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Transcript of Jianzhong Jiao, Ph.D.

Date: August 2, 2023

Case: Volkswagen Group of America, Inc. -v- Spero (PTAB)

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1 UNITED STATES PATENT AND TRADEMARK OFFICE

2
3 BEFORE THE PATENT TRIAL AND APPEAL BOARD

4
5 VOLKSWAGEN GROUP OF AMERICA, INC.,

6 Petitioner,

7 v.

8 YECHEZKAL EVAN SPERO,

9 Patent Owner.

10
11 IPR2022-01586

12 U.S. Patent No. 11,208,029 B2

13
14
15 DEPOSITION OF JIANZHONG JIAO, PH.D.

16 Washington, DC

17 Wednesday, August, 2, 2023

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22 Reported by: Judith E. Bellinger, RPR, CRR

1 Deposition of JIANZHONG JIAO, PH.D. held at
2 the offices of:

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16 Pursuant to notice, before Judith E.
17 Bellinger, Registered Professional Reporter,
18 Certified Realtime Reporter, and Notary Public in
19 and for the District of Columbia.
20
21
22

A P P E A R A N C E S

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C O N T E N T S

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|--------------------------------------|------|
| EXAMINATION OF JIANZHONG JIAO, PH.D. | PAGE |
| By Mr. Turner | 6 |

E X H I B I T S

(Attached to the transcript)

| | |
|-----------------------|------|
| Jiao Exhibits: | PAGE |
| Exhibit 1 Declaration | 163 |

1 P R O C E E D I N G S

2 JIANZHONG JIAO, PH.D.,

3 being first duly sworn, was examined
4 and testified as follows:

5 EXAMINATION BY COUNSEL FOR THE PATENT

6 OWNER

7 BY MR. TURNER:

8 Q All right. Good morning, Dr. Jiao.

9 A Good morning.

10 Q Am I pronouncing your name correctly,
11 Jiao?

12 A Almost perfect.

13 Q Excellent. Good.

14 Do you understand you're here today for
15 a deposition on IPR number 2022-01586?

16 A Yes.

17 Q Okay. Have you been deposed before?

18 A Yes, I have.

19 Q About how many times?

20 A Approximately, 20ish.

21 Q So you're a pro.

22 Have you been deposed before for IPRs?

1 A No.

2 Q Okay. All right. So how did you
3 prepare for your deposition today?

4 A I first had a phone conversation with
5 counsel here; that was last week. And I came to
6 their office Monday, Tuesday, so we had reviewed
7 my declaration. And that's pretty much the
8 preparation for that time.

9 Q Okay. And who did you meet with,
10 anybody besides Ian?

11 A And Jason.

12 Q Okay. Anyone else outside of Sterne
13 Kessler?

14 A No.

15 Q And what documents did you review in
16 preparation for the deposition?

17 A We reviewed my declaration and the arts
18 referenced in my declaration, and the claims in
19 the '029 patent.

20 Q Okay. Did you review any documents
21 that are not cited in your declaration?

22 A Do you mean in preparation for my

1 deposition?

2 Q Correct.

3 A No.

4 Q Who drafted your declaration?

5 A We collaborated, like, drafted it
6 together, meaning my counsel and myself.

7 Q By your counsel, that's the gentlemen
8 in this room?

9 A Correct.

10 Q Okay. And, approximately, how much
11 time did you spend working on your declaration?

12 A 40ish hours.

13 Q Okay. And did you work with anyone,
14 outside of the attorneys in this room, on
15 preparing your declaration?

16 A No.

17 Q And what did you rely on in preparing
18 your declaration?

19 A I relied on the guidance from the
20 counsels regarding the legal standards, as well as
21 the arts that I reference in my declaration. And
22 I also did my own search for the prior arts. We

1 had overall discussions regarding what arts should
2 be referenced to the declaration.

3 Q Do you know if any of the prior art
4 references in your declaration were ones that you
5 found?

6 A At least a couple of them, yes.

7 Q Do you know which references those
8 were?

9 A I think the reference that related to a
10 conference PAL. It's a symposium piece. If I put
11 it in the declaration. I'm pretty sure at least
12 one, that was what I found.

13 Q Did you attend the PAL conference?

14 A I did twice, throughout all the series
15 of PAL conference.

16 Q So that's a recurring conference?
17 Annual conference?

18 A It's every other year until, I don't
19 know, before pandemic situation changed.

20 Q And what does "PAL" stand for?

21 A Progress in Automotive Lighting. I
22 think, since then, they changed to something else.

1 Back then, it was PAL, Progress in Automotive
2 Lighting.

3 Q All right. Have you worked with Sterne
4 Kessler before this declaration?

5 A No.

6 Q Have you worked with Volkswagen prior
7 to this declaration?

8 A No.

9 Q So even in your engineering experience,
10 you never worked with Volkswagen.

11 A Not directly. I may have a work
12 relationship with their supplier, not directly
13 with OEM.

14 Q Okay. Where did you go to college?

15 A I went to undergraduate school in
16 Beijing, China, and so is my master program, in
17 Beijing, China, which both are indicated in my CV.

18 Q Okay.

19 A Then I attended graduate school, first,
20 at RPI, Rensselaer Polytechnic Institute, in Troy,
21 New York. That was a physics degree program. I
22 didn't finish it, but I transferred to

1 Northwestern University in Evanston, Illinois,
2 that's where I finished my Ph.D. in electrical
3 engineering.

4 Q Okay. And when did you finish your
5 Ph.D. program?

6 A August 1989.

7 Q Okay. And you said your program was in
8 electrical engineering, correct?

9 A Correct.

10 Q Your Ph.D. program is.

11 All right. So after school, where did
12 you work?

13 A Right after my Ph.D. program finished,
14 I joined General Motors. At that time, their
15 lighting division called Inland Fisher Guide
16 division, IFG, that's GM internal lighting
17 division. I worked there four years.

18 Then I joined another lighting company
19 called North America Lighting, which is subsidiary
20 of Koito, which is a Japanese automotive lighting
21 company. I worked there for 14 years.

22 Q Okay. So what was the time frame that

1 you worked at GM, what years was it?

2 A '89 to '93.

3 Q Okay. When did you work at NAL?

4 A '93 to 2007.

5 Q Okay. What is NAL's business, or what
6 was their business at the time you were working
7 there? Did they provide products, services?

8 MR. FITZSIMMONS: Objection. Form.

9 A NAL is one of the automotive lighting
10 companies in United States. Its customer,
11 primarily, is OEM, and their product is a hundred
12 percent exterior lighting, automotive lighting.

13 Q What type of lighting does exterior
14 lighting include?

15 A Exterior lighting includes, loosely,
16 two groups of lighting, forward lighting or
17 road-illumination devices, and signal lighting,
18 including signal and marking devices. All these
19 is, clearly, we usually find everything mounted
20 exteriorly of the vehicle body is considered
21 exterior lighting.

22 Q Does that include any rearward

1 lighting, like brake lighting?

2 A It does.

3 Q Okay. Is that considered -- that would
4 be considered signal lighting?

5 A Correct.

6 Q Okay. So you mentioned NAL works for,
7 primarily, Japanese OEMs; is that correct?

8 Sorry. NAL primarily supplies products
9 to Japanese OEMs?

10 A If I recall the overall scope, I think
11 it's about half and half, or maybe more domestic
12 customers than Japanese customers.

13 Q So you were at NAL for quite a long
14 time.

15 What were your different positions at
16 NAL?

17 A I was always the same position, just
18 different title. I was in charge of the
19 engineering and technology of the company.

20 Q So that's a general manager position?

21 A I was promoted to general manager. I
22 was initially started as the manager.

1 Q So how many engineers did you have
2 reporting to you at NAL?

3 A Starting from day one, I was by myself.

4 Q Okay.

5 A The time I left, it was about 40ish.

6 Q Okay. How did you have the engineers
7 organized into teams?

8 A I organized my department based on
9 functionality. We have four grouping of
10 functionality.

11 Do I need to name all?

12 Q Yes, please.

13 A First is optical design group; the
14 second is electronic technology group; the third
15 one is engineering analysis and testing group; the
16 first [sic] one is standard regulation group.

17 Q So how did the different groups work
18 together?

19 MR. FITZSIMMONS: Objection to form.

20 A It was pretty cohesive, collaborative
21 work team.

22 Q So how did you develop design criteria

1 for the different products?

2 MR. FITZSIMMONS: Objection. Form.

3 A Usually, it's based on the technology
4 readiness, as well as customer, namely, OEM's
5 specifications. Often, because I was in charge,
6 R&D, we'd also tried to promote new technologies
7 to the OEMs.

8 Q So what were some of the new
9 technologies that you promoted?

10 A Different new light sources, including
11 HID, high intensity discharge. Neon, gas
12 discharge, LED, and lasers, as well as new
13 configurations, optical configurations, electronic
14 configurations, and sometimes we'll even promote
15 new testing technologies.

16 Q Okay. Do you remember when you first
17 promoted LED technologies for forward-lighting
18 applications?

19 A Yes.

20 Q When was that date?

21 A It was in late '90s.

22 Q Late '90s.

1 For this proposed LED forward-lighting
2 design, did you propose replacing certain
3 components with the LEDs?

4 MR. FITZSIMMONS: Objection. Form.

5 A I don't quite understand the question.

6 Q Okay. Can you explain your proposed
7 LED lighting designs to the OEMs in the '90s?

8 MR. FITZSIMMONS: Objection. Form.

9 A The concept is using LED as light
10 source because the differences between LED and
11 other traditional light sources, there's always
12 related configuration and needed optically,
13 electronically.

14 Q So did you propose this as a
15 replacement to existing LED -- sorry, strike that.

16 Did you propose an LED lighting design
17 as a replacement to a conventional headlamp?

18 MR. FITZSIMMONS: Objection. Form.

19 A Well, the headlamp always exist.
20 Whatever the sources configuration used, anything
21 new is replacement for existing. But there's
22 always new configurations.

1 Q Okay. So in your proposed design, what
2 components were you replacing?

3 A In LED lighting category, especially in
4 United States, we understand the regulation law,
5 we call integrate beam; it means that LEDs cannot
6 be separate from headlamp as replaceable, any
7 bulbs. For that reason, any proposal for using
8 LEDs, at that time, even up to today, will be
9 complete integration, the whole headlamp
10 replacement.

11 Q So you said the LED cannot be separate
12 from the headlamp for replacement.

13 Does that mean you can't replace the
14 individual component; it's a whole headlight,
15 itself, needs to be replaced?

16 A In the United States, that's law.

17 Q Why is that?

18 A Why did Congress wrote law like this?

19 Q Correct?

20 A Per my interpretation?

21 Q Yes.

22 MR. FITZSIMMONS: Objection. Calls for

1 a legal conclusion. Calls for speculation.

2 THE WITNESS: I should answer, right?

3 A Headlamp is very highly regulated
4 lighting device, in terms it's performance,
5 including the testing for the purpose of safety.

6 For that reason, the headlamp light
7 sources used to achieve these performances also
8 regulated. For instance, if it's replaceable, the
9 source has to be regulated and regulations demand
10 what kind of source can be replaced with all the
11 characteristics and the performance measures that
12 government or regulation body believes.

13 So an LED -- due to flexibility of
14 mountable sources were not easy to establish.
15 There hasn't been established replaceable source
16 criteria by industry nor government. For that
17 reason, today, regulation doesn't allow you to
18 replace LED sources.

19 Q Do you know what body creates these
20 regulations?

21 A Yes. DOT, NHTSA. National Highway
22 Transportation Safety Agency. N-H-T-S-A, NHTSA.

1 Q Do you know if NHTSA has revised these
2 regulations for forward-lighting since the time
3 frame we're talking about?

4 MR. FITZSIMMONS: Objection to form.

5 A From time to time, there's some
6 revisions. Usually, we also refer to
7 interpretations to see what elements of the law
8 could be interpreted. They do that anyways.

9 Q Do you know what specific NHTSA
10 provision regulates the light source for the
11 headlamps?

12 A I think it's part of 641. I can't
13 recall. Different part from the M -- Motor
14 Vehicle Safety Standard, MVSS108. The source is a
15 different part.

16 Q Can you describe some of the
17 differences between a -- your proposed LED
18 headlamp assembly and the existing conventional
19 headlamp assemblies at the time you were at NAL?

20 MR. FITZSIMMONS: Objection. Form.

21 A Conceptually, is to use LED as light
22 source.

1 Q So the -- what's included in the light
2 source of the LED?

3 A In general, we, as industry, we define
4 light source, including emitting devices and
5 controlled devices, and combine them by light
6 source.

7 Q What is the control device for these
8 emitting devices?

9 A Including -- they're often including
10 drivers, ECUs, and -- or other features that have
11 been integrated into ECUs that operate a light
12 source.

13 Q Are these ECUs and drivers integrated
14 into the headlamp assembly or are they separate
15 from the headlamp assembly?

16 A Either. They can be either.

17 Q Would you have one driver and
18 controller in each headlamp assembly or would one
19 of them control both headlamp assemblies?

20 A In most of the cases, each lamp has
21 dedicated driver, and they also can have an ECU
22 that control both headlamps.

1 Q And this is -- your description of the
2 LED driver -- your description of the LED headlamp
3 assembly, this is with reference to the designs
4 you proposed when you were at NAL, correct?

5 A That was common practice at NAL
6 anywhere.

7 Q At the time, even when you were working
8 there, correct?

9 A Yes. As long as we introduce LED, we
10 all understand the control that's needed.

11 Q So where does the controls for the LED
12 assembly receive its power on a vehicle
13 application?

14 A Battery.

15 Q So, DC power?

16 A Always.

17 Q Okay. And what type of control signal
18 does the controller provide to the LEDs?

19 A It depends. If the function is only
20 provided, the illumination purpose, then usually
21 it's the power control, except the LED has its
22 current device, there's also possibility of

1 testing variations.

2 But if the function also changes
3 through driving, and you do need other sensors to
4 provide signal to allow the lamp to be operated
5 and cut into the sensing signals.

6 Q So these sensors, what are these
7 sensors monitoring?

8 MR. FITZSIMMONS: Objection. Form.

9 A Because they have to have a sensor to
10 monitor. Generally speaking, we break into three
11 cases; A, road conditions; B, driving conditions;
12 C, weather conditions. All the sensing system,
13 in general, they sense all these things
14 surrounding the vehicles.

15 Q So what type of sensors did you propose
16 in the LED headlamp assemblies while you were at
17 NAL?

18 MR. FITZSIMMONS: Objection. Form.
19 Objection. Scope.

20 A At the time we practiced the LEDs, the
21 sensing existing technology, we used a vendor to
22 design our own sensor.

1 Q What type of sensors? What did these
2 sensors measure? Lights? Did they measure
3 temperature? What characteristics did they
4 measure?

5 MR. FITZSIMMONS: Objection. Form.
6 Compound questions.

7 A Again, the sensors, we have multiple
8 types, remember, I mentioned the three categories.
9 So, it depends more the sensing needs. You can
10 have the sensing for any type of signal, whether
11 it's mechanical, electrical, or optical.

12 Q So, how did you determine what type of
13 sensors to include in your design?

14 A Usually, it comes from OEM direction,
15 if they ask, the beam should be changed according
16 to whatever condition that associated sensor will
17 be proposed.

18 Q Can you give an example of a sensor
19 proposed to meet certain beam change?

20 A For example, if you want to make the
21 beam swivel to the direction of turn or curve.

22 There's a possibility you need a sensor

1 to sense, you know, steering wheel change, and you
2 may, also, need to have a sensor to detect a road
3 change. And if you want to look at how the light
4 related to speed, you may need a speed sensor to
5 tell where the light changes.

6 Q Did the OEMs require sensors for
7 performance of certain functionality, or was it
8 more of a reliability concerns?

9 MR. FITZSIMMONS: Objection. Form.

10 A Almost in all cases, it's for
11 performance.

12 Q I'm sorry, did you say no cases or all
13 cases?

14 A All cases. Again, it is highly
15 regulated, safety-wise.

16 Q So you mentioned having a sensor to
17 detect how the road changed. What type of sensor
18 would that be?

19 A The -- I cannot pinpoint specific
20 sensing capability. Again, we're using vendors.
21 If we want to have an ability to detect a road
22 condition change, we know there's existing

1 technology, an already existing sensor can be used
2 to detect road, whether it's optically or
3 electronically. Or if you have ability to take
4 other information, such as GPS or map data, that
5 is all part of the control mechanism.

6 Q You mentioned the sensor to detect
7 optically or electrically, the road. Can you
8 explain what you mean by the difference between
9 those?

10 A Optically, you can use camera as
11 function, as a sensor. Electrically, you can use
12 whatever pulsing signal to detect the road
13 conditions. Again, I'm not really pinpointing
14 specific sensor that we'd propose. We know these
15 are existing technologies.

16 Q So those were existing technologies at
17 the time you were at NAL?

18 A Yes.

19 Q Would electronically -- sorry, strike
20 that.

21 Is a light sensor an electrical sensor
22 for detecting road conditions?

1 A I don't understand that question.

2 Q Can you give an example of an
3 electrical signal -- sorry, electrical sensor for
4 detecting road conditions?

5 MR. FITZSIMMONS: Objection. Form.

6 A We had to consider radar sensor, that's
7 electrical.

8 Q Reader?

9 A Radar.

10 Q Radar. Okay. Thank you.

11 Did any OEMs include your proposed LED
12 headlamp assembly in a commercial product while
13 you were at NAL?

14 MR. FITZSIMMONS: Objection. Form.
15 Objection. Scope. Relevance.

16 A Remember, I left NAL 2007. So you're
17 including entire time frame?

18 Q I meant -- yes.

19 A Oh, yes. We launched LED lamps with
20 Koito, early 2000, for Lexus.

21 Q Was that the first LED headlamp
22 assembly in production, worldwide?

1 A That's what Koito claimed.

2 Q I'm sorry, can you tell me that year
3 again?

4 A I don't recall the year, early 2000,
5 but that's launch of production. The
6 preproduction, prototype research is done years
7 and years before, usually. The design phase for
8 any automotive is three to four years.

9 Q So, do you know when the first OEM
10 started selling products, selling vehicles that
11 had LEDs for forward-lighting applications?

12 MR. FITZSIMMONS: Objection. Form.
13 Objection. Scope. Objection. Calls for
14 speculation.

15 A Early 2000s.

16 Q And that was Lexus?

17 A Yes, as I recall, Lexus.

18 Q What functionality did this LED
19 headlamp assembly for Lexus provide?

20 MR. FITZSIMMONS: Objection. Form.

21 A They provide -- I know it's primarily
22 low beam. I don't recall it including high beam

1 or not. That's, again, that's production that's
2 on the road. And prior to production, in the
3 engineering model, we probably did study all kinds
4 of possibilities long before production.

5 Q So, the first production design that
6 NAL provided that Lexus commercialized, the LEDs
7 were only for the low beam?

8 A NAL was just part of the family. It
9 really was Koito Japan. That was low beam.

10 Q Do you know if the controller for that
11 headlamp assembly controlled both the high beams
12 and the low beams?

13 MR. FITZSIMMONS: Objection. Form.

14 A I don't recall.

15 Q Did this Lexus headlamp assembly
16 include different optics for the high beam that
17 used incandescent light bulb as compared to the
18 optics for the low beam that used LED light
19 source?

20 MR. FITZSIMMONS: Objection. Form.

21 Objection. Scope.

22 A LED, at least the LED portions use very

1 unique optics. I don't recall the high beam.

2 Q Can you describe these optics for the
3 LEDs?

4 MR. FITZSIMMONS: Objection. Form.

5 A If I recall, the very first production
6 model, the old optics were used. If I recall, it
7 was called the projection system, which used
8 projectors. But they definitely used reflectors,
9 but mainly it's using projector to project the
10 beam.

11 Q How is it different from the optics for
12 the high beam that uses incandescent light bulbs?

13 A Again, I don't recall the function of
14 the high beam for that particular product.

15 Q Why did the optics have the
16 projection -- sorry -- strike that.

17 Why did the low beam portion of the
18 lamp assembly, that included the LEDs, include
19 projection optics?

20 MR. FITZSIMMONS: Objection. Form.
21 Objection. Scope.

22 A At the time, I think the team believed

1 that the most optimized approach, based on
2 efficiency, the overall optical efficiency, and
3 restriction for the beam pad inside -- beam cavity
4 size, the lamp size.

5 Q So packaging was a concern?

6 A Always.

7 Q Did you have certain design guidelines
8 for packaging space for LED assemblies?

9 MR. FITZSIMMONS: Objection. Form.
10 Objection. Scope.

11 A The space is always coming from OEM,
12 usually starting from design studio, and
13 negotiated with the engineering team to provide
14 the space that is sufficient to put any kind of
15 configuration into that pocket of a lamp. A
16 collaborative effort between OEM's design studios,
17 OEM engineers and lighting -- supply engineers'
18 cost.

19 MS. SHAH: I'm sorry. I think the
20 realtime feed may be stalled out. Oh, okay.

21 Q Are the packaging constraints different
22 for every vehicle application?

1 MR. FITZSIMMONS: Objection. Form.

2 Objection. Scope.

3 A Usually.

4 Q And what drives those constraints?

5 A Design studio.

6 Q By "design studio," you mean the OEM
7 design studio of the appearance of the vehicle?

8 A Correct.

9 Q Okay. Did the Lexus headlamp assembly
10 include any sensors?

11 MR. FITZSIMMONS: Objection. Form.

12 Q For the --

13 MR. TURNER: Sorry.

14 Q Let me rephrase it.

15 Did the Lexus headlamp assembly include
16 any sensors that provided signals input to the LED
17 control?

18 MR. FITZSIMMONS: Objection. Form.

19 Objection. Scope.

20 A I do not recall. I don't recall.

21 Q Do you know why this design didn't have
22 LEDs for the high beam functionality?

1 MR. FITZSIMMONS: Objection. Form.

2 Objection. Scope.

3 A First of all, I do not recall. If I
4 could speculate, it did not have high beam. But I
5 do know, if the high beam was not included,
6 primarily, it's due to the cost issue.

7 Q You said cost issue?

8 A Cost.

9 Q Can you explain? What was the cost
10 issue?

11 A The automotive headlamp, regardless
12 functions, there's always struggle between how
13 much you want to put in cost-wise. Where low beam
14 is always used, the high beam usage is very
15 minimum, technically, it's less than 20 percent or
16 even 10 percent usage. And the time putting LED
17 source into a headlamp is very costly, where you
18 have a lamp that is minimally used, usually, OEM
19 didn't feel make economical sense.

20 Q So it's difficult to justify the extra
21 cost for high beam if you're only using it
22 20 percent of the time?

1 MR. FITZSIMMONS: Objection. Form.

2 A That's often OEM's preference.

3 Q Okay. So what drove the cost increase
4 for the LED light source?

5 MR. FITZSIMMONS: Objection. Form.

6 Objection. Scope.

7 A LED, itself, the light source is a
8 higher cost than traditional bulbs.

9 Q When using LEDs, are there additional
10 components that are needed in the assembly that
11 are not needed in the conventional light source
12 headlamp assembly?

13 A It does. Does have additional
14 components.

15 Q What are some of these additional
16 components?

17 A Drivers, for instance, and PCPs that
18 put an LED on board. These are components
19 conventional light source do not need.

20 Q Why does a conventional light source
21 not need a driver?

22 A Conventional light source is operated

1 by DC input and just directly plug into the DC
2 input and you light the light source, which is, in
3 almost all cases, in our industry, we have a set
4 DC voltage, usually around 12 volts.

5 LEDs are operated much lower voltage.
6 And for that reason, LED has to be configured to
7 compensate that vehicle battery existing DC
8 voltage. For that reason, you need a driver.

9 Q So what is the input voltage to an
10 LED -- to a series of LEDs for headlamp assembly?

11 A One LED or series of LEDs?

12 Q Does the input voltage change based on
13 the number of LEDs?

14 A Yeah, but you cascade them together,
15 the voltage added together. So single LED,
16 usually, is three volts.

17 Q So what is a common number of LEDs in a
18 headlamp assembly?

19 MR. FITZSIMMONS: Objection. Form.

20 Q What is a common number of LEDs for a
21 low beam application in a headlamp assembly?

22 A Now or then?

1 MR. FITZSIMMONS: Objection. Form.

2 Q Back in the time frame you were at NAL.

3 A Multiple. I don't remember the number.

4 Multiple LEDs.

5 Q Six, ten, 20?

6 MR. FITZSIMMONS: Objection. Form.

7 A I can't recall. I know it's multiple.

8 Q Okay. So, is there a difference
9 between the amount of LEDs used back then and
10 currently, in the headlamp assembly, for a given
11 application, like a low beam application?

12 A Yes.

13 MR. FITZSIMMONS: Objection. Form.

14 A There's a difference.

15 Q Why is there a difference?

16 A Because throughout the years, the LED
17 has improved significantly, especially the
18 efficacy. The same amount of input for an LED
19 today will produce multiple times more lights than
20 20 years ago. So you need less number of LEDs
21 today.

22 Q So, today, you need less number of LEDs

1 to produce the same amount of light that you
2 needed back in your NAL time?

3 MR. FITZSIMMONS: Objection. Form.

4 A Correct.

5 Q So what are some of the improvements in
6 the LED technology that allows for such changes?

7 MR. FITZSIMMONS: Objection. Form.

8 A The -- in general, there are three
9 challenges for improvement. We're talking about
10 headlamp use, namely, light, LED. One is emitter,
11 typically using Gallium Nitride semi-conduct
12 materials. That emission, we call quantum
13 efficiency, that increase year by year into many
14 years later. So that's emission efficiency.

15 Second, is that the LEDs always produce
16 single-colored light, either blue or UV. You have
17 to go through the phosphor to achieve the
18 secondary emission of the white. So over the
19 years, the phosphor conversion technology has been
20 improved significantly.

21 I think thirdly is optical
22 configuration, is how to manage or collect being

1 emitting light, being convergent light more
2 efficiently, based on the three. The LED's use
3 for headlamp or any white light has been continued
4 to improve, you know, 20 years, until a few years
5 ago.

6 Today, we're pretty much reached to the
7 maximum potential level of a LED light, overall
8 efficacy.

9 Q So you mentioned white LEDs. Is that
10 the most common type of LEDs used now for LED
11 headlamp assemblies?

12 A LED headlamps only use the white, in
13 general.

14 Q These are white lights or white LEDs?

15 A LED is a package, including the
16 emitter, or we use the word "LED dye,"
17 terminology, standard terminology. Dye is always
18 single color, namely, blue or UV. And you combine
19 with a phosphor to achieve white light. So we use
20 LED, the word, there's two tiers, dye or package.
21 They're packaged for headlamps, it's always white.

22 Q Has the color of the dye changed over

1 the last -- since your time at NAL?

2 MR. FITZSIMMONS: Objection. Form.

3 A Has the emission of blue or UV changed,
4 20 years until -- no, that's material, fundamental
5 property.

6 Q So the LEDs that you used in your --
7 back when you were at NAL, were those considered
8 white LEDs, red LEDs, blue LEDs?

9 MR. FITZSIMMONS: Objection. Form.

10 A For headlamp?

11 Q Correct.

12 A Again, headlamp, we always use the blue
13 or UV LED with the conversion of phosphor to make
14 it a white light.

15 Q So that LED technology, as far as
16 color, hasn't changed?

17 MR. FITZSIMMONS: Objection to form.

18 A Referring to what application?

19 Q So back when you were developing these
20 proposed LED headlamp assemblies at NAL, back in
21 the '93 to 2007 time frame, what color LEDs were
22 you proposing for these designs?

1 MR. FITZSIMMONS: Objection. Form.

2 A Headlamp, by regulation, by law, has to
3 be white. In order to achieve the white, we, the
4 industry, use the blue or UV LED dye, in
5 conjunction with the phosphor, to convert into
6 white LED packages. That blue LED dye, as far as
7 spectrum, or color-wise, 20 years, there's no
8 change.

9 Q So you mentioned that headlamp
10 regulation, by law, has to be white. Is that for
11 specific vehicle applications, forward lighting
12 versus other lighting?

13 A Can you rephrase, because you used
14 headlamp then you used the word "other lighting."
15 Headlamp is not other lighting.

16 Q Can you explain what color light is
17 regulated from headlamp assemblies in the United
18 States?

19 MR. FITZSIMMONS: Objection. Form.
20 Objection. Scope.

21 A You mean, you want me to point out
22 which standards or regulation that is referenced

1 for the color of headlamp in the United States?

2 Is that the question?

3 Q Let me rephrase that.

4 Does the U.S. regulate the color of
5 light emitted from forward headlights?

6 MR. FITZSIMMONS: Objection. Form.
7 Objection. Scope.

8 A U.S. does have a regulation for
9 headlamp color.

10 Q And that's the light emitted from the
11 headlamps?

12 A Correct.

13 Q Does the U.S. have regulations for
14 light emitted from signal lights?

15 MR. FITZSIMMONS: Objection. Scope.

16 A U.S. regulation regulates all exterior
17 lighting color.

18 Q Does the U.S. regulate the color of
19 light for cornering lighting in adaptive headlight
20 applications?

21 MR. FITZSIMMONS: Objection. Form.
22 Objection. Scope.

1 A U.S. does not have federal level of
2 regulation for corner lamp, include any
3 functionality of corner lamp; however, industry
4 have a standard for corner lamp, including color
5 and light distribution, where state level, state
6 vehicle codes, state regulatory bodies often use
7 industry standards, namely, SAE standard, to
8 regulate corner lamp, including color, although,
9 it's not federal.

10 Q Do the states have different
11 requirements for the color for cornering lighting
12 today?

13 MR. FITZSIMMONS: Objection. Form.
14 And scope.

15 A All the lamp, including cornering lamp,
16 the color standard is one standard from industry,
17 from SAE. The state level use almost, in all
18 cases, its state regulation reference to or
19 referred to industry standard, namely, SAE
20 standard.

21 Q Do you know how these industry
22 standards are developed?

1 A In the United States, we have
2 standardization body that the standard --
3 standardization body are accredited by American
4 national institute -- American National Institute
5 of Standard is an accredited standardization body
6 that develop all standards in this country for
7 lighting or, otherwise, a standard that can
8 sometimes harmonize with international standard,
9 namely, ISO. For automotive lighting, that
10 accredited standardization body is called SAE,
11 Society of Automotive Engineering, Lighting
12 Standard Committee. That committee writes all the
13 standards, lighting standards.

14 Q Do you know what design criteria this
15 SAE body considers to develop the standards?

16 MR. FITZSIMMONS: Objection. Form.
17 And scope.

18 A The SAE standard development is based
19 on industry's best practice. That is the standard
20 development principle.

21 In general, the standard developed
22 shall be consistent, shall be reliable. In

1 general, we also believe shall be scientifically
2 sound. That's how we -- how the industry develops
3 standards.

4 Q So while you were at NAL, did you
5 develop any other headlamp assemblies that
6 included LED light sources for both high beam and
7 low beam applications?

8 A If I recall, the development work using
9 LEDs is always parallel between high beam and low
10 beam. I don't think it would ever just consider
11 high beam.

12 Q Do you know if any of your designs were
13 commercialized while you were at NAL, that
14 included both high beam and low beam with LEDs?

15 A Well, throughout the time frame, until
16 2007?

17 Q Correct.

18 A I'm not sure. I would assume that
19 should be.

20 Q What were some of the challenges that
21 you encountered when developing these LED headlamp
22 assemblies for NAL?

1 A Besides the cost?

2 Q Correct.

3 A LEDs have a character that industry has
4 been highly concerned is, over the time, although,
5 LED continue to let the light output reduce, we
6 use terminology of lumen maintenance. And from
7 zero hour to whatever hour you use, that change
8 has been concerning in how stable the light output
9 over time.

10 Q So you're saying the color changes over
11 the lifetime of the LED.

12 A Mainly, the lumen output change, color
13 may change. Both changes we call lumen
14 maintenance and color limits. That was the one
15 major challenge or concern at the beginning of
16 implement.

17 Q What were some of the solutions you
18 developed to address these lumen changes?

19 MR. FITZSIMMONS: Objection. Form.

20 A The lumen maintenance change is highly
21 dependent on LED source maker's capability and
22 whether it's dye's stability or phosphor's

1 stability. Over the years, that has been improved
2 significantly. And in the time frame, we did
3 automotive headlamps, soon after that, using LED.

4 We also have enough data, through
5 independent research, to find out what is the
6 usage for headlamp on a vehicle for lifetime of
7 the vehicle. That data gave us a pretty good
8 indication. Automotive lamp, the LEDs do not need
9 to last as long as these general lightings. So
10 they help us kind of measure that first challenge,
11 the lumen maintenance challenge, based on
12 technology improvement and the usage automotive
13 lighting cases.

14 The second challenge would be the
15 integration and mechanically, electronically,
16 because using LEDs, you know, it's associated with
17 other components that were not used in the
18 traditional lighting system.

19 So adding these new components to
20 control the lights has been challenging. For one
21 main reason, that automotive world reliability is
22 very, very high demand. And any electronic

1 components, including LEDs, or any components
2 inside a driver, there's extreme high demanding of
3 its reliability, namely, quality. And automotive
4 has specific quality standards to dictate what
5 kind of components can be used.

6 So these are the challenges for using
7 LED headlamps.

8 Q So some of the reliability standards
9 for automotive applications, is this, like, a
10 period of time that it needs to meet or a certain
11 mileage of the vehicle?

12 MR. FITZSIMMONS: Objection. Form.

13 A The lumen maintenance is based on,
14 again, this is maintenance, is based on
15 conventional. We realize what is life of vehicle,
16 number of hours of headlamps operate. So we know
17 that's the duration of usage.

18 The components level, any components,
19 electronically, the reliability is based on
20 catastrophic failure. So that is largely based on
21 statistics and industry for years, years built
22 such components and standards, not to look for the

1 behavior change, but looking for the statistic of
2 catastrophic failure to minimize its catastrophic
3 failures on the level of billings. Means you can
4 only have one billing, one filler, multiple
5 limits, we use that measure.

6 Q By catastrophic failure, do you mean a
7 failure of the light itself or some type of
8 vehicle occurrence that would result in a problem
9 with the lighting?

10 A Typical automotive components
11 reliability requirements establish the failure
12 cost, and we use the word "stress," we stress the
13 parts. There's, generally, three stressors,
14 mechanical stress, vibrate, and you could have
15 electrical stress, with high voltage. Sometimes
16 we have other environmental stress, moisture,
17 whatever. In automotive world, all these
18 electronic components, the catastrophic failure is
19 based on number of duplication for the stressors,
20 especially test multiple, multiple times to see
21 how many parts fail.

22 That's what we define parts per million

1 failure. That's a reliability measure.

2 Q So you would test these components
3 under certain conditions, which were supposed to
4 represent vehicle life cycle, or vehicle
5 conditions to evaluate reliability?

6 MR. FITZSIMMONS: Objection. Form.

7 A That's industry practice, yes.

8 Q You mentioned the vibration concern.
9 Did you change the design, at all, to address
10 vibration issue?

11 MR. FITZSIMMONS: Objection. Form.

12 A Every light has standard requirement
13 for mechanical impact, including vibration. So
14 when the designs are proposed, you also need to
15 verify through the standard testing protocols,
16 including vibration.

17 Q So you mentioned that LED luminosity
18 changes over time; is that the correct term,
19 luminosity?

20 A Luminous flux.

21 Q Luminous. Okay.

22 So you mentioned luminous flux changes

1 over time, and you tested for this, correct?

2 A Usually, the LED makers test.

3 Q Okay. Did you monitor luminous flux in
4 a headlamp assembly over time and provide any type
5 of feedback system to adjust for it?

6 MR. FITZSIMMONS: Objection. Form and
7 scope.

8 A In our electronic control capabilities,
9 sometimes we do consider to monitor the light
10 change to categorize the luminous flux change.

11 However, in automotive lighting
12 applications, as far as I know, especially through
13 that time frame, we have substantial amount of
14 data to prove the luminous is sufficiently,
15 adequately good enough, not needing to be
16 monitored once assembled into a headlamp.

17 Q Okay. Was temperature or heat a
18 challenge for your LED lighting assemblies?

19 MR. FITZSIMMONS: Objection. Form.

20 A Yes.

21 Q Did the LEDs operate at a higher
22 temperature than conventional light bulbs?

1 MR. FITZSIMMONS: Objection. Form.

2 A LED, in principle, is a
3 temperature-dependent light source. In all cases,
4 the higher the temperature, the lower the luminous
5 flux output from LED is.

6 As such, managing the heat generated in
7 the LED, or heat from external environment of LED
8 lamp, has been challenging because LED light
9 output reduced when the temperature goes up.

10 Q So you tried to manage the LED, the
11 temperature of the LEDs within a certain range,
12 correct?

13 A The LED intrinsic temperature, the main
14 junction temperature is dictated by the LED
15 maker's capability. LED assembly into the
16 headlamp is to avoid the temperature to increase
17 to the level, to the maximum junction temperature.
18 So the design challenge is how to not increase
19 temperature, that's significant.

20 Q Does increased temperature of the LEDs
21 affect the reliability or durability of the LED
22 headlamp assembly?

1 MR. FITZSIMMONS: Objection. Form.

2 A If the increase of the temperature
3 leads to the reduction of the light output, yes,
4 it will be a design issue.

5 Q So what are some examples of heat
6 management strategies that you implemented, while
7 you were at NAL, to address these temperature
8 issues?

9 A Based on the nature of LED heat
10 generation, we have to use the way to conduct the
11 heat away from LED because there's no radiated
12 heat, it's conductive, sometimes -- it's mainly
13 conductive heat.

14 So the heat management, in a majority
15 of cases, is design heat sync that can take the
16 heat away from the meter as efficiently, as
17 quickly as possible. So industry has spent lots
18 of effort to design heat syncing mechanisms for
19 LEDs.

20 Q Are these passive heat syncs or more
21 active-type heat management systems?

22 A In majority of the cases, so I'll use

1 passive heat syncing, occasionally, the lighting
2 maker did introduce, for something called a force
3 collate, at a fan to blow LED, but add additional
4 components that may create a reliability issue.

5 In practice, I -- my memory is, in all
6 cases, passive, but I don't really dispute that
7 there's somebody that does use active cooling
8 system.

9 Q So passive system would include heat
10 syncs in the proximity to the LEDs to dissipate
11 the heat?

12 A Primarily, heat sync. Occasionally,
13 some lamp makers use heat pipe, which is also
14 passive device.

15 Q With a heat pipe, does that include any
16 type of fluid through the pipe?

17 A Correct.

18 Q Now, this additional structure for the
19 heat management, would that be included in the
20 headlamp assembly itself?

21 A Almost all cases. It's very adjacent
22 to LEDs.

1 Q Because it's by conduction, correct, so
2 it heats?

3 A LED-generated conductive heat,
4 conductive heat transferring.

5 Q Did these additional heat structures
6 create any challenges with your packaging
7 requirements?

8 A It does. It takes space.

9 Q So, did you mount these heat management
10 systems on the rearward side of your LED circuit
11 board?

12 A In general, the design guide principle,
13 heat syncs should -- heat sync, it should be close
14 to where heat sources are, the heat sources are to
15 the junction. That is not a meeting site, it's
16 opposite side of lighting emitting side.

17 Q So, it's the opposite side?

18 A Opposite side of light-emitting side.
19 That's where you put the heat sync.

20 Q Could you reduce the heat of an LED by
21 reducing the electrical power supplied to the
22 LEDs?

1 A LED is a current-driving device. The
2 light output is related to the input current, we
3 call operating current. If the reduced input
4 current, the light output will reduce. In order
5 to minimize or improve the heat being less
6 generated, you have to improve LED efficacy,
7 rather than just reduce power. Because reducing
8 the current, you're going to reduce light output.
9 Unless you produce higher output in the beginning.

10 Q So reducing current to the LEDs, to
11 address heat management, would also result in
12 reducing the output light. So would that be a
13 practical consideration?

14 MR. FITZSIMMONS: Objection. Form.

15 A Sometimes it can be, by operating the
16 LEDs in a lower level, consequence is lower light
17 output. Sometimes LEDs are more efficient in a
18 lower current situation. So the way to do that is
19 adding more LEDs, but overall power consumption
20 can be lower. Because overall, the LED is just
21 more efficient while it is operating at lower
22 level.

1 Q So, by adding more LEDs to the headlamp
2 assembly, you reduce the amount of current to each
3 one?

4 A Total power, yes.

5 Q But then, you might have more packaging
6 issues?

7 A Obviously. So that's -- usually,
8 that's not a practical approach.

9 Q Okay.

10 A But industry knows, by operating LED at
11 a lower current, can be more efficient.

12 MR. FITZSIMMONS: Andy, we're getting
13 close to an hour and a half, so maybe a break
14 somewhere soon.

15 MR. TURNER: Let me see. Yeah, why
16 don't we -- we can take a break now.
17 Five minutes.

18 MR. FITZSIMMONS: Take five minutes,
19 that's fine.

20 (Recess taken from 10:23 a.m. to
21 10:38 a.m.)

22 MR. TURNER: Dr. Jiao, I guess, before

1 we get started here, I would like to just identify
2 everybody in the room, if you don't mind. So this
3 is -- if you want to introduce yourself.

4 MR. FITZSIMMONS: Jason Fitzsimmons,
5 Sterne Kessler.

6 MR. SOULE: Ian Soule, Sterne Kessler.

7 MR. COLLETTI: Rob Colletti, Haug
8 Partners.

9 MR. TURNER: So, Jason and Ian, you
10 represent Volkswagen, correct?

11 MR. FITZSIMMONS: That's correct.

12 MR. TURNER: And, Rob, you represent?

13 MR. COLLETTI: I represent Porsche.

14 MR. TURNER: Okay. Thank you. All
15 right.

16 BY MR. TURNER:

17 Q So, Dr. Jiao, before the break, we were
18 talking a little bit about some of your
19 heat-management strategies while you were at NAL,
20 for addressing LEDs.

21 Can you describe a little bit more
22 about some of the -- sorry, a little bit more

1 detail about what specific criteria you were
2 trying to meet with your heat-management
3 strategies, like certain temperature ranges or
4 other criteria that you were targeting?

5 MR. FITZSIMMONS: Objection. Form.
6 Compound question.

7 A As industry, including my practice at
8 NAL, we have a common understanding regarding the
9 vehicle environment operating temperature, maximum
10 operating temperature.

11 The reason we want to have a common
12 understanding is all lamps, especially headlamps,
13 must be tested with a certain set temperature.
14 And the temperature is reflection of the real-life
15 vehicle environmental conditions.

16 And depends upon where the headlamp is
17 mounted and the temperature may even be more
18 severe, if it's very close to engine, for
19 instance.

20 For that reason, for headlamp
21 specifically, that we know the operation
22 temperature should be. So, for that reason, we

1 also know that the LEDs naturally have junction
2 maximum temperature, namely, $T_J \max$, $T_J \max$.

3 Between the $T_J \max$, and the maximum
4 temperature, you could meet for the environmental
5 testing reason. And it's not (indiscernible),
6 therefore, the criteria to establish the heat
7 management in the LED headlamp is always to try to
8 utilize the possibility of temperature increase to
9 the maximum operation temperature and how to
10 manage that heat for that scenario.

11 Q So is the maximum operating
12 temperature, is that specified by the OEM?

13 A Maximum temperature, it's a regulation.
14 It's also in industry standards. And both
15 industry standards and regulations are, in this
16 particular case, are somewhat consistent, pretty
17 consistent. OEM, yes, they often have addition
18 that could make it even higher requirements. So
19 that's the question, yes, it's OEM spec plus
20 regulations -- industry standard and regulation.

21 Q Could you tell us what the industry
22 standard was during your NAL time, what that

1 maximum temperature was for a headlamp assembly?

2 MR. FITZSIMMONS: Objection. Form and
3 scope.

4 A I don't remember the number. It's
5 pretty high. 85 C or higher. Higher than 85 C.

6 Q Do you recall the highest, if an OEM
7 specified a higher temperature, what would be kind
8 of a higher temperature than the standard?

9 MR. FITZSIMMONS: Objection. Scope.

10 A I don't remember. There's a number.
11 Could be 105 C .

12 Q Okay. So 85 to 105 C is kind of the
13 high end?

14 MR. FITZSIMMONS: Objection. Form.

15 A I didn't use the word "high end," I
16 said there is testing requirement. If I recall,
17 the number is 85 C or higher. But I cannot
18 memorize the precise number.

19 Q Now, is that maximum temperature
20 referred to an external temperature to the
21 headlamp assembly or proximate the LEDs
22 themselves?

1 MR. FITZSIMMONS: Objection. Scope.

2 A The standards are always external.

3 Inside headlamp, internal temperature is part of
4 heat management strategy. We have to figure out
5 what is inside temperature.

6 Q Do you monitor the internal temperature
7 in the field when -- on a headlamp assembly, do
8 you monitor that temp in real time?

9 MR. FITZSIMMONS: Objection. Form.

10 MR. TURNER: I can rephrase it.

11 A Yeah.

12 Q While you're at NAL, did your LED
13 light-source-based headlamp assemblies include
14 temperature sensors internally and proximate to
15 the LEDs, themselves, for monitoring temperature?

16 A I didn't recall I said to monitor
17 temperature in real operation. What I said was
18 the testing is always external temperature,
19 environmental temperature.

20 Inside temperature, under the external
21 environmental temperature, that should be decided,
22 determined, or measured in a design phase. You

1 need to know how much the LED -- the temperature
2 of LED is. We don't monitor in a car. In the
3 design phase, we make the measurements.

4 Q Okay. So the design phase, you develop
5 heat management based on predicted or estimated
6 temperatures in the field?

7 A The temperature in the field is given
8 by standards and spec. And the temperature
9 differences between external temperature, or LED
10 temperature, is identified during the design
11 phase.

12 Q Okay. So during the design phase of a
13 heat management system for headlamp assembly,
14 including LEDs, what other criteria do you
15 consider, besides the standard maximum operating
16 temperatures?

17 MR. FITZSIMMONS: Objection. Form.
18 Objection. Scope.

19 A I don't think I recall anything more
20 than standard or specifications.

21 Q By "specifications," do you mean
22 specifications from the OEM that are maybe unique

1 to the vehicle that this is being designed for?

2 A Yes.

3 Q So you mentioned proximity, I think, to
4 the engine compartment influences the temperature
5 that will be seen; is that correct?

6 A Yes.

7 Q Okay. Can you describe some of the
8 different functionality that your LED headlamp
9 assemblies provided or were designed to provide?
10 For example, we mentioned high beam/low beam.

11 Did you also design for more fog lamp
12 applications within the same headlamp assembly?

13 MR. FITZSIMMONS: Objection. Form.
14 Compound question.

15 MR. TURNER: I can rephrase it.

16 Q Did your LED-based headlamp assemblies
17 at NAL include fog lamp functionality?

18 A At the time?

19 Q Correct.

20 A No.

21 Q Why not?

22 MR. FITZSIMMONS: Objection. Form.

1 Objection. Calls for speculation.

2 A Fog lamp is an optional device, not
3 legally required in United States. Almost in all
4 cases, based on my knowledge, a fog lamp used in
5 the United States, or fog lamp equipped on the
6 vehicle, in general, is for a marketing purpose.

7 Fog lamp function, in general, can be
8 achieved by using low beam. So, adding a fog lamp
9 function in the low beam is not adding any
10 marketing value. And the OEM would rather sell a
11 vehicle with a separate fog lamp that has a better
12 marketing value than using low beam in conjunction
13 to serve fog lamp function. That's, generally,
14 the approach, I believe.

15 Q Okay. Does the headlamp need different
16 structure, such as optics, to provide low beam
17 functionality versus fog-lamp functionality?

18 A Their beam patterns are different.
19 Usually, the optics are different.

20 Q So different optics are typically
21 required for different beam patterns?

22 A Yes.

1 Q Can you explain what you mean by "beam
2 pattern"?

3 A Beam pattern is a light being projected
4 or emitted from a lamp, such as headlamp, that is
5 projected on the road. Beam pattern is a
6 description for light distributed angularly, and
7 in different level. We use word luminous
8 intensity, which is a lumen output of luminous
9 flux in that specific angle.

10 A beam pattern, generally speaking, is
11 a light angular distribution.

12 Q So you're saying the light angular
13 distribution is different for a fog lamp versus a
14 low beam?

15 A They're different.

16 Q How are they different? Are they
17 directed at different angles?

18 A A low beam requires a certain amount of
19 light in different angles for the purpose of
20 driving with the light to have sufficient
21 visibility in a different area of view, including
22 down the road, on sides. And headlamp, low beam

1 headlamp also have the requirement to avoid a
2 glare for oncoming vehicles.

3 In addition, low beam headlamp has a
4 light required to see signage lighting, such as
5 highway signs, above horizontal, so low beam needs
6 to produce all these lights in order to meet the
7 needs of the driving with the low beam.

8 Compared to low beam, fog lamp is used
9 to only below the horizontal line. There's no
10 lights above horizontal. And fog lamp has two
11 separate standards in our industry, U.S. version
12 and harmonized version. And the difference
13 between these two versions is the U.S. version, to
14 project -- they all project below horizontal line,
15 you have to aim it below. The difference between
16 those two versions, both meet the standard, is
17 U.S. version has a narrow spread and the
18 harmonized, or harmonized or European versions,
19 wider spread.

20 Fog lamp has some limitation regarding
21 the -- how much down light you can put down so
22 that it avoids the reflection from the wet road,

1 clear for oncoming vehicles, from ground.

2 Q So the different design requirement for
3 fog lamps in the U.S. versus Europe, does that
4 prevent an American headlamp -- sorry, strike
5 that.

6 Can you sell a fog lamp design for U.S.
7 standards outside of the U.S.?

8 MR. FITZSIMMONS: Objection. Form.

9 A Per my knowledge, other than United
10 States, other territory, including Europe and
11 China, anybody under United Nation, agreement fog
12 lamp is a mandatory lighting device; where the
13 U.S. version of the fog lamp, the angular
14 description, does not meet that requirement.
15 Therefore, you cannot sell U.S.-version fog lamp,
16 generally speaking, in other countries where
17 regulation demanded the fog lamp.

18 Q So you mentioned using a low beam to
19 illuminate a sign.

20 Can you explain that functionality?

21 A When you approach to -- driving the
22 highway, to any cross, and you'll see signage, and

1 whether it's exit, whether it's going to whatever,
2 in Chicago, that you're at, that signage shall be
3 lit by some low beam lights. So there's designate
4 amount of light being projected to where signage
5 is located.

6 Q Is this -- are you talking about that
7 the light assembly identifies the sign and
8 projects the light or is the light always
9 projecting where the sign would be located?

10 A It's part of standard regulations, it's
11 always there. It's a part of beam pattern
12 requirement.

13 Q So the low beam always provides light
14 to illuminate the signs, it doesn't actively turn
15 it on to when a sign is present?

16 MR. FITZSIMMONS: Objection. Form.

17 A The current regulation, and the
18 standards, the beam pattern is stationary.

19 Q Okay. Is there a new standard being
20 developed to make this dynamic functionality?

21 MR. FITZSIMMONS: Objection. Scope.

22 A There has been.

1 Q Is there a name for this type of
2 lighting of signage, active lighting of signs in
3 the industry?

4 A Again, United Nations and other ECE
5 territory, there's regulation for adaptive
6 forward-lighting system, AFS, as well as ADB,
7 adaptive driving beam. These are the dynamic type
8 of beam pattern. Not necessarily designated for
9 road signage, but designated for other safety
10 benefit.

11 They're both established, implemented,
12 and vehicle can be sold in all these countries
13 once you're in agreement for these two types of
14 headlamps, AFS and ADB.

15 However, in the United States, we -- I
16 don't believe we have ever adopted AFS
17 international standard. Until recently, the U.S.
18 published a new rule-making for ADB, I think it's
19 federal. I think, legally, in the United States,
20 we can't have ADB types of lamps being used on a
21 vehicle.

22 Q You're saying ADB is a new development

1 that is now available in the U.S.?

2 MR. FITZSIMMONS: Objection to form.

3 Objection. Mischaracterizes the witness's
4 statement.

5 A I said ADB is a new U.S. regulation.

6 Q Can you explain the difference between
7 ADB -- I guess, first, what does ADB, the acronym,
8 stand for?

9 A Adaptive driving beam.

10 Q Okay. And what does the acronym AFS
11 stand for?

12 A Adaptive forward-lighting system.

13 Q And can you explain the difference in
14 the regulations between these two?

15 A AFS is a system, adapt road conditions,
16 driving conditions, including weather. If I
17 recall, road conditions and driving conditions, to
18 alter the high beam light distribution by either
19 change of the direction or adding additional
20 lights to the desired direction for better
21 illumination.

22 ADB is adaptive terminology from Europe

1 because, in Europe, they don't use the word "high
2 beam," they use the word "driving beam."

3 So driving beam, in their regulation,
4 and their common language, is equivalent to U.S.
5 high beam.

6 So, ADB is, principally, adaptive high
7 beam function that is to provide high
8 beam-equivalent illumination in adaptive fashion.
9 As we all know, high beam is more desirable for
10 road illumination for higher-distance illumination
11 for better detections, safety. Yet, high beam
12 also provide glare to incoming proceeding
13 vehicles, and the concept is, if you can get rid
14 of the glare and still have the illumination,
15 would that be desirable? That's the basis ADB is.
16 You can't make the high beam driving beam become
17 adaptable and to avoid the glare to oncoming,
18 proceeding vehicles.

19 Q So this glare reduction functionality
20 is regulated by the ADB but not the AFS; is that
21 correct?

22 A ADB has a specific requirement how the

1 glare must be avoided in the regulation and remain
2 the high beam function, the part that is
3 illuminizied without detection of incoming --
4 oncoming and forward vehicle. AFS is, in general,
5 is low beam, adaptive low beam pattern, but glare
6 is always part of low beam requirements to begin
7 with. Low beam does not have a glare, even,
8 somehow, a consumer can apply a low beam.
9 Legally, or industry-wise, we do not believe low
10 beam has glare, unless you misuse the low beam.

11 Q Why does low beam not provide glare?
12 Is it based on the beam or the direction of the
13 light provided by the low beam assembly?

14 MR. FITZSIMMONS: Objection to form.

15 A Low beam is for the purpose of meeting
16 oncoming vehicles and use it when you follow other
17 vehicles. For that purpose, the low beam beam
18 pattern, namely, angular distribution, has already
19 considered how to avoid these glares. And in the
20 beam pattern, there is certain angle you prevent
21 to have any lights to cause, especially oncoming
22 vehicle, to glare. For following the vehicle

1 glare, we have, largely, based on the mounting
2 height of the beam.

3 So, if you happen to be a lower
4 vehicle, you have a very big truck, pickup truck,
5 especially, following you, you often will feel the
6 rearview mirror glare from their high-mounted
7 lamps. For that type of glare, from low beam, we,
8 as industry, we highly depend on the mounting
9 height requirements. For the reason we do need a
10 part of lights in that angle, to project the
11 lights for signage and others. But at the same
12 time, we can provide a glare to the vehicle front
13 view if your lamp is mounted too high.

14 For that reason, the low beam, by
15 default, shall not have a glare. If low beam is
16 mounted properly, it shall not have a glare. But,
17 again, all these regulation standards, all based
18 on stationary testing, the lamp level testing.
19 Once the lamp is put on the vehicle in the United
20 States, we don't have vehicle level specifications
21 or inspections. So, there's very good chance that
22 the lamp is designed perfect, but the use on the

1 vehicle may not be aimed properly so that may have
2 some glare. But by design, low beam does not have
3 a glare.

4 Q You said "mounted." So it could be
5 mounted on a different application or different
6 height from what it was designed to, built?

7 A In general, the OEM knows the mounting
8 height legal requirements. I do not believe any
9 vehicle maker will intentionally mount the lamp
10 higher -- low beam lamp higher to jeopardize
11 regulation.

12 But, the vehicle, users can change it,
13 higher, the wheels, do whatever they want to do so
14 that pickup truck, particularly, can suddenly
15 become much, much, higher than you initially
16 designed the vehicle height, so that creates a
17 mounting-height issue.

18 Q You mentioned for the AFS that it also
19 regulates moving direction or changing direction
20 of the light; is that correct?

21 A The regulation does, for the purpose of
22 low beam shall not have a glare. But when you

1 approach to a bending road, a curved road, when
2 AFS provide some kind of swivel, so that light
3 going to a direction will curve, may lead to curve
4 of the glare, because glare was designed on a
5 straight road. For that reason, there is
6 regulation requirements, how much you can do the
7 swivel, for the purpose of avoiding potential
8 glare, especially to the left curve, because you
9 cross the center line.

10 Q So this swivelling that you mentioned,
11 is there a terminology for this in industry?

12 A We generally use a beam contributor.

13 Q You use terminology like cornering
14 light or --

15 A Cornering light -- cornering lamp is
16 definition of a device that is a product that can
17 be used in this country and others. Like I said,
18 it's not federally regulated. But it's allowed,
19 in the United States, to equip with a cornering
20 lamp, as long as it meets industry, namely, SAE
21 standards.

22 Q So a cornering lamp provides swiveling

1 light; is that the industry terminology?

2 MR. FITZSIMMONS: Objection. Form.

3 A Industry define cornering lamp and the
4 function of a cornering lamp, for instance, one,
5 the cornering lamp shall be turned on or off. And
6 how far the lights go, that's in industry
7 standard, how far it's been distributed.

8 AFS, again, is a low beam, but you can
9 add additional lights to wherever you need it, as
10 long as you avoid glare. And you can also aim the
11 lamp, perhaps, a little bit higher, if you know
12 there is no vehicle in front of you. And very
13 often, in Europe, we call automatic leveling. And
14 in the United States, we don't have legal
15 requirements, but if you drive a fancy vehicle,
16 like all you lawyers, you may have that feature to
17 begin it, you just don't know.

18 Q So our cars -- I'm sorry, you said our
19 cars might have this feature, but we don't know it
20 or is it not enabled?

21 MR. FITZSIMMONS: Objection. Form.

22 Objection. Scope.

1 A My understanding, U.S. law, in general,
2 our regulations do not specifically say you cannot
3 do. Unless you said you can do whatever you want
4 to do.

5 Per that understanding, U.S. regulation
6 does not specify automatic leveling. Whether the
7 OEM decided to activate that device or not
8 activate the device, I think, either way, it
9 complies with the law. So this is just my sort of
10 estimate. Because the auto leveling is very, very
11 good feature, especially when your vehicle has
12 high load in it and the passenger, the lamp aimed
13 too high, whatever that is.

14 Having a leveling capability,
15 automatically, in my opinion, is a good feature.
16 U.S. law doesn't dictate that, but I don't believe
17 U.S. law prohibits to do that either.

18 Q Are there different brightness
19 requirements for high beam lights versus low beam
20 lights and, also, fog lamps?

21 MR. FITZSIMMONS: Objection. Form.

22 A In industry, we use the word "luminous

1 intensity," angularly. And each beam pattern is
2 the description of angular luminous intensity
3 distribution. All three lamps all have different
4 level of luminous intensity, and high beam,
5 obviously, is highest one.

6 Q So how would you control the luminous
7 intensity of each one?

8 A I don't understand the question.

9 Q So, for each headlamp, it's designed to
10 meet this luminous intensity, correct?

11 A Correct.

12 Q You can't actively control luminous
13 intensity of a headlamp assembly, correct?

14 A By regulation, United States, every
15 lamp is a stationary. You are not allowed to
16 alter any beam pattern in the operation.

17 Q By altering beam pattern, are you
18 referring to luminous intensity or other
19 characteristics of the beam pattern?

20 A All characteristics.

21 Q All characteristics.

22 So, for example, you couldn't design

1 your headlamps to dim under certain conditions
2 because that would affect the luminous intensity?

3 A By law, no.

4 Q Okay. Can you change the color of the
5 output color of the light, would that affect the
6 luminous intensity?

7 MR. FITZSIMMONS: Objection. Form.

8 A By law, no. The only exception for the
9 last two questions was U.S. law doesn't
10 specifically prohibit you to turn off your
11 headlamps while you are in an intersection or
12 engine is stopped. Because law says that's a
13 driving, functions while you're driving. Again,
14 if you have fancy vehicles, for all of you, you
15 may notice your car will turn off the headlamps
16 automatically when you stop the engine, at
17 intersection or otherwise. Our U.S. law allows
18 you to do that, even your low beam's off when you
19 are at an intersection, the car can automatically
20 stop the light, which is dimmed to zero, but it is
21 because you are stopped.

22 Q So the vehicle is not considered

1 driving, in that scenario?

2 A All the lamps regulated by U.S. law,
3 except side marker, is all under driving
4 conditions. Side marker, you have to be not
5 driving because you park on the side of a vehicle
6 that you have to let other vehicles see you're
7 parking.

8 Q What was the exception you just
9 mentioned?

10 A Parking lamp. Side marker.

11 Q Okay. Side marker.

12 So when you mentioned there's the AFS
13 is that a -- that's a standard or that's a
14 regulation or is that a body that regulates these
15 features? What does "AFS" stand for again?

16 A Adaptive forward-lighting system.

17 Q Okay. So when you mentioned that there
18 were regulations for the AFS, and also regulations
19 for ADB, who provides these regulations?

20 MR. FITZSIMMONS: Objection. Scope.

21 A You're referring to different countries
22 or...

1 Q Okay. We'll do one at a time.

2 So ADB is the one that's available in
3 the U.S., correct?

4 A Correct.

5 Q So who, or what entity regulates ADB?

6 MR. FITZSIMMONS: Objection. Scope.

7 A In the United States, that will be
8 NHTSA.

9 Q And you mentioned that current NHTSA
10 requirements or regulations do allow for ADB
11 functionality?

12 A As I remember, it starts from February
13 this year, yes.

14 Q Was this ADB functionality permissible
15 outside of the U.S. before February '23?

16 MR. FITZSIMMONS: Objection. Scope.

17 A If I understand it correctly, it is an
18 ECE regulatory territory.

19 Q Do you know when that regulation took
20 effect?

21 MR. FITZSIMMONS: Objection. Scope.

22 A I do not remember --

1 MR. FITZSIMMONS: Objection.

2 Relevance.

3 A I do not remember the dates.

4 Q Dr. Jiao, are you familiar with the
5 term "spatial distribution"?

6 A I do.

7 Q What does that term mean, to you?

8 A Often, we use spatial distribution in
9 the lighting world, it's to describe angular
10 distribution for the reason that our lighting
11 devices measure only by angle. And occasionally,
12 not from regulation, from a specification point of
13 view, we do have a distance requirement. But a
14 distribution concept is primarily angular. And
15 spatial has another dimension distance. In
16 automotive lighting, we don't standardize,
17 regulate, in general, the distance, but
18 customer -- OEM specification, sometimes, do have
19 a distance requirement.

20 Q Does the distance requirement relate to
21 intensity of the light?

22 A The intensity is always measured in an

1 angular way. That's why I call it intensity, we
2 call it luminous intensity. The terminology is
3 luminous intensity. The definition is lumen per
4 steradian angle. So the testing concept. In our
5 lighting field, including automotive, always
6 referring to the angular intensity is measured
7 (indiscernible) infinite to distance. But the
8 practical measurement, we do measure in some
9 distance, but that's not, as metrology terms, is
10 not that relevant.

11 Q So how do you control the spatial
12 intensity?

13 MR. FITZSIMMONS: Objection. Form.
14 Vague.

15 A I don't understand the question.

16 Q So how would you design -- strike that.
17 What components of a light assembly
18 would you change, or would you control, to meet
19 specific spatial distribution requirements?

20 MR. FITZSIMMONS: Objection to form.

21 A Again, all our automotive lamps, we use
22 beam pattern concept, it's angular distribution.

1 It's light, or luminous intensity being projected
2 at different angles. And the contribution to meet
3 such luminous intensity distribution requirements
4 is combination of A, light source, and, B, optics.

5 Q So, do you use different light sources
6 for different functionality within a headlamp
7 assembly?

8 MR. FITZSIMMONS: Objection. Form.

9 A We don't have a simple. It depends
10 upon number of sources you have. If you only have
11 one source, then you don't have that much
12 alteration for the source, you would use optics to
13 control the distribution.

14 Q So, the LED light source is so if you
15 had an array of LED light sources, would you use
16 the same type of LEDs to provide different
17 functionality, both high beam, low beam, signal
18 lights?

19 MR. FITZSIMMONS: Objection. Form.

20 A When you use the word "different type,"
21 can you specify, what does that mean?

22 Q Do you use the same LEDs to provide

1 high beam functionality and low beam
2 functionality?

3 A Again, LED, you're referring to, is the
4 dye or the package. Which one, you're referring
5 to?

6 Q How do you typically refer to them? In
7 your term, does it include both?

8 A If you only ask for the dye, high beam
9 and low beam use the same LED dye.

10 Q So how does the package differ between
11 LEDs for high beam and low beam functionality?

12 A It may not be different. You can
13 choose to have different package.

14 Q So you've mentioned optics, too. So
15 how are the optics different for high beam
16 functionality versus low beam functionality?

17 MR. FITZSIMMONS: Objection. Form.

18 A The optics is a modulator, or
19 manipulator, where the lights come from LED. So
20 intrinsically, LED, the light emit from the LED is
21 the terminology, we call, a light version, it's
22 lights uniformly spread. In order to put lights

1 in the designate angle, be it low beam, high beam,
2 you have to design optics either with LED package
3 or additional, to combine all these optical
4 elements to form that particular angular
5 distribution.

6 Q Do you typically use multiple optics,
7 like, primary, secondary, tertiary, optics to
8 provide high beam functionality?

9 MR. FITZSIMMONS: Objection. Form.

10 A Almost in all cases.

11 Q Are these optics different than what
12 would be used in a headlamp assembly that has
13 incandescent bulbs or some other type of
14 conventional light bulb?

15 MR. FITZSIMMONS: Objection. Form.

16 A LED source-operated headlamps always
17 use specific optics that's associated with that
18 specific LED source.

19 Q Okay. So how do the optics vary by
20 function?

21 A What do you mean, "function"?

22 Q So what type of optics are commonly

1 used in an LED headlamp assembly?

2 A LED package usually contain optics,
3 such as the dome or flat, depends upon what is the
4 most efficient way to get the light out of the LED
5 package.

6 In addition to the optics assembled
7 onto the LED package, typical optical elements
8 used in headlamps assembly, including low beam
9 headlamp, they include lens, reflector, and/or any
10 optical modulator present could be, or light pipe,
11 or anything that you can manipulate light.

12 Q So what -- how does each optic
13 manipulate the light?

14 MR. FITZSIMMONS: Objection. Form.

15 A The nature of the optics does two
16 things, usually, collecting the light and redirect
17 the light. And by -- the optical feature of
18 collection and redirecting, usually, almost all
19 cases, is based on the curvature, the index
20 refraction, and the shape.

21 Q When you mention curvature and shape,
22 are you referring to the light itself, or some of

1 the hardware, the shape of the hardware?

2 A I'm referring to the optics.

3 Q Okay. The shape of the optics.

4 So these optics are all positioned
5 between the LEDs and the outer lens of the
6 headlamp assembly? They're all in line?

7 MR. FITZSIMMONS: Objection. Form.

8 A I don't understand the word "in line."

9 Q How are the optics arranged in the
10 headlamp assembly between the LED and the outer
11 surface?

12 MR. FITZSIMMONS: Objection. Form.

13 A I still don't understand the question.

14 Q Where are the optics located within the
15 headlamp assembly?

16 A It's always located at the LED, on the
17 LED, comes out from the LED, and has to hit
18 optics. And rest of them is optional, alter
19 lamps, weather.

20 Q How are they designed to accommodate
21 some of the OEM depth criteria?

22 MR. FITZSIMMONS: Objection. Form.

1 Q Packaging constraints.

2 MR. FITZSIMMONS: Objection. Form.

3 A You have to choose the components that
4 are able to do such optical function that has
5 geometry that is within the packaging limitation
6 or you can negotiate with the OEM to have the
7 standard packaging size.

8 Q You mentioned, earlier, that you use
9 drivers to control the LEDs. What type of signal
10 do the drivers provide to the LEDs themselves? Is
11 it more of a constant or a pulse signal?

12 MR. FITZSIMMONS: Objection. Form.

13 A Pulse.

14 Q So in what conditions, in what
15 applications would you use a constant -- a
16 constant signal?

17 A Once the light output of LEDs need not
18 to be changed, you can provide -- you can drive
19 the LED with constant current.

20 Q So, why would you drive it with -- in
21 what -- sorry. Strike that.

22 Why would you drive it with pulse

1 current?

2 A When you use pulse with modulation, or
3 driving LED with a pulse, it is to take advantage
4 of when you turn the LED on and off fast enough,
5 optically, including human eyes, you cannot detect
6 it. For instance, the switch off and on,
7 including the cycle of how often switching off.
8 You can vary the perceived brightness or
9 intensity.

10 Q So what applications would you use such
11 pulse width modulation control?

12 MR. FITZSIMMONS: Objection. Form.
13 Vague.

14 A In general, pulse width modulation may
15 have little benefit, or some benefit, by turning
16 the LED with a pulse, or turn on and off, may
17 produce less heat versus constant on situation.

18 So, for that reason, you can implement
19 PWM for whatever application you want, with,
20 without intensity control.

21 Q Can you control conventional headlamps
22 or conventional light sources, such as

1 incandescent bulbs, with a PWM signal?

2 A You can't, but it doesn't make a
3 difference between the incandescent filament take
4 time to cool down or heat up. So even a positive
5 light is still on. You cannot turn off
6 immediately, like LED does.

7 Q So a conventional light cannot turn off
8 as fast, so you wouldn't receive the benefits of
9 the pulse width modulation?

10 A Correct.

11 MR. FITZSIMMONS: Objection. Form.

12 Q Is pulse width modulation a common
13 strategy for LEDs?

14 A What do you mean in "common"? Is it
15 industry knowledge? Yes.

16 Q Is that more commonly used than a
17 constant current supply for LED control?

18 MR. FITZSIMMONS: Objection. Form.

19 A I do not know if there's limitation
20 where the pulse width modulation would be used.
21 It's probably always design mode, optimization,
22 how do you operate LEDs best.

1 Q Dr. Jiao, are you familiar with the
2 term "optical axis"?

3 A Yes.

4 Q What does optical axis mean to you?

5 A We have standard terminology, including
6 in the regulation, and the regulations, referring
7 optical axis, is where a given lamp that is
8 aligned with the vehicle Z-axis is considered
9 optical axis.

10 In more general terms, is where the
11 optics that you designed has a principal
12 direction, that's called optical axis.

13 Q So optical axis is parallel with the
14 vehicle axis?

15 A That's defined in the regulation for
16 the headlamp, per se, in any lamp, that optical
17 axis is parallel to the Z direction.

18 Q Does the headlamp assembly include one
19 optical axis or multiple optical axes?

20 A As one lamp, per regulation, the one
21 lamp can use one optical axis.

22 Q But does each -- so a lamp includes

1 multiple light sources, correct? So a lamp
2 assembly -- sorry. Strike that.

3 Does each light source within a
4 headlamp assembly include or does it have its own
5 optical axis?

6 A They do.

7 Q So how does the light source optical
8 axis differ from -- is there a -- okay. Strike
9 that.

10 Does the headlamp assembly have one
11 optical axis?

12 A One assembly only had one optical axis.

13 Q Right. So how does the optical axis of
14 each light source correlate to the optical axis of
15 the headlamp assembly?

16 A It's all based on the beam
17 contributors. Additively, if you have multiple
18 sources, regardless where the optical axes are,
19 additively, as long as they can meet that beam
20 pattern in a center point or any other points.
21 That center point of additive, of old optical
22 access or optical sources -- I mean, LED sources,

1 is not relevant. It's the lamp assembly will be
2 tested using that lamp level optical axis.

3 Q So does each -- does the low beam
4 portion of the headlamp assembly have a different
5 optical axis than the high beam portion of the
6 optical -- of the lamp assembly?

7 A Per regulation, they're the same
8 optical axis. They all have to point to Z
9 direction.

10 Q Is there a different optical axis for
11 lights that provide cornering functionality?

12 A Well, cornering lamp is tested
13 differently. Cornering lamp has different light
14 distribution. There's no definition where the
15 cornering lamp optical axis is per regulation of
16 standard. But we do know the testing is based on
17 vehicle-mounting position. Regardless where the
18 optical axis is, as long as the beam pattern meets
19 the cornering lamp angular distribution, that is
20 fine.

21 Q Is there a regulation for cornering
22 light?

1 A Not a federal level.

2 Q What other level of regulation covers
3 cornering light?

4 A We have an SAE standard, industry
5 standard for cornering light. Often state level
6 refer to SAE standard for cornering lamp.

7 Q Can you describe some of the
8 requirements for the cornering light from the SAE
9 standard?

10 MR. FITZSIMMONS: Objection. Scope.

11 A Cornering lamp is considered as road
12 illumination device, RID, because the function of
13 the cornering lamp is illumination, not for
14 signaling. Cornering lamp has requirement of a
15 testing distribution, where the lights should be.
16 Cornering lamp has a color requirement, namely,
17 white, in most cases. Cornering lamp also has
18 operation requirement, where, one, you can turn on
19 the corner lamp.

20 Cornering lamp also, in the industry
21 standards, subject, pretty much, all lighting,
22 testing standards, meaning, the elemental test.

1 Q Do you know when this RID standard was
2 created?

3 A Road emission device is a group of
4 devices that includes cornering lamp. And,
5 really, there's more than that. Low beam and the
6 high beam headlamp, that's RID fog lamp, that's
7 RID; corner lamp is RID. Auxillary high beam is
8 also RID. So all these, above, is considered RID.

9 One, the very first one, 1938. The
10 standard was established.

11 Q Do you know when the standard was
12 updated to address cornering lighting?

13 A We have an obligation, every SAE
14 standard, to be updated every five years. So if a
15 cornering lamp was not updated, has to be anytime
16 within the last five years, as part of SAE
17 requirement for all standards.

18 Q So it was first introduced into the
19 RI -- cornering lighting functionality was first
20 introduced in the RID standard within the last
21 five years?

22 A No.

1 MR. FITZSIMMONS: Objection, form.

2 A Cornering lamp has always been there.
3 I don't remember the first version. Just as any
4 standard that is developed and maintained by SAE
5 Lighting Committee, all standards shall be
6 maintained or updated every five years, unless we
7 archived it and are stabilized, means that that
8 standard, don't use it. We don't need to change
9 for ten years. Otherwise, all standards need to
10 reaffirm, with or without change, within
11 five years.

12 Q So the RID standard included cornering
13 light functionality at the time you were at NAL,
14 back when you were at NAL?

15 A Yes.

16 Q So you mentioned that it covers
17 intensity. What are the intensity requirements
18 for cornering light for the RID standard?

19 A For the cornering lamp --

20 MR. FITZSIMMONS: Objection. Scope.

21 A Road illumination device is category of
22 multiple devices. Each has a separate standard.

1 Headlamp has standards, fog light has standards,
2 and corner lamp has standards. Auxillary also has
3 standard. Industry has total four standards, for
4 RID. When did each standard start? All of them
5 started 1930s, or whenever it was.

6 But when a cornering lamp, obviously,
7 long time ago, probably '60s, early '70s. But,
8 again, all these standards, I named four of them,
9 they all have to be either reaffirmed, updated,
10 modified, every five years.

11 So I do not remember what cornering
12 lamp -- when was cornering lamp last updated. But
13 I do know they're current. We use a current,
14 which means they don't need to be changed.

15 Q Are the intensity requirements, per
16 these standards, are the intensity standards
17 different between cornering lamps and low beam
18 lamps?

19 MR. FITZSIMMONS: Objection. Scope.

20 A They are.

21 Q How are they different?

22 MR. FITZSIMMONS: Objection. Form.

1 Objection. Scope.

2 A Low beam is primary forward function,
3 to the front of the vehicle. Cornering lamp is
4 primarily when the vehicle is taking a turn. For
5 that reason, cornering lamp has much more light
6 toward the corner and close to foreground, to aid
7 driver to see the corner.

8 Q So they're close to the --
9 "foreground," you mean close to the vehicle?

10 A Correct.

11 Q Can you quantify that distance? Is it
12 five feet, ten feet?

13 A We use meters.

14 Q Okay. In meters, please.

15 A If I project a cornering light -- if I
16 recall, I can't really precisely remember. The
17 reason we don't use distance, one more time, is
18 when we test the lamp, we only test angular
19 distribution. But we understand, when angle is
20 below horizontal, as such, that will illuminate
21 some distance.

22 Cornering lamp has a pretty lower

1 angle, definitely lower than 5 degrees.

2 Q So what would be the angle for a low
3 beam headlamp?

4 A Low beam headlamp is largely centered
5 around .5 degrees below horizontal, .6, .5, that's
6 what we call the far distance.

7 Q And when you're referring to cornering
8 light, the 5 degrees was relative to horizontal?

9 A 5 degrees down. We use the word up,
10 down, left, and right. Everything's referenced to
11 that center access. And 5 degrees down, that's
12 corner. Probably even more. I don't remember,
13 quantitatively.

14 Q So cornering light is 5 degrees down,
15 and forward light is .5 degrees down from
16 horizontal?

17 A What I said is, each beam has a pattern
18 that has a spread, horizontally and vertically.
19 What I said, cornering lamp, if I recall, can
20 spread as low as 5 degrees, down and certainly
21 spread very far to the right, probably 40 degrees,
22 or whatever degrees it is. I think it's over

1 40 degrees. It's a cone of light, like you can
2 imagine, a solid angle, cone, up and down. Where
3 low beam is much, much centered, roughly, one
4 degree to the right, half to 6.5 degrees down.
5 That's where the center of low beam is. For that
6 reason, you cannot really center because the
7 oncoming vehicles. So you're toward right a
8 little bit. The center of low beam is, roughly,
9 is 1 degree toward the right, but low beam can
10 spread as far as more than 20-some degree. But
11 you cannot spread beyond horizontal to avoid
12 glare, except the signage light, on the right.
13 Low beam cannot go too much far. I believe
14 there's some requirement by 40 degrees, I believe.
15 It's a cone of light and distribution, angular
16 distribution.

17 Q So you mentioned that the RID standards
18 also regulate the color of this light.

19 And so, what color is permissible for
20 cornering light?

21 MR. FITZSIMMONS: Objection. Form.

22 A If I recall, it's white. Whether the

1 industry standard allow to be yellow or not, I
2 don't remember. But if on top -- my memory, the
3 cornering light shall be white -- should be white.

4 Q Now, do the regulations require white,
5 generally, or is it more of, like, a specific
6 color temperature?

7 MR. FITZSIMMONS: Objection. Form.

8 A The industry standard, namely, the SAE
9 standards specifically, for color, there's one
10 standard for all exterior lighting devices used on
11 the vehicle. That standard described any kind of
12 lighting, including emergency, flashlight, what
13 color shall be.

14 U.S. regulation is very consistent with
15 industry, namely, as a color standards.

16 Irid or EC, very much consistent,
17 especially in the white region.

18 If you can imagine, a color can be a
19 two-dimensional, we call it chromatistic chart.
20 And because it's two dimensions, we use the word,
21 X, Y, or U prime, V prime, you can imagine the
22 two-dimensional, like the screen, you can see.

1 And the so-called white is very close to black
2 body locus line, where the thermal radiation
3 naturally radiates light.

4 So, in that chromatistic chart, there
5 is a white boundary defined by industry standards.
6 Especially if you're looking at a TV screen. Look
7 at the monument, that's a box. Anything in that
8 box is white. We call white. A lot of that box,
9 you can have a multiple different color
10 temperature. They all allowed to consider as
11 white. So it's not point as a region; we call
12 them white box.

13 So, technically, if you look at that
14 monument, you'll view a little bit of yellowish, a
15 little bit whitish, but as long as you fit in the
16 box, industry/regulation, we call that white.

17 Q So there's a certain range of
18 acceptable white that meets the white light
19 requirement?

20 A Color range, yes.

21 Q So next to the monument, we're looking
22 at the screen here, but next to the monument, the

1 sky being blue, that would not be permissible
2 color for forward light, correct?

3 MR. FITZSIMMONS: Objection. Calls for
4 speculation.

5 A I'm sorry. I mentioned forward
6 lighting each have one standard. There are four
7 standards.

8 So headlamp, including high beam/low
9 beam, has one color requirement, namely, white.
10 The blue doesn't meet it.

11 Q Okay.

12 A Fog lamp, though, it can be yellow.

13 Q Fog lamp can be yellow?

14 A In this -- I'm pretty sure, in this
15 country, a selective yellow.

16 Q Can fog lamp be blue or green?

17 A No.

18 Q Can cornering lighting be blue or
19 green?

20 A No.

21 Q High beams, blue or green?

22 A No.

1 Q Dr. Jiao, are optics used to divert
2 light?

3 A Can you describe what "divert" means?

4 Q I guess, are you familiar with the term
5 divert or diversion of an optic light?

6 A No.

7 Q How about, are you familiar with the
8 term of "attenuating light"?

9 A Yes.

10 Q What does attenuating light mean, to
11 you?

12 A Dim. Dim the light.

13 Q Okay. How does a light assembly dim
14 the light? Does it use optics to dim the light?

15 MR. FITZSIMMONS: Objection. Form.

16 A I don't think I understand that
17 question.

18 Q So what element of an headlamp assembly
19 would be used to attenuate the light?

20 A Usually, through driving mechanism of
21 the LED, you can dim the LED.

22 Q How would you do that with -- how would

1 you dim an LED with the driver of a lamp assembly?

2 A Generally, there's two ways. One is
3 reduce current, LED light, reduce, or apply pulse
4 width modulation past that different level, to a
5 reduced level.

6 Q Adjust the duty cycle of a pulse?

7 A Pulse frequency width.

8 Q So with the headlamp assembly, can you
9 use the same LEDs to provide low beam and corner
10 beam light?

11 A I don't think I understand the
12 question.

13 Same type of LED or same physical part?

14 Q The same physical LEDs.

15 A Well, if you have a multiple LED dye,
16 yes. If it's one LED, perhaps not.

17 MR. FITZSIMMONS: I missed to add an
18 objection to form to the last question.

19 Sorry. Go ahead.

20 MR. TURNER: No problem.

21 Q So would you use different optics to
22 provide low beam functionality and cornering

1 function?

2 A Again, I do not understand the
3 question.

4 Q So, for lamp assembly, that an
5 LED-based -- for lamp assembly that include LEDs
6 as a light source, would you use different optics
7 to provide the low beam lighting versus the
8 cornering lighting?

9 MR. FITZSIMMONS: Objection. Form.

10 A The assumption is you have multiple
11 LEDs?

12 Q Correct.

13 A When you have multiple LEDs, optical
14 designed for individual LED, often they do -- can
15 do both, and depends upon, you know, the design
16 strategy. It's rather flexible.

17 Q So you can use the same optics to
18 provide forward lighting -- forward low beam
19 lighting and cornering lighting?

20 MR. FITZSIMMONS: Objection. Form.

21 A Same optics, in terms of same type of
22 lens, yes, but each lens may have a different

1 curvature, may have a different whatever that is.
2 As long as you set up your design strategy, you
3 can -- it's pretty flexible. You use the word
4 "the same." Does that mean identical, the same?
5 If it's not, yeah, you can do any approach you do
6 because you can vary the optical elements
7 individually for each added LED. They're all the
8 same lens, but they vary differently. Different
9 description. They all do.

10 Q So if you have an array of LEDs,
11 10-by-10 array, if you have one specific LED in
12 there, could you use that one individual LED to
13 provide both forward lighting, low beam lighting,
14 and cornering lighting?

15 MR. FITZSIMMONS: Objection. Form.

16 A So whether that one LED of the ten can
17 be used for both? Yes.

18 Q And you would use the same optics to
19 provide both functionality?

20 A Again, optics is pretty broad term.
21 The optics include many ways to manipulate and
22 modulate light, if the fixed elements is there.

1 But you certainly have other way to modulate
2 light. You can, you know, change the direction,
3 change intensity, change -- sometimes even change
4 color. If you can modulate each individual LED,
5 defined by optics, you can do pretty much
6 everything.

7 Q So you're saying, based on the
8 modulation of the LEDs, so the control -- the
9 input power provided to the LEDs, you can control
10 the direction of the light between a low beam and
11 a cornering lamp?

12 MR. FITZSIMMONS: Objection. Form.

13 A I think you misunderstood me. The LED,
14 the dye, may not be alterable. But optics, use
15 the word optics, optics include many different
16 optical elements, lens is one of them, modulator
17 is another one. And when you use modulation, when
18 you say modulations of optics, the light
19 modulations, individually, they can pretty much
20 redirect light to any direction. They can also
21 change intensity. Sometimes they can even change
22 color.

1 Q So this -- you're referring to
2 active-type optics?

3 A Doesn't have to be active. Can
4 predetermine each element to begin with.

5 Q So, for optical modulation, that's not
6 necessarily an active-type optic.

7 A I don't think it has to be active, no.

8 Q Okay. Dr. Jiao, are you familiar with
9 the term "spatial modulator"?

10 A Yes.

11 Q What is a spatial modulator?

12 A It modulates the spatial distributions.
13 My understanding is modulate spatial distribution
14 of the light.

15 Q So this is an optical system that would
16 be using an headlamp assembly?

17 A It can be.

18 Q Have you designed a headlamp assembly
19 using a spatial modulator?

20 A I don't think, personally, but,
21 certainly, we had discussions throughout my --

22 Q Have you seen -- sorry.

1 Have you seen a headlamp assembly that
2 included a spatial modulator?

3 A I don't recall.

4 Q So you don't know if one has been
5 commercialized, that includes a spatial modulator?

6 A I can't answer that question. I don't,
7 not as far as I know.

8 Q So after NAL, you mentioned that you
9 worked at OSRAM; is that correct?

10 A I worked at OSRAM Opto Semiconductors.

11 Q What type of products did OSRAM Opto
12 Semiconductors provide?

13 A The company produced LEDs and lasers.

14 Q So the company supplied directly to the
15 OEMs or is it more of a, like, a tier 2
16 arrangement?

17 A Majority products are directly
18 supported OEM.

19 Q Did you supply products outside of the
20 automotive industry?

21 MR. FITZSIMMONS: Objection. Scope.

22 A Does OSRAM Opto Semiconductors supply

1 the product outside automotive lighting? It did.

2 Still does.

3 Q When you were at OSRAM, did you work on
4 just the automotive account or you handled
5 different industries?

6 A I worked for any potential LED
7 applications.

8 Q What were some of the other
9 applications that you worked on?

10 A General illumination, pop culture
11 lighting. We also have some IR product, maybe
12 building structures.

13 Q What are some of the different design
14 challenges between an automotive application and
15 a -- one of the other applications that you worked
16 on?

17 MR. FITZSIMMONS: Objection. Form.

18 A Based on my practice?

19 Q Correct.

20 A Automotive is high -- automotive
21 applications of LED has higher quality requirement
22 for reliability.

1 Q What's the difference in reliability
2 requirement, like, relative -- what were some of
3 the differences in reliability requirements?

4 MR. FITZSIMMONS: Objection. Form.
5 Vague.

6 A The automotive components has almost
7 cross-board electronic components quality
8 requirements, AEC, called automotive, A, E,
9 electronic, C, components, quality standards,
10 that's industry standards. AECQ. Automotive
11 Electronic Component Standards where -- they list
12 many specifications based on, as I said earlier,
13 catastrophic failure rate. And AECQ designates
14 many specific stress tests they can call
15 electronically, where other lighting applications
16 do not.

17 Q Is -- you mentioned before that cost
18 was a significant issue in the automotive space.

19 Did you have similar cost concerns in
20 the nonautomotive applications?

21 MR. FITZSIMMONS: Objection. Form.
22 Mischaracterizes witness's testimony.

1 A They do.

2 MR. TURNER: You guys want to break for
3 lunch?

4 MR. FITZSIMMONS: I was just going to
5 say, we've been going about an hour and a half.
6 Might be a good time to take a break.

7 MR. TURNER: All right.

8 (Recess taken from 12:16 p.m. to
9 1:05 p.m.)

10 BY MR. TURNER:

11 Q All right, Dr. Jiao. We discussed a
12 little bit about SAE standards and regulations in
13 the prior session.

14 I understand you've taught some classes
15 for SAE; is that correct?

16 A I taught some classes. SAE is a
17 facilitator to facilitate these courses. It
18 doesn't have to go through SAE.

19 Q Okay. Which courses have you taught
20 through SAE as a facilitator?

21 A I have three. They're all called
22 automotive lighting. And first class is called a

1 design and a technology. The second course is
2 called testing and standards. The third one is
3 called LED applications.

4 Q All right. And do you still teach
5 these classes?

6 A I do.

7 Q And when did you first start teaching
8 these classes?

9 A 2002.

10 Q So the first one you mentioned, it was
11 design and technology; is that correct?

12 A Correct.

13 Q All right. What are some of the
14 objectives of this class?

15 MR. FITZSIMMONS: Objection.
16 Relevance.

17 A Is to provide overview of automotive
18 lighting design principles and industry practice
19 and technology over.

20 Q Do you also cover some of the legal
21 aspects related to lighting?

22 MR. FITZSIMMONS: Objection.

1 Relevance.

2 A That is my second class, testing and
3 regulations.

4 Q Okay. So in testing and regulations,
5 what legal aspect do you discuss?

6 A Well, I -- in my class, I introduce our
7 legal infrastructure for the United States and
8 throughout the world, who are the rule makers and
9 the process of develop rules and enforce the rules
10 and filing the petition to ask of interpretations,
11 or others, to make sure the products comply. And,
12 I also point out the differences, if any, between
13 industry standards and the U.S. federal
14 regulations.

15 Q Okay. So if we go back to the first
16 class, which was the design and technology, who is
17 your target audience? Who attends these classes?
18 Engineers? Undergrad?

19 MR. FITZSIMMONS: Objection. Scope.
20 Objection. Relevance.

21 A It's whoever is interested in
22 understanding the lighting product. Primarily,

1 the audience came from automotive industry and can
2 be the OEM personnel or lighting supplier
3 personnel or another tier of personnel who supply
4 materials, for instance, to the lighting
5 companies.

6 One time -- I also had an in-house
7 lawyer in my class before, when I was teaching it.

8 There's, interesting enough, I often
9 have audience come from companies' purchasing
10 department and they want to understand the
11 lighting perspectives, in terms of their sourcing
12 criteria, decisions. And often, the purchasing
13 department is also responsible for supplier
14 quality. For that reason, they'd like to
15 understand what are the requirements in order to
16 qualify their suppliers.

17 Q So the audience is not just engineers
18 designing the product, it's sales teams and
19 attorneys and other people in the industry?

20 A Right. But, primarily, it's all in the
21 industry. I don't remember outside of industry.
22 Primarily, within automotive industry.

1 Q Okay. Now, do you focus on forward
2 lighting for these classes or is it forward
3 lighting, rearward lighting, other types of
4 automotive lighting?

5 A All my classes is largely focused on
6 exterior lighting.

7 Q Okay.

8 A I think only one of the classes, one
9 chapter has a little bit for interior lighting.

10 Q So what type of light sources do you
11 discuss in these automotive lighting classes?

12 MR. FITZSIMMONS: Objection. Scope.

13 A My class covers the concept light
14 source, in general, how the light is generated.

15 The class also covers the history, how
16 the light sources are developed. I didn't talk
17 about candela because we don't need to talk about
18 it.

19 Q We don't need to go there.

20 A For incandescent and to discharge and
21 to solid-state lighting. I described, generally
22 speaking, the characteristic light sources.

1 Q When looking at regulations, the
2 regulations, are they the same, regardless of the
3 type of light source?

4 MR. FITZSIMMONS: Objection. Form.
5 Scope.

6 A Are you referring to automotive
7 lighting regulations?

8 Q Right. So let me clarify.

9 So for regulations on automotive
10 headlighting -- headlamp lighting for forward
11 lighting, do the regulations specify the light
12 source and how they might be -- the regulations
13 are different for different light sources?

14 MR. FITZSIMMONS: Objection. Form and
15 scope.

16 A In the federal level, headlamp devices
17 are regulated as the product being installed on
18 the vehicle. But because some of the lamps have
19 replaceable light source, if you recall, there's
20 some incandescent bulbs you can even change
21 yourself, for that reason, in the federal level,
22 they also have a regulation specifying what kind

1 of light sources comply with the regulations.

2 Q So, now, in your SAE class, do you also
3 discuss optical design?

4 A The class does.

5 Q What type of optics are covered in the
6 class?

7 MR. FITZSIMMONS: Objection. Scope.
8 Relevance.

9 A The class teaches the optical -- optics
10 principles described what is optics. This branch
11 of physics describes, primarily, in two
12 categories, imaging optics and non-imaging optics,
13 both under geometric optics category. Where
14 lighting, in large, is non-imaging optical device.
15 So the class, or me, spent the most of time
16 providing information for designing non-imaging
17 optical devices used in automotive lighting
18 applications.

19 Q Can you clarify, what are the
20 differences between an imaging optic versus an
21 non-imaging optic?

22 A The fundamental difference is an

1 imaging system is emphasis of how optical system
2 is forming an image of object measured by quality
3 of image. Principally speaking, is anything an
4 object, going through the optical system, will be
5 point-to-point form imaging. When forming this
6 imaging, the optical system introduces possible
7 errors, distortions, including a word I don't like
8 to pronounce. Astigmatism. So these are the
9 introduction, intrinsically, from optical systems
10 called aberration. So the imaging system is
11 emphasis of correction of aberration corrections.
12 Imaging system does not include a light source.
13 Whatever the way to analyze optical system,
14 largely, using a retracing approach, is to
15 identify how well you can form an image with
16 minimal aberrations. Non-imaging system, it
17 doesn't care the image quality. That imaging
18 system is largely starting from a light source,
19 illumination source, and through an optical system
20 to redirect these lights in the desired angular,
21 in principal angular locations. Because the
22 lights carry energy, so, in principal, in the

1 energy system, it is really managing the energy
2 distribution.

3 Q You said the non-imaging optic, you're
4 using a light source within the headlamp assembly
5 itself to control redirection of light?

6 A What I said is non-imaging system
7 include the light source, often include the light
8 source. The non-imaging optical system is to
9 categorize how these lights, using individual
10 rays, coming from the light source, including
11 headlamp light source, through the optical system,
12 where these lights go. And to manipulate those
13 lights to go in direction where you wish, in an
14 angular distribution.

15 Q So this is controlling the light beam,
16 the angular distribution of the light beam?

17 A Correct.

18 Q Okay. So, the way you control these
19 optics, is that referred to as aiming, how you
20 would aim a light?

21 MR. FITZSIMMONS: Objection. Form.

22 A The headlamp concept, aiming, is

1 referring to totality of the headlamp, the whole
2 light coming from headlamp. That's where you use
3 the word "aiming."

4 Q Dr. Jiao, are you familiar with the
5 term "PARALUX."

6 A I don't think so. Can you further
7 clarify?

8 Q We'll move on.

9 So do you also discuss heat management
10 in your SAE class?

11 A It does.

12 MR. FITZSIMMONS: Objection. Scope.

13 Q What aspects of heat management do you
14 discuss in the -- your class directed to design
15 and technology?

16 MR. FITZSIMMONS: Objection. Scope and
17 relevance.

18 A I describe the nature of heat transfer
19 and the class also describes, based on the nature
20 of heat transfer, what is design consideration in
21 order to manage heat generated by the light
22 sources.

1 Q Are these some of the same design
2 considerations we discussed prior, as far as
3 regulations and customer requirements?

4 MR. FITZSIMMONS: Objection. Form.

5 A Standard regulations, they all have
6 temperature testing requirements, just as the
7 reason that automotive lighting is used in the
8 driving environment. The product, itself, is
9 subject to certain heat impact to begin with, and
10 the product, itself, also generates heat because
11 all the lighting devices have light sources.

12 So, in order to ensure the performance,
13 the lighting distribution requirements produced by
14 any lamp, the heat, generated by the light source
15 or externally from other components of the
16 vehicle, may change the performance of light
17 distribution. For that reason, you want to manage
18 the heat properly.

19 Q So you discuss different types of heat
20 management structures, such as heat syncs, along
21 those lines?

22 A Heat sync is one example, yes.

1 Q What other type of heat management
2 devices do you discuss in your class?

3 MR. FITZSIMMONS: Objection. Scope and
4 relevance.

5 A If I recall, we talk about the lamp
6 level material selections and geometry, and how
7 the light source relative to other boundaries of
8 heat interface.

9 Q Do you discuss adaptive
10 forward-lighting systems in your class?

11 A Yes.

12 Q What aspects of adaptive forward
13 lighting do you discuss?

14 A My class, first, introduced the
15 rationale why the lighting needs to be adaptive.
16 And the class described the condition change,
17 including road condition, driving condition, and
18 the weather condition.

19 And the class also described, with
20 these changes, the headlamp beam pattern, ideally,
21 should not be stationary, instead, they should be
22 adaptive for these conditions. The class

1 described, ideally, what are these variations
2 should it be, using example of road condition
3 change, bending road, curved road, or country
4 road, intersections. There's some consideration
5 of tunnel lights, so on and so on. And the class,
6 I believe, summarized, based on industry
7 consensus, is how many modes of adaptive beam
8 should be. And if I remember correctly, it should
9 be about three or four modes, like country road,
10 straightforward, high speed, bending road, and
11 intersection, or city lights, whatever they call
12 it.

13 Q So when you refer to "different modes,"
14 how do you design to accommodate different modes
15 with one incandescent?

16 A The combination for the mode change,
17 through the history of industry practice, and I
18 conclude there is about three approaches. You
19 can, A, change the entire beam pattern, either go
20 up and down, country road go up higher, city road,
21 you aim a little lower or left/right, swivel, left
22 and right, by changing entire lamp. The second

1 approach is by addition. You have a portion of a
2 light is a stationary, but when you have a need
3 case, such as curve, bending, you add lights. You
4 have more curve, you have more lights.
5 Intersection, you have corner light addition.
6 First, change the whole thing. Second is by
7 addition. Third lighting, I also described you
8 maybe change optics partially and meaning some
9 part of optics is stationary. When adaptive
10 features needed, you can change a portion of the
11 optics to make a portion of the light left/right,
12 or up and down. I think that's the three
13 categories that I summarized in terms of executing
14 adaptivity of the headlamp.

15 Q So those are three different design
16 strategies for headlamp assembly, to accommodate
17 all the adaptive forward-lighting system modes?

18 A If I recall, that's how I summarized in
19 the class.

20 Q Do you know if all those three options
21 have been commercialized?

22 MR. FITZSIMMONS: Objection. Scope.

1 And relevance.

2 A I know the addition, definitely, is
3 commercialized. You can always add beam
4 contributor to add more lights in a desired
5 fashion.

6 I also know the whole lamp being
7 changed up and down, I mentioned you guys have
8 automatic leveling and swivel, left and right,
9 that's highly commercialized.

10 The third approach is by only changing
11 portion of the optics. I don't know. I don't
12 remember. I don't remember any commercialized.
13 They might. I just don't have that.

14 Q Now, you also teach a class on the LED
15 applications; is that correct?

16 A Yes.

17 Q What is the focus of that class?

18 MR. FITZSIMMONS: Objection. Scope and
19 relevance.

20 A The class teaches fundamentals of LED
21 and how those LED work. And the class also
22 teaches how to test LED in case LEDs are measured

1 differently, often. Then the class teaches,
2 because of LED, and there's other additive
3 features that other light sources cannot achieve.
4 For instance, you can use LEDs to -- in
5 conjunction with a light pipe to make the light
6 source almost remote from the lamp. Not lighting,
7 the light pipe. So the lighting features can be
8 achieved when that source is not feasible.

9 Q Can you explain that a little bit?
10 What do you mean by a "light pipe"?

11 A I'm using terminology, optical fiber.
12 Do you understand the word fiber optics? It's the
13 same concept using TIR, total internal reflection,
14 where it just much larger, looks like a pipe. So
15 light source, such as LEDs, is emitting the light
16 at the end of it, usually, end of light pipe, or
17 light guide, and that location can be away from,
18 you know, light source -- I mean, away from a
19 lamp, immediate lamp location. Then the light
20 travel through the fiber or optical guide or pipe,
21 and by designing such light pipe, light guide,
22 with intentional leakage on a sidewalk, you can

1 emit a light in a fashion that's needed for
2 automotive applications. It would also be called
3 indirect lighting. You don't directly use LED,
4 but you use LED to emit the light to a light pipe
5 or light guide, that guide emitting light.

6 Q Okay. Are you familiar with the term
7 "solid-state lighting," or SSL?

8 A Yes.

9 Q Is that another term for LEDs or does
10 that refer to something else?

11 A What industry defined, government
12 agree, solid-state lighting, including the light
13 sources all in solid-state format. That is
14 light-emitting diodes, LED, and laser diodes, LD,
15 and organic LEDs, OLEDs. They're all under the
16 category of solid-state lighting.

17 Q So solid-state lighting is just a
18 broader term that includes LEDs and other types of
19 light sources; is that correct?

20 A It is correct to distinguish other type
21 of emitting source as also solid state.

22 Q Do you also discuss LED performance

1 relative to the regulations during this -- in this
2 class?

3 MR. FITZSIMMONS: Objection. Scope and
4 relevance.

5 A What do you mean "performance"?

6 Q As far as, for example, you said the
7 regulations have certain requirements for the
8 luminous flux, right, or the luminous -- what
9 term? Strike that.

10 Do you discuss the performance of the
11 LEDs in your class?

12 MR. FITZSIMMONS: Objection. Scope and
13 relevance. Objection to form.

14 A What do you mean by "performance"?

15 Q The output of the LEDs relative to
16 requirements.

17 A The class describes the LED's
18 characteristic, for instance, the light output
19 changes over time, the light -- I mean, the color
20 change over time. The light output changes space
21 on the temperature. These characteristics are
22 discussed in the class.

1 Q Do you discuss how LED technology has
2 changed over time?

3 MR. FITZSIMMONS: Objection. Scope and
4 relevance.

5 A The class described the technology, as
6 well as the road map, how the LED were initiated
7 and where it is. It even -- whatever the time
8 frame of when I taught that class, there is a road
9 map of LEDs.

10 Q Can you provide a summary of how LED
11 technology has changed over time with respect to
12 the luminous flux?

13 MR. FITZSIMMONS: Objection. Form.
14 Objection. Vague.

15 A Over the time, LED luminous efficacy
16 measured by lumen per watts, that has been changed
17 significantly.

18 The second quantifiable measurements,
19 which I don't remember, is often it is used lumen
20 per dollar, meaning the cost of emitting light
21 from the LED also being reduced over the time.
22 And I think there is also improvement in LED

1 stability over the time.

2 Q Can you quantify how the luminous
3 efficacy has changed over the time period from,
4 say, 2003 to today.

5 MR. FITZSIMMONS: Objection. Form.
6 Vague.

7 A They have doubled.

8 Q How about lumens per dollar, how has
9 that changed over the past 20 years?

10 MR. FITZSIMMONS: Objection. Form and
11 vague.

12 A That has been changed quicker than the
13 efficacy, maybe even magnitude of change. \$10 may
14 become one dollar.

15 Q What are some of the reasons for that
16 significant change in the lumens per dollar?

17 MR. FITZSIMMONS: Objection. Form.
18 Objection. Scope.

19 A U.S. LED will believe it's the Chinese
20 government manipulation.

21 In early 2000, Chinese government
22 stepped in and subsidized a huge, huge amount of

1 money to LED makers in China, brought the
2 technology into that country to mass-produce LEDs
3 in China. To an extent, it is so much, in the big
4 sense that, really, affect the total product cost
5 reduction based on China's growth in the LED
6 industry.

7 Q So, are most LEDs manufactured in China
8 today?

9 A LED, the key element is the -- I can't
10 pronounce. The wafer that were not actually made
11 in China. They're all still made in Japan, that's
12 the largest one, in Germany, and U.S. But the
13 wafer diced into individual dye and packaged out
14 is largely in China, as well as contract --
15 contracting party from these major companies in
16 Malaysia, China and Malaysia.

17 Q Okay. So more, I guess, the final
18 assembly is done in China?

19 A The package, LED package will put a dye
20 into the package including phosphor. Off the top
21 of my head, I believe China is the largest. But
22 others, they still have, largely Malaysia, and

1 other manufacturers, but Japan still have some,
2 China, Malaysia, yes.

3 Q So when you mentioned that the efficacy
4 doubled. By that, does that mean it takes half as
5 many LEDs to generate the same amount of output as
6 it did 20 years ago?

7 A What I meant is same amount input-wise,
8 the efficacy is matching lumen per watts. So
9 20 years ago, whatever the efficacy is, it's the
10 same amount while you produce twice as much lumens
11 per watts.

12 Q Okay. So you had the same number of
13 LEDs, but they provide twice as much lumens?

14 MR. FITZSIMMONS: Objection. Form.

15 A I don't think I mentioned number of
16 LEDs. I say lumen per watts, amount of light
17 produced by LEDs.

18 Q So this is light relative to the amount
19 of input power, in wattage?

20 A That's called efficacy, yeah.

21 Q And what is the reason for that
22 improvement?

1 MR. FITZSIMMONS: Objection to scope.
2 Relevance.

3 A I think I answered that question
4 before. I can reiterate.

5 The first is the dye improvement, is
6 the quantum efficiency improvement. The emission
7 capability, how much light come from the dye.
8 That is largely based off the process, the purity
9 of materials, all the semiconductor technologies.

10 The second part was phosphor
11 improvement. And phosphor efficiency also being
12 improved, the stability as well.

13 Thirdly is the optical capability, in
14 terms of collecting the light that's being emitted
15 and being used in LED package.

16 The final is the first two, the optical
17 part is less as significant as the first two, dye
18 improvement and phosphor improvement.

19 Q So the third class you teach has to do
20 with automotive lighting and the testing
21 requirements for it; is that correct?

22 A Yes.

1 Q And so, you mentioned the SAE group is
2 involved with the creation of the lighting
3 standards for the U.S.?

4 A SAE Lighting Standard Committee is
5 responsible to develop the SAE standards, not just
6 America, including Canada, that's North America.
7 That standard is equally adopted in Canada as U.S.

8 Q And then, they harmonize with other
9 international bodies for standards?

10 A Other international bodies do not have
11 industry standards, they have their country and
12 international regulations. And we, United States,
13 as far as I know, is only country; we have
14 industry standards. And the reason being so, I
15 mentioned earlier, because our country, our
16 regulations, our law system, two-tier system, we
17 have federal law, we have a state law. And
18 federal law, namely, federal regulation, governs,
19 in the federal level, what automotive lighting
20 shall comply. And state law option can be a
21 little different, but older state law is
22 hierarchy, you have to, first, meet the federal

1 law. For whatever reason, the federal law does
2 not have a requirement, such as fog lamp, and
3 state law would have it. And for that reason, the
4 state law referred to industry standard, namely,
5 SAE standard.

6 I don't believe that's the case in
7 Europe or in China. We're the only -- well,
8 Canada they don't have SAE, SAE included a member
9 from Canada. So the countries having the
10 standards developed by industry, yes, by that
11 group, that committee.

12 Q Okay. So you also mentioned, prior,
13 that there is a mechanism for enforcing these
14 standards.

15 Can you explain, what's the enforcement
16 mechanism for the standards?

17 MR. FITZSIMMONS: Objection. Scope and
18 relevance.

19 A My understanding is this country will
20 also have two tiers of the enforcement. In the
21 federal level, and NHTSA, as I mentioned, there's
22 rule-making group, they write the law, but there's

1 a much bigger group, called the enforcement group.
2 The federal level, the enforcement group does is
3 selecting -- select the product, the product that
4 means on the road, and take these product,
5 largely, headlamps, into an independent
6 laboratories and test these product performance.
7 And to ensure these product performance comply to
8 the federal regulations. If they don't,
9 obviously, there's tons of consequences, including
10 recall, if responsible.

11 In a state level, if enforcement is
12 done by a state trooper. And based on, largely,
13 that particular state or particular trooper's
14 knowledge of automotive lighting requirement, and
15 state trooper, for whatever reason, can stop the
16 vehicle based on that trooper's interpretation of
17 that lighting's requirement, provide a citation,
18 say that you violated state law.

19 Q So an automotive lighting company would
20 need to have their product certified by a lab to
21 meet federal regulations; is that correct?

22 A That's not correct. Interesting

1 enough, we are also the country, we're called
2 self-approval. The government allocated the
3 certification approval of your product to the
4 manufacturer; meaning, if you produce a vehicle,
5 drive on the road, you already approved that
6 vehicle and the lighting complied with the federal
7 law. Government does not test it. But if they
8 pick one, test it, then you have a compliance
9 issue.

10 Q So some self-regulating by the
11 manufacturer? They need to --

12 A Self-approval.

13 Q Self-approval?

14 A Regulations done by the government.
15 Self-approval.

16 Q So in this class, you discuss some of
17 the different tests for companies to approve for
18 the self-approval, or to test their own products;
19 is that correct?

20 MR. FITZSIMMONS: Objection. Scope and
21 relevance.

22 A I don't believe the class teaches

1 approval process. The class provides information,
2 what needs to be tested and how to do the test,
3 why -- often, that also explains why the testing
4 standard was written as such.

5 Q And this testing is all external
6 lighting, or is it limited to certain types of
7 automotive lighting, like, forward versus
8 signaling?

9 MR. FITZSIMMONS: Objection to form.

10 A The test standards written by SAE are
11 for all exterior lighting. The most common test
12 for every lamp is the photometric photometry
13 testing. That test is testing where light goes,
14 in terms of angles. All the lamps is for angular
15 and test distribution, except the one lamp.

16 You guys don't care about that lamp
17 either, license plate lamp. License plate lamp is
18 also federally regulate. But that lamp is not
19 tested in angular distribution, it tested how the
20 light projects the license plate, which is the
21 reason why everyone can see the license plate.

22 The testing how the optical test or

1 photometry test shall be conducted, there's
2 general guidelines in the industry that follows
3 regulations, that include how to set up test
4 criteria. Because all the lamps are testing,
5 ignore license plate lamp, is testing angular
6 distribution, testing distribution. Again,
7 angular and testing distribution, independent how
8 far you test, the concept of the light, headlamp,
9 with the lightbulb included, is to project the
10 light to a far, from very far. You either see the
11 road or you see the signal. In general, it
12 doesn't matter the size of the lamp. It's a light
13 that matters.

14 For that reason, we test all the lamps
15 by its angular testing distribution. But,
16 physically, we need to set up the distance to test
17 it and calibrate it in a way so that you can use
18 that meter, photometer to read candela, which is
19 angular distribution number. That distance is
20 regulated by government, that was agreed as a
21 standard.

22 We have two different distance headlamp

1 for testing distance, a single lamp will test
2 another distance. But that distance is fixed,
3 every single lamp throughout the country and the
4 world, it all uses the same distance. For that
5 reason, we can have a calibration for all the
6 photometers in that lab.

7 There's other test guidelines that's
8 needed to be taught in the class because for all
9 the lamp, especially headlamps, we only test
10 certain points, and you cannot test every single
11 point and there is reason for that. Now, what do
12 we do for these points you don't test? So there's
13 guideline that is provided in the class.

14 Besides the photometry test and, yes,
15 there's a group, which we call environmental test,
16 that's grouped into three parts, mechanical,
17 temperature, and humidity. And that environmental
18 test is generally same, except the headlamps, we
19 have additional tests, for the reason headlamps
20 may be more critical.

21 Q Now, for this testing, are you using
22 external sensors or, I guess, internal sensors to

1 the light assembly or what would be vehicle-level
2 sensors?

3 MR. FITZSIMMONS: Objection. Scope and
4 relevance.

5 A Are you referring to photometric tests?

6 Q Yes.

7 A Photometric tests is test a lamp being
8 let in the laboratory conditions in all cases, and
9 using photosensor to test the light from the lamp,
10 what we call the photometer, it's really a photo
11 sensor.

12 Q Is the photo sensor included in the
13 headlamp assembly?

14 A No. The photo lab -- photo sensor,
15 through the test-required photo sensor, is a
16 testing device in the laboratory, not inside of
17 headlamp. Headlamps only emit light.

18 Q So, do the headlamp assemblies include
19 their own sensors for monitoring the emitted
20 light?

21 A They can, but it's not required.

22 Q If a headlamp assembly does include

1 that type of sensor, would it be mounted in the
2 headlamp itself or an external headlamp?

3 A I think industry practice is both,
4 especially if you utilize camera, that's a sensor.
5 Most of the time, it acts outside the headlamp.

6 Q Okay. So if the camera is outside of
7 the headlamp, this would be a separate component
8 vehicle camera that's used for multiple
9 applications?

10 MR. FITZSIMMONS: Objection. Form.

11 A It can be either.

12 Q So if a camera is mounted external to a
13 headlamp assembly, how do they -- how does the
14 system correlate that point of view, that image
15 relative to the headlamp assembly itself?

16 MR. FITZSIMMONS: Objection. Form.

17 Objection. Incomplete hypothetical.

18 A I didn't say it has to be outside. It
19 can be either. In all cases, imaging information
20 from camera is going to an engine-gathering
21 processor and processors, in turn, provides the
22 control unit of the headlamp and become a

1 controlled event to operate the headlamp,
2 according to whatever the sensor's input end users
3 instruct.

4 Q So how do you correlate the image from
5 the sensor from a camera that's mounted remote to
6 the headlamp assembly?

7 MR. FITZSIMMONS: Objection. Form.
8 Objection. Incomplete hypothetical.

9 A I still don't understand the question.
10 Can you rephrase it?

11 Q Sure.

12 A What does it correlate?

13 Q So, for an LED headlamp assembly, how
14 do you use the image collected from a camera?

15 A Well, it depends upon the purpose,
16 right? The image, ADB case is that the image,
17 most likely, is to detect the vehicle in front of
18 you, whether it's proceeding or in the front of
19 you, and usually, the image and information
20 including projected width or height, or whatever
21 that information is. And the processors takes the
22 image and to transfer it to a command, command to

1 the headlamps to operate, in this case, an ADB or
2 LED lamps that they had either multiple LED
3 sources or multiple modulators. They can control
4 commonly.

5 Q Now, if the camera's mounted at a
6 different location from the headlamp assembly,
7 does that create issues with the control?

8 MR. FITZSIMMONS: Objection. Form.
9 Objection. Incomplete hypothetical.

10 A I don't see there's reason to create
11 that issue.

12 Q Is the point of view different or the
13 angle between the camera optical axis, whether
14 it's mounted with the headlamp assembly itself
15 versus remote?

16 MR. FITZSIMMONS: Objection. Form.
17 Objection. Incomplete hypothetical.

18 A In all cases, though, cannot be
19 calibrated.

20 Q So you need a calibration to correlate
21 those different positions, the image generated
22 from a headlamp assembly versus from an image

1 generated from a different location?

2 MR. FITZSIMMONS: Objection. Form.

3 A I think, objectively, it's whether it's
4 the headlamp itself or some angle of the vehicle
5 is whatever matter to the object being detected,
6 whether it's been pattern matters, whether it's
7 preceding vehicle or oncoming vehicle. If they're
8 in the beam pattern view, regardless where it's
9 detected, they all need to be calibrated.

10 Q So you mentioned using a camera to
11 detect an object such as a vehicle.

12 Can you use a light sensor for
13 detecting another object?

14 A I think so.

15 Q With a light sensor, can you detect
16 specific objects or just the presence?

17 MR. FITZSIMMONS: Objection. Form.
18 Objection. Incomplete hypothetical.

19 A I think it depends on the resolution
20 for the sensor.

21 Q So what kind of resolution would you
22 need for a light sensor to detect other objects?

1 MR. FITZSIMMONS: Objection. Form.

2 Objection. Incomplete hypothetical.

3 A I can't quantify that. The goal for
4 using whatever sensing system is to be able to
5 determine in what part of headlight high beam
6 needs to be dimmed or blocked to avoid a glare.
7 So that resolution requirement is the final
8 performance requirement, applying camera, applying
9 sensor, applying everything is, as long as that
10 resolution meets that requirement. Can't quantify
11 it. I don't believe the industry has a
12 quantification.

13 Q So, with ADB, how do you detect the
14 position of another object, such as another
15 vehicle, in the forward field of view?

16 A How do I do it?

17 Q How would a LED headlamp assembly
18 detect, that uses ADB, how would it detect a
19 vehicle in the forward field of view?

20 A Within headlamp assembly? Is that what
21 your question is?

22 Q Within that headlamp system.

1 A You can integrate a sensor in the
2 system or can be a camera in the system.

3 Q So what type of sensor would you use?

4 A Optical sensor. You can detect the
5 light.

6 Q And then, once you detect the light,
7 would you need any specific type of image
8 processing to identify different objects?

9 MR. FITZSIMMONS: Objection. Form.
10 Objection. Incomplete hypothetical.

11 A Any detection of a sensing
12 information needs to be processed to determine
13 whatever you want, shape, the objects in front of
14 you. The process is given as part of the purpose
15 to use the detector to be able to process.

16 Q So how would the processing be
17 different between when you're using a system with
18 a light sensor versus a camera for detecting
19 another object?

20 MR. FITZSIMMONS: Objection. Form.
21 Objection. Incomplete hypothetical.

22 A The logic's not different. Depends

1 upon how the signal is gathered.

2 MR. TURNER: All right. You guys want
3 to take a five-minute break?

4 MR. FITZSIMMONS: Sure.

5 (Recess taken from 2:10 p.m. to
6 2:27 p.m.)

7 BY MR. TURNER:

8 Q All right. Dr. Jiao, in the last
9 session, we discussed some of the improvements of
10 LED technology over time.

11 Have some of these improvements, have
12 they affected the adoption of LEDs in automotive
13 headlamps?

14 MR. FITZSIMMONS: Objection. Form.

15 A Yes.

16 Q How have they affected the adoption?

17 MR. FITZSIMMONS: Objection. Form.

18 A The increase of luminous efficacy helps
19 to use less number of LEDs. And the cost value
20 also helps to implement LED (indiscernible).

21 Q So, over time, cost was reduced and you
22 could use less LEDs to achieve the same output; is

1 that accurate?

2 A Correct.

3 Q And when we discussed the timeline of
4 adoption for, I guess, commercialization of the
5 LEDs, you mentioned the first -- a headlamp
6 assembly that included LEDs for low beam, but not
7 the high beam. And I believe that was for a Lexus
8 application; is that correct?

9 MR. FITZSIMMONS: Objection. Form.
10 Mischaracterizes the witness' testimony.

11 A I said, as I recall, Lexus, that I
12 know, at that time, did not include high beam. I
13 also said, my knowledge, Lexus claimed that was
14 the first LED headlamp on the road.

15 Q Okay. And do you remember what year
16 that was?

17 A It was beginning of 2000s, I don't
18 remember what year it was. Early 2000s.

19 Q Early 2000s.

20 Do you know when the first LED
21 automotive headlamp that included LEDs for high
22 beam functionality was commercialized?

1 MR. FITZSIMMONS: Objection. Scope and
2 relevance.

3 A I don't remember the year.

4 Q General, 2000s, after 2010?

5 MR. FITZSIMMONS: Objection. Calls for
6 speculation. Objection. Form.

7 A Can't clarify.

8 Q Are there headlamps, LED headlamps that
9 include LEDs for low beam and high beam available
10 for sale today?

11 MR. FITZSIMMONS: Objection. Scope and
12 relevance.

13 A I think so. I think my vehicle has
14 both.

15 Q Okay.

16 A And intentionally.

17 Q So sometime between 2000 and 2023, they
18 were introduced for high beam, occasionally; is
19 that fair?

20 MR. FITZSIMMONS: Objection. Form.

21 A I can't pinpoint what were high beam
22 became implemented.

1 Q Do you know when adaptive headlamp
2 technology was first adopted or commercialized in
3 the U.S.?

4 MR. FITZSIMMONS: Objection. Form.
5 Scope. Relevance.

6 A AFS or ADB?

7 Q Both.

8 MR. FITZSIMMONS: Same objections.

9 A Well, before February this year, this
10 country doesn't allow ADB. Technically, our law
11 didn't specifically say AFS is not allowed. For
12 that reason, U.S. vehicles, vehicles equipped with
13 AFS, can perform selective AFS functions within
14 the compliance of the law many, many years ago. I
15 can't pinpoint a year.

16 As soon as Europeans introduced AFS, I
17 think we, not lobbied, we requested interpretation
18 from NHTSA whether certain functions, such as
19 swivel, could be allowed in U.S. The answer
20 became yes.

21 Q So the answer became yes?

22 A Yes. From U.S. I don't remember when,

1 so that's the reason we did have a selective
2 ADB -- or AFS function in U.S. Not promoted by
3 law, but the law doesn't prohibit.

4 Q So AFS functionality was available
5 prior to February of this year, in the U.S.
6 market?

7 MR. FITZSIMMONS: Objection. Form and
8 scope.

9 Q Do you know if AFS can be enabled or
10 disabled in a vehicle?

11 MR. FITZSIMMONS: Objection. Scope.
12 Objection. Relevance. Objection. Calls for
13 speculation.

14 A I assume it can be disabled.

15 Q Dr. Jiao, are you familiar with
16 high-brightness LED chips?

17 A Yes.

18 Q What is high-brightness LED chip?

19 MR. FITZSIMMONS: Objection. Scope and
20 relevance.

21 A High brightness compared to low
22 brightness.

1 Industry debates about that terminology
2 and it is intentional not to quantify what is high
3 brightness. Generally speaking, there is, you
4 know, category how much lumen is brightness, but I
5 can't pinpoint it, for the reason we didn't want
6 to quantify high brightness. What is numbers high
7 brightness. So we, sometimes, we use a range, but
8 I don't remember that range.

9 Q Do you know what applications these
10 high-brightness LEDs are used for, for example,
11 high beam versus low beam applications?

12 MR. FITZSIMMONS: Objection. Form.
13 Scope. Relevance.

14 A The concept of high-brightness LED was
15 referring to the LEDs bright enough to use as
16 illumination device. And in my experience,
17 automotive headlight applications, always high
18 brightness.

19 Q So all LEDs for an automotive LED
20 headlamp assembly could be considered high
21 brightness?

22 MR. FITZSIMMONS: Objection. Form.

1 Objection. Mischaracterizes testimony.

2 A Doesn't have to be. In my memory,
3 often, that's the practice.

4 Q Are thermal management strategies
5 different for a high-brightness LED chip versus a
6 regular LED chip?

7 MR. FITZSIMMONS: Objection. Form.
8 Objection. Relevance. Objection. Scope.

9 A I don't recall, in at least my teaching
10 for thermal management, had to distinguish between
11 high brightness or not high brightness.

12 Q Dr. Jiao, are you familiar with an
13 organization called the Alliance for Solid-State
14 Illumination or ASSIST?

15 MR. FITZSIMMONS: Objection. Scope and
16 relevance.

17 A Yes.

18 Q Do you know what this organization
19 does?

20 A Yes.

21 Q Can you provide a summary of what this
22 organization does?

1 MR. FITZSIMMONS: Objection. Scope and
2 relevance.

3 A It's an abbreviation, doesn't make
4 right. Can you repeat the letters again?

5 Q The acronym might be incorrect.

6 A Right.

7 Q Alliance for Solid-State Illumination.

8 A I think it somehow doesn't seem like
9 it's complete. The alliance that formed, that I'm
10 aware, very similar to terminology, was industry
11 alliance to support Department of Energy, energy
12 saving act -- actually, Department of Energy is
13 under some kind of Congress law act for saving
14 energy. They formed such alliance -- are we
15 talking U.S. or internationally?

16 Q Well, we'll start with the U.S.

17 A We have one of the alliance, actually I
18 this -- the alliance in U.S. was industry members,
19 major LED companies or lighting companies forming
20 alliances to establish commercialization for LEDs.
21 But it was aimed for general illumination. That's
22 the reason it's partners with DOE. There's

1 alliances for (indiscernible) lighting
2 internationally, that organization, I'm not
3 extremely familiar, but I have a knowledge it
4 was -- it's the same concept is to look at
5 energy-saving benefit of LEDs by establishing some
6 consistent LED performance-related measurements.

7 Q Do you know if that was nonautomotive
8 applications? Was it -- or did it include
9 applications of automotive applications?

10 MR. FITZSIMMONS: Objection. Scope and
11 relevance.

12 A The one in U.S. does not include
13 automotive. The international alliance, I do not
14 remember.

15 Q Dr. Jiao, are you familiar with ioslux
16 diagrams?

17 MR. FITZSIMMONS: Objection. Scope and
18 relevance.

19 A Yes, I do. Can I -- now, you used an
20 acronym ASSIST, is that what you used before?

21 Q Correct?

22 A Oh, that, I do know. That's ASSIST in

1 RPI, RPI, Rensselaer Polytechnic Institute
2 Lighting Research Center. And they established a
3 program to, again, promote solid-state lighting
4 application. ASSIST is a program, I don't believe
5 is focused -- included for automotive. It's
6 largely, generally, ASSIST, alliance solid
7 state --

8 Q Yes.

9 A That's RPI, Lighting Research Center.

10 Q And was that the same one that you
11 mentioned before that was nonautomotive and geared
12 towards the United States?

13 A No, that's another alliance -- two
14 alliances. There's alliances by industry.

15 Q Okay.

16 A That is partnered with DOE, and that's
17 U.S. one, okay? And ASSIST is a program, it's not
18 purely academic, but it's an academic
19 organization, namely, Lighting Research Center of
20 Rensselaer Polytechnic Institute, to partner with
21 industry to conduct research on the benefit of
22 solid-state lighting, that includes potential

1 design implementations. That's the second. First
2 line is completely just partnership, allocated
3 funding and doing the development. There's also
4 international one sort of alliances that's largely
5 for energy-saving measures.

6 Q Okay.

7 All right. So if we can return back to
8 the ioslux diagrams.

9 You are familiar with these diagrams;
10 is that correct?

11 A Yes.

12 MR. FITZSIMMONS: Objection. Scope.
13 Relevance.

14 Q What is an ioslux diagram?

15 A Isolux is a graphic representation of
16 candela plotted in iso format and that you can't
17 indicate that particular headlamp. Candela-level
18 distribution in a special -- in an angular domain.

19 Q And by candela is a measure of what?

20 A Luminous intensity. Isolux can be,
21 also, projected on the road to protect project lux
22 distribution, such as bird's-eye view.

1 Q Again, that was for lumen intensity?

2 A Probably, I should correct. You used
3 the word "isolux," or isocandela, sometimes mixed.
4 Isolux is equal lux line connected together. Lux
5 is luminous measure. I'm sorry. Illuminance
6 measure. Illuminance is defined lumen per area, I
7 believe, is lux.

8 Q So that's illuminance is measured in
9 lux?

10 A Lux is unit to illuminance. I have to
11 really refresh. Illuminance is defined as lumen
12 per meter square.

13 Q Are isolux diagrams commonly used to
14 evaluate the performance of an LED headlamp
15 assembly?

16 MR. FITZSIMMONS: Objection. Form.
17 Scope.

18 A Isolux, in practice, is usually
19 computer-simulated result. I do not know if it
20 directly measures isolux. Isolux is the graphic
21 representation of the lux distribution on the road
22 surface to indicate headlamp performance.

1 Q But you're saying it's typically
2 computer-simulated, it's not based off of measured
3 testing; is that correct?

4 MR. FITZSIMMONS: Objection. Form.

5 A It can be both. The isolux is never
6 directly measured, it's either using the
7 computer-simulated candela output from angular
8 distribution and projected on the road, made
9 assumption, whatever, reflection of the road
10 surfaces and make it an isolux line. Or, you can
11 measure the headlamp candela distribution, in
12 turn, project on the road to plot the isolux line.

13 Q Okay. Are isolux diagrams used to
14 evaluate spatial distribution?

15 MR. FITZSIMMONS: Objection. Scope and
16 relevance. Objection. Form.

17 A I don't typically use that word,
18 "spatial distribution," related to the headlamp
19 performance.

20 Q Again, what does the term spatial
21 distribution mean to you?

22 A Spatial distribution is, principally,

1 based on angular distribution and then, maybe, if
2 add another dimension, distance, then it can be
3 also be considered spatial distribution.

4 (Jiao Exhibit 1 marked for
5 identification and attached to the transcript.)

6 Q Dr. Jiao, do you recognize this
7 document?

8 A Yes.

9 Q So what is this document?

10 A It's my declaration in regard to '029
11 patent.

12 Q Can you turn to page -- or to paragraph
13 229, please.

14 A I'm here.

15 Q So in your declaration, you analyze --
16 one of the grounds was you analyzed the
17 combination of Gotou and Karlsson; is that
18 correct?

19 A Yes.

20 Q For this combination, which reference
21 are you relying on for satisfying the light source
22 limitations?

1 MR. FITZSIMMONS: Objection. Form.

2 A Karlsson.

3 Q Do you know what feature of Karlsson?

4 MR. FITZSIMMONS: Objection. Form.

5 A LEDs.

6 Q All right. And which element are you
7 relying on for satisfying the processor
8 limitations?

9 MR. FITZSIMMONS: Objection. Form.

10 A I don't think I understand the
11 question.

12 Q So, do both references disclose a
13 processor or a controller?

14 A You're saying the process limitation is
15 referring to processors?

16 Q Correct.

17 A Both references include processors.

18 Q So you're relying on the processor of
19 both references for satisfying processor
20 limitation?

21 MR. FITZSIMMONS: Objection. Form.
22 Mischaracterizes witness's testimony.

1 A In my declaration, indicated, to me,
2 the processor related to limitations, I referenced
3 both references.

4 Q Do you rely on any hardware from either
5 of these references for satisfying other
6 limitation of the claim?

7 MR. FITZSIMMONS: Objection. Form.
8 Vague.

9 A Can you be more specific?

10 Q Are you relying on Karlsson's camera
11 for satisfying these claim limitations?

12 MR. FITZSIMMONS: Objection. Form.
13 Vague.

14 A I used Karlsson's camera, I relied on
15 Karlsson's camera descriptions to satisfy the
16 claim language related to camera limitations.

17 Q Does your combination include Gotou's
18 mechanism for moving or pivoting the headlamp
19 assembly?

20 A No.

21 Q Dr. Jiao, what is a person of ordinary
22 skill in the art?

1 A I think I provide a description in my
2 declaration, right?

3 Q You probably did. Do you know,
4 offhand, what a person of ordinary skill in the
5 art is?

6 A I'd prefer to just point you to the
7 paragraph in my declaration.

8 Q Okay.

9 A In my declaration, I state a person of
10 ordinary skill in the art is presumed to be aware
11 of all pertinent art, thinking along conventional
12 wisdom in art, and is a person of ordinary
13 creativity, not automation.

14 Q All right. Were you just reading from
15 a section of your declaration?

16 A Yes.

17 Q What paragraph was that?

18 A 27.

19 Q Okay. Do you consider yourself to be a
20 person of ordinary skill in the art?

21 A I do.

22 Q Is the person of ordinary skill in the

1 art relevant to a certain time frame?

2 A It is.

3 Q What time frame would that be?

4 A Time frame of this invention, the
5 challenged patent.

6 Q Do you consider yourself to have been a
7 person of ordinary skill in the art at the time of
8 this challenged patent, of the '029 patent?

9 A I do.

10 Q Dr. Jiao, can you turn to paragraph 19
11 of your declaration, please.

12 A I'm here.

13 Q So your first patent listed here is
14 7,144,141.

15 Do you recall this patent?

16 A Yes.

17 Q Do you remember what the novel aspect
18 was of this patent?

19 MR. FITZSIMMONS: Objection. Form.
20 Objection. Relevance.

21 A I don't recall. It largely related to
22 the title.

1 Q Do you remember the particular problem
2 you were trying to solve with this patent?

3 MR. FITZSIMMONS: Objection. Form.
4 Relevance.

5 A No, I don't remember.

6 Q Do you know if these -- any of these
7 patents on here were from your days at NAL?

8 MR. FITZSIMMONS: Objection. Form.
9 Relevance.

10 A A few are, yes.

11 Q Which ones?

12 A The patent number 6,953,261, titled
13 "Reflector Apparatus for Tubular Light Source,"
14 that is -- I'm sorry. That one's not NAL.

15 Patent number, the design patent Number
16 503,004, "Vehicle Fog Lamp." That's when I was at
17 NAL, and I think the rest of them are, too.

18 Q Okay.

19 A Yes, the rest of them. Wait a minute.
20 I'm sorry. I probably listed reversely, I guess,
21 in terms of patent number.

22 But at least that one and, also,

1 6,623,132, "Light Coupler Hingedly Attached to the
2 Light Guide for Automotive Lighting," that was
3 when I was at NAL.

4 There's others too.

5 Q Dr. Jiao, are you familiar with the
6 term "luminous spatial-angular distribution," or
7 LSAD?

8 A Can you repeat that question?

9 Q Are you familiar with the term luminous
10 spatial angular distribution?

11 A There's a spatial, slice, angular or --

12 Q Yeah, there's a hyphen.

13 A Oh. Yes.

14 Q What does that term mean to you?

15 A But luminous is definition of candela
16 per area. And it's a description of the light
17 source, light-emitting characteristics, generally.

18 So, by looking at the light source, and
19 from the emitting surface, there is spatial, in
20 the heating surface, and an angular distribution.

21 Q Okay. Do you know if there's an
22 equation that is used to define this relationship?

1 MR. FITZSIMMONS: Objection. Form.
2 Relevance. Incomplete hypothetical.

3 A I don't understand the question.
4 Equation to describe?

5 Q The luminous spatial angular
6 distribution.

7 MR. FITZSIMMONS: Same objections.

8 A I don't remember the equation, per se.

9 Q Okay. What is some of the design
10 criteria that you use when designing an LED
11 lighting system?

12 MR. FITZSIMMONS: Objection. Form.
13 Objection. Asked and answered.

14 A LED headlamps?

15 Q Correct.

16 A The headlamp, obviously, you have to
17 divide two different device, low beam/high beam.
18 Each has its specific luminous intensity
19 distribution. The design criteria to design, I
20 assume you asked the question for LED-driven high
21 beam or low beam, usually, is based on the --
22 first, it's based on do we have enough -- there is

1 enough LEDs that produce the sufficient total
2 luminous flux within the beam pattern. And total
3 luminous flux, being projected in the low
4 beam/high beam, are not established in the
5 regulation or standard, but is a part of
6 engineering practice. As I described, because the
7 requirements are -- the performance requirements,
8 photometrical performance requirements are angular
9 distribution, measuring the candela in different
10 angle.

11 But a candela is related to luminous
12 flux, luminous flux being put into one angle,
13 another angle, another angle. Additively, there
14 is a bunch of light inside a beam pattern. That
15 is call beam lumen, the total beam, how much light
16 is put in there.

17 Based on regulations, standards, or
18 customer specifications, usually, there is desired
19 how much light you're putting into each beam
20 pattern, for instance, low beam, how much, high
21 beam, how much.

22 Those number changes. I'm just

1 hypothetically, the lumen, if you additively put
2 all the numbers together, run 1,000 lumen, 800 to
3 a thousand, that's a good performance.

4 The first criteria is how do you get
5 the thousand lumen to the beam pattern by
6 understanding what would be optical efficiency,
7 and the pick up the LED, the design optics to
8 distributor lights, remember, LED conversion, make
9 sure the lights go wherever you want them to.
10 Usually, we have industry guidelines, optical
11 efficiency. Most efficient optical system, how
12 much can you waste, how much can you put in the
13 beam pattern. Rule of thumb, 50 percent is a good
14 number.

15 If you need a thousand lumen as beam
16 pattern, inside beam pattern, to meet all the
17 points government needs, customer needs, you need
18 it to have 2,000 lumens for LED in order to make
19 it work.

20 Usually, that's the very first
21 criteria. And how many LEDs you need to pick to
22 contribute to this 2,000 initial lumen is based on

1 the LED performance level. Not lumen per watts,
2 but lumen per LED. If you have to have good LED
3 in today's world, easily, whenever you can
4 produce, much several hundreds of lumens, you can
5 use only a few LED packages. LED package can have
6 multiple dye in there.

7 If I design LED headlight, that would
8 be first criteria. Then there is, second criteria
9 is usually dictated by the OEM design studio,
10 whether they want to have a projector look or want
11 to have a reflector look, want to have a many
12 discrete LED look, that could also alter the
13 design strategy, how did you pick LEDs.

14 Q When you say "the look," that's from
15 the external appearance or the -- more the
16 performance, how the beam looks?

17 A Design studio, usually, only care about
18 how the vehicle look. Even the light, it's not
19 that. On the light, it's light and most of the
20 people do not care. The drivers care, but the
21 rest of the people don't care. So design studio
22 often dictate how my headlamps look like and what

1 type of optics they use. That will be very
2 essential for the design criteria.

3 If they need a modular, multiple, how
4 many they like, studio also sometimes provide a
5 demand.

6 Q Now, you mentioned -- sorry, go ahead.

7 A Well, there are other criteria
8 regarding how to do package size, thermal
9 management.

10 Q Go ahead. I didn't mean to interrupt.

11 A Yeah, and, also, in other mechanical
12 design parameters need to be considered.

13 So I would assume these are some
14 criteria. There could be more.

15 Q So you mentioned, earlier, about the
16 different input voltage supplied to an LED
17 lighting system as compared to conventional light
18 system, that maybe had 12-volt supply and I
19 believe you mentioned there was a different input
20 voltage to each LED.

21 Do you recall that? Okay. Strike
22 that.

1 What's the input voltage supplied to an
2 LED light system, for headlamp applications.

3 A The industry common practice for
4 operating LED used in headlamp, LED dye itself, is
5 around three volts per dye. But LED package can
6 configure in the way you have a parallel plus
7 series of the connections. Packaging level of
8 voltage input doesn't have to be three volts, it
9 can be anywhere between three volts and 12 volts,
10 depends upon your electric connections available
11 to the dye within the package. Because each
12 package can have multiple dyes.

13 Q And the configuration of the LEDs would
14 affect that voltage, series, or parallel
15 configuration; is that correct?

16 A Correct.

17 Q So each driver for an application is
18 designed to provide that specific input voltage;
19 is that correct?

20 A Usually, the headlamp designs a driver,
21 one headlamp have one dedicated driver, and
22 depends upon the LED dye configuration, a driver

1 should design, accordingly, how the LED is
2 being -- each dye being individually connected or
3 individually controlled, that's how you design the
4 driver.

5 Q Are optics one of the considerations in
6 the design criteria for a headlamp assembly?

7 A Yes.

8 Q And also the -- how about is the
9 direction of the light another design
10 consideration in the headlamp assembly?

11 A I don't think I understand the
12 question.

13 Q Is the desired aiming of a headlamp
14 assembly one of the -- a design criteria of it?

15 MR. FITZSIMMONS: Objection. Form.

16 A I don't think I fully understand the
17 question.

18 The headlamp aiming is only referred to
19 entire lamp.

20 Q And is that specified --

21 A I --

22 Q Sorry, go ahead.

1 A It is specified in the regulation and
2 the standards.

3 Q So if you're designing a light for a
4 fog lamp, it needs to meet specific aiming
5 requirements or a high beam is different aiming
6 requirements; is that correct?

7 MR. FITZSIMMONS: Objection. Form.
8 Compound.

9 A I don't believe there are fog lamp
10 aiming requirements, again, because fog lamp is
11 not federally regulated light.

12 I do not remember, clearly, what is
13 high beam aiming requirement. But when we talk
14 about aiming, we're largely focused on low beam
15 aiming requirements.

16 Q And cornering aiming requirements,
17 right?

18 MR. FITZSIMMONS: Objection. Form.

19 A I don't recall cornering aiming
20 requirements.

21 Q Now, before you mentioned, when you
22 were going to design a headlamp assembly for a

1 certain amount of lumens, I believe you said if
2 the design was 1,000 lumens, you would select LED
3 for 2,000 lumens; is that correct?

4 MR. FITZSIMMONS: Objection. Form.
5 Mischaracterizes witness's testimony.

6 A I think what I said was you want to
7 know what is the desired or required total beam
8 lumen. I used 1,000 as the example.

9 I also said, depending on how the total
10 system, headlamp system optical efficiency, that
11 you estimate it or calculate it. And if you know,
12 I said this, 50 percent efficient is not a bad
13 number. That's the reason I used the 50 percent
14 as an example.

15 Q Okay. So that was based on an
16 estimated efficiency of the system?

17 A Optical efficiency.

18 Q Okay.

19 MR. TURNER: We're all set.

20 MR. FITZSIMMONS: We'll take
21 two minutes. It might actually be two, so you
22 might want to stick around. Unless you want to

1 get a little leg stretch, but...

2 (Recess taken from 3:26 p.m. to

3 3:28 p.m.)

4 MR. FITZSIMMONS: We have no further

5 questions. We can close out. Thank you,

6 Dr. Jiao.

7 MR. TURNER: Thank you.

8 (Off the record at 3:28 p.m.)

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1 CERTIFICATE OF SHORTHAND REPORTER - NOTARY PUBLIC

2
3 I, JUDITH E. BELLINGER, RPR, CRR, Certified
4 Reporter and Notary Public within and for the State
5 of the District of Columbia do hereby certify:

6 That Jianzhong Jiao, Ph.D., the witness whose
7 deposition is hereinbefore set forth, was duly sworn
8 by me before the commencement of such deposition and
9 that such deposition was taken before me and is a
10 true record of the testimony given by such witness.

11 I further certify that the adverse party,
12 Volkswagen Group of America, Inc., was represented
13 by counsel at the deposition.

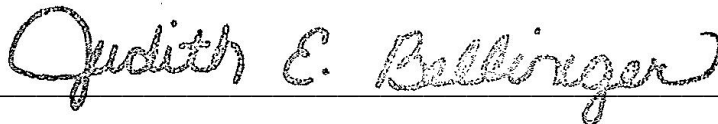
14 I further certify that the deposition of
15 Jianzhong Jiao, Ph.D., occurred at the offices
16 of Sterne, Kessler, Goldstein & Fox, P.L.L.C.,
17 1101 K Street, NW, Washington, DC 20005 on
18 Wednesday, August 2nd, 2023, commencing at
19 8:58 a.m. to 3:28 p.m.

20 I further certify the inspection, reading
21 and signing of said deposition was not waived
22 on the record by agreement of all parties.

1 I further certify that I am not related to
2 any of the parties to this action by blood or
3 marriage, I am not employed by or an attorney to any
4 of the parties to this action, and that I am in no
5 way interested, financially or otherwise, in the
6 outcome of this matter.

7
8 IN WITNESS WHEREOF, I have hereunto set my
9 hand this 9th day of August, 2023.

10 My commission expires: January 1, 2027
11
12

13 
14 _____

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16 THE DISTRICT OF COLUMBIA
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| A | | | |
|---|---|--|---|
| abbreviation 157:3 | achieve 18:7, 36:17, 37:19, 39:3, 128:3, 150:22 | 69:7, 69:22, 70:6, 70:15, 70:20, 70:22, 79:19, 80:2, 80:5, 80:10, 80:14, 145:16, 146:1, 148:13, 148:18, 153:6, 153:10, 154:2 | adopted 68:16, 136:7, 153:2 |
| aberration 120:10, 120:11 | achieved 63:8, 128:8 | add 52:3, 75:9, 105:17, 126:3, 127:3, 127:4, 163:2 | adoption 150:12, 150:16, 151:4 |
| aberrations 120:16 | acronym 69:7, 69:10, 157:5, 158:20 | added 34:15, 107:7 | advantage 89:3 |
| ability 24:21, 25:3 | act 157:12, 157:13 | adding 45:19, 54:19, 55:1, 63:8, 63:9, 69:19 | adverse 180:11 |
| able 88:4, 148:4, 149:15 | action 181:2, 181:4 | addition 58:17, 65:3, 86:6, 126:1, 126:5, 126:7, 127:2 | aec 112:8 |
| about 6:19, 13:11, 14:5, 19:3, 36:9, 56:18, 56:22, 57:1, 67:6, 104:7, 113:5, 113:12, 117:17, 124:5, 125:9, 125:18, 132:8, 140:16, 155:1, 173:17, 174:15, 176:8, 177:14 | activate 76:7, 76:8 | additional 33:9, 33:13, 33:15, 52:3, 52:18, 53:5, 69:19, 75:9, 85:3, 142:19 | aecq 112:10, 112:13 |
| above 65:5, 65:10, 95:8 | active 52:7, 68:2, 109:3, 109:7 | additive 92:21, 128:2 | affect 50:21, 78:2, 78:5, 133:4, 175:14 |
| academic 159:18 | active-type 51:21, 109:2, 109:6 | address 44:18, 48:9, 51:7, 54:11, 95:12 | affected 150:12, 150:16 |
| acceptable 102:18 | actively 67:14, 77:12 | adequately 56:20 | afs 68:6, 68:14, 68:16, 69:10, 69:15, 70:20, 71:4, 73:18, 74:2, 75:8, 79:12, 79:15, 79:18, 153:6, 153:11, 153:13, 153:16, 154:2, 154:4, 154:9 |
| access 92:22, 99:11 | acts 144:5 | adjacent 52:21 | after 11:11, 11:13, 45:3, 110:8, 152:4 |
| accommodate 87:20, 125:14, 126:16 | actually 133:10, 157:12, 157:17, 178:21 | adjust 49:5, 105:6 | again 23:7, 24:14, 24:20, 25:13, 27:3, 28:1, 29:13, 38:12, 46:14, 68:4, 72:17, 75:8, 78:13, 79:15, 82:21, 84:3, 97:8, 106:2, 107:20, 141:6, 157:4, 159:3, 161:1, 162:20, |
| according 23:15, 145:2 | adapt 69:15 | | |
| accordingly 176:1 | adaptable 70:17 | | |
| account 111:4 | adaptive 40:19, 68:5, 68:7, 69:9, 69:12, 69:22, 70:6, 70:8, 71:5, 79:16, 124:9, 124:12, 124:15, 124:22, 125:7, 126:9, 126:17, 153:1 | | |
| accredited 42:3, 42:5, 42:10 | adaptivity 126:14 | | |
| accurate 151:1 | adb 68:6, 68:14, 68:18, 68:20, 68:22, 69:5, | | |

| | | | |
|---|---|---|--|
| 177:10 agency 18:22 ago 35:20, 37:5, 97:7, 134:6, 134:9, 153:14 agree 129:12 agreed 141:20 agreement 66:11, 68:13, 180:22 ahead 105:19, 174:6, 174:10, 176:22 aid 98:6 aim 65:15, 75:10, 121:20, 125:21 aimed 73:1, 76:12, 157:21 aiming 121:19, 121:22, 122:3, 176:13, 176:18, 177:4, 177:5, 177:10, 177:13, 177:14, 177:15, 177:16, 177:19 aligned 91:8 alliance 156:13, 157:7, 157:9, 157:11, 157:14, 157:17, 157:18, 158:13, 159:6, 159:13 alliances 157:20, 158:1, 159:14, 160:4 allocated 139:2, 160:2 allow 18:17, 22:4, | 80:10, 101:1, 153:10 allowed 74:18, 77:15, 102:10, 153:11, 153:19 allows 36:6, 78:17 almost 6:12, 24:10, 34:3, 41:17, 52:21, 63:3, 85:10, 86:18, 112:6, 128:6 along 123:20, 166:11 already 25:1, 71:18, 139:5 also 8:22, 15:6, 18:7, 19:6, 20:21, 21:22, 22:2, 24:2, 43:1, 45:4, 48:14, 52:13, 54:11, 58:1, 58:14, 62:11, 65:1, 70:12, 73:18, 75:10, 76:20, 79:18, 94:17, 94:20, 95:8, 97:2, 100:18, 108:20, 111:11, 114:20, 115:12, 116:6, 116:13, 117:15, 118:22, 119:2, 122:9, 122:19, 123:10, 124:19, 126:7, 127:6, 127:14, 127:21, 129:2, 129:21, 129:22, 131:21, 131:22, 135:11, 137:12, 137:20, 139:1, 140:3, 140:18, 150:20, | 151:13, 160:3, 160:21, 163:3, 168:22, 173:12, 174:4, 174:11, 176:8, 178:9 alter 69:18, 77:16, 87:18, 173:12 alterable 108:14 alteration 83:12 altering 77:17 although 41:8, 44:4 always 13:17, 16:11, 16:19, 16:22, 21:16, 30:6, 30:11, 32:12, 32:14, 36:15, 37:17, 37:21, 38:12, 43:9, 58:7, 60:2, 60:18, 67:8, 67:11, 67:13, 71:6, 81:22, 82:5, 85:16, 87:16, 90:21, 96:2, 127:3, 155:17 america 1:5, 3:12, 11:19, 136:6, 180:12 american 42:3, 42:4, 66:4 amount 35:9, 35:18, 36:1, 49:13, 55:2, 64:18, 67:4, 132:22, 134:5, 134:7, 134:10, 134:16, 134:18, 178:1 analysis 14:15 | analyze 120:13, 163:15 analyzed 163:16 andrew 4:4 andy 55:12 angle 64:9, 71:20, 72:10, 81:11, 82:4, 85:1, 98:19, 99:1, 99:2, 100:2, 146:13, 147:4, 171:10, 171:12, 171:13 angles 64:17, 64:19, 83:2, 140:14 angular 64:11, 64:12, 66:13, 71:18, 77:2, 81:9, 81:14, 82:1, 82:6, 82:22, 85:4, 93:19, 98:18, 100:15, 120:20, 120:21, 121:14, 121:16, 140:14, 140:19, 141:5, 141:7, 141:15, 141:19, 160:18, 162:7, 163:1, 169:10, 169:11, 169:20, 170:5, 171:8 angularly 64:6, 77:1 annual 9:17 another 11:18, 81:15, 108:17, 116:3, 129:9, 142:2, 147:13, 148:14, 149:19, 159:13, 163:2, 171:13, |
|---|---|---|--|

| | | | |
|--|--|---|---|
| 176:9 answer 18:2, 110:6, 153:19, 153:21 answered 135:3, 170:13 any 7:20, 9:3, 12:22, 17:6, 17:7, 23:10, 26:11, 27:8, 30:14, 31:10, 31:16, 37:3, 41:2, 43:5, 43:12, 45:22, 46:1, 46:18, 49:4, 52:15, 53:6, 63:9, 66:22, 71:21, 73:8, 77:16, 86:9, 91:16, 92:20, 96:3, 101:11, 107:5, 108:20, 111:6, 115:12, 123:14, 127:12, 149:7, 149:11, 165:4, 168:6, 181:2, 181:3 anybody 7:10, 66:11 anyone 7:12, 8:13 anything 16:20, 61:19, 86:11, 102:7, 120:3 anytime 95:15 anyways 19:8 anywhere 21:6, 175:9 apparatus 168:13 appeal 1:3 appearance 31:7, 173:15 | application 21:13, 30:22, 34:21, 35:11, 38:18, 73:5, 89:19, 111:14, 151:8, 159:4, 175:17 applications 15:18, 27:11, 39:11, 40:20, 43:7, 46:9, 49:12, 62:12, 88:15, 89:10, 111:7, 111:9, 111:15, 111:21, 112:15, 112:20, 114:3, 119:18, 127:15, 129:2, 144:9, 155:9, 155:11, 155:17, 158:8, 158:9, 175:2 apply 71:8, 105:3 applying 148:8, 148:9 approach 30:1, 55:8, 63:14, 66:21, 74:1, 107:5, 120:14, 126:1, 127:10 approaches 125:18 approval 139:3, 140:1 approve 139:17 approved 139:5 approximately 6:20, 8:10 archived 96:7 area 64:21, 161:6, 169:16 around 34:4, 99:5, | 175:5, 178:22 arranged 87:9 arrangement 110:16 array 83:15, 107:10, 107:11 art 9:3, 165:22, 166:5, 166:10, 166:11, 166:12, 166:20, 167:1, 167:7 arts 7:17, 8:21, 8:22, 9:1 asked 170:13, 170:20 aspect 115:5, 167:17 aspects 114:21, 122:13, 124:12 assembled 49:16, 86:6 assemblies 19:19, 20:19, 22:16, 30:8, 37:11, 38:20, 39:17, 43:5, 43:22, 49:18, 60:13, 62:9, 62:16, 143:18 assembly 19:18, 20:14, 20:15, 20:18, 21:3, 21:12, 26:12, 26:22, 27:19, 28:11, 28:15, 29:18, 31:9, 31:15, 33:10, 33:12, 34:10, 34:18, 34:21, 35:10, 49:4, 50:15, 50:22, 52:20, 55:2, 59:1, | 59:21, 60:7, 61:13, 62:12, 67:7, 71:13, 77:13, 82:17, 83:7, 85:12, 86:1, 86:8, 87:6, 87:10, 87:15, 91:18, 92:2, 92:4, 92:10, 92:12, 92:15, 93:1, 93:4, 93:6, 104:13, 104:18, 105:1, 105:8, 106:4, 106:5, 109:16, 109:18, 110:1, 121:4, 126:16, 133:18, 143:1, 143:13, 143:22, 144:13, 144:15, 145:6, 145:13, 146:6, 146:14, 146:22, 148:17, 148:20, 151:6, 155:20, 161:15, 165:19, 176:6, 176:10, 176:14, 177:22 assist 156:14, 158:20, 158:22, 159:4, 159:6, 159:17 associated 23:16, 45:16, 85:17 assume 43:18, 154:14, 170:20, 174:13 assumption 106:10, 162:9 astigmatism 120:8 attached 5:7, 163:5, 169:1 attend 9:13 attended 10:19 |
|--|--|---|---|

| | | | |
|--------------------------|-----------------------------------|----------------------------|------------------|
| attends 115:17 | 136:19, 138:14, 138:19, 140:7, | back 10:1, 35:2, | 54:20, 70:1, |
| attenuate | 150:12, 151:21, | 35:9, 36:2, | 74:4, 74:8, |
| 104:19 | 155:17, 155:19, | 38:7, 38:19, | 76:10, 78:2, |
| attenuating | 158:9, 158:13, | 38:20, 96:14, | 78:12, 78:21, |
| 104:8, 104:10 | 159:5, 169:2 | 115:15, 160:7 | 79:5, 94:12, |
| attorney | auxillary | bad | 100:6, 101:20, |
| 181:3 | 95:7, 97:2 | 178:12 | 107:6, 117:17, |
| attorneys | available | based | 118:18, 120:21, |
| 8:14, 116:19 | 69:1, 80:2, | 14:8, 15:3, | 123:10, 128:2, |
| audience | 152:9, 154:4, | 30:1, 34:12, | 136:15, 141:4, |
| 115:17, 116:1, | 175:10 | 37:2, 42:18, | 142:8, 171:6, |
| 116:9, 116:17 | avenue | 45:11, 46:13, | 175:11, 177:10 |
| august | 3:16 | 46:14, 46:19, | become |
| 1:17, 11:6, | avoid | 46:20, 47:19, | 70:16, 73:15, |
| 180:18, 181:9 | 50:16, 65:1, | 51:9, 61:5, | 132:14, 144:22 |
| auto | 70:17, 71:19, | 63:4, 71:12, | been |
| 76:10 | 75:10, 100:11, | 72:1, 72:17, | 6:17, 6:22, |
| automatic | 148:6 | 86:19, 92:16, | 18:15, 20:11, |
| 75:13, 76:6, | avoided | 93:16, 108:7, | 36:19, 37:3, |
| 127:8 | 71:1 | 111:18, 112:12, | 44:4, 44:8, |
| automatically | avoiding | 122:19, 125:6, | 45:1, 45:20, |
| 76:15, 78:16, | 74:7 | 133:5, 135:8, | 50:8, 67:22, |
| 78:19 | avoids | 138:12, 138:16, | 75:7, 96:2, |
| automation | 65:22 | 162:2, 163:1, | 110:4, 113:5, |
| 166:13 | aware | 170:21, 170:22, | 126:21, 131:16, |
| automotive | 157:10, 166:10 | 171:17, 172:22, | 132:12, 147:6, |
| 9:21, 10:1, | away | 178:15 | 167:6 |
| 11:20, 12:9, | 51:11, 51:16, | basis | before |
| 12:12, 27:8, | 128:17, 128:18 | 70:15 | 1:3, 2:16, |
| 32:11, 42:9, | axes | battery | 6:17, 6:22, |
| 42:11, 45:3, | 91:19, 92:18 | 21:14, 34:7 | 9:19, 10:4, |
| 45:8, 45:12, | axis | beam's | 27:7, 28:4, |
| 45:21, 46:3, | 91:2, 91:4, | 78:18 | 55:22, 56:17, |
| 46:9, 47:10, | 91:7, 91:9, | beam-equivalent | 80:15, 112:17, |
| 47:17, 49:11, | 91:12, 91:13, | 70:8 | 116:7, 135:4, |
| 81:16, 82:5, | 91:14, 91:17, | beams | 153:9, 158:20, |
| 82:21, 110:20, | 91:19, 91:21, | 28:11, 28:12, | 159:11, 177:21, |
| 111:1, 111:4, | 92:5, 92:8, | 103:21 | 180:8, 180:9 |
| 111:14, 111:20, | 92:11, 92:12, | became | begin |
| 112:6, 112:8, | 92:13, 92:14, | 152:22, 153:20, | 71:6, 75:17, |
| 112:10, 112:18, | 93:2, 93:5, | 153:21 | 109:4, 123:9 |
| 113:22, 114:17, | 93:8, 93:10, | because | beginning |
| 116:1, 116:22, | 93:15, 93:18, | 15:5, 16:10, | 44:15, 54:9, |
| 117:4, 117:11, | 146:13 | 22:9, 35:16, | 151:17 |
| 118:6, 118:9, | <hr/> | 39:13, 45:16, | behalf |
| 119:17, 123:7, | B | 50:8, 51:11, | 3:3, 3:12, 4:3 |
| 129:2, 135:20, | <hr/> | 53:1, 54:7, | behavior |
| | b2 | | 47:1 |
| | 1:12 | | |

| | | | |
|---|---|---|---|
| beijing 10:16, 10:17 being 6:3, 36:22, 37:1, 54:5, 62:1, 64:3, 67:4, 67:19, 68:20, 83:1, 103:1, 118:17, 127:6, 131:21, 135:11, 135:14, 135:15, 136:14, 143:7, 147:5, 171:3, 171:12, 176:2 believe 43:1, 63:14, 68:16, 71:9, 73:8, 76:16, 100:13, 100:14, 125:6, 132:19, 133:21, 137:6, 139:22, 148:11, 151:7, 159:4, 161:7, 174:19, 177:9, 178:1 believed 29:22 believes 18:12 bellinger 1:22, 2:17, 180:3 below 65:9, 65:14, 65:15, 98:20, 99:5 bending 74:1, 125:3, 125:10, 126:3 benefit 68:10, 89:15, 158:5, 159:21 benefits 90:8 besides 7:10, 44:1, 61:15, 142:14 | best 42:19, 90:22 better 63:11, 69:20, 70:11 between 16:10, 19:17, 25:8, 30:16, 32:12, 35:9, 43:9, 58:3, 61:9, 65:13, 65:15, 69:6, 69:14, 84:10, 87:5, 87:10, 90:3, 97:17, 108:10, 111:14, 115:12, 119:20, 146:13, 149:17, 152:17, 156:10, 175:9 beyond 100:11 big 72:4, 133:3 bigger 138:1 billing 47:4 billings 47:3 bird's-eye 160:22 bit 56:18, 56:21, 56:22, 75:11, 100:8, 102:14, 102:15, 113:12, 117:9, 128:9 black 102:1 blocked 148:6 blood 181:2 blow 52:3 blue 36:16, 37:18, | 38:3, 38:8, 38:12, 39:4, 39:6, 103:1, 103:10, 103:16, 103:18, 103:21 board 1:3, 33:18, 53:11 bodies 41:6, 136:9, 136:10 body 12:20, 18:12, 18:19, 42:2, 42:3, 42:5, 42:10, 42:15, 79:14, 102:2 both 10:17, 20:19, 20:22, 28:11, 43:6, 43:14, 44:13, 58:14, 65:16, 68:11, 83:17, 84:7, 106:15, 107:13, 107:17, 107:19, 119:13, 144:3, 152:14, 153:7, 162:5, 164:12, 164:17, 164:19, 165:3 boundaries 124:7 boundary 102:5 box 102:7, 102:8, 102:12, 102:16 brake 13:1 branch 119:10 break 22:10, 55:13, 55:16, 56:17, 113:2, 113:6, 150:3 bright 155:15 | brightness 76:18, 89:8, 154:21, 154:22, 155:3, 155:4, 155:6, 155:7, 155:18, 155:21, 156:11 broad 107:20 broader 129:18 brooks 4:6 brought 133:1 building 111:12 built 46:21, 73:6 bulb 28:17, 85:14 bulbs 17:7, 29:12, 33:8, 49:22, 85:13, 90:1, 118:20 bunch 171:14 business 12:5, 12:6 <hr/> C <hr/> calculate 178:11 calibrate 141:17 calibrated 146:19, 147:9 calibration 142:5, 146:20 call 17:5, 36:12, 44:13, 54:3, 75:13, 82:1, 82:2, 84:21, 99:6, 101:19, 102:8, 102:11, 102:16, 112:14, |
|---|---|---|---|

| | | | |
|---|---|--|---|
| <p>125:11, 142:15, 143:10, 171:15 called 11:15, 11:19, 29:7, 42:10, 52:2, 91:12, 112:8, 113:21, 113:22, 114:2, 114:3, 120:10, 129:2, 134:20, 138:1, 139:1, 156:13 calls 17:22, 18:1, 27:13, 63:1, 103:3, 152:5, 154:12 came 7:5, 116:1 camera 25:10, 144:4, 144:6, 144:8, 144:12, 144:20, 145:5, 145:14, 146:13, 147:10, 148:8, 149:2, 149:18, 165:10, 165:14, 165:15, 165:16 camera's 146:5 can't 17:13, 19:12, 35:7, 68:20, 70:16, 77:12, 90:2, 98:16, 110:6, 133:9, 148:3, 148:10, 152:7, 152:21, 153:15, 155:5, 160:16 canada 136:6, 136:7, 137:8, 137:9 candela 117:17, 141:18, 160:16, 160:19, 162:7, 162:11,</p> | <p>169:15, 171:9, 171:11 candela-level 160:17 cannot 17:5, 17:11, 24:19, 59:17, 66:15, 76:2, 89:5, 90:5, 90:7, 100:6, 100:11, 100:13, 128:3, 142:10, 146:18 capabilities 49:8 capability 24:20, 44:21, 50:15, 76:14, 135:7, 135:13 car 61:2, 78:15, 78:19 care 120:17, 140:16, 173:17, 173:20, 173:21 carry 120:22 cars 75:18, 75:19 cascade 34:14 case 58:16, 126:3, 127:22, 137:6, 145:16, 146:1 cases 20:20, 22:11, 24:10, 24:12, 24:13, 24:14, 34:3, 41:18, 45:13, 50:3, 51:15, 51:22, 52:6, 52:21, 63:4, 85:10, 86:19, 94:17, 143:8, 144:19, 146:18</p> | <p>catastrophic 46:20, 47:2, 47:6, 47:18, 112:13 categories 23:8, 119:12, 126:13 categorize 49:10, 121:9 category 17:3, 96:21, 119:13, 129:16, 155:4 cause 71:21 cavity 30:3 center 4:7, 74:9, 92:20, 92:21, 99:11, 100:5, 100:6, 100:8, 159:2, 159:9, 159:19 centered 99:4, 100:3 certain 16:2, 23:19, 24:7, 30:7, 46:10, 48:3, 50:11, 57:3, 57:13, 64:18, 71:20, 78:1, 102:17, 123:9, 130:7, 140:6, 142:10, 153:18, 167:1, 178:1 certainly 99:20, 108:1, 109:21 certificate 180:1 certification 139:3 certified 2:18, 138:20, 180:3 certify 180:5, 180:11,</p> | <p>180:14, 180:20, 181:1 challenge 44:15, 45:10, 45:11, 45:14, 49:18, 50:18 challenged 167:5, 167:8 challenges 36:9, 43:20, 46:6, 53:6, 111:14 challenging 45:20, 50:8 chance 72:21 change 23:19, 24:1, 24:3, 24:22, 34:12, 39:8, 44:7, 44:12, 44:13, 44:20, 47:1, 48:9, 49:10, 69:19, 73:12, 78:4, 82:18, 96:8, 96:10, 108:2, 108:3, 108:21, 118:20, 123:16, 124:16, 125:3, 125:16, 125:19, 126:6, 126:8, 126:10, 130:20, 132:13, 132:16 changed 9:19, 9:22, 23:15, 24:17, 37:22, 38:3, 38:16, 88:18, 97:14, 127:7, 131:2, 131:11, 131:16, 132:3, 132:9, 132:12 changes 22:2, 24:5, 36:6, 44:10, 44:13, 44:18, 48:18, 48:22,</p> |
|---|---|--|---|

| | | | |
|---|---|---|---|
| 124:20, 130:19, 130:20, 171:22 changing 73:19, 125:22, 127:10 chapter 117:9 character 44:3 characteristic 117:22, 130:18 characteristics 18:11, 23:3, 77:19, 77:20, 77:21, 130:21, 169:17 charge 13:18, 15:5 chart 101:19, 102:4 chicago 67:2 china 10:16, 10:17, 66:11, 133:1, 133:3, 133:7, 133:11, 133:14, 133:16, 133:18, 133:21, 134:2, 137:7 china's 133:5 chinese 132:19, 132:21 chip 154:18, 156:5, 156:6 chips 154:16 choose 84:13, 88:3 chromatistic 101:19, 102:4 circuit 53:10 citation 138:17 cited 7:21 | city 125:11, 125:20 claim 165:6, 165:11, 165:16 claimed 27:1, 151:13 claims 7:18 clarify 118:8, 119:19, 122:7, 152:7 class 113:22, 114:14, 115:2, 115:6, 115:16, 116:7, 117:13, 117:15, 119:2, 119:4, 119:6, 119:9, 119:15, 122:10, 122:14, 122:19, 124:2, 124:10, 124:14, 124:16, 124:19, 124:22, 125:5, 126:19, 127:14, 127:17, 127:20, 127:21, 128:1, 130:2, 130:11, 130:17, 130:22, 131:5, 131:8, 135:19, 139:16, 139:22, 140:1, 142:8, 142:13 classes 113:14, 113:16, 114:5, 114:8, 115:17, 117:2, 117:5, 117:8, 117:11 clear 66:1 clearly 12:19, 177:12 close 53:13, 55:13, 57:18, 98:6, 98:8, 98:9, | 102:1, 179:5 codes 41:6 cohesive 14:20 collaborated 8:5 collaborative 14:20, 30:16 collate 52:3 collect 36:22 collected 145:14 collecting 86:16, 135:14 collection 86:18 college 10:14 colletti 3:14, 56:7, 56:13 color 37:18, 37:22, 38:16, 38:21, 39:16, 40:1, 40:4, 40:9, 40:17, 40:18, 41:4, 41:8, 41:11, 41:16, 44:10, 44:12, 44:14, 78:4, 78:5, 94:16, 100:18, 100:19, 101:6, 101:9, 101:13, 101:15, 101:18, 102:9, 102:20, 103:2, 103:9, 108:4, 108:22, 130:19 color-wise 39:7 columbia 2:19, 180:5, 181:16 combination 83:4, 125:16, | 163:17, 163:20, 165:17 combine 20:5, 37:18, 85:3 come 84:19, 116:9, 135:7 comes 23:14, 87:17 coming 30:11, 121:10, 122:2 command 145:22 commencement 180:8 commencing 180:18 commercial 26:12 commercialization 151:4, 157:20 commercialized 28:6, 43:13, 110:5, 126:21, 127:3, 127:9, 127:12, 151:22, 153:2 commission 181:10 committee 42:12, 96:5, 136:4, 137:11 common 21:5, 34:17, 34:20, 37:10, 57:8, 57:11, 70:4, 90:12, 90:14, 140:11, 175:3 commonly 85:22, 90:16, 146:4, 161:13 companies 12:10, 116:5, 116:9, 133:15, 139:17, 157:19 |
|---|---|---|---|

| | | | |
|--|--|---|--|
| company 11:18, 11:21, 13:19, 110:13, 110:14, 138:19 compared 28:17, 65:8, 154:21, 174:17 compartment 62:4 compensate 34:7 complete 17:9, 157:9 completely 160:2 compliance 139:8, 153:14 complied 139:6 complies 76:9 comply 115:11, 119:1, 136:20, 138:7 component 17:14, 112:11, 144:7 components 16:3, 17:2, 33:10, 33:14, 33:16, 33:18, 45:17, 45:19, 46:1, 46:5, 46:18, 46:22, 47:10, 47:18, 48:2, 52:4, 82:17, 88:3, 112:6, 112:7, 112:9, 123:15 compound 23:6, 57:6, 62:14, 177:8 computer-simulat- ed 161:19, 162:2, 162:7 concept 16:9, 70:13, | 81:14, 82:4, 82:22, 117:13, 121:22, 128:13, 141:8, 155:14, 158:4 conceptually 19:21 concern 30:5, 44:15, 48:8 concerned 44:4 concerning 44:8 concerns 24:8, 112:19 conclude 125:18 conclusion 18:1 condition 23:16, 24:22, 124:16, 124:17, 124:18, 125:2 conditions 22:11, 22:12, 25:13, 25:22, 26:4, 48:3, 48:5, 57:15, 69:15, 69:16, 69:17, 78:1, 79:4, 88:14, 124:22, 143:8 conduct 51:10, 159:21 conducted 141:1 conduction 53:1 conductive 51:12, 51:13, 53:3, 53:4 cone 100:1, 100:2, 100:15 conference 9:10, 9:13, 9:15, 9:16, 9:17 | configure 175:6 configured 34:6 configuration 16:12, 16:20, 30:15, 36:22, 175:13, 175:15, 175:22 configurations 15:13, 15:14, 16:22 Congress 17:18, 157:13 conjunction 39:5, 63:12, 128:5 connected 161:4, 176:2 connections 175:7, 175:10 consensus 125:7 consequence 54:16 consequences 138:9 consider 26:6, 43:10, 49:9, 61:15, 102:10, 166:19, 167:6 consideration 54:13, 122:20, 125:4, 176:10 considerations 123:2, 176:5 considered 12:20, 13:3, 13:4, 38:7, 71:19, 78:22, 91:8, 94:11, 95:8, 155:20, 163:3, 174:12 considers 42:15 consistent 42:22, 58:16, | 58:17, 101:14, 101:16, 158:6 constant 88:11, 88:15, 88:16, 88:19, 89:17, 90:17 constraints 30:21, 31:4, 88:1 consumer 71:8 consumption 54:19 contain 86:2 continue 44:5 continued 37:3 contract 133:14 contracting 133:15 contribute 172:22 contribution 83:2 contributor 74:12, 127:4 contributors 92:17 control 20:7, 20:19, 20:22, 21:10, 21:17, 21:21, 25:5, 31:17, 45:20, 49:8, 77:6, 77:12, 82:11, 82:18, 83:13, 88:9, 89:11, 89:20, 89:21, 90:17, 108:8, 108:9, 121:5, 121:18, 144:22, 146:3, 146:7 controlled 20:5, 28:11, |
|--|--|---|--|

| | | | |
|--|--|---|--|
| 145:1, 176:3 controller 20:18, 21:18, 28:10, 164:13 controlling 121:15 controls 21:11 conventional 16:17, 19:18, 33:11, 33:19, 33:20, 33:22, 46:15, 49:22, 85:14, 89:21, 89:22, 90:7, 166:11, 174:17 convergent 37:1 conversation 7:4 conversion 36:19, 38:13, 172:8 convert 39:5 cool 90:4 cooling 52:7 corner 41:2, 41:3, 41:4, 41:8, 94:19, 95:7, 97:2, 98:6, 98:7, 99:12, 105:9, 126:5 cornering 40:19, 41:11, 41:15, 74:13, 74:15, 74:19, 74:22, 75:3, 75:4, 75:5, 93:11, 93:12, 93:13, 93:15, 93:19, 93:21, 94:3, 94:5, 94:6, 94:8, 94:11, 94:13, | 94:14, 94:16, 94:17, 94:20, 95:4, 95:12, 95:15, 95:19, 96:2, 96:12, 96:18, 96:19, 97:6, 97:11, 97:12, 97:17, 98:3, 98:5, 98:15, 98:22, 99:7, 99:14, 99:19, 100:20, 101:3, 103:18, 105:22, 106:8, 106:19, 107:14, 108:11, 177:16, 177:19 correct 8:2, 8:9, 11:8, 11:9, 13:5, 13:7, 17:19, 21:4, 21:8, 31:8, 36:4, 38:11, 40:12, 43:17, 44:2, 48:18, 49:1, 50:12, 52:17, 53:1, 56:10, 56:11, 62:5, 62:19, 70:21, 73:20, 77:10, 77:11, 77:13, 80:3, 80:4, 90:10, 92:1, 98:10, 103:2, 106:12, 110:9, 111:19, 113:15, 114:11, 114:12, 121:17, 127:15, 129:19, 129:20, 135:21, 138:21, 138:22, 139:19, 151:2, 151:8, 158:21, 160:10, 161:2, 162:3, 163:18, 164:16, 170:15, 175:15, 175:16, 175:19, | 177:6, 178:3 correction 120:11 corrections 120:11 correctly 6:10, 80:17, 125:8 correlate 92:14, 144:14, 145:4, 145:12, 146:20 cost 30:18, 32:6, 32:7, 32:8, 32:9, 32:21, 33:3, 33:8, 44:1, 47:12, 112:17, 112:19, 131:20, 133:4, 150:19, 150:21 cost-wise 32:13 costly 32:17 could 19:8, 32:4, 47:14, 53:20, 58:4, 58:18, 58:21, 59:11, 73:4, 86:10, 107:12, 150:22, 153:19, 155:20, 173:12, 174:14 couldn't 77:22 counsel 6:5, 7:5, 8:6, 8:7, 180:13 counsels 8:20 countries 66:16, 68:12, 79:21, 137:9 country 42:6, 74:17, 103:15, 125:3, 125:9, 125:20, | 133:2, 136:11, 136:13, 136:15, 137:19, 139:1, 142:3, 153:10 couple 9:6 coupler 169:1 course 114:1 courses 113:17, 113:19 cover 114:20 covered 119:5 covers 94:2, 96:16, 117:13, 117:15 create 52:4, 53:6, 146:7, 146:10 created 95:2 creates 18:19, 73:16 creation 136:2 creativity 166:13 criteria 14:22, 18:16, 42:14, 57:1, 57:4, 58:6, 61:14, 87:21, 116:12, 141:4, 170:10, 170:19, 172:4, 172:21, 173:8, 174:2, 174:7, 174:14, 176:6, 176:14 critical 142:20 cross 66:22, 74:9 cross-board 112:7 crr 1:22, 180:3 |
|--|--|---|--|

| | |
|---|--|
| culture 111:10 current 21:22, 54:2, 54:3, 54:4, 54:8, 54:10, 54:18, 55:2, 55:11, 67:17, 80:9, 88:19, 89:1, 90:17, 97:13, 105:3 current-driving 54:1 currently 35:10 curvature 86:19, 86:21, 107:1 curve 23:21, 74:3, 74:8, 126:3, 126:4 curved 74:1, 125:3 customer 12:10, 15:4, 81:18, 123:3, 171:18, 172:17 customers 13:12 cut 22:5 cv 10:17 cycle 48:4, 89:7, 105:6 <hr/> D <hr/> data 25:4, 45:4, 45:7, 49:14 date 15:20 dates 81:3 day 14:3, 181:9 | days 168:7 dc 1:16, 2:8, 3:9, 21:15, 34:1, 34:4, 34:7, 180:17 debates 155:1 decided 60:21, 76:7 decisions 116:12 declaration 5:9, 7:7, 7:17, 7:18, 7:21, 8:4, 8:11, 8:15, 8:18, 8:21, 9:2, 9:4, 9:11, 10:4, 10:7, 163:10, 163:15, 165:1, 166:2, 166:7, 166:9, 166:15, 167:11 dedicated 20:21, 175:21 default 72:15 define 20:3, 47:22, 75:3, 169:22 defined 91:15, 102:5, 108:5, 129:11, 161:6, 161:11 definitely 29:8, 99:1, 127:2 definition 74:16, 82:3, 93:14, 169:15 degree 10:21, 100:4, 100:9, 100:10 degrees 99:1, 99:5, 99:8, 99:9, 99:11, 99:14, 99:15, 99:20, 99:21, 99:22, 100:1, 100:4, 100:14 demand 18:9, 45:22, 174:5 demanded 66:17 demanding 46:2 department 14:8, 116:10, 116:13, 157:11, 157:12 depend 72:8 dependent 44:21 depending 178:9 depends 21:19, 23:9, 57:16, 83:9, 86:3, 106:15, 145:15, 147:19, 149:22, 175:10, 175:22 deposed 6:17, 6:22 deposition 1:15, 2:1, 6:15, 7:3, 7:16, 8:1, 180:7, 180:8, 180:9, 180:13, 180:14, 180:21 depth 87:21 describe 19:16, 29:2, 56:21, 62:7, 81:9, 94:7, 104:3, 122:18, 170:4 described 101:11, 117:21, 119:10, 124:16, 124:19, 125:1, 126:7, 131:5, 171:6 describes 119:11, 122:19, 130:17 description 21:1, 21:2, 64:6, 66:14, 77:2, 107:9, 166:1, 169:16 descriptions 165:15 design 14:13, 14:22, 16:2, 16:16, 17:1, 22:22, 23:13, 27:7, 28:5, 30:7, 30:12, 30:16, 31:5, 31:6, 31:7, 31:21, 42:14, 48:9, 50:18, 51:4, 51:15, 51:18, 53:12, 60:22, 61:3, 61:4, 61:10, 61:12, 62:11, 66:2, 66:6, 73:2, 77:22, 82:16, 85:2, 90:21, 106:15, 107:2, 111:13, 114:1, 114:11, 114:18, 115:16, 119:3, 122:14, 122:20, 123:1, 125:14, 126:15, 160:1, 168:15, 170:9, 170:19, 172:7, 173:7, 173:9, 173:13, 173:17, 173:21, 174:2, 174:12, 176:1, 176:3, 176:6, 176:9, 176:14, 177:22, 178:2 |
|---|--|

| | | | |
|--|--|--|--|
| designate 67:3, 85:1 designated 68:8, 68:9 designates 112:13 designed 62:1, 62:9, 72:22, 73:6, 73:16, 74:4, 77:9, 87:20, 91:11, 106:14, 109:18, 175:18 designing 116:18, 119:16, 128:21, 170:10, 177:3 designs 16:7, 21:3, 38:22, 43:12, 48:14, 175:20 desirable 70:9, 70:15 desired 69:20, 120:20, 127:4, 171:18, 176:13, 178:7 detail 57:1 detect 24:2, 24:17, 24:21, 25:2, 25:6, 25:12, 89:5, 145:17, 147:11, 147:15, 147:22, 148:13, 148:18, 149:4, 149:6 detected 147:5, 147:9 detecting 25:22, 26:4, 147:13, 149:18 detection 71:3, 149:11 detections 70:11 detector 149:15 | determine 23:12, 148:5, 149:12 determined 60:22 develop 14:22, 42:6, 42:15, 43:5, 61:4, 115:9, 136:5 developed 41:22, 42:21, 44:18, 67:20, 96:4, 117:16, 137:10 developing 38:19, 43:21 development 42:18, 42:20, 43:8, 68:22, 160:3 develops 43:2 device 18:4, 20:7, 21:22, 52:14, 54:1, 63:2, 66:12, 74:16, 76:7, 76:8, 94:12, 95:3, 96:21, 119:14, 143:16, 155:16, 170:17 devices 12:17, 12:18, 20:4, 20:5, 20:8, 81:11, 95:4, 96:22, 101:10, 118:16, 119:17, 123:11, 124:2 diagram 160:14 diagrams 158:16, 160:8, 160:9, 161:13, 162:13 diced 133:13 | dictate 46:4, 76:16, 173:22 dictated 50:14, 173:9 differ 84:10, 92:8 difference 25:8, 35:8, 35:14, 35:15, 65:12, 65:15, 69:6, 69:13, 90:3, 112:1, 119:22 differences 16:10, 19:17, 61:9, 112:3, 115:12, 119:20 different 13:15, 13:18, 14:17, 15:1, 15:10, 19:13, 19:15, 28:16, 29:11, 30:21, 41:10, 62:8, 63:15, 63:18, 63:19, 63:20, 63:21, 64:7, 64:13, 64:15, 64:16, 64:17, 64:19, 64:21, 66:2, 73:5, 76:18, 77:3, 79:21, 83:2, 83:5, 83:6, 83:16, 83:20, 84:12, 84:13, 84:15, 85:11, 93:4, 93:10, 93:13, 97:17, 97:21, 102:9, 105:4, 105:21, 106:6, 106:22, 107:1, 107:8, 108:15, 111:5, 111:13, 118:13, 123:19, 125:13, 125:14, 126:15, | 136:21, 139:17, 141:22, 146:6, 146:12, 146:21, 147:1, 149:8, 149:17, 149:22, 156:5, 170:17, 171:9, 174:16, 174:19, 177:5 differently 93:13, 107:8, 128:1 difficult 32:20 dim 78:1, 104:12, 104:13, 104:14, 104:21, 105:1 dimension 81:15, 163:2 dimensions 101:20 dimmed 78:20, 148:6 diodes 129:14 directed 64:17, 122:14 direction 23:14, 23:21, 69:19, 69:20, 71:12, 73:19, 74:3, 91:12, 91:17, 93:9, 108:2, 108:10, 108:20, 121:13, 176:9 directly 10:11, 10:12, 34:1, 110:14, 110:17, 129:3, 161:20, 162:6 disabled 154:10, 154:14 discharge 15:11, 15:12, 117:20 disclose 164:12 |
|--|--|--|--|

| | | | |
|---|--|---|---|
| <p>discrete 173:12</p> <p>discuss 115:5, 117:11, 119:3, 122:9, 122:14, 123:19, 124:2, 124:9, 124:13, 129:22, 130:10, 131:1, 139:16</p> <p>discussed 113:11, 123:2, 130:22, 150:9, 151:3</p> <p>discussions 9:1, 109:21</p> <p>dispute 52:6</p> <p>dissipate 52:10</p> <p>distance 81:13, 81:15, 81:17, 81:19, 81:20, 82:7, 82:9, 98:11, 98:17, 98:21, 99:6, 141:16, 141:19, 141:22, 142:1, 142:2, 142:4, 163:2</p> <p>distinguish 129:20, 156:10</p> <p>distortions 120:7</p> <p>distributed 64:6, 75:7</p> <p>distribution 41:5, 64:11, 64:13, 69:18, 71:18, 77:3, 81:5, 81:8, 81:10, 81:14, 82:19, 82:22, 83:3, 83:13, 85:5, 93:14, 93:19, 94:15, 98:19, 100:15, 100:16, 109:13,</p> | <p>121:2, 121:14, 121:16, 123:13, 123:17, 140:15, 140:19, 141:6, 141:7, 141:15, 141:19, 160:18, 160:22, 161:21, 162:8, 162:11, 162:14, 162:18, 162:21, 162:22, 163:1, 163:3, 169:6, 169:10, 169:20, 170:6, 170:19, 171:9</p> <p>distributions 109:12</p> <p>distributor 172:8</p> <p>district 2:19, 180:5, 181:16</p> <p>diversion 104:5</p> <p>divert 104:1, 104:3, 104:5</p> <p>divide 170:17</p> <p>division 11:15, 11:16, 11:17</p> <p>document 163:7, 163:9</p> <p>documents 7:15, 7:20</p> <p>doe 157:22, 159:16</p> <p>doing 160:3</p> <p>dollar 131:20, 132:8, 132:14, 132:16</p> <p>domain 160:18</p> <p>dome 86:3</p> <p>domestic 13:11</p> | <p>done 27:6, 133:18, 138:12, 139:14</p> <p>dot 18:21</p> <p>doubled 132:7, 134:4</p> <p>down 64:22, 65:21, 90:4, 99:9, 99:10, 99:11, 99:14, 99:15, 99:20, 100:2, 100:4, 125:20, 126:12, 127:7</p> <p>dr 6:8, 55:22, 56:17, 81:4, 91:1, 104:1, 109:8, 113:11, 122:4, 150:8, 154:15, 156:12, 158:15, 163:6, 165:21, 167:10, 169:5, 179:6</p> <p>drafted 8:4, 8:5</p> <p>drive 75:15, 88:18, 88:20, 88:22, 139:5</p> <p>driver 20:17, 20:21, 21:2, 33:21, 34:8, 46:2, 98:7, 105:1, 175:17, 175:20, 175:21, 175:22, 176:4</p> <p>drivers 20:10, 20:13, 33:17, 88:9, 88:10, 173:20</p> <p>drives 31:4</p> <p>driving 22:3, 22:11, 64:20, 65:7,</p> | <p>66:21, 68:7, 69:9, 69:16, 69:17, 70:2, 70:3, 70:16, 78:13, 79:1, 79:3, 79:5, 89:3, 104:20, 123:8, 124:17</p> <p>drove 33:3</p> <p>due 18:13, 32:6</p> <p>duly 6:3, 180:7</p> <p>duplication 47:19</p> <p>durability 50:21</p> <p>duration 46:17</p> <p>during 58:22, 61:10, 61:12, 130:1</p> <p>duty 105:6</p> <p>dye 37:16, 37:17, 37:20, 37:22, 39:4, 39:6, 84:4, 84:8, 84:9, 105:15, 108:14, 133:13, 133:19, 135:5, 135:7, 135:17, 173:6, 175:4, 175:5, 175:11, 175:22, 176:2</p> <p>dye's 44:22</p> <p>dyes 175:12</p> <p>dynamic 67:20, 68:7</p> <hr/> <p>E</p> <hr/> <p>each 20:18, 20:20, 55:2, 77:1,</p> |
|---|--|---|---|

| | | | |
|---|--|--|---|
| 77:7, 77:9, 86:12, 91:22, 92:3, 92:14, 93:3, 96:22, 97:4, 99:17, 103:6, 106:22, 107:7, 108:4, 109:4, 170:18, 171:19, 174:20, 175:11, 175:17, 176:2 earlier 88:8, 112:12, 136:15, 174:15 early 26:20, 27:4, 27:15, 97:7, 132:21, 151:18, 151:19 easily 173:3 easy 18:14 ec 101:16 ece 68:4, 80:18 economical 32:19 ecu 20:21 ecus 20:10, 20:11, 20:13 edt 1:18 effect 80:20 efficacy 35:18, 37:8, 54:6, 131:15, 132:3, 132:13, 134:3, 134:8, 134:9, 134:20, 150:18 efficiency 30:2, 36:13, 36:14, 135:6, | 135:11, 172:6, 172:11, 178:10, 178:16, 178:17 efficient 54:17, 54:21, 55:11, 86:4, 172:11, 178:12 efficiently 37:2, 51:16 effort 30:16, 51:18 either 20:16, 36:16, 69:18, 76:8, 76:17, 85:2, 97:9, 125:19, 140:17, 141:10, 144:11, 144:19, 146:2, 162:6, 165:4 electric 175:10 electrical 11:2, 11:8, 23:11, 25:21, 26:3, 26:7, 47:15, 53:21 electrically 25:7, 25:11 electronic 14:14, 15:13, 45:22, 47:18, 49:8, 112:7, 112:9, 112:11 electronically 16:13, 25:3, 25:19, 45:15, 46:19, 112:15 element 104:18, 109:4, 133:9, 164:6 elemental 94:22 elements 19:7, 85:4, 86:7, 107:6, 107:22, 108:16 else 7:12, 9:22, | 129:10 emergency 101:12 emission 36:12, 36:14, 36:18, 38:3, 95:3, 135:6 emit 84:20, 129:1, 129:4, 143:17 emitted 40:5, 40:10, 40:14, 64:4, 135:14, 143:19 emitter 36:10, 37:16 emitting 20:4, 20:8, 37:1, 53:16, 128:15, 129:5, 129:21, 131:20, 169:19 emphasis 120:1, 120:11 employed 181:3 enabled 75:20, 154:9 encountered 43:21 end 59:13, 59:15, 128:16, 145:2 energy 120:22, 121:1, 157:11, 157:12, 157:14 energy-saving 158:5, 160:5 enforce 115:9 enforcement 137:15, 137:20, 138:1, 138:2, 138:11 enforcing 137:13 engine 57:18, 62:4, | 78:12, 78:16 engine-gathering 144:20 engineering 10:9, 11:3, 11:8, 13:19, 14:15, 28:3, 30:13, 42:11, 171:6 engineers 14:1, 14:6, 30:17, 115:18, 116:17 enough 45:4, 49:15, 89:4, 116:8, 139:1, 155:15, 170:22, 171:1 ensure 123:12, 138:7 entire 26:17, 125:19, 125:22, 176:19 entity 80:5 environment 50:7, 57:9, 123:8 environmental 47:16, 57:15, 58:4, 60:19, 60:21, 142:15, 142:17 equal 161:4 equally 136:7 equation 169:22, 170:4, 170:8 equip 74:19 equipped 63:5, 153:12 equivalent 70:4 errors 120:7 |
|---|--|--|---|

| | | | |
|--|--|---|--|
| especially 17:3, 35:17, 47:20, 49:12, 57:12, 71:21, 72:5, 74:8, 76:11, 101:17, 102:6, 142:9, 144:4 esquire 3:4, 3:5, 3:14, 4:4, 4:5 essential 174:2 establish 18:14, 47:11, 58:6, 157:20 established 18:15, 68:11, 95:10, 159:2, 171:4 establishing 158:5 estimate 76:10, 178:11 estimated 61:5, 178:16 europe 66:3, 66:10, 69:22, 70:1, 75:13, 137:7 european 65:18 europeans 153:16 evaluate 48:5, 161:14, 162:14 evan 1:8 evanston 11:1 even 10:9, 15:14, 17:8, 21:7, 32:16, 57:17, 58:18, 71:7, 78:18, 90:4, 99:12, 108:3, | 108:21, 118:20, 131:7, 132:13, 173:18 event 145:1 ever 43:10, 68:16 every 9:18, 30:22, 48:12, 77:14, 95:13, 95:14, 96:6, 97:10, 140:12, 142:3, 142:10 everybody 56:2 everyone 140:21 everything 12:19, 108:6, 148:9 everything's 99:10 examination 5:2, 6:5 examined 6:3 example 23:18, 23:20, 26:2, 62:10, 77:22, 123:22, 125:2, 130:6, 155:10, 178:8, 178:14 examples 51:5 excellent 6:13 except 21:21, 79:3, 100:12, 140:15, 142:18 exception 78:8, 79:8 executing 126:13 exhibit 5:9, 163:4 | exhibits 5:8 exist 16:19 existing 16:15, 16:21, 19:18, 22:21, 24:22, 25:1, 25:15, 25:16, 34:7 exit 67:1 experience 10:9, 155:16 expires 181:10 explain 16:6, 25:8, 32:9, 39:16, 64:1, 66:20, 69:6, 69:13, 128:9, 137:15 explains 140:3 extent 133:3 exterior 12:12, 12:13, 12:15, 12:21, 40:16, 101:10, 117:6, 140:11 exteriorly 12:20 external 50:7, 59:20, 60:2, 60:18, 60:20, 61:9, 140:5, 142:22, 144:2, 144:12, 173:15 externally 123:15 extra 32:20 extreme 46:2 extremely 158:3 | eyes 89:5 <hr/> F <hr/> facilitate 113:17 facilitator 113:17, 113:20 fail 47:21 failure 46:20, 47:2, 47:6, 47:7, 47:11, 47:18, 48:1, 112:13 failures 47:3 fair 152:19 familiar 81:4, 91:1, 104:4, 104:7, 109:8, 122:4, 129:6, 154:15, 156:12, 158:3, 158:15, 160:9, 169:5, 169:9 family 28:8 fan 52:3 fancy 75:15, 78:14 far 38:15, 39:6, 49:12, 75:6, 75:7, 99:6, 99:21, 100:10, 100:13, 110:7, 123:2, 130:6, 136:13, 141:8, 141:10 fashion 70:8, 127:5, 129:1 fast 89:4, 90:8 feasible 128:8 |
|--|--|---|--|

| | | | |
|--|--|--|--|
| feature 75:16, 75:19, 76:11, 76:15, 86:17, 164:3 features 20:10, 79:15, 126:10, 128:3, 128:7 february 80:12, 80:15, 153:9, 154:5 federal 41:1, 41:9, 68:19, 94:1, 115:13, 118:16, 118:21, 136:17, 136:18, 136:19, 136:22, 137:1, 137:21, 138:2, 138:8, 138:21, 139:6 federally 74:18, 140:18, 177:11 feed 30:20 feedback 49:5 feel 32:19, 72:5 feet 98:12 few 37:4, 168:10, 173:5 fiber 128:11, 128:12, 128:20 field 60:7, 61:6, 61:7, 82:5, 148:15, 148:19 fifth 3:16 figure 60:4 filament 90:3 | filing 115:10 filler 47:4 final 133:17, 135:16, 148:7 financially 181:5 find 12:19, 45:5 fine 55:19, 93:20 finish 10:22, 11:4 finished 11:2, 11:13 first 6:3, 7:4, 10:19, 14:13, 14:16, 15:16, 26:21, 27:9, 28:5, 29:5, 32:3, 45:10, 69:7, 95:9, 95:18, 95:19, 96:3, 113:22, 114:7, 114:10, 115:15, 124:14, 126:6, 135:5, 135:16, 135:17, 136:22, 151:5, 151:14, 151:20, 153:2, 160:1, 167:13, 170:22, 172:4, 172:20, 173:8 fisher 11:15 fit 102:15 five 55:17, 55:18, 95:14, 95:16, 95:21, 96:6, 96:11, 97:10, 98:12 five-minute 150:3 | fixed 107:22, 142:2 flashlight 101:12 flat 86:3 flexibility 18:13 flexible 106:16, 107:3 floor 3:17, 4:8 fluid 52:16 flux 48:20, 48:22, 49:3, 49:10, 50:5, 64:9, 130:8, 131:12, 171:2, 171:3, 171:12 focus 117:1, 127:17 focused 117:5, 159:5, 177:14 fog 62:11, 62:17, 63:2, 63:4, 63:5, 63:7, 63:8, 63:11, 63:13, 64:13, 65:8, 65:10, 65:20, 66:3, 66:6, 66:11, 66:13, 66:15, 66:17, 76:20, 95:6, 97:1, 103:12, 103:13, 103:16, 137:2, 168:16, 177:4, 177:9, 177:10 fog-lamp 63:17 follow 71:16 following 71:22, 72:5 | follows 6:4, 141:2 force 52:2 foreground 98:6, 98:9 format 129:13, 160:16 formed 157:9, 157:14 forming 120:2, 120:5, 157:19 forth 180:7 forward 12:16, 39:11, 40:5, 71:4, 98:2, 99:15, 103:2, 103:5, 106:18, 107:13, 117:1, 117:2, 118:10, 124:12, 140:7, 148:15, 148:19 forward-lighting 15:17, 16:1, 19:2, 27:11, 68:6, 69:12, 79:16, 124:10, 126:17 found 9:5, 9:12 four 11:17, 14:9, 27:8, 97:3, 97:8, 103:6, 125:9 fox 2:5, 3:6, 180:16 frame 11:22, 19:3, 26:17, 35:2, 38:21, 43:15, 45:2, 49:13, 131:8, 167:1, 167:3, 167:4 |
|--|--|--|--|

| | | |
|---|--|---|
| frequency 105:7 front 72:12, 75:12, 98:3, 145:17, 145:18, 149:13 fully 176:16 function 21:19, 22:2, 25:11, 29:13, 63:7, 63:9, 63:13, 70:7, 71:2, 75:4, 85:20, 85:21, 88:4, 94:12, 98:2, 106:1, 154:2 functionality 14:9, 14:10, 24:7, 27:18, 31:22, 41:3, 62:8, 62:17, 63:17, 66:20, 67:20, 70:19, 80:11, 80:14, 83:6, 83:17, 84:1, 84:2, 84:11, 84:16, 85:8, 93:11, 95:19, 96:13, 105:22, 107:19, 151:22, 154:4 functions 32:12, 78:13, 153:13, 153:18 fundamental 38:4, 119:22 fundamentals 127:20 funding 160:3 further 122:6, 179:4, 180:11, 180:14, 180:20, 181:1 <hr/> G <hr/> gallon 36:11 | gas 15:11 gathered 150:1 gave 45:7 geared 159:11 general 11:14, 13:20, 13:21, 20:3, 22:13, 36:8, 37:13, 42:21, 43:1, 45:9, 53:12, 63:6, 63:7, 71:4, 73:7, 76:1, 81:17, 89:14, 91:10, 111:10, 117:14, 141:2, 141:11, 152:4, 157:21 generally 22:10, 47:13, 63:13, 64:10, 66:16, 74:12, 101:5, 105:2, 117:21, 142:18, 155:3, 159:6, 169:17 generate 134:5 generated 50:6, 54:6, 117:14, 122:21, 123:14, 146:21, 147:1 generates 123:10 generation 51:10 gentlemen 8:7 geometric 119:13 geometry 88:5, 124:6 germany 133:12 | getting 55:12 give 23:18, 26:2 given 35:10, 61:7, 91:7, 149:14, 180:10 glare 65:2, 70:12, 70:14, 70:17, 70:19, 71:1, 71:5, 71:7, 71:10, 71:11, 71:22, 72:1, 72:6, 72:7, 72:12, 72:15, 72:16, 73:2, 73:3, 73:22, 74:4, 74:8, 75:10, 100:12, 148:6 glares 71:19 gm 11:16, 12:1 go 10:14, 36:17, 75:6, 100:13, 105:19, 113:18, 115:15, 117:19, 121:12, 121:13, 125:19, 125:20, 172:9, 174:6, 174:10, 176:22 goal 148:3 goes 50:9, 140:13 going 54:8, 67:1, 74:3, 113:4, 113:5, 120:4, 144:20, 177:22 goldstein 2:5, 3:6, 180:16 good 6:8, 6:9, 6:13, 45:7, 49:15, 72:21, 76:11, 76:15, 113:6, 172:3, 172:13, 173:2 gotou 163:17 gotou's 165:17 government 18:12, 18:16, 129:11, 132:20, 132:21, 139:2, 139:7, 139:14, 141:20, 172:17 governs 136:18 gps 25:4 graduate 10:19 graphic 160:15, 161:20 green 103:16, 103:19, 103:21 ground 66:1 grounds 163:16 group 1:5, 3:12, 14:13, 14:14, 14:15, 14:16, 95:3, 136:1, 137:11, 137:22, 138:1, 138:2, 142:15, 180:12 grouped 142:16 grouping 14:9 groups 12:16, 14:17 growth 133:5 guess 55:22, 69:7, |
|---|--|---|

| | | | |
|---|--|---|---|
| 104:4, 133:17, 142:22, 151:4, 168:20 guidance 8:19 guide 11:15, 53:12, 128:17, 128:20, 128:21, 129:5, 169:2 guideline 142:13 guidelines 30:7, 141:2, 142:7, 172:10 guys 113:2, 127:7, 140:16, 150:2 <hr/> H <hr/> half 13:11, 55:13, 100:4, 113:5, 134:4 hand 181:9 handled 111:4 happen 72:3 hardware 87:1, 165:4 harmonize 42:8, 136:8 harmonized 65:12, 65:18 haug 3:15, 56:7 head 133:21 headlamps 19:11, 20:22, 37:12, 37:21, 40:11, 45:3, 46:7, 46:16, 57:12, 68:14, 78:1, 78:11, 78:15, 85:16, | 86:8, 89:21, 138:5, 142:9, 142:18, 142:19, 143:17, 146:1, 150:13, 152:8, 170:14, 173:22 headlight 17:14, 40:19, 148:5, 155:17, 173:7 headlighting 118:10 headlights 40:5 heat 49:17, 50:6, 50:7, 51:5, 51:9, 51:11, 51:12, 51:13, 51:14, 51:15, 51:16, 51:18, 51:20, 51:21, 52:1, 52:9, 52:11, 52:12, 52:13, 52:15, 52:19, 53:3, 53:4, 53:5, 53:9, 53:13, 53:14, 53:19, 53:20, 54:5, 54:11, 58:6, 58:10, 60:4, 61:5, 61:13, 89:17, 90:4, 122:9, 122:13, 122:18, 122:20, 122:21, 123:9, 123:10, 123:14, 123:18, 123:19, 123:20, 123:22, 124:1, 124:8 heat-management 56:19, 57:2 heating 169:20 heats 53:2 height 72:2, 72:9, | 73:6, 73:8, 73:16, 145:20 held 2:1 help 45:10 helps 150:18, 150:20 here 6:14, 7:5, 56:1, 102:22, 163:14, 167:12, 167:13, 168:7 hereby 180:5 hereinbefore 180:7 hereunto 181:8 hid 15:11 hierarchy 136:22 high 15:11, 27:22, 28:11, 28:16, 29:1, 29:12, 29:14, 31:22, 32:4, 32:5, 32:14, 32:21, 43:6, 43:9, 43:11, 43:14, 45:22, 46:2, 47:15, 59:5, 59:13, 59:15, 62:10, 69:18, 70:1, 70:5, 70:6, 70:7, 70:9, 70:11, 70:16, 71:2, 72:13, 76:12, 76:13, 76:19, 77:4, 83:17, 84:1, 84:8, 84:11, 84:15, 85:1, 85:8, 93:5, 95:6, 95:7, 103:8, | 103:21, 111:20, 125:10, 148:5, 151:7, 151:12, 151:21, 152:9, 152:18, 152:21, 154:21, 155:2, 155:6, 155:11, 155:17, 155:20, 156:11, 170:17, 170:20, 171:4, 171:20, 177:5, 177:13 high-brightness 154:16, 154:18, 155:10, 155:14, 156:5 high-mounted 72:6 higher 33:8, 49:21, 50:4, 54:9, 58:18, 59:5, 59:7, 59:8, 59:17, 73:10, 73:13, 73:15, 75:11, 111:21, 125:20 higher-distance 70:10 highest 59:6, 77:5 highly 18:3, 24:14, 44:4, 44:20, 72:8, 127:9 highway 18:21, 65:5, 66:22 hingedly 169:1 history 117:15, 125:17 hit 87:17 horizontal 65:5, 65:9, 65:10, 65:14, 98:20, 99:5, |
|---|--|---|---|

| | | | |
|---|---|---|--|
| 99:8, 99:16, 100:11 horizontally 99:18 hour 44:7, 55:13, 113:5 hours 8:12, 46:16 however 41:3, 49:11, 68:15 huge 132:22 human 89:5 humidity 142:17 hundred 12:11 hundreds 173:4 hyphen 169:12 hypothetical 144:17, 145:8, 146:9, 146:17, 147:18, 148:2, 149:10, 149:21, 170:2 hypothetically 172:1 | 149:8 ifg 11:16 ignore 141:5 illinois 11:1 illuminance 161:5, 161:6, 161:8, 161:10, 161:11 illuminate 66:19, 67:14, 98:20 illumination 21:20, 69:21, 70:8, 70:10, 70:14, 94:12, 94:13, 96:21, 111:10, 120:19, 155:16, 156:14, 157:7, 157:21 illuminized 71:3 image 120:2, 120:3, 120:15, 120:17, 144:14, 145:4, 145:14, 145:16, 145:19, 145:22, 146:21, 146:22, 149:7 imagine 100:2, 101:18, 101:21 imaging 119:12, 119:20, 120:1, 120:5, 120:6, 120:10, 120:12, 120:17, 144:19 immediate 128:19 immediately 90:6 impact 48:13, 123:9 implement 44:16, 89:18, | 150:20 implementations 160:1 implemented 51:6, 68:11, 152:22 improve 37:4, 54:5, 54:6 improved 35:17, 36:20, 45:1, 135:12 improvement 36:9, 45:12, 131:22, 134:22, 135:5, 135:6, 135:11, 135:18 improvements 36:5, 150:9, 150:11 in-house 116:6 inc 1:5, 3:13, 180:12 incandescent 28:17, 29:12, 85:13, 90:1, 90:3, 117:20, 118:20, 125:15 include 12:14, 12:22, 23:13, 26:11, 28:16, 29:18, 31:10, 31:15, 41:2, 52:9, 52:15, 60:13, 62:17, 84:7, 86:9, 91:18, 92:4, 106:5, 107:21, 108:15, 120:12, 121:7, 141:3, 143:18, 143:22, 151:12, 152:9, 158:8, 158:12, 164:17, 165:17 included 20:1, 29:18, | 32:5, 43:6, 43:14, 52:19, 96:12, 110:2, 137:8, 141:9, 143:12, 151:6, 151:21, 159:5 includes 12:15, 91:22, 95:4, 110:5, 129:18, 159:22 including 12:18, 15:10, 18:5, 20:4, 20:9, 26:17, 27:22, 37:15, 41:4, 41:8, 41:15, 46:1, 48:13, 48:16, 57:7, 61:14, 64:21, 66:10, 69:16, 82:5, 86:8, 89:5, 89:7, 91:5, 101:12, 103:8, 120:7, 121:10, 124:17, 129:12, 133:20, 136:6, 138:9, 145:20 incoming 70:12, 71:3 incomplete 144:17, 145:8, 146:9, 146:17, 147:18, 148:2, 149:10, 149:21, 170:2 incorrect 157:5 increase 33:3, 36:13, 50:16, 50:18, 51:2, 58:8, 150:18 increased 50:20 independent 45:5, 138:5, 141:7 |
| I | | | |
| ian 3:5, 7:10, 56:6, 56:9 ideally 124:20, 125:1 identical 107:4 identification 163:5 identified 61:10 identifies 67:7 identify 56:1, 120:15, | | | |

| | | | |
|---|---|--|---|
| index 86:19 indicate 160:17, 161:22 indicated 10:17, 165:1 indication 45:8 indirect 129:3 individual 17:14, 106:14, 107:12, 108:4, 121:9, 133:13 individually 107:7, 108:19, 176:2, 176:3 industries 111:5 industry 18:16, 20:3, 34:3, 39:4, 41:3, 41:7, 41:16, 41:19, 41:21, 43:2, 44:3, 46:21, 48:7, 51:17, 55:10, 57:7, 58:14, 58:15, 58:20, 58:21, 65:11, 68:3, 72:8, 74:11, 74:20, 75:1, 75:3, 75:6, 76:22, 90:15, 94:4, 94:20, 97:3, 101:1, 101:8, 101:15, 102:5, 102:16, 110:20, 112:10, 114:18, 115:13, 116:1, 116:19, 116:21, 116:22, 125:6, 125:17, 129:11, 133:6, 136:11, 136:14, 137:4, 137:10, 141:2, 144:3, | 148:11, 155:1, 157:10, 157:18, 159:14, 159:21, 172:10, 175:3 industry's 42:19 industry-wise 71:9 infinite 82:7 influences 62:4 information 25:4, 119:16, 140:1, 144:19, 145:19, 145:21, 149:12 infrastructure 115:7 initial 172:22 initially 13:22, 73:15 initiated 131:6 inland 11:15 input 31:16, 34:1, 34:2, 34:9, 34:12, 35:18, 54:2, 54:3, 108:9, 134:19, 145:2, 174:16, 174:19, 175:1, 175:8, 175:18 input-wise 134:7 inside 30:3, 46:2, 60:3, 60:5, 60:20, 143:16, 171:14, 172:16 inspection 180:20 inspections 72:21 installed 118:17 | instance 18:8, 33:17, 57:19, 75:4, 89:6, 116:4, 128:4, 130:18, 171:20 instead 124:21 institute 10:20, 42:4, 159:1, 159:20 instruct 145:3 integrate 17:5, 149:1 integrated 20:11, 20:13 integration 17:9, 45:15 intensity 15:11, 64:8, 77:1, 77:2, 77:4, 77:7, 77:10, 77:13, 77:18, 78:2, 78:6, 81:21, 81:22, 82:1, 82:2, 82:3, 82:6, 82:12, 83:1, 83:3, 89:9, 89:20, 96:17, 97:15, 97:16, 108:3, 108:21, 160:20, 161:1, 170:18 intentional 128:22, 155:2 intentionally 73:9, 152:16 interested 115:21, 181:5 interesting 116:8, 138:22 interface 124:8 interior 117:9 internal 11:16, 60:3, | 60:6, 128:13, 142:22 internally 60:14 international 42:8, 68:17, 136:9, 136:10, 136:12, 158:13, 160:4 internationally 157:15, 158:2 interpretation 17:20, 138:16, 153:17 interpretations 19:7, 115:10 interpreted 19:8 interrupt 174:10 intersection 78:11, 78:17, 78:19, 125:11, 126:5 intersections 125:4 intrinsic 50:13 intrinsically 84:20, 120:9 introduce 21:9, 52:2, 56:3, 115:6 introduced 95:18, 95:20, 124:14, 152:18, 153:16 introduces 120:6 introduction 120:9 invention 167:4 involved 136:2 ioslux 158:15, 160:8, 160:14 |
|---|---|--|---|

| | | | |
|---|--|---|---|
| ipr 1:11, 6:15 iprs 6:22 ir 111:11 irid 101:16 ish 6:20, 8:12, 14:5 iso 42:9, 160:16 isocandela 161:3 isolux 160:15, 160:20, 161:3, 161:4, 161:13, 161:18, 161:20, 162:5, 162:10, 162:12, 162:13 issue 32:6, 32:7, 32:10, 48:10, 51:4, 52:4, 73:17, 112:18, 139:9, 146:11 issues 51:8, 55:6, 146:7 itself 17:15, 33:7, 47:7, 52:20, 86:22, 121:5, 123:8, 123:10, 144:2, 144:15, 146:14, 147:4, 175:4 | 13:9, 13:12 jason 3:4, 7:11, 56:4, 56:9 jeopardize 73:10 jianzhong 1:15, 2:1, 5:2, 6:2, 180:6, 180:15 jiao 1:15, 2:1, 5:2, 5:8, 6:2, 6:8, 6:11, 55:22, 56:17, 81:4, 91:1, 104:1, 109:8, 113:11, 122:4, 150:8, 154:15, 156:12, 158:15, 163:4, 163:6, 165:21, 167:10, 169:5, 179:6, 180:6, 180:15 job 1:20 joined 11:14, 11:18 judith 1:22, 2:16, 180:3 junction 50:14, 50:17, 53:15, 58:1 justify 32:20 | key 133:9 kind 18:10, 30:14, 45:10, 46:5, 59:7, 59:12, 74:2, 101:11, 118:22, 147:21, 157:13 kinds 28:3 know 9:3, 9:7, 9:19, 18:19, 19:1, 19:9, 24:1, 24:22, 25:14, 27:9, 27:21, 28:10, 31:21, 32:5, 35:7, 37:4, 41:21, 42:14, 43:12, 45:16, 46:16, 49:12, 57:21, 58:1, 61:1, 70:9, 75:11, 75:17, 75:19, 80:19, 90:19, 93:16, 95:1, 95:11, 97:13, 106:15, 108:2, 110:4, 110:7, 126:20, 127:2, 127:6, 127:11, 128:18, 136:13, 151:12, 151:20, 153:1, 154:9, 155:4, 155:9, 156:18, 158:7, 158:22, 161:19, 164:3, 166:3, 168:6, 169:21, 178:7, 178:11 knowledge 63:4, 66:9, 90:15, 138:14, 151:13, 158:3 knows 55:10, 73:7 | koito 11:20, 26:20, 27:1, 28:9 kushman 4:6 |
| L | | | |
| | | | lab 138:20, 142:6, 143:14 laboratories 138:6 laboratory 143:8, 143:16 lamps 26:19, 57:12, 66:3, 68:20, 72:7, 76:20, 77:3, 79:2, 82:21, 87:19, 97:17, 97:18, 118:18, 140:14, 141:4, 141:14, 146:2 language 70:4, 165:16 large 119:14 largely 46:20, 72:1, 99:4, 117:5, 120:14, 120:18, 133:14, 133:22, 135:8, 138:5, 138:12, 159:6, 160:4, 167:21, 177:14 larger 128:14 largest 133:12, 133:21 laser 129:14 lasers 15:12, 110:13 last 7:5, 38:1, 45:9, 78:9, |

| | | | |
|--|--|--|---|
| 95:16, 95:20, 97:12, 105:18, 150:8 late 15:21, 15:22 later 36:14 launch 27:5 launched 26:19 law 17:4, 17:16, 17:18, 19:7, 39:2, 39:10, 76:1, 76:9, 76:16, 76:17, 78:3, 78:8, 78:9, 78:12, 78:17, 79:2, 136:16, 136:17, 136:18, 136:20, 136:21, 137:1, 137:3, 137:4, 137:22, 138:18, 139:7, 153:10, 153:14, 154:3, 157:13 lawyer 116:7 lawyers 75:16 ld 129:14 lead 74:3 leads 51:3 leakage 128:22 least 9:6, 9:11, 28:22, 156:9, 168:22 led's 37:2, 130:17 led-based 62:16, 106:5 | led-driven 170:20 led-generated 53:3 left 14:5, 26:16, 74:8, 99:10, 125:21, 126:11, 127:8 leg 179:1 legal 8:20, 18:1, 73:8, 75:14, 114:20, 115:5, 115:7 legally 63:3, 68:19, 71:9 lens 86:9, 87:5, 106:22, 107:8, 108:16 less 32:15, 35:20, 35:22, 54:5, 89:17, 135:17, 150:19, 150:22 letters 157:4 level 37:7, 41:1, 41:5, 41:17, 46:18, 47:3, 50:17, 54:16, 54:22, 64:7, 72:18, 72:20, 77:4, 93:2, 94:1, 94:2, 94:5, 105:4, 105:5, 118:16, 118:21, 124:6, 136:19, 137:21, 138:2, 138:11, 173:1, 175:7 leveling 75:13, 76:6, 76:10, 76:14, | 127:8 lexus 26:20, 27:16, 27:17, 27:19, 28:6, 28:15, 31:9, 31:15, 151:7, 151:11, 151:13 license 140:17, 140:20, 140:21, 141:5 life 46:15, 48:4 lifetime 44:11, 45:6 light-emitting 53:18, 129:14, 169:17 light-source-bas- ed 60:13 lightbulb 141:9 lighting's 138:17 lightings 45:9 lights 23:2, 35:19, 37:14, 40:14, 45:20, 65:6, 65:10, 67:3, 69:20, 71:21, 72:10, 72:11, 75:6, 75:9, 76:19, 76:20, 83:18, 84:19, 84:22, 93:11, 94:15, 120:20, 120:22, 121:9, 121:12, 121:13, 125:5, 125:11, 126:3, 126:4, 127:4, 172:8, 172:9 likely 145:17 limitation 65:20, 88:5, | 90:19, 164:14, 164:20, 165:6 limitations 163:22, 164:8, 165:2, 165:11, 165:16 limited 140:6 limits 44:14, 47:5 line 65:9, 65:14, 74:9, 87:6, 87:8, 102:2, 160:2, 161:4, 162:10, 162:12 lines 123:21 list 112:11 listed 167:13, 168:20 lit 67:3 little 56:18, 56:21, 56:22, 75:11, 89:15, 100:8, 102:14, 102:15, 113:12, 117:9, 125:21, 128:9, 136:21, 179:1 llp 3:15 load 76:12 lobbied 153:17 located 67:5, 67:9, 87:14, 87:16 location 128:17, 128:19, 146:6, 147:1 locations 120:21 locus 102:2 |
|--|--|--|---|

| | | | |
|--|---|---|--|
| logic's 149:22 long 13:13, 21:9, 28:4, 45:9, 74:20, 75:10, 92:19, 93:18, 97:7, 102:15, 107:2, 148:9 look 24:3, 46:22, 102:6, 102:13, 158:4, 173:10, 173:11, 173:12, 173:14, 173:18, 173:22 looking 47:1, 102:6, 102:21, 118:1, 169:18 looks 128:14, 173:16 loosely 12:15 lot 102:8 lots 51:17 low 27:22, 28:7, 28:9, 28:12, 28:18, 29:17, 32:13, 34:21, 35:11, 43:7, 43:9, 43:14, 62:10, 63:8, 63:9, 63:12, 63:16, 64:14, 64:18, 64:22, 65:3, 65:5, 65:7, 65:8, 66:18, 67:3, 67:13, 71:5, 71:6, 71:7, 71:8, 71:9, 71:10, 71:11, 71:13, 71:15, 71:17, 72:7, | 72:14, 72:15, 73:2, 73:10, 73:22, 75:8, 76:19, 78:18, 83:17, 84:1, 84:9, 84:11, 84:16, 85:1, 86:8, 93:3, 95:5, 97:17, 98:2, 99:2, 99:4, 99:20, 100:3, 100:5, 100:8, 100:9, 100:13, 103:8, 105:9, 105:22, 106:7, 106:18, 107:13, 108:10, 151:6, 152:9, 154:21, 155:11, 170:17, 170:21, 171:3, 171:20, 177:14 lower 34:5, 50:4, 54:16, 54:18, 54:20, 54:21, 55:11, 72:3, 98:22, 99:1, 125:21 lsad 169:7 lumen 44:6, 44:12, 44:13, 44:18, 44:20, 45:11, 46:13, 64:8, 82:3, 131:16, 131:19, 134:8, 134:16, 155:4, 161:1, 161:6, 161:11, 171:15, 172:1, 172:2, 172:5, 172:15, 172:22, 173:1, 173:2, 178:8 lumens 132:8, 132:16, 134:10, 134:13, | 172:18, 173:4, 178:1, 178:2, 178:3 luminosity 48:17, 48:19 luminous 48:20, 48:21, 48:22, 49:3, 49:10, 49:14, 50:4, 64:7, 64:8, 76:22, 77:2, 77:4, 77:6, 77:10, 77:12, 77:18, 78:2, 78:6, 82:2, 82:3, 83:1, 83:3, 130:8, 131:12, 131:15, 132:2, 150:18, 160:20, 161:5, 169:6, 169:9, 169:15, 170:5, 170:18, 171:2, 171:3, 171:11, 171:12 lunch 113:3 lux 160:21, 161:4, 161:7, 161:9, 161:10, 161:21 <hr/> M <hr/> made 133:10, 133:11, 162:8 magnitude 132:13 main 45:21, 50:13 mainly 29:9, 44:12, 51:12 maintained 96:4, 96:6 maintenance 44:6, 44:14, 44:20, 45:11, | 46:13, 46:14 major 44:15, 133:15, 157:19 majority 51:14, 51:22, 110:17 make 23:20, 32:19, 38:13, 58:18, 61:3, 67:20, 70:16, 90:2, 115:11, 126:11, 128:5, 157:3, 162:10, 172:8, 172:18 maker 52:2, 73:9 maker's 44:21, 50:15 makers 49:2, 52:13, 115:8, 133:1 malaysia 133:16, 133:22, 134:2 manage 36:22, 50:10, 58:10, 122:21, 123:17 management 51:6, 51:14, 51:21, 52:19, 53:9, 54:11, 58:7, 60:4, 61:5, 61:13, 122:9, 122:13, 123:20, 124:1, 156:4, 156:10, 174:9 manager 13:20, 13:21, 13:22 managing 50:6, 121:1 mandatory 66:12 manipulate 86:11, 86:13, |
|--|---|---|--|

| | | | |
|---|---|--|--|
| 107:21, 121:12 manipulation 132:20 manipulator 84:19 manufactured 133:7 manufacturer 139:4, 139:11 manufacturers 134:1 many 6:19, 14:1, 36:13, 47:21, 107:21, 108:15, 112:12, 112:14, 125:7, 134:5, 153:14, 172:21, 173:11, 174:4 map 25:4, 131:6, 131:9 marked 163:4 marker 79:3, 79:4, 79:10, 79:11 market 154:6 marketing 63:6, 63:10, 63:12 marking 12:18 marriage 181:3 mass-produce 133:2 master 10:16 matching 134:8 material 38:4, 124:6 materials 36:12, 116:4, 135:9 matter 141:12, 147:5, | 181:6 matters 141:13, 147:6 max 58:2, 58:3 maximum 37:7, 50:17, 57:9, 58:2, 58:3, 58:9, 58:11, 58:13, 59:1, 59:19, 61:15 maybe 13:11, 55:13, 61:22, 111:11, 126:8, 132:13, 163:1, 174:18 mean 7:22, 17:13, 25:8, 31:6, 39:21, 47:6, 61:21, 64:1, 81:7, 83:21, 85:21, 90:14, 91:4, 92:22, 98:9, 104:10, 107:4, 128:10, 128:18, 130:5, 130:14, 130:19, 134:4, 162:21, 169:14, 174:10 meaning 8:6, 94:22, 126:8, 131:20, 139:4 means 17:5, 47:3, 96:7, 97:14, 104:3, 138:4 meant 26:18, 134:7 measure 23:2, 23:4, 45:10, 47:5, 48:1, 81:11, 82:8, 160:19, 161:5, 161:6, 162:11 | measured 60:22, 81:22, 82:6, 120:2, 127:22, 131:16, 161:8, 162:2, 162:6 measurement 82:8 measurements 61:3, 131:18, 158:6 measures 18:11, 160:5, 161:20 measuring 171:9 mechanical 23:11, 47:14, 48:13, 142:16, 174:11 mechanically 45:15 mechanism 25:5, 104:20, 137:13, 137:16, 165:18 mechanisms 51:18 meet 7:9, 23:19, 46:10, 57:2, 58:4, 65:6, 65:16, 66:14, 77:10, 82:18, 83:2, 92:19, 103:10, 136:22, 138:21, 172:16, 177:4 meeting 53:15, 71:15 meets 74:20, 93:18, 102:18, 148:10 member 137:8 members 157:18 memorize 59:18 | memory 52:5, 101:2, 156:2 mention 86:21 mentioned 13:6, 23:8, 24:16, 25:6, 37:9, 39:9, 48:8, 48:17, 48:22, 62:3, 62:10, 66:18, 73:18, 74:10, 79:9, 79:12, 79:17, 80:9, 84:14, 88:8, 96:16, 100:17, 103:5, 110:8, 112:17, 114:10, 127:7, 134:3, 134:15, 136:1, 136:15, 137:12, 137:21, 147:10, 151:5, 159:11, 174:6, 174:15, 174:19, 177:21 meter 51:16, 141:18, 161:12 meters 98:13, 98:14 metrology 82:9 mi 4:9 might 55:5, 75:19, 113:6, 118:12, 127:13, 157:5, 178:21, 178:22 mileage 46:11 million 47:22 mind 56:2 minimal 120:16 |
|---|---|--|--|

| | | | |
|--|---|--|---|
| minimally 32:18 | modulations 108:18, 108:19 | most 20:20, 30:1, 37:10, 86:4, 94:17, 119:15, 133:7, 140:11, 144:5, 145:17, 172:11, 173:19 | 35:4, 35:7, 35:19, 47:4, 47:20, 85:6, 91:19, 92:1, 92:17, 96:22, 102:9, 105:15, 106:10, 106:13, 144:8, 146:2, 146:3, 173:6, 174:3, 175:12 |
| minimize 47:2, 54:5 | modulator 84:18, 86:10, 108:16, 109:9, 109:11, 109:19, 110:2, 110:5 | motor 19:13 | must 57:13, 71:1 |
| minimum 32:15 | modulators 146:3 | motors 11:14 | mvss 19:14 |
| minute 168:19 | moisture 47:16 | mount 53:9, 73:9 | myself 8:6, 14:3 |
| minutes 55:17, 55:18, 178:21 | monday 7:6 | mountable 18:14 | <hr/> N <hr/> |
| mirror 72:6 | money 133:1 | mounted 12:19, 57:17, 72:13, 72:16, 73:4, 73:5, 144:1, 144:12, 145:5, 146:5, 146:14 | n-h-t-s-a 18:22 |
| mischaracterizes 69:3, 112:22, 151:10, 156:1, 164:22, 178:5 | monitor 22:10, 49:3, 49:9, 60:6, 60:8, 60:16, 61:2 | mounting 72:1, 72:8, 73:7 | nal 12:3, 12:9, 13:6, 13:8, 13:13, 13:16, 14:2, 19:19, 21:4, 21:5, 22:17, 25:17, 26:13, 26:16, 28:6, 28:8, 35:2, 36:2, 38:1, 38:7, 38:20, 43:4, 43:13, 43:22, 51:7, 56:19, 57:8, 58:22, 60:12, 62:17, 96:13, 96:14, 110:8, 168:7, 168:14, 168:17, 169:3 |
| missed 105:17 | monitored 49:16 | mounting-height 73:17 | nal's 12:5 |
| misunderstood 108:13 | monitoring 22:7, 60:15, 143:19 | move 122:8 | name 6:10, 14:11, 68:1 |
| misuse 71:10 | monument 102:7, 102:14, 102:21, 102:22 | moving 73:19, 165:18 | named 97:8 |
| mixed 161:3 | more 13:11, 23:9, 24:8, 35:19, 37:1, 51:20, 54:17, 54:19, 54:21, 55:1, 55:5, 55:11, 56:21, 56:22, 57:17, 61:19, 62:11, 70:9, 88:11, 90:16, 91:10, 95:5, 98:5, 98:17, 99:12, 100:10, 101:5, 110:15, 126:4, 127:4, 133:17, 142:20, 165:9, 173:15, 174:14 | much 7:7, 8:10, 32:13, 34:5, 37:6, 61:1, 65:21, 73:15, 74:6, 83:11, 94:21, 98:5, 100:3, 100:13, 101:16, 108:5, 108:19, 128:14, 133:3, 134:10, 134:13, 135:7, 138:1, 155:4, 171:15, 171:19, 171:20, 171:21, 172:12, 173:4 | namely 15:4, 36:10, |
| mode 90:21, 125:16 | morning 6:8, 6:9 | multiple 23:7, 35:3, | |
| model 28:3, 29:6 | | | |
| modes 125:7, 125:9, 125:13, 125:14, 126:17 | | | |
| modified 97:10 | | | |
| modular 174:3 | | | |
| modulate 107:22, 108:1, 108:4, 109:13 | | | |
| modulates 109:12 | | | |
| modulation 89:2, 89:11, 89:14, 90:9, 90:12, 90:20, 105:4, 108:8, 108:17, 109:5 | | | |

| | | | |
|--|--|--|---|
| 37:18, 41:7, 41:19, 42:9, 46:3, 58:2, 71:18, 74:20, 94:16, 101:8, 101:15, 103:9, 136:18, 137:4, 159:19 narrow 65:17 nation 66:11 national 18:21, 42:4 nations 68:4 naturally 58:1, 102:3 nature 51:9, 86:15, 122:18, 122:19 nd 4:8 necessarily 68:8, 109:6 need 14:11, 22:3, 23:22, 24:2, 24:4, 33:19, 33:21, 34:8, 35:20, 35:22, 45:8, 48:14, 61:1, 63:15, 72:9, 75:9, 88:17, 96:8, 96:9, 97:14, 117:17, 117:19, 126:2, 138:20, 139:11, 141:16, 146:20, 147:9, 147:22, 149:7, 172:15, 172:17, 172:21, 174:3, 174:12 needed 16:12, 21:10, 33:10, 33:11, 36:2, 126:10, | 129:1, 142:8 needing 49:15 needs 17:15, 23:9, 46:10, 65:5, 65:7, 124:15, 140:2, 148:6, 149:12, 172:17, 177:4 negotiate 88:6 negotiated 30:13 neon 15:11 never 10:10, 162:5 new 3:18, 10:21, 15:6, 15:8, 15:10, 15:12, 15:15, 16:21, 16:22, 45:19, 67:19, 68:18, 68:22, 69:5 next 102:21, 102:22 nhtsa 18:21, 18:22, 19:1, 19:9, 80:8, 80:9, 137:21, 153:18 nitrite 36:11 non-imaging 119:12, 119:14, 119:16, 119:21, 120:16, 121:3, 121:6, 121:8 nonautomotive 112:20, 158:7, 159:11 north 11:19, 136:6 northwestern 11:1 notary 2:18, 180:1, | 180:4, 181:15 notice 2:16, 78:15 novel 167:17 number 6:15, 34:13, 34:17, 34:20, 35:3, 35:20, 35:22, 46:16, 47:19, 59:4, 59:10, 59:17, 59:18, 83:10, 134:12, 134:15, 141:19, 150:19, 168:12, 168:15, 168:21, 171:22, 172:14, 178:13 numbers 155:6, 172:2 nw 2:7, 3:8, 180:17 ny 3:18 <hr/> O <hr/> object 120:2, 120:4, 147:5, 147:11, 147:13, 148:14, 149:19 objection 12:8, 14:19, 15:2, 16:4, 16:8, 16:18, 17:22, 19:4, 19:20, 22:8, 22:18, 22:19, 23:5, 24:9, 26:5, 26:14, 26:15, 27:12, 27:13, 27:20, 28:13, 28:20, 28:21, 29:4, 29:20, 29:21, 30:9, 30:10, 31:1, 31:2, | 31:11, 31:18, 31:19, 32:1, 32:2, 33:1, 33:5, 33:6, 34:19, 35:1, 35:6, 35:13, 36:3, 36:7, 38:2, 38:9, 38:17, 39:1, 39:19, 39:20, 40:6, 40:7, 40:15, 40:21, 40:22, 41:13, 42:16, 44:19, 46:12, 48:6, 48:11, 49:6, 49:19, 50:1, 51:1, 54:14, 57:5, 59:2, 59:9, 59:14, 60:1, 60:9, 61:17, 61:18, 62:13, 62:22, 63:1, 66:8, 67:16, 67:21, 69:2, 69:3, 71:14, 75:2, 75:21, 75:22, 76:21, 78:7, 79:20, 80:6, 80:16, 80:21, 81:1, 82:13, 82:20, 83:8, 83:19, 84:17, 85:9, 85:15, 86:14, 87:7, 87:12, 87:22, 88:2, 88:12, 89:12, 90:11, 90:18, 94:10, 96:1, 96:20, 97:19, 97:22, 98:1, 100:21, 101:7, 103:3, 104:15, 105:18, 106:9, 106:20, 107:15, 108:12, 110:21, 111:17, |
|--|--|--|---|

| | | | |
|--|---|--|--|
| <p>112:4, 112:21, 114:15, 114:22, 115:19, 115:20, 117:12, 118:4, 118:14, 119:7, 121:21, 122:12, 122:16, 123:4, 124:3, 126:22, 127:18, 130:3, 130:12, 130:13, 131:3, 131:13, 131:14, 132:5, 132:10, 132:17, 132:18, 134:14, 135:1, 137:17, 139:20, 140:9, 143:3, 144:10, 144:16, 144:17, 145:7, 145:8, 146:8, 146:9, 146:16, 146:17, 147:2, 147:17, 147:18, 148:1, 148:2, 149:9, 149:10, 149:20, 149:21, 150:14, 150:17, 151:9, 152:1, 152:5, 152:6, 152:11, 152:20, 153:4, 154:7, 154:11, 154:12, 154:19, 155:12, 155:22, 156:1, 156:7, 156:8, 156:15, 157:1, 158:10, 158:17, 160:12, 161:16, 162:4, 162:15, 162:16, 164:1, 164:4, 164:9, 164:21, 165:7, 165:12, 167:19, 167:20, 168:3, 168:8, 170:1, 170:12, 170:13, 176:15, 177:7, 177:18, 178:4</p> | <p>objections 153:8, 170:7 objectively 147:3 objectives 114:14 objects 147:16, 147:22, 149:8, 149:13 obligation 95:13 obviously 55:7, 77:5, 97:6, 138:9, 170:16 occasionally 52:1, 52:12, 81:11, 152:18 occurred 180:15 occurrence 47:8 oem 10:13, 12:11, 23:14, 27:9, 30:11, 30:17, 31:6, 32:18, 58:12, 58:17, 58:19, 59:6, 61:22, 63:10, 73:7, 76:7, 81:18, 87:21, 88:6, 110:18, 116:2, 173:9 oem's 15:4, 30:16, 33:2 oems 13:7, 13:9, 15:7, 16:7, 24:6, 26:11, 110:15 offhand 166:4 office 1:1, 7:6 offices 2:2, 180:15</p> | <p>often 15:5, 20:9, 33:2, 41:6, 58:17, 72:5, 75:13, 81:8, 89:7, 94:5, 106:14, 116:8, 116:12, 121:7, 128:1, 131:19, 140:3, 156:3, 173:22 oh 26:19, 30:20, 158:22, 169:13 okay 6:17, 7:2, 7:9, 7:12, 7:20, 8:10, 8:13, 10:14, 10:18, 11:4, 11:7, 11:22, 12:3, 12:5, 13:3, 13:6, 14:4, 14:6, 15:16, 16:6, 17:1, 21:17, 26:10, 30:20, 31:9, 33:3, 35:8, 48:21, 49:3, 49:17, 55:9, 56:14, 59:12, 61:4, 61:12, 62:7, 63:15, 67:19, 69:10, 78:4, 79:11, 79:17, 80:1, 85:19, 87:3, 92:8, 98:14, 103:11, 104:13, 109:8, 113:19, 115:4, 115:15, 117:1, 117:7, 121:18, 129:6, 133:17, 134:12, 137:12, 144:6, 151:15, 152:15, 159:15, 159:17, 160:6, 162:13,</p> | <p>166:8, 166:19, 168:18, 169:21, 170:9, 174:21, 178:15, 178:18 old 29:6, 92:21 older 136:21 oleds 129:15 once 49:16, 68:13, 72:19, 88:17, 149:6 oncoming 65:2, 66:1, 70:17, 71:4, 71:16, 71:21, 100:7, 147:7 one 9:12, 12:9, 14:3, 14:15, 14:16, 20:17, 20:18, 34:11, 36:10, 41:16, 44:14, 45:20, 47:4, 55:3, 75:4, 77:5, 77:7, 80:1, 80:2, 83:11, 84:4, 91:18, 91:20, 91:21, 92:10, 92:12, 94:18, 95:9, 98:17, 100:3, 101:9, 103:6, 103:9, 105:2, 105:16, 107:11, 107:12, 107:16, 108:16, 108:17, 110:4, 111:15, 114:2, 114:10, 116:6, 117:8, 123:22, 125:15, 132:14, 133:12, 139:8, 140:15, 157:17, 158:12, 159:10, 159:17,</p> |
|--|---|--|--|

| | | | |
|--|---|--|---|
| 160:4, 163:16, 168:22, 171:12, 175:21, 176:5, 176:14 one's 168:14 ones 9:4, 168:11 only 21:19, 28:7, 32:21, 37:12, 47:4, 65:9, 78:8, 81:11, 83:10, 84:8, 92:12, 98:18, 117:8, 127:10, 136:13, 137:7, 142:9, 143:17, 173:5, 173:17, 176:18 operate 20:11, 46:16, 49:21, 90:22, 145:1, 146:1 operated 22:4, 33:22, 34:5 operating 54:3, 54:15, 54:21, 55:10, 57:9, 57:10, 58:11, 61:15, 175:4 operation 57:21, 58:9, 60:17, 77:16, 94:18 opinion 76:15 opposite 53:16, 53:17, 53:18 optic 86:12, 104:5, 109:6, 119:20, 119:21, 121:3 optical 14:13, 15:13, | 23:11, 30:2, 36:21, 85:3, 86:7, 86:10, 86:17, 88:4, 91:2, 91:4, 91:7, 91:9, 91:12, 91:13, 91:16, 91:19, 91:21, 92:5, 92:7, 92:11, 92:12, 92:13, 92:14, 92:18, 92:21, 92:22, 93:2, 93:5, 93:6, 93:8, 93:10, 93:15, 93:18, 106:13, 107:6, 108:16, 109:5, 109:15, 119:3, 119:9, 119:14, 119:17, 120:1, 120:4, 120:6, 120:9, 120:13, 120:19, 121:8, 121:11, 128:11, 128:20, 135:13, 135:16, 140:22, 146:13, 149:4, 172:6, 172:10, 172:11, 178:10, 178:17 optically 16:12, 25:2, 25:7, 25:10, 89:5 optics 28:16, 28:18, 29:1, 29:2, 29:6, 29:11, 29:15, 29:19, 63:16, 63:19, 63:20, 83:4, 83:12, 84:14, 84:15, 84:18, 85:2, 85:6, 85:7, 85:11, 85:17, 85:19, 85:22, 86:2, | 86:6, 86:15, 87:2, 87:3, 87:4, 87:9, 87:14, 87:18, 91:11, 104:1, 104:14, 105:21, 106:6, 106:17, 106:21, 107:18, 107:20, 107:21, 108:5, 108:14, 108:15, 108:18, 109:2, 119:5, 119:9, 119:10, 119:12, 119:13, 121:19, 126:8, 126:9, 126:11, 127:11, 128:12, 172:7, 174:1, 176:5 optimization 90:21 optimized 30:1 option 136:20 optional 63:2, 87:18 options 126:20 opto 110:10, 110:11, 110:22 order 39:3, 54:4, 65:6, 84:22, 116:15, 122:21, 123:12, 172:18 ordinary 165:21, 166:4, 166:10, 166:12, 166:20, 166:22, 167:7 organic 129:15 organization 156:13, 156:18, 156:22, 158:2, 159:19 | organized 14:7, 14:8 osram 110:9, 110:10, 110:11, 110:22, 111:3 other 9:18, 16:11, 20:10, 22:3, 25:4, 39:12, 39:14, 39:15, 43:5, 45:17, 47:16, 57:4, 61:14, 66:9, 66:10, 66:16, 68:4, 68:9, 71:16, 77:18, 79:6, 85:13, 92:20, 94:2, 108:1, 111:8, 111:15, 112:15, 116:19, 117:3, 123:15, 124:1, 124:7, 128:2, 128:3, 129:18, 129:20, 134:1, 136:8, 136:10, 142:7, 147:22, 165:5, 174:7, 174:11 others 72:11, 74:17, 115:11, 133:22, 169:4 otherwise 42:7, 78:17, 96:9, 181:5 out 30:20, 39:21, 45:5, 60:4, 86:4, 87:17, 115:12, 133:13, 179:5 outcome 181:6 outer 87:5, 87:10 output 44:5, 44:8, |
|--|---|--|---|

| | | | |
|---|--|--|---|
| 44:12, 50:5, 50:9, 51:3, 54:2, 54:4, 54:8, 54:9, 54:12, 54:17, 64:8, 78:5, 88:17, 130:15, 130:18, 130:20, 134:5, 150:22, 162:7 outside 7:12, 8:14, 66:7, 80:15, 110:19, 111:1, 116:21, 144:5, 144:6, 144:18 over 36:18, 37:22, 44:4, 44:9, 44:10, 45:1, 48:18, 49:1, 49:4, 99:22, 114:19, 130:19, 130:20, 131:2, 131:11, 131:15, 131:21, 132:1, 132:3, 132:9, 150:10, 150:21 overall 9:1, 13:10, 30:2, 37:7, 54:19, 54:20 overview 114:17 own 8:22, 22:22, 92:4, 139:18, 143:19 owner 1:9, 4:3, 6:6 <hr/> P <hr/> package 37:15, 37:20, 84:4, 84:10, 84:13, 85:2, 86:2, 86:5, 86:7, 133:19, | 133:20, 135:15, 173:5, 174:8, 175:5, 175:11, 175:12 packaged 37:21, 133:13 packages 39:6, 173:5 packaging 30:5, 30:8, 30:21, 53:6, 55:5, 88:1, 88:5, 88:7, 175:7 pad 30:3 page 5:2, 5:8, 163:12 pages 1:21 pal 9:10, 9:13, 9:15, 9:20, 10:1 pandemic 9:19 paragraph 163:12, 166:7, 166:17, 167:10 parallel 43:9, 91:13, 91:17, 175:6, 175:14 paralux 122:5 parameters 174:12 park 79:5 parking 79:7, 79:10 part 19:12, 19:13, 19:15, 25:5, 28:8, 60:3, 67:10, 67:11, 71:2, 71:6, 72:10, 95:16, | 105:13, 126:9, 135:10, 135:17, 148:5, 149:14, 171:5 partially 126:8 particular 29:14, 58:16, 85:4, 138:13, 160:17, 168:1 particularly 73:14 parties 180:22, 181:2, 181:4 partner 159:20 partnered 159:16 partners 3:15, 56:8, 157:22 partnership 160:2 parts 47:13, 47:21, 47:22, 142:16 party 133:15, 180:11 passenger 76:12 passive 51:20, 52:1, 52:6, 52:9, 52:14 past 105:4, 132:9 patent 1:1, 1:3, 1:9, 1:12, 4:3, 6:5, 7:19, 163:11, 167:5, 167:8, 167:13, 167:15, 167:18, 168:2, 168:12, 168:15, 168:21 patents 168:7 | pattern 64:2, 64:3, 64:5, 64:10, 67:11, 67:18, 68:8, 71:5, 71:18, 71:20, 77:1, 77:16, 77:17, 77:19, 82:22, 92:20, 93:18, 99:17, 124:20, 125:19, 147:6, 147:8, 171:2, 171:14, 171:20, 172:5, 172:13, 172:16 patterns 63:18, 63:21 pc 4:6 pcps 33:17 people 116:19, 173:20, 173:21 perceived 89:8 percent 12:12, 32:15, 32:16, 32:22, 172:13, 178:12, 178:13 perfect 6:12, 72:22 perform 153:13 performance 18:4, 18:11, 24:7, 24:11, 123:12, 123:16, 129:22, 130:5, 130:10, 130:14, 138:6, 138:7, 148:8, 161:14, 161:22, 162:19, 171:7, 171:8, 172:3, 173:1, 173:16 performance-rela- ted 158:6 |
|---|--|--|---|

| | | | |
|---|---|--|---|
| performances 18:7 perhaps 75:11, 105:16 period 46:10, 132:3 permissible 80:14, 100:19, 103:1 person 165:21, 166:4, 166:9, 166:12, 166:20, 166:22, 167:7 personally 109:20 personnel 116:2, 116:3 perspectives 116:11 pertinent 166:11 petition 115:10 petitioner 1:6, 3:3 ph 1:15, 2:1, 5:2, 6:2, 11:2, 11:5, 11:10, 11:13, 180:6, 180:15 phase 27:7, 60:22, 61:3, 61:4, 61:11, 61:12 phone 7:4 phosphor 36:17, 36:19, 37:19, 38:13, 39:5, 133:20, 135:10, 135:11, 135:18 phosphor's 44:22 photo 143:10, 143:12, 143:14, 143:15 | photometer 141:18, 143:10 photometers 142:6 photometric 140:12, 143:5, 143:7 photometrical 171:8 photometry 140:12, 141:1, 142:14 photosensor 143:9 physical 105:13, 105:14 physically 141:16 physics 10:21, 119:11 pick 139:8, 172:7, 172:21, 173:13 pickup 72:4, 73:14 piece 9:10 pinpoint 24:19, 152:21, 153:15, 155:5 pinpointing 25:13 pipe 52:13, 52:15, 52:16, 86:10, 128:5, 128:7, 128:10, 128:14, 128:16, 128:20, 128:21, 129:4 pivoting 165:18 plate 140:17, 140:20, 140:21, 141:5 please 14:12, 98:14, 163:13, 167:11 plot 162:12 | plotted 160:16 plug 34:1 plus 58:19, 175:6 pmw 89:19 pocket 30:15 point 39:21, 81:12, 92:20, 92:21, 93:8, 102:11, 115:12, 142:11, 144:14, 146:12, 166:6 point-to-point 120:5 points 92:20, 142:10, 142:12, 172:17 polytechnic 10:20, 159:1, 159:20 pop 111:10 porsche 56:13 portion 29:17, 93:4, 93:5, 126:1, 126:10, 126:11, 127:11 portions 28:22 position 13:17, 13:20, 93:17, 148:14 positioned 87:4 positions 13:15, 146:21 positive 90:4 possibilities 28:4 possibility 21:22, 23:22, | 58:8 possible 51:17, 120:6 potential 37:7, 74:7, 111:6, 159:22 power 21:12, 21:15, 21:21, 53:21, 54:7, 54:19, 55:4, 108:9, 134:19 practical 54:13, 55:8, 82:8 practice 21:5, 42:19, 48:7, 52:5, 57:7, 111:18, 114:18, 125:17, 144:3, 156:3, 161:18, 171:6, 175:3 practiced 22:20 preceding 147:7 precise 59:18 precisely 98:16 predetermine 109:4 predicted 61:5 prefer 166:6 preference 33:2 preparation 7:8, 7:16, 7:22 prepare 7:3 preparing 8:15, 8:17 preproduction 27:6 presence 147:16 |
|---|---|--|---|

| | | | |
|---|---|--|---|
| <p>present 67:15, 86:10</p> <p>presumed 166:10</p> <p>pretty 7:7, 9:11, 14:20, 37:6, 45:7, 58:16, 59:5, 94:21, 98:22, 103:14, 107:3, 107:20, 108:5, 108:19</p> <p>prevent 66:4, 71:20</p> <p>primarily 12:11, 13:7, 13:8, 27:21, 32:6, 52:12, 81:14, 98:4, 115:22, 116:20, 116:22, 119:11</p> <p>primary 85:7, 98:2</p> <p>prime 101:21</p> <p>principal 91:11, 120:21, 120:22</p> <p>principally 70:6, 120:3, 162:22</p> <p>principle 42:20, 50:2, 53:12</p> <p>principles 114:18, 119:10</p> <p>prior 8:22, 9:3, 10:6, 28:2, 113:13, 123:2, 137:12, 154:5</p> <p>pro 6:21</p> <p>probably 28:3, 90:21, 97:7, 99:12, 99:21, 161:2, 166:3, 168:20</p> | <p>problem 47:8, 105:20, 168:1</p> <p>proceeding 70:12, 70:18, 145:18</p> <p>process 115:9, 135:8, 140:1, 149:14, 149:15, 164:14</p> <p>processed 149:12</p> <p>processing 149:8, 149:16</p> <p>processor 144:21, 164:7, 164:13, 164:18, 164:19, 165:2</p> <p>processors 144:21, 145:21, 164:15, 164:17</p> <p>produce 35:19, 36:1, 36:15, 54:9, 65:6, 89:17, 134:10, 139:4, 171:1, 173:4</p> <p>produced 110:13, 123:13, 134:17</p> <p>product 12:11, 26:12, 29:14, 74:16, 111:1, 111:11, 115:22, 116:18, 118:17, 123:8, 123:10, 133:4, 138:3, 138:4, 138:6, 138:7, 138:20, 139:3</p> <p>production 26:22, 27:5, 28:1, 28:2, 28:4, 28:5, 29:5</p> <p>products 12:7, 13:8, 15:1, 27:10, 110:11, 110:17,</p> | <p>110:19, 115:11, 139:18</p> <p>professional 2:17</p> <p>program 10:16, 10:21, 11:5, 11:7, 11:10, 11:13, 159:3, 159:4, 159:17</p> <p>progress 9:21, 10:1</p> <p>prohibit 78:10, 154:3</p> <p>prohibits 76:17</p> <p>project 29:9, 65:14, 72:10, 98:15, 141:9, 160:21, 162:12</p> <p>projected 64:3, 64:5, 67:4, 83:1, 145:20, 160:21, 162:8, 171:3</p> <p>projecting 67:9</p> <p>projection 29:7, 29:16, 29:19</p> <p>projector 29:9, 173:10</p> <p>projectors 29:8</p> <p>projects 67:8, 140:20</p> <p>promote 15:6, 15:14, 159:3</p> <p>promoted 13:21, 15:9, 15:17, 154:2</p> <p>pronounce 120:8, 133:10</p> <p>pronouncing 6:10</p> <p>properly 72:16, 73:1,</p> | <p>123:18</p> <p>property 38:5</p> <p>proposal 17:7</p> <p>propose 16:2, 16:14, 16:16, 22:15, 25:14</p> <p>proposed 16:1, 16:6, 17:1, 19:17, 21:4, 23:17, 23:19, 26:11, 38:20, 48:14</p> <p>proposing 38:22</p> <p>protect 160:21</p> <p>protocols 48:15</p> <p>prototype 27:6</p> <p>prove 49:14</p> <p>provide 12:7, 21:18, 22:4, 27:19, 27:21, 30:13, 49:4, 62:9, 63:16, 70:7, 70:12, 71:11, 72:12, 74:2, 83:16, 83:22, 85:8, 88:10, 88:18, 93:11, 105:9, 105:22, 106:7, 106:18, 107:13, 107:19, 110:12, 114:17, 131:10, 134:13, 138:17, 156:21, 166:1, 174:4, 175:18</p> <p>provided 21:20, 28:6, 31:16, 62:9, 71:13, 108:9,</p> |
|---|---|--|---|

| | | | |
|---|---|--|--|
| 142:13 provides 67:13, 74:22, 79:19, 140:1, 144:21 providing 119:16 provision 19:10 proximate 59:21, 60:14 proximity 52:10, 62:3 public 2:18, 180:1, 180:4, 181:15 published 68:18 pulse 88:11, 88:13, 88:22, 89:2, 89:3, 89:11, 89:14, 89:16, 90:9, 90:12, 90:20, 105:3, 105:6, 105:7 pulsing 25:12 purchasing 116:9, 116:12 purely 159:18 purity 135:8 purpose 18:5, 21:20, 63:6, 64:19, 71:15, 71:17, 73:21, 74:7, 145:15, 149:14 pursuant 2:16 put 9:10, 30:14, 32:13, 33:18, 53:19, 65:21, 72:19, 84:22, 133:19, 171:12, | 171:16, 172:1, 172:12 putting 32:16, 171:19 pwm 90:1 <hr/> Q <hr/> qualify 116:16 quality 46:3, 46:4, 111:21, 112:7, 112:9, 116:14, 120:2, 120:17 quantifiable 131:18 quantification 148:12 quantify 98:11, 132:2, 148:3, 148:10, 155:2, 155:6 quantitatively 99:13 quantum 36:12, 135:6 question 16:5, 26:1, 40:2, 57:6, 58:19, 62:14, 77:8, 82:15, 87:13, 104:17, 105:12, 105:18, 106:3, 110:6, 135:3, 145:9, 148:21, 164:11, 169:8, 170:3, 170:20, 176:12, 176:17 questions 23:6, 78:9, 179:5 quicker 132:12 quickly 51:17 quite 13:13, 16:5 | <hr/> R <hr/> r&d 15:6 radar 26:6, 26:9, 26:10 radiated 51:11 radiates 102:3 radiation 102:2 range 50:11, 102:17, 102:20, 155:7, 155:8 ranges 57:3 rate 112:13 rather 54:7, 63:10, 106:16 rationale 124:15 rays 121:10 reached 37:6 read 141:18 reader 26:8 readiness 15:4 reading 166:14, 180:20 reaffirm 96:10 reaffirmed 97:9 real 60:8, 60:17 real-life 57:14 realize 46:15 | really 25:13, 28:9, 52:6, 95:5, 98:16, 100:6, 121:1, 133:4, 143:10, 161:11 realtime 2:18, 30:20 rearview 72:6 rearward 12:22, 53:10, 117:3 reason 17:7, 18:6, 18:17, 34:6, 34:8, 45:21, 57:11, 57:20, 57:22, 58:5, 72:9, 72:14, 74:5, 81:10, 89:18, 98:5, 98:17, 100:6, 116:14, 118:21, 123:7, 123:17, 134:21, 136:14, 137:1, 137:3, 138:15, 140:21, 141:14, 142:5, 142:11, 142:19, 146:10, 153:12, 154:1, 155:5, 157:22, 178:13 reasons 132:15 recall 13:10, 19:13, 27:4, 27:17, 27:22, 28:14, 29:1, 29:5, 29:6, 29:13, 31:20, 32:3, 35:7, 43:8, 59:6, 59:16, 60:16, 61:19, 69:17, 98:16, 99:19, 100:22, 110:3, 118:19, |
|---|---|--|--|

| | | | |
|--|--|--|--|
| <p>124:5, 126:18, 138:10, 151:11, 156:9, 167:15, 167:21, 174:21, 177:19 receive 21:12, 90:8 recently 68:17 recess 55:20, 113:8, 150:5, 179:2 recognize 163:6 record 179:8, 180:10, 180:22 recurring 9:16 red 38:8 redirect 86:16, 108:20, 120:20 redirecting 86:18 redirection 121:5 reduce 44:5, 53:20, 54:4, 54:7, 54:8, 55:2, 105:3 reduced 50:9, 54:3, 105:5, 131:21, 150:21 reducing 53:21, 54:7, 54:10, 54:12 reduction 51:3, 70:19, 133:5 refer 19:6, 84:6, 94:6, 125:13, 129:10 reference 8:21, 9:9,</p> | <p>21:3, 41:18, 163:20 referenced 7:18, 9:2, 39:22, 99:10, 165:2 references 9:4, 9:7, 164:12, 164:17, 164:19, 165:3, 165:5 referred 41:19, 59:20, 121:19, 137:4, 176:18 referring 38:18, 77:18, 79:21, 82:6, 84:3, 84:4, 86:22, 87:2, 91:6, 99:7, 109:1, 118:6, 122:1, 143:5, 155:15, 164:15 reflector 173:11 reflection 57:14, 65:22, 128:13, 162:9 reflector 86:9, 168:13 reflectors 29:8 refraction 86:20 refresh 161:11 regard 163:10 regarding 8:20, 9:1, 57:8, 65:20, 174:8 regardless 32:11, 92:18, 93:17, 118:2, 147:8 region 101:17, 102:11</p> | <p>registered 2:17 regular 156:6 regulate 40:4, 40:18, 41:8, 81:17, 100:18, 140:18 regulated 18:3, 18:8, 18:9, 24:15, 39:17, 70:20, 74:18, 79:2, 118:17, 141:20, 177:11 regulates 19:10, 40:16, 73:19, 79:14, 80:5 regulation 14:16, 17:4, 18:12, 18:17, 39:2, 39:10, 39:22, 40:8, 40:16, 41:2, 41:18, 58:13, 58:20, 66:17, 67:17, 68:5, 69:5, 70:3, 71:1, 72:17, 73:11, 73:21, 74:6, 76:5, 77:14, 79:14, 80:19, 81:12, 91:6, 91:15, 91:20, 93:7, 93:15, 93:21, 94:2, 101:14, 102:16, 118:22, 136:18, 171:5, 177:1 regulations 18:9, 18:20, 19:2, 40:13, 58:15, 58:20, 67:10, 69:14, 76:2, 79:18, 79:19, 80:10,</p> | <p>91:6, 101:4, 113:12, 115:3, 115:4, 115:14, 118:1, 118:2, 118:7, 118:9, 118:11, 118:12, 119:1, 123:3, 123:5, 130:1, 130:7, 136:12, 136:16, 138:8, 138:21, 139:14, 141:3, 171:17 regulatory 41:6, 80:18 reiterate 135:4 relate 81:20 related 9:9, 16:12, 24:4, 54:2, 114:21, 162:18, 165:2, 165:16, 167:21, 171:11, 181:1 relationship 10:12, 169:22 relative 99:8, 112:2, 124:7, 130:1, 130:15, 134:18, 144:15 relevance 26:15, 81:2, 114:16, 115:1, 115:20, 119:8, 122:17, 124:4, 127:1, 127:19, 130:4, 130:13, 131:4, 135:2, 137:18, 139:21, 143:4, 152:2, 152:12, 153:5, 154:12, 154:20, 155:13, 156:8, 156:16, 157:2, 158:11, 158:18, 160:13, 162:16,</p> |
|--|--|--|--|

| | | | |
|--|---|--|--|
| 167:20, 168:4, 168:9, 170:2 relevant 82:10, 93:1, 167:1 reliability 24:8, 45:21, 46:3, 46:8, 46:19, 47:11, 48:1, 48:5, 50:21, 52:4, 111:22, 112:1, 112:3 reliable 42:22 relied 8:19, 165:14 rely 8:17, 165:4 relying 163:21, 164:7, 164:18, 165:10 remain 71:1 remember 15:16, 23:8, 26:16, 35:3, 59:4, 59:10, 80:12, 80:22, 81:3, 96:3, 97:11, 98:16, 99:12, 101:2, 116:21, 125:8, 127:12, 131:19, 151:15, 151:18, 152:3, 153:22, 155:8, 158:14, 167:17, 168:1, 168:5, 170:8, 172:8, 177:12 remote 128:6, 145:5, 146:15 rensselaer 10:20, 159:1, 159:20 repeat 157:4, 169:8 | rephrase 31:14, 39:13, 40:3, 60:10, 62:15, 145:10 replace 17:13, 18:18 replaceable 17:6, 18:8, 18:15, 118:19 replaced 17:15, 18:10 replacement 16:15, 16:17, 16:21, 17:10, 17:12 replacing 16:2, 17:2 reported 1:22 reporter 2:17, 2:18, 180:1, 180:4 reporting 14:2 represent 48:4, 56:10, 56:12, 56:13 representation 160:15, 161:21 represented 180:12 requested 153:17 require 24:6, 101:4 required 63:3, 63:21, 65:4, 143:21, 178:7 requirement 48:12, 59:16, 65:1, 66:2, 66:14, 67:12, 70:22, 81:13, 81:19, 81:20, 94:14, 94:16, 94:18, 95:17, 100:14, 102:19, | 103:9, 111:21, 112:2, 137:2, 138:14, 138:17, 148:7, 148:8, 148:10, 177:13 requirements 41:11, 47:11, 53:7, 58:18, 71:6, 72:9, 73:8, 74:6, 75:15, 76:19, 80:10, 82:19, 83:3, 94:8, 96:17, 97:15, 112:3, 112:8, 116:15, 123:3, 123:6, 123:13, 130:7, 130:16, 135:21, 171:7, 171:8, 177:5, 177:6, 177:10, 177:15, 177:16, 177:20 requires 64:18 research 27:6, 45:5, 159:2, 159:9, 159:19, 159:21 resolution 147:19, 147:21, 148:7, 148:10 respect 131:11 responsible 116:13, 136:5, 138:10 rest 87:18, 168:17, 168:19, 173:21 restriction 30:3 result 47:8, 54:11, 161:19 retracing 120:14 return 160:7 | reversely 168:20 review 7:15, 7:20 reviewed 7:6, 7:17 revised 19:1 revisions 19:6 ri 95:19 rid 70:13, 94:12, 95:1, 95:6, 95:7, 95:8, 95:20, 96:12, 96:18, 97:4, 100:17 right 6:8, 7:2, 10:3, 11:11, 11:13, 18:2, 56:15, 92:13, 99:10, 99:21, 100:4, 100:7, 100:9, 100:12, 113:7, 113:11, 114:4, 114:13, 116:20, 118:8, 125:21, 125:22, 126:11, 127:8, 130:8, 145:16, 150:2, 150:8, 157:4, 157:6, 160:7, 164:6, 166:2, 166:14, 177:17 road 22:11, 24:2, 24:17, 24:21, 25:2, 25:7, 25:12, 25:22, 26:4, 28:2, 64:5, 64:22, 65:22, 68:9, 69:15, 69:17, 70:10, 74:1, 74:5, 94:11, |
|--|---|--|--|

| | | | |
|---|--|---|---|
| <p>95:3, 96:21, 124:17, 125:2, 125:3, 125:4, 125:9, 125:10, 125:20, 131:6, 131:8, 138:4, 139:5, 141:11, 151:14, 160:21, 161:21, 162:8, 162:9, 162:12 road-illumination 12:17 rob 56:7, 56:12 robert 3:14 room 8:8, 8:14, 56:2 roughly 100:3, 100:8 rpi 10:20, 159:1, 159:9 rpr 1:22, 180:3 rule 115:8, 172:13 rule-making 68:18, 137:22 rules 115:9 run 172:2</p> <hr/> <p style="text-align: center;">S</p> <hr/> <p>s 15:21, 15:22, 16:7, 97:7 sae 41:7, 41:17, 41:19, 42:10, 42:15, 42:18, 74:20, 94:4, 94:6, 94:8, 95:13, 95:16, 96:4, 101:8, 113:12, 113:15, 113:16, 113:18,</p> | <p>113:20, 119:2, 122:10, 136:1, 136:4, 136:5, 137:5, 137:8, 140:10 safety 18:5, 18:22, 19:14, 68:9, 70:11 safety-wise 24:15 said 11:7, 17:11, 32:7, 59:16, 60:16, 60:17, 69:5, 73:4, 74:17, 75:18, 76:3, 99:17, 99:19, 112:12, 121:3, 121:6, 130:6, 151:11, 151:13, 178:1, 178:6, 178:9, 178:12, 180:21 sale 152:10 sales 116:18 same 13:17, 35:18, 36:1, 62:12, 72:11, 83:16, 83:22, 84:9, 93:7, 105:9, 105:13, 105:14, 106:17, 106:21, 107:4, 107:8, 107:18, 118:2, 123:1, 128:13, 134:5, 134:7, 134:10, 134:12, 142:4, 142:18, 150:22, 153:8, 158:4, 159:10, 170:7 sangeeta 4:5 satisfy 165:15</p> | <p>satisfying 163:21, 164:7, 164:19, 165:5, 165:11 saving 157:12, 157:13 say 24:12, 76:2, 108:18, 113:5, 132:4, 134:16, 138:18, 144:18, 153:11, 173:14 saying 44:10, 64:12, 68:22, 108:7, 162:1, 164:14 says 78:12 scenario 58:10, 79:1 school 10:15, 10:19, 11:11 scientifically 43:1 scope 13:10, 22:19, 26:15, 27:13, 28:21, 29:21, 30:10, 31:2, 31:19, 32:2, 33:6, 39:20, 40:7, 40:15, 40:22, 41:14, 42:17, 49:7, 59:3, 59:9, 60:1, 61:18, 67:21, 75:22, 79:20, 80:6, 80:16, 80:21, 94:10, 96:20, 97:19, 98:1, 110:21, 115:19, 117:12, 118:5, 118:15, 119:7, 122:12, 122:16, 124:3, 126:22, 127:18, 130:3,</p> | <p>130:12, 131:3, 132:18, 135:1, 137:17, 139:20, 143:3, 152:1, 152:11, 153:5, 154:8, 154:11, 154:19, 155:13, 156:8, 156:15, 157:1, 158:10, 158:17, 160:12, 161:17, 162:15 screen 101:22, 102:6, 102:22 se 91:16, 170:8 search 8:22 second 14:14, 36:15, 45:14, 114:1, 115:2, 125:22, 126:6, 131:18, 135:10, 160:1, 173:8 secondary 36:18, 85:7 section 166:15 see 19:7, 47:20, 55:15, 65:4, 66:22, 79:6, 98:7, 101:22, 140:21, 141:10, 141:11, 146:10 seem 157:8 seen 62:5, 109:22, 110:1 select 138:3, 178:2 selecting 138:3 selections 124:6 selective 103:15, 153:13,</p> |
|---|--|---|---|

| | | | |
|--|--|--|---|
| 154:1 self-approval 139:2, 139:12, 139:13, 139:15, 139:18 self-regulating 139:10 sell 63:10, 66:6, 66:15 selling 27:10 semi-conduct 36:11 semiconductor 135:9 semiconductors 110:10, 110:12, 110:22 sense 22:13, 24:1, 32:19, 133:4 sensing 22:5, 23:9, 24:20 sensor 22:9, 22:22, 23:16, 23:18, 23:22, 24:2, 24:4, 24:16, 24:17, 25:1, 25:6, 25:11, 25:14, 25:21, 26:3, 26:6, 143:11, 143:12, 143:14, 143:15, 144:1, 144:4, 145:5, 147:12, 147:15, 147:20, 147:22, 148:9, 149:1, 149:3, 149:4, 149:18 sensor's 145:2 sensoring 22:12, 22:21, 23:10, 148:4, 149:11 | sensors 22:3, 22:6, 22:7, 22:15, 23:1, 23:2, 23:7, 23:13, 24:6, 31:10, 31:16, 60:14, 142:22, 143:2, 143:19 separate 17:6, 17:11, 20:14, 63:11, 65:11, 96:22, 144:7 series 9:14, 34:10, 34:11, 175:7, 175:14 serve 63:13 services 12:7 session 113:13, 150:9 set 34:3, 57:13, 107:2, 141:3, 141:16, 178:19, 180:7, 181:8 several 173:4 severe 57:18 shah 4:5, 30:19 shall 42:22, 43:1, 67:2, 72:15, 72:16, 73:22, 75:5, 96:5, 101:3, 101:13, 136:20, 141:1 shape 86:20, 86:21, 87:1, 87:3, 149:13 shorthand 180:1 | should 9:1, 18:2, 23:15, 43:19, 53:13, 57:22, 60:21, 94:15, 101:3, 124:21, 125:2, 125:8, 161:2, 176:1 sic 14:16 side 53:10, 53:16, 53:17, 53:18, 79:3, 79:4, 79:5, 79:10, 79:11 sides 64:22 sidewalk 128:22 sign 66:19, 67:7, 67:9, 67:15 signage 65:4, 66:22, 67:2, 67:4, 68:2, 68:9, 72:11, 100:12 signal 12:17, 12:18, 13:4, 21:17, 22:4, 23:10, 25:12, 26:3, 40:14, 83:17, 88:9, 88:11, 88:16, 90:1, 141:11, 150:1 signaling 94:14, 140:8 signals 22:5, 31:16 signature-plkal 181:13 significant 50:19, 112:18, 132:16, 135:17 significantly 35:17, 36:20, | 45:2, 131:17 signing 180:21 signs 65:5, 67:14, 68:2 similar 112:19, 157:10 simple 83:9 since 9:22, 19:2, 38:1 single 34:15, 37:18, 142:1, 142:3, 142:10 single-colored 36:16 site 53:15 situation 9:19, 54:18, 89:17 six 35:5 size 30:4, 88:7, 141:12, 174:8 skill 165:22, 166:4, 166:10, 166:20, 166:22, 167:7 sky 103:1 slice 169:11 so-called 102:1 society 42:11 sold 68:12 solid 100:2, 129:21, 159:6 solid-state 117:21, 129:7, |
|--|--|--|---|

| | | | |
|---|--|---|---|
| 129:12, 129:13, 129:16, 129:17, 156:13, 157:7, 159:3, 159:22 solutions 44:17 solve 168:2 some 15:8, 19:5, 19:16, 33:15, 36:5, 43:20, 44:17, 46:8, 47:7, 51:5, 52:13, 56:18, 56:22, 62:7, 65:20, 67:3, 73:2, 74:2, 82:8, 85:13, 86:22, 87:21, 89:15, 94:7, 98:21, 100:10, 100:14, 111:8, 111:11, 111:13, 112:2, 113:14, 113:16, 114:13, 114:20, 118:18, 118:20, 123:1, 125:4, 126:8, 132:15, 134:1, 139:10, 139:16, 147:4, 150:9, 150:11, 157:13, 158:5, 170:9, 174:13 somebody 52:7 somehow 71:8, 157:8 something 9:22, 52:2, 129:10 sometime 152:17 sometimes 15:14, 42:8, 47:15, 49:9, 51:12, 54:15, | 54:17, 81:18, 108:3, 108:21, 155:7, 161:3, 174:4 somewhat 58:16 somewhere 55:14 soon 45:3, 55:14, 153:16 sorry 13:8, 16:15, 24:12, 25:19, 26:3, 27:2, 29:16, 30:19, 31:13, 56:22, 66:4, 75:18, 88:21, 92:2, 103:5, 105:19, 109:22, 161:5, 168:14, 168:20, 174:6, 176:22 sort 76:9, 160:4 soule 3:5, 56:6 sound 43:2 source 16:10, 18:9, 18:10, 18:15, 19:10, 19:14, 19:22, 20:2, 20:4, 20:6, 20:12, 28:19, 32:17, 33:4, 33:7, 33:11, 33:19, 33:20, 33:22, 34:2, 44:21, 50:3, 83:4, 83:11, 83:12, 83:14, 85:18, 92:3, 92:7, 92:14, 106:6, 117:14, 118:3, 118:12, 118:19, 120:12, | 120:18, 120:19, 121:4, 121:7, 121:8, 121:10, 121:11, 123:14, 124:7, 128:6, 128:8, 128:15, 128:18, 129:21, 163:21, 168:13, 169:17, 169:18 source-operated 85:16 sources 15:10, 16:11, 16:20, 18:7, 18:14, 18:18, 43:6, 53:14, 83:5, 83:10, 83:15, 89:22, 92:1, 92:18, 92:22, 117:10, 117:16, 117:22, 118:13, 119:1, 122:22, 123:11, 128:3, 129:13, 129:19, 146:3 sourcing 116:11 southfield 4:9 space 30:8, 30:11, 30:14, 53:8, 112:18, 130:20 spatial 81:5, 81:8, 81:15, 82:11, 82:19, 109:9, 109:11, 109:12, 109:13, 109:19, 110:2, 110:5, 162:14, 162:18, 162:20, 162:22, 163:3, 169:10, 169:11, 169:19, 170:5 spatial-angular 169:6 speaking 22:10, 64:10, | 66:16, 117:22, 120:3, 155:3 spec 58:19, 61:8 special 160:18 specific 19:9, 24:19, 25:14, 39:11, 46:4, 57:1, 64:9, 70:22, 82:19, 85:17, 85:18, 101:5, 107:11, 112:14, 147:16, 149:7, 165:9, 170:18, 175:18, 177:4 specifically 57:21, 76:2, 78:10, 101:9, 153:11 specification 81:12, 81:18 specifications 15:5, 61:20, 61:21, 61:22, 72:20, 112:12, 171:18 specified 58:12, 59:7, 176:20, 177:1 specify 76:6, 83:21, 118:11 specifying 118:22 spectrum 39:7 speculate 32:4 speculation 18:1, 27:14, 63:1, 103:4, 152:6, 154:13 speed 24:4, 125:10 spend 8:11 |
|---|--|---|---|

| | | | |
|---|---|--|---|
| <p>spent 51:17, 119:15</p> <p>spero 1:8</p> <p>spread 65:17, 65:19, 84:22, 99:18, 99:20, 99:21, 100:10, 100:11</p> <p>square 161:12</p> <p>ssl 129:7</p> <p>stability 44:22, 45:1, 132:1, 135:12</p> <p>stabilized 96:7</p> <p>stable 44:8</p> <p>stalled 30:20</p> <p>stand 9:20, 69:8, 69:11, 79:15</p> <p>standard 14:16, 19:14, 37:17, 41:4, 41:7, 41:16, 41:19, 41:20, 42:2, 42:5, 42:7, 42:8, 42:12, 42:18, 42:19, 42:21, 48:12, 48:15, 58:20, 58:22, 59:8, 61:15, 61:20, 65:16, 67:10, 67:19, 68:17, 75:7, 79:13, 88:7, 91:5, 93:16, 94:4, 94:5, 94:6, 94:9, 95:1, 95:10, 95:11, 95:14, 95:20, 96:4, 96:8, 96:12,</p> | <p>96:18, 96:22, 97:3, 97:4, 101:1, 101:8, 101:10, 101:11, 103:6, 123:5, 136:4, 136:7, 137:4, 137:5, 140:4, 141:21, 171:5</p> <p>standardization 42:2, 42:3, 42:5, 42:10</p> <p>standardize 81:16</p> <p>standards 8:20, 39:22, 41:7, 41:22, 42:6, 42:13, 42:15, 43:3, 46:4, 46:8, 46:22, 58:14, 58:15, 60:2, 61:8, 65:11, 66:7, 67:18, 72:17, 74:21, 94:21, 94:22, 95:17, 96:5, 96:9, 97:1, 97:2, 97:3, 97:8, 97:16, 100:17, 101:9, 101:15, 102:5, 103:7, 112:9, 112:10, 112:11, 113:12, 114:2, 115:13, 136:3, 136:5, 136:9, 136:11, 136:14, 137:10, 137:14, 137:16, 140:10, 171:17, 177:2</p> <p>start 97:4, 114:7, 157:16</p> <p>started 13:22, 27:10, 56:1, 97:5</p> <p>starting 14:3, 30:12,</p> | <p>120:18</p> <p>starts 80:12</p> <p>state 41:5, 41:6, 41:17, 41:18, 94:5, 129:21, 136:17, 136:20, 136:21, 137:3, 137:4, 138:11, 138:12, 138:13, 138:15, 138:18, 159:7, 166:9, 180:4</p> <p>statement 69:4</p> <p>states 1:1, 12:10, 17:4, 17:16, 39:18, 40:1, 41:10, 42:1, 63:3, 63:5, 66:10, 68:15, 68:19, 72:20, 74:19, 75:14, 77:14, 80:7, 115:7, 136:12, 159:12</p> <p>stationary 67:18, 72:18, 77:15, 124:21, 126:2, 126:9</p> <p>statistic 47:1</p> <p>statistics 46:21</p> <p>steering 24:1</p> <p>stepped 132:22</p> <p>steradian 82:4</p> <p>sterne 2:5, 3:6, 7:12, 10:3, 56:5, 56:6, 180:16</p> <p>stick 178:22</p> | <p>still 70:14, 87:13, 90:5, 111:2, 114:4, 133:11, 133:22, 134:1, 145:9</p> <p>stop 78:16, 78:20, 138:15</p> <p>stopped 78:12, 78:21</p> <p>straight 74:5</p> <p>straightforward 125:10</p> <p>strategies 51:6, 56:19, 57:3, 126:16, 156:4</p> <p>strategy 60:4, 90:13, 106:16, 107:2, 173:13</p> <p>street 2:7, 3:8, 180:17</p> <p>stress 47:12, 47:14, 47:15, 47:16, 112:14</p> <p>stressors 47:13, 47:19</p> <p>stretch 179:1</p> <p>strike 16:15, 25:19, 29:16, 66:4, 82:16, 88:21, 92:2, 92:8, 130:9, 174:21</p> <p>structure 52:18, 63:16</p> <p>structures 53:5, 111:12, 123:20</p> <p>struggle 32:12</p> <p>studio 30:12, 31:5,</p> |
|---|---|--|---|

| | | | |
|--|--|---|--|
| 31:6, 31:7, 173:9, 173:17, 173:21, 174:4 studios 30:16 study 28:3 subject 94:21, 123:9 subsidiary 11:19 subsidized 132:22 substantial 49:13 suddenly 73:14 sufficient 30:14, 64:20, 171:1 sufficiently 49:14 summarized 125:6, 126:13, 126:18 summary 131:10, 156:21 supplied 53:21, 110:14, 174:16, 175:1 supplier 10:12, 116:2, 116:13 suppliers 116:16 supplies 13:8 supply 30:17, 90:17, 110:19, 110:22, 116:3, 174:18 support 157:11 supported 110:18 supposed 48:3 sure 9:11, 43:18, | 103:14, 115:11, 145:11, 150:4, 172:9 surface 87:11, 161:22, 169:19, 169:20 surfaces 162:10 surrounding 22:14 switch 89:6 switching 89:7 swivel 23:21, 74:2, 74:7, 125:21, 127:8, 153:19 swiveling 74:22 swivelling 74:10 sworn 6:3, 180:7 symposium 9:10 sync 51:15, 52:12, 53:13, 53:19, 123:22 syncing 51:18, 52:1 syncs 51:20, 52:10, 53:13, 123:20 system 22:12, 29:7, 45:18, 49:5, 52:8, 52:9, 61:13, 68:6, 69:12, 69:15, 79:16, 109:15, 120:1, 120:4, 120:6, 120:10, 120:12, 120:13, 120:16, 120:18, 120:19, 121:1, 121:6, 121:8, | 121:11, 126:17, 136:16, 144:14, 148:4, 148:22, 149:2, 149:17, 170:11, 172:11, 174:17, 174:18, 175:2, 178:10, 178:16 systems 51:21, 53:10, 120:9, 124:10 <hr/> T <hr/> take 25:3, 51:15, 55:16, 55:18, 89:3, 90:3, 113:6, 138:4, 150:3, 178:20 taken 55:20, 113:8, 150:5, 179:2, 180:9 takes 53:8, 134:4, 145:21 taking 98:4 talk 117:16, 117:17, 124:5, 177:13 talking 19:3, 36:9, 56:18, 67:6, 157:15 target 115:17 targeting 57:4 taught 113:14, 113:16, 113:19, 131:8, 142:8 teach 114:4, 127:14, 135:19 teaches 119:9, 127:20, | 127:22, 128:1, 139:22 teaching 114:7, 116:7, 156:9 team 14:21, 29:22, 30:13 teams 14:7, 116:18 technically 32:15, 102:13, 153:10 technologies 15:6, 15:9, 15:15, 15:17, 25:15, 25:16, 135:9 technology 13:19, 14:14, 15:3, 22:21, 25:1, 36:6, 36:19, 38:15, 45:12, 114:1, 114:11, 114:19, 115:16, 122:15, 131:1, 131:5, 131:11, 133:2, 150:10, 153:2 tell 24:5, 27:2, 58:21 temp 60:8 temperature 23:3, 49:17, 49:22, 50:4, 50:9, 50:11, 50:13, 50:14, 50:16, 50:17, 50:19, 50:20, 51:2, 51:7, 57:3, 57:9, 57:10, 57:13, 57:14, 57:17, 57:22, 58:2, 58:4, 58:8, 58:9, 58:12, |
|--|--|---|--|

| | | | |
|--|--|--|---|
| <p>58:13, 59:1, 59:7, 59:8, 59:19, 59:20, 60:3, 60:5, 60:6, 60:14, 60:15, 60:17, 60:18, 60:19, 60:20, 60:21, 61:1, 61:7, 61:8, 61:9, 61:10, 62:4, 101:6, 102:10, 123:6, 130:21, 142:17</p> <p>temperature-depe- ndent</p> <p>50:3</p> <p>temperatures</p> <p>61:6, 61:16</p> <p>ten</p> <p>35:5, 96:9, 98:12, 107:16</p> <p>term</p> <p>48:18, 81:5, 81:7, 84:7, 91:2, 104:4, 104:8, 107:20, 109:9, 122:5, 129:6, 129:9, 129:18, 130:9, 162:20, 169:6, 169:9, 169:14</p> <p>terminology</p> <p>37:17, 44:6, 69:22, 74:11, 74:13, 75:1, 82:2, 84:21, 91:5, 128:11, 155:1, 157:10</p> <p>terms</p> <p>18:4, 82:9, 91:10, 106:21, 116:11, 126:13, 135:14, 140:14, 168:21</p> <p>territory</p> <p>66:10, 68:5, 80:18</p> | <p>tertiary</p> <p>85:7</p> <p>test</p> <p>47:20, 48:2, 49:2, 94:22, 98:18, 127:22, 138:6, 139:7, 139:8, 139:18, 140:2, 140:10, 140:11, 140:13, 140:15, 140:22, 141:1, 141:3, 141:8, 141:14, 141:16, 142:1, 142:7, 142:9, 142:10, 142:12, 142:14, 142:15, 142:18, 143:7, 143:9</p> <p>test-required</p> <p>143:15</p> <p>tested</p> <p>49:1, 57:13, 93:2, 93:12, 140:2, 140:19</p> <p>testified</p> <p>6:4</p> <p>testimony</p> <p>112:22, 151:10, 156:1, 164:22, 178:5, 180:10</p> <p>testing</p> <p>14:15, 15:15, 18:5, 22:1, 48:15, 58:5, 59:16, 60:18, 72:18, 82:4, 93:16, 94:15, 94:22, 114:2, 115:2, 115:4, 123:6, 135:20, 140:3, 140:5, 140:13, 140:22, 141:4, 141:5, 141:6, 141:7, 141:15, 142:1, 142:21, 143:16, 162:3</p> | <p>tests</p> <p>112:14, 139:17, 142:19, 143:5, 143:7</p> <p>th</p> <p>3:17</p> <p>thank</p> <p>26:10, 56:14, 179:5, 179:7</p> <p>themselves</p> <p>59:22, 60:15, 88:10</p> <p>therefore</p> <p>58:6, 66:15</p> <p>thermal</p> <p>102:2, 156:4, 156:10, 174:8</p> <p>they'd</p> <p>116:14</p> <p>thing</p> <p>126:6</p> <p>things</p> <p>22:13, 86:16</p> <p>think</p> <p>9:9, 9:22, 13:10, 19:12, 29:22, 30:19, 36:21, 43:10, 61:19, 62:3, 68:18, 68:19, 76:8, 99:22, 104:16, 105:11, 108:13, 109:7, 109:20, 117:8, 122:6, 126:12, 131:22, 134:15, 135:3, 144:3, 147:3, 147:14, 147:19, 152:13, 153:17, 157:8, 164:10, 166:1, 168:17, 176:11, 176:16, 178:6</p> <p>thinking</p> <p>166:11</p> <p>third</p> <p>14:14, 114:2, 126:7, 127:10,</p> | <p>135:19</p> <p>thirdly</p> <p>36:21, 135:13</p> <p>thousand</p> <p>172:3, 172:5, 172:15</p> <p>three</p> <p>22:10, 23:8, 27:8, 34:16, 36:8, 37:2, 47:13, 77:3, 113:21, 125:9, 125:18, 126:12, 126:15, 126:20, 142:16, 175:5, 175:8, 175:9</p> <p>through</p> <p>22:3, 36:17, 45:4, 48:15, 49:12, 52:16, 104:20, 113:18, 113:20, 120:19, 121:11, 125:17, 128:20, 143:15</p> <p>throughout</p> <p>9:14, 35:16, 43:15, 109:21, 115:8, 142:3</p> <p>thumb</p> <p>172:13</p> <p>tier</p> <p>110:15, 116:3</p> <p>tiers</p> <p>37:20, 137:20</p> <p>time</p> <p>7:8, 8:11, 11:14, 11:22, 12:6, 13:14, 14:5, 17:8, 19:2, 19:5, 19:19, 21:7, 22:20, 25:17, 26:17, 29:22, 32:16, 32:22, 35:2, 36:2, 38:1, 38:21, 43:15, 44:4, 44:9, 45:2,</p> |
|--|--|--|---|

| | | | |
|---|---|---|---|
| 46:10, 48:18, 49:1, 49:4, 49:13, 58:22, 60:8, 62:18, 72:12, 80:1, 90:4, 96:13, 97:7, 98:17, 113:6, 116:6, 119:15, 130:19, 130:20, 131:2, 131:7, 131:11, 131:15, 131:21, 132:1, 132:3, 144:5, 150:10, 150:21, 151:12, 167:1, 167:3, 167:4, 167:7 timeline 151:3 times 6:19, 35:19, 47:20 tir 128:13 title 13:18, 167:22 titled 168:12 tj 58:2, 58:3 today 6:14, 7:3, 17:8, 18:17, 35:19, 35:21, 35:22, 37:6, 41:12, 132:4, 133:8, 152:10 today's 173:3 together 8:6, 14:18, 34:14, 34:15, 161:4, 172:2 tons 138:9 took 80:19 top 101:2, 133:20 | total 55:4, 97:3, 128:13, 133:4, 171:1, 171:2, 171:15, 178:7, 178:9 totality 122:1 toward 98:6, 100:7, 100:9 towards 159:12 town 4:7 trademark 1:1 traditional 16:11, 33:8, 45:18 transcript 5:7, 163:5 transfer 122:18, 122:20, 145:22 transferred 10:22 transferring 53:4 transportation 18:22 travel 128:20 trial 1:3 tried 15:6, 50:10 trooper 138:12, 138:15 trooper's 138:13, 138:16 troy 10:20 truck 72:4, 73:14 true 180:10 try 58:7 | trying 57:2, 168:2 tubular 168:13 tuesday 7:6 tunnel 125:5 turn 23:21, 67:14, 78:10, 78:15, 89:4, 89:16, 90:5, 90:7, 94:18, 98:4, 144:21, 162:12, 163:12, 167:10 turned 75:5 turner 4:4, 5:3, 6:7, 31:13, 55:15, 55:22, 56:9, 56:12, 56:14, 56:16, 60:10, 62:15, 105:20, 113:2, 113:7, 113:10, 150:2, 150:7, 178:19, 179:7 turning 89:15 tv 102:6 twice 9:14, 134:10, 134:13 two 12:16, 37:20, 65:10, 65:13, 65:16, 68:13, 69:14, 78:9, 86:15, 101:20, 105:2, 119:11, 135:16, 135:17, 137:20, 141:22, 159:13, 170:17, 178:21 two-dimensional 101:19, 101:22 | two-tier 136:16 type 12:13, 21:17, 22:15, 23:1, 23:10, 23:12, 24:17, 37:10, 47:7, 49:4, 52:16, 68:1, 68:7, 72:7, 83:16, 83:20, 85:13, 85:22, 88:9, 105:13, 106:21, 110:11, 117:10, 118:3, 119:5, 124:1, 129:20, 144:1, 149:3, 149:7, 174:1 types 23:8, 68:13, 68:20, 117:3, 123:19, 129:18, 140:6 typical 47:10, 86:7 typically 36:11, 63:20, 84:6, 85:6, 162:1, 162:17 <hr/> U <hr/> under 48:3, 60:20, 66:11, 78:1, 79:3, 119:13, 129:15, 157:13 undergrad 115:18 undergraduate 10:15 understand 6:14, 16:5, 17:4, 21:10, 26:1, 77:8, 80:17, 82:15, 87:8, 87:13, 98:19, 104:16, |
|---|---|---|---|

| | | | |
|--|---|--|--|
| 105:11, 106:2, 113:14, 116:10, 116:15, 128:12, 145:9, 164:10, 170:3, 176:11, 176:16 understanding 57:8, 57:12, 76:1, 76:5, 109:13, 115:22, 137:19, 172:6 uniformly 84:22 unique 29:1, 61:22 unit 144:22, 161:10 united 1:1, 12:10, 17:4, 17:16, 39:17, 40:1, 42:1, 63:3, 63:5, 66:9, 66:11, 68:4, 68:15, 68:19, 72:19, 74:19, 75:14, 77:14, 80:7, 115:7, 136:12, 159:12 university 11:1 unless 54:9, 71:10, 76:3, 96:6, 178:22 until 9:18, 37:4, 38:4, 43:15, 68:17 updated 95:12, 95:14, 95:15, 96:6, 97:9, 97:12 usage 32:14, 32:16, 45:6, 45:12, 46:17 use 19:21, 25:10, | 25:11, 28:22, 36:10, 37:2, 37:12, 37:16, 37:19, 38:12, 39:4, 41:6, 41:17, 44:6, 44:7, 47:5, 47:12, 51:10, 51:22, 52:7, 52:13, 59:15, 64:7, 70:1, 70:2, 71:16, 72:22, 74:12, 74:13, 76:22, 81:8, 82:21, 83:5, 83:12, 83:15, 83:20, 83:22, 84:9, 85:6, 85:17, 88:8, 88:15, 89:2, 89:10, 91:21, 96:8, 97:13, 98:13, 98:17, 99:9, 101:20, 104:14, 105:9, 105:21, 106:6, 106:17, 107:3, 107:12, 107:18, 108:14, 108:17, 122:2, 128:4, 129:3, 129:4, 141:17, 145:14, 147:12, 149:3, 149:15, 150:19, 150:22, 155:7, 155:15, 162:17, 170:10, 173:5, 174:1 users 73:12, 145:2 uses 29:12, 142:4, 148:18 using 16:9, 17:7, 24:20, 29:9, 32:21, 33:9, 36:11, 43:8, | 45:3, 45:16, 46:6, 63:8, 63:12, 66:18, 93:2, 109:16, 109:19, 120:14, 121:4, 121:9, 125:2, 128:11, 128:13, 142:21, 143:9, 147:10, 148:4, 149:17, 162:6 usually 12:19, 15:3, 19:6, 21:20, 23:14, 27:7, 30:12, 31:3, 32:18, 34:4, 34:16, 49:2, 55:7, 63:19, 86:2, 86:16, 86:18, 104:20, 128:16, 145:19, 161:18, 170:21, 171:18, 172:10, 172:20, 173:9, 173:17, 175:20 utilize 58:8, 144:4 uv 36:16, 37:18, 38:3, 38:13, 39:4 <hr/> v <hr/> vague 82:14, 89:13, 112:5, 131:14, 132:6, 132:11, 165:8, 165:13 value 63:10, 63:12, 150:19 variations 22:1, 125:1 vary 85:19, 89:8, 107:6, 107:8 vehicle 12:20, 19:14, | 21:12, 30:22, 31:7, 34:7, 39:11, 41:6, 45:6, 45:7, 46:11, 46:15, 47:8, 48:4, 57:9, 57:15, 62:1, 63:6, 63:11, 68:12, 68:21, 71:4, 71:22, 72:4, 72:12, 72:19, 72:20, 73:1, 73:9, 73:12, 73:16, 75:12, 75:15, 76:11, 78:22, 79:5, 91:8, 91:14, 98:3, 98:4, 98:9, 101:11, 118:18, 123:16, 138:16, 139:4, 139:6, 144:8, 145:17, 147:4, 147:7, 147:11, 148:15, 148:19, 152:13, 154:10, 168:16, 173:18 vehicle-level 143:1 vehicle-mounting 93:17 vehicles 22:14, 27:10, 65:2, 66:1, 70:13, 70:18, 71:16, 71:17, 78:14, 79:6, 100:7, 153:12 vendor 22:21 vendors 24:20 verify 48:15 version 65:11, 65:12, 65:13, 65:17, |
|--|---|--|--|

| | | | |
|--|---|--|---|
| 66:13, 66:15, 84:21, 96:3 versions 65:13, 65:16, 65:18 versus 39:12, 63:17, 64:13, 66:3, 76:19, 84:16, 89:17, 106:7, 119:20, 140:7, 146:15, 146:22, 149:18, 155:11, 156:5 vertically 99:18 vibrate 47:14 vibration 48:8, 48:10, 48:13, 48:16 view 64:21, 72:13, 81:13, 102:14, 144:14, 146:12, 147:8, 148:15, 148:19, 160:22 violated 138:18 visibility 64:21 volkswagen 1:5, 3:12, 10:6, 10:10, 56:10, 180:12 volt 174:18 voltage 34:4, 34:5, 34:8, 34:9, 34:12, 34:15, 47:15, 174:16, 174:20, 175:1, 175:8, 175:14, 175:18 volts 34:4, 34:16, 175:5, 175:8, | 175:9 <hr/> W wafer 133:10, 133:13 wait 168:19 waived 180:21 want 23:20, 24:3, 24:21, 32:13, 39:21, 56:3, 57:11, 73:13, 76:3, 89:19, 113:2, 116:10, 123:17, 149:13, 150:2, 155:5, 172:9, 173:10, 173:11, 178:6, 178:22 washington 1:16, 2:8, 3:9, 180:17 waste 172:12 wattage 134:19 watts 131:16, 134:8, 134:11, 134:16, 173:1 way 51:10, 54:18, 76:8, 82:1, 86:4, 108:1, 120:13, 121:18, 141:17, 175:6, 181:5 ways 105:2, 107:21 we'll 15:14, 80:1, 122:8, 157:16, 178:20 we're 19:3, 24:20, 36:9, 37:6, | 55:12, 102:21, 137:7, 139:1, 177:14, 178:19 we've 113:5 weather 22:12, 69:16, 87:19, 124:18 wednesday 1:17, 180:18 week 7:5 went 10:15 wet 65:22 whatever 16:20, 23:16, 25:12, 44:7, 47:17, 67:1, 73:13, 76:3, 76:13, 89:19, 99:22, 107:1, 120:13, 125:11, 131:7, 134:9, 137:1, 138:15, 145:2, 145:20, 147:5, 148:4, 149:13, 162:9 wheel 24:1 wheels 73:13 whenever 97:5, 173:3 whereof 181:8 wherever 75:9, 172:9 whether 23:10, 25:2, 44:22, 67:1, 76:6, 100:22, 107:16, 145:18, 146:13, 147:3, 147:6, 153:18, 173:10 white 36:18, 37:3, | 37:9, 37:12, 37:14, 37:19, 37:21, 38:8, 38:14, 39:3, 39:6, 39:10, 94:17, 100:22, 101:3, 101:4, 101:17, 102:1, 102:5, 102:8, 102:11, 102:12, 102:16, 102:18, 103:9 whitish 102:15 whoever 115:21 whole 17:9, 17:14, 122:1, 126:6, 127:6 wider 65:19 width 89:11, 89:14, 90:9, 90:12, 90:20, 105:4, 105:7, 145:20 wisdom 166:12 wish 121:13 within 50:11, 62:12, 83:6, 87:14, 88:5, 92:3, 95:16, 95:20, 96:10, 116:22, 121:4, 148:20, 148:22, 153:13, 171:2, 175:11, 180:4 without 71:3, 89:20, 96:10 witness 18:2, 151:10, 180:6, 180:10, 181:8 |
|--|---|--|---|

| | | | |
|---|--|---|---|
| witness's 69:3, 112:22, 164:22, 178:5 word 37:16, 37:20, 39:14, 47:12, 59:15, 64:7, 70:1, 70:2, 76:22, 83:20, 87:8, 99:9, 101:20, 107:3, 108:15, 120:7, 122:3, 128:12, 161:3, 162:17 work 8:13, 10:11, 11:12, 12:3, 14:17, 14:21, 43:8, 111:3, 127:21, 172:19 worked 10:3, 10:6, 10:10, 11:17, 11:21, 12:1, 110:9, 110:10, 111:6, 111:9, 111:15 working 8:11, 12:6, 21:7 works 13:6 world 45:21, 47:17, 81:9, 115:8, 142:4, 173:3 worldwide 26:22 wouldn't 90:8 write 137:22 writes 42:12 written 140:4, 140:10 wrote 17:18 | Y yeah 34:14, 55:15, 60:11, 107:5, 134:20, 169:12, 174:11 year 9:18, 27:2, 27:4, 36:13, 80:13, 151:15, 151:18, 152:3, 153:9, 153:15, 154:5 years 11:17, 11:21, 12:1, 27:6, 27:7, 27:8, 35:16, 35:20, 36:14, 36:19, 37:4, 38:4, 39:7, 45:1, 46:21, 95:14, 95:16, 95:21, 96:6, 96:9, 96:11, 97:10, 132:9, 134:6, 134:9, 153:14 yechezkal 1:8 yellow 101:1, 103:12, 103:13, 103:15 yellowish 102:14 york 3:18, 10:21 yourself 56:3, 118:21, 166:19, 167:6 Z z-axis 91:8 zero 44:7, 78:20 \$ \$10 132:13 | , ,2 1:17 . .0800 3:19 .2600 2:9, 3:10 .4400 4:10 .5 99:5, 99:15 .6 99:5 0 01586 1:11, 6:15 029 7:19, 163:10, 167:8 05 113:9 1 1 113:9 1,000 172:2, 178:2, 178:8 10 3:17, 32:16, 55:20, 55:21, 107:11, 150:5 1000 4:7 10151 3:18 105 59:11, 59:12 108 19:14 11,208,029 1:12 1101 2:7, 3:8, | 180:17 12 34:4, 113:8, 174:18, 175:9 14 11:21 16 113:8 163 5:9 181 1:21 19 167:10 1930 97:5 1938 95:9 1989 11:6 2 2 150:5, 150:6 2,000 172:18, 172:22, 178:3 20 6:20, 32:15, 32:22, 35:5, 35:20, 37:4, 38:4, 39:7, 100:10, 132:9, 134:6, 134:9 2000 26:20, 27:4, 27:15, 132:21, 151:17, 151:18, 151:19, 152:4, 152:17 20005 2:8, 3:9, 180:17 2002 114:9 2003 132:4 2007 12:4, 26:16, |
|---|--|---|---|

| | | | |
|---|---|--|--|
| 38:21, 43:16 2010 152:4 202.371 2:9, 3:10 2022 1:11, 6:15 2023 1:17, 152:17, 180:18, 181:9 2027 181:10 212.588 3:19 22 4:8 229 163:13 23 55:20, 80:15 248.358 4:10 26 179:2 27 150:6, 166:18 28 179:3, 179:8, 180:19 2nd 180:18 <hr/> 3 <hr/> 3 179:2, 179:3, 179:8, 180:19 38 55:21 <hr/> 4 <hr/> 40 8:12, 14:5, 99:21, 100:1, 100:14 48075 4:9 <hr/> 5 <hr/> 50 172:13, 178:12, | 178:13 501714 1:20 503,004 168:16 58 1:18, 180:19 <hr/> 6 <hr/> 6,623,132 169:1 6,953,261 168:12 6.5 100:4 60 97:7 641 19:12 <hr/> 7 <hr/> 7,144,141 167:14 70 97:7 745 3:16 <hr/> 8 <hr/> 8 1:18, 180:19 800 172:2 85 59:5, 59:12, 59:17 89 12:2 <hr/> 9 <hr/> 90 15:21, 15:22, 16:7 93 12:2, 12:4, 38:21 9th 181:9 | | |
|---|---|--|--|