



**Holly Ridings**

NASA FLIGHT DIRECTOR

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00:00:02,426 --> 00:00:05,666

>> Josh Byerly: Good afternoon everybody from the Johnson Space Center here in Houston, Texas.

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00:00:05,666 --> 00:00:06,506

I'm Josh Byerly.

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00:00:06,506 --> 00:00:09,406

We'd like to welcome you to today's news conference as we take a look

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00:00:09,406 --> 00:00:14,336

at the upcoming historic demonstration mission by SpaceX to the International Space Station.

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00:00:14,336 --> 00:00:17,156

We are joined by an entire panel today, which includes Bill Gerstenmaier,

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00:00:17,596 --> 00:00:21,116

NASA's Associate Administrator for Human Exploration and Operations.

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00:00:21,466 --> 00:00:25,446

We also have Mike Suffredini the Program Manager for the International Space Station.

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00:00:25,926 --> 00:00:27,556

We are also joined by Alan Lindenmoyer,

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00:00:27,556 --> 00:00:32,396

NASA's Commercial Orbital Transportation Services Program Manager as well as Elon Musk,

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00:00:32,486 --> 00:00:35,406

the Chief Executive Officer and Chief Designer for SpaceX.

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00:00:35,816 --> 00:00:38,806

And finally we have Holly Ridings who is the NASA Flight Director who will be

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00:00:38,806 --> 00:00:41,006

on console during the upcoming flight.

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00:00:41,336 --> 00:00:42,076

We'll start off with Bill.

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00:00:43,186 --> 00:00:43,746

>> Bill Gerstenmaier: Thanks Josh.

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00:00:44,486 --> 00:00:48,806

Today we did the flight ratings review for the SpaceX Dragon flight.

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00:00:49,476 --> 00:00:54,666

This was not a shuttle flight review in a sense that we didn't really look

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00:00:54,666 --> 00:00:56,396

at all the aspects of the launch.

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00:00:56,396 --> 00:00:59,656

We really just focused really on the ISS portion of the launch.

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00:01:00,146 --> 00:01:04,036

And this is very similar to what we've done in the past for the Automated Transfer Vehicle

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00:01:04,036 --> 00:01:06,576

and also for the Japanese Transfer Vehicle, the HTV.

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00:01:06,576 --> 00:01:11,896

What we do in the review is we make sure that the station is ready to receive the vehicles.

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00:01:11,896 --> 00:01:15,886

That the teams are trained,  
that the crew on orbit is ready,

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00:01:15,886 --> 00:01:20,276

that we thought about all the contingencies  
that could occur and we're really ready to go,

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00:01:20,506 --> 00:01:22,056

go through the demonstration mission.

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00:01:22,056 --> 00:01:25,056

And again, I think the teams  
are very well prepared.

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00:01:25,346 --> 00:01:29,676

The SpaceX team gave us a nice  
kind of introductory review

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00:01:29,676 --> 00:01:31,626

of what they've done and their preparations.

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00:01:31,626 --> 00:01:34,586

It was a very thorough discussion  
by the SpaceX team.

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00:01:35,036 --> 00:01:38,696

They've done a tremendous amount of  
work getting ready to get to this point.

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00:01:38,696 --> 00:01:42,146

They've done a lot of work in terms of  
both hardware, getting it ready to go fly,

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00:01:42,146 --> 00:01:43,766

getting the software ready to go fly.

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00:01:44,086 --> 00:01:46,336

I was very impressed with the overall work.

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00:01:47,026 --> 00:01:50,326

Again, I think they've made tremendous progress as a team

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00:01:50,326 --> 00:01:54,406

so they've got the one more long simulation to go do, one more simulation to do.

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00:01:54,406 --> 00:01:57,066

And Holly will probably talk that some more.

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00:01:57,066 --> 00:02:00,186

There's still some work we need to do, some more software testing that needs

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00:02:00,186 --> 00:02:01,636

to get done, some other activities.

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00:02:02,036 --> 00:02:05,436

Everything looks good as we head towards the April 30th launch date,

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00:02:05,436 --> 00:02:08,916

but I would caution us all that there's still quite a bit of work that needs to be done.

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00:02:09,386 --> 00:02:13,436

There's some things we've got to do on our side to validate some software and things

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00:02:13,436 --> 00:02:17,876

after the SpaceX team completes and our teams will have to go look at that data

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00:02:17,876 --> 00:02:19,616

and then make sure that it's all okay.

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00:02:19,616 --> 00:02:23,286

So, I think there's a good

chance to make the 30th.

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00:02:23,286 --> 00:02:26,096

We'll continue to work through this stuff over the next week or so.

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00:02:26,486 --> 00:02:29,816

On the 23rd of April we'll get back together again and just kind of assess

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00:02:29,816 --> 00:02:32,216

where we are overall to see how things are moving forward,

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00:02:32,216 --> 00:02:34,576

but again tremendous progress by the teams.

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00:02:34,946 --> 00:02:39,216

I was very impressed with the discussion between the NASA teams and the SpaceX teams.

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00:02:39,646 --> 00:02:44,226

When I hear the discussion back and forth it's really one team, they're really focused

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00:02:44,226 --> 00:02:46,586

on how do we deliver cargo to space station?

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00:02:46,936 --> 00:02:48,576

How do we get ready for this next phase?

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00:02:48,656 --> 00:02:51,086

And the teams have worked just phenomenally well together.

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00:02:51,086 --> 00:02:53,586

So, with that kind of attitude I'd look forward

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00:02:53,586 --> 00:02:56,776

to good activities as we  
move towards the launch.

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00:02:57,176 --> 00:02:57,826

So, thank you.

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00:02:58,306 --> 00:02:58,486

Mike.

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00:02:59,946 --> 00:03:00,886

>> Mike Suffredini: Well, good afternoon.

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00:03:01,536 --> 00:03:05,236

We're always excited when we  
have a vehicle coming to ISS.

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00:03:05,236 --> 00:03:10,906

But, this will be one of those historic launches  
with the first commercial vehicle coming to ISS

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00:03:10,906 --> 00:03:14,916

to provide supplies not only  
for this particular flight,

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00:03:14,916 --> 00:03:17,416

which is a demonstration flight,  
but really for the long term.

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00:03:17,506 --> 00:03:22,576

This is the beginning of a long term effort to  
have the commercial vehicles supply the ISS,

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00:03:22,576 --> 00:03:25,326

which is a critical need for the program.

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00:03:25,626 --> 00:03:31,166

As Bill said we had successful flight  
readiness review and then prior

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00:03:31,166 --> 00:03:35,216  
to that the program has what we  
call a stage ops readiness review.

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00:03:36,056 --> 00:03:40,366  
And at that time what we verify in  
this new world order is really safety

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00:03:40,366 --> 00:03:43,386  
of the vehicle within a sphere around the ISS.

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00:03:43,556 --> 00:03:49,726  
We call it the approach ellipsoid and it's about  
2 kilometers by 4 kilometers around the ISS.

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00:03:49,776 --> 00:03:55,886  
And the requirements we levy on the SpaceX  
company and any of the vehicles that want

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00:03:55,886 --> 00:03:59,556  
to do a burn that enters them  
into or aims them to come

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00:03:59,556 --> 00:04:04,066  
into that ellipsoid requires  
that they meet our requirements.

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00:04:04,066 --> 00:04:08,716  
And all of those requirements are  
built around safety of the vehicles

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00:04:09,266 --> 00:04:12,416  
and safety of the crew themselves.

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00:04:12,986 --> 00:04:17,616  
And so, we have spent the last couple of years,

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00:04:17,616 --> 00:04:24,186  
several months with our SpaceX colleagues  
working through the verifications,

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00:04:24,186 --> 00:04:30,226

all of the requirements that had to met,  
the testing that was-- that we dictated.

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00:04:30,226 --> 00:04:35,016

But, also the testing they did on their own  
to validate the performance of the vehicle.

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00:04:35,016 --> 00:04:39,426

And then as this part of the process as  
we get closer to launch we're cleaning

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00:04:39,426 --> 00:04:43,376

up our verifications where they  
complete testing, they send the reports

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00:04:43,376 --> 00:04:45,096

to say this is what occurred during the test.

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00:04:45,096 --> 00:04:50,126

We review the reports, we review the data  
and confirm that the vehicle's ready to go.

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00:04:50,646 --> 00:04:54,746

So, at this stage of preparations  
as we get close

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00:04:54,746 --> 00:04:59,096

to a potential April 30th launch  
we're in, we're in good shape.

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00:04:59,096 --> 00:05:02,346

We still have some what we refer  
to as non standard open work

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00:05:02,346 --> 00:05:06,926

and that just means there's some of the  
verification closures need to be completed.

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00:05:07,486 --> 00:05:11,946

They're related to hardware  
in the loop type testing.

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00:05:12,816 --> 00:05:14,816

It's where you get the hardware  
and the software together

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00:05:14,816 --> 00:05:16,926

and make sure they operate the way you expect.

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00:05:17,816 --> 00:05:21,586

So, we have the last little bit of  
that testing to go and then they'll--

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00:05:22,056 --> 00:05:27,156

our SpaceX colleagues will submit their  
reports to us based on the plan we have.

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00:05:27,156 --> 00:05:32,956

And we'll review those and assuming  
everything's fine we'll be ready for the launch.

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00:05:34,066 --> 00:05:37,726

What is unique about this however, is you  
notice I didn't say we had any requirements

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00:05:37,726 --> 00:05:42,096

for mission success and that's what our  
SpaceX colleagues have been working on

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00:05:42,096 --> 00:05:47,046

and Bill referred to since we're  
not responsible for the ascent phase

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00:05:47,046 --> 00:05:50,696

or even the early on orbit phase.

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00:05:50,696 --> 00:05:54,616

This is the responsibility of our SpaceX colleagues and we've left it to them

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00:05:54,616 --> 00:05:58,106

to define their requirements and then meet the requirements prior to launch.

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00:05:58,716 --> 00:06:03,776

And it's been a learning experience I think for both NASA and SpaceX.

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00:06:03,776 --> 00:06:10,156

We've really grown together as two organizations and I would say not only is the logistics

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00:06:10,206 --> 00:06:12,736

that this vehicle will bring not only this flight,

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00:06:12,786 --> 00:06:15,516

but in subsequent flights important to this program.

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00:06:15,516 --> 00:06:21,216

But, I think the relationship between a company like SpaceX and NASA in terms

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00:06:21,216 --> 00:06:25,926

of our design engineers and even us program managers have learned a lot from one another.

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00:06:25,926 --> 00:06:29,586

And so, that's been a great benefit for us as a program.

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00:06:30,166 --> 00:06:35,316

Quickly, the-- SpaceX will bring up this vehicle even though it's a demo flight will bring

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00:06:35,316 --> 00:06:39,426

up 521 kilograms of cargo to the ISS.

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00:06:39,426 --> 00:06:46,826

So, we are going to utilize the flight for real hardware that is necessary for ISS.

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00:06:46,826 --> 00:06:53,816

And in addition to that and an important aspect, unique aspect of the SpaceX will be the return

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00:06:53,816 --> 00:06:58,076

of cargo and we have about 660 kilograms of cargo that will be returned.

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00:06:58,606 --> 00:07:04,396

Some of it we would like to get back and refurbish for subsequent flights.

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00:07:04,396 --> 00:07:10,146

And so, this is a very important flight for us and, and we're utilizing it as such.

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00:07:10,646 --> 00:07:14,966

However, each, each piece of hardware that's going up and each piece we've put on there

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00:07:14,966 --> 00:07:18,206

to come home we did do an assessment since this is a demo flight.

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00:07:18,206 --> 00:07:22,156

We did an assessment and said if things didn't quite work out is that okay

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00:07:22,156 --> 00:07:25,326

and we didn't put anything on the vehicle we didn't think

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00:07:25,816 --> 00:07:29,326

that we could stand to not get home.

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00:07:29,606 --> 00:07:34,606

But, it is always an advantage to us whenever we can try to get additional information

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00:07:34,606 --> 00:07:37,776

and that's what we focused on, on this flight and the return manifest.

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00:07:38,316 --> 00:07:41,726

Just real quickly I want to talk about where we are in the--

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00:07:42,176 --> 00:07:45,626

in space station on orbit relative to this flight and all the other work.

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00:07:45,626 --> 00:07:49,906

The crew has been focusing on research as we've talked about a lot

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00:07:49,906 --> 00:07:52,026

over the last several get-togethers.

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00:07:52,536 --> 00:07:59,066

And as we approach this period that includes the SpaceX launch and birthing,

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00:07:59,296 --> 00:08:01,136

we have a number of activities going on.

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00:08:01,526 --> 00:08:07,426

We have the 47P launch that's scheduled next on April the 20th

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00:08:07,426 --> 00:08:09,896

and it will dock to the ISS on the 22nd.

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00:08:10,616 --> 00:08:18,146

Shortly after that the crew  
will return home, Dan and Anton

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00:08:18,146 --> 00:08:20,606

and Anatoly will come home on the 27th of April.

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00:08:20,606 --> 00:08:25,296

And then after that we'll prepare the--

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00:08:25,356 --> 00:08:31,816

Don and Andre will prepare for the  
birthing of the SpaceX vehicle.

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00:08:32,266 --> 00:08:35,676

And prior to that time I think Holly might  
touch on a little bit, we've done the prep work.

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00:08:35,676 --> 00:08:37,916

The crew actually is getting  
additional training on orbit.

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00:08:38,436 --> 00:08:43,726

But, not only do they need to do that training  
for what's going to happen on the 3rd of May,

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00:08:43,726 --> 00:08:48,446

but they also have to do all the work they need  
to do to get the other crew ready to come home

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00:08:48,446 --> 00:08:52,536

and also to have the docking  
of this 47 progress.

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00:08:53,036 --> 00:08:57,156

And then after the SpaceX gets there, we have  
the next Soyuz that's going to come up and dock

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00:08:57,156 --> 00:09:02,756

and then after that we'll have the release  
and return of the SpaceX demo vehicle.

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00:09:03,166 --> 00:09:05,926

So, you can see that while we are going to focus

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00:09:05,926 --> 00:09:09,026

on getting this new vehicle there  
it is, it is a workhorse for us.

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00:09:09,026 --> 00:09:13,786

It is intended to be a logistics vehicle that  
gets to station, it delivers its cargo and then,

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00:09:13,786 --> 00:09:16,506

then it departs so the next  
vehicle can take its slot

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00:09:16,506 --> 00:09:18,526

or show that the crew can  
then focus on research.

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00:09:18,906 --> 00:09:21,296

And, and it will begin that  
way with the very first flight.

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00:09:21,296 --> 00:09:25,806

We're not, we're not opening up a big  
hole and having this demo take effect,

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00:09:25,806 --> 00:09:29,736

it's an integrated part of on overall  
plan and we intend to treat it as such.

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00:09:29,736 --> 00:09:31,806

And so, we're looking very  
forward to that flight.

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00:09:32,406 --> 00:09:34,456

And with that I'll hand it  
over to Al Lindenmoyer.

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00:09:35,056 --> 00:09:38,536

>> Alan Lindenmoyer: Okay, thank you Mike.

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00:09:38,766 --> 00:09:39,846

Good afternoon everybody.

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00:09:39,846 --> 00:09:44,486

So, when the decision was made to retire the shuttle

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00:09:44,486 --> 00:09:47,736

and continue our exploration program we very much would have liked

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00:09:47,786 --> 00:09:51,176

to purchase commercial services to resupply the space station.

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00:09:52,736 --> 00:09:56,796

But, those capabilities just simply didn't exist in the U.S. markets.

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00:09:58,216 --> 00:10:03,396

So, we decided to think, think like an investor.

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00:10:03,486 --> 00:10:08,886

We wanted to become a consumer of services rather than a customer of requirements.

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00:10:08,886 --> 00:10:10,616

That would be our more traditional approach.

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00:10:10,976 --> 00:10:15,386

Write our requirements, go hire a prime contractor and develop the capability.

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00:10:15,386 --> 00:10:22,916

But, we believed that these capabilities were within the grasp of U.S. commercial industry.

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00:10:24,516 --> 00:10:27,426

So, five years ago we set these objectives for the program,

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00:10:27,426 --> 00:10:29,886

you could pull those up if you would.

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00:10:30,426 --> 00:10:32,356

We had to learn to think like an investor.

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00:10:32,356 --> 00:10:36,066

We wanted to place strategic financial investments

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00:10:36,066 --> 00:10:39,086

to help stimulate the commercial space industry.

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00:10:40,456 --> 00:10:47,266

Then we put some structure around those investments where we developed the program

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00:10:47,316 --> 00:10:53,356

to have the companies demonstrate these capabilities with the goal of achieving safe,

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00:10:53,356 --> 00:10:55,876

reliable and cost effective services.

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00:10:55,876 --> 00:11:00,396

We were looking to help lower the cost of access to space.

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00:11:01,026 --> 00:11:07,076

We believed that that would, of course, help us out and also be the key to opening

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00:11:07,076 --> 00:11:08,846

up new markets in low Earth orbit.

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00:11:10,406 --> 00:11:15,766

And the third thing we said is, if we're successful in placing these investments

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00:11:15,766 --> 00:11:22,846

and have solid commercial partners, well then, it's important to be able to sustain

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00:11:22,846 --> 00:11:26,686

that new capability, sustain the new market that's created

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00:11:26,976 --> 00:11:29,726

and NASA would become a customer for those services.

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00:11:31,436 --> 00:11:37,846

And by reducing the costs we hope that this will also be sustained by opening up new markets

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00:11:38,196 --> 00:11:40,836

by this lower cost access to space.

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00:11:40,946 --> 00:11:48,146

Well, we came-- we followed through on that promise in December of 2008.

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00:11:48,146 --> 00:11:52,046

Not only had we awarded the Space Act Agreements for the development program

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00:11:52,116 --> 00:11:56,706

for the new commercial services, but we also awarded the resupply contracts

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00:11:57,286 --> 00:11:58,166

for the space station.

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00:11:58,166 --> 00:12:05,256

So, we certainly followed through on our promise to become a very interested customer.

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00:12:05,296 --> 00:12:05,816

Next chart.

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00:12:07,186 --> 00:12:11,906

So, this is a summary of the new capabilities we're about to see demonstrated with SpaceX.

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00:12:12,556 --> 00:12:16,686

We did sign the agreement with SpaceX in August of 2006.

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00:12:17,496 --> 00:12:23,296

We monitored SpaceX's performance over the years through a series of prenegotiated milestones.

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00:12:23,786 --> 00:12:29,026

And this is also a difference that-- from our traditional approach of regular contracting.

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00:12:29,416 --> 00:12:34,596

In this case we only made payments after the milestone was achieved.

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00:12:35,926 --> 00:12:43,206

It was up to SpaceX to provide the necessary funding and resources necessary to meet each one

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00:12:43,206 --> 00:12:45,586

of these incremental milestones and then

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00:12:45,586 --> 00:12:48,766

when they were successfully made we made our incremental payments.

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00:12:48,766 --> 00:12:55,656

To date we've paid 37 put of a total of

40 for 381 million dollars of investment

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00:12:55,656 --> 00:13:00,536

out of a possible 396 million  
dollars total on the agreement.

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00:13:01,726 --> 00:13:07,706

All the milestones are completed except for the  
last three, this upcoming demonstration flight,

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00:13:07,706 --> 00:13:11,446

that this is the second demonstration  
under our Space Act Agreement.

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00:13:12,206 --> 00:13:19,626

The first demonstration flight was completed  
for our program in December of 2010,

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00:13:19,626 --> 00:13:24,626

a very successful first flight of the  
Dragon space craft on the Falcon 9,

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00:13:25,346 --> 00:13:26,976

an orbital demonstration and return.

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00:13:27,516 --> 00:13:31,776

[ Silence ]

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00:13:32,276 --> 00:13:33,336

>> Alan Lindenmoyer: Next chart please.

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00:13:34,306 --> 00:13:39,846

In addition, we also have a commercial  
partnership with Orbital Sciences.

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00:13:39,846 --> 00:13:44,736

This is a very similar Space Act  
Agreement-- arrangement with Orbital.

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00:13:44,736 --> 00:13:50,386  
They started a year and a half  
later than our agreement with SpaceX

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00:13:50,386 --> 00:13:52,706  
and they're also making very good progress.

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00:13:53,056 --> 00:13:55,796  
We'll see Orbital planning  
to fly later this year.

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00:13:55,796 --> 00:13:59,806  
They'll be starting with a maiden flight

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00:13:59,806 --> 00:14:03,546  
of their new launch vehicle,  
the Antares launch vehicle.

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00:14:03,546 --> 00:14:07,096  
This will be launched out of the brand  
new launch pad at Wallops Island,

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00:14:07,096 --> 00:14:09,616  
Virginia off the eastern shore of Virginia.

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00:14:10,296 --> 00:14:12,196  
So, we're looking for that later in the year.

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00:14:13,136 --> 00:14:17,636  
They have five milestones left to  
completion of the first stage assembly,

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00:14:17,996 --> 00:14:24,646  
the maiden test flight, then they will be--  
complete the vehicle for the demonstration

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00:14:24,646 --> 00:14:26,226  
to the International Space Station.

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00:14:26,856 --> 00:14:33,976

And that agreement will finish up with the flight to the station later in the year as well.

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00:14:35,436 --> 00:14:36,116

Next chart.

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00:14:36,766 --> 00:14:43,926

So, this is a history of the performance of the milestones that we established in the agreement.

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00:14:43,926 --> 00:14:48,006

Up top you'll see SpaceX agreement starting on 06.

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00:14:48,516 --> 00:14:53,856

It started with a series of design reviews, system requirements reviews,

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00:14:53,856 --> 00:14:57,706

preliminary design reviews moving into a critical design phase.

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00:14:58,456 --> 00:15:01,446

Then SpaceX moved on to the test and production phase.

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00:15:01,996 --> 00:15:04,936

We saw the maiden test flight in 2010.

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00:15:04,936 --> 00:15:10,156

And then last year we requested and received funding for--

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00:15:10,156 --> 00:15:14,226

additional funding for our program to help improve the chances

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00:15:14,226 --> 00:15:16,536

of mission success for our program.

223

00:15:17,116 --> 00:15:26,946

So, we worked together SpaceX and I and we came up with a series of additional milestones

224

00:15:26,946 --> 00:15:31,326

to add additional testing to help improve the chance of mission success.

225

00:15:31,406 --> 00:15:33,566

This was primarily system level testing.

226

00:15:34,176 --> 00:15:38,256

Last year SpaceX completed system level thermal vacuum tests,

227

00:15:38,876 --> 00:15:42,106

electromagnetic interference tests, acoustic testing

228

00:15:43,086 --> 00:15:48,366

and all that was of very high importance to us.

229

00:15:48,366 --> 00:15:53,316

There was a lot of learning going on and I think it is going to be very, very valuable to us.

230

00:15:53,316 --> 00:15:59,126

So, that was completed last year and now we're moving into the finishing

231

00:15:59,126 --> 00:16:03,226

up our demonstration phase with demonstration to the station.

232

00:16:03,806 --> 00:16:10,206

So, let's talk about the objectives of this flight.

233

00:16:10,206 --> 00:16:16,866

We call it C2 that stands for COTS 2,  
it's the COTS demonstration 2 flight.

234

00:16:18,086 --> 00:16:21,706

This flight originally was  
to a fly by to the station.

235

00:16:22,426 --> 00:16:28,456

That is it was to do a rendezvous with the  
space station and then it is to do a fly

236

00:16:28,456 --> 00:16:32,256

by beneath the station no closer  
than two and a half kilometers

237

00:16:32,256 --> 00:16:35,196

or about a mile-- a mile and a half.

238

00:16:35,296 --> 00:16:39,246

And during this period it is going  
to execute prerequisite maneuvers

239

00:16:39,246 --> 00:16:44,106

that are required before we give the  
final approval for the final approach

240

00:16:44,206 --> 00:16:45,946

and birthing with the space station.

241

00:16:46,906 --> 00:16:51,176

These are the same type demonstration  
objectives that were accomplished

242

00:16:51,176 --> 00:16:54,916

with other visiting vehicles to the station.

243

00:16:54,916 --> 00:16:59,706

The ATV and the HTV, all demonstrated before  
the final approach that they had the ability

244

00:16:59,706 --> 00:17:05,216

to do GPS navigation, relative navigation, absolute navigation,

245

00:17:05,416 --> 00:17:12,746

the ability to do abort maneuvers, the ability to free drift and hold for a while.

246

00:17:13,676 --> 00:17:20,846

These are the requirements that must be achieved before the go is given to do the final approach.

247

00:17:21,726 --> 00:17:26,586

That would be a very successful mission under the C2 program

248

00:17:26,586 --> 00:17:30,506

and then it would reenter and be recovered.

249

00:17:31,326 --> 00:17:36,676

SpaceX approached us last year and said they would like to attempt

250

00:17:36,676 --> 00:17:38,536

to also complete the birthing--

251

00:17:39,216 --> 00:17:42,616

the final approach and birthing to the demonstration on the upcoming flight.

252

00:17:43,306 --> 00:17:49,086

So, after reviewing the proposal and doing the required safety analysis to be assured

253

00:17:49,416 --> 00:17:54,656

that the vehicle and the systems are ready to go we agreed to give SpaceX that opportunity

254

00:17:54,706 --> 00:17:58,496  
for actual completing the birthing  
demonstration on this flight.

255

00:17:59,486 --> 00:18:02,806  
That will also include demonstrating  
the LIDAR sensors.

256

00:18:03,066 --> 00:18:06,426  
Those are the radars and the rendezvous  
sensors that gives you the range

257

00:18:06,426 --> 00:18:08,866  
and the range rate information  
as you approach the station.

258

00:18:09,156 --> 00:18:14,816  
They will be doing some close in retreat  
demonstrations, hold demonstrations

259

00:18:14,816 --> 00:18:19,516  
and finally the vehicle will captured  
by the robotic arm and then birthed

260

00:18:19,796 --> 00:18:23,946  
to the Earth facing side of the  
forward node on the station.

261

00:18:25,946 --> 00:18:30,546  
After about eighteen days of  
demonstrating the transfer of cargo to

262

00:18:30,546 --> 00:18:34,076  
and from the station we'll  
see the Dragon un-birthed

263

00:18:34,076 --> 00:18:38,956  
from the station and then return, return home.

264

00:18:38,956 --> 00:18:40,956

We call this mission C2 Plus.

265

00:18:40,956 --> 00:18:43,826

It's the C2 mission plus  
the additional objectives

266

00:18:43,826 --> 00:18:49,666

of completing the C3 objectives on this flight.

267

00:18:50,256 --> 00:18:54,106

So, let's see if you run the video now I  
guess we'll take a look at what we can expect

268

00:18:54,106 --> 00:18:58,546

to see targeting now for the end of the month.

269

00:18:58,546 --> 00:19:04,116

We'll see the Falcon 9 lift off  
on a beautiful day at the Cape.

270

00:19:04,566 --> 00:19:10,256

About three minutes later we'll see  
the stage separation between the first

271

00:19:10,256 --> 00:19:12,256

and upper stages on the Falcon 9.

272

00:19:13,436 --> 00:19:16,346

Then about ten minutes into  
flight it'll be in orbit.

273

00:19:16,936 --> 00:19:21,626

The Dragon and its trunk will  
separate from the upper stage,

274

00:19:21,626 --> 00:19:24,736

about a minute later the  
solar rays will be deployed.

275

00:19:25,406 --> 00:19:29,996

And then it'll begin its phasing maneuvers to the space station.

276

00:19:29,996 --> 00:19:33,936

It takes about a day to get to the proper phasing and rendezvous with the station.

277

00:19:34,386 --> 00:19:39,116

The second day will be used to complete the demonstration maneuvers I talked about.

278

00:19:39,796 --> 00:19:43,466

And if all goes well SpaceX will re-rendezvous with the station

279

00:19:43,466 --> 00:19:47,176

and on the third day we'll see the final approach

280

00:19:47,716 --> 00:19:52,726

and the vehicle will be captured by the arm and birthed.

281

00:19:52,726 --> 00:19:58,236

This operation takes about eight hours by the time you get into the final approach

282

00:19:58,236 --> 00:20:00,746

to the actual birthing with the station.

283

00:20:01,386 --> 00:20:03,876

After a few weeks on orbit it'll be un-birthed--

284

00:20:03,876 --> 00:20:04,326

>> [Inaudible background discussion]

285

00:20:04,326 --> 00:20:13,576

>> Alan Lindenmoyer: And then it'll be preparing for a de-orbit burn and reentry

286

00:20:13,576 --> 00:20:15,296

at about two to four orbits later.

287

00:20:16,296 --> 00:20:22,826

We'll see the Dragon reenter, parachute deploy  
and splash down off the coast of California.

288

00:20:23,426 --> 00:20:26,916

That would be a very good day.

289

00:20:27,416 --> 00:20:31,836

I wanted to thank everybody.

290

00:20:31,906 --> 00:20:33,846

We're certainly very excited to be here.

291

00:20:33,926 --> 00:20:36,896

This has been a great partnership  
between NASA and SpaceX.

292

00:20:36,896 --> 00:20:41,286

I want to thank my team, Mike Horkachuck,  
Project Executive's been with us

293

00:20:41,386 --> 00:20:49,196

since the beginning and his assistant Juan  
who's helped make available vast resources

294

00:20:49,706 --> 00:20:52,506

at NASA to help SpaceX.

295

00:20:52,506 --> 00:20:53,036

So, thank you.

296

00:20:53,036 --> 00:20:54,146

It's been a great partnership.

297

00:20:54,146 --> 00:20:56,006

We're really excited and  
looking forward to the launch.

298

00:20:56,426 --> 00:20:56,636

Elon.

299

00:20:57,096 --> 00:20:57,276

>> Elon Musk: Alright.

300

00:20:58,026 --> 00:21:02,476

Alright well, I'd just like to  
start off by saying thank you

301

00:21:02,476 --> 00:21:05,956

to NASA for giving us this opportunity.

302

00:21:06,466 --> 00:21:10,386

As you may have heard me say before SpaceX  
wouldn't have been able to get started

303

00:21:10,386 --> 00:21:13,216

without the amazing work that  
NASA has done in the past

304

00:21:13,326 --> 00:21:16,236

and we wouldn't have gotten this  
far without the help of NASA.

305

00:21:16,326 --> 00:21:22,176

So, I'd like to be real clear in  
expressing my appreciation for that.

306

00:21:22,176 --> 00:21:24,896

I'd also like to express a note of  
appreciation to the American public

307

00:21:24,936 --> 00:21:28,846

who are ultimately funding this  
and just want people to know

308

00:21:29,016 --> 00:21:34,306

that we've really done everything we can to make sure that this mission is going to go well.

309

00:21:34,596 --> 00:21:38,676

It's been a huge amount of hard work by the SpaceX team in partnership with NASA.

310

00:21:39,346 --> 00:21:46,086

And I think we've got a pretty good shot, but it is worth emphasizing that there is a lot

311

00:21:46,146 --> 00:21:50,456

that can go-- well, a lot that can go wrong on a mission like this because you've got

312

00:21:50,456 --> 00:21:55,376

to have the success of the rocket and then you've got have success of the spacecraft.

313

00:21:55,376 --> 00:21:59,866

Now, we have-- we've launched the rocket twice before and we've launched the spacecraft once,

314

00:22:00,296 --> 00:22:02,656

but they're still, they're still relatively new.

315

00:22:02,996 --> 00:22:07,996

And then there's the whole proximity operations and birthing system,

316

00:22:08,406 --> 00:22:11,356

which is going to be tested for the first time in space.

317

00:22:11,356 --> 00:22:15,956

And so, there's-- and there's no space station on the ground.

318

00:22:15,956 --> 00:22:18,136

So, our work to date has been done with--

319

00:22:18,566 --> 00:22:24,206

done by a simulation and by approximating  
the circumstances that it would find in orbit

320

00:22:24,206 --> 00:22:26,036

and approaching the space station.

321

00:22:26,676 --> 00:22:33,646

So, I think that's just important to appreciate  
that those-- this is, this is pretty tricky.

322

00:22:34,436 --> 00:22:39,716

And I think also for, for the public out  
there they may not realize that the, you know,

323

00:22:40,486 --> 00:22:43,576

the space station is zooming around  
the Earth every ninety minutes

324

00:22:43,576 --> 00:22:46,516

and it's going seventeen thousand miles an hour.

325

00:22:46,966 --> 00:22:49,266

And so, you've got to launch up  
there and you've got to rendezvous

326

00:22:49,266 --> 00:22:53,146

and be tracking the space  
station to within inches really.

327

00:22:53,576 --> 00:22:57,386

And this is, you know, something  
that's going twelve times faster

328

00:22:57,386 --> 00:22:58,826

than a bullet from an assault rifle.

329

00:22:59,556 --> 00:23:01,286

So, it's hard.

330

00:23:01,686 --> 00:23:07,986

And-- but, I think we've got a pretty good chance, but there's like I said I want

331

00:23:08,626 --> 00:23:14,346

to emphasize this, but this as it's been said by other people

332

00:23:14,346 --> 00:23:18,636

on the panel that this is a test flight.

333

00:23:18,816 --> 00:23:25,756

So, if we don't succeed in birthing on this mission then we've got a couple

334

00:23:25,756 --> 00:23:32,226

of more missions later this year that-- and I think we'll succeed on one of those.

335

00:23:33,316 --> 00:23:35,976

And yea-- so-- and I think we've videos of the preparation that we can show.

336

00:23:36,516 --> 00:23:44,366

[ Setting up video ]

337

00:23:44,866 --> 00:23:46,976

>> Elon Musk: There we have the rocket in the hangar at Cape Canaveral.

338

00:23:47,516 --> 00:24:03,586

[ Silence ]

339

00:24:04,086 --> 00:24:04,936

>> Elon Musk: The Dragon spacecraft.

340

00:24:05,516 --> 00:24:13,736

[ Video running ]

341

00:24:14,236 --> 00:24:16,716

>> Elon Musk: Now, one of the things that worth knowing about the Dragon is that we tried

342

00:24:16,716 --> 00:24:24,326

to design something that is very similar between cargo transport and astronaut transport.

343

00:24:24,656 --> 00:24:30,976

So, it's-- we expect there to be relatively few differences between the two.

344

00:24:31,516 --> 00:24:39,436

[ Silence ]

345

00:24:39,936 --> 00:24:43,156

>> Elon Musk: There's Dragon mounted on dock 9.

346

00:24:44,516 --> 00:24:59,726

[ Silence ]

347

00:25:00,226 --> 00:25:04,436

>> Elon Musk: And here we're doing a wet dress rehearsal, which means we load the liquid oxygen

348

00:25:04,546 --> 00:25:09,216

and kerosene, the fuel of the rocket and just make sure everything's okay.

349

00:25:09,656 --> 00:25:16,496

And coming up soon we'll have the static fire where we'll light the engines and shake things

350

00:25:16,496 --> 00:25:22,766

up a little, but keep the rocket held down

and then see if everything's okay before.

351

00:25:23,186 --> 00:25:26,036

And we'll spend several days  
analyzing that information

352

00:25:26,036 --> 00:25:31,806

and if that's looking good then we'll--  
it'll be okay to launch the rocket in theory.

353

00:25:31,806 --> 00:25:34,496

So, do we have another video?

354

00:25:34,496 --> 00:25:34,856

>> [Inaudible]

355

00:25:34,856 --> 00:25:36,256

>> Elon Musk: Pardon me.

356

00:25:36,956 --> 00:25:37,616

>> COTS milestones.

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00:25:37,616 --> 00:25:38,216

>> Elon Musk: Oh COTS milestones.

358

00:25:38,216 --> 00:25:38,976

So, we've got one more video to show.

359

00:25:39,516 --> 00:26:02,876

[ Silence ]

360

00:26:03,376 --> 00:26:05,966

>> Elon Musk: So, just elements of the  
rocket and spacecraft being tested.

361

00:26:06,516 --> 00:26:27,076

[ Silence ]

362

00:26:27,576 --> 00:26:28,976

>> Elon Musk: I think it is worth the--

363

00:26:29,586 --> 00:26:34,536

emphasizing that the Falcon 9 has flown has flown twice before and Dragon has flown once.

364

00:26:35,166 --> 00:26:39,416

So, I think a lot of people in the public may not be aware of that.

365

00:26:39,416 --> 00:26:41,186

So, the thing that's really being tested

366

00:26:41,186 --> 00:26:46,376

on this flight hopefully is the proximity operations and birthing system.

367

00:26:47,116 --> 00:26:51,006

So-- and there are other things as well like the solar panels and a few other things,

368

00:26:51,036 --> 00:26:57,786

but it's worth knowing the rocket has flown twice and the spacecraft has flown once.

369

00:26:58,196 --> 00:26:59,176

Alright well, with that--

370

00:27:01,086 --> 00:27:01,406

>> Holly Ridings: Alright.

371

00:27:02,186 --> 00:27:04,176

Well, good morning-- actually afternoon everyone.

372

00:27:04,236 --> 00:27:07,496

My name is Holly Ridings and I'm the Lead NASA Flight Director

373

00:27:07,836 --> 00:27:11,106

for the SpaceX Dragon demo mission.

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00:27:12,246 --> 00:27:13,736

I'd like to tell you guys today

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00:27:13,736 --> 00:27:17,316

that the operations teams have  
been working extremely hard

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00:27:17,316 --> 00:27:25,936

for multiple years really preparing for  
the launch and leading up to this day

377

00:27:25,936 --> 00:27:30,086

so that we could come and explain to you  
exactly what we've, we've built together.

378

00:27:30,536 --> 00:27:36,566

The first part of course is when you incorporate  
a new team, a new partner in this case SpaceX,

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00:27:36,566 --> 00:27:40,506

our first commercial partner into  
the space station there's a lot

380

00:27:40,506 --> 00:27:41,996

of technical things you do.

381

00:27:42,246 --> 00:27:47,406

The nuts and bolts make sure that we can talk  
back and forth between the two control teams,

382

00:27:47,476 --> 00:27:53,196

the control team in Hawthorne in California at  
the SpaceX facility and of course our team here

383

00:27:53,196 --> 00:27:59,806

in Houston commanding back and forth telemetry,

back and forth and as well as information

384

00:27:59,806 --> 00:28:05,396

that can pass all the way from their facility in Hawthorne up to the space station.

385

00:28:05,836 --> 00:28:09,946

So, we put that infrastructure in place to incorporate them as a new partner.

386

00:28:10,456 --> 00:28:14,826

We move on from there really to build the framework of how we're going to fly.

387

00:28:15,216 --> 00:28:20,226

This takes multiple years really for their team to learn about the space station,

388

00:28:20,276 --> 00:28:22,436

for us to learn about the Dragon.

389

00:28:23,126 --> 00:28:27,046

It's really a partnership, they're certainly experts on the Dragon,

390

00:28:27,046 --> 00:28:30,426

we're the experts on the space station and we treat it as one team.

391

00:28:30,426 --> 00:28:34,686

It's two dynamic vehicles flying in space together and it's extremely important

392

00:28:34,996 --> 00:28:40,386

that you communicate and understand each team's roles and responsibilities.

393

00:28:40,416 --> 00:28:46,096

As was alluded to earlier our role here in Houston is really the safety of the crew

394

00:28:46,096 --> 00:28:48,496

on board the space station,  
the space station itself

395

00:28:48,856 --> 00:28:52,506

and then the SpaceX Dragon team is  
responsible for the mission success.

396

00:28:52,886 --> 00:28:56,646

And we've built a framework working  
together where we should be able to get both

397

00:28:56,646 --> 00:28:59,666

of those items successfully accomplished.

398

00:29:00,166 --> 00:29:05,826

We write documentation, procedures, flight  
rules, the things you're familiar with,

399

00:29:06,216 --> 00:29:09,616

with the other vehicles that  
NASA has flown in space.

400

00:29:09,946 --> 00:29:14,456

And we make sure that the teams are  
trained to use all of that information.

401

00:29:15,086 --> 00:29:21,726

So, we practice using our simulation capability  
learning how that process is going to work,

402

00:29:22,036 --> 00:29:24,506

coming up with failure scenarios and talking

403

00:29:24,506 --> 00:29:27,956

through how we're going to  
react and recover from those.

404

00:29:27,956 --> 00:29:32,046

And again, as was alluded to earlier  
we've performed a series of those

405

00:29:32,046 --> 00:29:34,366

for all the different phases of the flight.

406

00:29:34,806 --> 00:29:40,926

The last simulation, just the final  
clean run for the polish before we go

407

00:29:40,926 --> 00:29:44,486

and fly here shortly will actually be next week.

408

00:29:44,486 --> 00:29:48,716

And so, we're really looking forward  
to doing this run one last time

409

00:29:48,716 --> 00:29:51,086

on the ground before we get on orbit.

410

00:29:51,576 --> 00:29:55,516

The other big piece of operations team  
of course is our space station crew

411

00:29:56,106 --> 00:30:00,886

since they will be performing the  
grapple of the Dragon vehicle,

412

00:30:01,046 --> 00:30:03,036

the birthing to the space station.

413

00:30:03,366 --> 00:30:07,466

And so, that team-- our crew  
team has been working hard

414

00:30:07,466 --> 00:30:09,716

to prepare for this mission as well.

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00:30:10,286 --> 00:30:13,956

The time frame that we're discussing launching in is one

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00:30:13,956 --> 00:30:19,956

in which we've got two crew members available to perform the Dragon operations.

417

00:30:20,416 --> 00:30:26,526

And so, we've spent a lot of time communicating with them, Don Pettit and Andre Kuipers,

418

00:30:27,176 --> 00:30:32,776

making sure that they understand exactly what will be expected of them.

419

00:30:32,776 --> 00:30:36,086

They of course were trained on the ground, but they have been on orbit for a while,

420

00:30:36,086 --> 00:30:39,056

while we've continued to work down here and learn new things.

421

00:30:39,056 --> 00:30:44,126

And so, we spend a lot of time communicating all of that information to make sure really

422

00:30:44,346 --> 00:30:47,696

as the third piece of our operations team they're ready to go for us.

423

00:30:47,696 --> 00:30:51,816

So now, we're going to kind of walk through the mission that we've put together

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00:30:51,816 --> 00:30:53,296

so if I could have the first still please.

425

00:30:54,146 --> 00:30:56,906

You can see the different phases of the flight.

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00:30:56,906 --> 00:31:01,966

So, we've got our launch followed by the phasing where the Dragon's still far away

427

00:31:01,966 --> 00:31:06,446

from the space station, as was mentioned earlier will come up and do a fly

428

00:31:06,446 --> 00:31:08,696

under of the space station all the way around.

429

00:31:08,936 --> 00:31:14,346

We've got some demonstration maneuvers followed by all of the new activities in the rendezvous

430

00:31:14,346 --> 00:31:19,896

and proximity operations, the birthing, finally, the departure, reentry and recovery.

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00:31:20,196 --> 00:31:24,116

And I've got some graphics in a minute, but before we leave this slide, in terms of roles

432

00:31:24,116 --> 00:31:26,476

and responsibilities, you know, really the launch

433

00:31:26,476 --> 00:31:32,866

and the phasing piece is again SpaceX responsibility

434

00:31:32,866 --> 00:31:35,096

until they get close to the space station.

435

00:31:35,396 --> 00:31:42,546

That operations team is taking care of the Dragon and designed all of that independently.

436

00:31:43,126 --> 00:31:48,306

We have understanding of exactly how that will go, but certainly that's there responsibility.

437

00:31:48,356 --> 00:31:53,916

When we come up close to the space station then the interaction with the NASA team begins

438

00:31:54,296 --> 00:32:00,886

and we've got some gates and some process in place where we make sure that the safety

439

00:32:00,886 --> 00:32:03,436

of that space station-- our space station is protected.

440

00:32:03,436 --> 00:32:10,286

And again, once the Dragon has left after departure, the SpaceX team takes over again

441

00:32:10,576 --> 00:32:17,966

and works with the FAA colleagues and brings the Dragon home and performs the recovery.

442

00:32:18,536 --> 00:32:21,356

Again, certainly that NASA cargo so we're interested in it,

443

00:32:21,356 --> 00:32:27,056

but from an operations sense the Dragon team performs that function in terms

444

00:32:27,196 --> 00:32:28,816

of the departure and the recovery.

445

00:32:29,366 --> 00:32:30,986

If we could go to the next slide please.

446

00:32:31,646 --> 00:32:35,616

So, one of the things that I mentioned was the demonstration objectives,

447

00:32:36,316 --> 00:32:37,936

these were touched on a little bit earlier.

448

00:32:38,376 --> 00:32:43,416

We do have some demonstrations to really talk about the abort capability,

449

00:32:43,416 --> 00:32:48,816

that's one of primary sort of pieces of our safety infrastructures,

450

00:32:48,816 --> 00:32:55,706

the capability to safely perform an abort where if there was an issue the Dragon could fly away

451

00:32:55,776 --> 00:33:00,836

from the space station to prevent having any type of collision.

452

00:33:00,836 --> 00:33:03,946

And so, that's a very important aspect of our safety framework.

453

00:33:04,646 --> 00:33:08,776

Different pieces of navigation as you get closer to the space station you have to be able

454

00:33:08,776 --> 00:33:13,116

to navigate more accurately and so we make sure that all of those pieces work correctly.

455

00:33:13,566 --> 00:33:18,316

Communication of course to dynamic vehicles in space need to be able to talk to each other

456

00:33:18,606 --> 00:33:23,726

and then just the general controllability in

terms of the guidance and navigation, you know,

457

00:33:23,726 --> 00:33:26,416

how the engines work, those type of activities.

458

00:33:26,416 --> 00:33:30,446

This has all been tested extensively  
by the SpaceX team on the ground.

459

00:33:30,726 --> 00:33:34,466

We've had NASA folks as well  
involved in the verification,

460

00:33:34,706 --> 00:33:40,516

but these are really the very important critical  
pieces that we want to validate on orbit,

461

00:33:40,706 --> 00:33:45,346

look at that capability before we use  
it in a safety critical situation.

462

00:33:45,346 --> 00:33:47,096

So, it's really a building block approach

463

00:33:47,656 --> 00:33:52,236

where we execute a demonstration  
objective is what we call it.

464

00:33:52,236 --> 00:33:56,646

So, a piece of functionality of the  
spacecraft, make sure it works and then later

465

00:33:56,646 --> 00:33:58,986

in the mission we will need that capability.

466

00:33:59,636 --> 00:34:00,336

Let's see, next page.

467

00:34:00,946 --> 00:34:03,496

So, here's our mission profile.

468

00:34:04,166 --> 00:34:06,526

This is obviously a two dimensional representation

469

00:34:06,736 --> 00:34:11,076

of two dynamic vehicles moving very quickly in space as Elon alluded to.

470

00:34:11,376 --> 00:34:15,516

But, if you look at the red arrow down in the bottom right hand corner and think

471

00:34:15,516 --> 00:34:19,836

about the Dragon moving in that direction over time.

472

00:34:20,206 --> 00:34:26,436

You can see down in the far right hand corner, that's really the phasing time frame.

473

00:34:26,656 --> 00:34:31,936

It's not to scale so that time frame could be, you know, a day or two or three depending

474

00:34:31,936 --> 00:34:36,236

on exactly how long the Dragon's going to take to phase to the space station.

475

00:34:37,246 --> 00:34:42,886

So, that capability again is the function of the Dragon control team.

476

00:34:43,486 --> 00:34:49,966

So, the Dragon will come up finish its phasing and where the red arrow is kind of pointing

477

00:34:49,966 --> 00:34:54,426

at the green line, that's about ten

kilometers underneath the space station

478

00:34:54,426 --> 00:34:56,826

and it'll perform what we call a burn.

479

00:34:56,826 --> 00:34:59,516

So, turn on its engines,  
maneuver the spacecraft and head

480

00:34:59,876 --> 00:35:04,966

up that green line towards the  
space station ready to perform a fly

481

00:35:04,966 --> 00:35:08,076

under of the space station  
at two and half kilometers.

482

00:35:08,336 --> 00:35:12,576

And so, that fly under is very important to  
us because it's the first time the Dragon

483

00:35:12,626 --> 00:35:15,186

and the space station will  
communicate with each other,

484

00:35:15,566 --> 00:35:18,406

an absolute requirement for  
proximity operations.

485

00:35:18,406 --> 00:35:22,596

It's the first time that the crew  
onboard the ISS will send a command

486

00:35:22,916 --> 00:35:24,286

to Dragon and get response.

487

00:35:24,566 --> 00:35:28,266

This is just a test command  
so it's a light on the Dragon,

488

00:35:28,476 --> 00:35:31,686

but it's leading toward the crew  
potentially needing to see--

489

00:35:31,726 --> 00:35:37,506

to send more invasive commands such as  
hold or retreat or even an abort later

490

00:35:37,746 --> 00:35:40,396

and command the Dragon when  
it's at the capture point.

491

00:35:40,916 --> 00:35:48,176

We're also gathering navigation data so the way  
the two vehicles navigate together is relative

492

00:35:48,176 --> 00:35:53,016

where you get pieces of information from  
both vehicles and you do a calculation

493

00:35:53,016 --> 00:35:56,986

and then they know exactly where they  
are in space relative to each other.

494

00:35:57,166 --> 00:36:01,126

And so, we're gathering information to  
make sure that navigation system works.

495

00:36:01,406 --> 00:36:05,126

So, we're flying to the space station, gather  
all that information, the Dragon's going

496

00:36:05,206 --> 00:36:10,926

to head back down to about ten  
kilometers below and then do a big lap

497

00:36:11,316 --> 00:36:14,956

around the space station called  
the fly around where it comes

498

00:36:14,956 --> 00:36:16,606

up the left hand side of that graphic.

499

00:36:16,606 --> 00:36:19,866

It's phased fairly far out in front of the space station by then,

500

00:36:20,226 --> 00:36:22,446

greater than two hundred kilometers.

501

00:36:22,706 --> 00:36:25,676

And so, it'll perform again, a burn, another turn on the engines

502

00:36:25,676 --> 00:36:31,076

and move the spacecraft headed up and over the space station, come across the top

503

00:36:31,076 --> 00:36:36,946

of the space station and then down the backside relative to the graphic again,

504

00:36:37,336 --> 00:36:40,586

fairly far out from the space station beyond two hundred kilometers.

505

00:36:41,306 --> 00:36:46,916

So, that entire process should take just about a full day on the order of twenty two

506

00:36:46,916 --> 00:36:49,056

to twenty four hours to complete.

507

00:36:49,826 --> 00:36:51,766

Let's see, next slide please.

508

00:36:51,816 --> 00:36:55,976

So, now we're kind of back where we started at our red arrow.

509

00:36:57,026 --> 00:37:00,906

Roughly again, that day later and we're headed again back up to two

510

00:37:00,906 --> 00:37:03,306

and a half kilometers below the space station.

511

00:37:03,806 --> 00:37:07,676

Remember that was the distance we did the fly under the day before.

512

00:37:07,786 --> 00:37:12,576

You can see the green dot, that's where we cross into what we call integrated operations

513

00:37:12,576 --> 00:37:17,066

and so I mentioned earlier sort of the responsibilities of the different team members,

514

00:37:17,316 --> 00:37:21,406

our responsibility in Houston being the safety of the space station

515

00:37:21,406 --> 00:37:22,896

and the crew on board the space station.

516

00:37:22,896 --> 00:37:27,466

And so, when we're inside of integrated operations which is in close proximity

517

00:37:27,466 --> 00:37:31,876

to the space station, the team here in Houston has authority over the mission.

518

00:37:32,106 --> 00:37:36,286

Of course again, we're working as a team and in partnership in communicating

519

00:37:36,286 --> 00:37:42,436  
with the Dragon team, but we do have the final  
authority so that we can keep that safety

520  
00:37:42,436 --> 00:37:44,496  
at the very top of the priority list.

521  
00:37:45,486 --> 00:37:49,786  
We've come up to two and a half  
kilometers inside of integrated operations

522  
00:37:49,786 --> 00:37:54,466  
and now we're going to head up to one  
point four kilometer, the little dots--

523  
00:37:54,526 --> 00:38:00,806  
the little red dots again, represent burns or  
again in time where Dragon will fire its engines

524  
00:38:00,806 --> 00:38:03,436  
and adjust its height relative to space station.

525  
00:38:03,436 --> 00:38:05,396  
So, it's headed up closer to the space station.

526  
00:38:05,396 --> 00:38:09,786  
So, now we're under at one  
point four kilometers.

527  
00:38:10,016 --> 00:38:13,926  
Again, next red dot, this  
is our approach initiation.

528  
00:38:14,006 --> 00:38:19,906  
So, this is the burn that will take  
the Dragon on an intercept trajectory

529  
00:38:19,906 --> 00:38:23,516  
with a position directly  
below the space station.

530

00:38:23,826 --> 00:38:28,326

We call it the R-bar, so it's the radius of the-- between the space station and the Earth.

531

00:38:28,326 --> 00:38:31,166

If you drew a line from the center of the space station to the center of the Earth

532

00:38:31,676 --> 00:38:36,416

and three hundred fifty meters below the space station you put a little Dragon that's

533

00:38:36,416 --> 00:38:37,806

where it's headed.

534

00:38:37,806 --> 00:38:45,806

So, it's going to end up on-- in that position and eventually will get to three hundred fifty,

535

00:38:45,966 --> 00:38:49,066

move another one hundred meters and actually pause automatically

536

00:38:49,066 --> 00:38:51,926

at the two hundred fifty meter hold point.

537

00:38:52,616 --> 00:38:53,136

Next page.

538

00:38:54,266 --> 00:38:59,746

So, we're up again on the R-bar, and two hundred fifty meters the Dragon is holding

539

00:39:00,046 --> 00:39:04,046

and we've got some more of our demonstration objectives that we need to complete.

540

00:39:04,696 --> 00:39:08,256

These involve the crew with some of the commanding.

541

00:39:08,546 --> 00:39:16,526

So, you can see the green Dragon represented on the slide, will approach from two hundred fifty

542

00:39:16,526 --> 00:39:19,086

so it starts moving towards the space station.

543

00:39:19,346 --> 00:39:23,306

The crew will then command a retreat and so it will turn and head back towards

544

00:39:23,306 --> 00:39:25,216

that two hundred fifty meter hold point.

545

00:39:25,686 --> 00:39:30,306

The graphic has all of the Dragon pictures spread

546

00:39:30,306 --> 00:39:32,246

out on the left so you can see the up and back.

547

00:39:32,496 --> 00:39:37,036

But, they actually all will happen on that R-bar line just forwards and backwards.

548

00:39:37,156 --> 00:39:39,016

It's just hard to represent on the slide.

549

00:39:39,686 --> 00:39:43,556

So, now we've gone to the-- commanded the retreat,

550

00:39:43,556 --> 00:39:46,676

we're headed back to two hundred fifty then the Dragon team

551

00:39:46,676 --> 00:39:49,426  
in Hawthorne will send the Dragon  
again towards the space station.

552  
00:39:49,796 --> 00:39:54,026  
The crew will tell the Dragon to hold,  
that'll be at about two hundred twenty meters.

553  
00:39:54,326 --> 00:39:58,886  
And so, that will be the last  
of our go/no go objectives

554  
00:39:58,886 --> 00:40:01,446  
in terms of the demonstration objectives.

555  
00:40:02,046 --> 00:40:08,186  
We do have go/no go criteria and that's our  
terminology that we use in our flight rules

556  
00:40:08,466 --> 00:40:15,146  
where here in Mission Control Houston and  
Mission Control in Hawthorne at SpaceX.

557  
00:40:15,426 --> 00:40:19,766  
We take a poll and make sure that  
all of the systems onboard the ISS,

558  
00:40:20,066 --> 00:40:26,076  
all the systems onboard the Dragon, any type of  
failure detection, you know, the robotic arm,

559  
00:40:26,076 --> 00:40:31,166  
the cameras, basically every thing you need in  
order to do that next step of the mission is

560  
00:40:31,166 --> 00:40:32,906  
in the configuration you expected.

561  
00:40:32,906 --> 00:40:36,956  
And then after you've had that communication

between the two teams and everything is

562

00:40:36,956 --> 00:40:42,366

in the proper configuration the go is  
allowing the Dragon to proceed and continue

563

00:40:42,366 --> 00:40:43,736

with the next step of the mission.

564

00:40:44,056 --> 00:40:47,596

So, when we use go/no go terminology  
that's exactly what we're talking about.

565

00:40:47,596 --> 00:40:51,176

So, at this point we're two hundred  
twenty meters below the space station.

566

00:40:51,456 --> 00:40:53,816

We've completed all of our demonstrations.

567

00:40:54,276 --> 00:41:01,366

Again, the controllability, the navigation,  
the abort, we have taken the poll and made sure

568

00:41:02,106 --> 00:41:05,556

that we've got all of the functionality we need

569

00:41:05,706 --> 00:41:09,376

and we're headed on up towards  
the space station.

570

00:41:09,376 --> 00:41:13,766

Again, we're going to cross into  
what's called the keep out sphere.

571

00:41:13,766 --> 00:41:19,206

So, it's two hundred meter circle around the  
space station, which we kind of use as a line

572

00:41:19,206 --> 00:41:23,356  
of demarcation for us to know that we  
need all of that functionality checked

573  
00:41:23,356 --> 00:41:26,716  
out before we head past that point.

574  
00:41:27,256 --> 00:41:29,036  
We're going to head all the  
way to thirty meters--

575  
00:41:30,026 --> 00:41:34,046  
if I can have the slide back  
please, might be easier.

576  
00:41:34,176 --> 00:41:34,466  
Thank you.

577  
00:41:34,506 --> 00:41:36,276  
So, we're going to head all  
the way to thirty meters

578  
00:41:36,536 --> 00:41:39,796  
and the Dragon again will  
automatically stop at thirty meters.

579  
00:41:39,796 --> 00:41:42,836  
We're going to perform another  
one of those go/no go so a poll

580  
00:41:42,836 --> 00:41:44,586  
to make sure we have all the functionality.

581  
00:41:45,066 --> 00:41:49,566  
At this point the crew is  
heavily involved with us.

582  
00:41:49,606 --> 00:41:55,816  
They've been monitoring the Dragon certainly  
throughout those demonstration objectives

583

00:41:55,816 --> 00:41:58,586

where they were sending several  
commands and also

584

00:41:58,976 --> 00:42:03,086

as the Dragon headed towards the  
space station with the capability

585

00:42:03,086 --> 00:42:06,306

if necessary to go ahead and take action.

586

00:42:06,526 --> 00:42:10,646

Although the Dragon vehicle itself  
is designed by the SpaceX team

587

00:42:10,846 --> 00:42:13,466

to really be very automated  
and to take care of itself.

588

00:42:13,506 --> 00:42:18,236

The crew is really there kind of as  
safety net certainly with the first flight

589

00:42:18,466 --> 00:42:24,966

of the demonstration capability, we really  
would like to make sure we've got all

590

00:42:24,966 --> 00:42:27,846

of the crew involved as well  
as the vehicle itself.

591

00:42:28,396 --> 00:42:30,686

So, we're at thirty meters,  
we've taken our poll.

592

00:42:31,186 --> 00:42:32,876

Now, we're going to head up to the ten meters,

593

00:42:32,876 --> 00:42:36,516

you may also hear this referred  
to as the capture point.

594

00:42:36,516 --> 00:42:40,686

The Dragon will hold again automatically  
ten meters from the space station,

595

00:42:41,236 --> 00:42:45,916

another poll to make sure we've got all  
of the technical capability required

596

00:42:45,916 --> 00:42:48,016

and then we give a final go for capture.

597

00:42:48,016 --> 00:42:52,346

We tell the crew that we  
are ready for that capture

598

00:42:52,346 --> 00:42:54,186

and then they really take over from that point.

599

00:42:54,186 --> 00:43:00,206

They have a command to inhibit the thrusters  
on the space station so those will not fire.

600

00:43:00,626 --> 00:43:05,166

They'll take the Dragon to what we call free  
drift so gain, where the thrusters do not fire.

601

00:43:05,456 --> 00:43:11,386

And then they will drive the robotic arm,  
the SSRMS out and capture the Dragon.

602

00:43:11,596 --> 00:43:15,756

Obviously you don't want thrusters  
on either spacecraft firing

603

00:43:15,966 --> 00:43:20,516

when you've got your robotic arm connecting

the two until it's had an opportunity

604

00:43:20,516 --> 00:43:22,416

to rigidize otherwise you might harm it.

605

00:43:22,416 --> 00:43:26,636

So, that process will be  
taken care of by the crew.

606

00:43:26,636 --> 00:43:29,986

Now, we've captured the Dragon successfully.

607

00:43:30,316 --> 00:43:37,206

The next couple steps we are headed  
towards doing a birthing of the Dragon.

608

00:43:37,606 --> 00:43:42,046

We do some system configuration to  
make sure it's ready to be birthed.

609

00:43:42,496 --> 00:43:47,356

We'll make sure that the common birthing  
mechanism, the passive side that's

610

00:43:47,356 --> 00:43:54,476

on the Dragon is clean of any type of  
debris and then we'll head on in robotically

611

00:43:54,476 --> 00:43:58,246

with the crew flying the  
robotic arm to birth the Dragon

612

00:43:58,246 --> 00:44:03,396

to the node two meter position  
again, the Earth facing position.

613

00:44:04,226 --> 00:44:10,796

All of that activity from coming up the  
two and a half kilometers all the way

614

00:44:10,796 --> 00:44:12,606

up the R-bar takes place in one day.

615

00:44:12,606 --> 00:44:13,756

It's a fairly long day.

616

00:44:13,756 --> 00:44:18,786

It's about seven and a half hours for that rendezvous and proximity operation.

617

00:44:19,236 --> 00:44:22,796

The next morning we'll get up and open the hatch for the first time

618

00:44:22,876 --> 00:44:26,216

and perform the very first cargo transfer.

619

00:44:26,886 --> 00:44:32,326

We're going to perform roughly twenty five hours of cargo transfer both unpacking

620

00:44:32,326 --> 00:44:35,466

and then packing the Dragon while it is on orbit.

621

00:44:35,466 --> 00:44:40,076

And then several weeks later we'll get the Dragon ready to come on home.

622

00:44:40,076 --> 00:44:41,166

If I could have the next slide.

623

00:44:41,166 --> 00:44:45,496

And so, here's our reentry and recovery.

624

00:44:46,286 --> 00:44:52,426

Terms of space station operations we take the robotic arm and un-birth the Dragon

625

00:44:52,916 --> 00:44:58,456

from node two Nadir and birth it from the CBM,  
we'll hold it out on the end of the robotic arm,

626

00:44:58,726 --> 00:45:01,206

make sure it's got all of  
its navigation capability up

627

00:45:01,206 --> 00:45:04,146

and running and then we release the Dragon.

628

00:45:04,306 --> 00:45:10,386

It performs a series of burns, again  
maneuvers, there are three of them.

629

00:45:11,176 --> 00:45:18,256

So, one you can see where the green Dragon is,  
a second at kind of the end of that half circle

630

00:45:18,256 --> 00:45:20,856

and then a third one at the  
end of the second half circle.

631

00:45:20,856 --> 00:45:23,536

So, a series of three, we  
call them departure burns

632

00:45:23,996 --> 00:45:27,046

and then the Dragon will head  
away from the space station.

633

00:45:27,046 --> 00:45:32,626

We check that it is on a safe trajectory  
away from the space station and then

634

00:45:32,626 --> 00:45:40,486

as I mentioned earlier the operations team in  
Hawthorne then is in control again of course

635

00:45:40,486 --> 00:45:44,886  
of the Dragon in terms of  
outside of integrated operations.

636

00:45:45,326 --> 00:45:51,076  
And so, they will make sure that its ready  
to do a [Inaudible] and come on home,

637

00:45:51,076 --> 00:45:56,146  
splash down in the Pacific and then they've got  
their recovery operations that they are going