

U.S. DEPARTMENT OF COMMERCE

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NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION (NOAA)

HYDROGRAPHIC SERVICES REVIEW PANEL

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PUBLIC MEETING

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MONDAY,
SEPTEMBER 11, 2017

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The Hydrographic Services Review Panel met in the Prescott Ballroom, Sheraton Portsmouth Hotel, 250 Market Street, Portsmouth, New Hampshire, at 8:30 a.m., William Hanson, Chair, presiding.

MEMBERS PRESENT:

WILLIAM HANSON, HSRP Chair
JOYCE E. MILLER, HSRP Vice Chair
DR. LARRY ATKINSON
DR. LAWSON W. BRIGHAM
LINDSAY GEE*
KIM HALL
EDWARD J. KELLY
CAROL LOCKHART
DR. DAVID MAUNE
ANNE MCINTYRE
EDWARD J. SAADE
SUSAN SHINGLEDECKER
GARY THOMPSON*

NON-VOTING MEMBERS:

ANDY ARMSTRONG, Co-Director, NOAA/University of
New Hampshire Joint Hydrographic Center
JULIANA BLACKWELL, Director, National Geodetic
Survey, NOS
RICH EDWING, Director, Center for Operational
Oceanographic Products and Services, NOS
DR. LARRY MAYER, Co-Director, NOAA/University of
New Hampshire Joint Hydrographic Center

STAFF PRESENT:

REAR ADMIRAL SHEP SMITH, HSRP Designated Federal
Official; Director, Office of Coast Survey
DR. PAUL DOREMUS, Acting Assistant Secretary for
Conservation and Management
GLENN BOLEDOVICH, Policy Director, NOS PCAD
CAPTAIN RICK BRENNAN, Chief, Hydrographic Surveys
Division
ASHLEY CHAPPELL, IWG-OCM
DR. GREG DUSEK, CO-OPS
CARL KAMMERER, NOS OCS
LYNNE MERSFELDER-LEWIS, HSRP Coordinator
JIM RICE, NOS PCAD
ERICA TOWLE, NOS OCS
E.J. VAN DEN AMEELE, Chief, Coast Survey
Development Laboratory
LT DAVID VEJAR, NOS OCS

ALSO PRESENT:

PATRICK CARROLL, Office of Representative Carol
Shea-Porter (New Hampshire)
THOMAS CHANCE, Chief Executive Officer, ASV
Global
KERRY HOLMES, Office of Senator Maggie Hassan
(New Hampshire)
DOUG LOCKHART, Vice President and General
Manager, Teledyne CARIS Inc.

BONITA POTHIER, Office of Senator Angus King
(Maine)

REBECCA T. QUINTAL, Hydrographic Survey and Data
Solutions Manager, Leidos

ELIZABETH WESTER, Office of Senator Jeanne
Shaheen (New Hampshire)

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

(8:33 a.m.)

1
2
3 CHAIRMAN HANSON: All right, if
4 everybody can take a last shift there and get
5 ready for -- start. I think we're online and so
6 let me go ahead and do the honors here. Go ahead
7 and call the meeting to order here.

8 Good morning, I'm Bill Hanson, chair
9 of the Hydrographic Surveys Review Panel. And to
10 my right, is Joyce Miller, my co-chair -- the
11 co-chair. Both call to order and welcome all to
12 the panel's fall meeting.

13 It is great to be in New England and
14 the great city of Portsmouth. We're looking
15 forward to hearing more from the UNH Joint
16 Hydrographic Center and Center for Coastal and
17 Ocean Mapping over the next -- course of next
18 couple of days.

19 My thanks to the panel members and
20 staff for putting together a robust program
21 including presentations by NOAA leadership, Dr.
22 Paul Doremus, Glen Boledovich, and speakers from

1 prominent organizations focusing on R&D,
2 technology and highlighting the importance of
3 navigation services contribution to the backbone
4 and infrastructure of the U.S. including the Corp
5 of Engineers, the National Geospatial-
6 Intelligence Administration, otherwise known as
7 NGA, and others.

8 We obviously a lot going on in the
9 country right now. We want to send our thoughts
10 to the folks recovering from Hurricane Harvey, in
11 Texas, and those still feeling the impacts from
12 Hurricane Irma. And our thanks go to National
13 Survey and NOAA for fulfilling a very important
14 emergency response mission when needed, as they
15 are now.

16 Folks who withstood Harvey have a long
17 recovery and those also just now being impacted
18 by Irma with effects to be still be felt. And NOS
19 has personnel who have been playing a vital role
20 in preparation and as well as in response.

21 We want to especially give a shout out
22 to National Geodetic Survey and Julianna

1 Blackwell's staff who are busy with imagery and
2 remote sensing to CO-OPS whose sensors are 24/7
3 in the water and on land and being mentioned on
4 The Weather Channel -- so you've hit the big time
5 -- congratulations.

6 Thanks to the NRTs who were positioned
7 to swoop into to the ports to help survey and
8 reopen the ports. Again, a lot of that's in
9 Houston and a lot of it's ongoing now in Florida
10 as well up the East Coast and in the Gulf -- a
11 very big storm.

12 NOS, NAV Services data, products, and
13 services are absolutely essential in such
14 emergency. We are in New England and not far
15 from the Wells National Estuarine Research
16 Reserve. Joyce, you want to say a couple words?

17 VICE CHAIR MILLER: Yes, when I joined
18 the panel -- and I believe Susan was on and
19 couple of others -- there was a wonderful woman,
20 Dr. Michele Dionne, who was in charge of the
21 National Estuarine Research Reserve and she
22 passed away four years ago, I believe.

1 And so while we're in her territory,
2 I just wanted to say she was a real addition to
3 the panel.

4 CHAIRMAN HANSON: Thank you, Joyce.
5 And we're also mindful that today is 9/11 and I
6 know that everybody's mind and thoughts
7 immediately race to where you were and the
8 impacts on all of us. Andy Armstrong, would you
9 say, you know, a couple of thoughts on 9/11?

10 CAPT ARMSTRONG: Yes. Thank you,
11 Bill. I think, as you say, we all remember where
12 we were and what we were doing on that day when
13 our nation was attacked. And I think,
14 particularly in light of what's going on now,
15 it's good for us to thank our first responders
16 for their work then and now and also remember the
17 victims of 9/11.

18 And I think if we could have a moment
19 of silence for the victims at this point, that
20 would be nice.

21 (Moment of Silence)

22 Thank you.

1 CHAIRMAN HANSON: And thank you, Andy.
2 But, back to the meeting here. We'll do our best
3 to stay on schedule. I've got a very small
4 little hammer here so I'll try to be loud with
5 it, yet recognizing everybody wants to contribute
6 and have questions to ask.

7 We've been a very interactive panel in
8 recent meetings and would encourage that to stay
9 the same for this meeting. Members, please feel
10 free to call on the experts in the room for
11 questions and clarification of points throughout
12 the meeting.

13 As a point of order, all comments from
14 non-members will be held to the designated public
15 comment period of the meeting. Your comments can
16 also be sent by the webinar or by email to the
17 HSRP mailbox and to Lynne Mersfelder.

18 You know, one of the things I don't
19 recall us doing -- and I think we've done it in
20 past meetings -- is do a quick introduction of
21 who the members are.

22 Is that appropriate just real quick

1 who we are with affiliation just so members of
2 the panel and public remember just how diverse a
3 group this is? Carol, do you mind starting off?

4 MEMBER LOCKHART: There we go. So I'm
5 Carol Lockhart. I run a woman-owned small
6 business called Geomatics Data Solutions. So
7 we're -- my expertise is in hydrographic lidar
8 and hydrographic multibeam service.

9 MEMBER BRIGHAM: Lawson Brigham. I'm
10 a professor at the University of Alaska Fairbanks
11 and retired Coast Guard Officer.

12 MEMBER McINTYRE: Anne McIntyre. I'm
13 a Maritime Pilot with the Columbia River Pilots.

14 MEMBER SHINGLEDECKER: Susan
15 Shingledecker, Vice-president of BoatUS
16 Foundation. I work with recreational boaters
17 around the country.

18 MEMBER KELLY: Ed Kelly. I'm the
19 Executive Director of the Maritime Association in
20 the port in New York and New Jersey.

21 MEMBER ATKINSON: Larry Atkinson, Old
22 Dominion University.

1 MEMBER EDWING: Rich Edwing, Director
2 of the Ocean Service Center for Operational
3 Oceanographic Products and Services.

4 MEMBER MAUNE: Dave Maune from
5 Dewberry. I'm a specialist in digital elevation
6 models and cost-benefit analysis that I'm going
7 to do for the 3D Nation study for NOAA.

8 MEMBER SAADE: Ed Saade with Fugro. I'm
9 the President of Fugro USA and the Regional
10 Director for the Marine Division.

11 MEMBER HALL: Hi, I'm Kim Hall. I'm
12 the principal consultant and founder for a woman-
13 owned small business as well named Brizo Maritime
14 Consulting, and I specialize in
15 maritime security and nautical operations.

16 MS. BLACKWELL: Julianna Blackwell,
17 Director of NOAA's National Geodetic Survey.

18 CAPT ARMSTRONG: Andrew Armstrong.
19 I'm the NOAA Co-director of the NOAA University
20 of New Hampshire Joint Hydrographic Center.

21 DR. MAYER: If Andy says Andrew, I'll
22 say, Lawrence Mayer, Center for Coastal Ocean

1 Mapping, University of New Hampshire and Joint
2 Hydrographic Center.

3 RDML SMITH: Shep Smith, the director
4 of the Office of Coast Survey at NOAA.

5 CHAIRMAN HANSON: I'm Bill Hanson,
6 chair of HSRP and with Great Lakes Dredge and
7 Dock Company.

8 VICE CHAIR MILLER: Joyce Miller, I'm
9 semi-retired from the University of Hawaii. I
10 worked in multibeam pretty much my entire career.

11 DR. DOREMUS: Paul Doremus. I'm the
12 Acting Assistant Secretary for Conservation and
13 Management at NOAA.

14 CHAIRMAN HANSON: While we're on a
15 roll, we're going to go ahead and ask the
16 audience as well just so -- again, these meetings
17 always draw a diverse group of folks and it's
18 important to kind of know who's in a room just so
19 you can call in that expertise. So Captain, if
20 you don't --

21 CAPT VAN DEN AMEELE: Good morning,
22 E.J. Van Den Ameele, Chief of the Coast Survey

1 Development Lab and --

2 CHAIRMAN HANSON: Public meeting, so
3 we have to have that microphone.

4 VICE CHAIR MILLER: That's fine. So
5 just, again, always talk with the mic, please.

6 CAPT VAN DEN AMEELE: Morning, E.J. Van
7 Den Ameele, Chief of the Coast Survey Development
8 Laboratory and Office of Coast Survey.

9 MR. LOCKHART: Good morning, I'm Doug
10 Lockhart. I'm with Teledyne Technologies. I'm
11 currently VP and General Manager of Teledyne
12 CARIS.

13 MR. CHANCE: Hi, my name is Thomas
14 Chance. I'm CEO of ASV Global, unmanned boat
15 company.

16 MS. QUINTAL: I'm Rebecca Quintal, the
17 Hydrographics Surveys Manager at Leidos.

18 MS. CHERRY: Good morning. I'm
19 Kristine Cherry. I'm the Advisor to the ASEM at
20 NOAA.

21 MR. RICE: Jim Rice, NOS Policy.

22 MR. DUSEK: Greg Dusek, Chief

1 Scientist for the Center for Operational
2 Oceanographic Products and Services, NOS.

3 MR. VEJAR: My name is David Vejar.
4 I'm the Navigation Manager in New York, New
5 Jersey, and New England.

6 MR. KAMMERER: I'm Carl Kammerer. I'm
7 with CO-OPS also, but I also sit at the
8 University of New Hampshire at the JHC.

9 MS. CHAPPELL: This is Ashley
10 Chappell, NOAA Integrated Ocean and Coastal
11 Mapping.

12 MR. FERGUSON: Scott Ferguson,
13 interested public.

14 MR. NOLL: Guy Noll, former NOAA Corps
15 and now with ISRI at Maritime Lead Consultant.

16 RDML GLANG: Good morning, Gerd Glang,
17 retired from NOAA and now with IIC Technologies.

18 CHAIRMAN HANSON: Sorry, Admiral
19 Glang. We just were commenting on your witness
20 protection program disguise there. So I've been
21 doing this for -- did we get everybody?

22 MR. COLE: We've got the other side

1 here.

2 CHAIRMAN HANSON: Oh, I'm sorry.

3 MR. COLE: Hi, I'm Eric Cole. I'm
4 here as a public attendee.

5 MS. POTHIER: My name is Bonita
6 Pothier I work with U.S. Senator Angus King's
7 office.

8 MR. MADDOCK: Hi, I'm Dave Maddock.
9 I'm Technical Director for programming for
10 HYPACK.

11 MR. ORLINSKY: And last, I'm -- good
12 morning, Harold Orlinsky, general manager for
13 HYPACK and ex-NOAA Corps as well.

14 CHAIRMAN HANSON: Thank you.

15 VICE CHAIR MILLER: Glen, did you
16 introduce yourself?

17 MR. BOLEDOVICH: Glen Boledovich. I'm
18 the policy director for NOAA's National Ocean
19 Service.

20 MS. MERSFELDER-LEWIS: I'm Lynne
21 Mersfelder-Lewis, I'm the -- I'm HSRP program
22 manager.

1 MS. TOWLE: Thank you. Erica Towle.
2 I'm Coast Survey front office staff.

3 CHAIRMAN HANSON: I think we were going
4 to introduce you guys later, but if you want to
5 go ahead and do it now, thanks.

6 MS. WESTER: Liz Wester, Office of
7 Senator Jeanne Shaheen.

8 MS. HOLMES: Kerry Holmes, Office of
9 Senator Maggie Hassan.

10 MR. CARROLL: I'm Patrick Carroll from
11 Congresswoman Shea-Porter's office.

12 CHAIRMAN HANSON: And thank you very
13 much for being here. Thanks for everyone else for
14 the introductions. It just helps to set the tone,
15 so appreciate that.

16 So I've been doing this for eight
17 years and which means this is my last meeting. So
18 as we had a little administrative session this
19 morning and talked about new leadership.

20 And so I want to announce that the new
21 chair of HRSP and congratulate Joyce Miller on --
22 who will serve as the new chair and Ed Saade who

1 will serve as the co-chair. So thank you for
2 your willingness to serve. And, Joyce, it's been
3 a treat to working with you over these last many,
4 many years now -- so congratulations on that.

5 Kim Hall will also serve as co-chair
6 of the Planning and Engagement Working Group.
7 Thanks, Kim. So if we can give them a round of
8 applause for their willingness.

9 Plans for our 2018 meetings are
10 tentatively scheduled for Miami in April to
11 coincide with the Miami Ports system dedication.
12 And in August, potentially in Alaska.

13 They're tentative dates and obviously
14 subject to change, don't -- but go ahead and put
15 them on your calendars as possible.

16 And now I'd like to introduce Rear
17 Admiral Shep Smith, our federal designated
18 officer and director of NOAA's Office of Coast
19 Survey. During his 23-year NOAA career, he has
20 advanced in State of Art in hydrography and
21 cartography commanded several NOAA vessels.

22 His full biography and all speaker

1 member bios are in your meeting materials,
2 handouts at the sign-in table, and also available
3 on the HSRP web site.

4 Admiral Smith, thank you for taking
5 the time to be with us this morning. We know
6 you've got a lot of going on, but as we said in
7 the past, it's very critical to have leadership
8 participate in these FACA meetings, and it says a
9 lot to have you here, so thank you.

10 RDML SMITH: Thank you, Bill. I --
11 and we need to update the boiler point language
12 there because I hit 24 this year, so just cutting
13 you a break.

14 Welcome to the -- to this meeting of
15 NOAA's Hydrographic Services Review Panel. First
16 a few book -- housekeeping announcements. Exit
17 doors are clearly marked. Restrooms are right
18 here behind the -- back in this corner. And we
19 don't expect any drills or any other emergencies,
20 but we understand from the hotel that they'll be
21 announcements and bells and that sort of thing.

22 So congratulations to Ed Kelly --

1 where's Ed there -- and to Sal Rasello, who
2 couldn't join us here who have been sort of
3 reappointed for second four-year terms -- so
4 thank you for offering to continue to serve. We
5 appreciate the continuity of leadership.

6 In addition this year, we will be
7 welcoming three new members -- Sean Duffy, Jr.,
8 who is the executive director of the Big River
9 Coalition; Julie Thomas, who's a senior advisor
10 for IOOS at SCRIPPS; and Ed Page, the executive
11 director of the Marine Exchange of Alaska.

12 I do want to just make a quick side
13 comment that, you know, this panel is -- has this
14 range of expertise in geographic scope not by
15 accident, but by design, and we're really pleased
16 to have found such great new panelists to fill
17 the roles of some of our departing panelists, so
18 we're really excited for the future of the panel
19 as well.

20 Joyce, Ed, Kim, and Dave, thanks for
21 agreeing to serve in your new HSRP positions for
22 2018. And this is Bill's eighth on the HSRP and,

1 along with Lawson and Brigham and Scott Perkins,
2 this will be their last meeting so I want to help
3 go out with a bang and do my best to ensure that
4 this meeting is productive, strategic and useful
5 for your last meeting.

6 We're honored to have such a robust
7 group of experts assembled in the room and
8 partners at the -- from the University of New
9 Hampshire. For the Center of Coastal Ocean
10 Mapping and the UNH NOAA Joint and Hydrographic
11 Center. I'm honored to welcome the speakers.

12 I'm really -- this agenda this week I
13 just want to -- I'm diverting from my script here
14 for a minute -- but the -- this -- the agenda for
15 this week has taken a lot of work and a lot of
16 great creativity to put it together and I'm
17 really excited about and particularly the
18 unmanned systems focus.

19 The UNH folks have a -- have been
20 building experience and will have a demo for us
21 this week and we have a fabulous panel to walk us
22 through sort of what the state-of-the-art is and

1 where the pain points and opportunity points are
2 going forward -- so I'm really looking forward to
3 that deep dive.

4 So in that unmanned systems sessions,
5 we have Thomas Chance, Doug Lockhart, and Rebecca
6 Quintal, and Captain E.J. Van Den Ameele, who
7 will all be speaking. And thank you, Carol, for
8 moderating that session.

9 So -- oh, and I -- Lyndsay Gee was
10 really one of the primary leaders in putting this
11 session together and he is, unfortunately, not
12 able to join us, but you -- his efforts for
13 putting this together will certainly be felt at
14 the meeting.

15 So in addition, I want to recognize
16 subject matter experts NOAA's staff here with us.
17 And, Bill and Joyce, and other members, please
18 feel free to call on them during the meeting.

19 The last thing we want to do is have
20 a disconnect between what the panels thinking and
21 what -- and what's already happening within the
22 agencies so let's try to get those -- it's a good

1 opportunity to get synced up as we go along. And
2 they've already introduced themselves.

3 So I do want to call out the regional
4 NOS staff, Carl Kammerer from CO-OPS, who
5 introduced himself, Lieutenant David Vejar from
6 Coast Surveys, the NAV manager for the Northeast
7 Region. And we're just starting that role this
8 year and so this is -- he's spinning up quickly,
9 but it's a big part of our regional presence to
10 have the -- that NAV manager at all the meetings
11 in the region. So he puts a lot of miles on the
12 suburban getting around.

13 For -- Dr. Greg Dusek introduced
14 himself for -- from CO-OPs. From NOS
15 headquarters, Glen Boledovich, who has been with
16 HSRP from the beginning, I believe, and really he
17 knows all the history of these discussions and is
18 a real process expert as well in how to make our
19 thoughts felt effectively -- so please use Glen.

20 From Coast Survey, I sort of apologize
21 because we usually have a bigger footprint here,
22 but we -- there's a hurricane going on and we

1 thinned down our present --- our presence here
2 for the folks that are directly involved in the
3 hurricane response preparation.

4 So but we do have Captain Rick
5 Brennan, who I think is stepped out to -- for the
6 hurricane call, Captain E.J. Van Den Ameele,
7 Ashley Chappell from IOCM, let's see, Christie
8 Vandell couldn't make it. Erica Towle, as her
9 first HSRP, has been a great addition to the
10 Coast Survey front office and picks things up
11 really quickly -- so glad to have her here as
12 well.

13 And, of course, none of this would
14 happen at all even these words that I'm reading
15 without Lynne Mersfelder-Lewis, who organizes and
16 orchestrates this whole enterprise -- so thank
17 you, Lynne.

18 And I really can't -- we already outed
19 Admiral Glang back there in the back, but I did
20 want to call out and thank him for his presence
21 here as well. Not representing NOAA anymore, but
22 his depth of experience and commitment to this

1 panel and to the hydrographic enterprise has been
2 decades and decades long -- so thank you. I'm
3 really happy to have you here, Gerd.

4 With that, I think it's back to you,
5 Bill.

6 CHAIRMAN HANSON: All right. Thank you,
7 Admiral Smith. Again, we do appreciate you and
8 your experts being here. They make the meetings
9 much more productive. We also want to thank,
10 again, the congressional staff representatives
11 for being here as well. That means a lot to us as
12 well.

13 Obviously, all the recommendations
14 that we make are very appropriate for you folks
15 as your advocacy and something for you to
16 champion and to take credit for, for your support
17 of the work that NOS does.

18 One of the things that I've come to
19 appreciate over the years on the panel is just
20 the amount of innovation and forward-thinking
21 that goes on within NOS. And as someone who
22 spends a lot of time advocating for

1 infrastructure investment, certainly innovation
2 is the way forward.

3 It's not going to be -- we're not
4 going to move forward by doing things the same
5 way that we've always done them. And this group
6 and NOAA and NOS, particularly, embody that
7 innovation thought process that will help drive
8 this nation forward and so your continued support
9 of their efforts is much appreciated.

10 And the more we can help articulate
11 those points as are relevant to you and in the
12 work you do, we very much look forward to doing
13 that. So we've got Kerry Holmes from the Senator
14 Hassan's office, we've got Mr. Wester from
15 Senator Shaheen's office, and then Patrick
16 Carroll, thanks, from Congresswoman Carol
17 Shea-Porter's Office.

18 So we've also got messages -- video
19 messages -- and even an a letter that will be
20 read a little bit later. And Bonita, thanks for
21 showing up as well. Appreciate that. So with
22 that, I think we're actually going to moving

1 forward here, sir, so --

2 RDML SMITH: Yes, I just want to --
3 may I just echo your thanks for our -- the
4 representatives from our Washington delegation
5 being here.

6 We've had a really great support from
7 the New Hampshire delegation over the years
8 expressed not only through support for the Joint
9 Hydrographics Center, but for NAV services
10 overall, and so thank you. I know that that's --
11 I know that level of support comes with a level
12 of commitment. I really appreciate it.

13 I also want to flag representation
14 from my home state of Maine and thank you to the
15 -- to Senator King for making you available to
16 join us today, so thank you.

17 CHAIRMAN HANSON: You want to talk
18 about our issue papers, so.

19 RDML SMITH: So that's the panel to
20 review and provide your consensus comments to
21 NOAA on the OCS autonomous system strategy. I
22 appreciate the work you've already done, and look

1 forward to receiving your comments at the end of
2 the meeting.

3 CHAIRMAN HANSON: Great, thank you.

4 And so for the members of the audience, one of
5 the things that this panel has taken on over the
6 last few years is, rather than just sitting
7 around and making a -- it's common for FACA is to
8 do recommendation letters to the whatever group
9 they're reporting to.

10 This group took on another level of
11 detail and started writing issue papers to give
12 us more of a chance to put down on paper some of
13 our thoughts, some of the things that we've been
14 -- we'd like to see come out of these discussions
15 and some -- so we've done, I think, nine?

16 RDML SMITH: Nine.

17 CHAIRMAN HANSON: Nine papers to date,
18 and we've got two more issue papers for you today
19 that we're looking to finalize -- one on
20 precision navigation, and the other that I'm
21 particularly excited about -- is the R&D benefits
22 for NOAA in the industry.

1 So we'll discuss and prioritize
2 additional issue papers in the future, but we're
3 excited to be able to complete these two at this
4 meeting. Okay. All right. And for those who are
5 interested, the papers that we'll be talking
6 about and finalizing are available at the front
7 desk as you check in.

8 RDML SMITH: Thank you, Bill. I just
9 want to echo my thanks and congratulations to the
10 panel for all of the hard work in developing all
11 those papers. We -- as you know, it -- we are
12 in the midst of leadership changes in Washington
13 and have an opportunity to reintroduce our
14 programs to folks that have not had a lot of
15 history with them and these types of papers are
16 really helpful to us to have some as part of our
17 briefing to new leadership and provides a nice,
18 independent view of our program -- so thank you.

19 CHAIRMAN HANSON: Great. So you're
20 probably tired from hearing from us at this point
21 so we'll get -- go ahead and get the staff and
22 folks ready to geared up. If you don't mind,

1 Kerry Holmes from Senator Hassan's Office, I
2 believe you have a letter?

3 MS. HOLMES: I do, yes, thank you. So
4 the letter to read on behalf of Senator Hassan.
5 She regrets she couldn't be here today.

6 "Dear Rear Admiral Smith, I regret
7 that I am unable to attend the Hydrographic
8 Services Review Panel meeting in Portsmouth
9 today, but I would like to welcome you to New
10 Hampshire and thank all of the stakeholders and
11 the National Oceanic and Atmospheric
12 Administration partners for attending this
13 important meeting.

14 The Hydrographic Services Review Panel
15 meeting is an important opportunity for NOAA
16 officials, HSRP members, NOAA partners and other
17 marine stakeholders to come together and discuss
18 ways to improve NOAA data products and services
19 and recommend changes.

20 This work is critical to ensuring that
21 the users of our waterways from small,
22 recreational boaters to large, commercial vessels

1 have the data and the tools that they need to
2 safely and efficiently navigate our nations
3 waterways. A well-functioning marine
4 transportation system is critical for global
5 commerce and our economy.

6 The HSRP and these meetings are
7 important tools to ensure that we continue to
8 improve and enhance our marine transportation
9 system. Once again, thank you for your work. I
10 look forward to continuing to work together on
11 these and other important marine issues. With
12 every good wish, Margaret Wood-Hassan, United
13 States Senator."

14 CHAIRMAN HANSON: Thank you very much
15 and please pass our appreciation as well.
16 Liz Wester from Senator Shaheen's Office.

17 MS. WESTER: Yes. "Dear Rear Admiral
18 Smith, thank you for the invitation to attend
19 today's meeting of the Hydrographic Services
20 Review panel. I wish I could join you, but want
21 to pass on my appreciation to NOAA and everyone
22 else who has made today's panel possible.

1 We, in New Hampshire, are always aware
2 that the ocean are -- is one of our most
3 important beautiful resources. Residents,
4 tourists, and a variety of industry's all benefit
5 from the coastline -- a fact that illustrates
6 significance of its stewardship and sound
7 management.

8 By focusing on research and the
9 development of new hydrographic technologies, we
10 will give scientists and researchers access to
11 data and information that will broaden our
12 understanding of the ocean and how it can be made
13 safer for private and commercial travel.

14 Modernizing the way we survey, chart
15 and navigate our oceans will give greater insight
16 that will help all of us make decisions that will
17 preserve, if not improve, our way of life in our
18 coastal regions.

19 Thank you again for the invitation, I
20 look forward to hearing from your continued
21 successes. Sincerely, Jeanne Shaheen, United
22 States Senator."

1 CHAIRMAN HANSON: Wonderful. Thank
2 you, and please again, pass on our thanks for the
3 participation also encouragements as well.
4 Patrick Carroll, representing Representative
5 Shea-Porter. Thank you for being here.

6 MR. CARROLL: Thank you, and good
7 morning to everyone. On behalf of the
8 Congresswoman at our office, welcome to the first
9 district from the beautiful coastline up to the
10 White Mountains. We're very proud of this
11 district and happy to brag about it. Thank you
12 for coming.

13 "Thank you for inviting me to the NOAA
14 Hydrographic Services Review Panel Public meeting
15 in Portsmouth, New Hampshire. I regret that I
16 cannot be here with you in person today. I
17 represent the first district of New Hampshire,
18 which includes Portsmouth a port city.

19 As a member of the Congressional Ports
20 caucus, I support its mission to promote the
21 importance of our ports to the nation's economy
22 and the need to secure them since U.S. ports

1 support 13.3 million jobs across the country and
2 contribute \$3.15 trillion to the economy and
3 business activity.

4 This means that safe and efficient
5 maritime transportation and commerce is essential
6 to the United States, to New England to the New
7 Hampshire economy and even to the well-being of
8 our citizens. For example, the primary delivery
9 of both heating oil, LNG and salt to New England
10 is by ship.

11 Marine transportation depends on
12 accurate and up-to-date navigation services. The
13 accuracy of navigation services is vital, but
14 accurate depth information for nautical charts is
15 particularly challenging in the New England
16 region where the irregular and rocky seafloor off
17 New Hampshire created by glaciers require surveys
18 using modern, multibeam echo sounders.

19 In addition, accurate tides and
20 currents data must be collected and updated as
21 the Port of Portsmouth, with its critical
22 Portsmouth naval shipyard -- one of the U.S.

1 Navy's four public shipyards -- has a high range
2 of tide and very strong currents. Reliable data,
3 tide data and tidal current predictions and the
4 supporting observations are essential.

5 Finally, accurate depths and reliable
6 tide predictions depend on a robust underlying
7 network of geodetic positions and vertical
8 elevations which makes accurate, modern mapping
9 equally essential.

10 I also understand how catastrophic
11 events like Hurricanes Harvey and Irma can impact
12 its critical infrastructure and thank the
13 navigation response teams and others including
14 several folks who were supposed to attend this
15 meeting, who have deployed to these areas to
16 provide needed services.

17 We are fortunate in the first district
18 of New Hampshire to be home to the Joint
19 Hydrographic Center at the University of New
20 Hampshire. New Hampshire is proud to have the
21 Joint Hydrographic Center at UNH and the
22 effective collaboration it facilities among NOAA

1 the university, and its private sector partners.

2 It is a world leader in hydrographic
3 and ocean method technology and the premier
4 provider of advanced education in these
5 technologies. I understand that many of the NOAA
6 leaders in this room have graduated from the UNH
7 program and that several of the private sector
8 organizations of record here are industrialized
9 partners for the center.

10 New Hampshire is also proud to be the
11 home port of NOAA's most modern, hydrographic
12 vessel, the NOAA ship, Ferdinand Hassler.

13 Given the need for accurate and
14 up-to-date data to ensure port and navigational
15 safety in general and, in particular, to ensure
16 safety at the port of Portsmouth for national
17 security reasons related to the Portsmouth naval
18 shipyard, I will work hard to ensure that NOAA is
19 adequately funded to maintain its critical
20 navigational services.

21 And I hope that NOAA will continue to
22 give strong support to the Joint Hydrographic

1 Center at the University of New Hampshire.

2 Thank you again for inviting me to
3 share my thoughts about these important issues.

4 Sincerely, Carol Shea-Porter, Member of
5 Congress."

6 CHAIRMAN HANSON: Thank you very much,
7 Mr. Carroll. Thanks for reading that, and
8 please, again, pass along our thanks and
9 congratulations for all of her support. We have
10 another letter from Senator Collins, and allow me
11 to go ahead and read that into the record.

12 "Dear Friends, I'm pleased to --
13 welcome me to the meeting of the Hydrographic
14 Survey Review panel, the National Oceanographic
15 and Atmospheric Administration. This panel plays
16 a vital role in advising the NOAA administrator
17 on issues related to hydrographic and shoreline
18 surveying, nautical charting and several other
19 areas that enhance our management of coastal and
20 marine ecosystems.

21 I am confident that your work here
22 will greatly contribute to our understanding and

1 stewardship of America's oceans. I am pleased to
2 join the many welcome you today and extend my
3 appreciation for your outstanding work.

4 Sincerely, Susan Collins, United States Senator."

5 And then we also have a video. Let's
6 see, Congresswoman Chellie Pingree of Maine has
7 provided a video message. If we can -- are we
8 able to roll that now?

9 HON. PINGREE: Hello. I'm
10 Congresswoman Chellie Pingree. Thank you for the
11 opportunity to share a few words for the latest
12 meeting of the Hydrographic Services Review
13 Panel.

14 As someone who lives on an island in
15 Maine's Penobscot Bay, I have a personal
16 appreciation for the work of NOAA's navigation
17 services.

18 In our community, getting out on the
19 water is a fact of life whether it's taking the
20 ferry to the mainland, using a lobster boat to
21 make a living or simply sailing across the main
22 coast.

1 For us and thousands of other Mainers,
2 being on the water safely depends on having the
3 best information possible about sea levels,
4 current speeds, navigational routes and more.
5 NOAA's navigation services does an exceptional
6 job of collecting and distributing that vital
7 information.

8 As a member of Congress too, I'm
9 grateful for the broad range of services you
10 offer. Your nautical charts are essential to our
11 states marine economy.

12 And the wealth of data you collect on
13 shorelines and water levels helps researchers,
14 policy makers and coastal communities plan for
15 the future of our marine resources.

16 The technology available today, to map
17 and measure our oceans, is simply amazing. But
18 the sheer amount of data it provides must be
19 overwhelming. I truly appreciate the work of the
20 Hydrographic Services Review Panel to help NOAA
21 decide how to distill and distribute that
22 information so it can be most useful for those

1 who need it.

2 Thank you for lending NOAA your time
3 and expertise. My thanks also to NOAA staff. I
4 truly appreciate the many areas of work this
5 agency does. As a member of the House
6 Appropriations committee, I will continue
7 advocating for the resources it needs to carry
8 out its important mission. Thank you all, and
9 take care.

10 CHAIRMAN HANSON: And thank you for
11 that note -- message as well. We appreciate the
12 letters and the videos and your participation.

13 One of the things at HSRP is we do
14 travel around the country, as you've heard, and
15 one of the messages that I think you can carry
16 back is that a lot of the issues facing this
17 region are not that unique.

18 A lot of the coastal and ocean issues,
19 you have a lot of friends on the Hill, a lot of
20 friends in congress that have the very same
21 issues, no matter what side of the aisle they're
22 on when it comes to coastal and ocean issues.

1 So we encourage you to continue to
2 work not only for your region in your districts
3 and your states, but also for the nation and
4 looking for coalitions that help advance the very
5 same things we're all advocating for -- so
6 appreciate you being here. Thanks again.

7 It's now my pleasure to introduce
8 NOAA's leadership representative here, Dr. Paul
9 Doremus, performing the duties of Assistant
10 Secretary for Conservation and Management of
11 NOAA.

12 Dr. Doremus is responsible for driving
13 NOAA's programs in areas ranging from enabling
14 marine transportation to managing our nations
15 fisheries and protecting and preserving coastal
16 resources.

17 He also serves as a deputy assistant
18 administrator for Operations at NOAA Fisheries
19 where he is the Chief Operating Officer. He is
20 responsible for the day-to-day management of the
21 agency operations and oversees NOAA Fisheries
22 financial and business processes, works to

1 strategically align and improve the performance
2 of NOAA Fisheries and ensures NOAA Fisheries has
3 effective and efficient infrastructure for its
4 mission ranging from fleet and facilities to
5 information technology and workforce.

6 His full bio, if there could be one,
7 is in your materials. Dr. Doremus, thanks for
8 being where we're with us today. We know there's
9 a lot going on. And again, look forward to your
10 comments.

11 DR. DOREMUS: Thank you, Mr. Chair,
12 it's a great pleasure to be here. And I do want
13 to start off by thanking you and acknowledging
14 your eight years of service on the panel and
15 recent activities as chair.

16 Greatly appreciated by NOAA. And I'm
17 extending thanks on behalf of the acting NOAA
18 administrator, Ben Friedman, for your service --
19 as well, Lawson, for yours. It's been a great
20 pleasure to have both of you serve the panel for
21 such an extended period of time and we look
22 forward to future collaboration with you both.

1 Also want to acknowledge Sal Rasello,
2 not here, but Ed, congratulations on your
3 reappointment and we will look forward to new
4 members in the next meeting as has already been
5 acknowledged.

6 And Julie, we're really pleased to
7 have you step up as chair; likewise, Ed as
8 co-chair, and look forward to working with you
9 both in that capacity.

10 I also appreciate, Bill, your
11 observations right at the outset about where we
12 are today and a lot of our organization's focus,
13 understandably, on events in Florida, continued
14 events in Texas and the moment of reflection, a
15 number of years ago, on 9/11.

16 These are extraordinary events, awful
17 in their scale and their human impact. But also,
18 rather incredible examples of how our
19 institutions and how our society works and really
20 comes together and meets these very stressful
21 tests of the very fabric of society.

22 And it's outstanding to me and awesome

1 in many respects how strong, flexible, resilient,
2 you will, that social fabric is.

3 And I think we're seeing that play out
4 now throughout the Gulf of Mexico in the most
5 extraordinary back-to-back set of extreme weather
6 that we have seen from just phenomenal
7 precipitation levels in Texas and extraordinary
8 flooding to the circumstances we have with storm
9 that's wider than the peninsula of the entire
10 peninsula of Florida.

11 So we're tracking that very closely.
12 And I think that you see in this both the
13 entirety of the federal government, but the
14 public sector enterprise.

15 Our relationships with our state and
16 local public sector entities, the response
17 community -- the emergency response community --
18 as well as our long-term restoration activities
19 require an incredible level of collaboration not
20 just across government, but between government,
21 private sector, academic sector and society at
22 large.

1 And we are -- we're seeing that play
2 out now and we're going to see that in large
3 measure in the long-term response to these
4 incredible events. And that is, in fact, I think,
5 at root, one of the things that I find most
6 impressive about this advisory committee.

7 It is linking those communities. It's
8 inking our federal community, our private sector
9 community, our academic community around the
10 programmatic areas for hydrographic services. We
11 know how vital navigation services are.

12 It's interesting, at times, the
13 smoothness and underlying reliance of the nature
14 on a highly functioning productive efficient
15 navigation system is. And it comes to the
16 surface and to people's attention when it's
17 disrupted and we're seeing that in big, big
18 measure right now in the Gulf.

19 So clearing, reopening ports and
20 waterways, incredible work that needs to be done
21 there. And the long-term restoration of those
22 capabilities as well as the ability of our

1 community to maintain pace with technology and to
2 provide these sort of capabilities, the sort of
3 infrastructure for commerce and for exchange will
4 be a big part of -- has been a big part of your
5 work, your advice to us, and will be a big part
6 of our future efforts.

7 And the entirety of the NOAA
8 leadership team is very grateful for that
9 service. And we look forward to continued work
10 with the panel to that end.

11 We have seen an incredible and very
12 productive and informative set of formal advice
13 come from the committee. In issue papers, three
14 special reports sets the recommendations across a
15 variety of areas from the policy-driven domains
16 of the U.S. Ocean Action Plan to the National
17 Coastal Mapping strategy, Arctic Priorities and
18 the upcoming work that you're citing in your new
19 issue papers which we're very much looking
20 forward to.

21 This has been a very impressive set of
22 recommendations and a record of accomplishment

1 and one that's been very influential to our
2 thinking into our operations.

3 I've been working, over time, prior to
4 my current responsibilities -- for a period of
5 time I was essentially served as NOAA's Chief
6 Strategy Officer and worked with virtually all of
7 NOAA's federal advisory committees.

8 And I've -- from, you know, the broad,
9 encompassing work of the Science Advisory Board
10 through to the line of program-specific advisory
11 committees.

12 And the work of this committee has
13 been very, very valuable and an essential part of
14 that, what I view as sort of an external board
15 function for our public agency. And we take it
16 very seriously and rely on it very heavily and
17 look forward to continued collaboration along
18 those lines.

19 As you indicated, we're in the middle
20 of an extended transition. I'm serving in the
21 capacity of assistant secretary until the
22 administration appoints someone into this

1 position. And as of this point in time, we have
2 a very limited number of political appointees at
3 NOAA.

4 Chris Oliver serves -- was recently
5 appointed. He serves as the assistant
6 administrator for NOAA Fisheries. And we had just
7 announced, a matter of days ago, the
8 administration's nomination of Admiral Tim
9 Gallaudet, former oceanographer of the Navy, to
10 be the Assistant Secretary for Earth Observations
11 and Predictions.

12 Colloquially, that's the dry side
13 assistant secretary. I'm functioning as the
14 wet side assistant secretary. And we are
15 thrilled to have him come on board. Deeply
16 knowledgeable about our organization about the,
17 in particular, the physical infrastructure assets
18 that we need to observe the environment in all
19 its dimensions, many of which have been the focus
20 of this panel and will continue to be.

21 And he will not only be stepping in as
22 our assistant secretary in NOAA's organizational

1 structure, that position is next in line and
2 order of succession for the NOAA administrators.

3 Right now we have NOAA's highest
4 ranking career executive, the Deputy
5 Undersecretary for Operations, Ben Friedman,
6 serving as the NOAA administrator.

7 We anticipate that Admiral Gallaudet
8 will step into that capacity presuming he is
9 confirmed by the Senate -- and so we await that
10 entire process. But if that all plays out, as we
11 hope, then we'll see that likely change of
12 command there.

13 There's been a lot of reports in the
14 press about the administration being prepared
15 soon to nominate a NOAA administrator. We look
16 forward to that. And likewise would have to go
17 through the same steps of Senate confirmation.

18 And in the meantime, your faithful
19 career executives will maintain operational
20 continuity. That's primarily my goal, and that's
21 been playing out in our inner agency environment
22 as well as in response to the administration and

1 their emerging priorities.

2 It's been a pleasure to meet with
3 Secretary Ross. I think you can -- you see a lot
4 of the dimensions -- of the Secretary's
5 priorities and the public work, and he's got a
6 very, very strong focus on trade.

7 We have used that as an opportunity to
8 talk about the various ways in which commerce
9 depends upon NOAA's services -- maritime
10 infrastructure being only one of them, but a very
11 significant one.

12 The Secretary has also been very
13 focused on aspects of our trade balances on other
14 parts of NOAA's business, particularly in
15 fisheries, my kind of home office. There's a big
16 focus on the seafood trade deficit and the
17 possibility of building domestic capacity in
18 seafood production, which could largely come
19 through the expansion of aqua-culture activities.

20 And as everything in our world is
21 connected, that comes back to understanding all
22 kinds of activity in the ocean and coastal

1 domain, how ocean and coastal resources are
2 currently being used and need to be used in the
3 future for commerce, for security, for energy,
4 for fish production, for commerce of various
5 sorts -- recreational activities.

6 It's a complex set of uses and we have
7 to be increasingly sophisticated in our knowledge
8 of how those uses relate and can coexist. And
9 likewise, coexist in a manner that's conducive to
10 long-term ecological health as well and that's
11 fundamentally what we do and requires all of our
12 communities to work very closely together to make
13 that all work smoothly.

14 We are acutely aware, as are you, of
15 shortcomings in a nation's infrastructure and we
16 are looking forward to collaboration with the
17 administration on that front. There's been much
18 said about the potential for an infrastructure
19 initiative.

20 A couple of dimensions on that front.
21 One is looking very hard, and the administration
22 has issued executive orders along these lines, at

1 the legal regulatory environment around
2 infrastructure investments and trying to
3 streamline those processes, environmental
4 reviews, in particular, as much as possible.

5 And then also looking at highest
6 priority needs for investment in our
7 infrastructure assets. And in that respect, I
8 think we have a great national challenge of
9 thinking through and responding to that very
10 question, what are the most critical and most
11 effective investments. And I commend the work of
12 the panel for drawing everybody's attention to
13 the infrastructure dimensions that our
14 Hydrographic Survey enterprise broadly construed
15 -- contributes to -- in terms of our ports, our
16 waterways, overall viability of the maritime
17 industry in both commercial and recreational
18 dimensions.

19 We also are very appreciative of the
20 focus that the panel has taken on our physical
21 observing assets, our fleet -- our fleet
22 modernization plan. We are pleased to be

1 interacting with Congress over the reinvestment
2 requirements there and anticipate, as well, our
3 aircraft recapitalization plan coming forward
4 very soon.

5 So I will, you know, note as we look
6 ahead here that -- and again, this is consonant
7 with your work, it's consonant with the focus of
8 your technical advisory papers that are coming
9 forward. We are deeply committed to investments
10 and the adoption of new technologies and
11 innovative ways of getting our work done.

12 You don't need me to point out the
13 difficult fiscal environment that we're in, and I
14 don't think that will change. And we don't need
15 to be, and always are, extraordinarily committed
16 to getting best value for or the public's
17 investment in our services. And technological
18 investments have a great promise in that
19 category.

20 Seeing a lot of progress -- I couldn't
21 begin to reference all of them. Certainly, things
22 like the digital elevation model. We now have a

1 kind of a standard geospatial approach that can
2 play into all sorts of applications from
3 inundation modeling, sea level change, coastal
4 management.

5 These types of infrastructure
6 resources and that's sort of technical backbone
7 are relied very heavily. And we're also looking
8 to extend the pilot in Long Beach, which is very
9 successful, and I think a great example of what
10 precision navigation can do. I'm sure that's
11 likely to be a focal point of one of your papers.

12 And we hope to be working in the Gulf
13 of Mexico to do the same type of high resolution
14 mapping work and harmonizing vertical data and
15 some -- among other improvements. And it is, as
16 we know, a very complex port structure. And I
17 think given all the disruptions in recent weeks,
18 the nation's sensitivity to that and the sort of
19 infrastructure assets to make it operate
20 effectively will come to the fore.

21 I'm really looking forward today to
22 the focus on use of unmanned systems and I'm also

1 looking particularly looking forward to the
2 opportunity this afternoon to tour the Joint
3 Hydrographic Center.

4 Again, a Class A example of the type
5 of partnership strategy we need to be successful
6 in this domain and has been a major contributor
7 to our advancement for years now. And I'm
8 looking forward to the opportunity to see current
9 thinking and current collaborative work that
10 we're engaged with over there.

11 So thank you, ultimately, for your
12 service as a panel -- also, each of you
13 individually. There are all kinds of significant
14 ways that you contribute not just to our
15 operations, but to the public's understanding and
16 to our Congressional members' understanding of
17 the value of our services and the ways in which
18 we work and collaborate with the private sector
19 and the academic sector to deliver that value.

20 And both as a committee and as
21 individuals, communicating that in an environment
22 of a great deal of noise -- it's a very loud

1 system -- and a lot of competition for resources
2 and your clear voice and a very businesslike and
3 programmatic focus on economic value is
4 extraordinarily helpful.

5 So thank you, Mr. Chair, and again,
6 many thanks for your service.

7 CHAIRMAN HANSON: Well, thank you, Dr.
8 Doremus. Appreciate you being here and I also
9 appreciate you sticking around this afternoon. I
10 know you've got some things to get back to
11 tonight, but Andy had me come up several years
12 ago to visit the UNH facilities and it's quite
13 impressive.

14 It's also interesting because we do a
15 lot of work with academics on other coastal
16 engineering type issues around the country. And
17 in a place and a time when coastal engineering
18 laboratories are closing or underfunded or just
19 lack of focus, to see the focus and the
20 innovation that comes out of UNH, it's very
21 impressive -- so glad you could join us.

22 DR. DOREMUS: Absolutely.

1 CHAIRMAN HANSON: Speaking of UNH,
2 where's Dr. Mayer?

3 DR. DOREMUS: He's getting mic'd.

4 CHAIRMAN HANSON: Good timing. Okay,
5 great, great. I can go ahead and introduce him
6 while he's mic'd. It's my pleasure to introduce
7 one of the world's premiere hydrographic experts,
8 Dr. Larry Mayer, Director of the University of
9 New Hampshire's Joint Hydrographic Center and
10 Center for Coastal and Ocean Mapping.

11 I felt like we got to have some
12 background music going on right now, don't you
13 think?

14 MALE PARTICIPANT: Boom, boom, boom.

15 CHAIRMAN HANSON: Boom, boom, exactly.
16 We're very fortunate that he serves as a
17 non-voting member of the HSRP. CCOM/JHC provides
18 NOAA, other federal agencies, industry and the
19 mapping community valuable research and
20 development for hydrographic services and has
21 spun many private sector technology projects.

22 You may recall his intriguing

1 visualization of the Chart of the Future at our
2 last meeting in Seattle. The panel will be
3 visiting the center this afternoon, and we look
4 forward to learning more about the novel work
5 being conducted at your facility, Dr. Mayer.

6 DR. MAYER: Well, thank you thank you
7 very much, Bill, and -- is that loud enough? Can
8 you hear it? Can you hear that? Great, thanks.

9 VICE CHAIR MILLER: Sir, it's not on.

10 DR. MAYER: It's not on. So you --
11 Gerd can hear it, but you can't.

12 VICE CHAIR MILLER: As long as the
13 court reporter can.

14 DR. MAYER: Okay. You're okay? Okay,
15 thanks. First of all, I want to welcome
16 everybody to New Hampshire. As Patrick said,
17 we're very proud of the region and I mostly want
18 to walk you through your visit this afternoon and
19 then a tour again on Tuesday, I think --

20 CHAIRMAN HANSON: Pier.

21 DR. MAYER: -- at the facilities -- at
22 the pier facilities -- to the center and to the

1 University of New Hampshire, in general. And I
2 have to apologize that I actually have to leave
3 at about noon today. I've had a long scheduled
4 and unmovable commitment in Stockholm that I have
5 to get to and so I really -- I'm sorry that I'll
6 miss that.

7 A couple of meetings ago, I presented
8 an overview of activities of the center. And as
9 Bill mentioned, last meeting we took a much
10 closer look at one aspect of that and that's our
11 work on the Chart of the Future.

12 And I'm really thrilled that this
13 afternoon you get to be able to see firsthand
14 some of the products that are part of that
15 effort. What I'm going to do today is something
16 that maybe a little strange, but I think is
17 actually very relevant.

18 I'm going to be a little
19 retrospective, and I hope that what I'm going to
20 talk about is going to epitomize the kind of
21 things that Paul mentioned and Bill mentioned
22 also.

1 I'm going to tell the story that I
2 don't think has been talked about much at the
3 HSRP -- I don't remember it being discussed --
4 and that's the activities of our lab, the
5 activities of the Office of Coastal Survey
6 including some people sitting right next to me,
7 and our industrial partners in the Deepwater
8 Horizon oil spill.

9 And I do that at this time of Harvey
10 and Irma and who knows what's going to happen
11 next because I want to remind us that sometimes
12 the research that we do has many unexpected
13 applications, particularly in times of national
14 crisis.

15 Also want to point out, you know, I
16 think it should be very clear, but I want to
17 emphasize that the Office of Coastal Survey has
18 played and will continue to play a critical role
19 as the nation's ocean mapping experts often well
20 beyond issues of safety and navigation.

21 I'm going to be self-serving and
22 hopefully this will point out also that the

1 collaboration between NOAA and the academic
2 community can play -- pay off in often unexpected
3 ways and I also help will set the scene for Ed's
4 discussion of his working groups activities in
5 terms of the technology that they'll talk about
6 because this will give some of the background for
7 where that technology came from -- and that's
8 about as much as I can sit down.

9 I don't think I -- it's not going to
10 work. I was going to try, but it's just not
11 going to work. I got to get going here. So I'm
12 going to start many, many years ago in, again,
13 kind of an academic dream world when multibeam
14 sonars first kind of were being delivered and
15 some of us thought that, well, gee, that's
16 wonderful how we can map the sea floor, but
17 there's information in the water column too and
18 why can't we extract that?

19 And it turns out when the sonar
20 manufacturers built those sonar's, they built
21 them very, very specifically to maintain the
22 record of the bottom and not look at the water

1 column. It was an engineering issue.

2 And so we worked very hard with one of
3 the manufacturers, Kongsberg Simrad, at that
4 time, to try to produce a one-off sonar for us
5 that led us to look at the water column. And our
6 effort there was, again, to expand the value --
7 oh, I can see just fine. Where can I stand? I
8 keep wanting to --

9 VICE CHAIR MILLER: There is good.

10 DR. MAYER: This is better. To expand
11 the value of the sonar and the focus was on
12 fisheries. Could we use these amazing sonars
13 that showed us why there's -- to look at
14 fisheries?

15 Well, it took a long time. We started
16 to do some stuff -- that's Herring in 1994 -- but
17 it took a very long time for the sonar
18 manufacturers to turn around and actually start
19 building sonars that would do that as their
20 standard equipment.

21 But they did, and again as we involved
22 with the senator hear, the focus on that value

1 added was really fisheries -- fisheries issues.

2 We tried to find hydrographic
3 applications for that water column work, and
4 there clearly were. There were hazards in the
5 water column. There's lease depths on wrecks.
6 And so there were indeed value-added from a
7 hydrographic perspective, but in our mind the
8 application was really fisheries, and that was
9 until the first deep water system was delivered
10 to NOAA on the Okeanos Explorer.

11 And on its very first test trip, on
12 the acceptance -- the seagoing acceptance trial
13 for the vessel -- steaming back into the port in
14 San Francisco, it was running along with its
15 water column data. And I showed you this at the
16 last meeting what did we see but a mile-high
17 plume of gas coming out of the sea floor.

18 Now we shouldn't have been surprised.
19 Gas is an amazing acoustic target, but we said,
20 wow, you know, there's another application here
21 and that's -- we can see gas in the water column.
22 And we started tuning some of the fish tools to

1 also be able to extract gas.

2 And here we see, we came back after
3 that first pass to see if it was still there and
4 it was and there were a whole series of these gas
5 flumes -- these natural gas seeps -- coming out
6 of an area that that is a -- it's a hydrocarbon
7 material.

8 So again, it wasn't surprising. We
9 were just surprised with the ability of the sonar
10 to extract that information. Well this test took
11 place about two, three months before Deepwater
12 Horizon -- April 20th, 2010. And I think, it's --
13 I -- in this room I don't have to remind any of
14 you about Deepwater Horizon.

15 It's really interesting now, as I talk
16 to students sometime, many of them have no idea
17 what I'm talking about. It's, you know, seven
18 years ago. They were ten-years-old or
19 15-years-old or something.

20 And it's scary, but I think, again, we
21 here remember how catastrophic the event was --
22 the loss of life, the remarkable size of this

1 spill, and equally remarkable response in terms
2 of vessels, responders, aircraft -- all kinds of
3 dispersant issues which are still being talked
4 about -- so lots of lessons learned in
5 retrospect.

6 I think the first lesson learned is
7 that if you're a Coast Guard Admiral, you might
8 not want to listen to the owners of the well to
9 find out whether it was leaking. The first
10 reports for several days came out that there was
11 no leak associated with the explosion.

12 And finally, it took about four days
13 to realize that there was a leak -- or for it to
14 be acknowledged that there was a leak. And at
15 that time, the way the leak, of course, was
16 discovered was with ROV's down below. We saw
17 these remarkable pictures.

18 And I have to give credit to Coast
19 Guard Admiral Allen who, when he saw this as the
20 Incident Commander, insisted that this feed be
21 kept up on the web 24 hours a day.

22 And it was a constant reminder about

1 what was going on there, but it also allowed,
2 again, many members in the academic community to
3 start looking at this feed and to start to try to
4 calculate what the flow rate was.

5 And it took a while, but there were
6 several estimates what that flow rate was and
7 that flow rate was absolutely incompatible with
8 the slick on the surface. And finally, again, it
9 was about two, three weeks that it took, but
10 there was a recognition that they couldn't
11 account for all the oil on the surface, something
12 must be going on below and the idea that there
13 was a giant flume forming below -- and this was
14 the real challenge.

15 We really had never experienced a leak
16 at this depth. The wellhead was at about 1,500
17 meters, 2,000 meters or so depth. And somewhere
18 in the water column, a lot of the unaccounted oil
19 had to be sitting.

20 And so this was a challenge. So on the
21 18th of May, just a couple of days after the
22 reports came out, the White House actually called

1 a meeting, invited a small group of academics.

2 The meeting was hosted by the
3 President's Science Advisor, had the Secretary of
4 Interior there, the EPA Administrator, the
5 Assistant Secretary for Oceans and Atmosphere at
6 the time, I think, the same day the NOAA
7 administrator was testifying, so she couldn't
8 make it. The USGS director. So it was a fairly
9 high-level meeting.

10 And what they basically said is, help
11 us try to find us this deep plume. They really
12 didn't have the capability. And they asked each
13 of us -- or allowed each of us --- to show three
14 slides for how you'd approach trying to find the
15 three flumes.

16 So I showed that picture. I said,
17 look, we can find gas. I'm not sure we can find
18 oil, but we can find gas and always with the oil
19 there's gas associated with -- in a leak like
20 this.

21 And I also showed an experiment that
22 the Norwegians did where they intentionally set

1 off a spill in a thousand meters of water and
2 basically were seeing if they could trace it -- a
3 controlled spill. They were like able to shut it
4 off too -- and they were acoustically.

5 They were able to use sonars. And I
6 don't have a pointer, but I guess right here.
7 They were able to see the oil coming from the
8 wellhead -- oil and gas and what they might be
9 seeing is just the gas.

10 Again, this is a question, can you see
11 oil? You can see gas. And they got very excited
12 about this. And they said -- John Holdren said,
13 do we have that equipment? And I said, yes, yes,
14 NOAA has the perfect system. This was 38
15 kilohertz.

16 But we had a brand new -- that system
17 we had just tested 30 kilohertz multibeam sonar
18 on the Okeanos Explorer. But at that time the
19 Okeanos Explorer was heading to Indonesia.

20 And actually, the comment was made
21 that, this will all be over by the time we get it
22 back. So the Okeanos Explorer was not recalled,

1 unfortunately, at the time, because I don't think
2 anybody realized how long this would go on.

3 But we said, do we have other devices?
4 Said, well, the Norwegians had used fisheries
5 echo sounders and perhaps we can do that. You'll
6 see the tradeoff in a minute why we'd much rather
7 have had the multibeam, but they said, okay, can
8 you do that?

9 And I think it was Steve Murawski from
10 NOAA there who said, yes, you know, we can -- we
11 have some of these, we can start diverting the
12 ship. But who went onboard? and here's, again,
13 Sam Greenaway, NOAA Corps officer who was also a
14 student with us at time. I'm not sure of the
15 timing.

16 Tom Weber, a professor in our lab gets
17 sent on the NOAA Fisheries vessel with extra
18 equipment for what we call the CTD, a device you
19 can lower down and try to actually detect a deep
20 plume with an instrument called the fluorometer,
21 looking at the fluorescence of the water.

22 That was on the Gunter. There was

1 another ship, the Thomas Jefferson. I think, you
2 were sitting in Galveston at the time and my
3 phone starts ringing, and -- was it Captain or
4 Commander at the time -- Commander Smith's
5 calling.

6 He said, oh, this is a terrible
7 national crisis. We have to get going. Had to
8 put an EK60. There wasn't one of these sounders
9 on the -- you had this, yes, you had put the
10 electronics onboard the ship, again, get devices
11 lowered down.

12 And Admiral Smith is saying, he says,
13 I got to get going. I said, well, have you got
14 permission yet? Ah -- and I don't know -- and we
15 spent many, many weeks out there and I don't know
16 how many times I said to him, you're either going
17 to get fired, or you're going to become the
18 admiral. So.

19 And then the ships got there. But this
20 what was going on. And all the effort was
21 focused on trying to the cap the wells and drill
22 -- already starting to drill the relief wells.

1 And so this idea of getting over the
2 wellhead with the sonar was not terribly
3 feasible, but, you know, their priority, and
4 rightly so, was cap the well. And you see how
5 crowded it was out there. And so at first they
6 kept us very, very far, far away.

7 They were very, very nervous about our
8 sonar systems interfering with their ROV
9 navigation. But I think as they gained
10 confidence, we started being -- kept 20 miles
11 away and then 10 miles away and then 5 miles
12 away.

13 So, but we were out there surveying.
14 But when you start so far away, that's not the
15 experiment that we proposed. We proposed of
16 getting on top of it and tracing the plume from
17 the wellhead. You're kind of fishing in the dark
18 there.

19 And we were using kind of the standard
20 techniques that people were using with the CTD
21 and these instruments to try to find things. So
22 you dip a instrument in the water and if there's

1 no oil, you don't see any kick in fluorescence
2 and the oxygen levels behave like a normal ocean
3 column, this is zero to 1,600 meters to 700
4 meters depth.

5 But if there is the oil plume, and
6 where it was it was always at 1,150 meters --
7 very consistent -- you get this big kick in this
8 fluorescence, an indicator of organic material in
9 the water, and a decrease in oxygen as the
10 microbes are starting to eat the oil. They
11 utilize the oxygen.

12 And so that's what many vessels were
13 doing, not just the vessels with the sonar
14 systems but everybody just kind of blindly
15 dipping.

16 And this afternoon when you go to the
17 lab, you'll see a tool that we developed after
18 the fact that I so wish we had there that takes a
19 look at the 4D flow. And you put on stereo
20 glasses and you can see the 4-dimensional flow in
21 the water column and you can put a tracer in the
22 water at any level and it'll show you where, at

1 least the models -- the updated models are
2 showing it's going.

3 Had we had it at that time, it
4 would've been very helpful and kind of, you know,
5 not just randomly having ships around doing dips,
6 but we could've really been focused on where, at
7 least the models were saying, the deep flow --
8 the flow at that level should be going.

9 So we tried to look at this
10 acoustically. Here's an area where there was
11 nothing in the water column. This what you see
12 up here is what we call the scattering layer --
13 these, little organisms that the Fisheries sonars
14 look at -- the sea floor -- and you don't see
15 much in there.

16 But here's a place where we do have --
17 did have a kick again -- 1,150 meters -- the big
18 kick -- and I was always convinced that I could
19 see a little layer, a bottom following layer,
20 here.

21 Here's the CTD. You guys can see the
22 CTD come through it. My acoustics colleagues

1 were not as convinced, but it was -- there are
2 only a few of these opportunities where we
3 actually hit it and saw a target like that.

4 But what we did do is see lots of gas
5 seeps -- gas seeps everywhere. And this is,
6 again, not unusual in the Gulf of Mexico. These
7 are natural seeps for the most part, although we
8 saw some unnatural ones -- I'll talk about that
9 in a moment.

10 And what we were doing -- and this is
11 part of the collaboration with our industrial
12 partners, too, at the time -- is we're onboard
13 collecting this data using whatever software
14 products we had and having the software updated
15 and updated and updated, sending it back and
16 forth from shore.

17 We actually didn't have all that much
18 bandwidth, but it was certainly enough to get
19 updated sets of code and really developing tools
20 to look at these seeps and extract them and try
21 to locate them very precisely and develop tools
22 for visualizing as much as we could in the

1 region.

2 Oh, thank you, that's great. Now I'm
3 dangerous. Everybody have sunglasses on? Because
4 I'll starting waving around. We finally got
5 within a mile of the spill, at that point, in the
6 surface slick.

7 And with a high frequency, a echo
8 sound there could easily see -- this is a series,
9 as we were driving in through, a series of -- as
10 go in circles, a series of profiles of the water
11 column acoustically. And each one of these is
12 the spill itself coming up in the oil. That's at
13 high frequency.

14 And, Shep, I think this is where you
15 probably had the most difficulty in terms of the
16 -- and that was not comfortable in the slick
17 itself and the vessel was -- had to come and be
18 washed and things like that. I think the air was
19 not so comfortable either.

20 But so certainly if we can get right
21 on top of it, we could see directly the oil, at
22 least at high frequency. What we really wanted to

1 do, though, was get right on top of the well.

2 And the reason I wanted to use that
3 multibeam originally is here's where all the
4 kinds of tracks we were running many different
5 ships over much time. To see it with that
6 Fisheries echosounder at which looks straight
7 down, we'd have to get right on top of it and
8 then start tracing the gas and oil and plume
9 away.

10 With a multibeam, we could've sat as
11 much as two and a half, three kilometers away
12 outside of the traffic and all the effort over
13 the wellhead and still see the slick and start
14 tracing things. So that was the original reason
15 for use a multibeam, but, I said, unfortunately
16 it was off deployed somewhere else.

17 Finally, on the 15th of July, I got
18 what was probably the scariest phone call of my
19 entire academic career -- or any career. I had,
20 for weeks, been serving on the Secretary of
21 Energy's review panel. They met every eight hours
22 -- 24 hours a day, every eight hours, his review

1 panel with BP.

2 And the government would present their
3 concerns, BP would present their responses and
4 the next eight hours they'd discuss it again.
5 And I got a call out of the eight-hour cycle from
6 the Secretary.

7 And I should say, in terms of lessons,
8 the biggest lesson learned to me was if you're
9 going to have a Secretary to Energy it doesn't
10 hurt to have a Nobel Laureate in Physics.

11 You know, he was absolutely
12 remarkable. He really was. Challenging BP, making
13 them read papers, challenging their calculations.
14 It was really impressive. But I got a call and
15 was told that they think they finally have a
16 solution to the capping the well. This is by
17 July. Now remember, this started in April.

18 And the modeling of the bore hole
19 itself showed some concern over the integrity of
20 the bore hole. And the concern was that if the
21 cap worked, there'd be a side wall blowout and
22 there's no stopping that until the well is

1 depleted or they have the safety wells drilled
2 which wouldn't be until October.

3 But if they caught it early, they can
4 uncap the well and go back to -- and his question
5 was, can you guarantee -- the models all show
6 that if this is going to be a blowout, it's going
7 to be gas first, it's going to be coming within,
8 they said, 500 meters of the water hole -- can
9 you guarantee you can see gas?

10 And I thought we could, but guarantee
11 is -- that's not a word that scientists like to
12 use, ever. And so I got all our acoustics
13 experts, you know, and we all said, yes, yes, we
14 -- so we said, yes. And they said, okay, and they
15 started capping the well and he did some pounding
16 on the table, but had us drive right through
17 there.

18 And, you know, really kudos to the
19 NOAA boat drivers because that's what they had to
20 do, drive through. That's from the window of the
21 survey vessel as we were going by other vessels.
22 But over the wellhead, and what did we see but

1 gas coming out of the capped well.

2 And so there was a panic, as there
3 should've been, and BP said, no, no, no, you're
4 just totally wrong, it's -- you're just totally
5 misinterpreting this. See, there's no way that
6 can be -- you're -- there's lots of
7 infrastructure down there, and you're
8 misinterpreting the infrastructure for gas
9 leaking.

10 And we came back and said, no, no, we
11 recognize the infrastructure. That's a riser.
12 That's the wreck of the Deepwater Horizon with 9
13 ROVs still around it. That's another riser. But
14 this, which is what I plotted there as a single
15 pass, is three passes over gas rising up.

16 So they scrambled and they come back
17 and say, oh, yes, yes, well, it's gas, but it's
18 not methane, it's really nitrogen exuding from
19 the cement.

20 And we came back and said, no, because
21 we had been looking at gas seeps -- methane seeps
22 -- for months now and every one of them comes up

1 to about 400, 500 meters and then disappears.
2 And that's because the gas is surrounded by an
3 ice coating and that's what keeps from going into
4 solution -- is something we call a hydrate -- and
5 then when it gets to 400, 500 meters depth, that
6 ice coating goes away and the methane goes into
7 solution and this is exactly how this was
8 behaving.

9 And so then, finally, they came back
10 and said, oh, yes, yes -- and they found the leak
11 and that's all it was. It was a scratch on a
12 metal-to-metal flange, and it was just a few
13 bubbles a second, but that few bubbles a second
14 leads to a target like that. That's how sensitive
15 the sonar is to gas bubbles which resonates, so.

16 And it turned out that BP just had to
17 keep an eye out on it. All the engineers said
18 there wouldn't be an issue, keep an eye on it,
19 and they did for the next ten months and nothing
20 ever changed with that, and so that was not a big
21 deal.

22 But here I should -- what I want to

1 mention here was -- this here is a -- that gas
2 hydrate stained by oil -- some of that frozen
3 gas. And every once in a while a piece would
4 break off and we can just trace the piece coming
5 right up. So again, how accurate that sonar
6 could be.

7 And then all we did for the next --
8 and you talk about boring, we did this on kind of
9 two-week shifts on different vessels for the next
10 three months until the relief wells were finally
11 drilled and the well was cemented in. Just went
12 back three times a day back and forth and back
13 and forth, making sure that nothing changed.

14 And so we would just rotate people
15 down doing that every couple of weeks. Finally,
16 in the following year, we got the multibeam
17 sonars to the Gulf of Mexico, as we had wanted to
18 do, and started to look at the amazing
19 distribution of these natural gas seeps. Also,
20 some unnatural ones.

21 This is just -- the blue dots are all
22 gas seeps we mapped around the -- this is the

1 Deepwater Horizon site. The yellow is the
2 infrastructure -- pipelines and wellheads and
3 things like that. Wherever there is a blue dot
4 on the infrastructure, it indicates that it's a
5 leaky wellhead or leaky pipe.

6 And they're not serious leaks. They're
7 all little tiny leaks like that, but each one we
8 would contact MMS at the time and they have an
9 obligation to go and try to find what was going
10 on.

11 But as we were now bringing the
12 multibeam in, we started to really fine-tune the
13 tools to make sure that we could really find this
14 seep quite accurately because if you want to go
15 and look at it with an ROV you have to know where
16 it is within about 30 meters or so.

17 So we worked all that out, kind of
18 georeferencing it, and really got to the point of
19 being able to precisely locate it. And this is
20 where the software started to become useful for
21 folks like Ed Saade and Fugro, who were working
22 on exploration in the Gulf of Mexico.

1 And these tools became very, very --
2 and that's the kind of stuff you read about --
3 very, very helpful to Ed and to Exxon and to
4 other players in the area in terms of helping
5 locate both hazards, but also using it as a tool
6 for exploration.

7 And so this is part of this technology
8 transfer that started in a totally different
9 world looking at Fisheries research, but has come
10 around to being something that's very, very
11 useful. And Ed, in his paper, talks about some
12 of the ramifications of that.

13 But we don't stop there. We want to
14 say, well, we can find the seeps, can we now
15 measure how much it's coming out? And so that's
16 now turned around into a new research program
17 that's not funded necessarily by NOAA, it's
18 funded by NSF and DOE and other folks where we're
19 now actually looking at trying to be quantitative
20 about the rate at which the oil is coming out.
21 And that really depends on understanding the size
22 of the bubbles.

1 We started with some just primitive,
2 little experiments sending down a -- the Okeanos
3 Explorer with its little submersible or ROV, I
4 should say, and just trying to measure the rate
5 to get some groundtruth and capture some gas so
6 we can see bubbles quite nicely with high
7 definition cameras. You can see those -- but
8 they make those amazing targets.

9 We just took a little grid behind it
10 so we can actually see the size of bubbles and
11 write some software to track them and measure
12 their rise rate and their size, estimate it from
13 that. Estimate it from the acoustics, compare
14 our estimates.

15 We are estimating our rate of .003
16 liters per second from the acoustics. And then
17 go out and try to do the ultimate groundtruth in
18 terms of what the flux is, put a bucket over it,
19 and we do. And, again, you can capture it. It's
20 going to turn into this hydrate, into this frozen
21 gas, right away as soon as it comes there.

22 The frozen gas will expand so when we

1 bring it up and we get to about that kind of 400
2 meter -- I don't know if we have the time to
3 watch it. It all expand into, back into free gas
4 when it -- well, you'll see a little bit starting
5 to happen here.

6 That's, I think we have -- you okay?
7 We're okay, with time, Joyce? I only have one
8 more slide, I think, after this and then I think
9 we're okay. So, it's because it's fun to watch
10 this disassociate. At least it's fun for me. I
11 don't know.

12 I guess we each have our own. Here we
13 go. It's starting. It's going to be at about --
14 and all of a sudden, it'll reach this what we
15 call the hydrate stability zone. And there it
16 goes, boom.

17 And so we get two measurements. We
18 get measurement of the frozen gas volume and the
19 free gas volume. So this gives us, for seven
20 minutes we know how -- what the volume is. And so
21 ours meant, there it was .0024 -- so versus the
22 .003 -- so we were pretty happy about that.

1 And so when we went -- again this is
2 funded now by the National Science Foundation.
3 Again, so NOAA, the Center, became a seed for
4 something that really took off in terms of going
5 to a place in the Eastern Siberian Arctic where
6 there's supposedly a lot of gas and now using a
7 new really broadband -- so really broad range of
8 frequency sonar -- to really try to get down to
9 the size of the bubbles.

10 And so we upgraded the sonar on a
11 Swedish ice breaker. And this is looking at
12 individual, what they thought were individual
13 targets, with the expanded Fisheries sonar, but
14 when you use the broadband one you see -- you
15 really were seeing clumps of them.

16 And now we can get down to the
17 individuals. And with this we've now got a
18 graduate student who's actually measuring
19 individual bubbles and being able to trace
20 individual bubbles coming up and measure their
21 rise rate and measure their size. And I think
22 that's the very last slide.

1 We just go through a bunch of
2 pictures. But the bottom line is we now are
3 making estimates of flux. And I just want, again,
4 I just want to tell this story -- an old story --
5 but I think it has lots of resonant messages that
6 you never know where the research is going to go.

7 We start off thinking about fish and
8 end up something that's helping Ed in the
9 industry tremendously, that helped in Deepwater
10 Horizon. And it's really, in these national
11 crises, who knows what will involve from the work
12 that NOAA will go out and start doing after the
13 hurricanes.

14 That the collaboration, again, between
15 the academic and industry and NOAA, I think, has
16 been fruitful; that, again, it was OCS that was
17 called upon.

18 I mean, none of this would've happened
19 without the Corps officers, the OCS folks who are
20 trained as the mappers, who, again, went off for
21 a different application, but that amazing
22 expertise that spreads to wide national needs and

1 then finally something that may even have an
2 industrial payoff -- a big industrial.

3 You've given the numbers. They're
4 huge numbers in terms of the industrial payoff.
5 So I thank you all. And I guess I'm even
6 finished early, so that's --

7 VICE CHAIR MILLER: Questions.
8 Questions.

9 DR. MAYER: Questions? No, that wasn't
10 in the contract. Questions. I'm happy to answer
11 questions, but maybe now I'll sit down.

12 Questions for Paul. It's much better,
13 questions for Paul than for me.

14 CHAIRMAN HANSON: I'm going to open
15 for questions for either Dr. Mayer or Dr. Doremus
16 or the panel? Observations, Dave? Okay.

17 MEMBER MAUNE: Oh, I guess I was
18 supposed to -- no, no, this just -- and I'm going
19 to turn it over to Andy because we were supposed
20 to have breakfast, give a little -- since we have
21 a moment or two, just to -- about this
22 afternoon. Is that --

1 VICE CHAIR MILLER: It'd be great. But
2 Paul is only here with us today. So if you have
3 questions -- and Larry is only here with us
4 today. Take that time and use that time.

5 MEMBER MAUNE: Okay. Well, I'll
6 do that, but they didn't seem to have questions.

7 CHAIRMAN HANSON: Okay. Well, we're
8 going to go ahead and if there are no others
9 questions, we'll go ahead and take a -- go ahead
10 and do our break. Certainly, Larry, we've got
11 you until noon, until you go to Stockholm, Texas
12 or where you going?

13 DR. MAYER: I'm not going to say, I
14 wish.

15 CHAIRMAN HANSON: And so got a few
16 minutes to grab them at the break or -- and then,
17 Paul, you'll be with us for the rest of the day,
18 so appreciate that. And I'm sure there's -- be
19 some questions that will come up. All right,
20 let's go ahead and take a break. We'll come back
21 at 10:15 for unmanned systems for hydrographic
22 surveying.

1 DR. MAYER: Thank you.

2 (Whereupon, the above-entitled matter
3 went off the record at 9:56 a.m. and resumed at
4 10:19 a.m.)

5 CHAIR HANSON: All right. Now we're
6 reconvened here. We've got our first panel, and
7 I'm going to go ahead and turn the mic over to
8 Carol Lockhart as the moderator. Carol is a
9 working hydrographer, a small business owner, a
10 member of the HSRP. And it's also our Technology
11 Working Group.

12 Thanks, Carol.

13 MEMBER LOCKHART: Thanks, Bill.

14 So I was going to do a brief
15 introduction of everybody's bios and things. But
16 I think we have a short amount of time, and
17 everyone is really interested to see what the
18 panel has to say.

19 We have some great presenters here
20 today. Most of you already know Captain E.J. Van
21 Den Ameele. He served with NOAA for 23 years,
22 and he's currently the director of the Coast

1 Survey Development Lab. He's going to give us an
2 introduction or overview of autonomous vessels as
3 they pertain to hydrographic survey, show us some
4 examples of vessels NOAA has used, and describe
5 NOAA's involvement in the industry and some of
6 the lessons learned so far.

7 We're then going to move on to Thomas
8 Chance, who probably needs no introduction to
9 anybody that's been working in the hydrographic
10 survey industry. He was the CEO of C&C
11 Technologies. They did a wealth of surveying
12 with AUVs, but more recently, he's now the
13 founder of ASV Global which he started back in
14 2010. And I'm sure he'll talk about ASV Global
15 during his presentation. He's going to talk
16 about their experiences and go into details of
17 the vessels they've designed and built. So I'm
18 sure in 30 minutes here you guys will be in
19 engineering heaven.

20 Doug Lockhart is the vice president
21 and general manager of Teledyne CARIS, and he's
22 going to talk about how autonomy applies to

1 hydrographic surveying with an analysis of the
2 potential cost benefits as we introduce various
3 levels of autonomy.

4 And then we're going to move on to
5 Rebecca Quintal who is the Hydrographic Survey
6 Data Solutions Manager for Maritime Systems
7 Division of Leidos. And she's going to talk
8 about the research and development of the Sea
9 Hunter, which is a longer endurance ocean-going
10 autonomous vessel -- so a little bit different
11 from the initial presentations -- and talk about
12 the kind of technology involved in making
13 something like that happen.

14 So hopefully, we'll give you a broad
15 overview. There are some things we recognize may
16 be missing from this presentation. We're
17 probably pretty light on the processing side of
18 autonomy. That was recognized when we set this
19 panel up. But hopefully, we'll have time to
20 actually have some good questions and panel
21 discussions so we can talk a little bit more
22 about some of the things we may have missed as we

1 go through it.

2 So without further ado, I'm going to
3 hand over to E.J. here.

4 CAPT VAN DEN AMEELE: Great. Thank
5 you very much, Carol. And good morning,
6 everyone. It's a pleasure to be here to talk
7 about the Autonomous Systems Strategy that the
8 Office of Coast Survey has developed. And in
9 doing so, this morning, I hope to somewhat set
10 the stage for the further discussion on the
11 panel.

12 Coast Survey has about over a dozen
13 years or so of experience with unmanned and
14 autonomous systems. And based on that
15 experience, we did develop the strategy, and we
16 certainly look to not only our internal resources
17 but our academic and industrial partners as well
18 to help us fulfill some of the objections of the
19 strategy. So hopefully, this introduction to our
20 strategy will help set the stage for further
21 discussion on the panel, and I look forward to
22 the other three presentations from my colleagues

1 here as well.

2 So as mentioned and I think has been
3 distributed to the panel and others, we have, I
4 guess, we still consider it a draft, pending
5 final comments and review. But of the Office of
6 Coast Survey's Autonomous Systems Strategy, we
7 both developed a longer version, which is about a
8 seven or eight-pager -- which I know many of you
9 have reviewed -- as well as a more flashy one-
10 pager that we've distributed as well.

11 So this was briefed out to the HSRP
12 Technology Working Group back in early August.
13 We had some very good discussions based on that,
14 and we've received some great comments back. So
15 we certainly appreciate the feedback that we
16 received back from the working group and the
17 panel as well, as we look to finalize those and
18 use that input to update our strategy. So thank
19 you for that.

20 So Admiral Smith has spoken to this
21 before. I believe he spoke to it back at the
22 meeting in April and may speak to it again at

1 this meeting as well: The new sort of Coast
2 Survey focus areas, particular with regards to
3 our data acquisition efforts for hydrographic
4 survey as well as updating our charts. And I
5 just wanted to mention these again briefly,
6 because as we look to the use of autonomous
7 systems for our mission, we look how we can apply
8 these in these three kind of key focus areas.

9 The first being the critical under-
10 keel clearance and ports. These are the high-
11 risk areas with deep draft, large volume traffic
12 where very high resolution and high accurate
13 hydrographic surveys are necessary to ensure safe
14 and efficient transportation.

15 A renewed focus on reserving and
16 cleaning up chart discrepancies. These are the
17 many things that get put on the chart that are
18 very difficult to remove from the chart, whether
19 it's a vessel that sank -- but you don't know
20 quite exactly where it was -- to somebody found a
21 shoal sounding and reported it and now it stays
22 on the chart as a reported sounding or a position

1 approximate and those sorts of things.

2 So I think our current inventory of
3 those of recent count was over 10,000 on NOAA's
4 1,000-plus charts. So we need to go ahead and
5 look those up. And do we have a role for
6 autonomous systems in being able to help fulfill
7 that need as well as a more broad
8 interdisciplinary seafloor mapping?

9 So this is beyond the routine shallow
10 water coastal harbors and approaches work to
11 really mapping out the full U.S. EEZ and beyond,
12 as we even look to things like Seabed 2030 and
13 how do unmanned systems fulfill a role in
14 potentially that application.

15 And then the fourth one that isn't
16 listed here but I often like to mention in
17 regards to this talk is the Arctic as well.
18 That's a priority, and I think there's a role for
19 these types of systems in fulfilling our need.

20 The Arctic is a big area that, as
21 everyone knows, is opening up to commerce and
22 transportation. There's lots of white areas up

1 there on the charts that don't have a lot of
2 soundings and getting that mapped is no small
3 feat. And how do we do that? And there's
4 probably a role, and we've done a little bit of
5 work to date with that as well.

6 So those are kind of the key focus
7 areas I ask everyone to maybe think about as well
8 as the panel as we look at how we can best apply
9 the use of these systems in those priority
10 mission areas.

11 So just a quick synopsis on our
12 unmanned work to date, particularly within Coast
13 Survey and the hydrographic survey program. As I
14 mentioned, we first got into this about a little
15 over a dozen years ago, probably around 2004 or
16 so. And our initial work was to see how we can
17 use the force multiplier concept with regards to
18 unmanned systems.

19 So these ships are very expensive, and
20 they're tough to get station and on location. So
21 when they're there, you want to maximize your
22 data acquisition and your cost benefit. So can

1 you get as many sensors in the water as possible?
2 And sometimes, maybe that wasn't always carrying
3 big boats or large ships but a smaller platform
4 like the AUV, the one in the upper left-hand
5 corner, that particular one.

6 So that was the first one we acquired.
7 That was a Hydroid REMUS 100, as you can see,
8 deployable by a couple of people over the side of
9 a boat and didn't really require any sort of
10 specialized handling equipment. Get it into the
11 water and get it out of the water. And this one
12 in particular was equipped with side scan sonars,
13 so the equipment used to locate obstructions on
14 the seafloor which are hazardous to navigation.

15 And after several years of that, we
16 were very successful. We did transition that
17 type of vehicle to operations. We found that we
18 can acquire at least seafloor imagery data and
19 detect obstructions on the seafloor with the same
20 bit of accuracy that we could we the tradition
21 tow systems which we would typically tow behind a
22 vessel.

1 And so that system is operational now.
2 What you see in particular right there is
3 primarily used these days for emergency response
4 work, such as we have ongoing right now with the
5 current hurricanes. And that one may, in fact,
6 deploy down to Florida as part of the result.

7 So based on our successes on those
8 types of vehicles, we then wanted to move up and
9 solve the next question. So we next acquired a
10 larger vehicle, the one in the bottom left-hand
11 corner, which was the same manufacturer, Hydroid
12 REMUS, but as I mentioned, a larger vehicle.

13 And we had a couple of objectives with
14 this in particular. The first was, can we now
15 acquire very accurate bathymetry data that would
16 meet our nautical charting standards and IHO
17 standards with a multibeam echo sounder on board?
18 And the second area that we were trying to
19 address was, can we increase the endurance of the
20 vehicles that we're operating?

21 So initially, that top one, we could
22 run for about seven or eight hours. So a typical

1 kind of day operations before we run out of juice
2 and have to bring it back and download the data
3 and recharge it.

4 So our goal with the larger vehicle
5 there was to see if we can get 24 hours. So can
6 we run a full day out at sea and bring it back
7 and do the same type of thing: Offload the data,
8 put in a new set of batteries in it while we
9 recharge the ones that were in there, and get it
10 right back out on a mission?

11 So with those particular objectives,
12 after again, several years of development, we
13 were very successful. However, we found that
14 some of the logistical challenges made it,
15 perhaps, not necessarily the best vehicle for a
16 typical sort of hydrographic survey work for a
17 few reasons.

18 One was, as you can kind of see from
19 this picture there, getting it in and out of the
20 water was, at that point, much more difficult.
21 And if you were to, say, deploy it on a vessel of
22 opportunity, they might not have that specialized

1 handling equipment, launch or recovery system.

2 So then you're kind of adapting what you do have
3 on board in terms of A-frames or cranes or things
4 like that.

5 So that certainly becomes a challenge,
6 and someone starts to limit the sea state that
7 you can especially recover these types of
8 vehicles. And so that was a limiting factor.

9 The second factor was, unlike the side
10 scan sonar AUV -- which you like to get down
11 below the surface at a certain depth for its
12 maximum effectiveness -- when you're talking
13 about acquiring bathymetry data from a multibeam
14 sonar, you want to be high above the seafloor as
15 you can because that maximizes your data
16 acquisition.

17 But where we're operating these types
18 of vehicles, again, in more highly trafficked
19 areas, you've got to get them down low to not be
20 a hazard to navigation or for that collision
21 risk. So it was far less effective in at least
22 multibeam bathymetry data than we were able to

1 get from a surface vehicle.

2 So we then later asked the question,
3 well, is it worthwhile for us to hang onto this
4 if it doesn't suit our primary mission objective?
5 But it still is -- we found it certainly can
6 collect very good, high resolution bathymetry of
7 the seafloor, just not as efficiently as a
8 surface vessel.

9 So it has a large application to a
10 whole other range of seafloor mapping missions
11 within NOAA and beyond the agency as well. So
12 we've decided to hang onto that one right now and
13 kind of have it as a gun for hire, so to speak,
14 for potential other mapping missions within the
15 agency.

16 So based on that experience, with a
17 larger vehicle, we then said, okay, well, it
18 looks like maybe we need to start investigating
19 the surface vessel aspect because of the lessons
20 we learned with our underwater vessel. So we
21 first turned to the smaller ones, like the Z-
22 boats that you see in the upper right-hand corner

1 there, the Teledyne Z-boat.

2 That was initially equipped with a
3 single beam sonar and a positioning system that
4 would operate concurrently with both a large
5 mother vessel -- in this case, the NOAA Ship
6 Thomas Jefferson -- but also some of their
7 smaller survey launches.

8 So this was looking to kind of expand
9 the mission profile a little bit. It could
10 operate in very shallow water on shore where we
11 still had a need for collecting sounding data for
12 the chart. But maybe we wouldn't be sending our
13 30-foot survey launches or even larger ships just
14 because it was shallow. So in this case, it was
15 kind of acting as that force multiplier and
16 expanding into a more nearshore region.

17 And we also wanted to look to large
18 vessels. So can we then start performing the
19 mission of a typical hydrographic survey launch
20 or a ship even with an unmanned vessel? So last
21 fall, we -- and realizing a difficult -- I should
22 mention one thing and up to date, this would've

1 all been when we were acquiring these vehicles
2 ourselves.

3 I'm not sure if anybody has been
4 through the government acquisition process
5 before. It can be very challenging and lengthy,
6 and maybe it could take you a couple of years by
7 the time you get through a budget cycle and then
8 an acquisition cycle to get your equipment on
9 board. And certainly, you're not doing a lot of
10 innovation and development while you're working
11 through that.

12 So in this case, to hasten or speed
13 the research and development of the larger USVs,
14 we did a lease with Mr. Chance's company here
15 last fall. So he'll talk to it.

16 Not to steal your thunder too much,
17 but that's a C-Worker 5, which is a five-and-a-
18 half-meter vessel that we deployed on the NOAA
19 Ship Nancy Foster for a couple of weeks in
20 September of last year off of the Carolinas. And
21 this was a multi-disciplinary mapping mission
22 where it was just not strictly for nautical

1 charting, but it was also a habitat mission for
2 fisheries and it was sort of a map once, many
3 times. And I've got a couple more slides coming
4 up on that.

5 So that's our unmanned work to date,
6 kind of a brief synopsis over the last 12 years
7 or so. And again, I'll speak to how our lessons
8 learned informed how we developed our strategy
9 moving forward and where we see the best
10 application of the technology and as it matures
11 and develops.

12 So again, this is just some more
13 images and a brief on the lease of the C-Worker 5
14 last year. So this was a little bit of a -- I
15 personally wasn't there, but I've certainly
16 gotten the stories from our folks who were. So
17 we had to, again, as usual, adapt to the
18 infrastructure that was aboard the ship, the
19 Nancy Foster in particular. It didn't have a
20 very talented deck crew who are used to putting
21 boats in and out of the water all the time.

22 But you take a person off of that

1 boat, and it ramps up the challenge a little bit
2 when you don't have somebody physically on the
3 thing that you're putting in the water and taking
4 it out. So we adapted to there, and I think you
5 built a particular type of handling cradle for it
6 as well to adapt to the knuckle boom crane that
7 the ship had.

8 So again, the objective of this test
9 was to evaluate the shipboard infrastructure
10 requirements. What kind of staffing needs do you
11 need? What are the manpower requirements? What
12 are the technical capabilities? Can we acquire
13 just as good data with an unmanned system as we
14 can with a manned platform? And start to develop
15 what the operational concept would look for
16 deploying a high endurance USV.

17 And just a couple stats on the vehicle
18 itself. I think it was deployed with the same
19 speed of survey equipment that we would have on
20 one of our manned boats. So a multibeam sonar
21 for high resolution bathymetry, the POS MV for
22 high accurate position, and the HYPACK data

1 acquisition system. So the same things that our
2 vessels with folks on board have them.

3 In this case, the vehicle has
4 endurance up to five days. And I think you'll
5 talk about your full range of offerings in your
6 presentation, so I won't go too much further into
7 that.

8 So some of the synopsis of the survey
9 operation. So as I mentioned, it was over the
10 course of about two weeks, a full five days of
11 acquisition. Even though it was two weeks, some
12 of that was a little bit weather based where they
13 had some down days.

14 Some of it was just because they had
15 to transit back and forth between the particular
16 survey area. So it wasn't one contiguous area.
17 It was kind of a little bit here and then they
18 had to transit 20 miles or so to the next survey
19 area. So that was a factor as well.

20 And again, that was the reason for the
21 longest deployment. So as you saw on the
22 previous slide, these vessels have an endurance

1 of, potentially, up to five days. But in this
2 case, the longest deployment was 26 hours. That
3 wasn't a limitation of the vessel itself. It was
4 just more because of the nature of the mission
5 and the spread out areas that needed to get
6 addressed.

7 So the other thing of note is in this
8 case -- as we like to kind of joke about a little
9 bit -- we had six people working on an unmanned
10 systems mission on board the ship. So that was
11 three ASV Global engineers that came along in
12 support of the mission as well as three of our
13 own survey watchstanders.

14 So on a typical 24-hour period, there
15 were three eight-hour watches. We had a vessel
16 operator or engineer that was ready to take
17 control of the vessel, if needed, to maneuver or
18 help avoid traffic or bring it alongside and it
19 need to be recovered and that sort of thing. And
20 then we also had a watchstander for our survey
21 data acquisition.

22 So you can see that in the photo on

1 the lower right-hand side there where the person
2 in the foreground there, he's both operating, I
3 think, the HYPACK software as well as the
4 multibeam data acquisition software, just albeit
5 remotely through high bandwidth communications
6 between the host vessel and the unmanned vessel.
7 And then in the background is the vessel operator
8 as well.

9 And in this particular case, the
10 bridge crew on the ship were the ones that were
11 providing the situational awareness and the
12 lookout as well for the vessel. So they would
13 always -- they'd keep it in line of sight so they
14 knew where it was. It has an AIS on board, so
15 you can track it electronically.

16 And other vessels have that awareness
17 too with the AIS. But anytime there was a
18 potential traffic situation, the bridge crew
19 would get on the radio and try to hail the other
20 vessel as well as relaying back to the operator
21 back in the vessel's plot room as to stop it or
22 have it alter course to 90 degrees, or whatever

1 the case may be, to help avoid with that vessel
2 type of situation.

3 So we think we could get that
4 potentially down to three people perhaps. And
5 that would be just one watchstander who maybe
6 could do both functions once they had enough
7 skill and experience and training in the systems
8 they needed to. But again, at least in this
9 particular case on this crew is that we at least
10 needed those resources to maintain the
11 situational awareness for the vessel and avoid
12 any kind of situation.

13 And again, just some more photos of
14 the operation here. So not too much of a -- or I
15 wouldn't say too much of a challenge, but it was
16 reasonable to accomplish when you had a very nice
17 sea state and calm conditions, as you see in
18 these couple of photos here.

19 And again, some more recovery. So in
20 this case, there's a belly pack that the operator
21 has that when you bring the ship to a stop and
22 then you go down and take over control of the

1 vehicle from the deck right there. As you bring
2 it in, your deck crew, in this case, tries to get
3 the whip from the crane down to the cradle on the
4 vehicle as you're bringing it alongside, and then
5 you make the recovery.

6 And as you can see here, there's quite
7 a number of folks on deck -- about five or six in
8 this particular case -- on a good day to --
9 again, if we were adapting the ship's
10 capabilities along with what we had to try to
11 make it work, there are particular dedicated
12 launch and recovery systems that are made for
13 these that might that a bit easier. But again,
14 the challenge of getting in and out of the water,
15 even on a good day, was tough.

16 And then this was, I think, about the
17 best -- the highest sea state that we could hope
18 to operate that vehicle with this particular
19 crew. Again, because of the launch recovery, the
20 data we got from the vessel was just fine in
21 these conditions and was good as we would've
22 gotten on one of our boats.

1 But in this case, you can kind of see
2 in the lower right-hand corner, as it's rocking
3 back and forth up against the hull of the Nancy
4 Foster. And they're trying, again, get the hook
5 to the cradle and get it on board, it became a
6 particular challenge. And I think we banged up a
7 couple of antennas on the vehicle in that
8 particular case there.

9 And you've got a tender as well. You
10 can see the rib there with the coxswain and folks
11 in the boat, just ensuring everything goes well.
12 And just highlighting one of the challenges, they
13 then brought that boat back on board the ship
14 with a little bit less challenges because you
15 have folks on board that are able to do that. So
16 one of the challenges and obstacles to be further
17 developed and overcome in operating these
18 systems.

19 So some of the key findings from this
20 particular mission, which I've touched on, again,
21 the launch and recovery is a challenge. A lot of
22 these, whether it's AUVs or USVs, do have

1 dedicated and well-developed launch and recovery
2 systems that you can deploy; that can be, again,
3 if you're on a vessel of opportunity, integrating
4 those with the vessel that you have can be a
5 challenge versus having a fixed installation on a
6 dedicated ship.

7 Staffing in this particular case, so
8 we were just getting started and it's new. But
9 it was, in this case, consistent with a manned
10 survey launch, and it can certainly require new
11 skill sets from what we're typically used to
12 having.

13 The autonomy and situational awareness
14 is somewhat rudimentary and certainly a point
15 open for discussion -- I think, a good, lively
16 discussion. But in this case, required
17 supervision from a manned platform and that
18 ability to take over, as needed.

19 And then communications, I should
20 touch on. The one slide I didn't mention. So we
21 were limited not only because of the lookout and
22 the visual lookout that we wanted to maintain for

1 the vessel, but also to be able to do the sonar
2 operation and even potentially recover --
3 retrieve the data from the vehicle.

4 It requires a very high bandwidth
5 communications, and those are very much range
6 limited. In this case, I think the max was about
7 seven or eight kilometers that they could
8 operate, so not even close to over the horizon in
9 this particular case. And so we need to further
10 develop that technology to further enable these
11 systems.

12 So we had last summer as well -- and
13 the key point here, as I've mentioned, whether
14 through ASV Global, we also have some of our
15 contract survey partners who had began to employ
16 unmanned systems in their work. And this was
17 from a survey done by TerraSond last summer up in
18 Etolin Strait and Nunavik Island and kind of the
19 northeast reaches of the Bering Sea last summer.

20 And they utilize an ASV Global system
21 in kind of the same way that it was done on the
22 NOAA Ship Nancy Foster was. We call it kind of a

1 mother duck and baby duck configuration. So
2 basically, we were able to get another platform
3 in the water and double their data acquisition on
4 many days and really get a lot more effect in
5 this and bang for their buck.

6 This is a video. I don't know how to
7 run the video from -- if there's a way, if you
8 can just click on the -- do you have the master?
9 No?

10 PARTICIPANT: Sorry, we don't have the
11 video.

12 CAPT VAN DEN AMEELE: Okay. It was
13 embedded in the slide. If you just click on the
14 image, it might play. If that doesn't work,
15 that's fine. There you go, yes.

16 So you can see the TerraSond's main
17 survey vessel in the background there near the
18 horizon as they operated the C-Worker from afar,
19 I believe, in very much the same sort of
20 operational scenarios we did on the Nancy Foster.
21 In this particular one, which we did not have,
22 but I believe this one also had a winch on board

1 it, which they used to tow a side scan sonar as
2 part of their survey operations.

3 And I think the one thing that we were
4 told was that this certainly wasn't anywhere the
5 limit of the sea state that the vessel could
6 operate in. But it was close in limit of what
7 the drone that they used to capture the aerial
8 footage could handle on that particular day.

9 And again, we're trying to advance
10 this technology. Certainly, nowhere near on our
11 own, but as I showed, through our commercial
12 partners, through our contract partners, as well
13 as our academic partners. And I know that I
14 don't want to -- you'll certainly see a lot more
15 of this over the next couple of days from UNH,
16 from CCOM, and JHC here as well as on the water
17 vessel demonstration. So I'm very much looking
18 forward to that myself.

19 So we're working, obviously, as close
20 as we can with our partners here at UNH. And
21 more recently, we have a new grant with the
22 University of Southern Mississippi, their School

1 of Hydrographic Science. And they're going to be
2 performing some work with us as well,
3 particularly on the unmanned surface vessels as
4 well. So we work very closely with our
5 industrial, contract, and academic partners in
6 helping to advance our goals here and our
7 strategy.

8 But can it work everywhere? There's
9 some places where this just might not be the best
10 took for the job. And you look at a busy port
11 like this where there's a lot of traffic going in
12 and out, and I'd mentioned on one of the first
13 slides how the port areas with minimal under-keel
14 clearance are one of our focus areas. But
15 applying that technology in an area like this is
16 certainly challenging. So obviously, you have to
17 pick and choose where it's the best took for the
18 job.

19 And one thing that we track and look
20 to -- three minutes, okay, thank you -- is the
21 state of autonomy. And as I mentioned before,
22 certainly, I think we have some pretty good

1 discussions on where we are on the spectrum.

2 But just briefly, the way we look at
3 the state of technology is on a five-scale level
4 where Level 1 is just basic remote piloting.
5 There's an operator who's remotely operating the
6 vessel at all times, and they've got their eye on
7 it.

8 To Level 2, which is basic autonomy,
9 which is essentially executing a preprogrammed
10 mission.

11 So you have a set of lines and
12 waypoints and things that you need to do. And
13 the vehicle goes out and executes it as its
14 preplanned but doesn't really respond or react
15 very much to things it encounters along the way,
16 which is the intermediate stages of autonomy.

17 To something that could be as simple
18 being chart aware, so it knows where obstructions
19 are and the shoreline and things that it
20 shouldn't hit and it can avoid those.

21 To perhaps reacting to changes in the
22 environment, whether it's the thermocline in the

1 water column or a shoaling that wasn't unexpected
2 or some things like that, or other vessel traffic
3 in the area, that it knows how to properly avoid.

4 To the Level 5 is the full state of
5 autonomy where you can just say, here's an area
6 that I need worked on or data collected in, and
7 here's some parameters that we have. And the
8 intelligence goes out and figures out the most
9 effective way to execute that mission while
10 avoiding and adapting to things it encounters in
11 the environment.

12 So to wrap up, some of our key
13 findings that helped drive our strategy moving
14 forward is that unmanned systems require the
15 development of new technologies. And what I mean
16 by that is not just the autonomy and the ability
17 to go out and maneuver autonomously. But it's
18 some of the things like the high bandwidth
19 communications that you need to be able to both
20 monitor your vessels as well as even get the data
21 off, for example.

22 So for a vehicle that has an endurance

1 of five days, you don't want to wait five days to
2 get your high resolution water column plus
3 bathymetry off of that. You want it as quickly
4 as possible to ensure the effectiveness of your
5 mission. But that's voluminous data that
6 requires very high bandwidth communications just
7 to even extract the data from the vehicle.

8 Unmanned systems, we must provide new
9 capabilities or new mission profiles so they're
10 not a one-for-one replacement, per se, of typical
11 traditional missions on manned boats or ships.

12 They require skilled personnel to
13 operate and maintain. So as I mentioned, this is
14 kind of a new skill set, being able to know the
15 best way to operate these vessels, to maintain
16 them, to have that engineering support for them.
17 It requires a development of new human resource
18 capability.

19 And they do not diminish the need for
20 ships. So that question comes up very
21 frequently, particularly as we look at fleet
22 recapitalization and need more money to build new

1 ships. It doesn't necessarily replace the need
2 for heavy steel. They expand your mission
3 profile, but they don't necessarily replace any
4 kind of capability.

5 And they require unique in-board
6 infrastructure. So you need the deck space,
7 obviously, to be able to launch and recover them.
8 You need someplace to house them on board the
9 ship where you can maintain them and take them
10 apart and fix them and things like that. And
11 some of these, as you saw, can be very large. So
12 you need that kind of space on board the ship and
13 facilities to be able to do that.

14 And again, they're not fully
15 autonomous, as we would say, where they can go
16 out and think for themselves or react. They
17 still require some level of supervision or
18 monitoring as they execute their missions.

19 So based on that, our unmanned systems
20 strategy, kind of four key points that were in
21 the documents that we distributed. The first one
22 was to continue the development of the technology

1 and processes that enable manned operations and
2 support -- I should say unmanned operations and
3 unmanned systems.

4 So again, as I mentioned, that's the
5 high bandwidth radios. It's the automated data
6 acquisition, the automated processing of things
7 that are beyond the autonomy but that enable the
8 unmanned systems.

9 The next thing that we're going to do,
10 particularly in the Office of Coast Surveys, is
11 the standup and operational unit with expertise
12 in unmanned systems, and the key word I focus on
13 there is "operational".

14 So this won't be developing the art or
15 the technology. This will be a group of folks
16 with a speed of unmanned systems that are
17 available to go perform mapping missions to
18 support NOAA's operational requirements, whether
19 it'd be hydrographic surveys or some of the more
20 broad interdisciplinary ocean mapping
21 requirements that I had mentioned.

22 Obviously, we'll continue to

1 collaborate with academic and industrial partners
2 on developing the technology. That's why we're
3 all here today or one of the many reasons.

4 And finally, one specific thing that
5 we're going to do is to -- hopefully, we'll have
6 an award this week, I hope, as to contract for
7 the conversion of, hopefully, two NOAA survey
8 launches to what we're calling a dual mode or an
9 optionally manned capability.

10 So this is essentially taking the
11 brains of an unmanned surface vehicle and putting
12 it on board one of our traditionally manned
13 hydrographic survey launches and then being able
14 to operate it in a manned mode or an unmanned
15 mode or maybe somewhere in between, both as the
16 requirements of the mission dictate.

17 You might need to work in a tricky
18 area in the morning, so you've got people on
19 board who can monitor it. But then your
20 afternoon requirement might be offshore, so you
21 might not need that. But it also enables us to
22 help develop the state of the technology while

1 having somebody on board to hit the big red stop
2 button when things aren't going well. So we look
3 forward to doing that and continuing to advance
4 the technology that way.

5 So briefly, some of the -- I think
6 I'll stop here, yes. I'll think I'll stop here.

7 (Laughter.)

8 CAPT VAN DEN AMEELE: I've got a
9 couple extra slides, but --

10 MEMBER LOCKHART: If we have time, we
11 can go back.

12 CAPT VAN DEN AMEELE: Yes, thank you,
13 Carol.

14 MEMBER LOCKHART: Thanks very much,
15 E.J.

16 I'm going to hand right over to
17 Thomas. But before I do -- yes, you can take
18 those, feel free, get yourself ready -- I was
19 asked to say -- we're going to hold questions to
20 the end, by the way, so we can have more of a
21 panel discussion.

22 We have a green laser pointer, and as

1 a green laser expert, I was asked to mention that
2 these things are extremely powerful. So when you
3 are switching it on, make sure it is pointing at
4 the screen, and do not switch it on and point it
5 around the room. Thank you very much.

6 Thomas?

7 MR. CHANCE: Okay. Am I turned on?
8 The mic works? All right, great.

9 So I'm Thomas Chance. I'm president
10 and CEO of ASV Global. It's great to be here
11 today, great to be in front of the Hydrographic
12 Service Review Panel. I've seen you all since,
13 what, before you existed. And now you're here,
14 and you've been doing stuff for many years.

15 And of course, to be here, to be able
16 to see the UNH program that Larry stood up many
17 years ago and is doing fabulous. And I will tell
18 you, Larry, and I will tell you all here, and for
19 the people from Washington D.C. representing the
20 Hill, that the group at UNH is not only number
21 one in New Hampshire, it's number one in the
22 United States. It's, by far, number one in the

1 world.

2 These guys are like head and shoulders
3 over everybody else. And the work that NOAA has
4 done with UNH is just really stellar and that you
5 really lead the world in so many ways. So the
6 synergies are just fabulous.

7 So it's great to be here, and I'll
8 jump right into it. Of course, my background, I
9 had a survey company, Hydrographic Survey, and we
10 had done a lot of work for NOAA doing
11 hydrographic surveys and a lot of oil and gas
12 survey work.

13 A lot of AUV work, autonomous
14 underwater vehicles, I had done that for 15, 18
15 years. Did about 500,000 kilometers of AUV work,
16 which is, according to the Navy, more than
17 they've done. So I'm really covered with scars
18 because I've been in the unmanned business
19 forever and ever, right?

20 So I sold that company, C&C
21 Technologies, back in 2015. But back in 2010, I
22 had started unmanned surface vehicles. So we

1 went from autonomous underwater vehicles to
2 autonomous surface vehicles.

3 A lot of advantages when you start
4 talking about getting on the surface with an
5 unmanned boat. Now, you can have bigger
6 payloads. You can have more energy sources. You
7 can have coms. You can have GPS. You can things
8 like air, so you can have diesel engines running.
9 You don't rely on batteries and things. So the
10 opportunities really grow.

11 So if you go to the next slide -- oh,
12 I've got the button? I'm sorry. Try that. If
13 you go to the next slide, Thomas.

14 (Laughter.)

15 MR. CHANCE: So ASV Global designs,
16 builds, sells, leases, and supports autonomous
17 surface vehicles. So kind of the full nine
18 yards, make it easy for the users, and like I
19 said, founded the company in about 2010. We have
20 about 110 people now. It's a U.S.-owned company.
21 I have an office in Louisiana where our
22 headquarters is and then an office in the UK.

1 Most of our work has been for the
2 defense industry, but we have done a huge amount
3 for the commercial industry as well. We do
4 unmanned boats. We do optionally unmanned boats
5 -- as E.J. had just mentioned and talked about --
6 where you have somebody on, if you want somebody
7 on, or you can take the person off and let the
8 boat run by itself. And conversions of existing
9 boats to optionally unmanned, so I'll talk about
10 all of these things.

11 We've delivered over 90 boats. In
12 fact, we're on Hull No. 94 right now, which is
13 for an actively propelled unmanned surface boat.
14 It's probably ten times more than our competitor.
15 And we've done boats up to about 42 feet in
16 length right now. And most of them are powered
17 by diesel, although we've done some electric and
18 things like that.

19 We're operating in a supervised
20 autonomous mode. I think it's an analogy, as you
21 look at the driverless cars, all the driverless
22 cars have drivers, right? So all the driverless

1 cars have a steering wheel and a driver's seat.

2 And at some point, you won't have
3 somebody in that driver seat. But for now, we're
4 not ready to throw the kids in the backseat and
5 have nobody at the steering wheel and have the
6 car drive down the highway at 70 miles an hour.
7 The world is not ready for that.

8 And I think that analogy is the same
9 for the unmanned surface boat industry is that
10 it's actually a lot more rational to think about
11 going into open ocean at five knots in a 20-foot
12 boat when you can see that there's nobody around
13 for a long way. So I think it's a lot easier to
14 try to make that work in the unmanned surface
15 boat area. And I'll talk more about that in a
16 bit here.

17 And we've done work not only over
18 where we monitor the boats over a radio link, but
19 we also monitor them over satellite links and
20 have done several projects where customers have
21 been on the other side of the world and over a
22 satellite link, we're watching it for them or

1 else they pick it up and watch.

2 I've done a lot on the payloads. Of
3 course, it doesn't help to have an unmanned boat
4 unless you have the payload actually doing the
5 work, right? People don't want an unmanned boat
6 for the sake of having an unmanned boat. They're
7 trying to get something done, right? So we've
8 done a lot of work with the payload integration,
9 integrated more than 30 different payload types.

10 Launch and retrieval too, and E.J.
11 talked about that a little bit, is equally as
12 important as a force multiplier. If you can't
13 get the thing on and off your big ship, you don't
14 need it. So you have to take that into account.

15 And collision avoidance, we've done a
16 lot of work on collision avoidance. We've done a
17 lot of work in the military side with collision
18 avoidance. And on the commercial side, we have
19 very limited rollout of our collision avoidance
20 software, but we've done a ton of work in that,
21 everything. But we got 25 programmers just
22 working on that. So our objective, from a

1 collision avoidance standpoint, is going 30 knots
2 at a moderately cluttered environment operating
3 under the COLREG rules.

4 So we've done a lot on that. And now,
5 the boat that you all had did not have that.
6 Frankly, most of the boats that we have, we don't
7 have our collision avoidance on because it's not
8 publically released yet. So we need to be
9 working on that too. Okay.

10 So these are some of the boats that we
11 have put together from the small to large. And
12 so you'll see C-Stat, the numbers after it, that
13 indicates the length in meters, right? I'm very
14 conscious of this screen pointer guy. So I'll
15 talk a little bit about these different boats,
16 more on some than the others.

17 So we're also, as I mentioned, doing
18 a lot in the military. Some of these bigger
19 boats, just like 1,000 horsepower boats that are
20 pulling big sonars, synthetic aperture sonars,
21 and whatnot.

22 So in addition to commercial and

1 military boats and conversion of existing boats,
2 we do quite a bit. You can see here this is a
3 Canadian Hydrographic Service survey launch.
4 We're just completing the conversion of one of
5 their vessels right now so they can operate it in
6 an optionally manned mode.

7 So there's basically a little button
8 on the boat on the bridge. So you push the
9 button. You're in unmanned mode, and you flip it
10 the other way and then you're back to manned.

11 So if they have a mission where they
12 want people on the boat -- they're going to pick
13 up something that's floating in the water and
14 they want people on the boat -- they put people
15 on the boat and go. Or if they say, hey, look,
16 we're going to just run parallel to the mother
17 ship for the next few weeks, so we can just watch
18 this thing from afar. So they flip that button
19 and then off it goes.

20 So what you have on the unmanned boat
21 end is an electronics package. It's actually a
22 bit more than that. It's not terrible, but it is

1 a bit more than that. And so this interfaces
2 with all the aspects of the boat, and it doesn't
3 matter if it's a new boat. It may be a boat we
4 built. It may be a boat somebody else built.

5 We interface that in to the CAN bus on
6 an operating system in this boat. And we've got
7 it set up where we can control if somebody has
8 somebody has jet drives or somebody has dual
9 direct propulsion or single drives or outboards
10 or two outboards. I mean, it's like 16 different
11 propulsion combinations that we've set up for so
12 it's highly flexible.

13 And then on your remote supervision
14 end, you have basically an electronic chart where
15 you see the boat and you see other boats in the
16 area picked up by AIS or radar overlay on it.
17 And this is what you see, a radar overlay over an
18 electronic chart. Thank NOAA for that. And then
19 you have some different boats, depending on what
20 we put on a boat.

21 In this one, you're looking at the
22 picture that comes off the boat. And here, they

1 have fore, aft, port, starboard cameras. In
2 other situations, we have this ring of cameras
3 where you have both daylight and thermal cameras
4 looking 360 and getting that data back. And then
5 you have a lot of line functions that you can run
6 to the boat.

7 So at the same time, the survey
8 operations, whether it be for multibeam -- in
9 other words, the NOAA fuel guys, they're running
10 with multibeam and side scan sonar, and they were
11 using HYPACK or whatever. I mean, they're used
12 to those instruments. They're used to running
13 those instruments, and so we don't want to have a
14 set up where they have to learn new instruments,
15 right?

16 So when they're running those
17 multibeam sonars or they're watching those
18 multibeam sonars, it's just like if they were on
19 that boat. It's the same screen. Now, they're
20 on the mother ship, and they're looking at the
21 same screen. They calibrate the same way. They
22 run their multibeams the same way. They run

1 their side scans the same way, except they're on
2 the mother ship. They're not out there on the
3 launch.

4 And as I've mentioned, the belly pack,
5 this is so -- of course the boat will run by
6 itself. You give a program and set a launch, and
7 it'll run the pattern and all these kind of
8 things. And if it has collision avoidance, it'll
9 go around things. And we've been doing that for
10 three years.

11 But when you want to bring the boat
12 back to the mother ship and you're going to bring
13 it back on the back deck of the mother ship,
14 let's say. So then you take over by hand because
15 you know your brain works better than -- we won't
16 tell the computer guys this, but you all's brains
17 work much better than the computers do.

18 When you want to say, hey, look, we're
19 going to get that unmanned boat and we're going
20 to put it up on that boat trailer on the boat
21 ramp, it's easier to just do something like this.
22 This is the Governor of Mississippi, by the way,

1 Phil Bryant.

2 And then there's optional items that
3 you have to think about. Well, do we want a boat
4 trailer or do we want a cradle? Do we want a
5 launch and retrieval system? All those kind of
6 things. Do we want a lot of collision avoidance
7 software or support when camera systems are
8 minimal? Do we want help on payload integration?
9 Do we want fuel support? Do we want an
10 articulating ram that'll lower and raise a
11 transducer? Do we want an A-frame off the stern?

12 This is one of the smaller boats.
13 This is a C-Stat for stationary. So it's, like,
14 eight-foot long, a 2.4-meter. So it just holds
15 its position for several days, kind of, like --
16 it's, like, a buoy. Not really pertinent to this
17 a whole lot, though.

18 This is a C-Cat 3. This is an all-
19 electric vehicle right here, and we had built a
20 C-Cat 2 and decided, with the lesson we learned
21 from the C-Cat 2, a catamaran, we came up with a
22 C-Cat 3.

1 And you get a little bit bigger
2 vehicles. Now, this is the one that UNH has.
3 This is a C-Worker 4. It's a jet drive, not a
4 dual drive. It's a single jet drive. And you'll
5 see that hopefully in the next -- tomorrow maybe;
6 is that right? So they're doing development work
7 with that. And so it's great for our technical
8 people that work with the technical people here
9 at UNH on that program.

10 A C-Cat 4, it's a little bit bigger
11 catamaran. This is one that we sold to the
12 Japanese. C-Worker 5, E.J. had showed you all
13 several slides of the C-Worker 5.

14 We went back up to TerraSond this
15 year. Last year, we were doing -- you see towed
16 side scan here. So you had multibeam and towed
17 side scan last year. This year, it was primarily
18 multibeam work only.

19 This year, they did 4,700 kilometers
20 of multibeam work next to a mother ship. So the
21 mother ship was a 105-foot mother ship. And the
22 TerraSond people would put the unmanned boat in,

1 and they would run the parallel survey lines.

2 And actually a boat like this -- we've got four
3 of them like that right now -- it did more than
4 the mother ship. Fifty-three percent of the
5 survey was done by the unmanned boat. And in
6 that case, we had two ASV people out there just
7 to help in case there were any kind of issues.

8 Of course, this is an area -- they
9 were working in Alaska again, so it's not like
10 you're working in, like, a hugely congested,
11 dangerous area. I mean, I think that everybody
12 in this room understands that what we need to do
13 is start off and be pragmatic about what we're
14 doing. But that said, we've worked in some very
15 congested areas. And if you're working in
16 congested areas, whether it's a manned boat or an
17 unmanned boat, it just takes a lot of attention
18 so you don't get yourself in trouble.

19 C-Worker 6 is a bit different. It
20 looks the same. It's another one of those yellow
21 boats, but this one has dual diesel generators
22 and an electric propulsion system. The payload

1 is set up with a one-meter by one-and-a-half-
2 meter moon pool, a hole all the way through the
3 boat where you put a variety of payloads in
4 there.

5 The other boats that I've shown you,
6 like the C-Worker 5 on the previous slide, is set
7 up with a hatch here where you drop -- we
8 basically have a 19-inch rack thing. So most of
9 that equipment, the survey equipment, is all
10 rack-mounted.

11 So all that survey equipment goes in
12 there, and it's an air conditioned area, which
13 you probably don't need in Alaska. But most
14 other areas of the world, you really do. You
15 don't want to underestimate how hot the
16 electronics get and it fails, and Murphy's Law
17 just can't wait for you to not put an air
18 conditioner in there. So it can knock you on
19 your tail.

20 But people look at this, and they say,
21 man, this is almost like you invented a pickup
22 truck. In fact, you can put all kind of

1 different things in this payload, and sure
2 enough. And I've been in the maritime sensor
3 business for my whole life, since I was 17 when I
4 started surveying. And it's just amazing the
5 number of things that people come up and say,
6 hey, we can use this unmanned boat for this. Oh,
7 we can use this unmanned boat. And it's like,
8 yes, I guess. I mean, you get power and coms
9 from the boat and off you go.

10 And then this is a C-Worker 7. It's
11 a little bit bigger version. The payload in it
12 is two-and-a-half meters by a meter. So we've
13 done several. I'd say we've done two of these.
14 I mean, some of these boats, we've done four and
15 five of, and others, we've just done one.

16 C-Worker 8, we've actually done eight.
17 Eight of these boats, we sold to a company in
18 Europe. They have a bunch of unmanned underwater
19 vehicles. They bought eight. There's too many
20 acronyms there. It's AUVs, right? And they
21 bought eight AUVs, and so they bought eight boats
22 from us. They only show six in this picture

1 because they went from six to eight.

2 And these boats acoustically
3 communicate and position the AUVs and then relay
4 that data back to the mother ship. And so then
5 this is the real one. So it's amazing how we
6 went from what was supposed to be to what it
7 actually is. And you can see one of our boats
8 there. And that's a dual diesel direct drive
9 vessel.

10 You can see here these cone things.
11 This is to help on the launch and retrieval. So
12 because you don't have anybody on this boat,
13 right? This is a totally unmanned boat. It's
14 not optionally manned. So we have it set up so
15 when you come to retrieve it from the mother
16 ship, you have this, like, a boat hook. And you
17 can shove this -- it's a bullet-type shaped
18 system in on your launch and retrieval. And it
19 goes right in there, snaps in on the bow and
20 stern, so you can lift it up and put it on the
21 mother ship.

22 C-Worker 12 is a 40-foot boat. We've

1 launched one like this just a few weeks ago.

2 This is a boat that'll go about a quarter of the
3 way around the world. It'll go about four or
4 five knots, and then if you really gun it, you
5 can't go that far, but it'll go about nine knots.

6 You see it here with a multibeam
7 transducer, this is something that when you start
8 doing things unmanned, it makes things a lot
9 simpler. Okay? I mean, it's like a big boat.
10 This is a 40-foot boat, but we're talking to
11 people right now about 100-foot boats, 180-foot
12 boats.

13 And if you make them totally unmanned,
14 then you don't need the bunk space, and you don't
15 need the heads, and you don't need the gallery,
16 and you don't need the refrigerator, and you
17 don't need the stove and washing machines and all
18 the things that break and the hot water heaters.
19 So this boat right here is basically diesel
20 tanks, two diesel engines, and some computers.

21 Now, we've made it optionally manned
22 just a little bit. All of the back port of this

1 boat is open deck to put payload. You can take
2 4,000 pounds of payload on this boat. But here,
3 you can put a couple of people, or you can put a
4 few people on to test stuff out, right? We're
5 going to try to launch these big things or pick
6 up these big things and see.

7 And you can see two sat-domes on it,
8 different frequencies and different sat-domes,
9 and then you can have a tertiary sat-dome. So
10 now, we're really talking about operating long
11 periods away from the mother ship, totally
12 independent. Not as a force multiplier but
13 really as an independent boat.

14 So like I said earlier, we've done
15 several projects like this, but this is, like,
16 seriously doing it. And here's an image with a
17 bigger transducer. So when you talk about mid-
18 frequency multibeam, certainly high frequency
19 multibeam, you can do off of this and certain
20 mid-frequency multibeam and just go for a month
21 or so.

22 This is a C-Enduro. It's an energy

1 harvesting type vessel. So we use and take
2 advantage of solar panels, wind, and we do also
3 have a baby diesel generator in there. So when
4 mother nature doesn't cooperate -- like the sun
5 is not shining and whatever else, wind is not
6 blowing, waves aren't moving -- then we still
7 need to get our job done.

8 But the endurance on this, you're
9 talking about 30 days. But it's with minimum
10 power for your payload. And realistically, if
11 you're a 50-watt payload, that's okay. But you
12 can't do a whole lot with it. But we've made
13 three. We're building a fourth one right now.

14 Operated payloads, we've done a
15 variety of payloads. Like, multibeam echo
16 sounders, obviously, that's something of interest
17 to NOAA. Kongsberg EM2040, RESON systems,
18 multiple RESON, R2Sonic, Teledyne, EdgeTech,
19 NORBIT, we've done those. I mean, every high
20 frequency multibeam system, we've had on our
21 boats, one way or the other, for multiple times,
22 multiple missions. We've done towed side scan

1 sonars at EdgeTech 4200, both the stainless steel
2 and aluminum versions, the EdgeTech towed side
3 scan and the Tritech.

4 So certainly, I mean, lots of other
5 things that some of them are not really pertinent
6 to the group here. Mid-frequency multibeam is
7 something that we've got repeat -- a lot of
8 interest in. Next, in the coming weeks, we're
9 going to be putting a big, ginormous compressor
10 in for Shell Oil in one of our boats -- in the
11 bigger -- in the 40-foot boat to go do some
12 seismic test.

13 So it's just mind boggling to think.
14 I mean, I didn't think I would ever -- nobody
15 would've said -- if somebody would've said,
16 Thomas, you're going to talk about putting a
17 seismic compressor in an unmanned survey boat. I
18 would've said, yes, right, sure, yes, you're
19 crazy. But it's here. Okay.

20 So the summary, so ASV has repeatedly
21 demonstrated benefits in hydrography and
22 substantial production increases. And let me

1 just reiterate. You see a company like
2 TerraSond. Now, TerraSond doesn't own any --
3 it's a survey company contracted to NOAA to help
4 them do some work. Okay? They own some boats,
5 but they don't own a fleet of boats. Okay?

6 So they have a choice, right? They
7 have a choice of, we're going to go do this job
8 with an unmanned boat, or we're going to use our
9 own boat, or we're going to rent another boat,
10 right? So they, hands down, boom. This is the
11 third year in a row they do it.

12 They say they can -- this is a lump
13 sum job for them. As a commercial entity, they
14 want to do it as quick as they can and get the
15 best data possible. Okay? So they're
16 continuously coming back and saying, we want to
17 do it with an unmanned boat because we can do it
18 so much more efficiently.

19 If you have a manned launch out there
20 -- and I've lived it, right? We had eight ships
21 up to 250 feet long. We go out there, and not
22 for NOAA but for other customers, we try to put a

1 launch in the water -- a manned launch. And NOAA
2 has to do this all the time. You have a big ship
3 with manned launches. But it's a little rough,
4 so you don't want to put somebody out there
5 because you may not be able to get them back on
6 the boat.

7 So we're about to put them out there.
8 Finally, the weather has calmed down, but we
9 think the weather is going to get bad again, so
10 we can't put -- we've had 250-foot boats sitting
11 for six days waiting to put the launch in so we
12 can get the nearshore work done. It's, like,
13 hugely inefficient. And of course, at night, you
14 don't want them out there at night. So it's
15 starting to get dark. You all better come in.

16 So now when you go unmanned, you're
17 not worried about killing people. You're not
18 worrying. You can run it 24-7. You can run it
19 closer to where you wouldn't run a manned boat
20 because you're afraid of crashing and hitting
21 rocks and that kind of stuff.

22 So there's huge financial drivers on

1 all of this stuff. So it's exciting to be here,
2 exciting to be in the unmanned boat business
3 right now. So a lot of production increases. A
4 lot of safety increases.

5 Until autonomy is perfected, ASVs must
6 be supervised. You want somebody watching this,
7 especially if it's in a very congested area. You
8 want somebody watching it while you're running it
9 for now.

10 It will certainly require some
11 training and including some onboard training.
12 Just like I mentioned, we have two of our guys on
13 the TerraSond project. We have a project running
14 in Egypt off the Nile Delta right now, all kind
15 of sensors on it. We have a couple of people out
16 there.

17 You can't eliminate the ships and
18 personnel. This is exactly what E.J. was saying.
19 NOAA still needs big boats and people. For as
20 long as we can think, they're going to need that.
21 You're not really replacing. You're augmenting
22 and you're dramatically increasing production.

1 So you must account for the launch and
2 retrieval systems, spares, upgrades, CTDs. And
3 if you're collecting multibeam data and you don't
4 get the water velocity profile stuff, you're
5 wasting your time. So you have to have that on
6 the unmanned boat as well.

7 So the three takeaways, I think if you
8 take away anything from what I'm saying here
9 today, is something like this. I mean, I'm
10 showing our stuff, and I apologize. I know this
11 looks really like an advertisement, and I
12 apologize because I don't have slides on other
13 people's stuff. And frankly, there's not a lot
14 of other stuff out there, right?

15 But the C-Worker 5 is a great
16 hydrographic survey multiplier. We've seen that
17 time and time again. That's a second generation
18 boat. We've built four like that, and then we
19 already know what we're going to do to make the
20 next one better.

21 The second thing I would say is that
22 the 40-foot boat, it's an Over-the-Horizon survey

1 vessel, ideal for working away from the mother
2 ship.

3 And the third thing I'd say is that
4 you take the existing NOAA launches and you
5 upgrade them to optionally unmanned. That's like
6 an open court lay-up. This is, like, that should
7 be done.

8 So I think that's all I have.

9 MEMBER LOCKHART: Thanks very much,
10 Thomas. We're going to move right into Doug.

11 MR. LOCKHART: Can you hear me all
12 right? Sounds like it. Since I came over here,
13 my wife ran off.

14 (Laughter.)

15 MR. LOCKHART: Fairly typical.

16 So my name is Doug Lockhart. I'm with
17 Teledyne Technologies. I'm currently working
18 with Teledyne CARIS up in Canada.

19 I joined Teledyne about, I guess,
20 eight years ago or so. And every quarter with
21 Teledyne, I go to Thousand Oaks, and I sit
22 through a three-day quarterly review where we

1 talk about all the technology in the company and
2 how it's being deployed and what it is.

3 And in that -- what is that --
4 somewhere around 24 three-day meetings of this, I
5 still cannot adequately describe the breadth and
6 width and depth of Teledyne Technologies in the
7 pieces of stuff they have. And I found trying to
8 give a sort of broad brush presentation of what
9 Teledyne does, pretty unsatisfactory for the
10 people I'm talking to.

11 Trying to drill down into some of
12 those technology pieces works a little better,
13 but for this group, I've decided instead to try
14 to look at sort of the business case for autonomy
15 rather than specific technology pieces and try to
16 understand how we can evaluate when a technology
17 is ready for us, what it's going to do for us,
18 almost in a businesslike sense.

19 I worked for Ed Saade for a number of
20 years, and he had -- in his boardroom or his
21 conference room -- a little piece of paper taped
22 to the wall that said, revenue is vanity, profit

1 is sanity, and cash flow is reality. And that
2 distills the business down to its utter core.

3 And I was trying to produce something
4 like that here, and this is sort of evidence of
5 how, utterly, I failed at that. But at least it
6 may give you some ideas of how we might look at
7 this stuff.

8 Also, you'll find that large fonts are
9 pretty inexpensive in Canada right now, so I've
10 used a lot of them.

11 (Laughter.)

12 MR. LOCKHART: But we're going to look
13 at some autonomy levels. Thank you, E.J., for
14 starting that off. We'll take a quick look at
15 that. Technical readiness, I know a lot of you
16 are familiar with TRL, but we need to kind of
17 understand that. Risk and efficiency or
18 productivity are things that we need to
19 understand, and then finally, cost.

20 And we'll try to put together a
21 baseline for how we can sort of manage what
22 system is preferable to another system and how we

1 can gauge or understand when to deploy a certain
2 suite of equipment.

3 So this is what E.J. was talking
4 about. This had been all set up for the
5 automobile industry, these levels of autonomy.
6 So over here on the far left at Level 0, it's you
7 and your old Ford with the stick shift and the
8 clutch and no power steering. And on the far
9 right over here, Level 5, you just tell that
10 thing to go anywhere in the world and it goes
11 there. It doesn't need to really even know the
12 road. This is serious, figure out on the fly
13 autonomy. And then there's everything sort of in
14 between.

15 When we move to hydrography, the
16 situation gets a little more complicated. We
17 think we're riding around on the surface on the
18 water, but we're really riding on the seafloor.
19 That's our road. That's what we're trying to
20 map. We're not a conveyance anymore. We're
21 trying to put a sensor in position.

22 So all these things, all this

1 integration of sensor fusion starts to matter to
2 us. That has to feed directly into the autonomy.
3 On the surface, we have to avoid hazards and
4 avoid targets and stuff like that. But that's
5 how we look at boats because we're on boats
6 ourselves. So that's our primary perspective,
7 but that is not the primary goal of the
8 autonomous survey launch. The goal of that
9 vehicle is, get your sensor where you need it to
10 be in the most efficient manner possible.

11 So things like auto-tuning for survey
12 sensors, multiple data processing streams,
13 combined and operated, sensor fusion and data
14 fusion on the fly, those start to matter to us as
15 we get increasing levels of autonomy. And we'll
16 look at it later. I think we're kind of in here,
17 this Level 1 or Level 2 area right now. And you
18 guys have probably a better gauge of that. It
19 probably depends if it's your commercial or your
20 sort of military or defense operations.

21 And then technology readiness levels,
22 and Larry is probably familiar with this stuff

1 pretty well. Basic principles was sort of when
2 the light comes on all the way down here to
3 number nine. It's a cost product. You can buy
4 it shrink wrapped down at Best Buy or something
5 like that and all the way through.

6 There are some key points right in
7 here around five and six that technology
8 validated in a relevant environment and
9 demonstrated in a relative environment and
10 demonstrated in an operational environment.

11 We are operational, and there's a lot
12 of our technologies, things that we see as being
13 technologies that we could use for autonomy that
14 are way down here for vehicles and aircraft and
15 all kinds of other things that haven't been
16 demonstrated in our operational environment. So
17 from our perspective, those things are at TRL
18 Level 6 and not the TRL 9 that we kind of think
19 of them as because we see them out there in the
20 world all the time.

21 This matters because of this little
22 action here, this thing called the Valley of

1 Death. And it's something that we deal with all
2 the time as a technology business. As technology
3 evolves, it gets to a point where the research
4 funding push dies out and we start looking for a
5 commercial pull. And in something like the
6 automobile industry, that commercial pull is
7 huge.

8 In the hydrographic industry, it's a
9 lot smaller. That's why there's only one Thomas
10 Chance up here rather Ford and GM and Elon Musk
11 and all these other guys. There just is not that
12 much business to pull a lot of these technologies
13 we need across in a way that there is in the
14 automobile industry.

15 We have a few of these at Teledyne.
16 We have a way of collecting remote speed of sound
17 without casting a probe. We can do this
18 acoustically, and we have it at TRL Level 6.
19 We've taken it out. We've demonstrated it. It
20 works, and we cannot figure out how to get it
21 into the market space.

22 And there's all kinds of things that

1 are stalled out there like that, and that's
2 something I think this group needs to be aware
3 of. There's a possibility of pulling things
4 across this gap and to help ourselves out if we
5 can identify what stalled out, what's not getting
6 help from something else.

7 Risk is another thing, and Thomas
8 started talking about this. I think it's helpful
9 to look at automobiles first. We're all very
10 comfortable in automobiles. We drive them around
11 all the time. But they are, in fact, the
12 riskiest way we can use to get from one place to
13 another. If there was a riskier way to get
14 around, we would replace it with the automobile,
15 except for Carol on her motorcycle, and that's up
16 here.

17 (Laughter.)

18 MR. LOCKHART: But yes, there's a
19 significant amount of carnage every year on the
20 highways. And we can kind of look and see how
21 much there is out there with that.

22 So what the folks in the automobile

1 industry are doing, they're trying to move away
2 from that sort of high likelihood of failure
3 scenario. That's the whole pull. It's not that
4 driving is that hard. It's just that it's that
5 dangerous. So they're trying to make it less and
6 less likely to fail.

7 But the fact is there's still squishy
8 bodies in the car. So if there is an incident,
9 the severity of failure is always going to be
10 high. Automobiles are going to stay up at that
11 level as long as there's people in the car. If
12 something happens, it's bad.

13 For survey vessels, though, it's a
14 different story. The first thing that happened
15 with autonomous survey vessels is we took the
16 squishy people out of the car or out of the
17 vessel. That's great. It's a lot safer.

18 So this is exactly what Thomas was
19 talking about here. He's coming down this curve
20 on the bottom. So we immediately find a benefit
21 where we start taking people out of harm's way.
22 And this, in itself, is a pretty strong reason to

1 just start adopting this technology because we
2 are suddenly safer for what matters to us most.
3 If we can take people off the boat, put them on
4 the mother ship, or take them off the ships and
5 put them on shore, we've suddenly made things a
6 lot safer for ourselves.

7 So by the same token that an
8 automobile is up in the upper right-hand corner,
9 we have to assume that that's where our survey
10 launch is as well. It is the riskiest way that
11 we can collect hydrographic data simply by
12 definition. It's how we do it. If I just define
13 this new international symbol for a survey
14 launch, running on the rocks --

15 (Laughter.)

16 MR. LOCKHART: -- endangering a sea
17 serpent, an endangered species.

18 So the objective then is to move away
19 from that curve in one direction or another. And
20 we don't have a lot of examples out there that I
21 have access to. We have a number with Thomas'
22 stuff, but we have the APEX Argo floats. They're

1 an autonomous vessel of some sort. They're out
2 there drifting around, and we don't tell them
3 what to do. They just drift.

4 We can see what their life span and
5 what their risk is. They still have a high
6 likelihood of failure. They're designed to fail.
7 They're going to run up on the rocks somewhere,
8 but there's no cost really or no severity
9 involved when we do that.

10 We also have the gliders. They are a
11 little less likely to fail but still fairly low
12 risk. I wasn't really sure where to put ASVs on
13 here. I didn't want to stick anything over in
14 one of these red boxes. That just looks bad.
15 But I think an analysis like this is sort of
16 important when we look at this technology and try
17 to fully understand what we want to deploy and
18 what not to.

19 So now, on the cost side, I've come up
20 with, I guess, seven different scenarios here to
21 try and benchmark the relative productivity of
22 having a survey boat out doing survey work or a

1 survey boat and an autonomous vessel all the way
2 up to Option G down here where it's two
3 autonomous launches out there totally
4 unsupervised.

5 So the one-man launch, that's
6 typically how we go to work. But the most
7 prevalent way of doing anything with an
8 autonomous vessel right now requires a launch and
9 an ASV. So I've also benchmarked two manned
10 launches because that'll give us something to
11 scale with directly.

12 And you can see here, we're doing SVP
13 casts from the manned launch and eventually we
14 start doing them automatically from the remote
15 launch. And we have different numbers of
16 operators. Right here at Level C, you can see I
17 have three operators here now. So I think I'm
18 undercounting by one, what they're doing at
19 TerraSond.

20 And just for review, these are the
21 levels of autonomy. So if we go back here and
22 look, each of these say what levels of autonomy

1 we're expecting out of the surface vehicles, the
2 ASVs.

3 I had to define sort of a baseline
4 productivity. And so I figured 30 meters depth,
5 that's deep enough for any Panamax vessel. One
6 hundred and fifty degrees swath, that's the most
7 you can get out a commercial sonar right now
8 without doing a whole lot of jumping around.
9 Eight knots, if you go any faster than that,
10 you'll exceed your IHO Order 1, a long track
11 specification.

12 So I said a single launch surveying at
13 eight knots in an infinite straight line, you'll
14 get about 3.3 kilometers squared per hour. And
15 we'll just say that's 100 percent efficient.

16 In an actual survey, you have overlap,
17 you have turns, you have sound velocity casts.
18 You have a lot of stuff that's going to diminish
19 your efficiency. And then we have capital costs
20 of the various pieces that we have out there.

21 And I just kind of made this stuff up.
22 I bought a boat a few years ago. I figured

1 250,000 bucks for the boat, 300k for all the
2 survey gear you have: Manuals, sound velocity
3 probe, an automatic one that you don't have a to
4 touch.

5 Autonomy software, I figured every
6 time we move up a level, it's going to cost us an
7 extra 50,000 bucks for the software once we're
8 sort of at the coxswain level. These are fairly
9 granular, I admit, but I needed to start
10 somewhere. And then we have operational costs:
11 Fuel and maintenance, operators, surveyors. And
12 the technology lifespan I said was five years.
13 We have to have some period of time to measure
14 this over.

15 And down here, this table is a method
16 of trying to understand what the efficiency is as
17 we go up in autonomy level. As you go higher and
18 higher in autonomy level, you move closer and
19 closer to your 100 percent maximum speed. Your
20 coxswain isn't fooling around doing other stuff.
21 Frankly, I've been on boats where it'd be a
22 challenge to get this sort of performance here.

1 But as you get more and more autonomy, you have
2 less and less overlap. You're closer and closer
3 to your optimal speed.

4 HYPACK has a piece of software now
5 that does automatic line control or line
6 selection, and that probably fits in out in here.
7 And this helps work on your overlap that you're
8 calculating on every line, reducing that and
9 making you more efficient. So there are
10 technology pieces that are fitting in along there
11 as well. Five minutes? Okay. Thanks.

12 So as we do this, this is our single
13 boat scenario again. So one boat surveying by
14 itself. It looks like it's about 57 percent
15 efficient. When you go to two boats -- I changed
16 it to productivity because efficiency didn't
17 really seem to fit here -- but it's about twice
18 as productive. And over here, we have the days
19 it takes to survey 100 square kilometers.

20 So you can see that starting to come
21 down as we gain autonomy, and you can see the
22 productivity level start to climb on up. I think

1 C and D are about where somewhere in there where
2 TerraSond is trying to operate right now.

3 Now, for this graph here, I assumed we
4 had a five-million-dollar budget to spend over
5 five years. We're going to spend a million bucks
6 a year. We're going to see how much survey we
7 could do with that every year or what it would
8 cost us per square kilometer to survey under
9 those guidelines.

10 Again, this is our single vessel, the
11 capital costs down here at 600,000 dollars. It
12 costs us about 1,500 dollars a day to run, and
13 it's costing us about 130 dollars per kilometer
14 squared. So when we have two vessels, we're up
15 here. Our first level autonomy comes in right
16 here on C, and then D, I think, is where the
17 multi-vessel --

18 PARTICIPANT: You have more time.

19 MR. LOCKHART: Oh, I have more time.

20 Wow.

21 (Laughter.)

22 MR. LOCKHART: Yes, let me know how I

1 did that. I would like to repeat that later on.

2 (Laughter.)

3 MR. LOCKHART: But as you can see,
4 right in here by C, our cost per kilometer
5 squared starts to become advantageous and
6 advantageous in a big way. We're going to start
7 surveying a lot more with the same budget, with
8 the same technology lifespan.

9 Conclusions, hey, I'm way ahead. So
10 one of the things I've noticed here, we have a
11 lot less testing in the marine environment than
12 we've had in the automotive environment, many
13 orders of magnitude less testing. Those guys
14 have millions and millions of days that they
15 wrapped up. We have probably thousands of survey
16 days with this stuff. So we're way behind on the
17 testing.

18 But this second item, the decreased
19 severity of failure may outweigh any other
20 financial consideration. If we have these
21 autonomous vessels or even the shepherded vessels
22 around, if we're using those in places that

1 aren't near ports and harbors, that's an easy way
2 to de-risk our operations and potentially save
3 lives and save injury.

4 And again, the road is defined by our
5 survey specification. It's not the surface of
6 the ocean. It's the bottom of the ocean that
7 we're mapping, and it tells us where we need to
8 go and what we need to do. The stuff on the
9 surface is just clutter that we need to avoid and
10 need to deal with, but the real optimization of
11 the survey asset is going to come through looking
12 at the data, looking at what's on the seafloor,
13 and directing that vessel based on what it sees
14 on the seafloor, not necessarily what's on the
15 surface.

16 And Scenario C there -- which I think
17 is about where we are right now with Thomas' gear
18 and TerraSond and some of these other customers -
19 - that's already productive and making money.
20 And actually, my little spreadsheet came out at
21 about 55 percent, I think. I've taken
22 productivity out when I did this. So yes, I

1 think that sort of made sense to me.

2 And as we get more advanced, it'll
3 only improve the financial aspect of this. I
4 don't think it'll significantly de-risk it, but
5 it'll make it more financially compelling.

6 So that's what I have. Thank you very
7 much.

8 MEMBER LOCKHART: Okay. Thanks, Doug.

9 We're going to move right on to
10 Rebecca. We are running a little behind, but I
11 think Lynne managed to shift everything out 15
12 minutes. So we've got a little extra time.
13 We're still going to be pretty short on time for
14 questions, though.

15 So thanks, Rebecca.

16 MS. QUINTAL: Okay. Thanks. It's a
17 great opportunity to round out this great panel.
18 That's a preview. That's a preview.

19 (Laughter.)

20 MS. QUINTAL: They're loading up the
21 slides. I'll start out without bringing up the
22 slides, just saying that I'm actually presenting

1 a subset of a slide deck that was produced by
2 three of my colleagues. Their names are on the
3 screen there, and the reason for that is these
4 slides are all released for public release from
5 the sponsor of this work which is DARPA, the
6 Defense Advanced Research Projects Agency.

7 So the project was called ACTUV, which
8 is Anti-Submarine Warfare Continuous Trail
9 Unmanned Vessel. And what that was, was to
10 develop a medium displacement unmanned surface
11 vessel that needed to have ocean spanning range,
12 have months of endurance, be able to carry a
13 substantial payload, have enough power to support
14 that, and demonstrate a high level of autonomy
15 for independent operations with only sparse
16 supervisory control.

17 And the idea was to demonstrate a high
18 level of autonomy for game-changing approach to
19 anti-submarine warfare. The idea is that this
20 platform will be able to track and trail a quiet
21 diesel-electric submarine. And then it needed to
22 be able to demonstrate additional utility for

1 Navy missions.

2 One of the other priority missions
3 that has kind of bubbled up to the surface has
4 been hydrographic survey, which is why it's
5 applicable to NOAA's mission and HSRP. We were,
6 just a few weeks ago, able to demonstrate
7 hydrographic survey as an alternate mission using
8 the test platform for the Sea Hunter, which is a
9 40-foot workboat. But it has the same autonomy
10 engine that's on board the Sea Hunter here.

11 And we were able to demonstrate at the
12 Advanced Naval Technology Exercise which took
13 place at the Naval Surface Warfare Center in
14 Panama City, Florida and also at the Naval
15 Undersea Warfare Center in Newport, Rhode Island.
16 We performed an autonomous multibeam survey in
17 Florida. We actually had the screens of the ship
18 ported up to the tent on the pier in Newport, and
19 we were able to control the survey from Newport.

20 Some of the metrics for how this
21 program will be measured against, the platform
22 needs to be compliant with International Maritime

1 Organization Rules for Preventing Collisions at
2 Sea, or COLREGs. It needs to have propulsion and
3 maneuvering that can outmatch a next-generation
4 diesel-electric submarine. It needs to have an
5 endurance greater than 70 days. And once we get
6 to that point of getting to unit production, it
7 needs to have a cost of less than 20 million
8 dollars.

9 The image on the left was the artist's
10 rendition what this would look like during the
11 design phase, and the image on the right is what
12 it looks like today. And there's two things that
13 you can notice right away. The image on the
14 right has a bridge, and that's because right now
15 there is actually someone on the bridge. We're
16 legally required to have that. And it also has a
17 railing, and you'll see images later where
18 there's lots of government observers that are
19 standing on the platform. And that's for their
20 safety.

21 Here's some more images of the
22 platform, and I'll just tell you a little bit

1 more about Sea Hunter. It's 132 feet long. It's
2 47 feet wide, ama to ama, which is the pontoon to
3 pontoon. But it's just over 11 feet wide at the
4 center hull, so it has efficient use of space
5 there.

6 It has twin diesel engines. It has a
7 fuel tank, 14,000 gallons, which gives it an
8 endurance of over 13,000 nautical miles. What
9 that means is it can leave San Diego, go to Guam,
10 and back on a single tank of fuel. It was
11 designed to operate in Sea State 5 and survive
12 Sea State 7. It has a wave-piercing trimaran
13 design which is important for stability. And it
14 has five water-tight containers, any one of which
15 can flood and the platform can still float.

16 This website, we're going to queue up
17 a video here. If anyone is interested, DARPA has
18 posted quite a few still images and videos. The
19 video we're going to watch here is of some recent
20 maneuvering testing that was done.

21 MS. QUINTAL: And it's very dramatic
22 music.

1 (Video played.)

2 MS. QUINTAL: All right. You can
3 probably stop it there.

4 (Video ends.)

5 MS. QUINTAL: Thank you.

6 So you can see there's not anywhere to
7 sit onboard. A lot of standing. If you do want
8 to sit, if you go inside, they do have folding
9 camp chairs that you can sit down, and that's
10 about it.

11 So where is the program now? We are
12 currently in the tail end of year one of a two-
13 year sea trial phase. They started out by
14 testing the physical ship. How did the engines
15 work? How fuel efficient are they? How's the
16 bow thruster work? The stability of the
17 platform, et cetera. We're moving into the
18 COLREGs testing now, and then things like
19 endurance testing will follow after that.

20 The program is currently transitioning
21 from DARPA to ONR, which is a good thing. It
22 means they think it's successful. And ONR's job

1 will be to decide how best to deploy this to the
2 fleet.

3 This slide has a lot going on, on it,
4 but the idea is to talk about open system
5 architecture which was a keystone for the
6 development of the architecture for the system.
7 And I'll jump to the next slide real quick, and
8 this is a cartoon of how the different systems
9 are segmented and the hierarchical layering of
10 decision making that takes place.

11 The architecture allows for adding new
12 sensors or systems or behavior in a simplified
13 manner. So for example, the original ACTUV
14 mission, while it was supposed to be able to do
15 transoceanic voyages, never had behavior to be
16 able to line follow like we would for a
17 hydrographic survey. But we were able to add in
18 that capability, which we demonstrated last month
19 at ANTX, very simply because of this
20 architecture.

21 For each of these categories, there's
22 redundant and backup systems included. So the

1 idea is that a single point of failure would not
2 cause the platform to be unable to return back to
3 its home port. It may not be able to complete
4 its mission, or it may have to limp home, for
5 example, if one of the engines went out but it
6 could still get there.

7 In some of the areas of redundant
8 systems, we have redundant steering and
9 propulsion controls. We have automatically
10 paralleling generators. The propulsion and the
11 electricity generation are separated. We have
12 two seawater pumps for the generators, two
13 seawater pumps for the chillers. We have
14 multiple radars with overlapping ranges, and they
15 don't all have to be functional at the same time
16 for the autonomy to work. We have 100 percent
17 redundant computer hardware on board.

18 In addition to the backup systems,
19 each component that was chosen for this vessel
20 had to be chosen based on automated control. And
21 you can think of that down to the most basic
22 element of the system. You can't have anywhere

1 on board a switch that needs someone to switch it
2 on, a valve, even in an emergency situation, that
3 needs someone to turn it. So you can think
4 about, like, if a breaker trips, you can't have a
5 breaker that needs to be toggled back on.

6 One of the important boxes worth
7 mentioning is the health monitoring. The
8 platform needs to be able to monitor itself in
9 its own status. It needs to know what the
10 optimal performance is for every computer on
11 board and every software package that's running
12 as well as the plant, the physical ship. And so
13 there is supervisory software that's running to
14 check that.

15 If it needs to, it will reboot a
16 specific computer, shut down a specific piece of
17 software, and restart that software if it's not
18 functioning as its expected.

19 One of the other things that you need
20 for an automated system is you can't employ any
21 software that has pop-up boxes. It can't be
22 waiting there for someone to say, okay, yes,

1 really do it.

2 So one of the boxes, the World Model,
3 I'm going to talk about on the next slide. So
4 what we call the World Model is all of the
5 information that the platform has available to it
6 to be able to make decisions.

7 Some of that information, it's
8 collecting itself: its position, sensors it has
9 on board, radar, cameras, and AIS information
10 from other vessels around it. And it could be
11 some a priori information: nautical charts that
12 are currently published, data that were
13 previously collected in that area. It fuses all
14 of that information together to create a World
15 Model so that it can make decisions, and it's
16 constantly updating and evaluating that World
17 Model to say, now what should I do?

18 Two of the things I want to highlight
19 is hazard avoidance, optical avoidance, and
20 COLREGs compliance. For hazard avoidance, built
21 into the system, there are exclusion zones that
22 are user selected.

1 How big of an exclusion zone do you
2 want to have around a charted wreck position
3 approximate? How big of an exclusion zone do you
4 want to have around shoals to have the vessel
5 stay clear of those areas? And you may want to
6 adjust that exclusion zone based on the
7 particular waters that you're in, and for
8 example, things like, what is the age of the
9 nautical chart?

10 COLREGs compliance, the software is
11 constantly looking at its environment and
12 determining if it detects any contacts. It'll
13 use AIS if it's available, if a contact has AIS,
14 because that'll help it determine what the rules
15 of the road are based on what time of vessel it
16 is.

17 It will determine the risk of
18 collision. It'll identify what Sea Hunter's role
19 is in this situation. Is Sea Hunter supposed to
20 stand on here or give way? It'll then take the
21 appropriate action. And in the case that you
22 have a noncompliant contact -- the other guy is

1 not following the rules of the road -- it'll take
2 action. All right.

3 So one of the things -- for a long
4 duration asset when an organization is going to
5 send that vessel over the horizon and it'll be
6 maybe days away from the nearest human help --
7 you need to think about how you protect that
8 asset. It'll be not too far in the distant
9 future we'll have, I believe, oceanic shipping
10 vessels. And they're going to put a lot of
11 thought into that, how they protect those assets
12 when they send those across the ocean.

13 And maybe just as important,
14 particularly with the emerging technologies, is
15 how do you protect the intellectual property of
16 those technologies? And that was a big part of
17 developing the system for Sea Hunter was
18 including information assurance, how do you
19 protect the data, the software, the algorithms?
20 And also, how do you build in anti-tampering
21 which is physically protecting the asset?

22 You want to know if someone has

1 boarded your vessel out there in the open ocean
2 and is trying to get access to your system.
3 That's a really important aspect, and it's not
4 something you can layer on after the fact. It
5 has to be built into the framework of the system.

6 So as a summary, we've built in
7 COLREGs behaviors. We're currently undergoing
8 sea trials. A lot of thought went into
9 redundancy and cybersecurity. One thing I
10 haven't mentioned yet is the idea of
11 collaborative teams.

12 Getting back to that price point of 20
13 million dollars for one of these units, the idea
14 was not to have a single Sea Hunter out there but
15 have a fleet of Sea Hunters that could work
16 collaboratively to perform a mission:
17 collaboratively amongst themselves as well as
18 other unmanned platforms and manned platforms.
19 And so we see that as pretty exciting, going
20 forward.

21 Thank you very much.

22 MEMBER LOCKHART: Thanks, Rebecca.

1 Thanks to everyone for presenting today, for
2 taking the time to come up here and present. We
3 really appreciate it.

4 With that said, I'm going to open it
5 up for -- I think we have time for a few
6 questions. So does anybody have any questions?
7 Ed?

8 MEMBER SAADE: So I guess for Doug and
9 for Thomas, one of the strategies we were
10 considering -- and I'm curious if you think this
11 has any validity -- forget about the mother ship.
12 Once batteries and longevity of operation and
13 fuel tanks are big enough, why can't we just
14 launch them in the harbor and let them go do
15 their thing?

16 MR. CHANCE: So the C-Worker 12 that
17 I showed, the 40-foot boat, will be set up for
18 that. Now, what we may -- I mean, it's a new
19 boat, and you could theoretically do that. I
20 think we haven't done it yet, but we'll probably
21 be doing that in the next month, two months.

22 And it's set up so you can -- it's

1 optionally manned, right? So you can put people
2 on it. What we would probably do is put people
3 on it till we get it away from a congested area -
4 - the dock area. And although they've got
5 satcoms on there and things like that, in some of
6 these port areas, you've got a lot of electrical
7 noise, radios go down, all that kind of stuff.

8 So I think that's a pragmatic approach
9 until -- but I mean, that's -- and we're already
10 talking about people doing loop current stuff in
11 the Gulf of Mexico with that. Just go back and
12 forth, 40 miles this way, 40 miles back, 40 miles
13 this way, 40 miles back. Just have it leave the
14 dock, go out there and run for three weeks and
15 refuel, and go back and do it again.

16 So I mean, we're really, really,
17 really, really, really close, I think. So ask me
18 in a few months and we'll know.

19 MEMBER SAADE: No, and I understand
20 all this is probably years out. But that's kind
21 of where we'd like to see the industry go, just
22 because of, as you know, the HSE requirements for

1 a lot of the companies that we all work for, the
2 more humans we can get off the boat or get them
3 out of the picture completely.

4 MR. CHANCE: And let me say one other
5 thing. So the C-Worker 6 is one of the first
6 boats that we made. It had a lot of dual
7 redundancy on that boat, and it was set up to
8 take a sat-dome so that we could do exactly that.

9 We put those boats in the water about
10 four years ago now -- maybe five years ago. And
11 it didn't work, and the reason why it didn't work
12 is because the VSAT people made all kind of
13 promises about what sat-dome stuff could -- the
14 sat. And everybody here that's been on the boats
15 knows the challenges of making VSAT stuff work
16 reliably on a boat.

17 And we started off with it pretty
18 small. It was a 60 centimeter type dome. So you
19 saw the boat that I showed there has two big --

20 MEMBER SAADE: Yes.

21 MR. CHANCE: We're going with the big
22 ones, and we're doing two. Actually, we'll have

1 a third tertiary satcom system using Inmarsat
2 Global Xpress -- and I'm sorry -- using Iridium
3 NEXT, which is the next version. Your older
4 Iridium stuff leaves a lot to be desired.
5 Iridium NEXT has a lot more data. So that was
6 the biggest hurdle was the satcoms because you
7 wanted to monitor this stuff, for sure.

8 MEMBER SAADE: Thanks.

9 MEMBER MAUNE: I have a question. I
10 was intrigued by the idea of using multibeam in
11 an autonomous underwater vehicle where you want
12 to go underneath the other vessels there. I'm
13 used to using GPS for position and inertial
14 measurement units for orientation. How do you
15 position autonomous underwater vehicles?

16 MR. CHANCE: Sure. Okay. Is it on?
17 All right.

18 So people have been doing multibeam on
19 autonomous underwater vehicles since 2000. And
20 so to position them, there usually is an ultra-
21 short baseline acoustic positioning. And so you
22 have a mother ship in the area that acoustically

1 positions, and then you also have inertial nav
2 and Doppler Velocity Log. So it's kind of like
3 the Doppler Velocity Log is going to look at the
4 bottom and figure out which way it's going.

5 Those are not absolute positioning
6 systems, but the USBL acoustic positioning system
7 is. Or else you have to put in an array on the
8 bottom so it can position itself. Or else you
9 have to come to the surface and get a GPS fix and
10 then go back down.

11 The challenge with that is that your
12 Doppler Velocity Log has to be able to see the
13 bottom when you're all the way to the surface.
14 And if you're in kind of deep water, that doesn't
15 work. So then by the time you get down, you're
16 kind of lost again.

17 So it's a challenge. I mean, there's
18 a system called Nautronix NASNet which is like an
19 underwater GPS. But I mean, it gets hugely
20 expensive to do that. So USBL, Ultra-Short
21 Baseline Acoustic Positioning from the mother
22 ship, is the best, most pragmatic way.

1 MEMBER MAUNE: Thank you.

2 MR. LOCKHART: Just another quick
3 comment on that. So I think I'm on. There we
4 go.

5 So there is a bunch of technology
6 evolving now for indoor mapping: Things called
7 like SLAM, Simultaneous Location and Mapping,
8 where you can send a LiDAR into a building when
9 you're GPS denied. And using your inertial
10 system and the cameras and the LiDAR, you can map
11 your way around the building without any external
12 positioning information. And that technology
13 will come along and help this underwater
14 navigation problem.

15 The environment is a little rougher.
16 We don't have square edges and nice walls and
17 flat surfaces. But if we're able to get some
18 data off the bottom before we dive and we still
19 have GPS, or right after we dive before our
20 position degrades too much and we're able to get
21 back there, we can use survey tools like block
22 adjustments and things like that to pull all this

1 data sort of back into position.

2 So there are methods that are coming
3 along to help get us away from this constant need
4 for LBL and USBL and stuff like that. They're a
5 ways off, but again, they're being developed for
6 another application. But we should be able to
7 pull them across eventually.

8 MEMBER MAUNE: Thank you.

9 DR. MAYER: Okay. Let me just chime
10 in, because I had a follow-up to Ed's question
11 and Thomas' response. And I think that we have
12 to -- and your question really about a very
13 crowded port and true autonomy. And as early as
14 we are in the stages of developing the autonomous
15 vessels, we're even earlier in developing, I
16 think, the infrastructure to support them.

17 And so I can envision -- and I think
18 we should all be thinking about -- what sort of
19 port infrastructure might you want to establish
20 to truly allow, even in a crowded port,
21 autonomous vessels to behave properly? And I
22 think it's just something we haven't started to

1 think about yet, but it's something we probably
2 should.

3 MR. CHANCE: I'll just say real quick,
4 Larry. From my standpoint, I would have never
5 assumed that we could actually change anything
6 like that. So our way is to figure out how to
7 try to work around the existing system.

8 MS. QUINTAL: Well, and --

9 DR. MAYER: Sorry.

10 MS. QUINTAL: I was going to say,
11 there's no, like, supervisory board that would,
12 for a lack of a better word, certify when a
13 vessel or a technology is ready to go autonomous
14 when you can send it over the horizon now. And
15 there's a ways to go too to update national and
16 international maritime rules and regulations to
17 allow for, in some cases, legal unmanned
18 operation of these platforms. So infrastructure
19 and rules and regulations, it all needs to be
20 updated.

21 MR. LOCKHART: I think those autonomy
22 levels give us a lot of insight into when this is

1 going to happen. Autonomy Level 4 should support
2 that unmanned, moving around in a port that you
3 already know the geometry of. You may not know
4 the traffic in the port. You may not know what's
5 going on in there. But if you know, essentially,
6 the physical layout of the port, Autonomy Level 4
7 should get you there.

8 Autonomy Level 5 should get you into
9 any port anywhere in the world, whether you've
10 been there or not. That's why those things are
11 defined that way. So until we get to Autonomy
12 Level 4, you're still going to need people on the
13 boat to get you out of the port, for example.
14 But at Level 4, it should be good to go, assuming
15 you have some a priori understanding of what the
16 layout of the port is.

17 DR. MAYER: Think about something like
18 a realtime feed to the autonomous vessel from the
19 vessel traffic control system.

20 MR. LOCKHART: Well, you shouldn't
21 need any feed. There's no --

22 DR. MAYER: No?

1 MR. LOCKHART: -- realtime feed coming
2 from vehicles. There isn't going to be a
3 realtime feed from your Tesla going anywhere.
4 When it gets to Autonomy Level 4, it's just
5 driving.

6 DR. MAYER: But if it's there, why not
7 use it?

8 MR. LOCKHART: Sure, yes.

9 VICE CHAIR MILLER: Having been at sea
10 a fair amount, things always break. They always
11 break. And I mean, Rebecca's -- the philosophy
12 of dual everything is a great one. But on small
13 vessels, that's just not possible. You can't
14 necessarily have two generators and two air
15 conditioners and two everything.

16 So I didn't see any discussion of,
17 what happens if the vessel breaks that it can't
18 get back to the ship and the manning necessary to
19 repair it and so forth? So I guess I think the
20 optimism is great, but there's some
21 practicalities about going to sea that I haven't
22 seen addressed here.

1 MS. QUINTAL: I think that there's a
2 certain amount of risk, and you can build it into
3 the program. You can get really fancy with a lot
4 of things, how you deal with materials that come
5 into the seawater intake, a foreign object.

6 There's lots of problems that have to be
7 addressed. And some of them, you'll do a cost
8 benefit analysis to say, well, how risky is this?
9 Do we need to add another level of technology to
10 handle that or is just having redundant systems
11 enough?

12 MR. CHANCE: I would say I totally and
13 absolutely agree with you, first of all. And
14 like I tell people, it's, like, 50 percent
15 engineering and 50 percent is trying to figure
16 out how Murphy's Law is not going to kick you
17 down.

18 So for example, the boat that we have
19 to go independently, all right. So I mean, first
20 of all, we talk about the boats that are force
21 multipliers that are working within line of sight
22 of the mother ship. That's an easier deal,

1 right?

2 But when you get to going over the
3 horizon, you can bet Murphy's Law is going to --
4 I mean, there's going to be rope in front of you
5 that your rope cutters on your props aren't going
6 to be handle or it's going to be floating. The
7 human eye can't see those things at night. You
8 run over somebody's rope that fell off their
9 boat.

10 And so the boat that we have, it's
11 dual redundant throughout, but you've been there.
12 I've been there. We'll just have to see. The
13 easiest stuff is the force multiplier stuff. The
14 tougher stuff is exactly what you're talking
15 about. You take the big boat. You send it out
16 there.

17 And we'll be out there. I'll be able
18 to tell you all the bad stuff that happens, and
19 you'll be able to tell me before it happens. I
20 mean, what you're pointing out is a very valid
21 thing is that you don't know where the bombs are
22 going to come from when you're trying to do stuff

1 like this.

2 VICE CHAIR MILLER: I think any cost
3 benefit analysis has to take that into effect. I
4 mean, I guess you have to be able to just lose
5 the vessel. I mean, it seems like, at some
6 point, it's halfway across the Pacific. What are
7 you going to do with it? I mean, do you have a
8 switch that says, boom?

9 (Laughter.)

10 MR. CHANCE: Not that I know of. But
11 to some degree, you can drop an anchor or drop a
12 drive line or something. But I mean, what you're
13 saying is real. I mean, we've done designs of
14 bigger boats where we put a heliport on there, I
15 mean, for that very purpose. In a lot of places,
16 you just can't get a helicopter that far out,
17 right? So I mean, I'm not going to say what
18 you're saying is not a valid point. You're spot
19 on.

20 MEMBER SAADE: So I threw some more in
21 there just for you to consider. We've probably
22 had half a dozen refugee incidents over the last

1 year globally. That's probably going to
2 increase. What do you do when they start
3 climbing on your autonomous vehicle?

4 We've had tremendous amount of
5 vandalism on meteorological moorings. I can just
6 imagine these folks that really like our moorings
7 are going to really love these ASVs as well. And
8 then the whole marine mammal observer interface
9 that you have to deal with on a regular survey.
10 All those things have to come into the equation.

11 MR. CHANCE: So as far as piracy and
12 things and people getting on, I mean, we're not
13 there. Obviously, we've thought about this a
14 bunch, right? And we know these people. They
15 just love -- not that we know them. We don't
16 know them.

17 (Laughter.)

18 MR. CHANCE: For them to climb on
19 board and cut off your solar panels and cut off
20 your antennas and anything that they can take or
21 steal a diesel and all of that sort of stuff.
22 And there's a lot you can do with an unmanned

1 boat when you design to try to minimize that or
2 limit it. And then there's some things that you
3 can do with -- what's the spray -- the pepper
4 spray or things like that.

5 It's a challenge. I mean, now, they
6 can hook on the bit on the bow of your boat and
7 tow it to their dock. But you'll be watching
8 them the whole time. You can have the sheriff or
9 whoever meet them at the dock, but that'll
10 probably be their cousin.

11 MS. QUINTAL: Well, I think the old
12 adage definitely applies: Don't put anything in
13 the water that you're not willing to lose, and I
14 think that has to go.

15 And so that's one of the reasons why
16 trying to get -- 20 million dollars is a lot of
17 money. But to try to get that cost point down,
18 when you talk about trying to do -- in this
19 particular -- for Sea Hunter, it's not very much
20 money when you're talking about how much a
21 submarine costs. And so that'll be something
22 that the Navy has to weigh of, at what point can

1 you get the cost cheap enough that maybe, in some
2 cases, they are disposable?

3 MEMBER MAUNE: And this just doesn't
4 pertain to autonomous vehicles. It also pertains
5 to manned vehicles. I remember when a -- what
6 was it -- F-22, lost and crashed in Alaska. That
7 plane cost 150 million dollars, and that didn't
8 even make the news. Down here, it didn't. Maybe
9 it did in Alaska.

10 MEMBER LOCKHART: Okay, Lawson, last
11 question.

12 MEMBER BRIGHAM: Just a comment. It
13 seems like the interface of smaller vehicles with
14 your survey vessels and having the mother ship,
15 the survey vessel. And the survey vessel being
16 either autonomous or not but also interfacing
17 with a smaller vehicle seems a bit more cost
18 effective and a little less man intensive.

19 Kind of a combination of using these
20 tools but tightly controlling them, particularly
21 in the frontier areas. But maybe in a port area
22 as well because you have tighter control. I

1 mean, I think it seemed like in the near term,
2 the next decade, that might be the way to pursue.

3 CAPT VAN DEN AMEELE: And I think one
4 challenge or area that we're trying to realize
5 is, how many things can we monitor at once for
6 that maximum effectiveness, right? And now that
7 we've done one, for example, ASV, can we go do
8 two or three or four and monitor all them at the
9 same time just to get more of that force
10 multiplier effect?

11 So I think, yes, in the short term,
12 while we're still under this shorter term under
13 more supervised autonomy, that we want to
14 continue to push that envelope to see how many
15 things we can get in the water and still maintain
16 some level of control over them.

17 MR. CHANCE: On that note, I would say
18 that, like I showed you, the example, we have one
19 customer that's doing eight ASVs with the one
20 mother ship. Now, that's pushing it. So
21 somebody has to do it.

22 MEMBER LOCKHART: Okay. I'd like to

1 thank everybody again for their presentation. If
2 we can show them our appreciation.

3 (Applause.)

4 MEMBER LOCKHART: Sorry for going
5 long. I'm going to hand it back to Bill.
6 Thanks.

7 CHAIR HANSON: Not long at all, and
8 thanks for that. For me, some things we've been
9 talking about for many years now is this backlog
10 of survey work that needs to get done. And so
11 not only just the gee-whiz applications of this.
12 It's also really got a real-life application to
13 help in NOAA's mission. So appreciate all of
14 that.

15 And also maybe just a recommendation,
16 because this is such a fast-moving, fast-paced
17 discussion, that if you had it again in six
18 months or another year, it's probably going to
19 change dramatically in that time frame. So you
20 might want to keep your pulse on this issue
21 moving forward as well. And I can do that now.
22 I can make recommendations for future panels,

1 right?

2 (Laughter.)

3 VICE CHAIR MILLER: Of course.

4 CHAIR HANSON: Make work for Joyce
5 here. So I really appreciate the panelists and
6 all the discussion here.

7 We're at a point now in our meeting
8 where we can open for public comment. A little
9 format there, whether you're in the audience or
10 on the webinar. If you're in the audience, I
11 guess you need a microphone, right? Okay. And
12 I'll do that one. But I also want to make the
13 announcement first.

14 So anybody in the audience or on the
15 webinar, if you've got questions, please go ahead
16 and submit those now. We do have one question
17 that our mystery man, the most mystery man in the
18 world, has presented.

19 Dr. Mayer, I don't think I need to
20 read it to you.

21 DR. MAYER: Well, I had to read it.
22 I did? Yes, and I think lessons have been

1 learned, certainly. I think --

2 CHAIR HANSON: There's a question?

3 Okay. I'll save you from that, Larry.

4 DR. MAYER: Thank you.

5 CHAIR HANSON: All right. Referring
6 to the presentation by Dr. Larry Mayer, on the
7 use of multibeam echo sounder technology and the
8 response to the deepwater horizon event, how has
9 NOAA applied the lessons learned from this
10 incident?

11 Specifically, are the multibeam
12 services, systems, and software now available
13 aboard more NOAA ships to be effective in
14 responding to future events where observation of
15 oil leaking into the water column needs to be
16 understood? Gerd Glang, Director, IIC
17 Technologies.

18 DR. MAYER: Yes, I think there has
19 been an expansion of the capability. A number of
20 the fisheries vessels now are being equipped with
21 kind of a hybrid type of multibeam that
22 originally was designed only for the water

1 column. But now, software has been developed for
2 those systems to map both the seafloor and the
3 water column. These are the ME70s, and so I've
4 seen those on many of the fishery vessels.

5 I think most of the NOAA large ships
6 are equipped now with multibeam. And so at that
7 time, the Okeanos Explorer with its EM302 was
8 really a one-off. But I think we're seeing that
9 capability spread much further amongst the fleet,
10 both on the fisheries vessels and certainly the
11 hydrographic vessels.

12 And TJ is getting both the 710 and
13 2040. So we're getting multiple systems on many
14 vessels. So I think had that situation or should
15 a situation like that arise now, I think there
16 are many, many more options to apply those
17 technologies and certainly the software
18 development has come very far.

19 CHAIR HANSON: Any questions from the
20 audience? None on the webinar. Go ahead.

21 MR. NOLL: Larry, I noticed that you
22 mentioned port infrastructure. And of course, we

1 had my colleague, Marten Hogeweg, present in
2 Seattle on that specific issue and how to
3 maintain the assets and ensure that the port
4 knows where everything is at.

5 I think it is a critical function for
6 the HSRP to weigh in on how important the shore
7 site infrastructure related to the ocean is, as
8 was demonstrated over the weekend with Irma
9 coming into shore. Many of those coastal regions
10 may not be as well-known as they need to be.

11 Do you have maybe a further
12 elucidation of where you were going with that
13 comment?

14 DR. MAYER: That's a question for me?

15 MR. NOLL: Yes.

16 DR. MAYER: No, it was just a thought
17 that as we push and develop the autonomous
18 systems, there may be a parallel infrastructure -
19 - a shore-based infrastructure that could really
20 expedite and improve their efficiency and use and
21 that it may not be an expensive infrastructure.
22 But I don't think we've thought much at all about

1 that, and I think it goes beyond just the
2 autonomous vehicle question, I think, as you say,
3 that the more that we can invest in understanding
4 the ports, the better off we are.

5 MR. NOLL: Maybe just a follow-up.
6 You mentioned -- or I think Doug mentioned during
7 the response the Tesla example. Now, of course,
8 the Departments of Transportation already have a
9 framework and a data infrastructure and a data
10 model for automobiles to travel on. And then
11 those are augmented by the actual remote sensing
12 that automobiles are doing in real time.

13 I think something similar needs to
14 happen for the seaway, right, just like the
15 highway. And right now, we don't have that.
16 Certainly, hydrographic vessels participating in
17 this drone mapping would be participants in
18 creating that infrastructure, and maybe it's the
19 data modeling that needs to be set up.

20 CHAIR HANSON: We were just chatting
21 about all the agency opportunities to get engaged
22 in that, not just NOAA but also Maritime

1 Administration, CMTS, all those groups that could
2 be involved in that. But certainly not doing
3 things the way we've always done them is
4 something that these types of panels should be
5 advocating for and can be.

6 So I think we're done for the morning.
7 Do you have anything?

8 RDML SMITH: I don't. I just want to
9 echo thanks to our panel. It was very thought
10 provoking. I wish we had another half hour for
11 discussion, because there's a bunch of threads to
12 pull on there. But I hope at least some of you
13 will be around for a little while, and we can
14 continue the conversations on the side. So thank
15 you.

16 CHAIR HANSON: Great.

17 MS. MERSFELDER-LEWIS: So the HSRP
18 members, if you would just stay here for five
19 minutes, Larry and Andy will talk to you about
20 your afternoon and tomorrow afternoon. The rest
21 of you guys, we'll see you tomorrow if you're
22 attending. We love that you -- we had a full

1 room. We're very happy to see who came, and
2 thanks very much. And then we are going to go to
3 the rooms, drop your stuff, and board the trolley
4 as quickly as possible.

5 (Laughter.)

6 MS. MERSFELDER-LEWIS: We're in great
7 time. Carol did a great job moderating.

8 (Whereupon, the above-entitled matter
9 went off the record at 12:17 p.m.)

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C E R T I F I C A T E

This is to certify that the foregoing transcript

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Public Meeting

Before: National Oceanic & Atmospheric Administration

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Place: Portsmouth, New Hampshire

was duly recorded and accurately transcribed under
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