Testimony

# Risks and Mitigation Options Regarding Use of Foreign Components in U.S. Launch Vehicles

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***Risks and Mitigation Options Regarding Use of Foreign Components in U.S. Launch Vehicles***[2]

**Before the Committee on Armed Services**
**Subcommittee on Strategic Forces**
**&**
**Committee on Commerce, Science, and Transportation**
**United States Senate**

**July 16, 2014**

Mr. Chairmen, Ranking Members, and distinguished Committee and Subcommittee members, thank you for the opportunity to testify before you today on this important issue.

My testimony today will focus on the key findings from the RAND research[3] on the implications of using foreign components in the Evolved Expendable Launch Vehicle (EELV) program. This study, mandated by Congress, was commissioned out of concern that the U.S. launch vehicle fleet depends on foreign components—most notably, the Russian RD-180 engine, the primary booster engine for the Atlas V rocket. I will identify the foreign components in the EELV program, describe the supply risk of these components, and assess the potential effects of supply interruptions on U.S. space launch capability and national security space missions.

## Foreign Components in the EELV Launch Vehicles

Both the Atlas V and Delta IV launch vehicles in the EELV program have complex supply chains with hundreds of participants, both U.S.-based and foreign. An interruption in their supply for the EELV could prevent the launch of critical national security space assets.

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[2] This testimony is available for free download at http://www.rand.org/pubs/testimonies/CT413.html.
[3] Section 916 of the National Defense Authorization Act for Fiscal Year 2013 directed the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD [AT&L]) to conduct an independent study to assess the potential risk of using foreign components in the EELV program. The Space and Intelligence Office in the Office of the USD (AT&L) asked the RAND National Defense Research Institute to help in such a study, and this report constitutes RAND's response to that request.

There are five major foreign components in the EELV. The RD-180 engine, the primary booster in all Atlas V launch vehicles, is supplied by NPO Energomash, a Russian company largely owned by the Russian government. The payload fairing, the interstage adapter, and the payload adapter system in certain Atlas V variants are supplied by RUAG, a government-owned Swiss company. The fuel tank on certain Delta IV variants is supplied by Mitsubishi Heavy Industries, a publicly held Japanese company. Some Delta IV launch vehicles also use the RUAG payload adapter system.

Lockheed Martin chose the RD-180 engine for its Atlas V launch vehicle because of its proven track record of success (based on the flight history of its predecessor engine), performance, and lower cost. The U.S. government was actively pursuing space cooperation with Russia in the 1990s and encouraged private-sector cooperation with Russia and other former Soviet Union states because of proliferation concerns.

The RD-180 engine is the most critical foreign component in terms of cost, schedule, and the technical difficulty of developing an alternative engine source. Other foreign components pose less risk: the cost and timelines associated with acquiring alternative sources for them would be less stressing, though not insignificant.

**Risk of Supply Interruption**

A supply interruption could occur for a number of reasons, including financial problems, production delays, and political disputes. We found the risk of financial problems or production delays is not that different for foreign and U.S. suppliers. Although NPO Energomash shows evidence of financial problems, it also has strong financial incentives to continue deliveries to United Launch Alliance (ULA). Moreover, in the event of financial distress or bankruptcy, it might be able to continue to operate under protection from its creditors, or its assets could be sold to other firms to avoid supply interruptions. NPO Energomash might also receive funding from the Russian government, the primary owner of the company. Production risks from product failures, industrial accidents, labor strikes, and natural disasters do not occur very frequently, and they do not seem to be higher for foreign suppliers than for U.S. suppliers.

Political factors, however, are a different matter. Foreign policy disputes with Russia in particular pose an uncertain threat. The risk of political conflicts with the other foreign suppliers is low because the United States has some form of defense cooperation (including defense space cooperation) with the countries in which these foreign suppliers' headquarters or production facilities are located. This is not the case with Russia. The only other potential area of concern

involves Swiss restrictions on defense exports, but this risk is relatively low because these components are used in space launch vehicles, not in weapon systems.

In addition to the major foreign suppliers mentioned above, many lower-tier foreign suppliers provide complex manufactured components, software, electronics, and raw materials. However, these suppliers do not appear to pose a risk because most of them are located in countries closely allied with the United States, and most of these components have alternative sources. The few components that are sole-source are in France and Germany, close allies of the United States.

**Mitigation Measures for an RD-180 Engine Supply Interruption**

Despite long-standing concerns about reliance on the Russian engine, ULA has not experienced any major disruptions in the acquisition of the RD-180 itself. Since the first launch of Atlas V 12 years ago, the few minor problems with RD-180 engines have never caused either a delay in the launch of an Atlas V or a launch failure. Nevertheless, given the concerns within DoD and Congress, various mitigation measures have been developed in case the supply of RD-180 engines is interrupted.

Maintaining a stockpile of at least two years' supply of RD-180 engines has been a risk-mitigation strategy since the beginning of the program. The stockpile provides a hedge against short-term supply interruptions. In the event of a supply interruption that lasts longer than two years, the Air Force would need to move some Atlas V satellites onto Delta IVs and increase production of Delta IV launch vehicles while an alternative engine for the Atlas V is being developed. Two launch vehicle families are required for the EELV program according to the United States' assured-access-to-space policy.

A number of alternative liquid oxygen/hydrocarbon engine designs exist within the U.S. rocket engine industrial base, but they are in their infancy. The development cost of an alternative engine can be expected to be on the order of $1 billion and could take about six years. These engines could also require modifications to the Atlas V launch vehicle because the engine loads might differ from those of the RD-180 engine. Thus, the cost, schedule, and risk implications of developing a new engine must include the effects on the launch vehicle.

All these options have cost implications. Ramping up production of Delta IVs could entail additional manufacturing costs. It could take a few years to ramp up depending on how quickly the manufacturer could accelerate the manufacturing and supply-chain capability to increase

production. It might also be necessary to invest in launch infrastructure at Cape Canaveral Air Force Station to support increased Delta IV launches that would minimize launch delays of national security space missions.

Domestic production of the actual RD-180 engines in the United States is another possible mitigation measure, but this option may not be desirable because it is only marginally better than developing a completely new engine in terms of cost and technical challenges.

In addition to these measures, other domestic launch vehicles are emerging that may be able to meet some of EELV launch needs. Although not technically a mitigation for a RD-180 supply interruption, a new space launch entrant increases the options available for assured access to space. SpaceX's Falcon 9 launch vehicle has made the most progress in the new entrant certification process and, once certified, it may be able to launch some of the satellites currently carried on Atlas V, although the first launch may not occur until two years after certification.[4] SpaceX's Falcon Heavy would be required to launch all the satellites carried by Atlas V, but this launch vehicle is not as far along in the new entrant certification process as Falcon 9.

Even with the mitigation measures in place, however, there are other risks that the U.S. space launch capability might temporarily face during a RD-180 engine supply interruption. First, the engine design expertise lies within NPO Energomash, and access to that expertise may not be possible during a supply interruption driven by political disputes. If this is the case, the U.S. may not have the technical expertise needed to resolve RD-180 engine anomalies in a timely manner during the transition period. Second, any unexpected delays in the availability of an alternative launch vehicle, either a re-engined Atlas V or a new-entrant launch vehicle, could undermine U.S. assured-access-to-space capability. If the Delta IV launch vehicle family were to encounter a problem during the transition period, the United States could temporarily lose the capability to launch national security space satellites until the problem was resolved. Third, while the Atlas V launch vehicle production is being ramped down during the transition to an alternative engine, the supplier base for the Atlas V could be affected. Some suppliers could disappear, depending on their level of reliance on Atlas V production. Weakening of the industrial base could lead to potential delays in delivering re-engined Atlas V launch vehicles.

[4] After certification, we assumed it will take an additional two years before the first routine NSS launch on Falcon 9, a typical lead time required to prepare a spacecraft to fly on a launch vehicle on which it has never flown.

**Effects of Foreign Supply Interruption on U.S. Space Launch Capability**

Because the United States is launching a larger number of satellites for the next few years, its vulnerability to a supply interruption, particularly of RD-180 engines, is likely to be highest now and in the immediate future. A supply interruption of the other foreign components is likely to pose only a minor disruption because these components are only used in some –not all-- of the Atlas V and Delta IV launch vehicles and the mitigation options (i.e., the number of components in stockpile and flexibility to move the satellites from the affected launch vehicle to another launch vehicle) can minimize launch delays. But an RD-180 engine supply interruption could cause a serious disruption in EELV launches because of difficulties in establishing an alternative engine source and the large number of scheduled Atlas V launches.

If the flow of RD-180 engines were interrupted in the near-term, the stockpile would be sufficient to last about two years without further mitigation efforts. An interruption that lasts longer than two years—or is permanent—will require moving many satellites currently carried on the Atlas V to Delta IVs. The current Air Force contingency plan would call for Atlas V operations to gradually ramp down and for Delta IV operations to ramp up to support the satellites originally intended to launch on Atlas Vs until a new entrant launch vehicle or a re-engined Atlas V becomes available.

Based on our assumption that national security space launches would take priority over civil and commercial launches, we conclude that the RD-180 engine stockpile appears to be sufficient to protect the launch schedule of a set of Atlas V satellites that are too difficult or too costly to move to Delta IVs. Nevertheless, some national security space launches are likely to be delayed while the Delta IV launch vehicle production ramps up because of the limited number of Delta IV launch vehicles and the limited launch throughput capacity at Cape Canaveral Air Force Station. Decisions about which launches should be delayed would be based on the priority of the national security space mission that the satellite supports and the operational status of the satellite constellation, with inputs from senior U.S. space leadership. We believe the risk these delays would cause is low for most national security space missions. However, we note that many variables will influence the final decision on the mitigation approach and which launches would be delayed. Other assessments of the impact of an RD-180 supply interruption on U.S. space launch capability may differ from ours if they are not based on the same assumptions.

In summary, there are both risks and benefits of using foreign components in the EELV program. The risk of potential supply interruption of most foreign components is low and manageable. The foreign component of most concern is the Russian RD-180 engine, but the impact of an interruption in its supply could be mitigated. Many variables will influence the mitigation approach,

which should be based on a consideration of the trade-offs regarding the costs and schedules, and thus mission risks, of different options.

Again, thank you for inviting me here today to testify on this very important national issue. I look forward to your questions.