figure I'm dead. I thought this tower was going to topple. So I start to run."

South Tower
Manuel Delgado (9110004), p. 14-15

(16) "Right after that, in my mind, I heard a rumbling, and it was almost as if it was the roller coaster at Coney Island. It seemed like a metal clanging on metal sound. Then we saw a black cloud come out, and I told everybody to run."

North Tower
George DeSimone (9110129), p. 6-7

(17) [He hears a "rumble" when the South Tower comes down. Then he says:]

"So when that collapsed, I felt a tremor and I ran towards North End, but we had a cloud following us..." [South Tower]

"...but when the second tower fell [North Tower], I never forget that sound. It sounded like a freight train passing by. I never forget that sound, never forget that sound. Like a freight train."

South Tower; North Tower
John Felidi (9110201), p. 8, 9

(18) "I heard a tremendous roar like I've never heard before and it sounded like a jet engine was like right over my head, like I was on a runway with a jet engine just taking off over my head.

At that point I kind of looked up in the air because that's where--and I was looking for a plane. I couldn't see anything, but I saw people running. So I said, well, this may be a good time to start running....I started running, and then there was a complete--a blanket over me..."

North Tower
Thomas Gaby (9110140), p. 11-12

(19) "At that point--again, not even--I would say about 40 seconds, we get to the middle of the street with this individual, and you heard like a loud 'rrrrr.' Everything started shaking. We thought it was another plane.

What we did, we all separated. Me and two other guys, Walker and Murphy, we went back to the building."

North Tower
Joseph Galasso (9110322), p. 9

(20) "It wasn't that long at all, and we heard this sound that kind of sounded like an airplane. We thought it was another airplane hitting the towers. That's exactly what it sounded like, you know, and it gradually got louder."

South Tower
Peter Giammarino (9110436), p. 4

(21) "...we started to hear this rumbling sound, and this was probably five, ten minutes after we got into the loading dock. We heard this rumbling sound and, you know, the rumors were there of additional planes missing, and actually, my initial thought was this was actually another plane...and the noise stopped, and we opened up the door, and everything was pitch black."

South Tower
Michael Guttenberg (911005), p. 10-11

(22) "...we were sitting there talking and we heard a sound that sounded like a plane -- like you were in the middle of a plane engine.

Everybody looked up and you said oh, no, a third one. That's how loud it was. Then we turned our eyes toward the Trade Center and we saw the top building [sic] come down...I ran. I dove under that ambulance and it started to get buried with rubble."

South Tower
Mark Harris (9110057), p. 5

(23) "9:55 we heard this loud rumbling noise, looked up and saw the building coming down. Everyone started yelling, run, run, run, so we started running up Vesey..." [p. 3]

"That's about the point when the building came down and my back was to it. I heard the noise. I turned around and it looked like I was looking at a movie. It was like surrealistic.

I can still vividly see the debris coming down and starting running. The noise is -- I thought it was another plane actually, because the noise was so deafening loud, from everything coming down." [p. 7]

South Tower
Stephen Hess (9110060), p. 3, 7

(24) "While she was telling her sister that she was safe, what I perceived to be the building started rumbling, the one we were in, and it was my impression that a third plane hit the building we were in. I had no idea that the first tower was collapsing...so it was my impression at that point that the whole building [the one they were in] was going down, that a third plane hit the building, and that we were probably going to be dead at that point...The rumbling, the building was rumbling, and we thought the whole building was coming down, people were screaming in the hall, the smoke engulfed us, we couldn't see, and there was just a loud rumble, a jet rumbling..."

South Tower
Randall Hirth (9110152), p. 4-5

(25) [Note: This refers to an occasion some days *after* 9/11 and illustrates the traumatizing effect of the collapse sounds.]

"There was thunder, I will never forget. I was home I guess the week after that, and thunder, there was this horrible storm that came through and I'm at home and I'm finally in my bed and I'm like okay, I can't sleep, everybody is knocked out and all of a sudden this big kaboom. I was in my bedroom and I have a ranch, a long ranch. My room is here, my daughter's is here and my son's is here and my son was sleeping with my daughter that night.

I got out of the bed, that boom, ran and scooped the two kids up and jumped on top of them. They are like, ah, what's the matter? I'm like what was that? My husband is like holy shit, you need to see somebody about that...

And I still do that, you know. They are demolishing buildings over by where I live to build a new mall. I'm like, what was that, you know, like commando on the floor. Come on baby, let's go. You know, it's wild."

Veronica Jacobs (110173), p. 12-13

(26) "We heard like a lot of trembling and everything. So we better get out of here. This doesn't look good. There is no more people coming.

So we started walking the same way the Chief went, and he was at the other end. He said the same thing. He said we better get our asses out of here. This doesn't look good at all. As we were walking, we heard -- we thought it was another plane coming. It was like a big shhhhh. A thousand times louder than that. It sounded like a missile coming and we just started booking. We took off like bats out of hell.

We made it around the corner and that's when the shit hit the fan right then and there. We heard that loud and then ba boom. I just -- it was like an earthquake or whatever. A giant, giant explosion." [Debris starts hitting him shortly after this.]

North Tower
George Kozlowski (9110308), p. 8

(27) "Before I could finish that sentence, we heard just a loud noise and looked up and tower two was starting to collapse. With that everybody just started running...

...

Tower one now comes down. Same thing but this time some of us take off straight down West street, because we realized later on, subconsciously we wanted to be near buildings. We all thought it was secondary explosives or more planes or whatever."

South Tower
Art Lakiotes (9110216), p. 4-5

(28) "Anyway, just to describe to you the collapse of the south tower coming down, I really wasn't aware there was a full collapse. I thought it might have been just a localized collapse. It was the loudest noise I've ever heard in my life. It was in both ears. Kind of like those rockets that they launch the space shuttles with, it was like I had one going off in each ear. When I thought it was the loudest noise I ever heard, every second it was just increasing getting louder and louder and louder.

I was running as fast as I could. With this noise getting louder and louder, also what's happening simultaneously was light -- what ever light we had was becoming darkness..."

South Tower
Robert Larocco (9110081), p. 21

(29) "We heard a noise like the plane was still coming in -- like another plane was coming in. We turned around to look, and that's when our building was going down."

Kirk Long (9110509), p. 6

(30) "Then all of a sudden there was like a loud -- almost like a rushing sound, a roar, and we looked up and we could see it looked like an implosion and the building kind of went in and out and kind of like shook and I remember like 20 or 30 guys, whatever it was, all there at the command post. A lot of them in front of me pulled towards West Street. We were looking up and then this thing started coming down and nobody ran. I could remember that. Even myself, I remember being hypnotized by this thing and just looking up at it and then finally, thank God, somebody yelled, 'Run.' And we took off..."

South Tower

David Loper (9110349), p. 10

(31) 10:

"-- at that time, I heard a rumble, you know, and then it was, you know, really like, almost like an earthquake.

Then what happened was I heard people screaming and running and then it seemed like they were going to -- it was like going to be a trampling. It was just like bedlam...

Then I started to run for safety too, because I looked up and I saw that the building was going to come down. We were right across the street from it...

...suddenly, I was near that garage area, the sky as it blacks out, and then all of a sudden, it just came down."

South Tower
Alexander Loutsky (9110151), p. 10, 11

(32) "...we started to hear a rumble that was about a thousand times more intense than the sound of the subway that runs underneath the ground, but something similar to that. Like I said, a thousand times more intense. With that, somebody came running around the corner and I always make the comment that I don't think his feet were touching the ground...and he was saying run run run, the building is coming down. There were some other people behind him. The dust cloud was right behind them."

North Tower
Daniel Lynch (9110185), p.7

(33) “I said it sounds just like this, this is exactly what it sounds like, here's another one, thinking it was a third plane. Meanwhile the sound to me was four distinct events. They all sounded the same. The two plane crashes and the two collapses, except the collapse lasted longer...

...

That was the fourth event in the sound department. The sound was the same thing again. Sounded like a plane to me. Sounded like another plane, but it was the collapse of tower one..."

South Tower; North Tower
Paul Mallery (9110312), p. 8, 11

(34) "Shortly before the first tower came down I remember feeling the ground shaking. I heard a terrible noise, and then debris just started [7] flying everywhere. People started running toward the staging area."

"By the time the debris settled from the first collapse, we started to walk back east towards West Street, and a few minutes later -- I really don't remember the time frames because we were so busy in trying to account for who was in the staging area and who wasn't -- we basically had the same thing: The ground shook again, and we heard another terrible noise and the next [7] think [sic] we knew the second tower was coming down."

South Tower; North Tower
Bradley Mann (9110194), p. 5, 6, 7

(35) "I was talking to him when I heard a loud, like a roaring noise, like a loud loud roaring noise. At the time I didn't know what it was I just looked up. All I could see because of the fog that was there, you couldn't see above. Your distance was limited. Once I heard that, I heard like a big explosion, a tremendous explosion, let me put it that way and a rumbling sound....
I also felt myself airborne. I was airborne. I didn't get that far. I was airborne. I felt a force behind me and it slammed me down on the ground. I got slapped down on the ground. Everything started hitting me, whatever was falling. At the time I didn't know what it was. I thought maybe that the building that was on fire exploded. I didn't know. I found out later on that the second plane had hit another building, the second tower." [GM: He's wrong: it's the first collapse]

South Tower
Edward Martinez (9110494), p. 5

(36) "As we got like a half a block away, you could hear a gigantic rumble. It sounded like a jet flying overhead. Everybody immediately looked up, and you could see just a big cloud of dust coming down to the ground. I didn't see the actual top of the building coming down, but you knew what it was."

North Tower
Vincent Massa (9110222), p. 7

(37) "...all of a sudden I heard this sound. It sounded like a jet, a high, whistling sound. There was like a rumble behind it. It was like a jet with a locomotive behind it.

I heard people screaming. All of a sudden, the firemen that were behind me were throwing their hose packs down. When I came out of the back of the truck, I looked up and I saw the second tower coming down. The second tower was coming down."

South Tower
Mark Mazur (9110118), p. 6

(38) "Shortly after they came out and got their gear on, we were ready to go straight ahead, you heard a roar, some sort of a vibration, like a vrr vrr vrr, getting louder and louder.

My first thought to myself, I live down in Rockaway so I have heard planes coming overhead for years. It sounded like a plane getting closer and louder and louder and next thing you know, you felt the building shook...I think I might have heard somebody say it's coming down or something." [He hides behind a wall and hears the Tower come crashing down.]

South Tower
Kevin McCabe (9110344), p. 13

(39) "I heard that roar again. Sounded like a big jet plane..."

North Tower
Richard McCahey (9110191), p. 26

(40) "Then we heard this loud noise like another plane. That's what we thought it was, another plane. It was a real loud rumbling. I can hear a lot of people screaming...we could see this big, black cloud of smoke coming up."

North Tower ?
Dulce McCorvey (9110007), p. 6

(41) "We went approximately one or two blocks when all of a sudden heard this big roar. It sounded like another plane coming in or it sounded like an earthquake, but it just didn't sound right. So we all started running, my partner and I, and we had the commissioner with us also. The next thing I know we were engulfed in this black cloud of smoke..."

South Tower
Richard McCurry (9110371), p. 5

(42) "The second collapse was really bad because the whole building really shook and the noise--it was--it sounded like it was another plane. I was waiting for the fuselage to come in. It was so loud."

North Tower
Jason McGimpsey (9110477), p. 7

(43) "Then within a minute or two, it sounded like a missile was about to come through the windows, I guess maybe on every floor, but it sounded like it was going to come right through the 23rd floor. Everyone automatically just hit the deck, like you do in a war movie.

We heard a crash and the ground shaking..."

South Tower
Edward Mecner (9110391), p. 5-6

(44) "Then I just remember that, distinct noise like an airplane being on a runway and it's ready to take off. I heard the loud roaring of like the engines, and I thought another plane was hitting the building.

Someone yelled run. I looked up, and the top of the tower I saw was starting to move over. It was bending like it was going to come down. Everybody started running...

...I really didn't know what was happening, I thought a plane had actually hit the building, a third plane."

South Tower
Bruce Medjuck (9110086), p. 10-11

(45) "Then all of a sudden you heard something, and it sounded like a harrier jet was landing right over top of us. Sure enough that second tower was just coming straight down.

It was sick. I didn't think I was going to survive. It was really a sick sight and a really sick sound."

South Tower
Craig Monahan (9110016), p. 7

(46) "we heard a high pitched whine and wind and heard thundering crashes."

North Tower
Roger Moore (9110214), p. 6

(47) "We were probably about a block away when we heard a giant rumbling sound. It sounded like jets were going overhead and then we looked up and we saw the tower start to fall and we just ran."

North Tower
Michael Morabito (9110461), p. 4

(48) "suddenly somebody to the front of us -- I don't know if it was a civilian or firefighter or cop or what -- said, 'She's coming down.' We were within a half a block of the north tower...
...

But that shout went up, and the crowd in front of us suddenly surged towards us. Everybody turned and started coming back north. I looked up, and it appeared as if the north tower -- it almost appeared to be liquefied. The very top of it began to cascade out and down, almost in a rolling motion.

As I watched it, the street started to fill with this tremendous sound of just noise. It reminded me of a jet aircraft engine when a jet takes off. It was that loud. The debris started coming out onto West and down."

North Tower
David Moriarty (9110228), p. 7

(49) "I walked about two, three minutes, and all of a sudden I heard a plane. Now, I'm like the only one walking on this block. I said oh, my God, we're being attacked again. Someone said it could have been a B15, a U.S. plane up in the air. Actually, what I think it was, was simultaneously the plane and the north tower coming down. So that's what the sounds were. I heard that rumble."

North Tower
Murray Murad (9110009), p. 11

(50) "I had heard right before the lights went out, I had heard a distant boom boom boom, sounded like three explosions. I don't know what it was. At the time, I would have said they sounded like bombs, but it was boom boom boom and then the lights all go out...I would say about 3, 4 seconds, all of a sudden this tremendous roar. It sounded like being in a tunnel with the train coming at you. It sounded like nothing I had ever heard in my life, but it didn't sound good. All of a sudden I could feel the floor started to shake and sway. We were being thrown like literally off our feet, side to side, getting banged around and then a tremendous wind started to happen. It probably lasted maybe 15 second, 10 to 15 seconds. It seemed like a hurricane force wind. It would blow you off your feet and smoke and debris and more things started falling."

South Tower
Keith Murphy (9110238), p. 19-20

(51) "...then you heard this noise and a few guys said it's another plane. But for whatever reason, I knew exactly what it was. It sounded like a freight train going right over your head. It was an unbelievable experience. Then, when the second one went, obviously, you heard the same noise, so you knew what that was."

North Tower; South Tower
Christopher Murray (9110327), p. 17

(52) "...about that time that you hear that same rumble, oh, fuck, it's happening again...Now you hear that big jet airplane going again. Fuck. Everybody starts running..."

North Tower
John Murray (9110407), p. 11-12

(53) "All of a sudden I heard this noise that was just horrible. I would say it sounded like a gate rattling or something like that...So I got out, and I started running, because everyone

started running. That was when the second tower collapsed. It was right at the beginning of the second towers collapse."

South Tower
Naomi Nacional (9110483), p. 4-5

(54) "I remember being over there, and did I hear yet another -- what I thought was a propulsion of a plane, and then an explosion, and then we all dove to the floor."

North Tower
Robert Norris (9110071), p. 17-18

(55) "...the first thing I hear is this roar and people screaming. I have a chance to look over my left shoulder.

As I'm looking over my left shoulder, I see a shadow coming towards me. I thought it was another plane. I didn't think the building was coming down. I thought it was another plane. I couldn't believe it."

North Tower
Brian O'Flaherty (9110431), p. 32-33

(56) "Then we heard jets overhead and we were concerned that there was another plane coming in to attack us. We just about finished packaging him when we heard that same roaring rumble that preceded the first collapse...and we just crossed our fingers and waited for the other collapse."

North Tower
Sean O'Malley (9110259), p. 16

(57) "I started to make my way to the command post when I heard that horrible sound again, you know that whining screeching jet engine.

I looked up and at that point I knew the north tower was coming down..."

North Tower
John Peruggia (9110160), p. 31

(58) "Just as I started walking back, just before that catwalk on the corner, some maybe 20 feet, I guess, 50 feet, I heard this sound...

That's when we heard that sound, again, and I swear it sounded like another plane coming in, just that rumbling noise, that steadily -- that continuous rumbling that was getting louder and louder, and I think the last words I had were, oh, God not another one."

South Tower
Joel Pierce (9110485), p. 5-6

(59) [Note: He is reflecting here on his current life.]

"A plane passes over, you hear...The airport closes at 12 midnight it's 2:00 in the morning, and I hear this roar of a plane go by. It's the same rumble. I was dreaming about this building falling down, with the smoke and all."

Steven Pilla (9110104), p. 17

(60) "It was at that point when I personally heard a loud rumbling noise. I thought it was another plane hitting the tower, and that's when the entire street filled with smoke, debris, became totally black, and we ran into the American Express Building."

South Tower
Jace Pinkus (9110042), p. 9

(61) "We got in front of the Marriott when what sounded like another plane coming in...and that's when the middle of the Marriott blew out at us."

South Tower
Richard Ratazzi (9110451), p. 3

(62) "I was in back of the vehicle and I heard, it sounded like I thought another plane had struck the building. This loud bang and then it sounded like a locomotive, or like when I used to live in Howard Beach, when the planes used to come in at night, flying right over the house. Everything started shaking and I heard like a thunderstorm. Somebody screamed it's coming down. I don't remember if it was on the radio, because the side door of the bus was open. The back door of the truck--I could see out of. I looked, and I bent all the way down to look up as far as I could, and I could see the cloud coming. I thought the building was actually falling over. I didn't know it was pan-caking."

South Tower
Eric Rodriguez (9110094), p. 7

(63) "At that time we were looking at the top of the towers and all the rubble and people coming off, and all of a sudden you heard -- it sounded like another airplane, or a missile. It was like a slow shake. The whole ground just vibrated and shook. We just told everybody to run, run into a building, let's go, run, run, run...

After that the debris was just coming down and coming down."

[later:]

"All of a sudden it happened again, the same exact sound, the same thing."

Q. "The noise and the vibrations?"

A. "The noise and the vibrations.

At that point everything -- it just came down. All you saw was the cloud of smoke coming at you, so we ran."

South Tower; North Tower
John Rothmund (9110112), p. 5-6; 13

(64) "The next thing you know, you hear a loud thundering noise. It sounded like a jet, a big rumble. I start looking around and I'm like, what is that? The next thing I know, I see the cop just take off. I'm like, where's he going?

Then I see the things on the floor, like Liberty -- you know, just like the movies, bouncing up and jumping and shaking. I mean, not like an earthquake, like a 6 point something or something like that. but you see stuff on the floor shaking from side to side. I'm like, on, my God. I look up and I was saying, oh, no, the building's going to fall down.

Let me tell you, you talk about being scared, never in my life -- I don't think ever again I'll ever be so scared. So I turn around. Right where I'm standing I turn around. I'm in the center of the building. I turn around, and I try to go inside the building... By now the sound is just getting louder and louder and louder. I said, oh, man, this building is going to fall on me right now. What do I do? I got up, and I just -- this is like a split second...What I wanted to do is I didn't want to run straight up; I wanted to go diagonally to get out of the -- because I figured this building was falling, it was tumbling over. I didn't think it was falling down on top of itself."

Q. "So you had a feeling the building was coming down right away?"

A. "Yeah."

Q. "Is that what you first thought?"

A."Yeah. The sound, it's just loud. At first it's (sound) and then you feel everything around you -- not around you but the floor. You feel the floor trembling and shaking. You look at the floor, the dirt, the sand and everything on the floor shifting from side to side. I'm like, oh, man."

South Tower
Robert Ruiz (9110333), p. 10-15

(65) "We heard a rumbling. We thought it was another plane. We looked up, and you actually saw the towers just starting to roll down at you. You saw the building portions coming down. I stood there and couldn't move. I just couldn't move. I couldn't believe what I was looking at.

A couple seconds later I turned around and started to go."

South Tower
Howard Sickles (9110189), p. 7

(66) "I was just stepping into the street off the center median when I heard what is going to be instilled in my memory forever; a sound that combines a railroad car, an airplane, a fighter jet and thunder. I looked up and I saw the World Trade Center falling down."

South Tower
Mark Stone (9110076), p. 9

(67) "...to me it sounded like the 8:45 from Jamaica station going to Atlantic -- to Flatbush Avenue, the Long Island Railroad, just some big train just right over your head, like a whole bunch of locomotives just running right over your head.

I looked up, and the building just tilted and started coming down. All I could say was run."

South Tower
David Timothy (9110156), p. 7

(68) "I remember he pulled me out and I actually thought a plane was coming because of the roaring sound. That's when he told me the tower collapsed."

William Truocollo (9110456), p. 3

(69) "The way the noise was going to me or to a lot of us, we thought it was another plane coming. It was two; why not three or four. It sounded to us like it was a plane coming through the window."

South Tower
John Weber (9110377), p. 6

(70) "we heard a -- we felt a loud -- a very strong vibration, shaking, and a loud noise like a subway train coming through a station at speed, like a jet engine at full throttle. It was a roaring sound..."

South Tower
Charles Wells (9110163), p. 6