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OVERSIGHT OF THE ELECTROMAGNETIC AIRCRAFT LAUNCH SYSTEM (EMALS)

HEARING

BEFORE THE

SEAPOWER AND EXPEDITIONARY FORCES SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SEAPOWER AND EXPEDITIONARY FORCES SUBCOMMITTEE,
Washington, DC, Thursday, July 16, 2009.

The subcommittee met, pursuant to call, at 10:04 a.m., in room 2212, Rayburn House Office Building, Hon. Gene Taylor (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. GENE TAYLOR, A REPRESENTATIVE FROM MISSISSIPPI, CHAIRMAN, SEAPOWER AND EXPEDITIONARY FORCES SUBCOMMITTEE

Mr. TAYLOR. The subcommittee will come to order. Today the subcommittee meets in open session to receive testimony from officials of the United States Navy on the current status of the electromagnetic aircraft launch system, or EMALS. The EMALS system is an electromagnetic catapult designed to use on the *Ford* class aircraft carriers. If the system delivers its full promised capability, *Ford* class carriers will have a catapult system that is far superior to the steam catapults of the *Nimitz* class.

The operational advantages are increased launch envelopes—that is the ability to launch both heavier and lighter aircraft than steam catapults—higher sortie rates, reduced weight, reduced mechanical complexity, reduced maintenance and reduce carrier manning. Unfortunately, what brings us together today is that the development of the program is so far behind schedule that it threatens the delivery date of the United States *Ford*.

For the record, I would like to briefly summarize the history of the program and the current status. EMALS was the core capability in the design of the next generation aircraft carrier, which the Navy called CVN–21 for the 21st century technology, which eventually became the USS *Ford*, CVN–78.

In 1999, the Navy entered into technological demonstration contracts with two different contractors, General Atomics and Northrop Grumman Marine Systems, to develop prototypes for the electromagnetic catapult. By 2004, the Navy down-selected to a system proposed by General Atomics and entered into a system design and development contract, or SDD contract, to build a full-scale ship representative prototype at the Navy test facility at Lakehurst, New Jersey.

That prototype was contracted to be completed in time for testing to begin in 2007. Testing was to have concluded up to two years. And presumably the results learned from the test program would influence the final production system, which would be shipped to the carrier construction yard for erection into the ship. It is now July of 2009, and full-scale testing is yet to begin at the Lakehurst facility.

The Navy is now faced with almost complete concurrency of testing and production of the first ship set if they are to meet the in-yard delivery dates to keep the USS *Ford* on schedule. There are a number of subsystems in the complete EMALS system. And each subsystem has different in-yard delivery dates. But some of those dates are as early as the summer of 2011. And to meet those dates, the production of the components, and at least the ordering of the material for the components, must begin now before full-scale testing of the prototype systems has begun.

To be fair, some testing has already occurred. The high-cycle tests for energy source systems is well underway, as is the highly accelerated life cycle testing of the launch motor segments. Those tests have identified some minor redesign issues, which can be incorporated into the production components. But until a full-scale catapult launch of the prototype occurs, questions will remain on the system's overall performance.

I have been briefed, as I believe other members of this subcommittee have been briefed, that the issues in completing and delivering the SDD components were a result of the contractor's inexperience managing a major production effort. I find that answer unsettling because it is the Navy's responsibility to oversee what their contractors are doing and to identify problems before they become problems.

I will note that a little over a year-and-a-half ago, the contractor did put in place an entirely new management and engineering team. Hiring away proven production engineers from both General Dynamics and Northrop Grumman. This new team seems to have righted the ship. But that ship is still on very dangerous seas.

So what we have is a program that is so essential to the carrier that if it does not work, the nation has paid billions of dollars for an unusable ship. If the ship is delayed, the carrier is automatically delayed. I am sorry. And every day of delay will push the costs higher for the carrier.

This is the first in what I intend to be a series of hearings on this program over the next few years. This is too important not to have close congressional oversight. I intend to continue close oversight of this program until it is delivered, installed, tested, certified for launching EMALS aircraft off the deck of the USS *Ford*.

I would also like to remind you gentlemen that when Chairman Bartlett was the chairman of this committee and I was the ranking member, on any number of occasions representatives from the Navy visited him and me and said the littoral combat ship system was on time and on schedule and on cost only to have some time around November of 2006 one of those, "aw, shucks," moments that has resulted in a ship that is well over twice the price it should be and 18 months late on each version. We cannot afford that on this program.

And I do welcome you here today. And I do welcome you taking these responsible jobs and hopefully seeing to it that this program is back on track.

Our witnesses today are Vice Admiral David Architzel, principal deputy to the Assistant Secretary Stackley; Rear Admiral (Select) Randy Mahr, program manager for EMALS; and Captain Brian Antonio, program manager for the *Ford* class aircraft carrier. Vice Admiral Architzel is representing the assistant secretary as the senior acquisition executive who is ultimately responsible for all Navy and Marine Corps acquisition programs. Admiral (Select) Mahr is the official whose only responsibility will be this program. Captain Antonio is responsible for building the entire carrier. He obviously has an interest in the success of EMALS.

This year's National Defense Authorization Act directs the Secretary of the Navy to keep Admiral (Select) Mahr in his position until the completion of the system development testing and the successful production of the first ship's set of components. That means that the admiral select who has been selected will be in place for a number of years and will have the opportunity to visit again on this subject.

I would now like to call on my friend from Missouri, the ranking member of the subcommittee, the Honorable Todd Akin, for any opening remarks he may wish to make.

[The prepared statement of Mr. Taylor can be found in the Appendix on page 37.]

STATEMENT OF HON. W. TODD AKIN, A REPRESENTATIVE FROM MISSOURI, RANKING MEMBER, SEAPOWER AND EXPEDITIONARY FORCES SUBCOMMITTEE

Mr. AKIN. Well, thank you, Mr. Chairman. I would just like to submit my remarks for the record, if I could and welcome our witnesses. My background was in engineering. And I used to work for IBM. We did a lot of project management.

This is something that really has the attention, not only of our subcommittee and committee, but the Chief of Naval Operations, everybody else. This has got to work. And this is an important hearing. I am looking forward to having a chance to ask some questions. Thank you, Mr. Chairman.

[The prepared statement of Mr. Akin can be found in the Appendix on page 39.]

Mr. TAYLOR. Thank you, Mr. Akin.

Vice Admiral Architzel, I understand that you will deliver the combined opening statement. I also understand that you have a short movie that will demonstrate how the EMALS system would work on the ship. Please proceed.

STATEMENT OF VICE ADM. DAVID ARCHITZEL, USN, PRINCIPAL MILITARY DEPUTY TO THE ASSISTANT SECRETARY OF THE NAVY (RESEARCH, DEVELOPMENT, AND ACQUISITION), U.S. NAVY

Admiral ARCHITZEL. Thank you, Chairman Taylor, Ranking Member Akin, and distinguished members of the committee. It is our honor to be to appear before you today to report on the development of the electromagnetic aircraft launching system, EMALS for the *Gerald R. Ford* CVN–78 class aircraft carriers and the Navy's plan for this effort.

I am joined by Captain Randy Mahr, the program manager for aircraft launch and recovery equipment to my right and Captain Brian Antonio, the program manager for the CVN–78 aircraft carrier program to my left. I would like to submit our written statement for the record.

Mr. TAYLOR. Without objection.

Admiral ARCHITZEL. Thank you, sir. As today's tactical aircraft have evolved, the percentage of high-energy launches for the embarked airwing has steadily increased as has the attendant stress applied to those aircraft from today's steam catapult system. Likewise, with the higher loads required, the maintenance man-ours to maintain our carrier catapults has increased.

The Navy recognized these trends and sought to replace steam catapults on the *Ford* class aircraft carriers with EMALS, electromagnetic aircraft launching systems, a system that is designed to reduce manual requirements, increased operational availability and give greater performance over legacy steam systems. Similarly, EMALS supports the CVN–78 key performance parameters such as sortie generation rate, reduced shipboard manning and will support current and future airwing operation requirements, which include the addition of the joint strike fighter and Navy Unmanned Combat Air System, or N–UCAS, in the future.

EMALS is a critically important capability for our future carriers and embarked airwings. During its development over the past year, we have made good progress. But as you are aware and have pointed out, we have also had to overcome technical issues, programmatic challenges and cost growth.

I want to leave this committee with two important takeaways. First, we are here today to provide you with the most up-to-date, straightforward answers as possible. And if we don't have answers to your questions, we will get them. Second, that the team—and that is the collective team on the government's side and industry side—is committed to delivering this capability with our principal industry partners, General Atomics and Northrop Grumman Shipbuilding.

We are working hard with our industry partners in this critical program. And while we are making progress, concerns remain. And we will no doubt have additional challenges during the remaining test program.

We are collectively committed to meeting those challenges head-on. The Navy understands the concerns you and your subcommittee have expressed. And we are aggressively working to improve performance.

Chairman Taylor, we are implementing your recommendations to break EMALS' cost and performance data from CVN–78 for a separate review by Congress.

Finally, I feel that we have two of the finest program managers to lead both the EMALS program and the CVN–78 program with us today. And we are taking steps to ensure stability in the program's key technical and management teams. The department is committed to delivering CVN–78 with EMALS on time and on budget.

Mr. Chairman, with your permission, I would now like to provide the committee with a brief presentation on what constitutes a catapult launch, as was requested, with the goal of touching on some of the major components of the EMALS system. And following that, I would like to hand over the presentation to Captain Mahr, who will provide greater detail on the program as well as the components involved and its testing underway.

Finally, Captain Antonio will explain how EMALS is integrated into the *Ford* class aircraft carrier and how he is tracking progress to ensure the proper and timely integration of the EMALS system into CVN–78. At the conclusion of our presentation, our brief presentations, we will stand ready to answer any and all questions, sir.

[The joint prepared statement of Admiral Architzel, Captain Mahr, and Captain Antonio can be found in the Appendix on page 40.]

Mr. TAYLOR. Thank you, Admiral. If you would, please.

Admiral ARCHITZEL. Today's carriers in the fleet, the *Enterprise* and the 10 *Nimitz* class carriers, the catapult launches are accomplished through steam systems. Steam is stored, if you will, in wet accumulators. For the stored energy in the case of steam catapults is the steam system. And it is stored in wet accumulators where you have steam pressure available to launch aircraft.

When we commence a launch sequence, the aircraft is taxied to the catapult. A launch bar on the nose gear of the aircraft—we generally use all launched nose gear tow today—is extended, which locks itself onto the catapult on the above-deck space on the flight decks itself. Below decks, as you see, are ready to go, the airplane is brought to full power. It is being held by a trail bar.

And at that point—if you would hold the video, I do appreciate it. Thank you. If I could just for a second explain what steam is first—and held in place by a trail bar. Full power is applied. And when the deck edge operator touches the deck to launch the airplane, steam is released to the pistons below deck, which are accelerated and connecting to the shuttler, which is on the airplane—accelerate the airplane through about a 360-foot power stroke to reach the end speed required for that airplane based on its type model series, required wind speed, wind over deck and conditions that exist on that day.

Once the airplane is airborne, the shuttle—this catapult and the piston below decks is stopped physically mechanically by a water brake system. A spear on the front of the piston enters the water—physically enters a tank of water about 15 feet long. And the energy is absorbed in that water brake from the launch with the—to stop the piston. That piston is then retracted mechanically to set for another launch.

So, in essence, that is the steam system today. What is different about EMALS would be the—well, different and several similarities. But the biggest one would start with the concept of stored energy now is electromagnetic energy that is stored in the system. So power is drawn from the ship's electrical distribution system and stored in electrical storage units, of which there will be 12 on the *Ford* class. And that energy is available for the launch.

The aircraft positioning on the catapult is the same as on steam catapults. But once you get ready to launch and the deck edge operator touches the deck to launch, that stored energy, electrical energy is translated through a power conditioning system to the linear motors that run the length of the catapult, that 360-foot power stroke. And a moving magnetic wave is in—is passed through the stators, which is the linear motors.

In between those linear motors is a block of aluminum, represented by what I have in my hand. And on top of that, which is now the armature, is the shuttle I talked about, which attaches to the airplane. And as that moving magnetic wave, which is represented by this magnet, passes—this is nonferrous, so it is aluminum and a magnet—that magnetic field goes along.

It induces the current into the armature. The armature generates its own magnetic field. The magnetic fields are latched together, and it pulls down the track. If I put this on my desk and just physically move the magnet over the aluminum, you can see that I can stop or start this slide of aluminum right in my hand. That is the fundamental principle behind what is the electromagnetic launch system.

When the airplane reaches the end of the stroke and that energy is provided again to—significant power, more power than the steam catapults can provide—when it reaches the end, the block of aluminum now, which is the armature, is stopped electrically as well. There is no need for water brakes. It is stopped electromechanically, if you will, just by changing the frequencies induced into that field.

And then you can retract the shuttle without having to have a retraction engine and the mechanics that go with that. So there is several advantages to the system that go in with the EMALS. And you end up with more uniform acceleration, positive speed control throughout the length of the catapult stroke, elimination of the labor-intensive systems, far less wear and tear on the aircraft and the ship. And that is the goal behind the fundamentals behind the EMALS system.

The video you are going to see now is essentially—if you would run that, please—describes what I just went through and discussed in terms of understanding what a catapult launch is. So thank you.

[Begin video.]

The first part is positioning the aircraft on the catapult. It is just taxiing forward. And as is the case with any topside changes, really insignificant the—that portion of it is the same, whether you go from EMALS or steam systems today—in the Jet Blast Deflector (JBD) positions itself on the catapult.

You can see the storage device represented there below with the energy storage. Aircraft is on the catapult. The next step would be to—and it describes the major subsystems that go with launching as I described them—power conditioning, launch system, launch control and launch motor, as mentioned.

The aircraft comes forward, the launch part comes down. JBD comes up, applies full power to the airplane. And as then you take the moving magnetic field as the induced on the motors, the airplane is shot off. And you would then retract and continue with the second launch.

[End video.]

That is the fundamentals behind the launch sequencing. And I will turn it over to Captain Mahr for a description of the EMALS system in more detail.

STATEMENT OF CAPT. RANDY MAHR, USN, PROGRAM MANAGER FOR AIRCRAFT LAUNCHING AND RECOVERY EQUIPMENT (ALRE), U.S. NAVY

Captain MAHR. Sir, with your permission, I will stand and point to the board, sir.

Mr. TAYLOR. Please, sir.

Captain MAHR. Mr. Chairman. (OFF MIKE)

Mr. TAYLOR. Thank you, Admiral.

[The joint prepared statement of Captain Mahr, Admiral Architzel, and Captain Antonio can be found in the Appendix on page 40.]

Mr. TAYLOR. Captain.

STATEMENT OF CAPT. BRIAN ANTONIO, USN, PROGRAM MANAGER FOR FUTURE AIRCRAFT CARRIERS, U.S. NAVY

Captain ANTONIO. Good morning, Chairman Taylor, Ranking Member Akin, distinguished members of the subcommittee. Thank you for the opportunity for me to talk about the—my exciting program. It is certainly a great time to be a part of it.

Mr. Chairman, as you mentioned in your opening statement—in your statement, I am very interested in EMALS's development as I am, of course, of all the other developmental systems that are going onboard CVN–78 and the 21 class. With your permission, sir, I also have a couple slides that I would like to speak to.

Mr. TAYLOR. Please, sir.

Captain ANTONIO. First and foremost, ship construction for 78 is on track. And that construction is being supported by the design, including the 3–D product model. This is the first aircraft carrier that will be completely designed three dimensionally. That 3–D product model is 96 percent complete. And the chart that I am showing here is a shot from a 3–D—the completion of initial construction drawings for the ship stands at 41 percent, about 6,600 of 16,000 construction drawings. And those construction drawings are the product of the 3–D product model.

The drawings are completed ahead of construction—so the design is complete. The construction drawings are completed prior to beginning any of the construction on the ship. And those are—in order to take advantage of any—work done in the yard.

The congressional approved advanced construction we received—advanced construction authority we received for CVN–78 allowed us to get a running start into the advanced construction for the ship. And, in fact, since the time of contract award in September of 2008, we had about 300 of the whole units of the total number of about 1,204 structural units completed. And for those of you that are not familiar, the structural unit is similar to some of the building blocks you see depicted in this chart—for a different purpose. But the building blocks of the structural unit are depicted there.

For CVN–78 those units, structural units are built—there is some initial outfitting and some load-out of equipment into those units, especially large equipment. Some of them are combined to form super lifts. Some of them come out of shop as first and final and are loaded into the dock to build the ship.

On CVN–78 there is a total of 497 erectable lifts that will go in and make up the *Gerald R. Ford*. Once in the dock, additional outfitting and meeting with other units occurs until the ship is capable of being launched from the dock. And then—make sure the ship itself—the ship works.

As of today, the total number of 1,204 modules—the shipyard has begun work on 571 of those modules and has completed 450, or about one-third. About one-third of the ship in terms of structural fabrication is complete—and it allows us to prove out—that was brought online by the shipbuilder in order to support CVN–78. This ship is coming together incredibly well. And by any of the—to make a visit to the shipyard. I would be more than happy to help arrange for a tour. But every time I go down, I see more progress. And it is incredibly impressive to see—coming together.

Our next construction model—that is when we join the first units that are placed in the dock—join them together in the dry dock. And that is on track for mid-November of 2009, so only a few months away—I will get into a little bit about EMALS integration—my boss, Rear Admiral McMahon, the—for aircraft carriers and I visited Northrop Grumman shipbuilding and reviewed the EMALS integration and construction plan with the shipbuilder, including being able to don some 3–D glasses and virtually walk in some of the places where some of the arrangements are ongoing for EMALS——

From the construction perspective, the key EMALS activity that is important to get us to launch, which is currently scheduled in 2013, July of 2013, is going to be delivery of the motor generator unit. You have heard the admiral mention the energy storage system—with the motor generators. These are the 40-ton units that Captain Mahr showed earlier.

As I mentioned—and in particular, the first 8 of 12. And what I have got shown on this particular chart—and you have it on your desk as well—is two—these super lifts, as you see, depict the relative location of the first eight. There will be four loaded into each of these——

The ship is built completely different from the way a house is built. A house is framed and then items are brought into the house—the way a ship is built is they—around the dock or—early as possible in the construction sequence to do as much work as possible because it is the most efficient and least costly way to build a ship.

In the case of the motor generators, these are very large pieces of equipment. And to try to load them after we have built the whole ship would mean—very inefficient movement pattern throughout the ship.

And next is depicted as far as the load-out of the motor generators. What I show here is the orientation of the first four EMALS—generators loaded into the super lift that will form that wall unit that you saw in the previous chart.

The shipyard will receive the motor generators, do some preparatory work for it, bring it down to the unit, load it in—will be loaded out with the equipment that needs to be put in—put on. And then it will be loaded into the shop.

This shows how the—after ship's launch from July 2013 to ship delivery in September of 2015, the—delivery of the ship is going to be—linear motor subsystem. Installation of that linear motor subsystem in the catapult across on the ship and then the integrated testing of the entire EMALS system on the ship leading to—launching to show that the system works.

So again, recapsulating—before launch I am looking to the motor generator—after ship's launch—ship's loading I am looking at delivery of the linear motor subsystem. These are the two subsystems for the EMALS production—that have the least amount of schedule float, least amount of slack, if you will, between the time they are delivered—between the time of construction completed to the time of delivery—to the shipyard.

With that said, the current production integrated IMX—integrated—for EMALS support CVN–78 on time delivery. All required—are met. The amount of oversight that is in place—mentioned the—Office of the Secretary of Defense (OSD) oversight—continue to manage and be in place to make sure that EMALS is delivered—CVN–78. And we are ready to do that—that is all I have.

[The joint prepared statement of Captain Antonio, Admiral Architzel, and Captain Mahr can be found in the Appendix on page 40.]

Mr. TAYLOR. Thank you, sir.

We are going to go—we are very fortunate to have a physicist, an engineer, a retired Navy captain, and you and me. So we are going to turn to our engineer to start the line of questioning.

Mr. AKIN. Thank you, Mr. Chairman.

Captain, this whole area of project management has been something that our committee has been paying attention to. We have made some mistakes in other kinds of projects. One of the things that concerned us particularly was changing project managers all the way down the line. You change your horse not once in a battle, but four or five times. And that doesn't work very well.

And partly at the insistence of this committee, but perhaps for other people, too, you were the unfortunate person that was singled out because you have made a good reputation for yourself to be chained to this project for a certain period of time. And I think the first and the most important principle that I am curious about is do you feel you have the authority to basically manage this project and be in control of that? Obviously, a lot of that time schedule is not in your control. There is other vendors and different people.

But our concern is that there is one person that we are looking at that we are counting on, particularly to bring EMALS in. But I gather your responsibility is for the entire ship. First of all, is your responsibility the ship?

Captain ANTONIO. Yes, sir. My particular role is the CVN–78 program manager. My responsibility is for the entire ship working with the shipbuilder, Northrop Grumman shipbuilding down in Newport News. Captain Mahr is the EMALS program manager responsible for——

Mr. AKIN. So you have the whole ship, and Captain Mahr has got specifically the EMALS? Okay. And you are going to be around long enough to stay on top of this? Okay.

Because that is our concern. We have seen other places where everything is fine, everything is fine, everything is—we are double over budget and two years late or whatever it is. That is the kind of thing that we can't afford on this project.

Now, the EMALS itself, I think, is what the subject of our hearing is. And it is particularly because you are saying it is critical path to bring the project on time.

First of all, you have got something that you called storage units which are motor generators. How do you consider a motor generator to be a storage unit?

Captain MAHR. Sir, through the rotation of the motor generator maintains roughly 4,000 revolutions per minute (RPM). That is holding the electric kinetic energy, if you will.

Mr. AKIN. So you get big flywheels in these suckers? Is that what you are saying?

Captain MAHR. It is an electric flywheel, but, yes, sir. It is a very good analogy.

Mr. AKIN. But where is the electric energy stored?

Captain MAHR. It is in the generator itself. So the generator is holding the energy. It is maintaining 4,000 RPM. When a command discharge, the energy is commanded out of the motor—or drawn out of that generator.

Mr. AKIN. Okay. I have just been told it is a high-mass rotor. In other words, it is like a flywheel?

Captain MAHR. Yes, sir. It is——

Mr. AKIN. When you pull the trigger to launch, the motor generator loses its velocity?

Captain MAHR. Yes, sir. It draws down some of that energy and immediately starts trying to command it back up to speed. So as soon as I command launch, we are trying to drive energy back in to keep it at the max RPM.

Mr. AKIN. Okay. Now, the electrical energy that you are getting originally is coming from the ship's generators?

Captain MAHR. Yes, sir.

Mr. AKIN. And that is in the form of alternating current (AC) or direct current (DC) ?

Captain MAHR. AC, sir.

Mr. AKIN. AC power? It is going to a motor, which is an AC motor.

Captain MAHR. Yes, sir.

Mr. AKIN. Which is then going to go to a generator, which is a DC generator? Is it a modified AC?

Captain MAHR. You are talking about the motor generator itself?

Mr. AKIN. Right. The motor is an AC motor——

Captain MAHR. Yes, sir. We transmit the energy via DC for lower line law.

Mr. AKIN. Okay, so you have AC power coming from the ship's generator.

Captain MAHR. (OFF MIKE)

Mr. AKIN. It goes to the motor.

Captain MAHR. Yes, sir.

Mr. AKIN. The motor is an AC motor. It is spinning at 4,000 RPM.

Captain MAHR. Yes, sir.

Mr. AKIN. Driving a generator, which is a DC generator.

Captain MAHR. Yes, sir.

Mr. AKIN. The DC generator then is connected through a series of cables to the actual track.

Captain MAHR. Yes, sir.

Mr. AKIN. And you call them motors, which are really linear motors on each side of the aluminum block is going to run down these things?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. Now, when the process of putting this project together there is certain—obviously, there is new technology. The whole thing is new. And so, whenever you do something new, you are worried about bugs. So how much have you actually tested of this entire system? Have you actually put these motor generator full scale together and taken aluminum block and done this? Or is this all being done just modeled? Or do we actually have one that we have built?

Captain MAHR. Yes, sir. In the program definition and risk reduction (PDRR) phase, the competitive phase where we looked at both competitors we built a full-scale, half-length prototype, which was—which included——

Mr. AKIN. A full-scale, half-length?

Captain MAHR. Full scale, but half-length.

Mr. AKIN. Okay, so——

Captain MAHR. That went to the catapult track.

Mr. AKIN. Okay.

Captain MAHR. And that was built up at——

Mr. AKIN. So the amount of energy that you are transmitting and the amount of force and everything is full scale? It is just it is not running as long as the—okay.

Captain MAHR. Yes, sir. We demonstrated the ability to launch at bedload, which is a non-manned—it is an unmanned aerial aircraft, but it is something on wheels up to the speed of 150.

Mr. AKIN. Okay. And so, that is going through. Were there any surprises and things we learned in that, or not particularly?

Captain MAHR. From the physics point of view, no, sir. From the engineering point of view, we did learn some things. We took what we learned there and put it into the system we are now developing. So from 2004 until now it has been maturing that system into a ship-ready system. And we have——

Mr. AKIN. Well, there have been some problems on it. Is that right?

Captain MAHR. Yes, sir.

Mr. AKIN. What exactly were the problems? It is much more expensive now. General Atomics did us a favor and charged a whole lot more, right, because some things happened that made it more expensive?

Captain MAHR. Yes, sir.

Mr. AKIN. Where did we get off the track to start with?

Captain MAHR. From an engineering perspective, we have found a lot of things. We have tested the—we have completed one main phase of test, and we are in the process of finishing the next two main phases of test. The motor generator, as we have been talking about——

Mr. AKIN. So the first test was you took motor generators, the right size, and you demonstrated it half-length?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. And that is done. Was that the first phase?

Captain MAHR. That was done in 2004 in the—under the current contract for development, we took—we built a full motor generator that we intended the production representative of what we put on the ship. We put that in Tupelo, Mississippi, at General Atomics plant. And we ran that over a simulated 2,000-year output life.

So it is what we call 10,000 launch cycles on that. And we completed that last September. And we proved that the motor generator itself is capable of putting out the appropriate amount of power over 10,000 times.

That same motor generator then we went into what we call—that was high-cycle test, phase one. We are now in high-cycle test, phase two. We are not quite 80 percent through that. For the same motor generator I have accumulated about another 10,000 cycles on that one. And this time we have taken the motor generator. We have added all of the other components up to, but not including the linear motor. And so, I am putting the electronic components and running power through those.

In those two tests we found out things about the motor generator. We found that the vent—it vented oil mist into the air. And so, we had to put a demister on it. We found out that there were some oil leaks that we had to deal with. From a performance perspective, the only significant thing we found was that the motor generator shaft vibrated. It was the design point that we thought we would—or the operating point we had designed for was to have that—have a stable operating condition of 4,200 RPM.

We encountered there are critical points—as you are aware, there is critical points in any rotor where you will see some vibration. We wound up seeing one above 4,200 RPM, and then we started seeing some vibration near 4,200 RPM.

We identified the root cause of that to be associated with the bearing cooling where the main shaft bearing. It is an overhung mass on the bearing. It is cantilevered out. We changed the bearing to what we call a fore load bearing to provide additional cooling oil over the shaft. And the vibration was taken care of.

We have now retrofitted the four motor generators that are built and installed up in Lakehurst, New Jersey. Three of those are currently retrofitted. The last one will be retrofitted shortly. And that will be the configuration that we will take to the ship.

Mr. AKIN. Is that what cost us the extra money, was a different bearing design and different cooling in the bearing?

Captain MAHR. That did increase the cost of the unit a little bit. But it wasn't the cost—the cause of the overrun that got us to where we are today. The cause of the overrun where we got to today, sir, is—do you want me to go down that?

Mr. AKIN. Just quickly.

Captain MAHR. Okay. Real quickly, we planned a test schedule that was aggressive and optimistic. We were unable to execute that test schedule. The cost of materials went up to build some of the equipment. So that cost us.

Mr. AKIN. Was it on the motor generator? Is that what was——

Captain MAHR. Part of it was on the motor generator. But we use a fair amount of raw materials throughout the unit, so they spread that across everything. And then the labor. We identified that General Atomics and their—specifically and their industry partners needed about another 80 work years of engineering staffing. So we had to plus that up as well as we found the same thing on the—Navy needed additional——

Mr. AKIN. So what are you concerned about now?

Captain MAHR. What keeps me awake at night, that kind of a question?

Mr. AKIN. Yes, how do you make sure we are staying on schedule? What are the key things you are really watching? And do you have the authority that you need to make sure—do you know this is your project? And do you feel like you own this thing?

Captain MAHR. Yes, sir.

Mr. AKIN. And you going to be with it?

Captain MAHR. I have full responsibility for the EMALS system.

Mr. AKIN. Okay.

Captain MAHR. If you are looking for that one belly button, that belly button is me.

Mr. TAYLOR. If the gentleman would yield?

Mr. AKIN. I yield.

Mr. TAYLOR. No, in this year's bill I would remind you that we directed the secretary of the Navy to appoint someone—we didn't name the officer—to take this from present through testing. We encouraged him to have a six-month transition where someone would right seat, left seat. And then we directed him to have a second officer in charge from testing through delivery. So——

Mr. AKIN. Great. I just wanted to make sure because we have been in hearings before. And somebody is theoretically responsible, but it seemed like they weren't really. We just want to make sure that you really feel like you have got—you are on top of this and that you are going to be keeping an eye on it.

Captain MAHR. Sir, I feel absolutely responsible for EMALS delivery and development.

Mr. AKIN. And you know where your critical paths and pieces are all the way down the line?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. So then what keeps you awake at night then? I don't want to run too long, but——

Captain MAHR. Yes, sir. The critical path right now to system function administration, which is the major phase of testing we do next where we start launching debt loads up at Lakehurst, is getting those linear motors installed in the trough at Lakehurst. The motor support structure is a key to that. And it is—forward structure block 29 that will be delivered to—from the manufacturer precision custom components to Tupelo, Mississippi, in September. And then we have to outfit it with the linear motors and ship that up to——

Mr. AKIN. Let me try and get a mental picture then. What I am really seeing is you have got—basically got these motor generators, which are great, big hummers. And you have got to make sure those are working. You are pretty comfortable now the design on that is working okay.

Captain MAHR. Yes, sir, no problem.

Mr. AKIN. And you got some solid state controls that are basically controlling the electricity that is the DC power that is going to go from those to the motor in the launch system. Are you pretty comfortable with that? Is that straightforward?

Captain MAHR. Yes, sir, we are operating the control system right now up at Lakehurst.

Mr. AKIN. Okay. Then you have got the motors, which is basically, I assume, big coils that run the entire length of the track. Is that correct?

Captain MAHR. Yes, sir. They are more of an iron bar magnet with coils of wire around it. But yes.

Mr. AKIN. Yes, that is what I mean, coils with an iron. And that is creating a magnetic field on both sides of the aluminum plate?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. Then the aluminum plate is going to slide down this track of some kind, right?

Captain MAHR. Yes, sir.

Mr. AKIN. Now, what is the tricky part of that?

Captain MAHR. The tricky part of making it work will be controlling it. It is knowing where you are all the way along the track so you can keep the force pulling it forward and you don't retard the motion. And that will be part of the control system. We have showed it works in the PDRR. We have to build the catapult up at Lakehurst to prove it. There is fundamentally no challenge that we haven't encountered before that we—it will be a communication issue. It will be a closed look control issue. But that is——

Mr. AKIN. Now, these coils that are around this—the iron core—are there all these things separate so that you basically are energizing a whole series of them?

Captain MAHR. Yes, sir, I have in each—I have—four-foot section. In each four-foot section there are four individual motors. And then I have 29 of the 12-foot sections.

Mr. AKIN. Okay.

Captain MAHR. So in each——

Mr. AKIN. And you install that after the carrier is pretty much built? Those come straight down from the deck?

Captain MAHR. The catapult pieces will come in from the deck, yes, sir.

Mr. AKIN. Okay. So that is pretty straightforward. As long as you have got that working, you—that is top down kind of thing, whereas the motor generators, that is built way down. And that is what you have got to make sure that is in?

Captain MAHR. The motor generator is the earliest component after delivery of the ship.

Mr. AKIN. And then the aluminum plate piece—is that also a top down kind of installation?

Captain MAHR. Yes, sir. Yes, sir.

Mr. AKIN. So you are not as worried about that from a critical path point of view, other than the fact it has to be ready when you want the ship ready?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. Now, how about getting the DC power from your motor generators to those motors? Is that any particular problem from a craft point of view or the kind of insulation you need or cables? Or is that very straightforward?

Captain MAHR. I am hesitant about saying anything is very straightforward. We are putting together a very complicated system. But the technology within transformer rectifier—transformer rectifier has been around for a long time, so we understand what that is. We are talking on a fairly large scale. So there are some complexities there.

When we look at the inverters and the rectifiers and control circuits that we have to do, the process of tuning them is understood. We have to take our time and go through it. In fact, that is what we are doing right now down in Tupelo with one of the circuits. We are doing that control.

If I can get back to the linear motors for a second. I would be remiss if I didn't talk about—the challenge we are facing right now with the linear motors is keeping the interior of the motor drying so that I don't wind up with any short circuits in there.

The—which I didn't mention earlier. But it is up at Lakehurst, New Jersey. They are spraying it with a sodium dioxide fog as well as a salt fog and raining water onto it. We did find some moisture intrusion. We believe we know three likely ways that that is getting into the motor.

One of them is in the test motor only. It won't exist in production. The other two are where the cables connect into each of the internal stators. And then we believe there may be some coming in through some location.

Mr. AKIN. What voltage are you running DC when you hit that thing with full power?

Captain MAHR. I am sorry, sir. I can't remember that number off the top of my head. About 10,000 amps.

Mr. AKIN. But generally, you are talking a very high voltage or—over 1,000?

Captain MAHR. It is roughly in the neighborhood of 1,000 volts and 10,000 max peak on each side.

Mr. AKIN. So salt water doesn't work very well with that kind of voltage?

Captain MAHR. No, sir. We have a floating ground built inside that we are still operating it—we are operating the motor wet in haul because we believe it is safe to operate. We want to get the motor dry when we go to the ship. So we will work our way through that one.

Mr. AKIN. Yes.

Thank you very much, Mr. Chairman and for your forbearance.

Mr. TAYLOR. Thank you, Mr. Ranking Member, for an excellent line of questioning.

We now turn to Captain Massa.

Mr. MASSA. Thank you, Mr. Chairman. I appreciate the opportunity to ask a few questions.

And, First Admiral and Captain, personally thank you for your incredible focus on this very important issue and, frankly, for the service of the thousands of men and women who you represent here today whose life's passions are in maintaining and building our Navy.

I fear I am at somewhat of a loss in that I know a couple of you from many, many years ago. But I remind all that I am at my soul just a country guy from upstate New York.

You obviously know a great deal about the nuts and bolts of this system. And the Navy has focused incredible resources on this.

Vice Admiral Architzel, a very blunt question, if I may. What if this does not work?

Admiral ARCHITZEL. The technology now is critical to the ship. So let me answer the question by saying the Navy recognizes that first and foremost. In the past year, we have done a number of steps—over the past several years—a number of steps as outlined in my written testimony. But I want to take a moment to—specifically asking you to use.

You started with a program assessment review, which began when we first knew we potentially could have some issues then with the system and where we were and where we thought we would be, both in terms of cost and schedule and technical issues that were going to come up. That program assessment review done with accommodation of industry and—pointed to the fact that we needed to increase both systems engineering, which is what Captain Mahr spoke to, as well as our government oversight.

There were changes made in the General Atomics (G.A.) team, General Conger's team. There were changes made within the program management team. Coming out of those program assessment review, it took a while to really analyze what recommendations were and then incorporate those recommendations.

Many of those recommendations, Ranking Member Akin, were what drove costs into the program because to take those recommendations and implement them forward, drove manpower into the programs and that brings with it attendant costs. And we also identified some areas that needed corrected. And we corrected them.

Following that, the Under Secretary of Defense, then Mr. Young, directed that a DST, or defense support team, review be conducted of the EMALS system. That was done. The findings of that in summary were basically that we—recommendation concurrence to proceed with this system, but pointed to the fact that we needed to do some additional risk mitigation, which was also incorporated going forward.

As we continue to move forward, we were not satisfied with where the program was headed, so we initiated a three-star level ex-com review, which is executive committee review, which was made up of members of NAFC, the NAFC system commander specifically, their system commander and representatives from the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L)), a—myself as the chair. And we went to review with—take a round turn on the program again with the program managers, only this time to answer four basic questions: were the requirements met, what were our alternatives, what would those alternatives be, did we have the right program management in place to proceed with this, both in a government and in the industry team and what was our schedule commitment and what was our cost, where would we stand with—unit costs and average unit costs.

We took the findings of that committee to a series of briefings which culminated with the CNO, the Chief of Naval Operations to make a decision on whether to stay with EMALS or to look at a different ship. CNO took the information, made a decision. That decision made is now the path we are on, is the path to come forward with the EMALS system.

So what I will tell you is we are committed to the EMALS system.

Mr. MASSA. Admiral? Admiral?

Admiral ARCHITZEL [continuing]. EMALS, then we—it is not—we are past that.

Mr. MASSA. Thank you. What happens if it doesn't work?

Admiral ARCHITZEL. Sir, I have every expectation this EMALS system will, in fact, work.

Mr. MASSA. I don't want to appear insistent. Indulge me and allow me, please, to ask the question one more time. What happens if this does not work?

Admiral ARCHITZEL. With all candor, sir, the—if that system were not to work—it is a system that we are confident will work. And we are going to make every effort we have to make sure it does work.

Mr. MASSA. I am a little rusty on engineering. And you guys are very much active experts on this. Help me a little bit for just a few moments.

In linear induction motors, by my calculations, yours has a 348-foot long throw length. As the stator which is stationary imparts a large electromagnetic field. And we are talking in something here of 10,000 amps amplified through a pipe of 1,000 volts. So your measuring goes in somewhere in the mega ranges.

As that electromagnetic pulse precedes the shuttle during those 348 feet, one would suppose there is a peak spike of initiation and a peak spike on braking. Has anyone measured that in real-life terms? For any of you gentlemen.

Captain MAHR. Yes, sir, during the PDRR phase that we conducted up at Lakehurst we had on the front of the dead loads during the launch—we had an M.I. measuring circuit so we——

Mr. MASSA. Is that information in two- or three-dimensional graphic format available in an unclassified manner that I could be briefed on?

Captain MAHR. Yes, sir.

[The information referred to is classified and retained in the committee files.]

Mr. MASSA. I would appreciate that. I would also like to get some understanding of how specifically in Joint Direct Attack Munitions (JDAMs) and other exceptionally sensitive weaponized systems that electromagnetic interference (EMI) and electromagnetic pulse (EMP) is going to be grounded and mitigated, even if it is so much as to precede the airplane by nine feet, which by my calculations is where that pulse will spike in front of the nose of the aircraft. The A/NSP–118 on the F/A–18 is very sensitive, as you know. Any—to the point where we during weapons handling on any conventional carrier today shut down all electromagnetic interferences forward of the island. Now we are introducing a tremendously new variable.

Is it a true statement—well, ask me this. Has this ever been done outside of your half-length, full-power tests in any navy anywhere?

Captain MAHR. If you just clarify, sir. Has what been done?

Mr. MASSA. An all system been used?

Captain MAHR. No, sir.

Mr. MASSA. So this is the first time?

Captain MAHR. Yes, sir.

Mr. MASSA. And we are at the cutting edge of the technology?

Captain MAHR. Yes, sir.

Mr. MASSA. And if it works, we are it. We have saved 30 percent of the interior volume of the hull, a 20 percent reduction in crew and associated lifetime costs. These are all figures that are very, very attractive. I will state for the record, gentlemen, first I was against the Navy shifting to the construction of the *Ford* class and taking such a large leap of technology simultaneously new propulsion systems, weapons systems, electrical distribution systems, flight deck layouts, et cetera. I think it is a bridge too far with exceptionally high risk and very little mitigation capabilities.

Secondly and for the record, I am exceptionally concerned about the inability to extract an answer to the simple question of, "What happens if it does not work." The reality is, gentlemen, we will have just bought the world's largest helicopter carrier.

And that will, in fact, so totally impact the future of the Navy as to the reality that my limited imagination can't express the overall results. This committee and myself will do anything to help. But I am very, very worried about this leap in technology. And I would like to have that reflected in the record.

Thank you, Mr. Chairman.

Mr. TAYLOR. Thank you, Captain Massa, for an excellent line of questioning.

For the record, Captain, Admiral, I would like to know which of the weapons systems that the captain brought to your attention have already been tested within the electromagnetic pulse of these—this system.

Captain MAHR. Sir, what the Navy—the design of the weapons accounted for pulses of this frequency. We are in the process—the Navy has never had a source of energy in this frequency before. So we are now in the process of working with naval air warfare center weapons division, take those in and develop a—go through the tests——

Mr. TAYLOR. When will those tests be conducted, and when do you expect them to be completed?

Captain MAHR. They will be happening over the next year, sir. So we will have periodic—we will take several weapons in through the test——

Mr. TAYLOR. Yes, I would hope that you would stay in very close touch with the committee——

Captain MAHR. Yes, sir.

Mr. TAYLOR [continuing]. With the results of that.

Mr. Wittman, were you here at the gavel? We turn to the gentleman from Tidewater area, Mr. Wittman.

Mr. WITTMAN. Thank you, Mr. Chairman.

Admiral Architzel, Captain Mahr, Captain Antonio, thank you so much for joining us. I want to start out and just make a comment. You know, we are kind of pushing the envelope. We are during this span of time going to go from 11 to 10 carriers as we phase in the *Ford* and phase out the *Enterprise*.

It kind of puts us in a position where if there are challenges out there, we are going to be pushed to the max. I am confident in the Navy's assurance that strategically we will not let our guard down during that period of time. But it is even more incumbent to make sure that systems such as EMALS and the new systems on the *Ford* class carrier are functional and that we stay on schedule. And obviously scheduling issues there create larger problems for us down the road.

I wanted to learn a little about the decision making process and where we are. I understand about 18 months ago that General Atomics put in place a new management and oversight team. I wanted to learn a little bit about why that was necessary and if we believe that the current problems that we are—well, the problems that we had experienced there were simply an issue of poor management or if there were other issues there along the lines that have led to some of the hiccups in the EMALS program.

Admiral Architzel, I will direct the question to you.

Admiral ARCHITZEL. I would like to begin, and I will send it back over to Captain Mahr. But to directly address your question, the program assessment review was specifically designed to uncover what were our areas of concern and focused on both the government and the industry side.

Mr. WITTMAN. Okay.

Admiral ARCHITZEL. On the industry side we found that General Atomics did not have the systems engineering in place, personnel in place to really bring this from the development stage into production. And working with General Atomics, we agreed they have since hired a team in place to do this. We are confident they have the right people in place to make that happen.

And concurrent with that we also looked at the Navy program offices, both program offices here. We looked at both Naval Sea Systems Command (NAVSEA)—were they working together technically enough to address many of the things we were starting to discuss today about risk and were—could we—our assurance to have that done.

Changes were made in our government structure within how we go about doing technically to do the things. And a clear articulation of who was responsible, which goes back to the chairman's point about Captain Mahr and Captain Antonio, specifically Mahr and EMALS. I think I would like to have Captain Mahr continue the answer.

Captain MAHR. Sir, the brief answer to your question is yes, the changes were required. And, yes, they have been effective. In this case with management, it is always hard to find the exact thing that didn't go well. But all together I would say neither the Navy nor General Atomics appropriately staffed where for the level of technology production we were going to have to deliver. As a result of that, we got behind in our development and design such that the critical design review was pushed out by several months and then broken up into incremental phases.

That is not necessarily bad by itself. In fact, it allowed us to get a good look at each of the systems. But it was an indicator we had a problem. General Atomics stepped forward, brought in the appropriate level of management and as noted earlier, have continued to hire additional experienced managers and engineers from well-represented major industry representatives.

And then on the Navy side, we brought in a significant number of people and kept up over 50 work-years in Naval Air Systems Command (NAVAIR) alone and about the same in——

Admiral ARCHITZEL. I think there is another piece that Captain Antonio should answer, sir, also that goes to concerns about ship integration and making sure that this system and the ship are ready for that as well. Because there were changes made on that side as well.

Captain ANTONIO. Yes, sir. The Production Assessment Review (PAR) recommended—PAR recommendations were not just for General Atomics or just for the Navy. In fact, there were changes made at the shipbuilder as well. Northrop Grumman implemented a—or put in place a specific project manager whose sole function is EMALS integration. And so, we have an effort funded through the shipbuilder to make sure that the communication path is there, that they are a part of our technical governance and part of our overall management of the system through the development cycle in SDD so that those lessons learned can be imported over into the ship.

An example of that is as the initial pieces of the linear motor structure are being put in the trough in Lakehurst, we had Northrop Grumman shipbuilder production folks onsite watching how that install was going, making recommendations for how things ought to happen on the ship.

So all of this was a part of the PAR findings that we needed, different leadership and organization and different design integration leading to production on the ship. So we have addressed those.

Mr. WITTMAN. Thank you, Mr. Chairman.

Mr. TAYLOR. Thank you, Mr. Wittman.

Admiral ARCHITZEL. Mr. Chairman, could I just——

Mr. TAYLOR. Yes, sir, Admiral.

Admiral ARCHITZEL [continuing]. Correct one—I feel like we should correct one thing, or at least I should. When we talked about this technology all concerns—this is high-energy electrical systems. And we do have a technology that is far advanced. It was a competition between the Northrop Grumman design and the General Atomics design.

The graham ring technology of the General Atomics design was chosen, which is a core iron hull and a copper, well, u-shaped outer coating. And then that is wrapped with litz wire. And the current that goes through that linear motor is AC current, three-phase AC that goes down that motor.

So I think we had said some things about DC, and I want to make sure we don't have something that is misinterpreted here. So just a technical aspect that when you end up with the linear motor, you end up through the power conversion systems at the linear motors you are sending three-phase AC through those wrapped windings, which is what gives you that traveling magnetic wave down the linear motor itself.

The second point was the AC system from the ship is 13 AVA plus—wire, which sends 800 volts DC into the storage system generator. It is just a couple things that were said that were just to clarify.

Mr. AKIN. You have thoroughly confused me now. Let us start at the beginning. Okay? You start with the ship's generators. They are generating what?

Admiral ARCHITZEL. Thirteen eight K AC power.

Mr. AKIN. AC power?

Admiral ARCHITZEL. Yes, sir.

Mr. AKIN. That runs to the motor generator?

Admiral ARCHITZEL. Runs through a transformer rectifier that comes up and rectifies it to 800 volts DC. And I will let——

Mr. AKIN. So it is converted before it even gets to the motor generator to DC? It is a little more complicated than I thought.

Admiral ARCHITZEL. Yes, sir.

Mr. AKIN. Then you have got a DC motor spinning at 4,200 RPM.

Captain MAHR. There is an exciter on one end. And that is where you get the electrical acceleration from. So we run it into the exciter and that is what actually spins up the generator on the other side.

Mr. AKIN. Okay, so the motor is running from a converted AC to a DC. So it is a DC motor.

Captain MAHR. Yes, sir.

Mr. AKIN. It is running. It is spinning a generator, which is generating, what, DC power?

Captain MAHR. AC.

Mr. AKIN. AC power?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay. It is generating AC power, which is a three-phase AC, which is then going up to the actual static motors that are running along the launch?

Captain MAHR. In the middle for the transmission lines we transmit it as DC.

Mr. AKIN. You transmit it as DC? So—solid state we can flip it back whichever way we want at our convenience?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay.

Admiral ARCHITZEL. And the reason you do that just for the length of transmission on that.

Captain MAHR. You want more losses in the long line.

Mr. AKIN. I would love to ask another question, but I think I want to——

Mr. TAYLOR. Mr. Chairman, you are—I mean, Mr. Ranking Member, have at it.

Mr. AKIN. Well, one other thing. If you have got a large pulse of magnetic force near the aircraft and you have already tested this thing at half-length, have you ever stuck an F/A–18, just sit it there, not to launch it, but just sit it there and let that power go across it and see what had happened? The reason I ask that years ago I was in charge of maintenance at a steel mill. And we put some transformers in to power the electric arc. For instance, they had carbon rods about the size of telephone poles that you drop into—three of them that you drop into scrap. And it makes lightening. And it uses a fair amount of electricity.

Well, we had at a time where those transformers, there would be eddy currents that would just vaporize a two or three-inch bolt that, you know, that you didn't know where they were going to go. So there is—when you start dealing with tremendously high power kinds of things, that can have some influence.

You have got a magnetic field anyplace you have got a wire that is inducing. So I guess my question is can you stick an F/A–18 there with its radar and all that kind of stuff and just fire this thing off a few times and check? Because it would be nice if we could launch them. It would be better if we could launch them and have the thing working when it gets up in the air, too, you know.

Captain MAHR. Yes, sir. In fact, that specific test is planned as soon as we get the Lakehurst catapult operating. We will sit an F/A–18 astride the trough, and we will move the armature underneath it to see what the affects are. It will be—airplanes, but we ought to be able to get a lot of good data off of that. I don't expect there will be any problems.

Mr. TAYLOR. I apologize for interrupting again. The timeline on that is what? On that test?

Captain MAHR. I will have to get back to you on the exact date, sir. I don't know that date off the top of my head.

Mr. AKIN. We are talking a year or two away? Or——

Captain MAHR. No, next year, sir.

Mr. AKIN. Next year?

Captain MAHR. Yes, sir.

Mr. AKIN. Okay.

Captain MAHR. It will be during our system function demonstration.

Mr. AKIN. On paper what do we think from an engineering point of view? Will it be okay?

Captain MAHR. Yes, sir. NAVAIR looked at that, and we—the specific engineers for our EMI team have worked at it and it does not seem an issue.

Mr. AKIN. Okay.

Admiral ARCHITZEL. Ranking Member Akin, there is significant data that—and we will get back with Representative Massa and his request. I have done this before. We will come back again to him to clarify.

In the production development and risk reduction phase, which is the PDRR—was an acronym used, so I want to put that one—that was the initial—in that phase, we had antennas actually on the sleds that were pulled down to measure these fields. And the fields were measured, both the magnetic fields around and in the area of the—that data exists, sir.

And so, what the plan that Captain Mahr is talking about is to further go through both looking at—although we don't expect there to be Hazards of Electromagnetic Radiation to Ordnance (HERO) or Hazards of Electromagnetic Radiation to Fuel (HERF) or Hazards of Electromagnetic Radiation to Personnel (HERP). Those are electromagnetic magnetic interference for ordnance or fuel or personnel. That is in our test plan. And we are going to continue to look at that. So it is not like we are adding that to the plan. That plan exists. It has been throughout the program.

Captain MAHR. And we have been doing component-level testing down at Tupelo, Mississippi, on the actuated power trains. We have had antennas down there gathering the M.I. data. We have not seen anything abnormal outside of what we——

Mr. AKIN. Thank you.

Thank you, Mr. Chairman.

Mr. TAYLOR. Thank you, Ranking Member.

We now want to recognize the previous chairman of this committee, a physicist and our resident expert on electromagnetic pulse, Mr. Bartlett.

Mr. BARTLETT. Thank you very much. We have had a really excellent discussion of the technical problems that resulted in the cost overruns and the delays. But I would like to spend just a couple moments of reflecting on how we got here and lessons learned from that.

In a previous life I was privileged to work for the Navy and then for a captive Navy contractor, the Johns Hopkins University Applied Physics Lab where we wrote requests for proposals (RFPs). And then I moved to the industrial world. I worked for eight years in IBM Federal Systems Division where we responded to the kinds of RFPs that I helped write when I was working for the Navy and for the Johns Hopkins University Applied Physics Laboratory.

And there is an interesting and unavoidable phenomenon. It is characterized as optimistic assumptions of cost and development by the staff who put together a little briefing for us here. When I wrote for the IBM Corporation, that was kind of characterized by the biggest and best liar won. The person can be the best presenter for a very overly optimistic program of cost and assumptions is going to win the contract.

So they wouldn't let us do that at IBM. We couldn't lie. And so, we operated at a disadvantage in getting contracts. And this is all not intentional. Obviously, the people working on this are very optimistic about it, very confident in their abilities and so forth.

But the Navy had in one sector of their development a real advantage. And that was the applied physics lab. And they have shepherded through many, many years now the fleet ballistic missile system development through all of the fleet ballistic missiles. And they were looking over the shoulder of people like you in the Navy who are running the program, advising them as to whether or not this proposal from industry was likely to work.

And the applied physics lab is a unique organization. I think it is the only one in the country that will not compete with industry. And since it will not compete with industry, industry will share with it its deepest, darkest proprietary secrets so that the applied physics lab can be in a position to advise the Navy in what is likely to work and what will not work because the contractor is always going to be overly optimistic about what he can do and about how quickly he can do it and how low the costs will be.

Since we don't have in other parts of the Navy that kind of a— and there are 3,800 people there, about half of them really professional people. We don't have that anywhere else in the Navy. What can we do so that—you know, if you came into this program after the contract was let, you were handed a dog that couldn't hunt. And, you know, what do we do to avoid that in the future if we don't have other APLs to help us in other parts of the—of our procurement in the Navy?

Admiral ARCHITZEL. Well, I think the—we absolutely do value the work of APL and those laboratories and technology assets we do have to apply to this. And going down in this program, as we mentioned, some of the—one of the tasks was on the defense support team, which included industry representatives and also laboratory expertise, as you were mentioning, to go back and tell us did we have this right as well.

So Representative Bartlett, I just think I agree with you that we need those—we need that both within our laboratories as well as within our capability to know because that is where the expertise resides. And so, I don't argue for a minute that we need that kind of ability to call on because we need it to know the experts in the field, if you will.

Mr. BARTLETT. But neither you nor we have the depth of experience and knowledge that an institution like Johns Hopkins University Applied Physics Lab have. Wouldn't it be advantageous if we had those in other parts of our procurement so that we could have that kind of support and guidance?

Admiral ARCHITZEL. I can only agree. But I think they are available to us to call on them through—as needed through—when we have those kind of technical challenges. We can reach out to industry or laboratories to have that brought in in addition to our own field activities that have that expertise, perhaps not as great as—because we have new technology and we have to reach out to them to bring that as well. And I believe we do.

Mr. BARTLETT. I have been here nearly 17 years now. And the story has never changed. Every program is late and over cost. And, you know, what can we do to avoid repeating this in the future? And it all comes from the honest assumption on the part of the industry and those who are looking at the proposal that, gee, we really can do that. We need to have that. We really can do that.

And, you know, how do we avoid the problems that are created by this overly optimistic assumptions of cost and development, which apparently is the fundamental root cause of the schedule overruns and the cost overruns in all of our programs? How can we avoid that? Now, the APL helped the Navy to avoid that by saying, you know, that is just overly optimistic. They are not going to be able to do that.

Admiral ARCHITZEL. I believe what comes with this is proper systems engineering. And I don't use that as a catch phrase. I believe it. And we have come to that over the past year and-a-half as we have in the Navy taken a round turn on our process to come forward with program development and to take what it means to take a requirement and then give it to industry and say go build this.

When industry gets that, they don't understand enough of what it takes to build that to give a realistic estimate at times. So what we have to do is translate that requirement down into a lot more detail, which goes into systems design specification, that allows industry to know exactly what it is we want them to build. And they can then properly price and give us properly pricing to what it would be.

To your point sometimes this is not delivered or intentional, some—it would just be a not understanding what are the "-ilities" that go with this. What does it mean to have to develop a system or a ship that will go 50 knots versus one that may go 42 knots or to have this high-power, high-energy system and be able to launch aircraft at 70 million foot pounds to 150 knot end speed in a 360 power stroke, 360-foot power stroke when the Key Performance Parameter (KPP) just says make a sortie rate or reduce people.

And so, we have to really understand that industry can get in and—we don't need just to say you can do this. But what does it really take to get there? And that is the work we have to do. We owe it to this committee. We owe it to the Navy. And we are working diligently to make that happen across the board.

Unfortunately, a lot of our programs are well past this stage. And we are living with the—what we didn't do in the first. But I will tell you in future programs and forward that is exactly our intent, to not replicate this in the future. But I know that doesn't answer your question today because you would like to see it in all programs that have happened in the past.

And we needed to do that. And we need to do that as we go forward. That is as straightforward an answer as I can give you. I think you hit exactly on what we need to do. And we intend to do that, sir.

Mr. BARTLETT. Thank you.

Thank you, Mr. Chairman.

Mr. TAYLOR. Thank you, Mr. Bartlett, again, with a great line of questioning.

The chair now recognizes Mr. Coffman.

Mr. COFFMAN. Thank you, Mr. Chairman. I think this was an interesting lesson in acquisition reform. And I think the committee has made great steps in terms of providing some guidance in having one individual responsible for this project, that is going to stay with the project.

Mr. Chairman, I am a simple Army, Marine Corps infantry guy. And I would like to defer to some of the other members that have expertise, technical expertise if they would like to ask any other questions and defer my time.

Mr. TAYLOR. Thank you, Mr. Coffman.

Any follow-up questions? I have a few myself, but I would certainly want to let you gentleman go first.

Mr. BARTLETT. I appreciate very much the hearing. I am sorry I have got to run. I am now a half-hour late. But it was so important I stay. Thank you very much.

Mr. TAYLOR. Thank you, Mr. Bartlett.

Mr. Wittman.

Mr. WITTMAN. Go ahead, Mr. Chairman. I can follow-up after you.

Mr. TAYLOR. Gentlemen, a couple of quick things that I am curious about. I will use the analogy we have a new generation of turbine. You can look at a previous generation, look at the new one and have some idea whether you are repeating a past mistake or making improvements—diesel engines, bombs.

With so many of these technologies being new, I am curious what you use as your benchmark to know if you are going in the right direction. So I am going to ask a couple questions along that line. With the motor generators, is there anything similar to that commercially available anywhere of that size or capacity right now?

Captain MAHR. There are commercially available motor generators. They don't have the same power density that we do. So we have——

Mr. TAYLOR. By a factor of what, Admiral?

Captain MAHR. I can get you that answer, sir. I have not done an industry survey recently.

Mr. TAYLOR. Well, give me an idea. Is this twice as large, 10 times as large? It is something that you could go out and——

Captain MAHR. I will go back and get—I believe we are less than twice as power dense as the commercial ones. We are not a huge leap. And we have to go back a little bit in history.

In 2004, we were pretty far ahead. But commercial technology has caught on.

Mr. TAYLOR. All right. Okay, your prime power interface system, the one you are going to use for this program—is there something similar to it that is on an existing Navy program? Is this substantially larger than anything else you are using?

Captain MAHR. No, sir, it is comparable to what industry uses.

Mr. TAYLOR. Okay. So you don't expect any surprises there?

Captain MAHR. No, sir. Transformer rectifiers have been around for a long time. The control technology has been around. So this is really tuning it for our circuit.

Mr. TAYLOR. And I realize there is not another electromagnetic launch out there. But is that technology being used, again, commercially in a different form but similar form? And where would that be?

Captain MAHR. Yes, sir. Linear induction motors are used in various applications in industry. We are at a larger scale, obviously, than most of those. But the graham ring motor is a well-understood technology.

Mr. TAYLOR. And it is used where, Admiral?

Captain MAHR. I will get you some examples. I don't have any off the top of my head.

Mr. TAYLOR. Just for my information, your motor generator is spinning at 4,200 RPM. How much does it drop with each launch?

Captain MAHR. If I can just make a statement. It was 4,200 RPM—we are now operating at 4,000.

Mr. TAYLOR. Okay.

Captain MAHR. We lowered the operating point a little bit. Over a sequence of launches if we launched a full deck of aircraft, the motor generator will bottom out somewhere around 2,400 RPM.

Mr. TAYLOR. How much, sir?

Captain MAHR. Two thousand, four hundred.

Mr. TAYLOR. Okay.

Admiral ARCHITZEL. Mr. Chairman?

Mr. TAYLOR. And the recovery time is what, sir, the recovery time to get that——

Captain MAHR. It starts immediately, sir. So it comes back up. Over a very brief period of time it will be back up to 4,000.

Mr. TAYLOR. I am sorry to cut you off, Admiral.

Admiral ARCHITZEL. No, sir. Pardon me for interrupting. I think it might be helpful, sir, to answer that specific question if Captain Mahr would walk us through what goes on during these high-cycle testing of the generator because it cuts right to your exact question.

Mr. TAYLOR. We would appreciate that, Admiral.

Admiral ARCHITZEL. And I think he can provide the answer, both—in three different scenarios it will show you how these are—this exact phenomenon is measured.

Mr. TAYLOR. Sure.

Please, Admiral.

Captain MAHR. What scenario?

Admiral ARCHITZEL. Carrier launches.

Captain MAHR. Okay.

Admiral ARCHITZEL. Cyclic ops.

Captain MAHR. Yes, sir. In the high-cycle test ongoing at Tupelo right now we have three different scenarios, three main scenarios. We have a carrier qualification launch scenario. Carrier qualification in the Navy generally has a lighter weight aircraft and we launch them more frequently. And we have a cyclic ops scenario where you launch combat-weight aircraft, so a fully loaded aircraft. But you only launch 24 at a time for standard launch event.

And then mission capable, which is degraded launch mode where we still want to launch the same number of aircraft for a cyclic ops event but we understand that we lose some capability, either motor generator is not available due to maintenance or some other issue or we lose one of the motors itself on the——

In the carrier qualification episode, when the launch is commanded and the pulse is sent out, we have got a motor generator operating at 4,200 RPM. There are 12 of those throughout the ship. All 12 of them can supply energy to all four catapults.

When the launch is commanded, the power system as a whole starts drawing down. What we simulate in high-cycle tests is that coming off of one generator. That generator starts to draw down as soon as the generator power starts drawing down, the setter side draws power off the ship's power and tries to bring it back up. So even as I am pulling the RPM down, just like a flywheel, on the other side I am trying to spin it back up.

So we are constantly feeding energy back into the system and trying to keep it at in a static sense. Each time I launch in between launches is about 45 seconds. The energy starts coming back up and will not quite reach 4,200 RPM. And we will command another launch. It comes back down again.

And we see this sawtooth curve. And sawtooth curve at the bottom will bottom out at about 2,400 RPM before it starts coming back up. We repeat that sequence, again, accumulate close to 20,000 pulses on each of those three types of——

Mr. TAYLOR. It is my understanding that the A1B power plant on the *Ford* class is designed to go the entire life of the ship without refueling. Is that correct?

Captain MAHR. Sir, I defer to Captain Antonio.

Mr. TAYLOR. It is not?

Captain ANTONIO. No, sir, it is not. There will be a refueling complex overhaul plan for the *Ford* at about mid-life.

Mr. TAYLOR. And mid-life is expected to be what?

Captain ANTONIO. At about the 25-year point. The ship's life is being designed for 50 years.

Mr. TAYLOR. As a matter of curiosity, how much of that 25-year life is used up in the launch of aircraft? What do you envision?

Captain ANTONIO. Sir, I am not qualified to talk about the propulsion plan. I would have to defer that question and get back with you.

[The information referred to can be found in the Appendix on page 53.]

Mr. TAYLOR. Okay. I would be curious, obviously. It is going to be a new draw on the power plant that was not there in previous platforms.

Going to Mr. Bartlett's excellent line of questioning, you are can-do people. You do not come before Congress and say we can't do it. That is a double-edged sword. And we do often find ourselves with programs like the littoral combat ship (LCS) where can-do people suddenly find out that the can-do attitude wasn't enough to make up for a contractor that failed.

With that thought, I am particularly concerned with the line of questioning that Captain Massa had as to what affect this is going to have on the electronics systems of the aircraft that you launch, on the weapons systems of those craft. I would remind you that former governor, now Secretary of the Navy Mabus actually used his power as governor of Mississippi to prevent the Empress barge from being used off our shores some 20 years ago.

So it is something that the secretary is aware of, the electromagnetic pulse that goes back at—and what I would hope is not the case is that in the Navy's effort to get what I consider to be a great technology on this vessel that we are intentionally downplaying the affects on some of these systems and intentionally low-balling the cost of whatever changes would have to come as a result of that, not so much to the EMALS system, but all the other electromagnetic platforms that are associated with that vessel, which goes to my line of questioning about how quickly—and Mr. Wittman's line of questioning and Mr. Akin's line of questioning. How quickly are you going to test this in conjunction with all the other things that are going on on that ship?

Captain MAHR. Yes, sir. And I think the best way to answer it is to come back, again, to the PDRR. I was able to locate the data I had. The general limit right now would be 150 millivolts for HERO, hazardous emissions to ordnance.

In the testing we did with the full-scale, half-length catapult we never exceeded 120 millivolts. It is typical to work 40 to 80 millivolts. At the height above those troughs where you would see the ordnance test fired aircraft pass by. So we have got the field data from real tests that say we are okay.

The challenge that you give us and we have already accepted ourselves is go through that. And that is a process that can take place over the next year. I am going to go validate that in the laboratories. We are going to put the instrumented aircraft over the catapult trough. We will continuously measure it. We will be doing that in high-cycle tests at the component level. And I will owe you a future brief on the data that comes out of those tests.

Mr. TAYLOR. And whose job will it be to inform congress of the unintended consequences and the affects that it has on other systems?

Captain MAHR. Sir, I have responsibility——

Mr. TAYLOR. That is your job?

Captain MAHR [continuing]. For the EMALS program.

Mr. TAYLOR. Okay.

Mr. Courtney, do you have any questions?

Mr. COURTNEY. I am just taking a break from health care.

Mr. TAYLOR. This is probably a televised hearing. It is probably the wrong place to hide, Mr. Courtney.

Anyone else?

Yes, Mr. Wittman?

Mr. WITTMAN. I just wanted to ask another additional question and understand a little more about the administrative aspects of the things that have gone on. If you could, if you could explain the difference between what is in place now, the undefinitized contract action that is there with General Atomics on the EMALS for the USS *Ford* and the final contract action that you are pursuing. Can you tell me: Are both of those fixed price contracts?

And where do those two frameworks lead us if they are risks that come up down the road? In other words, if there are things that throw us off schedule if they are production issues, if they are performance issues there. Who assumes the risk there, both from a function standpoint and then also from a time standpoint? Because as we know, if we get pressed on this, you see the—we have seen the windows here are fairly small as far as making sure all these pieces work.

Who assumes the risk there? Because we all, as Mr. Bartlett said, we all get concerned about timing on this. And I brought that up as far as the production schedule for the *Ford* in relation to the *Enterprise* going out and that 3-year window where we go from 11 to 10 and then also the cost considerations on this. I just want to try to get you all to put that in perspective on what the differences are between those two.

Captain MAHR. Yes, sir. On the—contract action that the Navy and General Atomics signed on June 30th is the not-to-exceed price that will when we definitize the contract in the standard for definitizing that contract is 180 days, which would put it at the end of December. We definitize at or below the not-to-exceed price.

Mr. WITTMAN. Okay.

Captain MAHR. And will be a fixed price contract.

Mr. WITTMAN. Okay.

Captain MAHR. So I believe your comparison is fair that——

Mr. WITTMAN. Okay. And the final contract action then is going to be fixed price also?

Captain MAHR. Fixed price contract.

Mr. WITTMAN. Where is the risk assumed?

Captain MAHR. Any changes that come out of the systems design and development test, as an example—so if—I have talked about the wet motor. We have some moisture intrusion. The changes that come out of that are included in the cost of that contract. Any change I find in SDD I will fund SDD to develop the nonrecurring engineering on that. And that will be handed over to be included in the ship's—CVN–78 at no additional cost to the government.

Mr. WITTMAN. And so, you will also have that reflected in the final contract action? Also it is in the——

Captain MAHR. Yes, sir. That wording is currently in the undefinitized contract. That is already there.

Mr. WITTMAN. Okay. All right, very good.

Thank you, Mr. Chairman.

Mr. TAYLOR. Mr. Akin.

Mr. AKIN. Thank you, Mr. Chairman.

I had a couple of just kind of, "gee whiz" questions here to try and get a better perspective on what you are doing. First of all, in terms of your energy storage, you decided to go basically with a motor generators approach. Did you consider using capacitors or something like that? Or is this way beyond what we can do with a bank of capacitors?

Captain MAHR. There are other technologies out there that may be applicable out in the future. At the time the total contract was proposed, General Collins was proposing the motor generator. So we did not look at changing that from the—proposal. And——

Mr. AKIN. That is an old tried and true kind of thing in a way. But in terms of energy density, I suppose that is something that you are thinking about is how much space is it taking and all. But it does seem like it is—in a way, even though it is old, it seems like a bank of capacitors or something in a way are somewhat simpler. But——

Captain MAHR. There is battery technology. There is other technology out there for future ships, again, beyond CVN–78 that the Navy is looking at—and to Representative Bartlett's comments, that the labs are working on right now.

Mr. AKIN. Okay. And then the second thing, I guess, is the question is if you have this capacity to store up a lot of electrical energy and discharge it, would this ever be used in other kinds of weapons systems? Have you looked at that at all or not particularly? Or is that classified?

Admiral ARCHITZEL. Well, it is being looked at other systems. As an example, that would be the rail gun.

Mr. AKIN. Say again.

Admiral ARCHITZEL. A rail gun technology, which uses the same kind of technology. That is prototypical in development. That kind of technology is used there, as an example. And you mentioned——

Mr. AKIN. Where would that be sort of an anti-missile type of system or something or what?

Admiral ARCHITZEL. The technology is just to at this point would be to accelerate a projectile, which can get to significantly high speeds. I would like to end the conversation—the discussion there because it does get into other areas. But that is an example of one. And also using technology like this can go into transportation systems as well when you get into use of electromagnetics on rail transport. Those kinds of things are being looked at, both commercially as well as could be looked at——

Mr. AKIN. I was thinking lasers because our chemical airborne laser stores energy chemically to get a lot of energy all stored up.

Admiral ARCHITZEL. Yes, sir.

Mr. AKIN. This is a different way of storing some energy.

Admiral ARCHITZEL. Yes, sir.

Mr. AKIN. Yes. Just a couple of, you know, popular science questions.

Thank you, Mr. Chairman.

Mr. TAYLOR. Admiral, I know that, again, going back that you are an admiral because you are a can-do person. You accept the challenge when you are given to it. You don't question orders. But going back to Captain Massa's question, is it fair to say that should this program, for whatever reason—its affect on other weapons systems, its affect on other ships nearby—for whatever reason failed to materialize, would the delay be more than two years? And would the additional costs to the taxpayers to finish this carrier be more than $2 billion?

Admiral ARCHITZEL. Mr. Chairman, to that question directly, if we had to—yes, the answer would be most definitely more than two years and would be a significant cost.

Mr. TAYLOR. So what do you think it would be, sir?

Admiral ARCHITZEL. I really don't have a cost estimate. Although I do think that to go—in our discussions and come forward, sir, this year about with the CNO and about taking this to discussion—should we stay with EMALS—our discussion should we stay with EMALS or revert back to steam, at that time we looked at anywhere from 12 to 18 months delay if we had made the decision, say, 6 months ago. So to make that decision in the future would clearly be one, that when the decision was made by the CNO, we looked at—he looked all of us in the eye and particularly to the Systems Command (SYSCOM) commanders and myself and Mr. Stackley and said now we need to deliver on this system.

It clearly is a decision made. And without having that would be at least a two-year delay. And the cost would be significant.

Mr. TAYLOR. For stability purposes, is the size, weight and placement of the EMALS system—if it had to be replaced with a steam catapult—does that put you in a situation as far as stability and your center of gravity, center of buoyancy where you cannot finish the ship?

Captain ANTONIO. The last part of your question threw me there, sir. I was going to say that the relative weights and location of the steam system compared to the EMALS system are not that significant. There is some weight difference in some locations in terms of center of gravity which would require a difference of the placement of some ballasts in the ship.

But it is not to the point where the ship design would not be able to accept it if it were possible to do it if a decision were made. It would just be extremely costly and time-consuming.

Mr. TAYLOR. And just for the benefit of the committee because particularly I know the gentleman from the Tidewater area is very keenly aware of the delivery of carriers, as he should be—but for the benefit of the committee, what is the domino effect to our now 10-carrier fleet should this ship not be delivered on time? Aren't there vessels that are fairly close to retirement that we are planning on this vessel taking the place of?

And doesn't that not put—I mean, again, just to give—make the members aware of the gravity of this decision. Worst case scenario, the vessel is delayed by three years. How many carriers do we have then?

Admiral ARCHITZEL. Sir, the *Enterprise* is scheduled to decom or deactivate in November of 2012. At that point, the *Ford* will deliver, as mentioned, September of 2015. So the next carrier—what you have remaining at that point is the *Nimitz* class carriers.

So you have—to that is the *Nimitz* itself. And so, she will run up towards 50 years. And I will have to get exactly when that is. But she comes in around the time we would be, on the current schedule, somewhere close to when we would be with the next CVN–79 delivered. So that is about the timeframe—to put you on the 2012, 2013 timeframe.

Mr. TAYLOR. This is a reminder we did give the Navy in this year's bill temporary permission to dip down to, I believe, 10 carriers. And so, the failure for this ship to deliver on time makes it, not just a three-year permission. It could extend it out to six, seven years. And that is why, again, for all the reasons that you have heard our concerns today that this has to work.

I would like to tell the committee that I had a lengthy conversation with the secretary of the Navy on this last Friday, that he is very much onboard with our language to have a clear line of authority as to who is responsible for this program, a clear transition from one officer to another. And, again, I very much appreciate you gentlemen being here today.

If there are no further questions, I would hope that on those things that were unanswered today that you would get back to us. Is two weeks a reasonable amount of time to get those answers?

Admiral ARCHITZEL. Yes, sir, we can do that, Mr. Chairman.

Mr. TAYLOR. Okay.

Any further questions? The subcommittee stands adjourned.

[Whereupon, at 11:37 a.m., the subcommittee was adjourned.]

APPENDIX

JULY 16, 2009

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

JULY 16, 2009

Opening Statement of Congressman Gene Taylor
Chairman, Subcommittee on Seapower and Expeditionary Forces
Committee on Armed Services, U.S. House of Representatives
Oversight Hearing on the Electromagnetic Aircraft Launch System
July 16, 2009

The subcommittee will come to order.

Today the subcommittee meets in open session to receive testimony from officials of the United States Navy on the current status of the Electromagnetic Aircraft Launch System, or EMALS. The EMALS system is an electromagnetic catapult designed for use on the Ford-class aircraft carriers. If the system delivers its full promised capability, the Ford-class carriers will have a catapult system which is far superior to the steam catapults of the Nimitz-class. The operational advantages are increased launch envelopes, that is, the ability to launch both heavier and lighter aircraft than steam catapaults, higher sortie rates, reduced weight, reduced mechanical complexity, reduced maintenance, and reduced carrier manning.

Unfortunately, what brings us together today is that the development of this program is so far behind schedule that it threatens the delivery date for the USS Ford. For the record, I would like to briefly summarize the history of this program and the current status:

EMALS was a core capability in the design of the next generation aircraft carrier, which the Navy called "CVN 21" for "21th century" technology, and which eventually became the USS Ford (CVN 78) class. In 1999 the Navy entered into technology demonstration contracts with two different contractors; General Atomics and Northrop Grumman Marine Systems to develop prototypes for an electromagnetic catapult. By 2004 the Navy down-selected to the system proposed by General Atomics and entered into a System Design and Development contract, or SDD contract, to build a full scale, ship representative prototype at the Navy test facility in Lakehurst, New Jersey. That prototype was contracted to be completed in time for testing to begin in 2007, testing was to have concluded after two years and presumably the lessons learned from the test program would influence the final production system which would be shipped to the carrier construction yard for erection into the ship. It is now July 2009 and full scale testing has yet to begin at the Lakehurst facility. The Navy is now faced with almost complete concurrency of testing and production of the first ship-set if they are to meet the in-yard deliver dates to keep the USS Ford on schedule. There are a number of sub-systems to the complete EMALS system and each subsystem has different in-yard deliver dates, but some of those dates are as early as the summer of 2011, and to meet those dates the production of the components or at least the ordering of the material for the components must begin now—before full scale testing of the prototype system has begun. To be fair, some testing has already occurred. The High Cycle Test for the Energy Storage System is well underway, as is the Highly Accelerated Life Cycle Testing of the launch motor segments. Those tests have identified some minor redesign issues which can be incorporated into the production components. But until a full scale catapult launch from the prototype occurs, questions will remain on the systems overall performance.

I have been briefed, as I believe other Members of this subcommittee have been briefed, that the issues in completing and delivering the SDD components were a result of the contractor's inexperience managing a major production effort. I find that answer unsettling because it is the Navy's responsibility to oversee what their contractors are doing and to identify problems before they are problems. I will note that a little over a year and a half ago, the contractor did put in place an entirely new management and engineering team, hiring away proven production engineers from both General Dynamics and Northrop Grumman. This new team seems to have righted the ship, but that ship is still in very dangerous seas.

So what we have is a program that is so essential to the carrier that if it does not work, the nation has paid billions of dollars for an unusable ship. If the system is delayed, the carrier is automatically delayed. And every day of delay will push the cost of that carrier higher.

This is the first in what I intend to be a series of hearings on this program over the next few years. This is too important to not have close congressional oversight. I intend to continue close oversight of this program until it is delivered, installed, tested, and certified for launching naval aircraft off the deck of the USS Ford.

Our witnesses today are:

VADM David Architzel, Principle Deputy to Assistant Secretary Stackley

CAPT Randy Mahr, Program Manager for EMALS

CAPT Brian Antonio, Program Manager, Ford Class Aircraft Carrier

VADM Architzel is representing the Assistant Secretary as the senior acquisition executive who is ultimately responsible for all Navy and Marine Corps acquisition programs. CAPT Mahr, is the official whose only responsibility is this program. CAPT Antonio is responsible for building the entire carrier—he obviously has an interest in the success of EMALS.

This year's National Defense Authorization Act directs the Secretary of the Navy to keep CAPT Mahr in his position until the completion of the system development testing and the successful production of the first ship-set of components. That means the CAPT, who has been selected to the rank of Rear Admiral, will be in place for another few years and will have the opportunity to visit with us again on this subject.

I would now like to call on my friend from Missouri, the Ranking Member of this subcommittee, the Honorable Todd Akin for any opening remarks he may wish to make.

REMARKS—

VADM Architzel, I understand you will deliver the combined opening statement. And I also understand that you have a short movie that will demonstrate how the EMALS system will work on the ship. Please proceed.

Akin Opening Statement for Hearing on Electromagnetic Launch System for the Gerald R. Ford Class Aircraft Carrier

Washington, D.C. – U.S. Rep. Todd Akin (R-MO), Ranking Member of the House Armed Services Subcommittee on Seapower and Expeditionary Forces, today released the following prepared remarks for the subcommittee's hearing regarding the electromagnetic launch system for the Gerald R. Ford Class aircraft carrier:

"Thank you, Mr. Chairman, and welcome to our witnesses. We appreciate your willingness to appear before us today. As the Chairman has indicated, the Electromagnetic Launch System, known as EMALS, is a critical part of the military's largest and most expensive ship, the next generation aircraft carrier. The EMALS system is important because of the capability it delivers to the Gerald R. Ford-class carrier, allowing our Navy to increase its sortie generation rate and the carrier to launch both heavier and lighter aircraft, in more operating conditions, than is currently possible. This is a significant attribute, because the first of these carriers will be in service until at least 2065, and in order to maintain its relevance, the carrier will need to be able to launch F-35s, UAVs, and whatever else we may develop in the meantime.

"Additionally, EMALS is important because the schedule delays and cost growth experienced by the system have put the construction and cost of the carrier in jeopardy. As this subcommittee has noted on multiple occasions, the scale of our investment in aircraft carrier construction means that even small increases in cost have the potential to break the bank. Other shipbuilding programs have recently seen cost growth of close to 200 percent. If the carrier grows by even 10 percent, the impact is in the billions of dollars per vessel. Simply put, the EMALS program has no room for error. It must deliver on time, or put the carrier at risk. To get there, the EMALS program must engage in con-current development and production of the first ship set—a practice we know well from past experience is highly risky.

"But there is some good news. The contractor has been holding to schedule since the beginning of the year and has agreed to a fixed price production contract. The Assistant Secretary of the Navy for Research, Development, and Acquisition got personally involved and conducted an in-depth review of the program. Secretary Stackley has elected to proceed with the effort, a decision that I agree with, but has taken several steps to strengthen the management of the program. One of these steps includes lengthening the tour of the current program manager, CAPT Mahr, who is with us today. I have often noted that one of the first lessons I learned during my time at IBM, is that for any project to succeed, you need to have one person who is in charge. CAPT Mahr, this subcommittee has heard many good things about you, and your colleague CAPT Brian Antonio, the CVN 21 Program Manager. But we will be holding you to a very high standard. This is your baby and you must deliver. The consequences for the rest of naval shipbuilding are too great to tolerate anything less.

"In conclusion, I am interested in learning more today about the contract you are putting in place with the EMALS contractor for the production ship set, and the activities required to conclude system development and minimize risk to the CVN 21 program going forward. Thank you again for being here. I look forward to your testimony."

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NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
SEAPOWER AND EXPEDITIONARY WARFARE
SUBCOMMITTEE

STATEMENT OF

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PRINCIPAL MILITARY DEPUTY
RESEARCH, DEVELOPMENT AND ACQUISITION

AND

CAPTAIN RANDY MAHR, USN
PROGRAM MANAGER FOR AIRCRAFT LAUNCHING
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AND

CAPTAIN BRIAN ANTONIO, USN
PROGRAM MANAGER FOR FUTURE AIRCRAFT CARRIER

BEFORE THE

SEAPOWER AND EXPEDITIONARY WARFARE SUBCOMMITTEE

OF THE

HOUSE ARMED SERVICES COMMITTEE

ON

ELECTROMAGNETIC AIRCRAFT LAUNCH SYSTEM (EMALS)

JULY 16, 2009

NOT FOR PUBLICATION UNTIL RELEASED BY
THE HOUSE ARMED SERVICES COMMITTEE
SEAPOWER AND EXPEDITIONARY WARFARE SUBCOMMITTEE

Chairman Taylor, Ranking Member Akin, and distinguished members of the Subcommittee, thank you for the opportunity to appear before you today to report on the development of the Electromagnetic Aircraft Launch System (EMALS) for Gerald R. Ford (CVN 78) class aircraft carriers and the Department's plan ahead for this effort.

Steam catapults will continue to deliver the minimum required aircraft launching capability and remain the launching system on the NIMITZ-class aircraft carrier for the next fifty years. However, the steam catapult system limits the full potential of the inherent improved capability of the FORD-class aircraft carrier. As modern aircraft, including the Joint Strike Fighter, grow heavier and require higher launching end speeds, and the maintenance man-hours required to maintain the readiness of the steam catapult increases, it is imperative that the Navy continue development of a launching system with reduced manning and increased operational availability. In response to meeting this future need, EMALS is being developed for the CVN 78 class to replace the steam catapult system. EMALS design requirements support the CVN 78 sortie generation rate Key Performance Parameter (KPP) through increased reliability and system capability. It provides a higher energy launch capability as well as an expanded launch envelope to support future airwing capabilities. EMALS is also projected to reduce shipboard manning requirements, improve aircraft launching system maintainability, and provide better control and more efficient application of acceleration forces throughout the aircraft launch cycle.

EMALS development began with a competitive prototyping effort between General Atomics (GA) and Northrop Grumman Marine Systems in 1999. The Navy down-selected to the GA design in 2004 following completion of approximately 1500 launch demonstration events conducted on both competing systems. Based on the successful prototype testing, the Navy awarded the EMALS System Development and Demonstration (SDD) contract to GA in 2005, which is scheduled to complete in early 2012.

The EMALS program is currently executing the test portions of the SDD phase and procuring long lead time material as it begins production of the CVN 78 ship set. Near term events such as successful completion of High Cycle Test (HCT) Phase I and commencement of High Cycle Test (HCT) Phase II, Highly Accelerated Life Testing (HALT), as well as start of commissioning testing for System Functional Demonstration (SFD), will validate the system design and enable transition into production. HCT II testing of a complete power train, with the exception of the launch motor, is ongoing at the GA Tupelo, Mississippi site. HALT testing of the launch motor is taking place at the Naval Air Warfare Center test site in Lakehurst, NJ. Production Readiness Reviews (PRRs) are currently ongoing to support release of EMALS subsystem components for production. Baseline drawing packages are projected to complete by the end of FY 2009.

Full scale, full length testing of EMALS, including the launch of manned aircraft, is scheduled to begin at Lakehurst during the summer of 2010.

Concurrent with testing, EMALS manufacturing and production efforts began in December 2007 with the first Long Lead Time material procurements to support CVN 78 required in yard delivery dates and will continue through 2014 for delivery of all CVN 78 ship set components. The Navy has placed an undefinitized contract action (UCA) with a not to exceed value with General Atomics leading to an Advanced Acquisition Fixed Price contract for the remaining ship set material. Definitization of this contract is targeted for later this year. The Navy's and GA's support for a fixed price contract reflects our collective confidence in the EMALS' technology maturity and capability. The contract will be based on the EMALS performance specification and Procurement Data Packages. Specific component production release will be tied to Production Readiness Reviews and successful completion of specific test events. The Production Integrated Master Schedule shows the program will meet CVN 78 production required in yard delivery dates.

As EMALS progressed through SDD tests and began the transition to production, schedule delays and cost overruns were experienced. A series of actions aimed at improving management of the EMALS prime and subcontractors were taken by the Navy. In late 2007, Navy leadership initiated a three-month independent and in-depth Production Assessment Review (PAR). The PAR provided specific recommendations for processes and leadership improvements, which are being implemented. Most recently, senior Navy leadership conducted a detailed assessment of the viability of continuing with EMALS or reverting to a legacy steam catapult system for CVN 78 based on indications that schedule and cost performance was declining. After an extensive review, the Navy re-confirmed it's commitment to EMALS as the CVN 78-class aircraft launching system, while implementing additional actions to improve performance and mitigate risk.

The production contract will ensure rigorous management and oversight. In April 2004, the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)) established a critical technology Integrated Product Team (IPT) to maintain oversight of all CVN 78 critical technologies, including EMALS development. Additionally, the Navy has implemented two detailed reviews to identify needed improvements to support better schedule and cost performance while completing technical efforts. The review of the PAR in 2008 provided a thorough assessment of GA's ability to transition from development to production and to support the CVN 78 production schedule. The Navy aggressively implemented many of the PAR recommendations including leadership changes, new program and technical governance processes, increased involvement of the shipbuilder and a revised test program to mitigate production schedule risks. A three-star Executive Committee, which includes the OPNAV resource sponsor, Commanders of the Naval Sea Systems Command and

Naval Air Systems Command, and the Principal Military Deputy for ASN RDA meet quarterly for program reviews and to provide oversight of EMALS development. Most importantly, direct responsibility for EMALS is being executed by the NAVAIR program manager for Aircraft Launch & Recovery Equipment (ALRE), who reports to PEO TACAIR and COMNAVAIR to support delivery of this new program within cost and schedule.

Issues with cost and schedule performance have created overlaps between production component manufacturing and system level testing. Cost and schedule performance have not been where they need to be. Recognizing this, the Navy has taken steps to better define needed testing, improved management oversight, insisted on near term definitization of the UCA into a fixed price contract, and increased funding to the program to cover anticipated growth. With system level testing ongoing the potential for additional cost increases and schedule delays remain. However, the Navy is putting additional oversight in place to maximize performance and minimize the likelihood of overruns. Given the advantages that EMALS is projected to afford the next generation of aircraft carriers, these actions are essential for providing the fleet what it needs.

Component, subsystem, and system testing is identifying technical issues, retiring technical risk, and demonstrating the capability of the EMALS. Key to the Navy's strategy is having a management team in place both within the Navy and at its prime contractor that is aggressively attacking these issues and retiring risks on a schedule that supports ship construction. We are working hard towards these ends. The management focus, review processes and oversight that the Navy is employing are mitigating future EMALS SDD phase technical, cost and schedule risks. The Navy will leverage management processes established during the SDD phase by building upon these lessons learned during system production and ship integration, including the extensive involvement of the shipbuilder in the production and integration process. A rigorous process exists for incorporating the results of upcoming testing in the production baseline which will mitigate cost and schedule risks of concurrency between the SDD and production phases. The Navy has also taken steps to include, as mentioned previously, the use of fixed price contracting where appropriate, to control EMALS cost and schedule variances during the subsystem production phase.

Mr. Chairman, the Navy understands the concerns you and your subcommittee have expressed, and is aggressively working to improve performance. We are implementing your recommendations to breakout EMALS cost and performance data for separate review by Congress, and to provide stability in the program's key technical and management teams. The Department is committed to delivering CVN 78 with EMALS on time and on budget. EMALS will enable current and future generations of Naval Aviators to perform their missions more safely, efficiently and effectively. I thank you for the opportunity to testify and look forward to answering your questions.

REPORT TO CONGRESS ON THE ELECTROMAGNETIC AIRCRAFT LAUNCH SYSTEM (EMALS)

Prepared by:
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June 2009

Report Requirement- Explanatory Statement to Division C of the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (Public Law 110-329)

ELECTROMAGNETIC AIRCRAFT LAUNCHING SYSTEM (EMALS) - An additional $24,000,000 is provided to address cost overruns in the Electromagnetic Aircraft Launching System (EMALS) program. Due to continuing concerns about meeting the schedule for integration into PCU Gerald R. Ford (CVN 78), the Secretary of the Navy is directed to submit a report to the congressional defense committees by April 1, 2009, which shall contain a description of efforts to control cost and schedule, an updated schedule for completion of research and development efforts and integration into CVN 78, and an assessment of aircraft launch system options for CVN 78, including cost estimates of those options, if the EMALS program experiences further delays.

Background

The Electromagnetic Aircraft Launch System (EMALS) is being developed for CVN 78 to replace the steam catapult system which is currently used on the USS ENTERPRISE and NIMITZ Class aircraft carriers. EMALS is designed to increase launch system reliability supporting increased sortie generation rate and providing increased high energy launch capability and an expanded launch envelope to support future airwing capabilities. EMALS also reduces shipboard manning requirements, improves aircraft launch system maintainability, and provides better control of forces applied to aircraft. EMALS consists of six major subsystems; Launch Control Subsystem (LCS), Launch Motor Subsystem (LMS), Power Conversion Subsystem (PCS), Prime Power Interface Subsystem (PPIS), Energy Distribution Subsystem (EDS), and Energy Storage Subsystem (ESS).

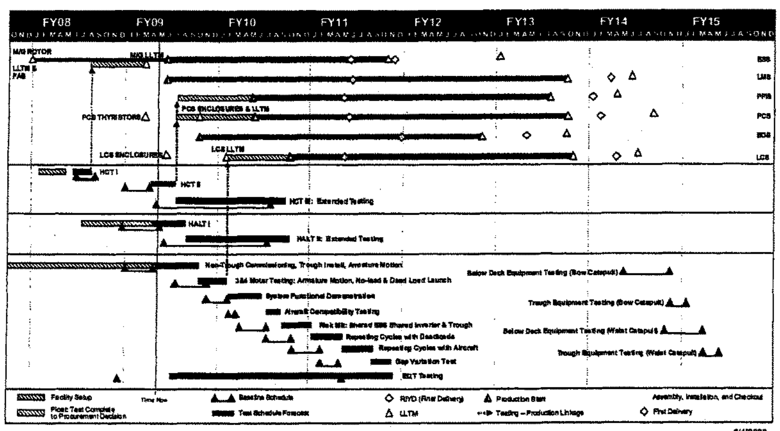
EMALS development began with a competitive prototyping effort between General Atomics and Northrop Grumman Marine Systems in 1999. The Navy down-selected to the General Atomics design in 2004 following completion of approximately 1,500 launch demonstration events conducted on each competitor's system. General Atomics successfully demonstrated concept operations in a relevant environment by launching deadloads from a full-scale, half-length prototype. Based on successful prototyping testing, the Navy funded full development and design of EMALS under a System Development and Demonstration (SDD) contract with General Atomics in 2005, which is scheduled to complete in early 2012. EMALS manufacturing and production efforts began in 2008 with material procurements to support CVN 78 required in yard delivery dates and will extend through 2014 for delivery of all CVN 78 shipset components.

EMALS SDD and Production Schedule

Figure (1) provides the timeline (as of May 2009) for completion of the EMALS SDD Phase test program, equipment production, shipboard installation and shipboard testing. The remainder of the SDD contract covers ongoing developmental efforts (funded with Research, Development, Test and Evaluation (RDT&E) appropriations) to complete subsystem component qualification testing.

EMALS subsystem production efforts (funded with Shipbuilding and Conversion, Navy (SCN) appropriations) include material procurement, equipment manufacture and factory testing, and delivery to shipbuilder. Figure (1) shows a high degree of concurrency between subsystem component qualification testing and procurement/manufacturing efforts. This concurrency results in added risk to the program. The Navy has taken action to mitigate risk due to this concurrency. These actions are described in later sections of this report.

Figure (1) - EMALS SDD & Production Schedule



The green dotted line on Figure (1) indicates decision points following the component qualification testing that lead to start of production of the component.

Cost and Schedule Control

SDD Phase

Poor cost and schedule performance during EMALS development resulted in program cost increase and concurrency in the testing and production phases of EMALS. The high degree of concurrency between SDD and production phases requires continuous assessment of the technical risk remaining to be resolved during testing. This risk resolution will be closely and continuously managed to avoid negative impacts to CVN 78 construction cost and schedule. The Navy has taken the following steps to control cost and schedule variances over the remainder of the EMALS SDD phase.

1. Developed a revised Estimate at Completion (EAC) for SDD and this has been used to develop budget requirements.

2. Reinforced technical governance forums to address issues across stakeholder organizations as a proactive method to control both cost and schedule risk. Some key technical forums and their roles are as follows: (1) Configuration Control Board (CCB) - approves design and configuration changes and manages the resulting funds for changes, (2) Engineering Review Board (ERB) - adjudicates technical issues emerging from pre-manufacture testing and production, (3) Joint Test Planning Group (JTPG) - provides oversight and direction for test planning, (4) Joint Test Team (JTT) - provides oversight and direction for test evolutions.

3. EMALS updates are regularly provided to senior Navy leadership. For transparency, CVN 21 and EMALS program management has reinforced the use of leading indicators to proactively identify potential cost and schedule control issues. EMALS updates are channeled through various program meetings and forums such as: (1) Weekly Integrated Management Team (IMT) meetings, (2) PEO bi-weekly meetings, (3) Three-star Executive Committee (EXCOMM) meetings, (4) Northrop Grumman Shipbuilding, Newport News (NGSB-NN) Quarterly Program Reviews, (5) NAVAIR Test & Evaluation Deep Dives, and (6) Status Updates to the Navy Secretariat. The regular updates provide Navy leadership the opportunity to engage and provide direction earlier in the process to resolve cost and schedule problems.

Production Phase

Figure (1) shows that production scope is scheduled to increase in FY 2009. The Navy will leverage management processes established during the SDD phase by building upon these lessons learned during system production and ship integration. In addition, the Navy has taken steps (described in the following paragraphs) to control EMALS cost and schedule variances during the subsystem production phase.

1. The Navy has implemented a rigorous Production Readiness Review (PRR) process to verify manufacturing processes prior to subsystem production. This process uses an incremental approach to approve component production based on results of component qualification tests and is intended to mitigate schedule risk resulting from concurrency between SDD and production phases. By combining EMALS subsystem PRRs with incremental production decisions, both production cost and schedule risk is managed.

2. Existing Navy systems engineering risk management programs which have been put in place to mitigate EMALS risks during SDD will be used throughout production and shipboard integration. Program risk processes reflect those best practices commonly used among Navy programs and are proven to be successful for managing cost and schedule risk associated with both developmental and integration efforts.

3. The Navy plans to award a fixed price contract for EMALS subsystem production as a cost control measure. Based on the maturation of EMALS subsystems during SDD and progress in improving management and manufacturing processes, the EMALS developer and Navy both agree that pursuing a fixed price contract for equipment production is feasible. Due to the current status of EMALS testing, this fixed price contract arrangement will be established in FY 09 but not definitized until FY 10.

Launch System Options for CVN 78

In January 2009, as a result of developmental test schedule erosion and production estimates provided by the contractor that exceeded Navy estimates, Senior Navy leadership called for a detailed assessment of the viability of continuing with EMALS or reverting to steam catapults for CVN 78. After an extensive review applying Nunn-McCurdy-like methodology, the Navy has decided to continue with EMALS as the CVN 78 Class aircraft launching system. The EMALS SDD efforts and production schedule in Figure (1) supports the CVN 78 construction schedule. While steam catapults remain a technically viable alternative to EMALS, reverting to steam at this point in the CVN 78 design and construction would cause a 12-18 month delay in the ship completion, along with associated costs for redesign and delay. At the time of the results of this assessment and the Navy decision to continue with EMALS, a final certified cost and pricing effort for the steam catapult alternative had not been completed.

Summary

Cost and schedule issues during SDD raised concerns about EMALS meeting the schedule for integration into CVN 78. As with any new technology, EMALS has risk that must be resolved during SDD and managed in production and through integration on CVN 78. The Navy has implemented a number of initiatives to increase management oversight and improve processes in order to control cost and schedule. The SDD and production planning efforts for EMALS currently meet the schedule for integration on CVN 78. Furthermore, the Navy has recently assessed the viability of EMALS and steam catapults and decided that EMALS would remain the CVN 78 Class aircraft launching system.

List of Acronyms

Ao	Materiel Availability
CCB	Configuration Control Board
EAC	Estimate at Completion
EDS	Energy Distribution Subsystem
EMALS	Electromagnetic Aircraft Launching System
EQT	Equipment Qualification Test
ERB	Engineering Review Board
ESS	Energy Storage Subsystem
EXCOMM	Executive Committee
HALT	Highly Accelerated Lifecycle Testing
HCT I	High Cycle Testing Phase I
HCT II	High Cycle Testing Phase II
IMT	Integrated Management Team
JTPG	Joint Test Planning Group
JTT	Joint Test Team
LCS	Launch Control Subsystem
LMS	Launch Motor Subsystem
LLTM	Long Lead Time Material
M/G	Motor/Generator
NGSB	Northrop Grumman Shipbuilding
PCS	Power Conversion Subsystem
PPIS	Prime Power Interface Subsystem
PRR	Production Readiness Review
RDT&E	Research, Development, Test and Evaluation
SDD	System Development and Demonstration
SCN	Shipbuilding and Conversion, Navy

WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING

JULY 16, 2009

RESPONSE TO QUESTION SUBMITTED BY MR. TAYLOR

Captain ANTONIO. The reactor energy needs projected for aircraft launching is less than 2% of total energy budget for CVN 78 class ships regardless of catapult system. Therefore, over the 25-year life, it is projected that less than 2% will be used in the launching of aircraft. [See page 28.]

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

JULY 16, 2009

QUESTIONS SUBMITTED BY MR. TAYLOR

Mr. TAYLOR. "Prior to committing to EMALS as the aircraft launcher for CVN–21/CVN–78, what real-world tests, simulations, modeling, calculations, etc., did the Navy perform to assure itself that EMI/EMP from EMALS would not create a problem for aircraft, munitions, and other shipboard systems? If the Navy performed real-world tests, were these full-scale tests involving actual aircraft, munitions, other shipboard systems, and full-scale, full-power EMALS technology?

Admiral ARCHITZEL. An EMALS Electromagnetic Environmental Effects (E3) Working Group consisting of subject matter specialists was established early in the EMALS program to examine E3 impacts to personnel, aircraft, ordnance and equipment. The EMALS E3 program is being conducted in accordance with the well established processes described in the Department of Defense Handbook on Electromagnetic Environmental Effects and Spectrum Certification Guidance for the Acquisition Process (MIL–HDBK–237). The program includes early characterization testing on full scale, full power hardware; calculation, modeling and analysis using well established techniques to assess compliance with requirements; and standard design techniques to mitigate risks.

During the EMALS Program Definition and Risk Reduction phase, the Navy conducted Electromagnetic Interference (EMI) and Electromagnetic Pulse (EMP) characterization testing using full scale, full power EMALS technology. During this phase the Navy used instrumentation—including Gauss Meters with 3-axis probes, Spectrum Analyzers, and loop antennas—as surrogates for aircraft, munitions, and shipboard systems. Testing examined EMI, magnetic, ordnance, and personnel risks at the component and system levels to define the EMALS-generated E3 environments. The data was compared to previously conducted modeling and simulation and aircraft, munitions, and shipboard design specifications. The results of the testing were used to validate the analytical models and refine the simulations used to establish the EMALS design requirements prior to entering the System Development and Demonstration phase.

The E3 characterization results were also used to support modeling and analyses to predict emissions from the EMALS power components and cable systems below deck. Standard practices for integration of high-power shipboard machinery, including separation distances (e.g., isolation of equipment and cable arrangement), shielding, and filtering, were then incorporated into the ship design and arrangement to insure that safe stand-off requirements were provided.

Mr. TAYLOR. If the Navy, prior to committing to EMALS as the aircraft launcher for CVN–21/CVN–78, did not employ real-world tests involving actual aircraft, munitions, other shipboard systems, and full-scale, full-power EMALS technology, what is the risk that the Navy will discover at some point that EMI/AMP from EMALS does indeed create a problem for aircraft, munitions, or other shipboard systems? Since EMALS is critical to making the ship capable of supporting CTOL aircraft operations, and since problems for aircraft, munitions, and other shipboard systems created by EMI/EMP from EMALS could prevent the Navy from using (or fully using) EMALS, was it wise for the Navy to commit to EMALS without conducting such tests?

Admiral ARCHITZEL. The EMALS Electromagnetic Environmental Effects (E3) program is being conducted in accordance with well established processes described in the Department of Defense Handbook on Electromagnetic Environmental Effects and Spectrum Certification Guidance for the Acquisition Process (MIL–HDBK–237). The E3 program consists of early characterization testing on full scale, full power hardware; calculation, modeling and analysis, using well established techniques to assess compliance with requirements; and standard design techniques to mitigate risks. Analyses of the observed and projected operational levels of Electromagnetic Interference (EMI) show no emission characteristics that require mitigation steps beyond the standard techniques used to integrate high power electrical/electronic systems in the ship.

E3 testing will continue through 2010 on full scale catapult systems and subsystems using instrumentation, aircraft and weapons firing circuits. If necessary, additional mitigation, including adjustments to space arrangements, separation distances (isolation & cable arrangement), shielding, and filtering will be incorporated.

Modeling, analysis, design mitigations, and testing throughout the development of EMALS have provided an appropriate level of assurance that the system will operate properly.

Mr. TAYLOR. If it turns out that EMI/EMP from EMALS creates problems for aircraft, munitions, or other shipboard systems, what would be the potential strategies for mitigating or working around these problems?

Admiral ARCHITZEL. The Electromagnetic Interference (EMI) and Electromagnetic Pulse (EMP) test results obtained during the EMALS Program Definition and Risk Reduction phase were used to support analyses characterizing the emissions from the EMALS power components and cable systems below deck. Standard practices for integration of high-power shipboard machinery—including separation distances (e.g., isolation of equipment and cable arrangement), shielding and filtering—were then incorporated into the ship design and arrangement to ensure that safe standoff distances were provided. These techniques will be applied if further mitigation is required.

Mr. TAYLOR. What elements of the EMALS development effort do the Navy consider to be more than low risk (i.e., low-to-moderate, moderate, moderate-to-high, or high risk)? What are the risk levels for these elements? What are the dates when the Navy expects to learn whether these elements of the EMALS development effort have been successfully completed?

Admiral ARCHITZEL. The EMALS Risk Management Program assesses risk levels on a monthly basis as low, moderate or high based on their impact on performance, schedule and cost. Assessments are conducted by senior personnel assigned to the EMALS program in accordance with the PMA 251 Risk Management Process. The Navy, General Atomics and Northrop Grumman participate in both the monthly EMALS Program Risk Assessment Board and CVN 21 Program Risk Board meetings.

As of July 16, 2009, the program assessed nine risks at the moderate level and none at the high level. Specifically:

- If EMALS emissions exceed Hazardous Radiation to Ordnance (HERO) limits, then shipboard ordnance handling may be affected, requiring changes to ship design. This risk is moderate with a plan to mitigate to low, via testing of EMALS components during 2010.
- If EMALS equipment is damaged during storage at the Lead Design Yard or during ship installation, then ship construction delays or program cost increase may result. This risk is currently moderate with a plan to mitigate it to low in early 2010.
- If unanticipated shared Energy Storage Subsystem (ESS) performance problems are observed during testing on the ship, the catapult commissioning and testing schedule may be impacted. This risk is currently moderate with a plan to mitigate it to low in mid-2011.
- If the Prime Power Interface Subsystem (PPIS) transformer/rectifier fails shock testing and correction requires a significant design change to the enclosure, transformer or choke design, the ship construction schedule may be impacted. This risk is currently moderate with a plan to mitigate it to low by the end of 2010.
- If Launch Motor Subsystem (LMS) stator assembly fails Environmental Qualification Tests, the LMS production schedule may be impacted to correct and retest the deficiencies. This risk is currently moderate with a plan to mitigate it to low by the end of 2010.
- If EMALS topside emissions exceed system interference or Emissions Control (EMCON) thresholds, design changes may be needed to EMALS or topside ship arrangements. This risk is currently moderate with a plan to mitigate it to low by testing the EMALS components during 2010.
- If the motor support structure production rate observed during the System Development and Demonstration (SDD) phase cannot be improved during ship set production, the LMS may not meet Required In-Yard Dates (RIYDs) for installation of the third and fourth catapult. This risk is currently moderate with a plan to mitigate it to low by the end of 2009.
- If the Motor/Generator (M/G) production rate observed during the SDD phase cannot be improved during ship set production, some M/Gs may not meet the RIYDs. This risk is currently moderate with a plan to mitigate it to low by the end of 2009.

- If the development test program is unable to fully test the Power Conversion Subsystem (PCS) shared inverter shipboard configuration (3 Inverters per phase and a set of inverters being shared between two launchers), ship integrated testing may be delayed. This risk is currently moderate with a plan to mitigate it to low by the end of July of 2009.

All other EMALS risks are currently assessed as low.

Mr. TAYLOR. How many months of additional delay, in which elements of the EMALS development effort, can be absorbed without affecting the construction schedule or construction cost of CVN–78?

Admiral ARCHITZEL. EMALS has specific Required In-Yard Dates (RIYD) for each component. In general, the EMALS CVN 78 production delivery schedule maintains at least six months of margin to the RIYD for all components with the exception of some of the Launch Motor Subsystem (LMS) trough components and Energy Storage Subsystem (ESS) Motor Generators. LMS components have at least five months of margin, while the two key ESS Motor Generators have approximately two months each. Production of LMS and ESS components is ongoing and being closely monitored.

Mr. TAYLOR. What has been the cost and schedule performance of the EMALS development effort since the start of the year?

Admiral ARCHITZEL. The EMALS System Development and Demonstration (SDD) Phase Cumulative Cost Performance Index declined slightly in June, representing an increase in the existing cost variance. This existing cost variance was due to the cost of delays initially encountered in the delivery of equipment to the full scale test site at Lakehurst in the last quarter of calendar year 2008. The Cumulative Schedule Performance Index improved during the same period. Using a critical path analysis, program execution, which was four months behind the baseline schedule in January, has been reduced to three months behind the baseline schedule.

Mr. TAYLOR. When the Navy originally awarded EMALS to General Atomics, why did the Navy not immediately begin taking steps to help General Atomics evolve from being an entity with a strength in research and development into one that was also strong in manufacturing and production?

Admiral ARCHITZEL. The Navy selected General Atomics (GA) in 2004 to design and produce the next generation Navy catapult following a competitive prototyping effort. Based on successful prototype testing, GA was chosen as the industry partner with the best capability to provide this technology. The Navy has worked with GA since that time.

Early in the Program Definition and Risk Reduction phase, the Navy emphasized the need for GA to strengthen its manufacturing and production capability. The development of the GA Tupelo, Mississippi manufacturing facility to produce the launch motor and power conditioning systems for the System Design and Development (SDD) and production phases resulted, in part, from these discussions. Lessons learned during production of the SDD units have been used to improve processes for ship set manufacturing. The Navy has strongly supported GA's efforts to pursue appropriate industry certifications and increase staffing in engineering, production planning and scheduling. In late 2007, GA and the Navy conducted joint production assessment reviews of the EMALS program that resulted in specific recommendations for processes and leadership improvements. Implementation of these recommendations resulted in the addition of senior managers with production experience at GA, and improved production planning utilizing a resourced integrated master schedule. The Navy and GA continue to work together to provide a manufacturing and production capability using well defined Production Readiness Review processes and applicable elements of the Navy's Flight Safe manufacturing and quality assurance standards.

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