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Vulcan

Vulcan development is going well and we're driving toward CDR this year. that is supported, depending on which engine we choose. We're coming up on our engine selection. If it turns out to be the BE-4, then that will support a Vulcan PDR with a nominal schedule, 50/50 probable schedule of flying by the end of 2019. If we end up choosing the AR1, they are more like 18 months, two months behind, and so that would delay, that would push everything out.

Both companies are doing well, they're both in testing. So aerojet has subscale components on the test stand for several months now. They're making great progress, right where I would expect them to be. So we're very pleased with that. Blue origin is up at the full scale level now so they have constructed a production like, flight like, full scale rocket engine, 11 feet tall, it's sitting on the test stand at Texas right now. And right next to it is a full scale power pack which is the turbo machinery; you know the pumps that move the propellant through the engine. They've been testing that for quite some time. It's doing very well. Sort of tuning that, rotating machinery, getting everything just the way they want it. They're also testing the full scale preburner, which is sort of the mini rocket engine. Literally just a scaled down version of the main rocket engine, that powers the power pack, that's also doing very well and pleased to see really no signs of combustion instability which is the primary risk that we're retiring the full scale static firing series.

Bearing in mind the chief risk we're trying to retire on the BE-4 with that testing is the fact that this would be the largest scale methane engine ever developed. The preburner, all by itself if I just stuck a nozzle on it, is the largest methane engine ever developed. So the fact that it's running well is starting to give us some confidence about the full scale test. So sometime within the next 30, 60 or 90 days, whenever, I expect we'll be testing the full scale engine, we'll run it for some number of weeks to collect the data. You don't just turn it on, stomp on the gas and hope everything goes well. you sort of sneak up on it ,you do short duration tests and you sort of ramp up the duration, ramp up the power level, start with very low power levels so you can look at the data and see what is going on. Then when we do that if we find that it's doing well, then we'll be in a position to down select. There's a down selection criteria that has a bunch of economic factors, as well as an evaluation of their ability to do production. Then the technical factor, we apply that equally to both aerojet and blue, for the BE-4 engine because they rea so far ahead.

The economic factors are generally retired and in place and we feel quite good about their production capability now as well so it's really down to this testing. I have an independent non-advocate review team, INAR, we call it, I stood up 9 months ago, so we have companies who are not ULA employees, not part of my engineering team that is really in charge of evalaut9ion, they're a separate team, sort of to be objective and not too close to it, we have a good team, we have former secAF shelia widnauf, ray Johnson, recently retired from aerospace corp, sue michiko, retired AF gen with a lot of space experience. We have a person from Boeing who is

helping us. They have been traveling out to the test stand, they've been out to Kent, they've been out to Aerojet, and they've been out to Denver to talk to my folks. They'll stay with me until after the testing is in place, then they will provide advice.

Turns out congress has also stood up their own INAR team staffed with nasa folks out at marshall. I thought that was great because this is a big decision. I am happy to have advice of experts. I've made our suppliers and my facilities available to them so they have been making the same rounds, then everyone stays through and when it's done they'll come and advise me. If my team and my INAR and marshall INAR and I expect the USAF will look at my data and have an opinion as well, it will be really convenient if everyone says the same thing. If not we'll resole whatever those differences are and we'll make a choice. I expect I'll be able to do that this summer, maybe in the fall, depending on how long it takes to get through all that. Share with my stakeholders because it's a big deal, you get to pick this engine basically once, if you do it wrong, It's really hard to walk back from. We're not rushing it, its event driven.

Then it's also important for my stakeholders my customers to have confidence, so I'm going to take a little bit of time to let them know what we're doing. I've made my INAR available to all my customers. If they want to meet with me separately, they're welcome to do that. Then we'll close. That will support CDR with Vulcan booster with that particular engine if we choose that one, later if not. Then upon that, we're in a position to start putting together pricing for Vulcan so sometime shortly after that, we'll be able to introduce it to the marketplace.

Do you really want the AR1?

I want the right engine. I have to have the right engine. I would like to have an engine that is available soon and is affordable and will work.

What happens if you decide you don't want AR1 and are told by parents to take AR1. What happens?

Everybody has a boss, you take instructions from your boss. That's not a conversation I have had with the owners, I would not expect that to be something that they would do. They also want the right engine. They are one of my stakeholders. They're going to get briefed by INARs and my team and they're going to have an opinion, and I believe they will allow ULA to make the choice. But we're kind of all in this together. I would very much like to have a consensus on the right choice. Because then I'll have more confidence that we are making the right choice.

Cislunar space 1000, with George sowers retiring, how serious are you about pursuing the greater metropolitan earth project?

Every bit as serious as the day before George sowers retired. George is a great visionary and rocket scientist, he's been in the industry for well over 30 years. I think that if you talk to George, you would find that he just felt he had really accomplished (this is what George shares with me) that he accomplished major career goals and sort of getting our ACES upper stage, which is the magic key that unlocks our cislunar space, into our baseline roadmap and literally into development and creating the connections with our partners like blue and other people who

are part of this and he just felt like he had accomplished his goals and he's been at this for a long long time and he wanted to retire. Spend more time with his significant other and I think right now they're in Sweden…George has been wonderful. I would love to keep George forever but I can't.

Who is going to replace George?

We haven't picked anybody yet. We have a guy acting in the role right now. That's Chris Deal, who is chief engineer on the Vulcan booster development and also just is very passionate about cislunar and aces and all of that stuff. He immediately volunteered to hold fort down while we decide what we're going to do. So he's doing that right now.

What are you doing to drive down cost of atlas to be more competitive commercially and what is baseline price?

All kinds of stuff. We're down about 33 pct from a baseline…that baseline is the price we had at the beginning of the block buy contract. So that was just under $190 (million), so $184 (million) I believe was the actual number for the entry level, 401, so that's huge in itself. In our industry, dropping a product by 1/3 is kind of a big deal. That's part of the way through our journey, we're not done. So it's a whole series of events, it started with sort of flattening the company to make it more agile. We took out 1/3 of our executives, eliminated those positions and reorganized around that so we could be more responsive and quicker and all that kind of stuff.

We got after our span times because time is money, so it now takes half as much time to build an atlas in the factory as it did before. It only takes about 1/3 the amount of time to integrate it with a spacecraft at the launch site and fly it as it did before. So about a 70 pct reduction, that's pretty impressive stuff. We got after our facilities, so we're shrinking out of facilities we don't' need and can use space more efficiently, although I'll tell you that the big facility bill is in your launch pads. So we have 5 launch pads, I have a plan to get to two, you can't get out of them until you fly the last rocket. So for example, the delta 2 pad, I have two delta 2s to go, so that pad doesn't close until after that. Eventually we'll down to an east coast and a west coast.

We went after our supply chain, that was really one of the big nods. So we did consolidations within the supply chain, creating what we think are really truly strategic partnerships. As an example, you might have two or three suppliers providing products, but they're similar kind of products. So we went to these guys and said 'well we'd like to have one of you, you get all the work, you get all the volume, but we need you to invest the non-recurring to be able to do that, and then give us a much lower price going forward. And then together we'll have a long term agreement so you know you can recover your investment costs and we know the price is good way out in to the future.'

So we've done a bunch of those kinds of deals and we've taken over 36 pct of the total supply chain costs out. The big suppliers, are numbers like 45, 40 pct recurring cost reductions and we're not yet done. then we get to the last part which is the hardest part, and it's deliberately last. That is reducing our head count. So we did all these other things first because a dollar is a dollar

right? So let's get as much out of this as we can before we touch the most precious resource, which is the people.

So we did a layoff last year, which we talked about, and at the time we said we'll do two. We're going to do one and then we'll do another one in 17. As we're sitting here right now, we're in the one in 17.

You're in the process now?

We're doing it right now.

How many people?

I'm not going to say how many for the second one, because that gives you the total and that becomes competition sensitive. We gave people the first number because it was only an increment. It's a little bit bigger than the number last year. The key element of this in our strategy in the people part is to maximize the number of voluntary layoffs. Because it does a couple things for us. A bunch of these people are kind of like George, they've had 30 plus years and they're going to retire and you never know when because they don't tell you until two weeks ahead of time, but they're going.

So by creating a voluntary opportunity, they get to tell us months in advance then we get to manage the knowledge transfer before they go. So I've bene targeting 70 pct of the exits to be voluntary. Looks like it is going to come out to 68 or so this year, so pretty close to the goal. We also did one other thing a little different with this one because being the last one, it's harder and more difficult to make sure you're doing this correctly in covering everything, so we used our knowledge management program to kind of go into this critical skills database, where we have 'these are the real critical skills and here who has them.' Some of those are very difficult to replace, maybe we don't have four or five guys with them, and maybe we have only one or two. Maybe it's going to take longer than a couple months to transfer the knowledge, it takes longer, we went to those people before the voluntary open, asked them if they were going to do it, and lot of them said 'well yes I am, I'm a critical skill expert because I've been doing this for 40 years.' Which BTW meant they were going to retire too.

So we said how would you like to be on a slightly different program? You can volunteer to leave and take your benefit, but we would like to keep you for another year or couple years. So there is a population of those people, the main activity is over this summer and they will actually continue on for a couple years until they transfer the knowledge and get past critical milestones.

How much support are you getting from nasa for cis lunar 1000?

So we have no contracts to do anything for cis lunar 1000, that's not really the concept. It's a commercial endeavor, so I've been off sharing it with nasa, nasa thinks it's cool, everyone we talk to thinks it's cool. I think nasa is formulating its current strategy about what they're going to do. I'm pretty excited because I see a lot of energy there. I think cis lunar will dovetail nicely what they're eventually going to come up with. Ask me at end of the year.