VEHICLE AND SURVIVAL FACTORS ATTACHMENT 8 – INTERVIEW OF TESLA ENGINEERS

Mountain View, CA

HWY18FH011

(31 pages)

UNITED STATES OF AMERICA

NATIONAL TRANSPORTATION SAFETY BOARD

```
* * * * * * * * * * * * * * * * * * *
Investigation of:                    *
                                     *
TESLA ELECTRIC PASSENGER VEHICLE     *
CRASH SANTA CLARA COUNTY, CALIFORNIA * Accident No.:  HWY18FH011
MARCH 23, 2018                       *
                                     *
* * * * * * * * * * * * * * * * * * *
```

Interview of: CHRISTIAAN KHURANA and
GEOFF CUTLER

Wednesday,
March 28, 2018

APPEARANCES:

THOMAS BARTH, Ph.D., Accident Investigator
National Transportation Safety Board

AL PRESCOTT, Associate General Counsel
and Director of Regulatory Affairs
Tesla, Inc.

SCOTT KOHN
Tesla, Inc.

I N D E X

I N T E R V I E W

DR. BARTH: Okay. This is Tom Barth of the NTSB. I'm at Tesla, in Palo Alto, California. It is March 28th, 2018. I am interviewing engineers from Tesla.

Can you state your name?

MR. KHURANA: My name is Christiaan Khurana. I work on the Battery Safety Engineering Team here at Tesla in Palo Alto.

DR. BARTH: And could you spell your last name?

MR. KHURANA: K-h-u-r-a-n-a. And my first name has two As at the end, so C-h-r-i-s-t-i-a-a-n.

DR. BARTH: Okay. And the other one is?

MR. CUTLER: My name is Geoff Cutler. I work with battery safety testing as well. Last name is spelled C-u-t-l-e-r. First name is G-e-o-f-f, not to be confused with the other Jeff.

DR. BARTH: Okay. And then also in the room are representatives from Tesla. They are:

MR. PRESCOTT: Al Prescott, P-r-e-s-c-o-t-t-.

MR. KOHN: Scott Kohn. Scott, S-c-o-t-t, Kohn, K-o-h-n.

DR. BARTH: Okay. So what I would like to do now is just ask for the engineers to -- you know, we're in the group together, so you can maybe have one of you start off, and kind of run through your story, and then the other one do theirs. And then afterwards, if we need, we can clarify, crosstalk between the two of you. Okay, so whoever would like to start, state your name and then go ahead and start.

INTERVIEW OF CHRISTIAAN KHURANA AND GEOFF CUTLER

MR. KHURANA: This is Christiaan. I'll be starting with the timeline of the incident.

So at around 9:30, the incident, from what I know, was reported to CHP. That's when the official SigAlert went out. I first heard about the incident when Frederick called me from Service Engineering, saying that it was important and that we needed to get on the phone with the fire department.

And around, at about 11 a.m., I spoke to Zack Bond, the fire department chief battalion, and the battalion chief for the Mountain View Fire Department. It was a very brief phone conversation. I introduced myself, told him that we were on our way to the scene ASAP, and we talked about directions and how to get there.

DR. BARTH: Can I ask a quick question? What's a "siga alert"?

MR. KHURANA: I just heard about what I was --

MR. CUTLER: SigAlert, S-i-g.

MR. KHURANA: S-i -- yes.

MR. CUTLER: It's like a California traffic alert.

DR. BARTH: And you get that from?

MR. KHURANA: I read on the media. That 9:30 that I'm stating is from the media online.

UNIDENTIFIED SPEAKER: The sheriff's department, publishes this.

1 DR. BARTH: Okay. So the SigAlert was a media alert that
2 you --
3 MR. KHURANA: Yes.
4 DR. BARTH: -- became aware of at your desk?
5 MR. KHURANA: Oh no. I had not -- I did not see the
6 SigAlert. I first became aware of the incident at 10:55 when I
7 spoke to Frederick, who's in Service Engineering at Tesla.
8 However, at 9 -- I just put the 9:30 timestamp on there to give
9 perspective as to when this first began, but I did not know about
10 it at 9:30.
11 DR. BARTH: Okay.
12 MR. KHURANA: And so Frederick, he informed me that the fire
13 department was unsure about how to -- if tow truck companies could
14 approach the vehicle and handle it. He had also sent me some
15 photos of what the car had looked like.
16 And so when we left Tesla at around 11:15, 11:20, we decided
17 we needed to stop by Home Depot to grab some bins. Now these bins
18 were going to be used to contain any hazardous exposed modules
19 that we -- that were at the scene.
20 So we stopped by Home Depot, close to the 101, and on the way
21 there, the fire department -- as I was in touch with Zack back and
22 forth about directions, and he had also mentioned that he was
23 hearing popping sounds as well. And I told him that this could
24 mean that there is a risk of reignition and to be prepared for
25 something like that to occur.

1 So we arrived on site at around 12:20 or so. And we -- the
2 first thing we did was we checked in with CHP, and Zack with the
3 fire department. We told them that we were going to go make
4 measurements on the vehicle and observe the situation at first.
5 And the first thing that we did Geoff measured the exposed
6 high voltage cables that were lying on the ground of the highway,
7 to ensure that there was no -- that they were not energized,
8 because that was the first hazard that was apparent to us, and we
9 measured no energy or voltage on those wires, meaning that the
10 contactors were most likely open, and --
11 DR. BARTH: Can you describe how that measurement is taken,
12 physically?
13 MR. KHURANA: Yes. The first thing you do is you take -- you
14 measure the voltage across the wires, and then you measure the
15 isolation of each wire to the chassis of the vehicle, to see that
16 it's --
17 DR. BARTH: And these wires are exposed wires from the
18 damage, or are they a specific connection point?
19 MR. KHURANA: They are exposed wires from the accident.
20 DR. BARTH: Okay.
21 MR. KHURANA: They run through some -- okay. Yeah. They're
22 coming from the rear -- from the battery, and powering the drive
23 unit.
24 DR. BARTH: Okay.
25 MR. KHURANA: So. And so we took those measurements to

ensure that there was no voltage across them, that couldn't pose a hazard. And then we saw that there was an exposed module, because the cover had been ripped open, of the battery pack. That exposed module had half -- most of the module had gone into thermal runaway, which means it had released its energy, however some of the cells had still -- still had energy in them, so -- that had not gone into thermal runaway.

So we measured the voltage on those cells to see what the state of charge was, to understand how much energy are we dealing with here. We measured the cell voltage at around 3.8 volts. And then we spoke to CHP and Zack Bond at the fire department again and advised that it was recommended that we take this exposed module and dunk it in a bin full of water, because it could potentially be, become unstable.

DR. BARTH: Okay. And then, and these are, the modules you're referring to are the 16 and 17, is that the right number, at the front?

MR. KHURANA: 16.

MR. CUTLER: 15 and 16, yes.

MR. KHURANA: Yeah.

DR. BARTH: 15 and 16, at the very front --

MR. CUTLER: Yeah.

DR. BARTH: -- of the module.

MR. CUTLER: That's called the stack curve.

MR. KHURANA: The front stack has Module 15 on the bottom and

16 on top. Module 16, we were able to remove that one. Module 15 was pinched in there pretty well, and had gone into thermal runaway completely, so we did not -- so there was no need to, I'd say, remove that module. The one, the Module 16 is what we removed and dunked inside a dunk tank of water.

DR. BARTH: Okay. And then what happened after that?

MR. KHURANA: Okay. So after that, while we were unbolting this module, to put it in this water bath, we were noticing some small arcing from the bus bar that goes to these modules, to the cover of the battery, which means that there is an isolation loss to the chassis of the vehicle and to the battery enclosure.

And so to understand how much voltage we're dealing with here, we measured the voltage from the bus bar to the chassis of the vehicle, and measured that at 25 to 50 volts, fluctuating. We measured it one time, it was 50, and measured it again, it was 25. And -- okay. Yeah. Then after -- that's -- then after that, we finished unbolting the module and dunked it.

DR. BARTH: Okay. And then -- and you can -- you're welcome to jump in, too.

MR. CUTLER: Okay, cool. I wasn't sure if we were one at a time or -- okay.

DR. BARTH: And just for the transcriber, you know, just say --

MR. CUTLER: You know, it's that --

DR. BARTH: This is now so-and-so talking. And --

1 MR. KHURANA: Okay. Yes.
2 MR. CUTLER: Yeah.
3 DR. BARTH: -- so you can either -- you can -- if you want to
4 finish out what you guys did on scene, or if you want to switch to
5 more detailed stuff that you had done, it's up to you.
6 MR. KHURANA: Would you like to comment on the 12:30 to 1
7 o'clock stuff?
8 MR. CUTLER: Yeah. Maybe I jump in here because this is kind
9 of a detailed area. This is Geoff Cutler. I was on the scene
10 with Christiaan.
11 So after doing the initial measurement on the exposed front
12 drive unit cables, we determined that there was no voltage or
13 electrical hazard presented by those. We went to the exposed
14 portion of the battery and noticed that there were some cells that
15 appeared to have not gone into runaway, but were not in a standard
16 physical formation.
17 I think one of the concerns about that particular situation
18 that led us to come to the conclusion that removing the module was
19 the best for the situation was, usually there's a structure that
20 holds it together. It was not there. Also exposed, so I thought
21 that that might be an area where we might see some flexing during
22 moving of the car.
23 So I figured that was kind of the, not necessarily that we
24 were going to see an incident there, but since we were on scene to
25 help mitigate, I decided to remove the exposed portion of cells

1 that appeared to be live.
2 And then again, while we were doing that, there was a
3 terminal with a bus bar still attached to the corner of the
4 module, and we noticed a little arcing. That's when we did a
5 measurement, and did see some fluctuation on that. Found it hard
6 to kind of speculate on why we were seeing a fluctuation, based on
7 the condition.
8 DR. BARTH: Okay.
9 MR. KHURANA: And that's what -- yeah.
10 DR. BARTH: Okay. So then you made the decision to -- so you
11 removed loose cells and put them in the tub of water?
12 MR. KHURANA: Yes.
13 DR. BARTH: You removed or attempted to remove the rest of
14 the grouped module of the top module?
15 MR. KHURANA: Yes.
16 MR. CUTLER: Yeah. And it was -- the center, you know, as
17 you can see in the picture, it was, the center's kind of burnt
18 out, and then it's kind of, the edges were still there. So it was
19 basically grabbing the ones, the live cells -- it was kind of some
20 chunks -- and putting that in the bucket of water.
21 DR. BARTH: And then the lower module was more difficult to
22 remove, so you left it there?
23 MR. KHURANA: There was --
24 MR. CUTLER: It was wedged, and it appeared that all the
25 cells had gone into runaway, on the lower.

1 MR. KHURANA: Which means they'd already released their
2 energy, but -- so.
3 DR. BARTH: Okay. So then after deciding that you were
4 finished with what you could take out of there and put into the
5 bucket of water, what happened next?
6 MR. CUTLER: So that was when we wanted to evaluate the
7 situation with the bus bar. We were getting some arcing. It had
8 stopped. We kind of saw where it was contacting the battery
9 cover. And at that point, I realized I had some spare high-
10 voltage gloves. And honestly, not totally sure whether this would
11 affect it, but wanted to try and insulate that bus bar as best as
12 possible, just to prevent any exposure, was also thinking about,
13 the car's going to be jostled a bit during towing and --
14 DR. BARTH: Right.
15 MR. CUTLER: -- transport.
16 MR. KHURANA: And the chains that they use could potentially,
17 you know, hit some of those exposed components.
18 DR. BARTH: Do you remember if the fire department had
19 located the high-voltage cut loop, and what the status of that
20 was?
21 MR. CUTLER: The cut loop was not present on the vehicle, due
22 to the accident. And I think that was one of the concerns they
23 expressed was they weren't sure, in this situation, how to
24 determine if that cut loop was severed, although the front of the
25 car being gone kind of would take that loop out, but.

1 DR. BARTH: Okay.
2 MR. KHURANA: Yeah.
3 DR. BARTH: And then -- okay. So then, what was the next --
4 what happened next?
5 MR. KHURANA: So after -- we tried to remove that bus bar,
6 but it, unfortunately, it was pinched into some components of the
7 battery enclosure, so we were unable to remove it. So as Geoff
8 stated, we covered it with high-voltage gloves, to try to insulate
9 it. And after that, we said that the car was ready to be put on
10 the tow truck.
11 DR. BARTH: Okay. And did -- who -- on the first responder
12 side, then you -- who did you tell that to, and who made the
13 decision to take the next steps?
14 MR. KHURANA: We mentioned that we were going to slowly load
15 the vehicle onto the tow truck. We talked to CHP and the fire
16 department, and talked to them about recommending that now we
17 could do this. I did express that moving the vehicle could still
18 pose a hazard, and that we needed to do it slowly and carefully,
19 and only -- and we helped direct where we should put the chains,
20 to drag the vehicle, and where -- what mounting points, if they
21 wanted to jack up the vehicle, they should be using, so they don't
22 hit the high-voltage battery, things like that.
23 DR. BARTH: Okay. And then, what happened after that?
24 MR. KHURANA: They --
25 MR. CUTLER: Slowly loaded it on to the truck. We used some

wood skids to kind of help reduce the impact to the battery on the front as it was being pulled out. That was one of the challenges, is it was, the lip of the battery was wanting to hit the front of the bed.

MR. KHURANA: And the front wheels weren't there anymore.

MR. CUTLER: So basically used some of, used 2 by 6s, or some planks, and kind of made a skid, got it up on the truck, secured it. We recommended, given the condition, that if it was possible, to have a fire truck follow the vehicle. We weren't sure if there was going to be reignition, but given the instability, it was a possibility.

Also, it sounded like the car was going -- I think it was about 20 miles to the tow yard, 15, 20, so it's quite a distance as well. That's why I thought maybe a tow -- or a fire truck would be --

DR. BARTH: And when they loaded it on to the tow truck, did you notice any smoking or popping or any activity of the battery?

MR. CUTLER: A couple --

MR. KHURANA: So do you want to mention -- okay. We did not hear anything on the tow truck, or while we were loading it to the tow truck, but I'd like to back up to before we decided to load the car. We were hearing, while we were handling the module and working with the bus bar, insulating it, et cetera, we had heard some popping sounds.

DR. BARTH: Okay.

1 MR. KHURANA: So -- and those could indicate battery vents
2 that -- you know, it could indicate there was some energy still
3 present and, you know.
4 DR. BARTH: And so was that a part of your decision to not
5 further attempt to remove the lower module?
6 MR. KHURANA: Exact -- or to not remove the bus bar. We were
7 not trying to remove the bottom module because it had already
8 fully gone into runaway and released its energy, but we were
9 trying to remove that pinched bus bar that was sort of hanging
10 out. And since we couldn't remove it, that's when we decided to
11 insulate it with high-voltage gloves.
12 DR. BARTH: Okay. I understand.
13 MR. KHURANA: Cool.
14 DR. BARTH: And so then they loaded it onto the tow truck?
15 MR. KHURANA: Yes.
16 DR. BARTH: And then what happened after that?
17 MR. KHURANA: We listened closely. We told them to stop a
18 few times as they were dragging it onto the tow truck, to listen,
19 to hear if we heard any signs of instabilities, et cetera. And
20 eventually it was loaded onto the tow truck, and we asked for
21 the -- we recommended the escort, the fire truck escort, and then
22 we were on the road.
23 DR. BARTH: Okay. So then you guys cleared the scene after
24 that?
25 MR. KHURANA: Yes.

1 MR. CUTLER: We followed the --
2 MR. KHURANA: We followed, but we went --
3 MR. CUTLER: -- kind of an ensemble up to the tow yard. So we
4 followed the -- there's a tow truck and -- actually, there's three
5 tow trucks and the fire engine. So we let the fire engine get in
6 behind the car.
7 DR. BARTH: Okay. Was it -- it was on a flatbed tow truck?
8 MR. KHURANA: It was on a flat -- yes.
9 MR. CUTLER: It was, yeah.
10 MR. KHURANA: Yes.
11 DR. BARTH: I have a question about the -- when you said that
12 you measured the 25 to 50 volts, fluctuating on, at the, between
13 the chassis and the -- that was between the chassis and the bus
14 bar?
15 MR. KHURANA: That bus bar. Yes, sir.
16 DR. BARTH: And how does that -- because that bus bar could
17 be -- well, so you -- it could be very high voltage, right?
18 What's the safe procedure -- like, did -- so you basically used
19 high-voltage gloves to do that? And how do you --
20 MR. KHURANA: Yes.
21 MR. CUTLER: Yeah. And so that's something, actually I
22 wanted to preface in the beginning was, first thing on the scene
23 is, you know, make sure we have our PPE.
24 MR. KHURANA: PPE, yeah.
25 MR. CUTLER: So gloves, glasses.

1 MR. KHURANA: Any measurements -- before touching this
2 vehicle, high-voltage gloves.
3 MR. CUTLER: Yeah. So all measurements are made, even the
4 cell voltage, which is only, you know, 3.8, we're doing all of
5 that with high-voltage gloves, with the leather protectors, given
6 the, kind of, exposed metal that we've got around us.
7 DR. BARTH: And had there been -- so that what's the
8 potential voltage that that bus bar could be at?
9 MR. KHURANA: It could --
10 MR. CUTLER: In a normal operating pack, if everything is
11 okay, that to-chassis should have zero.
12 DR. BARTH: Should have zero, if it's --
13 MR. CUTLER: Should have zero.
14 MR. KHURANA: Should be isolated.
15 MR. CUTLER: Yes.
16 DR. BARTH: And so is that -- but if it -- in a damaged
17 vehicle, if it was, if there was a high voltage there, would it
18 have fried the multimeter, or like what was the --
19 MR. CUTLER: No, no. Yeah. So if you have a category, I
20 think it's a 3 or a 4, 600-volt DC rated meter. So we're not
21 going to see more than --
22 DR. BARTH: Got it.
23 MR. CUTLER: -- 600 volts, if our source is --
24 MR. KHURANA: Yes. Battery pack is rated at 400, so --
25 DR. BARTH: Understood. Yeah.

1 MR. CUTLER: And then, so we have a meter that's actually a
2 combination that takes voltage, it also measures the insulation.
3 So we can detect, you know, if there's say a nick in a wire
4 insulation and it's hitting the chassis, we can basically do a
5 measurement on that. It's a pretty common --
6 DR. BARTH: Okay.
7 MR. CUTLER: -- meter.
8 MR. KHURANA: To test the continuity between that metal and
9 how well it's pressed against the chassis of the vehicle.
10 DR. BARTH: Okay. Did you see that the, were the
11 firefighters and others around the vehicle wearing PPE as well?
12 MR. CUTLER: Not, it did not appear they had electrical PPE.
13 MR. KHURANA: They did have gloves on, but not electrical
14 PPE. We don't -- yeah.
15 MR. CUTLER: Yeah. The gloves they were wearing appeared to
16 be thermal.
17 MR. KHURANA: Yes.
18 MR. CUTLER: It's that, I'm not sure if there is maybe, maybe
19 there's a layer inside of there.
20 DR. BARTH: Okay.
21 MR. CUTLER: I'm not aware of that, but --
22 DR. BARTH: And are -- in this kind of instance, are -- due
23 to potential venting, are breathing apparatus or other, any of
24 that kind of PPE required?
25 MR. CUTLER: Depending on the -- by the time we'd gotten

there, there was no fumes. I'm not sure what had transpired before, but they did appear to have all their breathing apparatus on. If we were to go to an active burn, it probably would be advisable to have breathing apparatus on.

DR. BARTH: Right. And so when you guys got there, there had been -- did the fire department say, like when the fire got put out or -- I mean, don't conjecture on -- but if they told you specifically, oh the fire, we had the fire out at this time, otherwise, there was -- you didn't see any flames or anything like that?

MR. CUTLER: No. No smoke, and not even, not even like, vapor that would indicate that there was a lot of heat, and the water was kind of baking off at that point, so.

MR. KHURANA: I do want to mention that in our first responder guide, the vapors from a burning or heated battery, it mentions that there is potential hydrogen gas, carbon dioxide, carbon monoxide and soot, et cetera. So when putting out a fire, and if there is these fumes present, we -- a respirator would be recommended.

DR. BARTH: Right.

MR. CUTLER: Yeah.

DR. BARTH: Okay. Is there anything else that I didn't mention, or other things that you want to bring up from the incident?

MR. KHURANA: I can finish going through the time line.

1 DR. BARTH: Okay.
2 MR. KHURANA: Cool. So we followed the tow truck to the
3 yard. We slowly unloaded the car. And before unloading, we --
4 from our emergency response guide, we recommended that there be a
5 50-foot radius around the car, because of course there is still
6 that risk of reignition, and so we want an ample perimeter on the
7 car.
8 Unfortunately, despite our recommendation, there was not
9 enough room in this tow yard, and it needed to be in this tow yard
10 because the CHP needed to access it afterwards for the
11 investigation. I did mention to possibly consider having it
12 brought to Tesla's service center, but that was not approved.
13 And we stressed that 50-foot radius, but eventually we did
14 the -- they did the best they could, to stay away from appearingly
15 flammable components around the vehicle.
16 DR. BARTH: And when offloading it from the tow truck, there
17 was no visible or, you know, no popping or smoke or anything like
18 that?
19 MR. KHURANA: So after we had moved it, after we had unloaded
20 the vehicle, we did hear some more popping sounds coming from
21 underneath the seat of -- from underneath the right passenger seat
22 of the car. And so the fire department, they had stayed on site
23 for a while, but by the time we heard the pops, though, they had
24 already left. So we called them back, after hearing that.
25 MR. CUTLER: Yeah. This is Geoff. So after we unloaded the

1 vehicle, I'd say it was probably 15 to 20 minutes later --
2 MR. KHURANA: Yeah.
3 MR. CUTLER: -- that we heard three to four pops under the
4 passenger, front passenger seat.
5 MR. KHURANA: Yeah.
6 MR. CUTLER: And that's when we --
7 DR. BARTH: So you called back the fire department, to come
8 back out?
9 MR. KHURANA: The CHP.
10 MR. CUTLER: CHP did.
11 MR. KHURANA: The CHP did it.
12 MR. CUTLER: Yeah.
13 MR. KHURANA: Yeah.
14 MR. CUTLER: She heard the pops, and she immediately called.
15 We were still kind of looking to see --
16 MR. KHURANA: The officer that remained on scene there was
17 Stephanie Combs. I'll put her name down in the --
18 DR. BARTH: Stephanie, what was her last name?
19 MR. KHURANA: Stephanie Combs. Here.
20 DR. BARTH: Okay. That's spelled C-o-m-b-s?
21 MR. KHURANA: Yes, sir.
22 DR. BARTH: And then, so she called for the fire department
23 to come back out again. And so did they do that? And did you
24 guys stay there?
25 MR. KHURANA: Yes. They came out. They had the -- we asked

1 to use their thermal camera to look, point in the region where we
2 saw these vents, to see what kind of temperature that we were
3 seeing is there. Of course, you know --
4 MR. CUTLER: Christiaan, if I could, you just said, "saw
5 these vents." Is that what you meant to say?
6 MR. KHURANA: No, sorry. I meant, in the are where we had
7 heard the vents coming, we had not -- we did not see any physical
8 evidence of the venting, but it is where we heard it coming from.
9 Apologies.
10 DR. BARTH: Okay.
11 MR. KHURANA: So we used their thermal camera to point in the
12 area where we thought we had heard these vents. We were looking
13 for a rise in temperature, not necessarily like a very large heat
14 signature because there's of course a lot of soot and thermal mask
15 covering the top of where this, the vents might have occurred. So
16 we were just looking for a temperature rise, to see if there was
17 potential -- increasing in temperature could indicate, you know,
18 potential reignition.
19 DR. BARTH: Okay.
20 MR. KHURANA: And so we did not notice anything like that.
21 We did not notice a temperature rise from the thermal camera
22 itself.
23 DR. BARTH: Okay. And had that thermal camera been used --
24 that was only available after, at the tow yard? That thermal
25 camera was not on scene, was --

1 MR. CUTLER: We had an IR gun, but the thermal camera
2 definitely gave us a lot better kind of resolution. You know, the
3 one thing with the IR gun is as you kind of go out, it'll spread
4 your area. So the thermal was a lot, kind of, a real --
5 DR. BARTH: So on scene, you used the IR gun. And what did
6 that -- what was the basic conclusion from the IR gun? Was
7 that --
8 MR. CUTLER: We were -- I mean, we were still warm. I don't
9 remember the exact temps we were getting. I think -- and I think
10 the IR gun --
11 MR. KHURANA: Sixty --
12 MR. CUTLER: -- was not -- I wasn't totally confident in the
13 reading --
14 DR. BARTH: Okay.
15 MR. CUTLER: -- we were getting out of it. So we may have
16 had an equipment issue on that. But --
17 DR. BARTH: Okay. And then the, at the tow yard, with the
18 thermal camera -- so this thermal camera was brought in by who?
19 MR. KHURANA: It was the fire department's thermal camera.
20 DR. BARTH: Okay. And --
21 MR. CUTLER: Yeah.
22 DR. BARTH: And just to clarify, so they did not have that on
23 scene on the highway?
24 MR. KHURANA: They -- we were not using it, but they might
25 have had it in the fire truck.

1 DR. BARTH: Okay.
2 MR. CUTLER: But it wasn't used --
3 MR. KHURANA: But we did -- it was not used at the prior --
4 this was the first time we had used a thermal camera, imaging
5 camera to take a look at the, this vehicle.
6 DR. BARTH: Okay. And what was the conclusions from that?
7 Did it --
8 MR. CUTLER: We saw, like a stable temperature gradient. So
9 basically, we didn't see any areas where we saw a peak in
10 temperature.
11 MR. KHURANA: The temperature rising.
12 MR. CUTLER: I believe we were --
13 MR. KHURANA: Yeah.
14 MR. CUTLER: -- about 70 C, and we had a ambient of a little
15 over 60. Given what had happened earlier and the amount of
16 thermal mass, it seemed like a reasonable temperature to still be
17 present, you know, within that area, 60s.
18 DR. BARTH: And so when you say gradient, you mean like
19 higher at the front and dissipating as you go to the back of the
20 vehicle?
21 MR. KHURANA: Just --
22 MR. CUTLER: Maybe gradient isn't the right word. Basically,
23 the thermal image we saw was even. So we didn't see, like a
24 lot -- any variation, or any --
25 MR. KHURANA: No hot spots.

1 MR. CUTLER: -- spikes or hot spots. Yeah. Yeah.
2 MR. KHURANA: Yes.
3 MR. CUTLER: And I'd like to clarify. The camera that we
4 used at the tow yard was actually provided by the San Mateo Fire
5 Department.
6 MR. KHURANA: Yes, San Mateo.
7 MR. CUTLER: So there was a handoff between the Mountain View
8 and the San Mateo Fire Departments at the tow yard, so
9 jurisdiction transfer. And one of the members of the San Mateo
10 Fire Department had gone through our training about two years ago.
11 DR. BARTH: Okay.
12 MR. CUTLER: Was pretty aware of it, so very comfortable kind
13 of a understanding, the residual energy issues that we were
14 exploring and --
15 DR. BARTH: And so did the -- did any -- so when you guys
16 were involved with the battery, there was no water on the -- like
17 the fire department did not have to put any water or anything on
18 the battery?
19 MR. KHURANA: Not afterward. Not afterwards.
20 DR. BARTH: Okay.
21 MR. KHURANA: Not as a result of the vents we had heard.
22 There was -- throughout -- after arriving, after we arrived, there
23 was no more water added to the actual vehicle.
24 DR. BARTH: Okay. It was just the water in the tub, and
25 putting cells into the tub?

1 MR. KHURANA: Yes. That was it.
2 MR. CUTLER: Prior to our arrival, though, they had used --
3 MR. KHURANA: They had to use water, yeah. Right.
4 MR. CUTLER: Quite a bit. And with the battery being open --
5 MR. KHURANA: And that brings me --
6 MR. CUTLER: Chance was inside.
7 MR. KHURANA: -- brings me, it brings us to the next step, is
8 since we realized that there is water inside this battery because
9 of, you know, the water that was applied to put out the fire, we
10 decided to have a slight tilt on the vehicle towards the front of
11 the vehicle. Since, you know, water can be, is a conductive
12 fluid, we wanted to be at the area of the battery pack that had
13 already released its energy, not the rear of the battery which
14 probably hadn't fully, you know, gone into thermal runaway.
15 DR. BARTH: Okay.
16 MR. KHURANA: So we had biased the vehicle forward, and then
17 we noticed that there was now 180 volts to that bus bar.
18 DR. BARTH: Okay. Okay.
19 MR. CUTLER: And it -- the -- this is Geoff again. Going
20 back to measuring that bus bar voltage, we had not measured that
21 after we had arrived at the tow yard, so --
22 MR. KHURANA: Yes.
23 MR. CUTLER: -- it's hard to determine when we saw that shift
24 in voltage. It could have been fluid, it could have been
25 mechanical. It's hard to ascertain.

1 MR. KHURANA: It could have been when it was on the tow
2 truck. We --
3 DR. BARTH: Okay. I understand.
4 MR. KHURANA: Then after that, we did notice some wispy white
5 mist kind of coming from the bottom -- from the cover, from
6 underneath the cover of the vehicle. We -- the fire department
7 did return, as a result of that. We used the thermal camera
8 again, to see if we were looking at -- seeing a temperature rise,
9 et cetera. This wispy smoke was indicative of electrolysis of
10 just water vapor itself because of water in high voltage, and it
11 was not actual smoke from a cell going into thermal runaway, so.
12 DR. BARTH: Okay.
13 MR. KHURANA: We did not notice any gradients or anything
14 like that, or any -- we did not notice any heat, abnormal heat
15 signatures from the thermal imaging camera afterwards. And then
16 we --
17 DR. BARTH: And so the decision was that there was no further
18 cooling water application or anything required?
19 MR. KHURANA: No. Yes. Exactly. Exactly.
20 DR. BARTH: Okay.
21 MR. KHURANA: And then we covered the vehicle with a tarp,
22 because we recommended that we didn't want any more water to get
23 inside from possible rain that could happen that weekend, et
24 cetera. And then we, so we covered the vehicle with a tarp, and
25 put life caution tape around it to hold the tarp down.

1 Then we spoke to the towing company, and informed them of,
2 you know, potential reignition hazards, informed them, you know,
3 about the hazards of that exposed bus bar if they were to go and
4 move this -- or move this vehicle, et cetera. And then we left.
5 DR. BARTH: Okay. The fire department that came to the tow
6 yard, was that the -- which fire department was that? Do you
7 know?
8 MR. KHURANA: It was the San Mateo.
9 MR. CUTLER: It was the San Mateo. Yeah. Because the tow
10 yard is located in San Mateo.
11 MR. KHURANA: Yes.
12 DR. BARTH: Okay.
13 MR. KHURANA: I think the -- before it was San Mateo it
14 was -- on the highway, it was Mountain View.
15 MR. CUTLER: Mountain View.
16 MR. KHURANA: Right. Zack Bond, yeah.
17 DR. BARTH: Okay. Any other items that you want to add?
18 MR. KHURANA: It's pretty much.
19 MR. CUTLER: I think, we did -- one of our recommendations
20 was to have it towed to Tesla's service center.
21 MR. KHURANA: Yeah, as an option.
22 MR. CUTLER: We did kind of offer to help, you know, maybe
23 further de-energize, but also understood that this was kind of
24 part of a larger investigation, given the circumstances.
25 MR. KHURANA: Right.

MR. CUTLER: Basically, we wanted to offer to say, hey, this is kind of what we'd recommend, probably long-term, especially looking at de-energizing this more, but it's as stable as it's going to be.

DR. BARTH: Okay.

MR. CUTLER: (Indiscernible).

DR. BARTH: Do you have any questions for me?

All right. Do you -- does Al or Scott have anything to add?

MR. PRESCOTT: No.

MR. KOHN: No.

DR. BARTH: Okay. Okay. This is Tom Barth. I am concluding the interview. It's 30 minutes, 44 seconds.

(Whereupon, the interview was concluded.)

CERTIFICATE

This is to certify that the attached proceeding before the

NATIONAL TRANSPORTATION SAFETY BOARD

IN THE MATTER OF:	TESLA ELECTRIC PASSENGER VEHICLE CRASH SANTA CLARA COUNTY, CALIFORNIA MARCH 23, 2018 Interview of Christiaan Khurana and Geoff Cutler
ACCIDENT NO.:	HWY18FH011
PLACE:	Palo Alto, California
DATE:	March 28, 2018

was held according to the record, and that this is the original, complete, true and accurate transcript which has been transcribed to the best of my skill and ability.

_____
Pamela Jacobson
Transcriber