

**IN THE MATTER OF THE THOMAS R. BRAIDWOOD, Q.C.,
COMMISSIONS OF INQUIRY UNDER THE *PUBLIC INQUIRY ACT*,
SBC 2007, c. 9**

Cypress Room
Residence Inn by Marriott Vancouver
1234 Hornby Street
Vancouver, B.C.

May 5, 2008

PROCEEDINGS AT
FORUM (DAY 1)

ORIGINAL

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FORUM (DAY 1)

Commissioner:	T.R. Braidwood, Q.C.
Commission Counsel:	A. Vertlieb, Q.C.
Associate Commission Counsel:	P. McGowan
Court Recorder:	P. Kealy, C.V.R., C.M.
Transcriber:	P. Neumann

1
Opening remarks by the Commissioner

Vancouver, B.C.
May 5, 2008

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4 THE COMMISSIONER: All right. Good morning everybody
5 and welcome to this first public forum. My name
6 is Thomas Braidwood and I am the sole commissioner
7 appointed under the B.C. **Public Inquiry Act**. With
8 me today are my Commission Counsel, Art Vertlieb,
9 Q.C., and Associate Commission Counsel, Patrick
10 McGowan.

11 I expect that all of you and many people
12 indeed around the world have seen the video
13 recording of the incident at the Vancouver
14 International Airport last October the 14th,
15 during which an officer of the Royal Canadian
16 Mounted Police used a conducted energy weapon
17 against Mr. Robert Dziekanski, who died within
18 minutes thereafter. Public reaction to the events
19 at the airport was immediate and intense.

20 At a more general level, concern was
21 expressed about the deployment and use of
22 conducted energy weapons by policing bodies in
23 British Columbia.

24 In response to this public concern the
25 Provincial Government appointed me to conduct two
26 separate inquiries under the **Public Inquiry Act**.
27 A "hearing and study" commission, which will
28 commence later this year, will inquire into and
29 report on the death of Mr. Dziekanski. I am
30 mandated to provide his family and the public with
31 a complete record of the circumstances relating to
32 his death and to make any recommendations that I
33 consider necessary and appropriate. The main
34 focus of that inquiry will be evidentiary hearings
35 in which witnesses will testify under oath and be
36 subject to cross-examination. I am not authorized
37 to make findings of civil or criminal liability,
38 but I may make findings of fact based upon the
39 evidence that I hear.

40 The second inquiry that brings us here today
41 is very different in nature. Under the **Public**
42 **Inquiry Act** it is described as a "study"
43 commission. I have been instructed to inquire
44 into and report on the use of conducted energy
45 weapons by police officers, sheriffs and
46 authorized persons under the **Corrections Act** and
47 to make recommendations on two matters: the

2
Opening remarks by the Commissioner

1 appropriate use of conducted energy weapons by
2 such persons in the performance of their duties,
3 and the appropriate training or retraining of such
4 persons in their use of conducted energy weapons.

5 For those of you who would like to see the
6 exact wording of the terms of reference, or would
7 like more information on these inquiry activities,
8 please go to the website, www.braidwoodinquiry.ca.

9 I should say that while I use the term
10 "conducted energy weapon", the conducted energy
11 weapon used at the Vancouver International Airport
12 incident on October the 14th, and only such weapon
13 authorized for use in British Columbia, is made by
14 TASER International of Scottsdale, Arizona.

15 Given the public concern about and the public
16 interest in the use of conducted energy weapons, I
17 am determined to make the inquiry activities and
18 process as public and as transparent and as
19 accessible as possible.

20 Over the next three weeks we will have 14
21 days of public hearings, of which more than 40
22 individuals and organizations will make
23 presentations. This will include experts on
24 various medical and scientific issues,
25 representatives of police force, and non-
26 governmental organizations with a long-standing
27 interest in the use of conducted energy weapons,
28 such as Amnesty International, the B.C. Civil
29 Liberties Association. In addition, I look
30 forward to hearing from members of the public
31 about the issues arising from the terms of
32 reference.

33 If the 14 days we have scheduled are not long
34 enough, we will arrange further public forums a
35 little later.

36 For those who will not make oral
37 presentations, but would like to express their
38 views on the issues before the inquiry, I
39 encourage such people to prepare a written
40 submission and forward it to the inquiry office.
41 Please do so, if you will, as soon as it is
42 convenient but disregard the April 15th deadline
43 noted in our website.

44 In addition to these public forums, the
45 inquiry's research team is engaged in an ambitious
46 series of projects, examining the legal framework
47 in which conducted energy weapons are used, each

1 police force's rules, policies and procedures,
2 training and retraining, and numerous scientific
3 and medical issues.

4 In order to develop a clear understanding of
5 how frequently and in what circumstances conducted
6 energy weapons have been used in British Columbia,
7 we will review incident reports from all police
8 forces. We will canvass other Canadian and
9 foreign jurisdictions to learn as much as possible
10 about their regulatory regimes, training and usage
11 of conducted energy weapons. We will review
12 recent published reports from other public bodies
13 and inquiries on the use of conducted energy
14 weapons, and we are monitoring the work of several
15 other contemporaries' inquiries across Canada. As
16 you will see, we have a lot to learn and an
17 ambitious consultation and research program.

18 The key element of our work is hearing your
19 views about the two issues that I am instructed to
20 make recommendations about: (1) the appropriate
21 use of conducted energy weapons, and (2)
22 appropriate training and retraining.

23 I would like to comment about two aspects of
24 the Terms of Reference for this study commission.
25 First the terms state that I am to submit my
26 report to the Attorney General by June the 30th,
27 2008. Given our public consultation schedule and
28 the complexity of the legal and research issues
29 involved, it has become clear that such date is
30 unrealistic. I have written to the Attorney
31 General, requesting an extension until later this
32 year, and I remain hopeful of a favourable
33 response.

34 Second, the Terms of Reference direct me to
35 inquire into the use of conducted energy weapons
36 by "Constables of police forces of British
37 Columbia other than the RCMP". As you may know,
38 eleven municipalities in British Columbia are
39 policed by municipal police forces. The remainder
40 of the province is policed by the RCMP under
41 contract with the Province. Because the RCMP is
42 regulated federally, a provincially appointed
43 inquiry such as this one has no authority to
44 inquire into the RCMP's administration or
45 management. It is for that reason that the terms
46 of reference exclude the RCMP.

47 Having said that, it would be regrettable if

Opening remarks by the Commissioner
Opening remarks by Mr. Vertlieb

1 the RCMP played no parts in this inquiry process.
2 About 70 percent of British Columbians live in
3 areas policed by the RCMP. And the events of
4 October the 14th in the Vancouver Airport took
5 place in the Municipality of Richmond, which is
6 policed by the RCMP. But I am pleased to report
7 that as a result of consultations that my team and
8 I have had with the RCMP, they have agreed to
9 participate in all aspects of the study
10 commission's activities.

11 That brings us to today's public forum.
12 This is primarily an educational process. These
13 proceedings are not adversarial in nature.
14 Presenters will not be required to testify under
15 oath, and the proceedings will be as informal as
16 the circumstances permit.

17 Commission counsel will lead each presenter.
18 If time permits, I will adjourn after a presenter
19 has given his main presentation and anyone
20 interested in asking a question by way of
21 clarification can speak to counsel and they will
22 do that on your behalf, again as time permits.

23 Now I invite Mr. Vertlieb to outline who we
24 expect to hear from over the next three weeks, and
25 begin indeed with the first day's presenter. Yes,
26 Mr. Vertlieb.

27
28 OPENING REMARKS BY MR. VERTLIEB:

29
30 MR. VERTLIEB: Thank you, Mr. Commissioner.

31 Just for reference, I just wanted to state
32 the proceedings this week will be here in this
33 hotel, May 5 to 9. And then starting next week,
34 May 12 to 19 at the Wosk Centre for Dialogue on
35 Hastings Street here in Vancouver. And then the
36 third week, starting on the Tuesday, May 20 to 23
37 will be at the Federal Courthouse at 701 West
38 Georgia. Sessions will start at 10:00 a.m. in the
39 morning, and afternoon sessions at 2:00 p.m.

40 Now, in terms of the methodology, Mr.
41 Commissioner, in accordance with your instructions
42 this is what we have done. First, we have
43 attempted to meet the presenters who wish to come.
44 Secondly, we have made it clear to them in
45 accordance with your instructions, that we are to
46 accommodate their schedules. The participation as
47 you have stated is voluntary. The events are to

1 be non-adversarial, and so we have gone out of our
2 way to accommodate schedules, and that means that
3 scheduling is in a state of flux continually.
4 Where we might have thought someone would come
5 tomorrow, that may have to be changed, and there
6 will be those sorts of changes to accommodate the
7 convenience of your presenters.

8 We have also informed the presenters and
9 counsel, where applicable, that there will not be
10 cross-examination of the presenters, and that if
11 any party wants an area to be questioned, that
12 that will be dealt with by myself and Mr. McGowan.

13 Now, also in accordance with your mandate, we
14 have endeavoured to make sure that the differing
15 points of view on this subject are going to be
16 presented to you and form part of the record.

17 We also, in accordance with your
18 instructions, have invited the different police
19 agencies that will be coming to present fully and
20 fairly their view about this equipment, this
21 weapon, and also to relate to you the stories of
22 use where they feel it has been an advantage to
23 have this type of equipment available.

24 We have endeavoured to make sure that all
25 presenters will realize that there is no
26 preconceived agenda, no preconceived notion, and
27 that it is a totally open and fair event. The
28 atmosphere we have encouraged our presenters to be
29 informal, and we have also done everything we can
30 to make all members of the public feel welcome and
31 we hope that will maintain throughout.

32 Now, in accordance with your instructions, we
33 just want to let you know that there have been
34 notices in newspapers around the province inviting
35 all interested parties and groups who wish to make
36 submissions to do so. To date we have
37 accommodated everyone's request that has wanted to
38 make a written presentation or oral presentation.

39 We, as counsel, and with our research team,
40 have sought a full review, and in that review we
41 have connected with people with expertise that
42 have been suggested by police forces. We have also
43 looked for people with expertise based on our own
44 research efforts and those people will be coming
45 to present.

46 Now, in terms of the categories of
47 presenters, I just want to outline these briefly

1 for you, Mr. Commissioner, and then we will go
2 into a bit more detail. We have six main
3 categories of presenters. The first category we
4 call the "Law enforcement" people. And the second
5 category is the "Manufacturer", which is TASER
6 International. The third will be "Medical
7 experts", meaning physicians, men and women of
8 medical training. The fourth category will be
9 "Non-medical experts". The fifth category of
10 presenters will be "Technical experts", and then
11 the last group we call "Interested groups and
12 individuals".

13 Now, I'd like to give you, Mr. Commissioner,
14 a breakdown of these categories, and the
15 anticipated presenters, based on the latest
16 information available to Mr. McGowan and myself.

17 "Law enforcement" presenters, there are a
18 number, I will just outline those for you briefly
19 now. We have Constable Mike Massine, who is the
20 Program Coordinator for Conducted Energy Weapons
21 in Victoria. Next we have Peter Coulson, who is
22 Warden of the North Fraser Pre-Trial Centre.
23 Next, Sergeant Clive Milligan, he is the Sergeant
24 in charge of training, Vancouver Police
25 Department. Number 4, Constable Tammy Hammell,
26 she is the Electronic Control Device Coordinator
27 for Vancouver Police Department. Dan McLachlan,
28 he is Firearms Training Officer, South Coast BC
29 Transportation Authority Police Service. With him
30 will be Bob Huston, who is the Inspector in
31 Charge, South Coast BC Transportation Authority
32 Police Service. He will simply be attending.
33 Next, Paul Corrado, he is the Superintendent,
34 Strategic Operations and Security, Sheriff
35 Services. Next, Sergeant Joseph Spindor, New
36 Westminster Police Department. Chief Constable
37 Jim Chu, Chief Constable Vancouver Police
38 Department. Chief Constable Jim Cessford, Delta.
39 Chief Constable Dan Maluta, Nelson. Chief
40 Constable Bill Naughton, Victoria. Deputy Chief
41 Bob Rich, he is Deputy Chief in Vancouver. He is
42 the President of the B.C. Association of Municipal
43 Chiefs of Police. The RCMP will attend. We don't
44 know the names of their presenters. We have Staff
45 Superintendent Mike Federico from Metro Toronto
46 Police Service. And we have Assistant Deputy
47 Minister Kevin Begg, Ministry of Public Safety and

1 Solicitor General.

2 Next under the "Manufacturer" we are going to
3 have Tom Smith. He has asked to be here. He is
4 the Chief Executive Officer of TASER International
5 and he wishes to have Dr. Ho, an Emergency Room
6 physician, come as well to present.

7 Now, the "Medical experts" generated by the
8 work of your commission, I wish to outline those
9 now. We have Dr. Christine Hall, an Emergency
10 Room physician from Victoria; Dr. Joe Noone, a
11 psychiatrist here in Vancouver; Dr. Charles Kerr,
12 a cardiologist in Vancouver; Dr. Mike Janusz, a
13 thoracic surgeon, a heart surgeon from Vancouver;
14 Dr. Zian Tseng, a cardiologist from San Francisco;
15 Dr. Lu Shawohua, a psychiatrist from Vancouver;
16 Dr. Maelor Vallance, a psychiatrist, Vancouver;
17 Dr. John Butt, a pathologist, Vancouver, and
18 lastly in the medical category, Dr. Keith
19 Chambers, an epidemiologist.

20 "Non-medical experts" we have Dr. Mike
21 Webster, a psychologist with expertise in crisis
22 management and police procedures. We have John
23 Kiedrowski, a criminologist, who has been embarked
24 on the study of this conducted energy weapon for
25 the Commissioner of the RCMP. And lastly we have
26 Paul Kennedy, he is the RCMP Complaints
27 Commissioner. Now, Mr. Kiedrowski cannot attend
28 until June, and Mr. Kennedy cannot attend until
29 June when his final report as RCMP Complaints
30 Commissioner will be available.

31 "Technical experts", we have Pat Reilly, who
32 will be the first presenter today. He is an
33 electrical engineer. We have Dr. John Webster,
34 who will be presenting this afternoon. He is a
35 biomedical engineer. And we have Dr. Pierre
36 Savard from Montreal. He will be presenting later
37 on. He is a biomedical engineer, as well.

38 Now, under the category, Mr. Commissioner,
39 "Interested groups and individuals". From the
40 Canadian Mental Health Association there will be
41 three presenters before you: Dr. Nancy Hall, Bev
42 Gutray, who is the Executive Director, and a Camia
43 Weaver. We have a presenter from Amnesty
44 International, Hilary Homes. We have from the
45 B.C. Civil Liberties Association Grace Pastine,
46 who is the Litigation Director. We have Cameron
47 Ward. He is counsel for the Bagnall family, which

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1 is involved in litigation arising out of the death
2 of Mr. Bagnall. We have Walt Kosteckyj, who is
3 counsel for Ms. Cisowski. Mr. Kosteckyj is here
4 today just to observe. He will be presenting
5 later in your proceedings. We have Catherine and
6 Joseph Gallagher. We have Jude Swanson, J. Page,
7 Errol Povah and Ken Stethem and Randy Puder,
8 individuals who wish to present to you.

9 Now, in closing at this point, I just want to
10 tell you, Mr. Commissioner, and for the benefit of
11 people attending, because of the scheduling and
12 the accommodation of people's schedule, there will
13 be days when we will be not in session for the
14 entire day.

15 We also recognize that during the course of
16 these presentations and forums, there may be
17 others who wish to come forward and we will do
18 everything in our ability to accommodate that.
19 For that reason we are going to try to keep the
20 proceedings as fluid and ongoing as possible.

21 You have already mentioned the request for
22 the extension, and I have mentioned to you that if
23 that is granted, then we would be able to have the
24 benefit of presentations from Mr. Kennedy and Mr.
25 Kiedrowski, both from Ottawa.

26 And to all of those present, at any time if
27 there are any questions or areas that we can
28 assist, it is the Commissioner's wish that all
29 people feel welcome to these forums, it is for the
30 people of this province, and feel free to contact
31 Mr. McGowan or myself.

32 So, Mr. Commissioner, that is the opening
33 outline of where we hope to be going over the next
34 few weeks.

35 THE COMMISSIONER: Thank you very much. Let's begin.

36 MR. VERTLIEB: Mr. Commissioner, our first presenter is
37 J. Patrick Reilly. Mr. Reilly, would you please
38 come forward and just sit at the presenter's
39 table.
40

41 J. PATRICK REILLY, a Technical
42 presenter.
43

44 QUESTIONS BY MR. VERTLIEB:

45
46 Q Now, Mr. Reilly --

47 THE COMMISSIONER: I believe it's Dr. Reilly, is it

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb

1 not?

2 MR. VERTLIEB: It actually is Mr. Reilly, sir.

3 THE COMMISSIONER: All right.

4 MR. VERTLIEB:

5 Q Now, Mr. Reilly, your first degree is from 1962,
6 the University of Detroit out of Detroit Michigan.

7 What was that degree, sir?

8 A That was in Electrical Engineering.

9 Q And then you continued your university studies at
10 George Washington University?

11 A Yes, I received a Master's Degree in Electrical
12 Engineering and Applied Science.

13 Q And since your first degree in 1962, what have you
14 been doing career-wise all these years?

15 A Well, for most of those years I spent most of my
16 career working at the Johns Hopkins University
17 Applied Physics Laboratory, during which time I
18 worked in a number of scientific disciplines doing
19 various types of research. And in a later part of
20 my career I began doing private consulting in
21 areas that were not being supported at the
22 laboratory.

23 Q And just tell us briefly about Johns Hopkins
24 University. What areas is it particularly known
25 for in the academic world?

26 A Well, it's really multi-disciplinary. The Applied
27 Physics Laboratory has a staff of close to 4,000
28 people today, probably 3,000 when I joined it.
29 They work in a number of disciplines. At the time
30 a lot of the work was supported by the Department
31 of Defense, but there were also many other
32 disciplines, including space work, biomedical
33 studies, environmental studies, and I participated
34 in a number of careers during my tenure with Johns
35 Hopkins University.

36 Q During those years you have published extensively,
37 as reflected in your resume, that you have been
38 the recipient of numerous awards for your
39 publications and your research?

40 A Yes.

41 Q You are still active in the field even after all
42 these years?

43 A Yes. I continue to have a part-time appointment
44 with the Johns Hopkins University, but I focus in
45 my private consulting on the type of work which is
46 really my first love, and that is bioelectricity,
47 the effects of electricity and electromagnetic

1 energy on living things.

2 Q In 1998 you were elected as a Fellow of a
3 prestigious organization in your field. Tell us
4 the organization.

5 A Well the organization is the Institute of
6 Electrical and Electronic Engineers known as I-
7 Triple-E and it has an international membership of
8 some 200,000 individuals spread across the globe,
9 and a small percentage receive the award as
10 designated as a Fellow of the I-Triple-E.

11 Q And you were designated a Fellow for furthering
12 the state of knowledge concerning human reactions
13 to electric current and electromagnetic fields
14 with application to medical devices, human hazards
15 and safety standards?

16 A That's right. And, yes, I spent a lot of my
17 career looking at electrical safety and I've been
18 very extensively involved with standard setting
19 organizations through the I-Triple-E and other
20 international organizations, as well.

21 Q Now, when did you first study the impact of
22 electricity on humans?

23 A Well, I began that work in the mid-'70s, and
24 that's when I began working with a group that was
25 newly formed at our laboratory in response to
26 public issues and very public concerns about our
27 use of energy. At the time energy was in short
28 supply, and environmental issues were becoming
29 into the focus of the public mind, and our
30 laboratory decided to start an environmental
31 group, looking at the effects of electrical
32 production on the environment, on people, and it
33 was then that I began studies of effects of
34 electricity on human beings.

35 Q And the purpose of that work was ultimately to
36 assist in what way?

37 A The work was fronted by the State of Maryland,
38 that's the state I reside in, and it was to set,
39 to determine an environmental assessment of the
40 impacts of power facilities in Maryland. And my
41 role in that was to look at effects on people,
42 electrical effects on people. The focus or the
43 purpose of that was to be able to look at various
44 proposals of power facilities and to advise the
45 State of Maryland, the Public Service Commission
46 on environmental impacts, and in some cases
47 mitigating measures that might need to be taken

1 into account.

2 Q You continued study in the field of electricity
3 and the impact on humans through the 1980s?

4 A Yes, I did, and that was as a result of my
5 involvement in this environmental work I realized
6 that I needed to understand the effects of
7 electricity on people at a very fundamental level,
8 and I eventually was able to gather the support
9 and funding through -- by the way, supported
10 jointly between the Canadian Electrical
11 Association and the State of Maryland, doing
12 research on people. The effects of electricity,
13 electric shock on people with human volunteers,
14 and studying levels of discharges, electrical
15 discharges to people even up to painful levels.

16 Q What was the purpose of that work?

17 A The purpose was to try to understand the
18 boundaries of when an electrical stimulus would be
19 unacceptable, and where you might need to take
20 certain mitigating factors into account in
21 developing electrical transmission facilities.

22 Q And those standards would then be developed to
23 protect the public?

24 A To protect the public, exactly.

25 Q Can you give a simple example of one of the ways
26 your work would have protected members of the
27 public, and I am thinking here of right-of-ways
28 and electrical lines over right-of-ways.

29 A Yes. High-voltage power transmission lines create
30 what we call an electric field, and under a high-
31 voltage power transmission line the electric field
32 can be quite intense and it can cause electric
33 shock to people who carry out some activities, and
34 in some cases within the right-of-way, and in some
35 cases off the right-of-way.

36 For example, you could find that if there was
37 a fence wire that was paralleling the right-of-
38 way, but perhaps on private property, under some
39 conditions of how that fence wire was constructed,
40 it could create an unpleasant electric shock to
41 someone who touched it. And so that would be a
42 case where we might recommend to the Public
43 Service Commission that the utility company, for
44 instance, a mitigating factor would be to ground
45 that fence wire in a way that that shock wouldn't
46 happen. So that would be an example of an
47 application.

1 We had a number of hearings, Public Service
2 Commission hearings where we went into issues just
3 like that.

4 Q Briefly tell us about your work with MRI testing.
5 We all hear about MRIs in the medical world and
6 indeed some of the people here in this room may
7 have had an MRI for injury. What have you done in
8 that field?

9 THE COMMISSIONER: Just a minute. What is an MRI?

10 A Okay. The "M" in MRI stands for "magnetic", it's
11 magnetic resonance imaging, and it's a technology
12 that has been around for a couple of decades now.
13 But you are put into a chamber with a great big
14 apparatus around you and by applying magnetic
15 fields, electromagnetic fields to your body, the
16 doctors can receive a picture, a very clear
17 picture of what is inside your body, the organs,
18 how they are, the appearance of the organs. It is
19 much more detailed than an X-ray would ever give
20 you and it doesn't have the hazards of X-rays. So
21 many of us have undergone MRIs at one time or
22 another.

23 So the word "M" stands for "magnetic".
24 Magnetic fields and electric fields are aspects of
25 electricity. So when you are inside of an MRI
26 machine, you are immersed with electromagnetic
27 fields. Those fields cause electric currents to
28 flow in your body, even though there are no wires
29 touching you. And under the right conditions
30 those magnetic fields and electric currents that
31 are induced in your body can under some conditions
32 be unpleasant, can under some conditions be even
33 painful, and under really intense fields could
34 even be dangerous.

35 So my role, I first started, I was engaged by
36 the Food and Drug Administration in the United
37 States to develop a scientific background from
38 which they produced the first standards on public
39 exposure to magnetic resonance imaging procedures.
40 And then they funded me to do a second more
41 detailed study. And that second study was later
42 adopted by the International Electrotechnical
43 Commission as their standards for public exposure
44 during MRI. And that's used in Europe, the IEC.
45 IEC, it's an organization that applies to mainly
46 Europe, but it's also recognized by other
47 countries.

1 MR. VERTLIEB:

2 Q Let's move to your work with Taser, the conducted
3 energy weapon. When did you first work in that
4 area and how did it come about?

5 A Well, I was first called on mainly because of my
6 reputation in electrical safety. I was invited by
7 a group, a research group under the U.S. Army, and
8 they were interested in the safety and efficacy of
9 electrical weapons like Tasers, but they weren't
10 necessarily Tasers, but they produced electric
11 shock like a Taser. And the idea was that they
12 were interested in was to have some non-lethal
13 method of dealing with possibly dangerous people
14 or belligerence, or other categories where they
15 didn't want to have the risk of killing someone,
16 but they still needed to incapacitate them in some
17 way. So I was called in there. I did some
18 studies and the kinds of things we looked at were
19 similar to the principles that are used in Tasers.

20 Q And specifically to Taser, you have a report that
21 was published in May of 2004. Does that reflect
22 the first work that you had done specifically with
23 this Taser device that will be discussed here in
24 this forum?

25 A Yes. That was a commission that was formed
26 jointly and funded by the Department of Defense in
27 the U.S. and the Department of Justice, and it was
28 to do an assessment of mainly safety but we also
29 treated efficacy, but safety was the prime focus,
30 of Tasers. And there was a report issued, one
31 version of which was public release and another
32 version of which had a limited distribution, not
33 available to the general public.

34 Q And the two things that you focused on, what were
35 the two areas or two questions that you were
36 wanting to consider at that time?

37 A Well, the things where my expertise came into play
38 and where I wrote a major chapter was first of all
39 to explain the mechanisms of interaction between a
40 Taser and the human body. That was one of my
41 roles. And then to make inferences about
42 potential hazards or things that could go wrong,
43 or under what conditions might this hurt somebody
44 or possibly even kill them. Those were the kinds
45 of things that I was addressing. And I was
46 addressing those from a background of theoretical
47 models which I had developed and which are quite

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb
Presentation

1 well-documented in my book. I have a book on this
2 subject, and also reference to many, many
3 experiments, studies that were done with animals
4 and humans and so on. I have in my book probably
5 a thousand references that I have reviewed, in
6 addition to my own personal research.

7 Q And from that work what did you conclude in terms
8 of effectiveness and hazard?

9 A Well, at the time, now, we knew a lot less than we
10 do now, there weren't near as many studies as
11 there are now. But at the time I concluded that
12 the use of Tasers, that there were hazards, but
13 that they were rare and that you could not rule
14 out the possibility of affecting the heart and
15 possibly even causing a fatal incident. But that
16 if that were to happen, the probability of it
17 happening would have to be very small, but that
18 you could not rule it out. And that also you had
19 to consider other possible injury mechanisms that
20 might be possible. So the conclusion was that it
21 was not a benign device, but had a small
22 probability, at least that was the best estimate
23 at the time, but it had a low probability of
24 causing injury or even conceivably death.

25 Q And that is in '04 that you were writing?

26 A Yes.

27 Q Since then there has been more research you are
28 familiar with?

29 A Yes. And that research, I think, reinforces that
30 opinion I had then, and I am going to go into that
31 today.

32 Q Thank you.

33 A I will go into quite a bit of detail on various
34 laboratory studies and other kinds of data related
35 to the use of Tasers.

36 MR. VERTLIEB: Well, I think with that, Mr.
37 Commissioner, we have given you a good sense of
38 Mr. Reilly's background. Perhaps, Mr. Reilly, you
39 can now embark on your presentation and feel free
40 to...

41 THE COMMISSIONER: Yes, thank you very much.

42

43 PRESENTATION BY MR. REILLY, "BIOPHYSICAL RESPONSES TO
44 ELECTRICAL STUN WEAPONS":

45

46 A Thank you, Mr. Commissioner. And if you don't
47 mind, I might just move around a little bit. So

1 the title of the talk is "Biophysical Responses to
2 Electrical Stun Weapons". And stun weapons is
3 kind of a generic term but when we talk about stun
4 weapons, really the one that's in use mostly is
5 that one produced by TASER International.

6 Let's go to the next slide.

7 These show two products that have been widely
8 used by police departments across the world. Two
9 weapons produced by TASER International. The
10 upper gun device is called their M26 and then you
11 can see there's a smaller version that's a more
12 recent one, lighter weight, and that's called the
13 X26. And these are both in use by police
14 departments, but I think the X26 is probably more
15 popular today.

16 And what happens when a police officer
17 engages a subject, he points the gun at the
18 subject and it paints a laser dot on the subject,
19 just like this laser pointer I have in my hand. I
20 point it at the screen, you can see the red dot.
21 And that gives the officer an aim point, so that
22 his objective is to put that dot somewhere on the
23 torso, upper part of the torso. He pulls the
24 trigger.

25 And what happens is that at the end of the
26 gun, there is a cartridge at the end of the gun,
27 we can see it in the diagram, in the photo here,
28 two little cartridges, those can be removed. And
29 inside those cartridges is a coil of wires and two
30 darts. I will show pictures of that a little
31 later. And they are propelled by a charge of
32 compressed nitrogen. They don't use gunpowder,
33 but it's compressed nitrogen. They fly through
34 the air and trailing wires, and they strike the
35 subject somewhere on the body and you really need
36 two contacts in order to complete the circuit. So
37 there is usually an upper wire, an upper dart, and
38 a lower dart that are sent to the subject.

39 And electricity is generated inside the gun
40 and it produces a series of current pulses, and I
41 will describe what I mean by that shortly. And
42 they flow into the subject. They flow between the
43 two contacts.

44 Typically a subject loses their ability to
45 control their musculature. They frequently tense
46 up, and they cry out, the subject will fall down
47 usually, and the intent is to incapacitate that

1 subject, to make the subject unable to carry out
2 physical activities that the police find
3 problematic.

4 Okay, let's look at the next slide.

5 This is an exploded view cutaway of the
6 Taser. You could see the two darts shooting
7 through the air with the wires on them, and on the
8 tips, you can just barely make it out in the
9 photo, there are two projectiles that look like
10 straightened-out fishhooks. They have a little
11 barb on the end and they're, oh, about three-
12 eighths of an inch long, about a little under a
13 centimetre, and those two darts, we'll call them,
14 may lodge into the body. They actually penetrate
15 the body. If you just imagine a little fishhook
16 there, just straighten it out, and you push that
17 into the body, and because it's got a barb on it,
18 it's not likely to come out very easily.

19 And while that's in place in the body, the
20 standard situation is that when the officer, after
21 he has pulled the trigger, the subject will
22 receive a series of pulse electric shocks for a
23 period of five seconds.

24 Then the officer decides if he needs to, that
25 the subject is not yet compliant, the officer can
26 pull the trigger again. Now, those wires are
27 still embedded in the subject. So at that point
28 the subject will get another five-second shock,
29 and again and again. And the officer can do this
30 many times. And the battery supply in the gun, I
31 think allows something like - according to the
32 data put out by TASER International - something
33 like 200 of these five-second intervals, that that
34 could be the maximum. So there is quite a bit of
35 capacity.

36 MR. VERTLIEB: Mr. Reilly, just could you hold the mike
37 away from you just a bit, because we're hearing
38 that it's muffling a bit.

39 A Oh, okay. How is this?

40 MR. VERTLIEB: Is that better now? Maybe you could
41 just repeat what you just last said there,
42 because...

43 A Okay. The one I guess I first used at the table,
44 I don't think is working. I think the last thing
45 I said was...

46 MR. VERTLIEB: One second, Mr. Reilly.

47 Do you want to just take a quick break so we

17

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1 can -- we're going to be here for the week.
2 THE COMMISSIONER: Good idea.

3
4 (PRESENTER STOOD DOWN)

5
6 (PROCEEDINGS ADJOURNED)

7 (PROCEEDINGS RESUMED)

8
9 J. PATRICK REILLY, a Technical
10 presenter, resumed.

11
12 THE COMMISSIONER: We'll commence once again. But let
13 me just say, gentlemen, we're certainly giving you
14 all the freedom we can, but let's have this area
15 kept clear and nobody walking back and forth, and
16 please, no flash cameras now. We don't want to
17 disturb a presenter, and Mr. Reilly here has to
18 get on with it. All right, thank you, sir.

19
20 PRESENTATION BY MR. REILLY, "BIOPHYSICAL RESPONSES TO
21 ELECTRICAL STUN WEAPONS", continuing:

22
23 A Okay. I think we had a little bit of problems
24 with the microphone. Does this seem to be
25 satisfactory now? Okay. Can you hear me, Mr.
26 Commissioner?

27 THE COMMISSIONER: Yes, I can.

28 A Okay. So we'll just back up because one slide I
29 was asked to repeat something. So if we could go
30 backwards one slide.

31 THE COMMISSIONER: Yes. The TASER people told you that
32 the batteries allow 200 shots at five seconds
33 each.

34 A Right. That's right. And I wanted to explain
35 that the officer can, each time he pulls this
36 trigger, the subject receives another five-second
37 shock, and he can do that as many times as he
38 feels he needs to.

39 Okay, now let's go to the next slide.

40 The subject, I mentioned, falls down, usually
41 cries out, stiffens up and falls down in a way
42 that he probably cannot control his fall. Like if
43 we were to fall, you could put your hands out to
44 try to cushion your fall, but the person stunned
45 with a Taser probably loses control of their
46 posture, I mean, they can't stand up. They may
47 lose control of using their limbs, and they really

1 can't control the fall.

2 Next slide, please.

3 I am going to go into some units of
4 electricity that I will be referring to in my
5 talk, and to try to make it understandable I have
6 drawn a connection between electricity in a wire
7 and water in a hose to try to bring out these
8 principles.

9 Now, we have all heard of voltage. For
10 instance, we hear that the voltage on our power
11 sockets is 120 volts. We could compare that to
12 water in a hose, to the pressure that the hose is
13 under and that would be measured in pounds per
14 square inch, or some similar unit. So we have
15 voltage.

16 We also have current. Now, the current is
17 the flow of electricity or the flow of electrons,
18 the movement of electrons, and that would be
19 analogous to the flow of water in a hose. So for
20 instance you could have voltage without current
21 if, let's say, the circuit wasn't completed there
22 could be a voltage across two wires but no current
23 flowing if the circuit wasn't completed. In the
24 same way, you could have pressure in a hose if the
25 nozzle was closed off and you could still have
26 pressure but no water would be flowing.

27 Now, the next thing, and this is the next
28 unit mentioned here is electrical charge, and we
29 measure that in units of coulombs. I will say
30 something about that in a moment. But the charge,
31 now, that's going to be particularly relevant to
32 Tasers, so I want you to understand what that
33 means, that that's a very relevant metric when
34 we're talking about stun weapons.

35 The charge is analogous to the volume of
36 water delivered in the hose. So, for instance, if
37 we were squirting water in a bucket, the amount of
38 water that goes into the bucket is the flow rate
39 times time, and it would be measured in gallons or
40 litres or something like that. So that's the idea
41 of electrical charge, it's the combined, the
42 cumulative effect of all these electrons flowing
43 and we measure that in coulombs.

44 Now, I'll be talking about different units.
45 You'll be hearing units like we may talk about
46 amperes, we may also talk about milli amperes. We
47 may talk about micro coulombs. Those prefixes

1 mean the following. A milli means one one-
2 thousandth, so a milli ampere is one one-
3 thousandth of an ampere. Or if we had a thousand
4 milli amperes, we would have one ampere.

5 A micro, I'll go to that one, on the micro,
6 means one one-millionth. So a micro coulomb is
7 one one-millionth of a coulomb, or it would take a
8 million micro coulombs to make one coulomb.

9 Kilo goes the other way. You have heard of
10 kilowatts, that prefix means one thousand. So a
11 kilowatt is a thousand watts.

12 A mega is a million, so a megawatt is a
13 million watts.

14 And power, now, that's another electrical
15 unit, so our light bulbs are rated in power. You
16 buy a 50-watt bulb or a 100-watt bulb. And the
17 way we would measure it, it's actually the product
18 of voltage and current, they both contribute to
19 power. And that would be analogous in the water
20 hose to the flow rate times pressure.

21 Now, I am going to say something about this
22 unit of power. In terms of electro stimulation,
23 which are the effects that I am going to be
24 referring to about a Taser, power or energy is not
25 a relevant metric of the ability of a current
26 stimulus to cause some reaction in a human. And
27 this causes a lot of confusion. The power of the
28 device is really irrelevant. What is most
29 relevant is the electrical charge.

30 Energy is another measurement we talk about
31 in electrical measurements and that would be
32 analogous to the flow rate times pressure times
33 time in a water hose.

34 We hear about resistance. It's measured in
35 ohms. It has that little symbol. That's a Greek
36 omega, it looks like an upside-down horseshoe, and
37 that would be analogous to the diameter of the
38 hose. So, for instance, if we had a small
39 diameter of hose under a certain pressure, you
40 could push so much water through it. But if you
41 had a bigger diameter hose with the same pressure,
42 you could push more water through it. And so the
43 idea is the same with resistance. If you had low
44 resistance or small number of ohms for a given
45 amount of voltage, you could push more current and
46 a high resistance would impede the flow of
47 electricity.

1 Now, this bottom panel is the one, it is
2 really critical for you to understand this one
3 because this is so relevant to Tasers and stun
4 weapons. I want to talk about current pulses.

5 So you can see that I made a little diagram
6 there, and what it shows is that if you could
7 image that's like a waveform. If you had an
8 oscilloscope and you connected a Taser to it, you
9 would see a burst of current, and then it would
10 stop, and then you could have zero for a while.
11 Then another burst of current, and then another
12 zero for a while, and a burst of current. And
13 this is very, very critical to understand this if
14 you want make comparisons between Tasers and any
15 other kind of electrical device, that Tasers are
16 pulsed current devices.

17 The analogy in a water hose is if we had one
18 of those nozzles with a trigger on it, and we
19 would operate the trigger, you would get bursts of
20 water like that. That would be the analogy in a
21 water hose.

22 So this is how a Taser operates with these
23 current pulses. And in fact the current pulses in
24 a Taser occur about 19 times per second, and
25 that's over the duration of five seconds. So that
26 means that you would have these things occurring
27 19 per second for five seconds, so the total
28 number of pulses you'd get for one shot would be
29 about 19 times five, whatever that comes out.
30 It's a little under a hundred.

31 Okay, next slide, please.

32 Now, these are some of the characteristics of
33 Taser stun weapons. And these, I'm showing
34 parameters here that we measured in the
35 laboratory, or that were measured under my
36 direction in the laboratory. And some of them,
37 for instance the upper panel, is just the
38 characteristic of the weapon as designed by TASER
39 International. So their design ranges up to about
40 seven metres. So that means beyond that two
41 things happened, the darts start to diverge and so
42 they may not strike the person properly, and
43 secondly, the wires are only a little over seven
44 metres long, or something. So that it's a close-
45 in weapon.

46 Now, there are these two devices, remember I
47 mentioned the M26 and the X26. The X26 is the

1 lighter, smaller one. They have a peak output
2 voltage of about 50,000 volts. It sounds like a
3 big number and it is. The X26 starts off with
4 50,000 volts and then suddenly drops down to about
5 25,000. The purpose of that high voltage, I'll go
6 into a moment later, next slide, but this time we
7 will just continue with this.

8 I'm sorry, back up. Okay. No, no, go
9 forward. There you go. Okay.

10 But when the darts hit the subject, it's no
11 longer 50,000 volts. When the darts hit the
12 subject, the voltage will be pulled down and what
13 we call that, that the device is "under load" is
14 what we would say. So the voltage of the M26,
15 then, would drop to about 7,000 volts and the X26
16 to about 1,300. Now, these are measured in the
17 laboratory, not data necessarily from TASER
18 International, but independent measurements that
19 were done under my direction.

20 The peak current would be about 17 amperes in
21 an M26 and about 3 amperes in the X26.

22 Now, remember I said that this electrical
23 charge was a critical parameter, and I am going to
24 be talking a lot about that when I compare Tasers
25 to other things that we know about in electricity
26 and how they affect the body.

27 So the electrical charge is about 100 micro
28 coulombs. So we will try to remember that number,
29 100 micro coulombs. That's about what a Taser
30 puts out. It could vary depending on the
31 characteristics of the resistance that the Taser
32 experiences when it strikes the body, but that's a
33 ballpark number.

34 The duration of the pulse now is very small.
35 This one for the M26 says 30 and that little
36 symbol that looks like a "U", it's actually a
37 Greek Mu, that stands for micro, 30 microseconds,
38 and that's 30 millionths of a second. And for the
39 X26 it's a little bit longer, about 80 millionths
40 of a second.

41 So remember I showed those pulses in the
42 current, so that's how long that pulse would last,
43 30 or 80 millionths of a second, then it would be
44 zero for a period, then another 30 millionths or
45 80 millionths of a second. And that occurs at the
46 repetition rate of 19 pulses per second, pps.

47 The burst length, that means it continues for

1 five seconds unless the officer pulls the trigger
2 again.

3 The power is not big. Electrically, this has
4 a capacity for doing some significant things to
5 the body, but the power is not great. It doesn't
6 need a lot of power. So the X26, the power would
7 for the conditions we measured were only about 1.3
8 watts, and for the X26 would be higher, about 15
9 watts. But you could see, I mean, that's a small
10 number compared to, let's say, a light bulb. But
11 this number has to do with average power. It
12 would be relevant to heating, but not relevant to
13 electrical stimulation, which I'll tell you what
14 is involved in that.

15 Now, notice also that the peak current I'm
16 mentioning as amperes. Now, sometimes you will
17 see references to literature, somebody may say,
18 well, the average current is so many milli
19 amperes. Milli means thousandths of an ampere.
20 So maybe you will hear numbers that maybe are a
21 thousand times smaller when people refer to
22 average current, or there's various ways of taking
23 an average. But why those numbers are so hugely
24 different is that the average current - remember I
25 had that little burst of current and then we had a
26 period where nothing was happening - so if you
27 were to take an average of something that had a
28 value, let's say one ampere, and then there were
29 99 other points that you sampled and it was zero,
30 if you took an average of that, it would, you
31 know, the average, the peak might be one ampere,
32 but the average would be one one-hundredth of an
33 ampere in that example. And that average current
34 is irrelevant to electrostimulation. It's
35 relevant only if we're talking about heat, and
36 I'll explain that in my presentation. It's
37 irrelevant, irrelevant compared to electrical
38 stimulation.

39 But what we should focus for these brief
40 electrical pulses is the micro coulombs. If the
41 pulses are much longer than what a Taser is using,
42 we maybe use other measures. But I don't want to
43 get into that. It just would get us on another
44 track. But for these brief pulses that Tasers put
45 out, we'll think of that metric.

46 Okay, let's go on.

47 These are actual waveforms. Now, if you've

1 never seen anything like this, we can imagine this
2 is the picture that would be painted on an
3 oscilloscope. In fact, that's how this was
4 derived. When you fire a Taser and the
5 oscilloscope measured the current waveform, let's
6 say the red figure there is the M26 and then the
7 darker figure is the X26. So these are two
8 different displays superimposed one on the other.

9 So the current, you'll notice this point on
10 the graph, current is measured on the vertical
11 axis, up and down, and time is measured along the
12 horizontal axis, left to right. And each major
13 division represents ten microseconds, that's ten
14 millionths of a second. And each vertical
15 division represents five amperes. That's a little
16 fuzzy on the screen, but if you have the paper
17 copy, you can probably read this better.

18 You can see that this waveform starts off at
19 zero. Either one starts off at zero. That's the
20 middle point on this graph. And then suddenly
21 when the officer pulls the trigger and this weapon
22 starts to conduct current, the current suddenly
23 jumps up to about 15 amperes for the M26, and then
24 it goes back to zero, and then it goes negative,
25 and what that means is the current reverses
26 direction. So remember like in your AC power
27 socket, you might recall that current goes back
28 and forth and we call that alternating current.
29 The electrons go this way, then that way. That's
30 what it means when that waveform goes below zero.
31 It reverses direction. And you can see the X26 is
32 a smaller waveform, but lasts longer in duration.

33 Now, it may seem counter-intuitive, but this
34 smaller waveform, the X26, is actually more
35 effective, or slightly more effective than the
36 M26, even though it's smaller in amplitude. And
37 the reason for that is that electrical charge that
38 I mentioned, that's determined by -- if you
39 imagine the area under the curve. So let's say if
40 we had some paint, we wanted to paint this
41 waveform underneath the curve between the zero
42 line and the curve, we've used so much paint to
43 paint in that figure, that would be, well, like
44 analogous to the amount of charge. And then if we
45 use the amount of paint in this first main lobe of
46 the M26, we would probably use a little bit less
47 paint to paint in that bigger amplitude. Because

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1 even though it's a taller amplitude, it's shorter
2 in duration.

3 THE COMMISSIONER: So if I understand this, the reddish
4 line is a greater current, but it lasts a lot
5 less --

6 A Exactly.

7 THE COMMISSIONER: -- than the other one.

8 A Exactly.

9 THE COMMISSIONER: The other one is a less intensive
10 current, but it lasts longer.

11 MR. REILLY: Exactly.

12 THE COMMISSIONER: All right.

13 MR. REILLY: So in practice these two devices, the X26
14 in practice is a little bit more effective and --
15 than the M26, but well, they're comparable. So
16 I'm going to use this number about 100
17 microseconds. It's close to the number you get
18 with either waveforms.

19 Next slide.

20 And so why do they use high voltage? So for
21 the M26 and X26 they have this peak voltage, not,
22 remember, not under load. It starts off at 50,000
23 volts. The X26 starts off that way and then drops
24 down to 25,000 volts and we call that, that's the
25 open circuit voltage, that means that nothing is
26 connected to the Taser. The darts are maybe just
27 like dangling in air, and then you'd get those
28 kind of voltages.

29 Why is that important? Well, one reason it's
30 important is because it's capable of creating an
31 electric arc that bridges an air gap. So let's
32 say if one of the darts hits your clothing but
33 doesn't actually touch the skin, there will be
34 like a spark, or they call it an arc. It's a
35 breakdown of air. It's like a mini lightning
36 bolt. That's what lightning is. It's an
37 electrical plasma, a breakdown of air, that the
38 electrons and the molecules of air are stripped
39 off by that high voltage. And when that happens,
40 that arc can go right through your clothing and
41 the dart doesn't have to touch the skin. The arc
42 will penetrate and it can jump an air gap of
43 several centimetres, or maybe a couple of inches.

44 So it doesn't require skin contact. And
45 another advantage is, let's say in normal electric
46 shock, you've heard about the dangers of getting
47 wet, you know, don't play with your radio when

1 you're in the bathtub or something. And the
2 reason for that is that normally the skin, the
3 outer layer of your skin, we call that the
4 corneum, it's a layer of dead skin cells, is
5 usually very insulating to electricity when it's
6 dry. But when it's wet, that insulation is no
7 longer there. It doesn't insulate any more, so it
8 becomes a good conductor. And so if you're wet,
9 you're not as well protected by that layer of
10 skin.

11 Now, so we call that dry skin, that's the
12 corneum, and we say that has a high impedance or
13 high resistance would be the equivalent statement.
14 But even if the skin is dry, because of that high
15 voltage used in a Taser, that dry layer of skin
16 will break down to become a good conductor. The
17 high voltage will transform that layer of skin so
18 it doesn't matter whether the skin is wet or dry.
19 You're going to get about the same dose of current
20 either way. It matters very little. And this is
21 important to realize. So if you're looking at
22 Taser deployments, the dryness or wetness of the
23 subject is really irrelevant when you consider
24 these kinds of devices.

25 Now, that wouldn't be true if I were talking
26 about electricity out of your power socket. It's
27 because of the nature of the high voltage that
28 breaks down that skin, the arc can penetrate
29 clothing or bridge an air gap. And it's even
30 conceivable that if one dart falls on the ground
31 and the other strikes the subject, if the surface
32 you're standing on is conductive, so that wouldn't
33 be true of this where I'm standing now on this
34 carpet. But let's say on the earth somewhere,
35 damp earth, the current could flow in the earth
36 and it could actually jump through the soles of
37 your shoes and depending on the footwear, that
38 could happen, and you could still get a shock.

39 So next slide.

40 Why aren't Tasers more dangerous? We've
41 heard that 120 volts, such as you have in your
42 home light socket and in two-tenths of an ampere
43 of current can be fatal. That we know. And a few
44 thousand volts that people come in contact with,
45 let's say on distribution lines, they show up at
46 the hospital emergency room with traumatic burns,
47 very horrible burns. So why aren't Tasers with a

1 voltage of 50,000 volts and peak currents over one
2 ampere, routinely lethal? And there's two reasons
3 for this.

4 The first I mention here, the voltage when
5 it's under load is no longer 50,000 volts, but
6 it's still high. It's still a thousand volts for
7 the X26. But the more important fact is that the
8 duration of that Taser pulse is short. It's in
9 the millionths of seconds. And if I look at the,
10 let's say, this is the current waveform that you
11 would get out of your light socket, or out of the
12 wall socket, we put that on an oscilloscope, this
13 goes up and down, it means it's alternating
14 current, goes back and forth, and that but it's
15 continuously operating. Whereas these pulses from
16 the Taser are there only for, you know, tens of
17 millionths of seconds at a time, then you have a
18 period of nothing, and another period. So it's
19 mainly because of that is why you're not being
20 killed by that voltage in those current levels.
21 If you had that same voltage and current levels
22 with this upper waveform, you would be dead or
23 you'd be horribly burned.

24 Okay, next, please.

25 Now, I've just got a little summary here.
26 This is a summary of deaths following Taser
27 exposures. There is really no clearinghouse of,
28 you know, data that comes in and where you can
29 have a good representation of this, what are the
30 incidents where people actually die. But there
31 have been some publications in this case. This is
32 the Los Angeles Police Department published some
33 data on where they said they had thousands of
34 incidents and they refer to a small number of
35 deaths, and cardiac-related five deaths. And in
36 most cases the time between the Taser use and the
37 death was some minutes.

38 Some of these subjects had drug intoxication,
39 others had major pathologies such as kidney,
40 severe kidney problems, or major injuries like
41 gunshot wounds. So you might wonder whether there
42 could be, you know, whether some subset like these
43 five subjects might have died, did they die
44 because of the Taser? And if that were so, you
45 can just see by looking, taking five and divided
46 by whatever "N" is, it's in the thousands, they
47 didn't give the exact number but they said it was

1 thousands, it would be worst a small probability.

2 Other statistics - next, please - that have
3 been published.

4 This upper panel, this was an analysis that
5 was done by, I think, sponsored by the Canadian
6 province of Vancouver, and it was a report by
7 Battershill and colleagues, and he went to the
8 information on the website by TASER International,
9 and he, you know, looked up 4,599 deployments, and
10 so on. And of these there were four deaths by
11 firearms and four designated as
12 respiratory/circulatory. And the non-fatal
13 medical incidents were also present.

14 The next two rows show data from the Orange
15 County in California and Seattle. In those cases,
16 let's see, we see large numbers of deployments. I
17 guess Seattle reported two deaths, but those were
18 by firearms.

19 So it appears, you know, we might say, well,
20 people are dying but it's not that common, it's a
21 low probability situation. But what is the Taser
22 doing? Could the Taser be responsible, or could
23 it do other injury things? So that's what I'm
24 going to go into from here on out.

25 Okay, next slide.

26 These are the biological systems that can be
27 affected by a Taser, by electric current, I should
28 say, in general -- not just a Taser, but electric
29 current. And I am going to give a little unit on
30 each one of these mechanisms and relate it to the
31 Taser. What do we know about the Taser? How does
32 it compare with laboratory experiment? How does
33 it compare with what we know about how people
34 react to currents.

35 And we'll be talking about one is
36 "Sensation", that, you know, you can feel it,
37 like, does it hurt? That's a sensation issue.
38 The next category I have there is called "Muscle",
39 and that could include skeletal muscle. It could
40 also, we could be concerned about respiration, the
41 muscles that help us breathe, and also I'll be
42 pointing out there are changes in blood chemistry
43 just due to the muscle reactions. And that could
44 be significant, we need to look at that. The next
45 category I have is the "Heart", effects on the
46 heart. And on the right-hand box we have
47 additional category the "Brain". And below that

1 we see the "Spinal reflex", and that may well be a
2 dominant mechanism in why people fall down, and
3 I'll explain that.

4 Those bullets that I've mentioned, those
5 points up to the spinal reflex, so, one, two
6 three, those five types of systems are all under
7 the category of what we call electrostimulation of
8 excitable tissue. Let's see what do we mean by
9 that.

10 Excitable tissue refers to specifically
11 nerves and muscle, and nerves and muscle operate
12 on electrical signals in the body. And if you
13 provide a proper electrical signal, it can send a
14 nerve impulse on a nerve that registers in the
15 brain, maybe as a sensation, or it can cause a
16 muscle to contract if it's a signal that's going
17 from the brain through a nerve to a muscle. Those
18 are all operating on electrical principles. And
19 so it shouldn't be surprising then that when we
20 introduce the electricity in the body that you can
21 either modify or cause those things to happen that
22 would normally happen naturally, but you may cause
23 them to happen in an unnatural way.

24 So these all come under the category of
25 electrostimulation of an excitable tissue.
26 Excitable means if you don't give it any
27 electricity, nothing happens, and if you give it
28 the right amount of electricity, something
29 suddenly happens. Either you get a nerve impulse
30 to the brain, or sent to the brain, or a nerve
31 impulse sent to a muscle.

32 The next two, tissue heating and cell
33 membrane electroporation, those -- those usually
34 occur with high level electric shock and I'll say
35 something about that toward the end, but it's --
36 I'll just give you the hint, you know, advance
37 hint that these two latter ones are probably much
38 less significant and not really a major issue with
39 Tasers.

40 So we're going to start our unit. The first
41 one is "Sensation", next slide, and this one shows
42 when the electrotherapy in 1785, that little girl
43 is receiving something I think the important-
44 looking man feels is going to be good for her.

45 And let's go to the next slide, "Electrical
46 excitation of nerve and muscle". They both
47 require electrical signals that propagate along

1 nerve cells. So, for instance, let's talk about a
2 nerve cell that is responsible for pressure in
3 your fingertip. So there's a little receptor in
4 your fingertip that responds to pressure. That
5 would be shown in this left-hand figure. If you
6 squeeze that, it sends, it causes an electrical
7 signal to appear on this long process that we call
8 an axon. It's like a wire, you can imagine it has
9 an electrical wire. And that goes from your
10 fingertip to your spinal cord, and thence to the
11 brain. So this one cell from your fingertip to
12 your spinal cord might be a metre long, one cell,
13 one nerve cell. The other kinds of nerve cells
14 take signals from the brain and they send
15 electrical signals to the muscle, and when those
16 signals appear at the muscle, it results in a
17 muscle contraction.

18 And then the skin, this shows a cross-section
19 of skin on the right side, and there are many,
20 many kinds of specialized receptors for all kinds
21 of environmental information. We have receptors
22 that respond to the fast onset of pressure. We
23 have specialized receptors that respond to the
24 slow onset of pressure. We have receptors that
25 respond to vibratory pressure. We have receptors
26 that respond to heat, that respond to cold, and
27 that respond to, in some cases, chemical effects.
28 And also we have a special class of receptors
29 called nociceptors, which report pain. When you
30 stimulate one of those, your brain says that's
31 painful.

32 All of these things, all of them can be
33 excited by electricity. Now, that's very
34 unnatural, because, you know, under normal
35 environmental conditions that doesn't happen. So
36 that's a very unnatural condition.

37 Let's look at what happens in a laboratory.
38 Next slide. These are from my own research with
39 human subjects. We develop various thresholds of
40 things happening. Let me explain what that word
41 "threshold" means. That's a concept you might say
42 what's the dose of electricity required to make
43 something happen? If you're above a certain
44 amount, something happens, and if you're below
45 that amount, nothing happens. We call that
46 dividing line the threshold. So we can have a
47 threshold of sensation, for instance. Above it,

1 it's perceptible, below it, not. We can also have
2 a threshold of pain. Above it, it's painful,
3 below not. We can have a threshold of causing a
4 muscle to jerk, various other types of things.

5 So what are the thresholds that we find in
6 the laboratory with human subjects? Now, these
7 are using brief high-voltage pulses, analogous,
8 not terribly unlike a Taser, but not as big, we
9 are able to titrate these or to put them to levels
10 where the subjects could just begin to feel them.
11 So on the fingertip subjects, this is the average,
12 the middle person, some were higher and some
13 lower, but that's the one in the middle, about .4
14 micro coulombs on the fingertip for pain, when the
15 subject reported pain. We would ask them to rate
16 the sensation and they could choose various
17 adjectives, and when it got to be that big, they
18 reported it as painful. And when it got to be .8
19 micro coulombs, they reported it as being
20 intolerably painful. That means that in an
21 experimental set-up, they said once I receive that
22 shock, I do not want to receive another one that
23 big. So that set an upper limit in our
24 experiments. And on the forearm you could see the
25 numbers were a little bit higher.

26 But now compare these numbers to the Taser.
27 Remember the relevant number I told you on the
28 Taser was 100 micro coulombs? So you can see that
29 these, the Taser is putting out a stimulus that's
30 like 100 times stronger than what it would take in
31 a laboratory to evoke pain in a subject. So I
32 would have to say that that is very painful.

33 So next slide gives me a summary of what I've
34 said about sensory effects. A single Taser pulse
35 is typically about 100 times as painful as a
36 single brief current in human-controlled
37 laboratory experiments. That's for one pulse.

38 What about if you have 19 per second, like a
39 Taser has? That makes the sensation even
40 stronger, because your brain encodes, interprets
41 information about how strong a stimulus is in part
42 by the rate of these nerve impulses reaching the
43 brain. You have more nerve impulses. The brain
44 says that's a stronger stimulus, or it might say
45 that's more painful yet. So we could then say
46 with repeated pulses as in a normal Taser, the
47 sensory effects would be even stronger.

1 So I am now going to move on to muscle
2 reactions. The next slide shows, this was in
3 1790, Galvani discovers what he thought was animal
4 electricity. He could make severed frog legs
5 jump. And what he was doing was creating a little
6 battery, applying them to the nerves of the
7 severed frog leg, and they would still respond.

8 Now we fast-forward, the next slide, another
9 200 years, and there is the famous experiments by
10 Charles Dalziel, testing what we call the let-go
11 level. That's the level at which a subject who
12 grabs an energized conductor can no longer release
13 it. And you can see just from this subject, he
14 doesn't look very happy. And this would be well
15 above the pain threshold. So these kinds of data
16 are used in electrical safety studies, the let-go
17 levels.

18 This one shows the effects of repeated pulses
19 on muscle contraction. Remember the Taser has
20 repeated pulses, 19 per second. So this diagram
21 shows on the horizontal axis, this is time, on the
22 vertical axis is muscle force. Somebody
23 instrumented muscle and if you give, on a nerve
24 that enervates the muscle, a single impulse, you
25 get what we call a twitch. The muscle jerks and
26 then it relaxes. So it starts at zero, give it
27 the impulse, goes up to a maximum force and then
28 it decays away.

29 And if you, on the other hand, let's say,
30 instead of a single pulse, you repeated these,
31 let's say at ten per second, you can see that the
32 force begins to build up. And as we go to 20 per
33 second, you can see that force builds up even
34 more, so that the repetition rate is very
35 significant in muscle reactions, not only in the
36 sensation. I've told you that it increased the
37 perceived sensation. But it also increases the
38 strength of the motor or the muscle reaction. And
39 the highest value there, that's a condition that
40 we call tetany, that the muscle is locked and
41 contracted as hard as it possibly can be. It's
42 likely that there will be at least some muscles in
43 tetany in a Taser encounter.

44 This diagram shows the relationship between
45 the electrode spacing and the reaction measured in
46 terms of force, and this was done in a pig,
47 anaesthetized pig. And by the way, there's

1 references on all of these. For instance, I give
2 a reference, Jauchem 2004. And if you go to the
3 end of my talk, you'll find the references to each
4 one of these, if you want to look them up.

5 And so when he put on a pig, he put the two
6 electrodes - this is a Taser now - initially,
7 let's say, five centimetres apart. That's at the
8 left-hand side of this block, and that gave a
9 force on one of the limbs of about 100 units of
10 force, whatever the units was that he used to
11 measure in, 100 units of force. As he moved the
12 electrodes further apart, 10 and 20, 30, 40
13 centimetres, you can see the force grows, the
14 reaction is stronger.

15 Now, the amount of current being dumped into
16 the body is pretty constant. The amount of micro
17 coulombs on each pulse doesn't change very much.
18 But why then is this pig showing greater reaction
19 as he moves electrodes further apart? And that
20 brings into mind this concept we call recruitment.
21 That means what volume of tissue is being excited.

22 So if we take two electrodes and put them
23 very close together, most of the current that
24 travels between those electrodes is going to go
25 directly from one to the other inside the body,
26 and there will be some current that spreads out a
27 little ways. But the whole volume that's being
28 engaged by the current is not very great.

29 As we move those electrodes further apart,
30 that current, the various current pads that are
31 travelling in the body, and there's like a whole
32 continuum of pads, it starts to spread out more,
33 and go deeper into the body and also fringe out
34 more to the sides of those two electrodes. And so
35 it engages more and more excited tissue. And so
36 the effect becomes greater.

37 Now, this is very relevant to a condition of
38 to Tasers because, you see, the Taser can be used
39 in two modes. One, I'll call it the dart mode,
40 which I illustrated at the beginning where he
41 pulls the trigger and two darts fly out, and then
42 they strike the subject on the torso. But the
43 officer can also, even if he takes the cartridge
44 out that contains the wires and the darts, the
45 electronics is still in the gun. So if he pushes
46 that weapon against the subject, they call it the
47 drive-stun mode. Now, in that case those two

1 electrodes are close together, and they don't
2 engage as much volume as when they're further
3 apart, so you get a smaller reaction.

4 And so under the drive-stun mode, it is
5 generally the experience of police that the main
6 compliance, the subject does not necessarily fall
7 down. The subject is not necessarily
8 incapacitated like it would be with the dart mode.
9 But it's painful and the subject, many subjects
10 will comply just on the basis of pain, even though
11 they don't lose muscle control. But it's probably
12 less painful, it's certainly there's less muscle
13 activity involved. The subject may not be as
14 heavily incapacitated, and any hazards are going
15 to be less. If there is a hazard, the potential
16 hazards in the drive-stun mode will be less than
17 in the dart mode, because you're engaging a
18 smaller volume of tissue that you're exciting.
19 Also the amount of current reaching the heart will
20 be less under the drive-stun mode than under the
21 dart mode.

22 Let's look at on the next slide some muscle
23 reactions to electric current in general. The
24 first four rows are not Tasers, but the bottom row
25 relates to a Taser. But this, these upper ones,
26 if we just talk about twitch, that's the very
27 minimum muscle reaction you could notice. And if
28 we do an experiment with humans, we find that in
29 terms of the micro coulombs, about three-tenths of
30 a micro coulomb will create a detectable twitch.

31 The next is that threshold where you cannot
32 let go of a grasped conductor. And, now, these
33 experiments were Dalziel were not done with Taser-
34 like pulses. But if you understand the principles
35 of bioelectricity, you can, and I did, make a
36 conversion to what Dalziel found and said what if
37 he had used Taser-like pulses, how big would they
38 have to be? And so there is biophysical
39 principles that allow me to do that, and so I
40 derived these numbers that where you could not let
41 go: three micro coulombs for males and two for
42 females.

43 Now, a couple of things to notice here. Why,
44 and this is true of many electrical reactions,
45 that women have lower thresholds than men, and I
46 guess the corollary, according to women, is that
47 men are less sensitive. So all our wives knew

1 that. So why does that happen? Well, it turns
2 out it has nothing to do with gender. And the
3 reason is, it has everything to do with body size,
4 and it turns out that women are in general smaller
5 people than men. And if you compare the
6 thresholds of men and women of equal stature and
7 size, that statistically they don't vary. That's
8 the only factor that we really know, and it's body
9 size.

10 But you can see, well, now how would that
11 relate to a Taser? Well, in the let-go, really
12 the reason why you can't let go of a conductor,
13 you grasp a conductor with your hands. Now, the
14 muscles responsible for operating your fingers are
15 not in your hand, they're in your forearm. You
16 have flexors and extensors, and the current goes
17 from your hand and then it flows into your arm,
18 then it starts to excite those muscles. And the
19 flexors are stronger than the extensors, and they
20 win out, and you can't let go. That could be a
21 situation in a Taser only if one of the darts
22 struck the hand or arm, and I don't know that it
23 would be necessarily dangerous, because it's only
24 five seconds, and then so but it's conceivable
25 that could happen.

26 Now, the next effect I have here, reaction,
27 is interference with reaction, of interference
28 with respiration. And this is now an estimate
29 using electrical safety, so that's not really been
30 well confirmed. But it would put the electrode,
31 the dose at about six micro coulombs.

32 Now, here's a real case, the next one. Now,
33 this is a case that I worked on, I analyzed this
34 case, a subject got an electric shock. He
35 received the severely shattered shoulder, had to
36 have a very massive surgical shoulder replacement,
37 and he did not fall down. The only way that could
38 happen was that the intense muscle contractions,
39 which he got through his arm and went into his
40 body, broke bones.

41 Now, that equivalent dose, if I compared it
42 to a Taser-like waveform, would have been 21 micro
43 coulombs, still a much smaller number. Now,
44 what's the experience with Taser? Well, I don't
45 know because there's really no clearinghouse for
46 these things. You know, I mean, I don't know.
47 You hear deaths might be reported in the paper

1 sometimes, but what if somebody just had an
2 injury? Are those reported and what's the
3 clearinghouse? There is none.

4 But we do know something as reported by
5 Battershill, again the Canadian researcher, that
6 he found that there were a number of lawsuits, I
7 think more than one, on police trainees who were
8 undergoing Taser stimulation, and who had suffered
9 rather significant orthopaedic injuries. Now,
10 that's, we have to call that anecdotal
11 information. In other words, it's not a
12 scientific study. It's just somebody noticed
13 this. It's a red flag anyhow. It's a red flag
14 that things could happen, and I think by virtue of
15 the other observations I have, I think it's a
16 possibility that we have to recognize there could
17 be cases when somebody may suffer a severe
18 orthopaedic injury, either by falling or by the
19 intense muscle contractions that occur.

20 Now, let's go on to respiration, next slide.

21 This shows an experiment with a dog. They
22 were actually driving respiration with this dog.
23 And depending on the amount of current they
24 provided what they call tidal volume, that means
25 the amount of air brought into the dog's lung
26 where it would become greater and greater.

27 Next slide. Let's look at some experiments
28 on respiration. You'll notice the last one is
29 humans, the bottom row, and the other rows are
30 animals. The top one is observation in dogs. And
31 so and that was that graph I showed you on the
32 previous slide, at about the equivalent of six
33 micro coulombs, and by the way he did use pulses,
34 not terribly unlike the Taser. And with six micro
35 coulombs per pulse, he could start to notice, you
36 know, a significant amount of driving of the
37 respiration. And at 25 micro coulombs, that was
38 pretty much like a full breath.

39 And also tested this, other people tested
40 this -- by the way, on this column called "Cite"
41 for "citation", I give letters and you can read at
42 the bottom of the slide which researcher that
43 refers to. In this case (c) refers to a paper by
44 Riscilli 1988 and you'll find the details of that
45 citation in the list of references at the end. So
46 that researcher found similar findings in baboons.

47 The next three relate to Tasers and pigs.

1 Now, the first of those three reference (d),
2 which is by Jauchem. He used an older Taser
3 version which isn't as strong as the present ones.
4 It had a lower PRF, but still he noticed that
5 there was no breathing during the stimulus. He
6 had the electrodes across the chest of the pig.

7 Similar findings by the next reference (e),
8 which is the paper by Dennis et al in 2007, again
9 they applied Tasers to pigs and there was no
10 breathing during stimulation.

11 Now, the last entry with humans, that's a
12 study (f) by Ho et al, and I think that's one of
13 the people that you have on your roster, Dr. Ho,
14 that you mentioned. So he may enlighten you more
15 on this. But he tested humans.

16 Now, this particular paper is the only one I
17 know of where the police trainees, where the
18 Tasers were put on their chest. I think
19 everything else from then on they only put the
20 darts on the back of the police. And you have to
21 say that by putting it on the chest there's a much
22 -- I mean, on the back it's much safer because
23 much less current is going to reach the heart. So
24 if you were concerned about avoiding a heart
25 incident, that would be one reason why you would
26 put the taser darts on the back. Not as much
27 current reaches the heart, lesser hazard.

28 So but at any rate, these police trainees, 52
29 of them, did breathe. Now, I am told, this is
30 anecdotal, I am told that during those experiments
31 there were people in front of the police shouting
32 at them, "Breathe! Breathe!" But they could
33 breathe.

34 So we have a situation where pigs didn't
35 breathe, in some cases in this paper by number (e)
36 here, Dennis et al. That was two sequences of 40-
37 second shocks, 80 seconds. They could breathe in
38 between the two 40 seconds, but that's a long time
39 to hold your breath. Five seconds, by the way, is
40 not a long time to hold your breath. So you
41 probably shouldn't worry about asphyxiation with a
42 five-second pull. But at any rate, those pigs did
43 not breathe - let's go to the next slide - but the
44 humans, the humans were able to breathe.

45 Taser-related acid-based blood chemistry.
46 Now, this is I think important, it's going to be
47 important in your deliberations. The acidic

1 condition of the blood is measured by a physical
2 quantity or a chemical quantity called pH. And
3 the normal range for human is around 7.45,
4 something like that. And the body maintains,
5 wants to maintain a very, very tight tolerance on
6 pH.

7 Now, what happens, how is pH affected by
8 Taser shots? Well, it's tied to muscle
9 contractions. Now, when you know like if you're
10 out of shape and you exercise and the next day
11 your muscles are sore, that's because you've been
12 producing lactic acid, and that can increase the
13 acidic condition in your skin and in your
14 bloodstream. Now, the Taser pulses are very,
15 very, very intense muscle contractions and they do
16 raise the lactate in the blood, and then
17 consequently they also lower the pH, and that
18 means when you lower the pH, it means the blood
19 becomes more acidic.

20 Now, this upper panel here, that's citation
21 (a) and that one would be by Dennis et al. He
22 also appeared on one of the other slides. The
23 pre-stimulation was 7.45. Post-stimulation is
24 6.81. He characterized that as severely acidic.
25 When he measured the lactate, these particular
26 units are millimoles per litre. Chemists and
27 physicians would understand that, I guess. But
28 you can see that it increased the lactate in the
29 blood by maybe it looks like 13 times or something
30 like that. So there's a huge increase in lactate
31 and a lowering of pH, to the extent that it was
32 characterized as severely acidic. Now, mind you,
33 that was two 40-second exposures. I mean, that's
34 a lot more than a standard Taser. Taser, one shot
35 gives you five seconds. This is 80 seconds, so
36 that would be equivalent to, what, 16 taser
37 encounters.

38 Also, I'll talk about this in a moment, but
39 you see under "Comments" I have listed here that
40 that researcher observed two deaths from
41 ventricular fibrillation, that means the heart was
42 not pumping. He noticed that there was no
43 breathing during the experiment. And all the
44 animals were subject to cardiac capture. Now,
45 I'll explain that when I talk about the heart,
46 what that means. But let's just focus on the
47 blood chemistry for now.

1 So some of his pigs were dying, and now
2 physicians will tell you that, you know, severely
3 acidic condition will lower the threshold of
4 ventricular fibrillation, so maybe these pigs died
5 because of the acidic condition.

6 So he did a second experiment, and that's
7 now, like it's published a year later, in the
8 second row, and it was now the same team as the
9 upper row but the lead author in the second group
10 was Walter et al. But both Walter and Dennis and
11 their colleagues were involved in both
12 experiments, so it's essentially the same group.

13 They said what if we did this again but we
14 fix it so that the animal does not become acidic,
15 what would happen, would the heart still exhibit a
16 problem? So what they did was I think very clever
17 approach, was they gave the pigs a paralytic
18 agent. That means that it was an agent that made
19 it impossible for the muscles to contract. And
20 they allowed, they gave ventilation, they had the
21 pigs ventilated. But because the muscles couldn't
22 contract, the ones around the Taser darts, you'll
23 notice now that the lactate in the second
24 experiment, went only by a factor of two, and it
25 did rise, it went from 1.5 to 3.5, but very much
26 less so than the first experiment. The pH didn't
27 change by very much. That would be considered
28 within normal physiological range. So the pH
29 didn't change, but still they had one ventricular
30 fibrillation death. So they concluded that it
31 wasn't solely the presence of this acidic
32 condition, but that the electricity itself must
33 have been doing something in those pigs.

34 Now, let's go on. The next set of
35 experiments also done, now, that was done by
36 Jauchem with that older-style Taser. He also did,
37 and it was also a longer-than-normal shot, 18
38 repetitions of five seconds on and then five
39 seconds rest. He did that 18 times. And there
40 the pH was lowered very significantly and the
41 lactate was increased quite significantly. That's
42 an independent look at this situation, although it
43 was a Taser not as strong as the modern ones.

44 The next entry, this was a single Taser shot
45 by the same researcher, but now this is only a
46 five-second burst. In that case he only reported
47 the lactate. The lactate did increase, but it's

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1 nowhere as, you know, with just a single five-
2 second burst. But it was nowhere near as high as
3 it was when he gave it many bursts.

4 So you might then suspect that there could be
5 an issue here with repeated shots. The problem is
6 we know that these pigs were getting severe
7 acidosis when they got 80 seconds of stimulation,
8 and we know that when it was only five seconds of
9 stimulation, it didn't appear to be very
10 significant, the acidosis. We don't know what's
11 in between. Where does the problem, where does
12 the boundary lie when it's too many? You know,
13 when one -- that I don't think we know.

14 The last entry is another device. It's not
15 made by TASER, and there's few details about the
16 comparison with that device and the Taser, so I'll
17 just go onto the next slide.

18 Now, those were all acid-base measures in
19 animals. Let's see, they were all pigs.

20 The next, this slide here is in humans. This
21 one by Ho, Dr. Ho, who will be here, in the 66
22 police volunteers he did notice roughly a 50
23 percent increase in lactate. He didn't report pH
24 specifically. And then the next researcher also
25 testing humans, but police shot in the back. And
26 again this Ho paper was also darts in the back of
27 the police. And there a single shot, you can see
28 created a doubling of lactate, but not enough, the
29 pH wasn't very much affected. So I would hope
30 that one of your pathologists will discuss, you
31 know, the implications, physiological implications
32 of this.

33 THE COMMISSIONER: Mr. Reilly, I wonder if we should
34 have a very short break.

35 A That would be fine with me.

36 THE COMMISSIONER: All right. We'll have just ten
37 minutes.

38
39 (PRESENTER STOOD DOWN)

40
41 (PROCEEDINGS ADJOURNED FOR MORNING RECESS)

42 (PROCEEDINGS RECONVENED)

43
44 J. PATRICK REILLY, a Technical
45 presenter, resumed.

46
47 THE COMMISSIONER: So we are going to start. Yes, sir.

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Presentation

1 PRESENTATION BY MR. REILLY, "BIOPHYSICAL RESPONSES TO
2 ELECTRICAL STUN WEAPONS", continuing:
3

4 A Okay. I think we finished talking about this
5 slide.

6 So this was a summary of the effects that we
7 talked about, muscle reactions. The Taser could
8 cause grip tetanus, inability to let go if applied
9 to the arm or hand. Anaesthetized pigs ceased
10 breathing during the application of a Taser
11 stimulus but human volunteers could breathe. In a
12 normal automatic mode of five seconds, a Taser
13 would not be an asphyxiation hazard. Tasers
14 exceed the equivalent exposure that caused the
15 shattered shoulder in an industrial accident.
16 Litigation from some officers receiving Taser
17 training have claims of compressed spine,
18 dislocated shoulder. And I don't know whether
19 those are due to falls or something else, but it
20 was just mentioned by Battershill that these
21 things are apparently issues. And severe acidosis
22 in pigs with prolonged or repeated taser exposure.

23 So now I am going to talk about the heart.
24 So this slide shows the first portable cardiac
25 pacer. That man could wheel that thing around
26 like that for about three days, it prolonged his
27 life by three days.

28 I am going to talk on the next slide, these
29 are the potential cardiac responses to electrical
30 stimulation, and these are things I'll be
31 mentioning. Well, I'm going to talk about
32 excitation. What is excitation? It's just the
33 production of an extra heartbeat at a period of
34 time in the cycle when you wouldn't normally
35 expect one.

36 Capture refers to the contractions of the
37 heart that are beating in synchrony with Taser
38 pulses. So that means individual Taser pulses are
39 driving the heart, and we call that capture. Now,
40 capture in the case of a Taser can lead to the
41 condition called tachycardia, that means just a
42 fast heart, is what it means. And if it's fast
43 enough it can lead to a condition where the
44 pumping of blood is compromised or even absent.

45 Standstill is the absence of beating and lack
46 of blood flow, but the heart can revert to normal
47 rhythm after the stimulus is removed. And

1 ventricular fibrillation is a disorganized rhythm
2 of the heart and without any pumping action, and
3 even after the stimulus is removed, the heart will
4 continue in that condition, usually, unless
5 somebody comes with those fibrillation paddles,
6 and that person under that condition if he's not
7 taken out of fibrillation will soon die.

8 Let's look at the next slide.

9 What this shows is that there is a vulnerable
10 period of when you can apply a shock. So this,
11 the figure with the graph in it shows different
12 periods in the cycle of the heart, and it says if
13 you apply a stimulus, let's say at the end of the
14 contraction, so the two lower figures is something
15 that would relate to an electrocardiogram. So
16 after the heart is finished pumping, it's in the
17 relaxed state, and during that time the threshold
18 of excitation is lowest. So that's what these
19 lower curves called excitation. The upper curve
20 called ventricular fibrillation. You can see that
21 that has a minimum during the time right after the
22 heartbeat but while it's still relaxing, that's a
23 so-called vulnerable period of the heart. And you
24 can see that there appears to be a fairly large
25 margin of safety between excitation and
26 ventricular fibrillation. So on this graph it's
27 nearly 100 to one.

28 So if you're not exciting the heart, you're
29 not going to fibrillate it, and if you're exciting
30 it with a single pulse, that need not be
31 dangerous. But if you have repeated pulses,
32 repeated excitations, then the next slide shows
33 what happens. These are some experiments where
34 they applied to guinea pig hearts in this
35 experiment, but there's a lot of other animal
36 studies like this, that show that as you continue
37 the duration of the shocks and you cause more and
38 more excitations, the threshold for ventricular
39 fibrillation on a subsequent shock applied during
40 the vulnerable period keeps getting lower and
41 lower until it eventually gets to a minimum.
42 Which is not terribly higher than the excitation
43 threshold.

44 So with repeated pulses, if the individual
45 pulses are at or about the threshold of
46 excitation, it could be potentially hazardous if
47 they are repeated. But if the individual pulses

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1 are below the threshold of excitation, then
2 nothing is going to happen, no matter how many you
3 have.

4 Okay, next slide.

5 This shows a relationship between body weight
6 in pigs. Now, this was done with Tasers, so they
7 had pigs of different body weights, and then the
8 triangles are plotted. He called it, this
9 researcher, the safety factor. What they did was
10 they took a standard Taser and they opened it up
11 and they modified it so it would put out stronger
12 pulses than it normally would. And then they
13 plotted how much stronger they had to make that
14 taser in order to cause ventricular fibrillation.
15 And you can see there's a relationship as the pigs
16 get bigger and bigger, that stimulus has to become
17 stronger and stronger. So this kind of relates to
18 something else I said, that small individuals tend
19 to have lower thresholds. This occurs in many
20 aspects of electrical stimulation, including
21 ventricular fibrillation.

22 The smallest safety factor this researcher
23 observed was a factor of 15, the lightest,
24 smallest pig had to have a taser that was,
25 according to his statement, beefed up by 15 times
26 so that you would conclude from that, well, gee,
27 there is not much risk of a Taser because here it
28 took 15 times higher than to cause that pig to go
29 into ventricular fibrillation. And for bigger
30 pigs it took even more output, even greater safety
31 factor.

32 But this is an issue that these safety
33 factors, I have concluded, that are published in
34 this paper are not accurate, that the author, and
35 I have corresponded with him about this, the data
36 he presented in his paper is not consistent with
37 these safety factors, and I would say the safety
38 factors would have to be reduced by a factor of at
39 least two. But still, you would conclude, even if
40 you did that, that from his experiments, a
41 standard Taser would not cause ventricular
42 fibrillation unless it was --

43 THE COMMISSIONER: Now, on your figures that's seven-
44 and-a-half times for that lighter pig.

45 A Yeah, it would be something like that, seven-and-
46 a-half or seven times. Yeah.

47 THE COMMISSIONER: All right.

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1 A But that's still, you know a safety factor. So
2 but that's what this guy showed.

3 Now, I am going to show you on the next slide
4 that other people have found other conclusions.
5 Here, and I am going to have to go through this in
6 some detail, because I think it's very important
7 and I know that this is the hot-button issue when
8 it comes to Tasers is, you know, is it going to
9 kill somebody, does it stop the heart? So we need
10 to understand this.

11 I give the various references at the top row.
12 It refers to the study that I referred to earlier
13 by Dennis et al. Remember he had two sequences of
14 40-second shocks from a standard X26, eight pigs
15 he tested. The Taser was not enhanced. I have
16 "times 1" here under this column. And he found
17 extreme acidosis and immediate tachycardia. That
18 means very fast beating without blood pressure.
19 So although most of those pigs were not in
20 ventricular fibrillation, they still, the lack of
21 blood pressure ought to be considered a dangerous
22 condition. And two of his pigs went into
23 ventricular fibrillation.

24 Then you recall I mentioned the same team did
25 another study where they used a paralytic, again
26 an unmodified Taser, and in this case one pig
27 suffered ventricular fibrillation. There was no
28 acidosis in those cases, but still there was
29 immediate tachycardia and no blood pressure.

30 The next row, reference (c) by Nanthakumar,
31 he tested six pigs, the 50 kilograms refer to the
32 average weight, with a TASER X26, and 96 percent
33 of the five-second discharges that he used
34 resulted in tachycardia without blood pressure.
35 So those would be studies that would make you
36 concerned that there might be a problem here.

37 Now, then we have some others that had more
38 reassuring outcomes, the next row, reference (d)
39 by Lakkireddy et al. He could only get
40 ventricular fibrillation, or capture, I should
41 say, he could only get capture by enhancing the
42 Taser. So he put the Taser darts across the chest
43 of the pig. This researcher could not cause the
44 condition that was observed by the ones above, and
45 he reported that. And he enhanced his Tasers by
46 two to ten times. Now, that, those factors, two
47 to ten, did not appear in his paper. He made the

1 same mistake that the other author did. So I've
2 modified his safety factors. But still he could
3 not fibrillate a pig at all and he couldn't cause
4 capture unless it was beefed up by a factor of at
5 least two, and as much as ten times.

6 The next researcher (e), which is Wu et al,
7 and that's a team that was headed by Dr. Webster,
8 and that's another one of your witnesses that you
9 have mentioned, Dr. Webster will be on hand
10 apparently. And this, he did peer studies. Let's
11 see, that's (e), Wu et al actually includes
12 Webster. I think Webster was the team leader in
13 that case. But Wu was the first name on the
14 paper.

15 So these next two studies, in the first study
16 he speculated that, well, maybe the pig isn't such
17 a good model for a human because the pig has much
18 more fat across its chest and more muscle, and
19 that the distance between the taser dart and the
20 heart will be greater in a pig than a human, so
21 maybe that the pig wouldn't be that, you know, too
22 conservative or wouldn't be a good subject. So
23 what he did is he surgically cut a well in the
24 pig's chest and he inserted the Taser dart in
25 there, and he moved it up and down until he could
26 cause fibrillation. And he found that on the
27 average if the dart was 17 millimetres from the
28 heart, he could cause fibrillation. And he also
29 reported that this distance could be found with
30 people that are relatively thin and with a taser
31 on the chest.

32 That study was criticized by some that by
33 cutting the well in the muscle that he altered the
34 distribution of the way the current flows and he
35 was causing more current to go to the heart than
36 would actually occur with a Taser. So he did a
37 second study and he found that in this case he
38 didn't actually do a surgical well, but he pushed
39 the Taser into the chest more or less, the dart,
40 and found again a distance relationship: the
41 closer you got to the heart and the more likely
42 you would get fibrillation. And the minimum
43 distance he found was something that he reported
44 you could find in humans, maybe like a one percent
45 or so of humans could have a distance as small as
46 the pig. So he found that you could only get
47 fibrillation when you pushed the dart closer to

1 the heart.

2 This last study mentioned here, number (g),
3 this researcher also could get fibrillation only
4 with a modified Taser that was enhanced.

5 So the picture here is a little unclear.
6 Some researchers are finding with an unmodified
7 Taser and darts on the surface of the pig they are
8 causing ventricular fibrillation. Other
9 researchers are doing similar experiments and are
10 not finding that, or they find they either have to
11 enhance the Taser or maybe push the heart, the
12 dart closer to the pig's heart, or something
13 unusual like that.

14 But we do, I think the fact that we do have
15 cases where an unmodified Taser is causing these
16 conditions ought to be a red flag that would say
17 in the case of humans this might be a concern.
18 Now, if it is a problem that could actually
19 happen, it would have to be a low probability
20 case. Because we are finding in the various
21 reports we receive from police departments and so
22 on that only of the many, many thousands of cases
23 that Tasers are used, only a small number result
24 in a death afterward. So at worst it would be a
25 small probability event in practice.

26 Now, that might have something to do with
27 where the darts hit. Now, Webster, for instance,
28 he found that there was a sweet spot, you had to
29 put the dart in the sweet spot just over the heart
30 and then you could get fibrillation. But these
31 other researchers, they just had the darts
32 straddling the heart and they didn't hit that
33 sweet spot, and they could.

34 So the next slide shows the conditions for
35 trainees, and these studies reported - that's by
36 Dr. Ho and another one by Levine - that they did
37 not find dysrhythmias, but again they're hitting,
38 they're putting the darts on the back of the
39 police trainees. But they reported they did not
40 find problems in humans.

41 Now, they did not actually measure whether
42 there was blood pressure during the Taser. I
43 mean, that's one question that the pig studies
44 would make you want to question. Was there blood
45 pressure while they were being Tasered? These
46 guys weren't able to measure that, or didn't
47 measure it. They only measured what would happen

1 after the Taser was over with. They found that
2 the heart was beating faster but the subjects
3 seemed to be okay otherwise.

4 Next slide is a summary of the effects on the
5 heart.

6 We have cardiac responses in some pigs with
7 electrodes on the chest, including immediate
8 cardiac capture with rapid tachycardia, without
9 blood pressure. Some studies have found
10 ventricular fibrillation both with and without
11 concurrent acidosis, and also that the probability
12 depends on the chest-to-heart distance. Other
13 studies have found a lack of cardiac response in
14 pigs, unless an enhanced Taser was used.

15 And the bottom bullet, there is no evidence
16 that I know of that proves that humans have
17 endured ventricular fibrillation immediately after
18 a Taser exposure. Now, that would be something,
19 you know, you would expect to happen right after
20 the Taser, rather than many minutes later. But
21 there are rare cases of Taser, of deaths after
22 Taser exposure during police encounters. I would
23 say that the probability of ventricular
24 fibrillation in humans cannot be ruled out, but
25 the probability would have to be very low.

26 Next we'll talk about the brain. Let me see.
27 In the interest of time, I am going to jump over
28 this, because I'll just give you the bottom line
29 here. That it's a rare condition that the Taser
30 dart will hit the head, but it's not impossible.
31 But of all of the cases that I've seen reported,
32 I've never seen a single one that reported a Taser
33 shot to the head. But I know there are some, I
34 think I've heard of a person getting shot in the
35 eye, but I haven't personally seen those
36 publications that report that.

37 But based on our experience with electro-
38 convulsive therapy, now that's something you know
39 that's used even today for severe depression and
40 other psychiatric problems, and what happens in
41 electro-convulsive therapy is they put electrodes
42 across the head and then you apply a current, and
43 that causes what they call a grand mal seizure.
44 Now, when they do electro-convulsive therapy, they
45 only do it with muscle relaxants, because without
46 muscle relaxants the muscle contractions can be
47 very intense and can even be, you know,

1 dangerously intense. So they use muscle
2 relaxants, they use anaesthesia. But I have
3 looked at electro-convulsive therapy literature
4 and none of it of course uses Tasers. But I've
5 concluded that the doses of electricity used in
6 electro-convulsive therapy are similar to the
7 doses applied by Tasers. So I would conclude that
8 if a Taser dart struck the head at a point, let's
9 say, outside the brain, you know, external to the
10 brain somewhere, if one of the darts hit the head,
11 there would be I think a reasonable probability of
12 a grand mal seizure ensuing.

13 So let's see, I'll just jump over, let's see,
14 one, two, let's go to page 38. Oh, let's see,
15 back up, let me see. There we go. Okay.

16 Now, why do people fall down? If you apply
17 the Taser, let's say to the chest, you will often
18 see humans and even animals, a stiffening of limbs
19 a distance from the place where the Taser hits. A
20 person loses posture, falls down, why?

21 One of the mechanisms, I think this is a
22 fairly new finding that I've had the privilege to
23 be able to contribute to this, it's explained by
24 what we call a spinal reflex. So what's a spinal
25 reflex? You go into the doctor, he taps your knee
26 with a little hammer, your knee jerks a fraction
27 of a second later. Why? Well, what happens is
28 there's certain inputs we call the sensory inputs
29 from that nerve tap travel up your leg, go to the
30 -- go to the spinal column, and in the spinal
31 column those are sensory inputs, they make
32 connections with other neurons that connect
33 muscle-controlling neurons. Those muscle-
34 controlling neurons then send the signals back to
35 the muscles in your leg and it tells certain
36 muscles to contract and other ones to relax, and
37 so your knee goes up. And that doesn't involve
38 the brain. You've got a computer in your spinal
39 cord. And just even posture, ability to stand,
40 your brain is not thinking about it. Your spinal
41 cord is programmed so that you stand up.

42 Let's go to the next slide.

43 Here's a good example. You step on a piece
44 of glass. This is a much more complicated spinal
45 reflex. What happens? Your foot feels various
46 things, a sharp object, sends signals to the
47 spinal column. That signal to the spinal column

1 has to send signals to that leg to lift it. Now,
2 what would happen if all you did was to lift your
3 leg and you didn't do anything else? You'd fall
4 down. The only reason I don't fall down, I shift
5 my body. So it has to take certain messages to
6 other muscles to tell the other muscles, you know,
7 shift your body weight, and that's all programmed
8 in your spinal cord.

9 Now, what happens in a Taser? In a Taser,
10 you're providing massive inputs to the spinal
11 cord, unnatural, and I would have to say that the
12 spinal cord is overwhelmed, it's confused and
13 doesn't know what to do. It's a very unnatural
14 stimulus. So there's good evidence that we're
15 about to publish that the spinal reflex plays a
16 very significant role in that.

17 Okay, that's enough said about that.

18 Let me go to page 41. This is just the
19 summary that a Taser shot most likely triggers a
20 spinal reflex leading to loss of posture. The
21 subject usually falls to the ground, but may be
22 unable to control or cushion the fall.

23 Now, let's talk about thermal effects.
24 Everything I've said up to now we call
25 electrostimulation. It talks about the excitement
26 of nerve and muscle. All the things I've
27 mentioned up to now.

28 Now, thermal effects is heating. Is that a
29 problem? Now with a TASER X26 the heat capacity,
30 as I showed you on of the very early slides, was
31 equivalent to a one-watt light bulb burning for
32 five seconds, and for the M26 it's approximately
33 equivalent to a 15-watt light bulb, again for five
34 seconds.

35 Now, small red marks appear at the site of
36 the Taser. Now, it's not clear whether those are
37 due to thermal burns, or maybe it's, of course,
38 you know, you're puncturing the skin with a dart.
39 That alone could cause an inflammation response.
40 And we know from other experiments that there can
41 be very localized erosion of the outer layer of
42 the dead skin cells of the skin. But other than
43 these factors, I think you would have to say that
44 if there is a thermal effect, any thermal damage,
45 it would have to be confined to a very small area.
46 So those little red marks are like, you know, like
47 a millimetre or two in diameter that people find

1 after being shot with a taser.

2 The other effect, in the next slide, is what
3 we call electroporation, and that means those very
4 strong currents in the body can punch holes in
5 this membrane that surrounds every cell in your
6 body. Now, normally those close up right away,
7 and, in fact, that mechanism is used by some
8 people to inject drugs into cells. You put the
9 cell in a medium and give the cell a shock and
10 then the pores appear and the drugs go inside, and
11 then the shock goes away and the cells close up.
12 If the electroporation cells are big enough and
13 they're held open long enough, they can fuse
14 together and then the contents of the cell can
15 spill out and that cell will die. But generally
16 we only see these things at fairly high levels of
17 stimulation where you'd expect electrical burns.
18 So we can't say, I can't rule out, that there
19 might be a small amount of electroporation and a
20 small amount of tissue damage very immediately
21 around the barb.

22 Another factor, the next slide is the
23 statistical variation among subjects.

24 There's a huge amount of literature on
25 electrical thresholds of animals, in people, and
26 all kinds of reactions, sensory and electrical
27 pain and muscle contraction and this let-go
28 threshold and electro-convulsive therapy and
29 ventricular fibrillation, many of these, that the
30 thresholds from one subject to another vary. The
31 only factor we know that can correlate with that
32 variation is body size, and that doesn't correlate
33 with everything. It doesn't make a perfect
34 correlation. So we are still left with unknown
35 factors, why does one person have a higher
36 threshold than another? But small subjects tend
37 to be more sensitive than large ones.

38 "Concluding remarks", I am going to now
39 summarize all the things that we went through.

40 Biophysical mechanisms will involve painful
41 sensations -- very painful.

42 Will cause intense muscle contraction,
43 possibly strong enough to cause skeletal muscle
44 injury in some cases.

45 That a lack of breathing has been seen in
46 pigs but not in humans during the application of a
47 Taser pulse.

1 Lack of posture is the normal sequence and
2 consequent injuries are possible from that.

3 Acidosis in pigs with prolonged or repeated
4 exposure.

5 Cardiac capture and ventricular fibrillation
6 in some animals, let's say, but ventricular
7 fibrillation would have to be ruled unlikely but
8 could not be ruled out in humans.

9 Grand mal seizure, although unconfirmed, is,
10 I would predict, would be possible if a dart
11 strikes the head.

12 And minor tissue damage possible around the
13 contact points due to dart penetration, tissue
14 heating or cellular electroporation.

15 Now, I've got my very last slide here.

16 These are the things that we don't know and
17 maybe you might say, well, what could there
18 possibly be? I mean, all these studies were done
19 with healthy animals, or police trainees, you
20 know, big strong guys. Could there be special
21 populations that are more vulnerable than others?
22 This is the part where we don't really have any
23 concerted studies, but these are the things that
24 you would want to worry about.

25 Now, I mention on each one of these, I give a
26 reference to some paper or somebody who has
27 information about it, if not a complete study.

28 Drugs. Two studies, one with a Taser and one
29 with not a Taser, showed that the cocaine
30 increases the threshold of ventricular
31 fibrillation.

32 On the other hand, another study showed that
33 epinephrine, which is also a stimulant that is
34 like adrenalin, lowers the threshold. That's
35 about, you know, other than that we don't have a
36 really good database on the effects of drugs.

37 What about young children? Well, they're
38 small people. Remember I mentioned the body size.
39 And we do have one case, a seven-month old child
40 dies after repeated Taser shocks by a foster
41 mother, and there's a reference there where you
42 can look that up. Now, that's not a scientific
43 study, it's a report.

44 Elderly people, this is something I would be
45 concerned about, individuals with orthopaedic
46 frailties. Those muscle contractions are so
47 strong that I would be concerned about people with

1 orthopaedic frailties. I have orthopaedic
2 frailties. I would not take a Taser shot because
3 of that. I have taken over my lifetime in
4 electric shock, thousands of shocks and some of
5 them unpleasant, but I would not, I would be
6 concerned because I have orthopaedic frailties.
7 But there's really no data to prove that.

8 Pregnant women. Well, let's say something
9 about this. There is one case here reported a
10 pregnant woman, three months pregnant, was shot in
11 the abdomen by police. According to the article I
12 think, as I recall, she didn't comply. She was I
13 think some drug charge and she did not comply to a
14 strip search or was not compliant and they shot
15 her in the abdomen. The next day she had spotting
16 and a week later she miscarried.

17 Now, I have to mention something because I've
18 seen this come up. I've seen this mentioned, it's
19 speculation by others, saying, well, the presence
20 of a woman's body is somehow shielding that foetus
21 and that current can't get there because, and they
22 call that a Faraday shield. And that comes up in
23 electromagnetic radiation, but that would not
24 apply at all to Tasers, and should just be
25 discounted as just incorrect speculation. The
26 fact is that the foetus inside the woman's womb
27 and the fluid surrounding is going to form a
28 continuum, so that current will be able to access
29 the foetus as it could the other tissues of her
30 body.

31 But I would be also very concerned about, you
32 know, possibly intense uterine contractions. I
33 don't know what these would do and perhaps one of
34 your medical people might comment on that. But
35 that would be another concern.

36 What about people with special body
37 configurations? Well, we know that there are many
38 electrical thresholds show that small people have
39 lower thresholds, and we also mentioned earlier
40 some studies by Webster, who will be here, showing
41 that small people might be more vulnerable than
42 big people, or skinny people more vulnerable than
43 fat people.

44 Physical condition. Let's see, I would be
45 concerned about even people with especially strong
46 musculature. Now we have those reports by
47 Battershill about lawsuits by police. Maybe

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1 strong people have unusually stronger contractions
2 and perhaps, you know, maybe could they be more at
3 risk for breaking bones? I don't know. But we
4 just don't have data on that.

5 The statistical variation of subjects from
6 one to another, we don't really have a good handle
7 on that when it comes to Tasers. What's the
8 variability? We know something about that in
9 other kinds of electrical stimulation, and I think
10 one needs to create, you know, an analysis model
11 that takes body size into account, and to my
12 knowledge that's not been done.

13 And then there's the issue of variations
14 among Tasers. If we have 100 Tasers that have
15 been sold at different times and we collect them
16 from around the country and test them, what's the
17 variation going to be? We know that they're not
18 going to be, you know, you can never manufacture
19 two things precisely alike, and what about age and
20 stuff? What does that do to their output? So we
21 don't really have data on that.

22 So I consider these things, and I'm not
23 saying that they are problems but I think they are
24 concerns that need to be addressed and just have
25 not yet been addressed.

26 So I think with that I will conclude my
27 presentation.

28 THE COMMISSIONER: Sir, thank you very much. I'll
29 pause now. Is anybody mindful of speaking to
30 counsel to see whether or not there should be some
31 questions put through counsel to clarify anything,
32 because if not, we can just adjourn for lunch now.

33 Well, I don't see anybody wishes any
34 questions then, and it's quarter to 1:00. We'll
35 break now until two o'clock.

36
37 (PRESENTER STOOD DOWN)

38
39 (PROCEEDINGS ADJOURNED FOR NOON RECESS)

40 (PROCEEDINGS RECONVENED)

41
42 J. PATRICK REILLY, a Technical
43 presenter, resumed.

44
45 THE COMMISSIONER: [Sound begins] ...to be asked.

46 MR. VERTLIEB: Thank you, Mr. Commissioner.

47

1 QUESTIONS BY MR. VERTLIEB, continuing:
2

3 Q Mr. Reilly, just for some clarification, just a
4 few things, please. When you mentioned
5 ventricular fibrillation, what is of concern about
6 that? Why are you concerned about that?

7 A Well, the concern is this, that, first of all, no
8 blood is pumping, and secondly that it's extremely
9 unlikely that it will correct itself unless
10 somebody has the defibrillation paddles available.
11 So that means that it's very likely to result in
12 death if it sets in and if someone's not on hand
13 to pull you out of that with a defibrillator.
14 It's likely to result in death.

15 Q Now, secondly there seems to be some contradictory
16 literature between the effect of the Taser when
17 used in the probe mode and when it's used in the
18 drive or push mode, so just to get your thoughts
19 about this. The probe mode is when those darts
20 come out, you mentioned like straight fish hooks.
21 That's the probe mode?

22 A Yes.

23 Q And there's different language, drive mode or push
24 mode, which do you prefer for that?

25 A Well, I have used the term drive-stun. I mean, I
26 have just seen that in print and so I have come to
27 use that term, drive-stun, which means you're not
28 firing the darts, but they take the gun without
29 the cartridge attached and push it against the
30 subject and pull the trigger; that I call the
31 drive-stun mode.

32 Q And so in terms of the worries that you have
33 mentioned about the effect on people, which would
34 cause you more concern?

35 A Well, let's put it this way, the mode that would
36 have the greatest effect that you're looking for,
37 that would mean debilitation, and also maybe the
38 greatest hazard, would be the probe mode where the
39 darts are spaced some ten centimetres or more
40 apart. And that as you move the darts closer
41 together as you have in the drive-stun mode, I
42 would expect that it would become less effective
43 as an incapacitating event and also that the
44 chance of some kind of dangerous situation ensuing
45 would also be reduced.

46 Q So less chance of danger with the drive mode
47 versus the probe mode?

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Questions by Mr. Vertlieb (cont'd)

1 A Yes, less chance of danger.

2 Q Now, very recently here we've been aware of an
3 article by a number of doctors from Toronto, a Dr.
4 Nanthakumar and a Dr. Dorian and others, who have
5 collaborated on an article, very recently
6 published in the *CMA Journal*. Have you seen that
7 article?

8 A Yes, I've seen it. It's very recent. In fact, I
9 think I reviewed it while I was on the plane
10 coming out here.

11 Q There's an abstract in that article. What's your
12 view of that abstract?

13 A Well, my view is that it's a summary, what he
14 describes as a summary, that of the state of
15 knowledge with respect to ventricular fibrillation
16 and the possibilities of it happening in a Taser.
17 And that he doesn't bring any new information in
18 this paper, but I would classify it as more of an
19 editorial opinion by this man. And if I may try
20 to paraphrase it, my understanding of what he is
21 saying in this article is this: How can people
22 say, and there are some who in his opinion are
23 trying to say this, how can people say that there
24 is zero probability of a fatal event or
25 ventricular fibrillation happening and that it
26 cannot happen with a taser when there are several
27 studies that show that it can, his being one of
28 them? And there are a couple of others that he
29 cites that it's not just his study. So I think
30 that's kind of the opinion that he rendered in
31 this paper, which is more of, as I say, a review.
32 There's really nothing new in it, other than he's
33 just trying to reinforce that opinion.

34 Q And do you agree or disagree with his abstract?

35 A I agree. I have said and continue to believe that
36 there is a very small chance of a fatal event,
37 albeit not zero, the probability would be small,
38 but should not be construed to be zero as far as
39 exposure to a human.

40 Q When you say what you've just said, what percent
41 would you attach to that?

42 A Okay, now, that's a real difficult one, to try to
43 quantify a rare event when you don't have all the
44 data to know just how to quantify it, who are the
45 people most at risk? But I would say that based
46 on just the experience of the number of
47 deployments that have been made and the numbers of

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb (cont'd)

1 people who have died after a Taser exposure, even
2 if you blame all of the incidents on the Taser,
3 even if you were to take that position that the
4 Taser somehow contributed or caused those deaths,
5 it still would have to be a probability, a small
6 probability well less than one percent.

7 To quantify that, I simply can't, and I have
8 to give this caveat when I make a statement like I
9 just did, that there is really no central data
10 collecting effort that really allows you to
11 adequately appraise those probabilities, that the
12 police are not required to report these things to
13 some central clearinghouse. Some of these go to
14 TASER International, the reports, and it's
15 strictly voluntary. According to Battershill, the
16 Canadian office that did a study on the statistics
17 of problems, that police departments only
18 voluntarily give information to TASER
19 International, and most do not. That was his
20 statement. So you have to colour these things
21 that we're kind of groping in an environment where
22 we don't have all the facts. And if we want to
23 really answer your question more definitively, we
24 need more information.

25 Q Well, do you have any recommendations on data
26 collection?

27 A Yes I do, indeed. This is what I guess would be a
28 recommendation I'd like to make, is that for every
29 Taser deployment, that the police department or
30 the individuals involved in that incident would be
31 required to file a report, and that report ought
32 to go to some central agency that is available to
33 the public and available to research scientists,
34 whoever is interested. And I think there ought to
35 be specific things that a police officer ought to
36 be asked to answer, and I have a number of
37 suggestions.

38 Q Please.

39 A And some of these things go into the areas of
40 uncertainty that I mentioned. I would suggest a
41 questionnaire to include these things, but
42 certainly not limit it to them: The height and
43 weight of the individual tased; whether it was a
44 drive-stun mode or in a dart mode; the number of
45 repeated shots; the number of Tasers applied to
46 the individual, whether it was just one gun or
47 multiple guns; the location of darts on the body,

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb (cont'd)

1 and for that I would suggest that the
2 questionnaire should include an outline of a human
3 being with maybe a grid system applied to it, and
4 it would show a front view and a rear view of a
5 human, and then the officer would maybe make an
6 "X" in the squares that were closest to the ones
7 where the darts landed. The questionnaire should
8 include the observed reaction of the subject, and
9 it should also ask whether there were any
10 observable injuries and what were the nature of
11 those things.

12 Now, that at the very least I would think
13 that should be asked, and hopefully over time then
14 we can begin to get a better handle on the
15 probability of these events that are unwelcome or
16 dangerous.

17 Q Why would you want to know with the chart of the
18 body front and back, the location of the darts?

19 A Well, it makes a difference in trying to assess
20 what might have been the likely cause of death.
21 So, for instance, if the darts were hit on the
22 abdomen or maybe the arm or leg, for instance,
23 then you could rule out that the Taser directly
24 caused ventricular fibrillation. But on the other
25 hand, if one of the Tasers was near the heart, one
26 of the darts was near the heart or the two darts
27 across the heart, then that might be a possible
28 explanation. So the location helps you to try to
29 determine what might have been the cause of death.

30 Q Is there any significance to the location of the
31 darts relative to the heart, if you had a dart on
32 top of the heart and one near the bottom, for
33 example, would that make any difference from an
34 electrical engineering standpoint?

35 A Well, that's a good question. I know that Dr.
36 Webster, who is going to appear here, says that
37 there's a sweet spot, a small like a one- or two-
38 centimetre diameter sweet spot, if one of the
39 darts hits inside that sweet spot, that's when you
40 get the greatest chance of ventricular
41 fibrillation. On the other hand, the studies that
42 I mentioned in one of my charts that showed
43 incidents where the pigs did go into ventricular
44 fibrillation, the darts were not on that sweet
45 spot.

46 So how do we get a better handle on this
47 question you asked is a very relevant one. The

1 research project I'm involved in is on the verge
2 of answering questions like that. We are creating
3 a highly detailed anatomical model of a human
4 being and also pigs, and the project is going to
5 be able to determine for any arbitrary placement
6 of darts what would be the electric currents in
7 different parts of the body. And there will also
8 be a verification of this model with animals, and
9 I think we will be better able to answer that
10 question but we're not there yet. And so it may
11 be a year before we have a good answer to that.

12 Q You mentioned the animal testing and in this case,
13 in this subject, has been with pigs. Is there a
14 reason that pigs were used versus dogs or other
15 animals, and tell us about the issues around
16 comparing animal testing with human testing.

17 A Okay. And that's also a fair question. This
18 question always comes up in safety studies, and I
19 don't care whether you're talking about
20 electricity or pharmacology, in general, you know,
21 you're not going to experiment with people when
22 you are questioning whether there could be a
23 serious hazard involved. A lot of your research
24 is going to be with animals, and so you always
25 have the question how do I relate the animal to
26 the human?

27 And in the case of the electrical exposure
28 over the years people have used various animal
29 models, and there is animals like dogs have been
30 one subject. But, you know, dogs are a lot
31 smaller than people. And you remember that those
32 body size relationships I mentioned, the smaller
33 individual tends to be at a lower threshold. So a
34 pig seems to be a big animal, kind of usually on
35 the size of a moderate size human. Their heart
36 architecture is similar to a human, so they're
37 often thought of as a reasonably good model to be
38 testing against humans. However, there are some
39 suggestions from data that say that a pig might be
40 in some cases more sensitive to ventricular
41 fibrillation, let's say, pound for pound as
42 compared to human. So it might be a little
43 conservative to use pigs as a model for humans.
44 But that's sort of where we are. In any safety
45 study, we try to do the best we can, and generally
46 the pig is accepted as a reasonable model for
47 humans.

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb (cont'd)

1 Q What is acidosis?

2 A Acidosis is a condition where the blood becomes
3 more acidic than the natural state. So acidic,
4 there's the two polar opposites of acidic, one
5 pole is acidic and the other is alkaline, and the
6 blood is usually very slightly alkaline. But if
7 the blood becomes more acidic, they call that
8 acidosis.

9 Q Now, you mentioned orthopaedic frailties. What
10 about someone who had a transplant of a joint, or
11 had some injury where they had metal screws in
12 their body from fracture. Would you have any
13 concern about that from your electrical
14 engineering background?

15 A Well, just from electrical engineering point of
16 view, we find this to be true, that when a person
17 has a metallic implant - and there can be many
18 kinds of implants, now, you mentioned screws and
19 the hip replacement, but there are lots of other
20 implants, for instance, heart pacemakers and other
21 kinds of devices that are implanted in the body -
22 that where those metallic objects are resident in
23 the body, if you have a current from some external
24 source that's, let's say, passing near those
25 implanted objects, the current will tend to be
26 drawn to those objects and will get a higher
27 current density near those objects. Now, that
28 higher current density can have a greater chance
29 of exciting nerves, for instance.

30 In the case of a hip replacement that you
31 mentioned, I can't think of a scenario where I
32 would worry about a danger from that alone, even
33 though the currents might be attracted and, you
34 know, intensified a little bit around the implant,
35 I don't see that as a specific danger. But there
36 could be other things that ought to be looked at
37 and I think, for instance, implanted pacemakers
38 and implanted defibrillators would certainly be
39 things on our list of things that we need to
40 understand better, whether the function of those
41 devices might be interfered with. And that's the
42 question that needs to be raised, and I don't have
43 an answer for it.

44 Q Lastly, have you been approached by TASER
45 International to do work for them?

46 A Well, I have been approached by more than one
47 company that manufactures electrical stun devices

J. Patrick Reilly (Technical presenter)
Questions by Mr. Vertlieb (cont'd)

1 and asking about possible interest and
2 collaboration in some respect, and that includes
3 TASER International. And I have, after
4 consideration, I have turned down anything along
5 those lines. And the reason was that I wanted to
6 remain as independent as I possibly can for the
7 purpose of appearing at some hearing just like
8 this. I really wanted to preserve independence
9 and to avoid any appearance of conflict.

10 And I might add that in the same respect I
11 also have turned down offers to do work against a
12 Taser company by somebody bringing a lawsuit for
13 this very same reason.

14 Q And you have not done that, either.

15 A I have not done that either.

16 MR. VERTLIEB: That's it, all right, nothing else for
17 you. Well, thank you so much for coming here, Mr.
18 Reilly. I know that we're all grateful to you.
19 Mr. Commissioner, those are our questions as
20 counsel.

21 THE COMMISSIONER: Mr. Reilly, I'm very grateful for
22 what you've done. I personally have found your
23 presentation very clear on a very difficult
24 subject, particularly for those of us that have a
25 lay background in this area. Thank you so much.

26 A Thank you, Mr. Commissioner.

27
28 (PRESENTER EXCUSED)

29
30 MR. VERTLIEB: Now, Mr. Commissioner, perhaps we could
31 just take a few minutes to help set up the
32 connection for the next presenter.

33 THE COMMISSIONER: all right. We'll take a five-minute
34 break.

35
36 (PROCEEDINGS ADJOURNED)

37 (PROCEEDINGS RECONVENED)

38
39 THE COMMISSIONER: Can we begin. All right. I am
40 informed that we have the hook-up necessary. Yes,
41 counsel.

42 MR. MCGOWAN: Mr. Commissioner, the next presenter is a
43 Dr. John Webster. He's a Professor from the
44 University of Wisconsin-Madison, where he has a
45 specialty in biomedical engineering. He is quite
46 familiar with the literature regarding Taser
47 studies involving animals and has himself

John G. Webster (Technical presenter)
Questions by Mr. McGowan

1 conducted a number of these studies, specifically
2 with pigs. He's here today to tell us about that
3 research and the knowledge he's gained from the
4 literature.

5 I should say just a brief word about the
6 method of his presentation, Mr. Commissioner. As
7 you can see, he's not here in person, time
8 constraints in the scheduling made it not possible
9 for him to attend in person, so we have arranged
10 for him to attend by way of a telephone conference
11 line and a SKYPE video link. There were some
12 practical reasons why the higher-tech
13 videoconferencing was not a practical option.

14 THE COMMISSIONER: Yes, thank you. I understand that
15 it was in excess of \$20,000 to set up the
16 appropriate link with satellite and I didn't want
17 to stretch the public purse that far. This seemed
18 to me to be quite an adequate method of doing it.

19
20 JOHN G. WEBSTER, a Technical
21 presenter, appearing via video
22 link.
23

24 QUESTIONS BY MR. MCGOWAN:
25

26 Q Now, Dr. Webster, can you hear me okay?

27 A I can hear you. Can you hear me?

28 Q I can hear you just fine. We'll progress and you
29 let me know if you have any difficulties hearing
30 either myself or the Commissioner.

31 A Okay.

32 Q And I'm going to start, before we send you off, I
33 understand you have a PowerPoint presentation and
34 before I send you off on that, I'm going to spend
35 just a few minutes with you discussing your
36 background and experience, all right?

37 A Okay.

38 Q Okay. I understand you started your education at
39 Cornell University?

40 A Right.

41 Q And what degree did you get there, Doctor?

42 A Well, it was a five-year program, a Bachelor of
43 Electrical Engineering.

44 Q Okay. And that was in 1953?

45 A Right.

46 Q Okay. And from there you went on to Rochester
47 University?

John G. Webster (Technical presenter)
Questions by Mr. McGowan

- 1 A Well, I spent about ten years in industry before I
2 went back to school, and after that went to the
3 University of Rochester to get my Ph.D.
- 4 Q Okay. And you did a Master in Science as well at
5 Rochester?
- 6 A Yes.
- 7 Q And what areas were your Master's and Ph.D. in?
- 8 A Well, I was invited by the National Institute of
9 Health to become re-trained to teach this new
10 field of biomedical engineering, so my speciality
11 was in biomedical engineering within the
12 Department of Electrical Engineering.
- 13 Q And what is biomedical engineering?
- 14 A Well, it's the application of engineering
15 principles to solve problems in healthcare. My
16 particular speciality is teaching students and
17 doing research in order to develop new medical
18 devices for hospitals and other healthcare.
- 19 Q All right. And you are currently a professor, an
20 acting professor at the University of Wisconsin-
21 Madison, and you've been there since 1967 in that
22 position; is that correct?
- 23 A Well, I was a professor up until 2001 and then I
24 retired and they made me an emeritus professor,
25 and then they wanted me to come back and teach
26 courses and do research. So I have been more or
27 less full time since.
- 28 Q All right. And you are, I understand, a member of
29 the Engineering in Medicine and Biology Society?
- 30 A Well, it's actually the I-Triple-E, that is the
31 Institute of Electrical and Electronics Engineers,
32 and they have many subgroups, one of which is
33 Biomedical Engineering.
- 34 Q All right. I see you have a number of areas of
35 interest when it comes to research and areas in
36 which you've gained expertise. They include
37 medical instrumentation and devices?
- 38 A Yes.
- 39 Q And the design of cardiac pacemakers and
40 defibrillators?
- 41 A Yes.
- 42 Q I wonder if you might just very briefly tell the
43 Commissioner a little bit about your work in that
44 area.
- 45 A Well, I teach about medical devices and
46 particularly those that are electric stimulators,
47 and a cardiac pacemaker is an electric stimulator,

- 1 similar to a Taser, which also electrically
2 stimulates the body. So there's a rather close
3 correspondence there.
- 4 Q I take it, it was because of your previous work
5 that you ended up moving into, as one of your
6 research areas, Taser; is that right?
- 7 A Well, I was alerted to the fact that the U.S.
8 Department of Justice had put out a request for
9 proposals to do research in this area, and it
10 seemed rather close correspondence with some of my
11 previous work, so I applied and then they gave me
12 the funds to do that.
- 13 Q All right. And how were you alerted to the
14 proposal that was available?
- 15 A Well, I know a man named Robert Stratbucker, who
16 happens to serve on the Taser Medical Board, and
17 he called me up and suggested that I get involved
18 in it.
- 19 Q I wonder if you could tell the Commissioner just
20 generally a little bit about the research that
21 came from that, that came about as a result of the
22 funding you received from the Department of
23 Justice?
- 24 A Well, my original hypothesis was that Tasers
25 cannot electrocute the heart. And then I got to
26 working on pigs, and it was pointed out to me by
27 someone who knows all about pigs that unlike you
28 and I they walk on all fours, and they have a very
29 thick band of muscle that's over the top of the
30 heart, and so in that small respect they are
31 different from us and therefore we should try to
32 figure out how close the darts get to the heart
33 before they cause trouble. Whereas all other work
34 that I am familiar with, people just put the darts
35 in the skin of a pig, which is farther away than
36 our work.
- 37 Q All right. And what's the extent of your research
38 experience using Tasers on pigs?
- 39 A Well, I had this government grant for two years,
40 and we tested Tasers on pigs at least 40 times and
41 so I'm very familiar with the response of pigs to
42 Tasers. And I assume that the response of humans
43 is somewhat similar from videotapes that I have
44 seen in their use on humans.
- 45 Q Right. Now, you're here today not as a witness,
46 Dr. Webster, you're here as a presenter. We have
47 a slightly less formal atmosphere. But I

John G. Webster (Technical presenter)
Questions by Mr. McGowan
Presentation

1 understand you have had some experience as an
2 expert witness in your field of expertise as an
3 electrical engineer; is that right?

4 A Yes. Sometimes I get called on by people that are
5 litigating between two companies, mostly patent
6 litigation, but some other types of litigation.
7 I'm familiar with courtroom procedures.

8 Q And has any of your expert witness involvement
9 centred around Tasers?

10 A Yes. There are currently several ongoing cases
11 and I have written expert reports in three of
12 these cases, so I'm familiar with the litigation
13 in this area.

14 Q Okay. And the cases involving Taser that you're
15 involved in, are you involved for the manufacturer
16 or for some other party?

17 A Well, the first case was someone that had made
18 some statements at a conference by the name of
19 Ruggieri, and TASER had sued him for defamation, I
20 think. And Ruggieri asked me if I would be
21 willing to testify on his behalf. So I did that,
22 and later the case was settled.

23 Q All right. And you are involved in other ongoing
24 matters now, which I won't ask you anything
25 further about.

26 A Yes.

27 Q All right. Does that about cover your relevant
28 experience and background, Dr. Webster, sufficient
29 to give us a sense of your body of knowledge and
30 expertise?

31 A Well, I think it does.

32 Q Okay. I'm going to invite you now, Dr. Webster,
33 to commence your PowerPoint presentation. I
34 understand that you have prepared a PowerPoint
35 presentation which you will be looking at at your
36 end and we will be displaying at the same time on
37 the screen we have here.

38 A Yes.

39 MR. MCGOWAN: Very well. Please feel free to begin.
40 If you have any difficulties, let me know. And if
41 there's anything we need clarified, we'll jump in
42 and ask for that.

43

44 PRESENTATION BY DR. WEBSTER:

45

46 A Okay. Well, I'm on slide number 1 now, which I
47 presume you can see, and it tells who I am and if

1 anyone wants to send me an e-mail, or by phone,
2 all my information is there.

3 So let's go to slide 2.

4 This shows the way a Taser works. Unlike a
5 stun gun, which is pushed against a person with
6 electrodes that are about two inches apart and
7 only stimulates a small area causing a lot of pain
8 but not incapacitation. The Taser is designed, as
9 you can see, to spread the darts vertically by
10 some distance, and then the electricity flows
11 between the two darts and stimulates the entire
12 torso, including the spine and all the nerves that
13 go to the limbs and the entire body becomes very
14 stiff and generally falls over.

15 Let's go to slide 3.

16 So what we see here are some darts and then
17 they have a heavy part behind them, that helps
18 them to eject, then they come out on the right
19 side, the cartridge on the front of the Taser, and
20 then they have these trailing wires that go out,
21 and sometimes land in the skin like darts, or they
22 can just go through clothing and then the voltage
23 is high enough so an electric arc jumps from the
24 dart to the skin in the same way that it would if
25 it was winter and you scuffed your feet and you
26 got near a doorknob and a spark jumped to the
27 doorknob. So we're all familiar with that.

28 Let's go to number 4.

29 So here's the problem. There is the question
30 at the top really: Can Tasers directly
31 electrocute the heart? And this is what we tried
32 to (indiscernible - word(s) skipped) on that
33 question. Because Amnesty International, which
34 seems to think that we should stop using Tasers,
35 states that a large number of people have died
36 after being shot with a Taser. But this isn't
37 really cause and effect. I think in the vast
38 majority of these cases people have taken an
39 overdose of drugs, they are behaving badly, the
40 police show up, they disobey the police, the
41 police shoot them with a Taser and then they die.
42 Not from the Taser, but from the drug overdose.
43 However, there may be a small number of these
44 people who were electrocuted by the Taser.

45 So number 2 there, we're trying to answer the
46 question: Can Tasers directly cause ventricular
47 fibrillation in humans?

1 So number 3, we determine the dart-to-heart
2 distance that causes ventricular fibrillation in
3 an anaesthetized pig because, as you might
4 imagine, if you were shot in the leg, it's not
5 going to kill you. You have to get close to the
6 heart. You have to get enough electricity flowing
7 through the heart in order to cause electrocution.
8 And it doesn't make any difference whether it's a
9 Taser or whether you put your finger in a socket
10 in the wall, if it goes through the heart, it can
11 electrocute you, and if it doesn't go through the
12 heart, why, it can't electrocute you.

13 So since we couldn't test on humans, that
14 would really be unethical, and I certainly
15 wouldn't want to get a Taser dart right over my
16 heart, we use a computer model - that's number 4
17 there - of the human thorax in order to estimate
18 this probability.

19 Let's go to slide 5.

20 So one of the questions that comes up is
21 haven't there been enough pig studies already?
22 And here is, well, the first major pig study which
23 was done by McDaniel, Stratbucker, Nerheim and
24 Brewer, two of the authors of this are employees
25 of TASER company. So it shows that if you look at
26 the weight of the pigs at the bottom, that as they
27 get heavier and heavier there's a safety factor, a
28 safety index on the left and it keeps going up and
29 up. And what they are saying here is that, well,
30 it takes 20 times as much as what the Taser puts
31 out in order to kill a pig, and therefore there's
32 a tremendous safety factor, and the Taser can't
33 kill pigs, or humans by implication.

34 But then in looking at the bottom left we see
35 humans don't have the fat and muscle layers of
36 pigs. Most humans, if they are like me, you can
37 put your fingers sort of over your heart and
38 between your ribs, and you can feel the heart
39 beating right on the other side of your ribs, I
40 mean, it's very close. You can't do that with a
41 pig because the pig has this big band of muscle
42 that's right over the top of that area, and on top
43 of that is generally a layer of fat, too. So in
44 this anatomical way, pigs and humans are
45 different.

46 Let's go to the next slide, number 6.

47 So we asked the question: How close to the

1 heart does the dart have to be to cause
2 ventricular fibrillation? Well, the first time we
3 tried this we made a little, you can take some
4 blunt forceps to sort of make your way in a hole
5 from the surface of the pig through to the heart,
6 and then we put an electrode in there some
7 distance from the heart, and when we turned on the
8 Taser, the whole pig just jumped around and
9 vibrates a lot and everything falls apart. And so
10 we made what you can see here in the photo on the
11 right, is sort of the plunger end of a syringe
12 which you can hold down against the rib cage, and
13 then even though the whole works is vibrating, the
14 distance of dart here remains fixed.

15 So what we see here on the left side is the
16 adjustable plunger, which is placed on top of the
17 rib cage, and next to that we see something that's
18 like the dart. We made up a calibrated tube of
19 plastic and with metal exposed at the end, exactly
20 the same length as the nine-millimetre dart of the
21 Taser, and then we could adjust this up and down
22 and we ran experiments in which we started a long
23 way away from the heart, and then moved in and
24 then moved in, and then moved in, and eventually
25 if you get close enough, the pig would go into
26 ventricular fibrillation, which we could monitor
27 on monitoring equipment.

28 Let's go to number 7.

29 So here's sort of a side view of everything
30 that's going on. First you remove (indiscernible
31 - word(s) skipped) the fat and the muscle down to
32 the rib layer, and then you could stabilize things
33 with a syringe and then you could slowly advance
34 through this tube and get closer to the heart.
35 And when we're all done we could take another
36 device like a little metal tube with a hook on the
37 end like a harpoon and put it in the same place so
38 that then when we dissected we could see exactly
39 where we landed on the heart. So we verified the
40 heart location using the detachable harpoon.

41 Next slide 8.

42 Well, what did we find out? We found with
43 pig number 1 we moved in until we were 18
44 millimetres away. Pig 2 we had to go down the
45 zero, right up next to the heart. And you could
46 see as we went through these ten pigs that we got
47 a variety of answers, because pigs are all

1 different, or maybe the little tube that we made
2 was different in each pig, or a different
3 location. Any time you work with mammals and
4 animals you have to run a number of them in order
5 to get an idea of what's going on, a range, and so
6 forth. So the average was 17 millimetres, and
7 that's less than an inch. So you have to get in
8 fairly close to the heart in order to make it go
9 into ventricular fibrillation.

10 Next slide 9.

11 Well, we sent our results to a number of
12 people. It's common in the university world to
13 try to get other people's opinion of your work.
14 And the opinion was not very good. They said,
15 "Oh, well, you put some gel in this tube and that
16 might have caused error." And we recognized that
17 that was a possibility.

18 So then we designed something that used no
19 gel at all. They said that the gel might have
20 conducted the electricity straight into the heart
21 and made it more sensitive than it would be
22 otherwise. So we made a special probe here, a
23 blunt probe so we have no tunnel, really, we just
24 sort of take this blunt probe and shove it through
25 the muscle and all, and it will go through, until
26 we get to the heart, and then we know where the
27 heart is because it starts bouncing up and down
28 every time the heart beats. And then we have a
29 test probe that we operated in the same way, this
30 same tract that runs from the surface into the
31 animal, and ran it that way.

32 So let's look at slide 10.

33 Slide 10 is a computer tomography image of
34 just what was going on. Here's the heart here,
35 this big round thing in the middle. And there's
36 the bone, the white part shown here in the centre,
37 just under the letter "A", and then down the
38 sides, and then you can see that there are muscles
39 in between the bone, and then you can see that
40 there's a layer of muscle and then a layer of fat
41 before you finally get to the outside. And so you
42 can see a picture of exactly what was going on and
43 you can see another piece of information that is
44 the black part of the picture you're seeing is
45 lungs, lungs full of air, so it absorbs extra
46 (indiscernible - word(s) skipped) in this picture,
47 and that the lung doesn't get in the way of what

1 we're doing. That is, you can see that we're
2 going directly through and measuring the distance
3 now from the heart to the end of this dart.

4 Well, you might ask why we used the blunt
5 dart? Well, we were fairly close here and if we
6 used the sharp dart and got too close and it
7 punctured the heart, the heart would immediately
8 bleed to death and the experiment would be over.
9 So we used a blunt dart that had a rounded end so
10 we didn't puncture the heart, which is the large
11 round thing in the middle.

12 Okay, next slide 11.

13 So here's some results. We can see that on
14 the left side, the mass of the pig, there's about,
15 oh, 60, 70 kilograms. That's about what I weigh,
16 so the pigs are the size of a human. And then we
17 ran a number of tests and measured the skin-to-
18 heart distance, which I note that on the average
19 it's 47 millimetres. It's a long way from the
20 skin of a pig to the outside of the heart because
21 of this layer of muscle and this layer of fat.
22 And it's very different from a human. There are
23 some humans where this distance is maybe 11
24 millimetres for particularly thin people, like I
25 say they can feel the heart beating right on the
26 other side of the rib, pretty much on the outside
27 of the rib.

28 So at any rate we got very different results
29 here. We see that our average distance was 5.8
30 millimetres as opposed to the 17 we got before,
31 and that it ranged from about two to eight
32 millimetres distance. Now, if you put all this
33 together, if a nine-millimetre dart goes into a
34 human that has 11 millimetre distance, these data
35 suggest that under those conditions the human
36 would be electrocuted.

37 But realize, too, that you have to have just
38 the right conditions. You have to be over the
39 heart and the dart has to land between the ribs
40 and under a small probability of all of these
41 things coming together at the same time, the human
42 could be electrocuted. Well, not only that, if it
43 happened, then the human would have to collapse in
44 a very short time, say on the order of 20 seconds
45 or something like that. And if all this comes
46 together, why, then, it's likely - certainly more
47 likely than not - that the Taser electrocuted

1 someone.

2 Okay. Let's go to the next slide number 12.
3 Part of our research in order to figure out what
4 was happening, what we got from the TASER
5 company's website, and what they've done is
6 they've asked police to report on where the darts
7 landed. So they had this grid. Well, this is the
8 back of a human and on your left side, you see the
9 front of the human, and I think you can see from
10 what I've said so far, the most dangerous areas
11 are B3 and C3, which are over the heart region.
12 And you can go over to the chart on the right and
13 figure out, well, how many darts landed in B3 and
14 C3, and compare them with the total number of
15 darts that landed, and from this we can get the
16 probability that the darts landed in these areas.
17 And so that helps us estimate the probability that
18 we came up with [indiscernible - word(s) missed].

19 Let's go to the next slide 13.

20 And here's some numbers in these B3 and C3
21 grids, so many out of so many hits were there, and
22 then we can calculate the probability, and then we
23 can see how many square centimetres there are,
24 then we come up with this pretty small number at
25 the bottom, that is, for one square centimetre
26 over your heart, it looks like less than one in a
27 thousand chance of darts landing in that area.

28 Okay, next slide, 14.

29 We needed more information. What are humans
30 like? And so I was able to get someone who works
31 in echocardiography, that is, they put a probe
32 against the front of human skin during normal
33 imaging of how the heart valve worked, and things
34 like that, and at the end of that they asked the
35 people to stand up because most assailants are
36 erect or standing, and measure the distance from
37 the outside of the skin to the nearest heart
38 location, and these are the results. That is, if
39 your body mass index is low, say, 20, then the
40 skin-to-heart distance is also small, it can be
41 around 10, 11, in that area. But if your body
42 mass index is 40, then it's likely that the skin-
43 to-heart distance is much higher because you have
44 a big layer of fat sort of protecting your heart
45 -- let's use that word. But you can certainly see
46 a correlation here. At any rate we could use all
47 this information now in our models to try to

1 estimate the probability that a human could be
2 electrocuted.

3 Next slide is 15. Okay.

4 So we tried to come up with a probability for
5 human ventricular fibrillation for just one square
6 centimetre. We don't know how many square
7 centimetres there are yet, but we'll get there.
8 And you can see that there are no humans where the
9 skin-to-heart distance is 10, so the probability
10 is zero. Now, there's one human, 11, two at 12,
11 five at 13, and so on, so as you can imagine, as
12 we permit the skin-to-heart distance to get
13 bigger, why the probability over here on the right
14 side is going to keep going up.

15 Next slide is 16. So our results sort of
16 suggested, looking at this anatomical figure, you
17 can see that the heart is sort of protected by the
18 sternum, this bone goes up and down the middle,
19 and the ribs that out to the side, and if the dart
20 landed on the sternum, that's not going to bother
21 you, because bone is not very electrically
22 conductive. And ribs are somewhat electrically
23 conductive, but the muscle in between the ribs is
24 the most electrically conductive. So in our
25 opinion this blue striped area is the most
26 dangerous area, that is, right over the heart,
27 between the ribs - right over the heart, between
28 the ribs - and then other measurements indicate
29 where the minimal distance from the skin to the
30 heart is.

31 Now, that's not to say that there aren't
32 other possibilities. If you reach down under your
33 sternum, you have a lot of soft tissue there and
34 you could push real hard right in here and get
35 close to the heart. And the heart isn't
36 necessarily always as shown. This is just one
37 example here. So it's possible that if you pushed
38 in the bottom here, you could get close to the
39 heart, but we've shown it here as just this blue
40 striped area is the most dangerous.

41 Okay. Next is slide 17.

42 So now we're getting closer to estimating the
43 probability, and we use data from the dart-to-
44 heart distance from pigs, we've been through that.
45 We've got the erect human skin-to-heart distance
46 from echocardiography; the dart landing
47 distribution from police reports. And then we had

1 a computer model, at this point we had to pull
2 experimental data into a computer model that we
3 made, and then we estimated the current density at
4 various distances for ventricular fibrillation.

5 Let's go to the next slide 18.

6 So we've already come up with the probability
7 of one square centimetre of the front chest being
8 a problem here, and then we had to get how many
9 square centimetres were involved here, and then we
10 added them all up to get the final result.

11 So the next slide 19 is just this
12 illustration of the computer model that we made.
13 On the very left side you see a rib that runs over
14 to the right side, and another rib that goes over
15 there and dead centre in the middle of the box is
16 a nine-millimetre dart, and then we divided this
17 all up and made an electric computer model we'll
18 see shortly.

19 And the next slide 20.

20 So here's a side view. On the very left in
21 the middle you see the dart coming in, it's white,
22 and you can see two ribs above and below that, and
23 you can see all these little tiny elements which
24 is why this is called a finite element model,
25 there's a lot of little elements. And you can see
26 that the elements are more congested right at the
27 tip of the dart where most everything is
28 happening, and a little more sparse as you get
29 farther away.

30 Next slide, 21, illustrates some results.

31 Going from zero at the top, the dart comes down
32 nine millimetres and you can see that the number
33 there, 62003 is a big number, which means that
34 there's a lot of current density there, but as you
35 get farther away it drops down to 1000 and 700,
36 and 500. So there is less electric current as you
37 get farther away from the dart, and you might
38 imagine that. It's sort of like taking a garden
39 hose and sticking it into a bucket, through a hole
40 in the side, where the hose first bursts out
41 you're going to have a lot of flow, a lot of
42 velocity, but as you get farther away it spreads
43 out and diffuses, and electricity acts exactly the
44 same way.

45 So using these numbers, let's go to the next
46 slide, the current density, which I just talked
47 about, decreases with the distance away from the

1 dart. It starts with a very high number on the
2 top left and then it keeps dropping rather rapidly
3 as the millimetres get away from it down to some
4 lower number that's down in the order of a hundred
5 or so. So you've got to get close in order to
6 cause electrocution of the heart.

7 The next slide, 23, illustrates sort of
8 what's going on. At the bottom we see a dart in
9 here, and you can see how the current spreads out
10 as you go away from it. And the top indicates
11 that if the darts are close together, that the
12 current travels more near the surface. If you
13 spread the darts farther apart, the current dives
14 deeper and deeper. And so essentially what TASER
15 has done is to shoot darts that are far apart so
16 that the current goes deeper.

17 Let's go to the next slide 24.

18 This is the model again of the dart at the
19 bottom left, which comes in nine millimetres, and
20 these are all the current density numbers, high
21 near the dart, low as you get farther away from
22 it, and there's a rib up there in the centre
23 toward the left side, and we use these numbers in
24 order to calculate how dangerous it is.

25 The next slide, which is 25, is looking
26 straight down and right under the dart the numbers
27 are the biggest, and as you move off to the side,
28 either going up, left, right, or down, the numbers
29 get smaller. So we could calculate what the
30 electric intensity is as a function of distance
31 away from the dart.

32 The next slide 26.

33 If, for example, you're 25 millimetres below
34 the skin, and you intersect with the heart at that
35 point, why we can tell you what number would cause
36 ventricular fibrillation.

37 Let's look at 27.

38 Here's an actual heart model. If you look
39 dead centre, you can see the front of the heart
40 looking at you. If you move one millimetre back
41 to the number two, say, it's bigger, three is
42 bigger, four is bigger, so it's sort of like a
43 mountain. You're looking at the top of the
44 mountain, if you like, and we can calculate the
45 area of all of these slices of the heart.

46 Let's look at the next slide, 28.

47 This is a side view of what we're talking

1 about. On the very left edge is the skin, then
2 the dart, then the heart. So we can make a number
3 of measurements here to see what the electric
4 current intensity is as we get close to the heart.

5 Let's look at the next slide, 29.

6 This is the slices of the ventricle that we
7 have looked at already.

8 Let's look at number 30.

9 So we multiplied for each of these distances,
10 and we estimate that the probability of human
11 ventricular fibrillation is about one in a
12 thousand. Now, that's for our first study, which
13 was criticized. And we reran it with a blunt
14 probe and we were required to be closer. And now
15 we see that it's only six per million, which is a
16 very small number. Either of these numbers will
17 tell you that it's not very likely that the Taser
18 will electrocute the human heart, but it's
19 possible.

20 Let's look at the next slide, 31.

21 These are right here this might be a
22 dangerous area for the heart, and this might be a
23 dart location, say, out here, or over here. At
24 the top the black dot or the left black dot or the
25 right black dot, and then it's dangerous if you
26 get close enough to this red area in the middle.
27 So this was part of our calculation.

28 The next slide is 32.

29 Now, we're going to examine a different
30 question. Up till now I've talked about our work
31 in estimating the probability of electrocution of
32 the heart. Now I'm going to answer the question
33 how effective is the taser and how does it work,
34 is it supposed to work? We're going to ignore the
35 heart for a while. So how effective is the Taser?
36 Which muscles of the body are stimulated? Well,
37 we used a larger model. We used a whole torso in
38 this case.

39 Let's look at the next slide which would be
40 33, and this illustrates our torso model. There's
41 our heart, lungs, muscle, and you can see that we
42 have divided it into a finite element model again.
43 The computer does this automatically.

44 The next slide is 34 and this is a little
45 closer view of regions of interest.

46 The next slide is 35, and this shows that if
47 there's a dart at the top and the dart at the

1 bottom, how the electric current lines run between
2 these two darts, you can see that they've spread
3 out a little bit, and that's sort of in the centre
4 there. On the left edge there are numbers
5 associated with current densities that appear on
6 the surface of the skin.

7 The next slide is 36 and we see that this is
8 the cross-section. If you were cut right through
9 the body, here's on the left side you'd see your
10 left edge of your body and on the right you'd see
11 the right side of your body, and then front to
12 back you're not as thick that way. And the
13 striped area that you see here is the area of
14 nerve stimulation, that is, we can calculate which
15 nerves are stimulated and it's not a very big
16 area.

17 The next slide, 37, is farther down the body.
18 Then we see that almost all the cross-section of
19 the body is stimulated, including the spine.

20 The next slide, 38, farther down.
21 Practically the whole body -- well, the whole
22 body, I think, is stimulated here, including the
23 spine.

24 The next slide down is 39. Well, we're
25 getting a little down below the bottom dart here
26 and we're not stimulating the entire cross-section
27 anymore.

28 Well, if you stack these all up - let's look
29 at 40 - well, it's even less there.

30 And here's the 41, where we have stacked up
31 what I have just showed you. And you can see at
32 the top of this, the human body outline, that up
33 near the neck we don't stimulate very much. But
34 through the torso, about at the level of the
35 heart, farther down at the level of the waist, and
36 farther down as you're getting toward below the
37 belt, that you can see that in the centre part of
38 the torso the entire cross-section is stimulated.
39 That means that the spinal cord will be
40 stimulated, and all the nerves to the spinal cord
41 go down into the legs and they go up into the arm.
42 And if you've ever seen a video of someone who has
43 been hit by a taser, they just get stiff like a
44 board and then they fall over. And we've observed
45 this in our 40 or so pigs, that the pigs get very
46 stiff, and practically all the muscles in the body
47 are stimulated and it's very effective in

1 incapacitating someone for the five-second period
2 of the taser application.

3 Okay. Let's look at 42. This sort of
4 answers the question: Does it make any difference
5 how far the darts are apart? And as far as being
6 near the heart, and we can see that if on the
7 right edge they are 32 centimetres apart, they
8 have a certain effectiveness, but if they're only
9 two centimetres apart, they're a little less
10 effective, maybe half as effective, or something
11 like that. But the Taser used in the drive-stun
12 mode is more like, well, ten centimetres apart,
13 something like that. So the amount of electricity
14 that gets to the heart is roughly the same,
15 whether it's in the drive-stun mode, just a little
16 less, than it is if they are widely separated. So
17 we are curious to look at all these factors in
18 determining what's going on.

19 Let's look at slide 43.

20 Now, this is the very famous strength-
21 duration curve, that is, how much current do you
22 need on the left edge, versus the duration on the
23 bottom, and you can see that in order to effect
24 the same safety or efficacy, how well it works.
25 And you can see that the duration is long, that a
26 certain amount of current makes things go. And
27 this is widely used for power lines. You get
28 electrocuted by putting your finger in the socket.
29 It's a rather long pulse, so you're way out on the
30 right side here, whereas the Taser has a very
31 short pulse. So the duration in order to get the
32 same effectiveness is much higher. You have to
33 boost the current. So it's a high current, short
34 pulse operation. Then we have to use this
35 information in order to calculate what's going on.

36 Let's look at the next slide, 44.

37 Here's Taser pulses. That is an older M26,
38 it has a big pulse that lasts about nine
39 microseconds, that's very short. And then it goes
40 down, and then it bounces up and down a little bit
41 before it settles down. Whereas the newer X26 has
42 a current that runs up to about two, three
43 amperes, that's a lot of current. But it's all
44 done by the time you get out here, it's on the
45 order of 100 microseconds. That's also very
46 short. And so these waveforms that we see, we
47 cannot apply to this previous strength-duration

1 curve unless we make an assumption, because the
2 previous strength-duration curve was for
3 rectangular waves, and these are certainly not
4 rectangular. They go all over the place. So we
5 had to figure out what was going on there.

6 Let's look at the next slide, 45.

7 So here's an X26 waveform with current at the
8 top. You see that it goes up to about two
9 amperes, and then it decreases. And we created
10 what's known or well-known resistance capacitance
11 parallel circuit, which stimulates how current
12 behaves when it stimulates the heart. And this is
13 well-known to many people. And so we put this
14 waveform into this special circuit and asked the
15 question: How much voltage will go up? Well, it
16 hiccups a little bit here, and then finally goes
17 up to here, and then it starts leaking off and
18 becoming less. So the effective time is about 120
19 microseconds, which we can calculate and use in
20 our estimation of what's going on.

21 Let's look at 44.

22 This is we ran some tests with electric
23 current from the wall at 60 Hz, and we noticed
24 that these times are very different, on the order
25 of milliseconds. We did the same thing. Here's
26 the 60 Hz current going up at the top left, and
27 then the voltage into this RC circuit goes up and
28 a little bit later it hits some kind of peak, and
29 from that we can calculate what's going on there.
30 And from this we can use this current on the left
31 side, versus time on the bottom, for six different
32 pigs and come up with the strength-duration curve
33 from which we can get the time constant to
34 calculate the factors of resistance and capacitors
35 we should use in a model like this.

36 So let's go to the next slide, which is 48.

37 And these are our results, that the time constant
38 for ventricular fibrillation is about 3.6
39 milliseconds, and that's a little different from
40 what other people have found for excitation. But
41 you have to recall that ventricular fibrillation
42 is not the same thing as exciting the heart. You
43 can have a pulse that excites the heart and the
44 heart will beat. Well, cardiac pacemakers do that
45 all the time. But that's not the same as
46 ventricular fibrillation, which involves the
47 entire heart and not just one small site on the

1 heart. So to my knowledge this is the first time
2 that someone has done work that came up with this
3 time constant for ventricular fibrillation.

4 And I think that where we have tried to
5 develop, if you read near the bottom here, safety
6 standards for future devices like this. Currently
7 these electromuscular incapacitation devices -
8 they have many names, you use a name, there's a
9 different name - have no standards, and we are
10 proposing standards based on some of our work so
11 that future devices could be, well, at least as
12 safe as the current X26, if people feel that's
13 safe enough. Or there may be some other devices
14 that other companies might develop and currently
15 there's no standards to test them to, whereas most
16 electrical devices have standards. There are
17 international standards, for example, for electric
18 fences, which are very similar to Tasers. They
19 put out a big pulse and, really, you won't touch
20 that electric fence again.

21 Okay. So let's go onto the next slide, 49.

22 What about people talk about the blood
23 chemistry changes, and we have run a little work
24 in this line, which I will present now, but other
25 people have done more comprehensive work. That
26 is, there's no doubt that when muscles contract,
27 and it doesn't make any difference whether you are
28 doing a marathon or getting hit by a Taser, if the
29 muscle contracts, it will change the chemistry of
30 your body. It will change, it will make the body
31 become more acid. It will dump potassium into the
32 blood. Other things will change. And even as
33 there's the theoretical possibility that these
34 chemistry changes may cause death by a Taser, I
35 don't think anyone has ever shown that.

36 Nevertheless, these chemical changes will
37 occur. I know of case where people have run
38 marathons and died, and it's because of the
39 chemical changes that occur in their body that
40 they can't sweep these chemicals out of the body
41 as fast as they could.

42 Nevertheless, we asked the question: If you
43 have a certain distance, 17 millimetres in our
44 case, and you start Tasering more than once, is
45 that more dangerous? Well, here's some results.
46 This pig weighs about what I do. Well, after 27
47 Taserings, that is, you turn it on for five

1 seconds, you rest for five seconds, you turn it on
2 for five seconds, you rest for five seconds,
3 ventricular fibrillation occurred; in this pig 19
4 times.

5 So there's no doubt that there's something
6 going on here. Why didn't the pig die after the
7 first Taserings? That's not enough. Something is
8 accumulating here. And one could speculate that
9 it's chemical changes that then make it more
10 susceptible to subsequent electrical discharges,
11 but that's not been proven. These are just some
12 results.

13 Then we went 30 times so we gave up. There
14 we go 22 times and we got ventricular
15 fibrillation. Here we went 30, gave up. First
16 time around here. So here's a case that we were
17 17 millimetres dart-to-heart, and on the very
18 first time we got ventricular fibrillation. Then
19 we defibrillate the pig. Then we went 30 times
20 and we weren't able to do it again. I mean, it's
21 hard to figure out what's going on here from the
22 limited data that we have here. Well, here's
23 another pig, first time around, ventricular
24 fibrillation from this distance, 17 millimetres.
25 Then we defibrillate. But recognize that when you
26 defibrillate, you may be damaging the heart muscle
27 and changing it a little bit. So you can't really
28 trust the second test around as well as you can
29 the first test. So one could speculate from this
30 that multiple Taserings are more dangerous than a
31 single Taserings.

32 Let's look at the next slide, 51.

33 Well, here's the time in minutes that we're
34 doing all of this multiple Taserings. This is the
35 pH, that's acidity. That pH goes down, that means
36 it becomes more acid. The heart rate goes up.
37 The pig doesn't like what's going on. The oxygen
38 goes down, carbon dioxide goes up. These are all
39 expected, and there's a number of numbers here. I
40 don't know what to make of them myself.

41 So the arterial blood electrolytes get
42 changed, the potassium goes up, people know that's
43 bad for you. And other things change.

44 Our next slide 53, the muscle response
45 decreased. We just noticed that. I mean, if you
46 start and you do 15 Taserings, all of a sudden
47 your pig is not getting so stiff any more. That

1 is, think of fatigue. You know, you run up a
2 mountain, after a while you just can't go anymore,
3 and I think the same kind of thing is happening
4 here.

5 54, we had lots of limitations in our test,
6 which have been pointed out to us by critics. We
7 assumed all the firings were perpendicular. Some
8 of them were a little off, there's no doubt that
9 some of them don't even penetrate at all. We
10 assumed they were all on the bare skin. If
11 clothing's present, they wouldn't penetrate as
12 far. Isoflurane anaesthesia, which we used, may
13 alter the ventricular fibrillation. The human may
14 be different from the pig. So these are
15 limitations.

16 Here's some more limitations. Our model used
17 a centre dart and the results may be different
18 with two darts instead of one. I think one is
19 enough. If one dart is close to your heart, that
20 will do it and it doesn't make any difference
21 whether the other dart is on your waist or on your
22 toe.

23 People have criticized that the electric
24 conductivities of muscle are more in one direction
25 than other, but Taser at high frequencies, muscles
26 have a small not the same electrical conductivity
27 in different directions.

28 The next slide, 56.

29 So what are the conclusions from all this?
30 Well, our estimate of the probability using only
31 the X26, using data from the pig study, shows that
32 the Taser ventricular fibrillation probability is
33 not zero. It's very small. The numbers are here,
34 you know, few per million or something based on
35 our study.

36 Another thing, stimulation, that
37 incapacitation can happen within 19 centimetres of
38 dart tips of measured distance.

39 And then we have sort of a general conclusion
40 that for direct electrocution of the heart, the
41 dart landing should be in a small frontal region
42 over the heart. You're not going to get
43 electrocuted if it hits you on the leg. And if
44 the heart's electrocuted, why it stops beating and
45 you have cardiac arrest, and your brain lacks
46 oxygen after, say, 20 seconds or something, and
47 you'll collapse. If that doesn't happen, the

1 heart wasn't electrocuted.

2 So if some coroner is going to describe
3 Tasers as the contributing cause of death, then he
4 should find out where the dart lands. If it lands
5 over the heart or near it, and a person collapses
6 within 20 seconds or so, that's a strong
7 implication, more likely than not, really, that
8 the Taser electrocuted the heart. And the result
9 certainly suggests that all Taser training should
10 be done on the back, because the back is a long
11 way from the heart and I think the darts on the
12 back are perfectly safe.

13 So these are a number of people who have
14 worked with me, and you'll notice that the project
15 was supported by the U.S. National Institute of
16 Justice and this is not their official position.

17 Now, I have a few more slides showing other
18 people's work, not our work. Up till now I've
19 shown our work. So we can take a look at those.

20 58, Lakkireddy, data, there's the pig, and he
21 shows that if you have a dart near the heart, it's
22 more dangerous than far away from the heart. But
23 these darts were all on the surface of the pig, on
24 the front or on the back. And then he shows that
25 if you're high on cocaine, for example, that
26 you're less likely to capture the myocardium.
27 Now, he never got ventricular fibrillation, but he
28 had the super Taser where he could jack up the
29 current compared to a regular Taser, and then come
30 up with results in his work.

31 Dennis showed electrocardiograms from an
32 animal taken before and after Taser discharge and
33 showed ventricular tachycardia, that's not life
34 threatening like ventricular fibrillation, but
35 then about three minutes later the tachycardia
36 changed into ventricular fibrillation. And so you
37 see that at the top when the pig is perfectly
38 healthy, you have this nice regular beat. And (b)
39 that's in the middle, you can see that the heart's
40 beating much faster than normal, tachycardia, and
41 (c) you see the sort of randomized and not regular
42 beating three minutes later. So this was a case
43 when the pig could be put into ventricular
44 fibrillation, and from darts in the skin, much
45 farther away than our work. But he had long
46 duration Taser in order to produce this.

47 Jauchem did a lot of work on muscle

John G. Webster (Technical presenter)
Presentation
Questions by Mr. McGowan (cont'd)

1 contraction. So you could see that he got force
2 measuring from the leg and things like that, so
3 that was interesting. He also showed that the pH
4 changed. Let's look at this. Here's pH, 7.4,
5 that's good. Below 7 is normally lethal. I mean,
6 if your pH gets below 7, you should really watch
7 out. So this is right after 18 Taser exposures.
8 Nevertheless, the pig recovered. Thirty minutes
9 later you can see that he's clearing the acid out.
10 The pH is going up. At 60 minutes later the pH is
11 heading back towards normal. Okay, that's the
12 first session. He repeated it, there's a second
13 session, same kind of thing. So there's no doubt
14 that multiple Taserings from these data indicate
15 that your pH goes way down, which is certainly
16 dangerous, and may contribute to the electrical
17 excitability of the heart.

18 But at any rate, let's go onto the next
19 slide, 62.

20 He also has the heart rate changing, oxygen
21 changes, down here, the oxygen level is 90 at the
22 bottom and then it goes down to about 60. I mean,
23 things are really happening after 18 Taser
24 exposures. So there's no doubt that multiple
25 Taserings affects the animal greatly and it could
26 result in ventricular fibrillation.

27 Well, that's my last slide, and I would be
28 glad to answer any questions you might have that
29 are related to this, or related to anything.

30 THE COMMISSIONER: All right. Thank you very much, Dr.
31 Webster. Counsel, have you any questions at all?

32 MR. MCGOWAN: I will have a few questions, Mr.
33 Commissioner. I wonder if it might be appropriate
34 to stand down for a few minutes and just see if
35 anybody else has any questions they'd like
36 discussed.

37 THE COMMISSIONER: Dr. Webster, we're going to have a
38 break to collect our thoughts. Thank you very
39 much. Maybe five minutes, what time is it? I
40 think maybe just ten minutes.

41 MR. MCGOWAN: Yes.

42 THE COMMISSIONER: All right, a ten-minute break.

43
44 (PRESENTER STOOD DOWN)

45
46 (PROCEEDINGS ADJOURNED FOR AFTERNOON RECESS)
47 (PROCEEDINGS RECONVENED)

John G. Webster (Technical presenter)
Questions by Mr. McGowan (cont'd)

1 JOHN G. WEBSTER, a Technical
2 presenter, resumed.
3

4 QUESTIONS BY MR. MCGOWAN, continuing:
5

6 Q Just about done here. I just have a very few
7 brief questions.

8 The Tasers, and this may be a little bit
9 outside the area of your research, but the Tasers
10 that you used during our research, did you or your
11 team test the electrical output of the Tasers to
12 see if it corresponded with the manufacturer's
13 specifications?

14 A Well, yes, we checked some of our publications
15 where we have waveforms in our publications, and
16 these are similar to those that have been
17 published previously by other publications. Most
18 of them are in the same ballpark. There may be a
19 slight difference.

20 Q Okay. And did you test only the Tasers that you
21 were using, or did you test a broad cross-section
22 of the weapons or devices?

23 A We just tested the Tasers that we used.

24 Q Are you aware of any research which has been
25 conducted of that type whereby a large number of
26 Tasers have been tested to see if they correspond
27 with the purported output?

28 A No, I don't know of any such research.

29 Q Would that be a difficult task to accomplish?

30 A Oh, it would be easy. I mean, you know, in an
31 electrical engineering laboratory similar to what
32 we have, you take the Taser and you fire it
33 through a typical resistance of the human body,
34 which might be 300 ohms, or something like that,
35 and then you measure the voltage output that you
36 get, and because this voltage output can be high,
37 sometimes you need to prepare a string of
38 resistors to make the voltage small enough to
39 measure on an oscilloscope, and the oscilloscope
40 remembers what you do and you can plot it out on a
41 piece of paper and make measurements, and you can
42 import it into a program that measures the charge
43 that's delivered, almost anything you describe
44 along these lines we have done already. And if
45 you had a hundred of them in a row, you know, it
46 would probably take you, I don't know, ten minutes
47 each to run through, make measurements, process

- 1 it.
- 2 Q Okay.
- 3 A It's not a large task.
- 4 Q Thank you, Dr. Webster. Now, we heard this
- 5 morning that the reason pigs are used in research
- 6 is because they appear to be reasonable and
- 7 perhaps the closest model available for conducting
- 8 this type of research. Do you agree with that?
- 9 A I think that's true. There are other reasons. I
- 10 would say several decades ago many people used
- 11 dogs in cardiac research. But because dogs are
- 12 used as human pets, why, the animal rights people
- 13 protest more loudly than they do for farm animals.
- 14 Q Okay. With the pigs you used, as far as you know,
- 15 did any of them have pre-existing heart conditions
- 16 or pathology?
- 17 A I think they were entirely normal farm animals.
- 18 Q Okay. Healthy as far as you know?
- 19 A Yes.
- 20 Q Okay. Was there any monitoring, long-term
- 21 monitoring of the animals or the subjects after
- 22 the conclusion of your experiment?
- 23 A No, all our experiments, the animals died at the
- 24 end.
- 25 Q Okay. Now, I wanted to ask you, Dr. Webster,
- 26 about something I think I heard you say during
- 27 your presentation. Did I understand you to say
- 28 that the amount of electricity that would be
- 29 conducted to the heart would be the same in the
- 30 drive-stun mode or the probe mode?
- 31 A Yes. In one of my slides we sort of said, well,
- 32 if the darts are, say, 10 centimetres apart, as
- 33 they are, let's say, I guess five centimetres
- 34 apart - the darts are two inches apart, which is
- 35 about five centimetres - that the amount of
- 36 electricity that gets to the heart is about the
- 37 same as if these electrodes were widely separated.
- 38 But this is only true if the darts do not
- 39 penetrate the skin. In the drive-stun mode, there
- 40 are no darts.
- 41 Q Do you have a view as to which of the two modes is
- 42 more dangerous?
- 43 A Well, certainly if you have a dart, the tip of the
- 44 dart is nine millimetres deeper than if you don't
- 45 have a dart. So the dart is more dangerous.
- 46 Q Okay, thank you, Dr. Webster. With respect to the
- 47 dart placement in what I think you were referring

1 to as the more dangerous zone, does it matter
2 which of the two darts on the Taser falls within
3 that zone?

4 A No, they're both the same.

5 Q Does that dangerous zone, based on your knowledge,
6 expand with multiple Taserings?

7 A Well, we've seen that with multiple Taserings
8 there are chemical changes in the body. And we've
9 also seen that multiple Taserings, you can go into
10 ventricular fibrillation, whereas you didn't the
11 first time around. So in my mind there's no doubt
12 that multiple Taserings is more dangerous than
13 single Taserings.

14 Q Okay. And Dr. Webster, one of the conclusions you
15 came to at the end of your presentation, based on
16 your research, I think I understood, was that to
17 conclude a Taser had caused direct electrocution
18 of the heart, one would have to find dart
19 placement within the range you identify and a loss
20 of consciousness closely following the application
21 of the Taser. Did I understand that?

22 A Well, that's close. I mean, certainly, I have
23 said that without giving numbers that you need to
24 be close to the heart and that the person has to
25 collapse and soon. Okay? But I wouldn't say that
26 our numbers are the last word, because there have
27 been other numbers produced by other researchers,
28 Nanthakumar, for example, in which ventricular
29 fibrillation was induced from a dart on the skin.
30 We were not able to do that except in the one case
31 I noted.

32 Q Okay. We heard something of the research by
33 Nanthakumar and Walter and Dennis this morning,
34 and I think you made reference to one of the
35 studies by Dennis where the ventricular
36 fibrillation appears to have started three minutes
37 after. How does that mesh with your conclusion or
38 your research, or are you able to say?

39 A Well, during our research, application of the
40 Taser in many cases caused ventricular
41 tachycardia, a high rate of beating, but not
42 abnormal rhythm, and in some cases that resolved
43 back to normal, and in other cases it resolved to
44 ventricular fibrillation, that is, it could go
45 either way. And so it doesn't surprise me, the
46 question you asked, basically can you get
47 ventricular fibrillation three minutes after the

John G. Webster (Technical presenter)
Questions by Mr. McGowan (cont'd)

- 1 application of the Taser? I would say the Taser
2 might have caused ventricular tachycardia, which
3 then resolved into ventricular fibrillation some
4 minutes later.
- 5 Q Okay. Now, through your research or your review
6 of the literature, are you able to assist the
7 Commissioner at all with the effect epinephrine
8 might have on a subject being Tasered?
- 9 A Yes, well, I think other people have done those
10 studies and so you'd have to look to those. We
11 never applied epinephrine.
- 12 Q Are you familiar with that research?
- 13 A Yes.
- 14 Q And what conclusions can you draw from your review
15 of it?
- 16 A Well, just that epinephrine seems to make things
17 more excitable, if I could use that word, and more
18 likely that the Taser would cause ventricular
19 fibrillation than without the epinephrine.
- 20 Q I'm sorry, I am having a little trouble hearing
21 your last answer. Maybe your audio is turned
22 down.
- 23 A Okay. Is that better?
- 24 Q That's better.
- 25 A Okay. Well, epinephrine seems to cause
26 excitation, if I could use that word, and seems to
27 promote the excitability and cause ventricular
28 fibrillation where it might not occur otherwise.
- 29 Q And what is epinephrine, Dr. Webster?
- 30 A Well, I think if someone came running at you with
31 a gun, why, your body would normally dump
32 epinephrine into your blood so you could run
33 rapidly, and it gets you excited, makes the heart
34 go faster, so it's a natural drug that can be
35 applied in order to speed up your heart, if I can
36 use that word.
- 37 MR. MCGOWAN: Thank you, Dr. Webster. Those are the
38 questions I have, Mr. Commissioner.
- 39 THE COMMISSIONER: Dr. Webster, thank you very much for
40 making this time available for us.
- 41 A You're welcome.
- 42 THE COMMISSIONER: You've certainly added significantly
43 to the understanding of these problems. Thank you
44 so much.
- 45 A You're welcome.
- 46
47 (PRESENTER EXCUSED)

1 THE COMMISSIONER: That concludes today's matters.
2 Counsel, I think we are ready to go tomorrow at
3 10:00?

4 MR. VERTLIEB: 19:00 a.m., Mr. Commissioner.

5 THE COMMISSIONER: All right. Adjourn until tomorrow
6 at 10:00.

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8 (PROCEEDINGS ADJOURNED TO MAY 6, 2008 AT
9 10:00 A.M.)

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