U.S. Department of Commerce
Bureau of Industry and Security
Office of Technology Evaluation

U.S. Rocket Propulsion
Industrial Base Assessment

Final Results
2018

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Who We Are:

• Bureau of Industry and Security (BIS)

**Mission:** Advance U.S. national security, foreign policy, and economic objectives by ensuring an effective export control and treaty compliance system and promoting continued U.S. strategic technology leadership.

- Develops export control policies
- Issues export licenses
- Prosecutes violators to heighten national security
- Develops and implements programs that ensure a technologically superior defense industrial base

• Office of Technology Evaluation (OTE)

**Mission:** OTE is the focal point within BIS for assessing the capabilities of the U.S. industrial base to support the national defense and the effectiveness of export controls.
OTE Industry Surveys & Assessments Background

• Under Section 705 of the Defense Production Act of 1950 and Executive Order 13603, ability to survey and assess:
  • Economic health and competitiveness
  • Defense capabilities and readiness

• Data is exempt from Freedom of Information Act (FOIA) Requests

• Enable industry and government agencies to:
  • Share data and collaborate in order to ensure a healthy and competitive industrial base
  • Monitor trends, benchmark industry performance, and raise awareness of diminishing manufacturing and technological capabilities
Rocket Propulsion Survey Assessment

Background

- Partnership with NASA’s Marshall Space Flight Center, and in collaboration with the Joint Army, Navy, NASA, Air Force (JANNAF) Working Group
- The principal goal is to gain an understanding of the supply chain network supporting the development, production, and sustainment of products and services supporting both USG and commercial propulsion-related systems

- Objectives:
  a) Map the propulsion industrial base supply chain in detail;
  b) Identify interdependencies between respondents, suppliers, customers, and USG agencies;
  c) Benchmark trends in business practices, competitiveness issues, financial health, etc. across many tiers of the propulsion industrial base; and
  d) Share data results with USG stakeholders to aid planning, outreach, and problem resolution
Methodology

• The scope of the survey and assessment was limited to U.S. based organizations with Propulsion-related activities, defined as:

  • “Any activity/component/subsystem/test/product/service that contributes to U.S. Government or Commercial propulsion systems (including the propulsion of a launch vehicle, missile, and in-space spacecraft propulsion). The activity/component/subsystem/test/product/service does not have to be specifically intended to support propulsion applications.”

• Survey exemptions were provided on a case-by-case basis with careful consideration provided by the BIS and relevant stakeholders

• Organization size was established based on sales from Propulsion related products manufactured in the U.S.:
  • Small: Under $10M in annual sales
  • Medium: $10M-$50M in annual sales
  • Large: Over $50M in annual sales

### Survey Taxonomy

**Propulsion Business Lines - 24**

1. Composite Materials  
2. Composite Materials Processing  
3. Electrical Systems  
4. Engineering Services  
5. Fabrication, (sub)system assembly  
6. Instrumentation, sensors, transducers  
7. Insulation  
8. Interconnects, fasteners, standards, seals  
9. Launch services  
10. Liquid propellant materials  
11. Machining  
12. Maintenance/aftermarket/refurbishing services  
13. Material preparation  
14. Material processing/finishing  
15. Mechanical controls  
16. Ordnance/ignition components or systems  
17. Raw materials  
18. Research and development  
19. Solid rocket linear material  
20. Solid rocket propellant material  
21. System integration  
22. Test equipment  
23. Testing services  
24. Other

**Propulsion Business Categories - 7**

1. Large liquid propulsion  
   a) Large chemical liquid propulsion systems  
   b) All engines with turbopumps  
   c) Features of the MPS that reside in the tanks  
   d) Booster/upper/in-space transit stages, propellant, pressurant  
2. Small liquid propulsion  
   a) Small chemical liquid propulsion systems  
   b) Pressure-fed engines  
   c) Spacecraft propulsion  
   d) Pressurant and propellant tanks, flow-control components, dedicated sensors, and engines  
3. Large solid rocket motor  
   a) 40” and larger motors requiring more than one mix to cast a single motor and relatively limited production rate  
4. Small solid rocket motor  
   a) 40” and smaller motors allowing casting of multiple motors from a single mix and relatively limited production rate  
5. Science and technology  
   a) Interagency collaboration for propulsion science and technology across all segments of the rocket propulsion industrial base (e.g. strategic missile boosters to space lift, in-space chemical and electric propulsion for satellites, to tactical missiles and missile defense)  
6. Test and evaluation  
   a) Connected with the National Rocket Propulsion Test Alliance  
7. Electric propulsion  
   a) Electrothermal rocket propulsion  
   b) Electrostatic or ion propulsion engine  
   c) Electromagnetic or magneto plasma engine

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Overview of Survey Data 2013-2016

Data is aggregated to allow public distribution of business confidential responses

Respondent Profile

- The data presented in this assessment represents the submissions of 361 organizations with 531 owned/internal facilities.
Propulsion Business Lines - 24
Involvement by Industrial Base Business Category (8 Total)

Number of Responses

- Large Liquid Propulsion
- Small Liquid Propulsion
- Large Solid Rocket Motor
- Small Solid Rocket Motor
- Science and Technology
- Test and Evaluation
- Electric Propulsion
- Other

Q1c, A

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Propulsion Business Categories – 8 Total
Company Participation by Category

- Small Liquid Propulsion: 452
- Test and Evaluation: 403
- Large Liquid Propulsion: 399
- Small Solid Rocket Motor: 389
- Science and Technology: 389
- Large Solid Rocket Motor: 311
- Other*: 301
- Electric Propulsion: 203

*Other includes lower tier facilities who were unsure of how they supported propulsion-related engines and systems

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
### Organization Information

<table>
<thead>
<tr>
<th>Countries (16) with Equity Ownership in U.S.-based Propulsion-Related Companies (33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Norway</td>
</tr>
<tr>
<td>Cayman Islands</td>
</tr>
<tr>
<td>Switzerland</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Netherlands, Canada, Austria, Sweden, United Arab Emirates, India, Israel and Luxembourg</td>
</tr>
</tbody>
</table>

- 33 respondents identified non-U.S. based organizations with equity ownership
- 4 respondents each had two countries with equity ownership, for a total of 37 non-U.S. based organizations with equity ownership
- 16 unique countries were identified with equity ownership

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
Organization Reporting Level

- Business Unit/Division, 31%
  - 113
- Corporate/Whole Organization, 69%
  - 248

Percentage of Respondents with Parent Organizations

- Yes, 39%
  - 139
- No, 61%
  - 222

Both questions are not mutually exclusive (e.g. respondents can report at the Business Unit/Division level and not have a parent organization)

Q1a, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Headquarter Location by State (361 Total)

Top States

<table>
<thead>
<tr>
<th>State</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>82</td>
</tr>
<tr>
<td>Florida</td>
<td>24</td>
</tr>
<tr>
<td>Arizona</td>
<td>19</td>
</tr>
<tr>
<td>NY, PA</td>
<td>18</td>
</tr>
<tr>
<td>AL, CT</td>
<td>15</td>
</tr>
</tbody>
</table>

Q1a, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Special Small Business Types
Number of Respondents by Special Business Types

31% self-identified as being dependent on the USG for continued viability

10% self-identified as being “unsure” if they were dependent on the USG for continued viability

18% were at moderate to severe financial risk according to 2016 financials

HUBZone businesses are located in and employ people living in Historically Under-utilized Business Zones as defined by the SBA

55 respondents identified as multiple special business categories, and therefore are counted twice.

Q1a, D

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Special Small Business Types
Breakdown of 186 Certified Small Businesses

Business Type

- Primary
- Additional

JANNAF Agency Contracts

- Direct
- Both
- Indirect

Some respondents identified multiple “Additional” business types and multiple agencies

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Special Small Business Types
Breakdown of 186 Certified Small Businesses

Number of Small Businesses by Business Line (some respondents identified multiple business lines)

- Machining: 128
- Engineering services: 101
- Raw material provider: 99
- Fabrication/system assembly: 98
- Prototyping: 76
- Testing services: 61
- Composite materials: 55
- Material preparation: 49
- Material processing/finishing: 48
- Composite materials processing: 48
- System integration: 45
- Instrumentation, sensors, transducers: 43
- Launch services: 41
- Electrical systems: 40
- Interconnects, fasteners, standards, seals: 37
- R & D: 34
- Test equipment: 33
- Mechanical controls: 32
- Insulation: 20
- Ordnance/Ignition components or systems: 16
- Maintenance/aftermarket/repair/refurbishing: 12
- Liquid propellant material: 10
- Solid rocket propellant material: 9

Number of Small Businesses by Industrial Base Category (some respondents identified multiple industrial base categories)

- Electric Propulsion: 201
- Large Liquid: 174
- Test & Evaluation: 146
- Small Solid: 140
- Other: 138
- Science & Technology: 131
- Large Solid: 125
- Electric Propulsion: 80

“Other” includes lower-tier companies who were unsure how they supported propulsion-related engines and systems

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Top 5 State Locations
By Organizations, Facilities, Suppliers, Customers

<table>
<thead>
<tr>
<th>Organization Locations (158)</th>
<th>California</th>
<th>82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>NY, PA</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>AL, CT</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

| Internal Facility Locations (224) | California | 122 |
|-----------------------------------|------------|
| Florida                           | 30         |
| Alabama                           | 28         |
| AZ, PA                            | 23         |
| New York                          | 21         |

**California is the number one state in all four categories**

| Supplier Locations (850) | California | 464 |
|--------------------------|------------|
| New York                 | 108        |
| CT, PA                   | 99         |
| Texas                    | 96         |
| Arizona                  | 83         |

| Customer Locations (713)  | California | 354 |
|---------------------------|------------|
| Alabama                   | 103        |
| Virginia                  | 91         |
| Florida                   | 90         |
| Colorado                  | 75         |

**A significant portion of the supply chain is located in Alabama, Arizona, Florida, New York, and Pennsylvania**

Q1A, Q2A, Q6B, & Q10B

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Highlight: California
By Top Cities (27 total)

- **HQ Locations (2 or more)**
- **Facility Locations (3 or more)**
- **Supplier Locations (10 or more)**
- **Customer Locations (10 or more)**

### Top Cities by Category:
- **HQ Locations** – Torrance (5)
- **Facility Locations** – El Segundo (9)
- **Supplier Locations** – Los Angeles (26)
- **Customer Locations** – Hawthorne (40)

Customers may be double counted (e.g., an organization can list a single customer 10 times which is represented below)

- 40 respondents listed 10 or more of their customers are based in Hawthorne

172 cities in California have at least one organization, facility, supplier, or customer

Q1A, Q2A, Q6B, & Q10B

Propulsion-Related NAICS Codes
Top 10 Most Common NAICS Codes

- Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing (336415)
- Machine Shops (336419)
- Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing (332710)
- Engineering Services (541330)
- Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) (541712)
- Aircraft Engine and Engine Parts Manufacturing (336414)
- Guided Missile and Space Vehicle Manufacturing (336412)
- Other Aircraft Parts and Auxiliary Equipment Manufacturing (336413)
- Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology) (541715)
- All Other Miscellaneous Fabricated Metal Product Manufacturing (332999)

North American Industry Classification System (NAICS) codes identify the category of product(s) or service(s) provided.

361 respondents’ products and services were categorized by 173 unique NAICS codes out of 2,196 total.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Propulsion-Related Product & Service Codes (PSC)
Top 10 Most Common PSC Codes

- Rocket Engines and Components (2845) - 27
- Space Vehicle Components (1675) - 20
- Guided Missile Components (1420) - 16
- Gas Turbines and Jet Engines, Aircraft, Prime Moving, and Components (2840) - 14
- Guided Missile and Space Vehicle Explosive Propulsion Units, Solid Fuel, and Components (1337) - 13
- R&D - Space: Aeronautics/Space Technology (Engineering Development) (AR14) - 12
- R&D - Defense System: Missile/Space Systems (Advanced Development) (AC23) - 12
- Guided Missile and Space Vehicle Inert Propulsion Units, Solid Fuel, and Components (1338) - 11

Product and Service Code(s) (PSC) are federal supply codes used by the U.S. Government to describe the products, services, and research and development purchased by the government.

361 respondents’ products and services were categorized by 349 unique PSC codes out of 2,907 total recorded.

Q1b, A


361 respondents
Business Categories – 9 Total
Business Category by Primary and Additional Focus

- Manufacturer
  - Primary: 232
  - Additional: 31

- Research & Development
  - Primary: 31
  - Additional: 92

- Service Provider
  - Primary: 38
  - Additional: 65

- Prototype Manufacturer
  - Primary: 6
  - Additional: 88

- Testing Facility
  - Primary: 5
  - Additional: 71

- Distributor
  - Primary: 37
  - Additional: 22

- Laboratory
  - Primary: 31
  - Additional: 1

- Non-Profit
  - Primary: 6
  - Additional: 7

- Holding Company
  - Primary: 7
  - Additional: 1

34.3% of respondents either primarily or additionally participated in manufacturing.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q1b, B
361 respondents
Business Categories by Financial Risk

"Primary" Business Category by Financial Risk Levels

<table>
<thead>
<tr>
<th>Business Category</th>
<th>Low/Neutral Risk</th>
<th>Moderate/Elevated Risk</th>
<th>High/Severe Risk</th>
<th>Insufficient Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>151</td>
<td>52</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Service Provider</td>
<td>26</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Distributor</td>
<td>26</td>
<td>7</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Research and Development</td>
<td>23</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Prototype Manufacturer</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Non-profit</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Testing Facility</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Laboratory</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holding Company</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

17% of responses are classified as Moderate/Elevated Risk and 5% are classified as High/Severe Risk

361 respondents
**Business Categories Financial Risk**

“Additional” Business Category by Financial Risk Level

<table>
<thead>
<tr>
<th>Category</th>
<th>Low/Neutral Risk</th>
<th>Moderate/Elevated Risk</th>
<th>High/Severe Risk</th>
<th>Insufficient Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and Development</td>
<td>55</td>
<td>17</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Prototype Manufacturer</td>
<td>55</td>
<td>20</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Testing Facility</td>
<td>43</td>
<td>15</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Service Provider</td>
<td>38</td>
<td>14</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>18</td>
<td>4</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Laboratory</td>
<td>21</td>
<td>53</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Distributor</td>
<td>15</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-profit</td>
<td>42</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holding Company</td>
<td>42</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.0% are classified as Moderate/Elevated Risk and 6.8% are classified as High/Severe Risk

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 respondents
Internal-Owned Facilities
Anticipated Change (2017-2021)

Respondents can have more than one facility

66 respondents indicated their organization intends to invest in Additive Manufacturing/3-D technology capabilities (propulsion-related 45, non-propulsion 21)

Future Investment
Investing in New or Improved Facilities

Of the 83 respondents that plan to expand operations, 47 respondents plan to invest in new or improved R&D facilities (owning, leasing or both)

- Owning: 28
- Leasing: 10
- Both: 9

Number of Facilities

- No Anticipated Changes: 395
- Expanding Operations: 83
- Other: 25
- Closing/Shutting Down/Reducing Operations: 16
- Moving Operations: 12

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Internal/Owned Facilities
Expanding vs Closing/Reducing Operations

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Internal/Owned Facilities
Moving vs Closing/Reducing Operations

54% of these 28 facilities that are expecting to close or move are manufacturers

60% of those manufacturers are expected to close/shutdown

“Other” includes lower-tier companies who were unsure how they supported propulsion-related engines and systems

“Development work has gone away and we don’t see any more work coming to us. Just structural support to Rocket launcher OEM.”
-Large Company

“California business climate is poor, intending to relocate to another state.”
-Small Company

Q2, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Joint Ventures (JVs)  
U.S. and Non-U.S. - 2013-2017

Number of JVs

<table>
<thead>
<tr>
<th>Year</th>
<th>JV-Propulsion</th>
<th>JV-Non Propulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2014</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2015</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>2016</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>2017</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018  
FOR PUBLIC DISTRIBUTION
Mergers, Acquisitions, and Divestitures (MADs)  
U.S. and Non-U.S. - 2013-2017

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Mergers, Acquisitions, and Divestitures (MADs) and Joint Ventures (JVs) – by Country 2013-2017

MADs & JVs 2013-2017:
Total MADs: 249
Total JVs: 56

For more information on Chinese MAD and JV activity, see slide 164

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
All Foreign Mergers, Acquisitions, and Divestitures (MADs) and Joint Ventures (JVs) - 2013-2017

Number of MADs & JVs

- JV-Propulsion
- JV-Non Propulsion
- MAD-Propulsion
- MAD-Non Propulsion

Q3, B

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Products and Services
Organization Participation by Propulsion-Related Product/Service Category (6 Total)

- Manufactured Components: 169 responses
- Production Techniques: 141 responses
- Systems and Services: 129 responses
- Electrical, Ignition, and Control: 111 responses
- Propellants and Other Materials: 108 responses
- Other: 48 responses

Respondents may supply product/services under more than one category.
“Other” includes maintenance, cleaning agents, propellant tanks, and misc.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
# Products and Services

## Respondent Financial Risk by Propulsion-Related Product/Service Categories

Financial Risk: based on profit margins, debt levels, liquidity, product dependence, and performance over time.

<table>
<thead>
<tr>
<th>Category</th>
<th>Low/Neutral Risk</th>
<th>Moderate/Elevated Risk</th>
<th>High/Severe Risk</th>
<th>Insufficient Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured Components</td>
<td>116</td>
<td>30</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Production Techniques</td>
<td>96</td>
<td>23</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Systems and Services</td>
<td>79</td>
<td>25</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Electrical, Ignition, and Control</td>
<td>69</td>
<td>23</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Propellants and Other Materials</td>
<td>65</td>
<td>26</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>31</td>
<td>12</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Insufficient data is a result of unavailable/missing data and source data mismatches.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
### Respondent Capabilities

**By Electrical, Ignition, and Control – 385 Total**

<table>
<thead>
<tr>
<th>Category</th>
<th>Product</th>
<th>Service</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical systems and components</td>
<td>20</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Actuators</td>
<td>20</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Avionics (sub)systems and components</td>
<td>14</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Mechanical controls</td>
<td>16</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Igniter system and components</td>
<td>12</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Ordnance systems and components</td>
<td>12</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Power electronics</td>
<td>11</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Sensors</td>
<td>8</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Harnesses</td>
<td>8</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Arm fire device/Armed or safe</td>
<td>10</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Batteries</td>
<td>6</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Pyrotechnics, cartridge &amp; propellant actuated devices</td>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Transducers</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Igniter material</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Fuses</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**Number of Responses**

- **Q4b, A**
- **361 Respondents**

*Additional 27 responses were reported as “Other” electrical, ignition, and control products/services as they fell outside the listed product/service categories (i.e. combustion chamber, circuit boards, welding equipment, etc.).*
**Respondent Capabilities**

**By Manufactured Components – 438 Total**

<table>
<thead>
<tr>
<th>Product/Service</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozzles</td>
<td>36</td>
</tr>
<tr>
<td>Fasteners, gaskets, o-rings, seals</td>
<td>24</td>
</tr>
<tr>
<td>Valves</td>
<td>14</td>
</tr>
<tr>
<td>Thrust chamber</td>
<td>19</td>
</tr>
<tr>
<td>Ducts, tubing, and hoses</td>
<td>20</td>
</tr>
<tr>
<td>Rotating machinery components</td>
<td>17</td>
</tr>
<tr>
<td>Pressure vessels/motor cases</td>
<td>22</td>
</tr>
<tr>
<td>Turbopump</td>
<td>16</td>
</tr>
<tr>
<td>Fairings and skirts</td>
<td>10</td>
</tr>
<tr>
<td>Bearings</td>
<td>15</td>
</tr>
<tr>
<td>Castings</td>
<td>9</td>
</tr>
<tr>
<td>Bellows</td>
<td>8</td>
</tr>
<tr>
<td>Spun metal domes</td>
<td>9</td>
</tr>
<tr>
<td>Regulators</td>
<td>8</td>
</tr>
<tr>
<td>Strut</td>
<td>5</td>
</tr>
<tr>
<td>Curvics</td>
<td>3</td>
</tr>
<tr>
<td>Springs</td>
<td>4</td>
</tr>
<tr>
<td>Dampers</td>
<td>3</td>
</tr>
</tbody>
</table>

An additional 53 responses were reported as “Other” manufactured components as they fell outside the listed product/service types (ex. textile cutters, cover plates, coils, etc.).

### Respondent Capabilities

#### By Production Techniques – 528 Total

<table>
<thead>
<tr>
<th>Production Technique</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision machining</td>
<td>42</td>
</tr>
<tr>
<td>Small machining</td>
<td>36</td>
</tr>
<tr>
<td>Fabrication</td>
<td>39</td>
</tr>
<tr>
<td>Additive manufacturing</td>
<td>19</td>
</tr>
<tr>
<td>Large machining</td>
<td>21</td>
</tr>
<tr>
<td>Heat treating</td>
<td>15</td>
</tr>
<tr>
<td>Sheet metal fabrication</td>
<td>15</td>
</tr>
<tr>
<td>Metal jointing</td>
<td>16</td>
</tr>
<tr>
<td>Brazing</td>
<td>10</td>
</tr>
<tr>
<td>Molding</td>
<td>13</td>
</tr>
<tr>
<td>Forming</td>
<td>12</td>
</tr>
<tr>
<td>Coating</td>
<td>9</td>
</tr>
<tr>
<td>Turbopump machining</td>
<td>11</td>
</tr>
<tr>
<td>Forging</td>
<td>10</td>
</tr>
<tr>
<td>Plating</td>
<td>6</td>
</tr>
<tr>
<td>Casting</td>
<td>7</td>
</tr>
<tr>
<td>Flow forming</td>
<td>2</td>
</tr>
</tbody>
</table>

An additional 23 responses were reported as “Other” production techniques as they fell outside the listed product/service types (i.e. cold treating, filament winding, rapid prototyping, etc.).

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
## Respondent Capabilities

### By Propellants and Other Materials Category – 273 Total

<table>
<thead>
<tr>
<th>Product/Service</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite materials</td>
<td></td>
</tr>
<tr>
<td>Coatings</td>
<td></td>
</tr>
<tr>
<td>Raw materials</td>
<td></td>
</tr>
<tr>
<td>Adhesives and resins</td>
<td></td>
</tr>
<tr>
<td>Carbon fibers</td>
<td></td>
</tr>
<tr>
<td>Solid rocket propellant material</td>
<td></td>
</tr>
<tr>
<td>Oxidizer</td>
<td></td>
</tr>
<tr>
<td>Insulation</td>
<td></td>
</tr>
<tr>
<td>Polymer</td>
<td></td>
</tr>
<tr>
<td>Liquid propellant and/or materials</td>
<td></td>
</tr>
<tr>
<td>Solid rocket liner material</td>
<td></td>
</tr>
<tr>
<td>Fuels</td>
<td></td>
</tr>
<tr>
<td>Weld wire</td>
<td></td>
</tr>
<tr>
<td>PBI-NBR rubber</td>
<td></td>
</tr>
<tr>
<td>Rayon</td>
<td></td>
</tr>
<tr>
<td>Pressurant</td>
<td></td>
</tr>
<tr>
<td>HC polymer</td>
<td></td>
</tr>
</tbody>
</table>

An additional 19 responses were reported as “Other” propellants and other materials as they fell outside the listed product/service types (ex. propellant fracture modeling, thruster, intermediate chemicals, etc.).

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Respondent Capabilities
By Systems and Services – 509 Total

- Engineering services: 6 Product, 49 Service, 13 Both
- Component testing: 19 Product, 21 Service, 14 Both
- Test services: 2 Product, 32 Service, 12 Both
- Machine parts and tooling: 27 Product, 10 Service, 9 Both
- System/subsystem assembly: 17 Product, 12 Service, 12 Both
- Fabricated assemblies: 16 Product, 6 Service, 15 Both
- System/subsystem integration: 12 Product, 15 Service, 10 Both
- Materials testing: 7 Product, 19 Service, 8 Both
- Composite materials testing: 9 Product, 11 Service, 8 Both
- Test equipment: 4 Product, 19 Service, 5 Both
- Launch services: 6 Product, 7 Service, 14 Both
- Engine/motor system testing: 9 Product, 8 Service, 10 Both
- Test stand design: 7 Product, 7 Service, 10 Both

An additional 12 responses were reported as “Other” systems and services as they fell outside the listed product/service categories (i.e. electric propulsion services, software services, Satellite ground systems and operations, etc.)

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Respondent Capabilities
By “Other” Category – 92 Total

Propellant Tanks
- Product: 12
- Service: 5
- Both: 4

Maintenance/Aftermarket/Repair/Refurbishing
- Product: 3
- Service: 10
- Both: 7

Cleaning Agents
- Product: 2
- Service: 5
- Both: 1

An additional 43 responses were reported as “Other” miscellaneous products/services as they fell outside the listed product/service types (ex. aerostructure fairing, risk analysis, etc.)

Q4b, F

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Domestic & Foreign Suppliers
Number of Propulsion-Related Suppliers by Respondent

- 70% of Respondents
- 26% of Respondents
- 3% of Respondents
- 1% of Respondents

- 500+ Suppliers
- 100-499 Suppliers
- 1-99 Suppliers
- 0 Suppliers

Input Category by Supplier*

- B: Manufactured Components: 840
- D: Propellants and Other Materials: 313
- A: Electrical, Ignition, and Control: 311
- F: Other: 219
- E: Systems and Services: 163
- C: Production Techniques: 71

Total Suppliers (not unique): 1,917

*269 respondents had 1 or more suppliers

“F: Other” includes maintenance, cleaning agents, propellant tanks, and misc

Companies that are service providers can report zero suppliers. Lower-tier companies can report zero propulsion-related suppliers if they do not consider themselves part of the supply chain.
Suppliers
Domestic Unique Suppliers by State: 1,343

Domestic unique suppliers (unique by name only) refers to the headquarter location since suppliers may be associated with multiple state locations.

Q6, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

269 respondents
### Propulsion-Related Suppliers

**By Top Inputs Sourced from Domestic Suppliers**

#### Domestic Inputs – By Category

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured Components</td>
<td>798</td>
</tr>
<tr>
<td>Electrical, Ignition, and Control</td>
<td>298</td>
</tr>
<tr>
<td>Propellants and Other Materials</td>
<td>260</td>
</tr>
<tr>
<td>Other</td>
<td>204</td>
</tr>
<tr>
<td>Systems and Services</td>
<td>147</td>
</tr>
<tr>
<td>Production Techniques</td>
<td>68</td>
</tr>
</tbody>
</table>

#### Domestic Inputs – Top 10 Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials (including Additive Manufacturing Stock)</td>
<td>77</td>
</tr>
<tr>
<td>Valves</td>
<td>68</td>
</tr>
<tr>
<td>Actuators</td>
<td>57</td>
</tr>
<tr>
<td>Fasteners, gaskets, o-rings, seals</td>
<td>56</td>
</tr>
<tr>
<td>Solid rocket propellant material</td>
<td>55</td>
</tr>
<tr>
<td>Other Electrical, Ignition, and Control</td>
<td>54</td>
</tr>
<tr>
<td>Electrical systems and components</td>
<td>49</td>
</tr>
<tr>
<td>Nozzles</td>
<td>47</td>
</tr>
<tr>
<td>Pressure vessels/motor cases</td>
<td>45</td>
</tr>
<tr>
<td>Turbopump</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

1,343 domestic suppliers (unique by name) supplied 1,775 products/services across 6 distinct input categories

Q6, A

269 Respondents
Propulsion-Related Suppliers
Top Inputs Sourced from Foreign Countries

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propellants and Other Materials</td>
<td>53</td>
</tr>
<tr>
<td>Manufactured Components</td>
<td>42</td>
</tr>
<tr>
<td>Systems and Services</td>
<td>16</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
</tr>
<tr>
<td>Electrical, Ignition, and Control</td>
<td>13</td>
</tr>
<tr>
<td>Production Techniques</td>
<td>3</td>
</tr>
</tbody>
</table>

Foreign Inputs – Top 10 Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials</td>
<td>32</td>
</tr>
<tr>
<td>Other Manufactured Components</td>
<td>18</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
</tr>
<tr>
<td>Thrust chamber</td>
<td>8</td>
</tr>
<tr>
<td>Solid rocket propellant material</td>
<td>7</td>
</tr>
<tr>
<td>Turbopump</td>
<td>7</td>
</tr>
<tr>
<td>Launch services</td>
<td>6</td>
</tr>
<tr>
<td>Other Systems and Services</td>
<td>5</td>
</tr>
<tr>
<td>Insulation</td>
<td>5</td>
</tr>
<tr>
<td>Ordnance systems and components</td>
<td>5</td>
</tr>
</tbody>
</table>

"Other" includes maintenance, cleaning agents, propellant tanks, and misc.

97 foreign unique suppliers (unique by name) provided 142 products/services across 6 distinct input categories

Q6, A

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
### Propulsion-Related Suppliers

**Foreign Unique Suppliers – (97) by Country – (28)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Unique Suppliers</th>
<th>Country</th>
<th>Unique Suppliers</th>
<th>Country</th>
<th>Unique Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>19</td>
<td>Norway</td>
<td>2</td>
<td>Austria</td>
<td>1</td>
</tr>
<tr>
<td>Germany</td>
<td>12</td>
<td>Switzerland</td>
<td>2</td>
<td>Malta</td>
<td>1</td>
</tr>
<tr>
<td>China</td>
<td>10</td>
<td>Israel</td>
<td>2</td>
<td>Ireland</td>
<td>1</td>
</tr>
<tr>
<td>Japan</td>
<td>7</td>
<td>New Zealand</td>
<td>2</td>
<td>United Kingdom</td>
<td>1</td>
</tr>
<tr>
<td>France</td>
<td>6</td>
<td>Norway</td>
<td>2</td>
<td>Swaziland</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>5</td>
<td>Taiwan</td>
<td>2</td>
<td>Malaysia</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>4</td>
<td>Finland</td>
<td>2</td>
<td>Thailand</td>
<td>1</td>
</tr>
<tr>
<td>Russia</td>
<td>3</td>
<td>Chile</td>
<td>2</td>
<td>Sweden</td>
<td>1</td>
</tr>
<tr>
<td>New Zealand</td>
<td>3</td>
<td>Mexico</td>
<td>1</td>
<td>Ukraine</td>
<td>1</td>
</tr>
<tr>
<td>India</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Foreign unique suppliers refers to the headquarters location since suppliers may be located in multiple countries*
Supply Chain Practices Defined

- MRP (Materials Requirements Planning): obtaining the correct quantity of materials and precise timeline to support production

- Multiple Sourcing: using various suppliers

- ERP (Enterprise Resource Planning): connecting producers with makers of raw materials

- Bar Coding: using a bar code as an identification tool to track products

- CRM (Customer Relationship Management): managing and tracking relationships with customers

- MRPII (Manufacturing Resource Planning): orchestrating the correct quantity of materials throughout the entire value stream
**Propulsion-Related Supply Chain**

### Disruptions/Impacts Experienced

- Supply Chain Disruptions: 343 Yes, 18 No
- Negative Impact of Imports: 357 Yes, 4 No
- Supply Chain Management Practices: 256 Yes, 105 No

### Number of Companies Using Top 10 Supply Chain Practices

- Materials Requirements Planning: 77
- Multiple Sourcing: 73
- Enterprise Resource Planning: 71
- Bar Coding: 67
- Subcontracting: 64
- Outsourcing: 63
- External Consultants: 52
- Full Time Manager: 51
- Customer Relationship Management: 46
- Manufacturing Resource Planning: 41

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Employment - Space Primes

Total U.S. Employment vs Propulsion-Related Employment

Total Space Primes - 11
- Total Employees: 61,312
- Propulsion Employees: 13,413

Legacy Space Primes - 5
- Total Employees: 53,828
- Propulsion Employees: 11,507

New Space Primes - 6
- Total Employees: 7,484
- Propulsion Employees: 1,906

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

11 Respondents
Employment at Legacy and New Space Primes
Percentage of Propulsion Employees by Age and Education

### Legacy Space Primes

- **25 or Younger**: 10% Associates and Below, 20% BA/BS, 20% Masters/Professional, 5% Ph.D.
- **26-35**: 10% Associates and Below, 40% BA/BS, 20% Masters/Professional, 5% Ph.D.
- **36-45**: 20% Associates and Below, 30% BA/BS, 20% Masters/Professional, 10% Ph.D.
- **46-55**: 10% Associates and Below, 20% BA/BS, 30% Masters/Professional, 10% Ph.D.
- **56-64**: 5% Associates and Below, 20% BA/BS, 30% Masters/Professional, 15% Ph.D.
- **65+**: 15% Associates and Below, 10% BA/BS, 20% Masters/Professional, 5% Ph.D.

### New Space Primes

- **25 or Younger**: 15% Associates and Below, 45% BA/BS, 20% Masters/Professional, 10% Ph.D.
- **26-35**: 10% Associates and Below, 40% BA/BS, 20% Masters/Professional, 10% Ph.D.
- **36-45**: 20% Associates and Below, 20% BA/BS, 30% Masters/Professional, 15% Ph.D.
- **46-55**: 15% Associates and Below, 30% BA/BS, 30% Masters/Professional, 5% Ph.D.
- **56-64**: 10% Associates and Below, 20% BA/BS, 30% Masters/Professional, 15% Ph.D.
- **65+**: 10% Associates and Below, 15% BA/BS, 15% Masters/Professional, 5% Ph.D.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

11 Respondents
Employment - 2016
Total Number of Employees (All Respondents) by State: 268,545

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Employment - 2016
Total Number of Propulsion-Related Employees (All Respondents) by State: 29,238

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPBA, 2018
FOR PUBLIC DISTRIBUTION
Employment – 2013-2016
Total U.S. Citizen vs Total Non-U.S. Citizen Employees

Number of Employees

- Total U.S. citizen employment increased by 4.4%
- Total Non-U.S. citizen employment increased by 34.7%

Q8, A
361 Respondents

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Employment – 2013-2016

Total Propulsion-Related vs Non Propulsion-Related Employees

Non-propulsion related employment increased on average annually by 1.7% compared to 3.1% for propulsion-related employment.

Q8, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Employment – 2013-2016
U.S. Citizen Propulsion vs Non-U.S. Citizen Propulsion Employees

Q8, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Employment – 2013-2016
Average Percentage of FTEs by Occupational Category

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Line Workers</th>
<th>Engineers</th>
<th>Testing Operators/Support Technicians</th>
<th>Scientists</th>
<th>IT Professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>45.0%</td>
<td>31.6%</td>
<td>15.0%</td>
<td>6.2%</td>
<td>3.2%</td>
</tr>
<tr>
<td>2015</td>
<td>46.7%</td>
<td>31.2%</td>
<td>14.4%</td>
<td>6.2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>2014</td>
<td>46.8%</td>
<td>31.2%</td>
<td>15.1%</td>
<td>5.9%</td>
<td>2.5%</td>
</tr>
<tr>
<td>2013</td>
<td>47.2%</td>
<td>30.5%</td>
<td>15.2%</td>
<td>6.0%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

Values are industry averages and will not total to 100%

Q8, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Employment – 2013-2016
Average Turnover Rate by Operations

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall Turnover Rate</th>
<th>Propulsion-Related Turnover Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>7.9%</td>
<td>3.1%</td>
</tr>
<tr>
<td>2014</td>
<td>8.4%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2015</td>
<td>9.2%</td>
<td>4.4%</td>
</tr>
<tr>
<td>2016</td>
<td>9.8%</td>
<td>4.6%</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q8, A 361 Respondents
Employment – 2016
Total STEM Degree Propulsion-Related FTEs by Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Associates and Below</th>
<th>BA/BS</th>
<th>Masters/Professional</th>
<th>Ph.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>65+</td>
<td>275</td>
<td>257</td>
<td>25</td>
<td>92</td>
</tr>
<tr>
<td>56-64</td>
<td>1,602</td>
<td>1,484</td>
<td>780</td>
<td>149</td>
</tr>
<tr>
<td>46-55</td>
<td>1,830</td>
<td>1,227</td>
<td>629</td>
<td>178</td>
</tr>
<tr>
<td>36-45</td>
<td>1,404</td>
<td>1,077</td>
<td>590</td>
<td>114</td>
</tr>
<tr>
<td>26-35</td>
<td>1,453</td>
<td>1,684</td>
<td>604</td>
<td>73</td>
</tr>
<tr>
<td>25 or Younger</td>
<td>566</td>
<td>497</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>

Total Number of Employees

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
361 Respondents
Employment – 2016
Average STEM Degree Propulsion-Related FTEs by Age

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q8, B
361 Respondents
Employment – 2016
Total Non-U.S. FTE Employees and Contractors by Visa Type

In 2016, 94 respondents employed 6,051 Non-U.S. Citizen FTEs
*Some respondents were unable to provide a visa-based breakdown of their Non-U.S. Citizen FTEs. Their responses are only included in the aggregate total.

Q8, C
94 Respondents

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Employment – 2016
Non-U.S. FTE Employees and FTE Contractors by Top 10 Countries

Mexico accounts for 54% of all Non-U.S. citizen FTE Employees and Contractors

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Customers
By Type of Customers Supported

Domestic Customers - 1,411

- USG Non-Defense: 473, 34%
- USG Defense: 167, 12%
- U.S. Commercial Defense: 383, 27%
- U.S. Commercial Non-Defense: 388, 27%

Foreign Customers - 226

- Non-USG Non-Defense: 58, 26%
- Non-USG Government Defense: 42, 18%
- Non-U.S. Commercial Defense: 90, 40%
- Non-U.S. Commercial Non-Defense: 36, 16%

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q10, B
361 respondents
Customers
Total Propulsion-Related Unique Customers by State: 637

One propulsion-related customer reported in Hawaii.

Q10, B

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Customers

Total Foreign Unique Customers by Country: 156

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Customers
Top 15 Product/Services Provided to U.S. and Non-U.S. Customers

Products/services were reported as “Other” if they fell outside the listed product/service types (i.e. combustion chamber, textile cutters, filament winding, propellant fracture modeling, etc.)

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
R&D, Testing, and Evaluation
General Participation

Percentage of All Respondents

- Yes: 178, 49%
- No: 183, 51%

Q11a, A

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
R&D Expenditures – 2013-2016
Total and Propulsion-Related R&D Expenditures by Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Total R&amp;D Expenditures ($ Millions)</th>
<th>Propulsion Related R&amp;D ($ Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>$11,827</td>
<td>$1,191</td>
</tr>
<tr>
<td>2015</td>
<td>$10,965</td>
<td>$1,034</td>
</tr>
<tr>
<td>2014</td>
<td>$10,587</td>
<td>$849</td>
</tr>
<tr>
<td>2013</td>
<td>$10,096</td>
<td>$635</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q11a, C

178 Respondents
R&D Expenditures – 2013-2016
R&D Intensity Ratio by Average Sales

Average R&D Intensity Ratio = Average R&D Expenditures / Average Total Sales

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q11a, C

178 Respondents
R&D Expenditures – 2013-2016

Top Categories of R&D Expenditures by Percentage

Values are industry averages and will not total to 100%

<table>
<thead>
<tr>
<th>Year</th>
<th>Basic Research</th>
<th>Applied Research</th>
<th>Product/Process Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>22.6%</td>
<td>65.7%</td>
<td>11.7%</td>
</tr>
<tr>
<td>2014</td>
<td>22.9%</td>
<td>65.4%</td>
<td>11.7%</td>
</tr>
<tr>
<td>2015</td>
<td>21.6%</td>
<td>65.0%</td>
<td>13.4%</td>
</tr>
<tr>
<td>2016</td>
<td>20.8%</td>
<td>67.8%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
R&D Expenditures – 2013-2016
Average R&D Expenditures by Company Size

Q11a, B

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

178 Respondents
Propulsion-Related R&D Expenditures
Top Sources of Propulsion-Related R&D Expenditures by Percentage

Values are industry averages and will not total to 100%

Q11a, C

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

178 Respondents
Propulsion-Related R&D Expenditures – 2013-2016

Average Propulsion-Related R&D Expenditures by Company Size

<table>
<thead>
<tr>
<th>Year</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$1.8</td>
<td>$0.8</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>$2.1</td>
<td>$0.9</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>$2.2</td>
<td>$1.0</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>$1.2</td>
<td></td>
<td>$6.1</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
R&D Funding
Total R&D Funding, Expenditures, and Refunds - 2013-2016

Q11a, B

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
R&D Expenditures Reimbursed – 2013-2016
Total R&D Expenditures Reimbursed by USG Agencies

Values are industry averages and will not total to 100%

Percentage of Total R&D Expenditures Reimbursed by USG Agencies

- DOD-Related
- Propulsion-Related
- NASA-Related

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
R&D Funding – 2013-2016
Top 3 Sources of R&D Funding by Percentage

<table>
<thead>
<tr>
<th>Year</th>
<th>Internal/Self-Funded R&amp;D</th>
<th>USG</th>
<th>U.S. Industry, Venture Capital, Non-Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>72.2%</td>
<td>45.5%</td>
<td>8.4%</td>
</tr>
<tr>
<td>2014</td>
<td>72.0%</td>
<td>47.8%</td>
<td>9.2%</td>
</tr>
<tr>
<td>2015</td>
<td>73.1%</td>
<td>48.2%</td>
<td>8.8%</td>
</tr>
<tr>
<td>2016</td>
<td>73.5%</td>
<td>46.5%</td>
<td>13.0%</td>
</tr>
</tbody>
</table>

Values are industry averages and will not total to 100%
USG-Related R&D Funding – 2013-2016

Top Sources of USG-Related R&D Funding by Percentage

- **DOD**
- **NASA**
- **Other**

Values are industry averages and will not total to 100%

<table>
<thead>
<tr>
<th>Year</th>
<th>DOD</th>
<th>NASA</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>40.1%</td>
<td>20.7%</td>
<td>8.7%</td>
</tr>
<tr>
<td>2014</td>
<td>41.3%</td>
<td>22.7%</td>
<td>10.5%</td>
</tr>
<tr>
<td>2015</td>
<td>43.6%</td>
<td>20.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>2016</td>
<td>43.1%</td>
<td>22.1%</td>
<td>7.8%</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

Q11a, C

178 Respondents
R&D Funding – 2013-2016
Average Value of R&D Funding by Company Size

Average R&D funding for medium sized companies decreased by 79%
Research, Development, Testing, and Evaluation
R&D Tax Credit Use and Type

R&D Tax Credit Usage

- Yes: 54
- Unsure: 19
- No: 105

Type of Tax Credit Used

- Both Federal and State: 58
- Federal Credit Only: 43
- State Credit Only: 4

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
Research, Development, Testing, and Evaluation

R&D Tax Credit Use by Company Size

R&D Tax Credit Usage (Small Companies)
- 23, 50% (Yes)
- 17, 37% (Unsure)
- 6, 13% (No)
46 Respondents

R&D Tax Credit Usage (Medium Companies)
- 10, 21% (Yes)
- 6, 13% (Unsure)
- 31, 66% (No)
47 Respondents

R&D Tax Credit Usage (Large Companies)
- 21, 25% (Yes)
- 7, 8% (Unsure)
- 57, 67% (No)
85 Respondents

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Research, Development, Testing, and Evaluation

R&D Application by Propulsion-Related Areas: 400 Total

Q11b

1 company reported R&D related to hydro-propulsion

No companies reported R&D related to laser electric propulsion or laser thermal rockets
R&D, Testing, and Evaluation

R&D Application Areas by Industrial Base Business Participation (Part 1 of 2)

- Small Liquid Propulsion
- Large Liquid Propulsion
- Other
- Small Solid Rocket Motor
- Science and Technology
- Large Solid Rocket Motor
- Electric Propulsion
- Test and Evaluation

Analytical modeling: 5 Small Liquid, 7 Large Liquid, 10 Other, 5 Small Solid, 8 Science, 2 Technology, 3 Large Solid, 3 Electric, 1 Test, 3 Evaluation

In-space propulsion: 15 Small Liquid, 3 Large Liquid, 3 Other, 3 Small Solid, 2 Science, 3 Technology, 4 Large Solid, 1 Electric, 1 Test, 3 Evaluation

Thrusters: 12 Small Liquid, 2 Large Liquid, 2 Other, 2 Small Solid, 1 Science, 2 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Nozzles: 9 Small Liquid, 4 Large Liquid, 10 Other, 4 Small Solid, 4 Science, 4 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Combustion chambers: 7 Small Liquid, 4 Large Liquid, 10 Other, 4 Small Solid, 3 Science, 4 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

High-temperature materials: 7 Small Liquid, 4 Large Liquid, 2 Other, 4 Small Solid, 3 Science, 4 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Small liquid rockets: 4 Small Liquid, 16 Large Liquid, 2 Other, 4 Small Solid, 2 Science, 4 Technology, 3 Large Solid, 4 Electric, 1 Test, 1 Evaluation

Propellant tanks: 7 Small Liquid, 6 Large Liquid, 1 Other, 1 Small Solid, 1 Science, 1 Technology, 2 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Small solid rockets: 1 Small Liquid, 15 Large Liquid, 1 Other, 1 Small Solid, 1 Science, 1 Technology, 1 Large Solid, 2 Electric, 1 Test, 1 Evaluation

Large liquid rockets: 1 Small Liquid, 17 Large Liquid, 1 Other, 1 Small Solid, 1 Science, 1 Technology, 2 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Electric propulsion/rockets: 4 Small Liquid, 2 Large Liquid, 11 Other, 2 Small Solid, 1 Science, 1 Technology, 1 Large Solid, 3 Electric, 2 Test, 1 Evaluation

Boosters: 2 Small Liquid, 7 Large Liquid, 3 Other, 1 Small Solid, 1 Science, 1 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Hypersonics: 1 Small Liquid, 6 Large Liquid, 1 Other, 3 Small Solid, 2 Science, 2 Technology, 1 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Gas turbines: 3 Small Liquid, 5 Large Liquid, 3 Other, 2 Small Solid, 1 Science, 1 Technology, 3 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Liquid propellant and fuels: 5 Small Liquid, 4 Large Liquid, 2 Other, 4 Small Solid, 2 Science, 2 Technology, 1 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Environmentally friendly propellant/fuel: 7 Small Liquid, 1 Large Liquid, 2 Other, 1 Small Solid, 1 Science, 1 Technology, 1 Large Solid, 1 Electric, 1 Test, 1 Evaluation

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

178 Respondents
## R&D, Testing, and Evaluation

### R&D Application Areas by Industrial Base Business Participation (Part 2 of 2)

<table>
<thead>
<tr>
<th>Field</th>
<th>Small Liquid Propulsion</th>
<th>Large Liquid Propulsion</th>
<th>Other</th>
<th>Small Solid Rocket Motor</th>
<th>Science and Technology</th>
<th>Large Solid Rocket Motor</th>
<th>Electric Propulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear thermal/nuclear fusion propulsion</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Large solid rockets</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Sensors</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Missiles - solids</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hybrid rockets</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Storable oxidizers</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Solid propellant and fuels</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retropropulsion</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Missiles - liquids</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Inert propellants</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Casings</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Thermal rockets</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supersonic retropropulsion</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite tethers</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel oils</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydropropulsion</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser thermal rockets</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser electric propulsion</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Other” includes manufacturing and additives, basic and applied research services, and experimental 3D printing.
### R&D, Testing, and Evaluation

#### Financial Risk by R&D Application Area (Part 1 of 2)

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Low/Neutral Risk</th>
<th>Moderate/Elevated Risk</th>
<th>High/Severe Risk</th>
<th>Insufficient Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical modeling</td>
<td></td>
<td>22</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>In-space propulsion</td>
<td></td>
<td>16</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Thrusters</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Nozzles</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Combustion chambers</td>
<td>11</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>High-temperature materials</td>
<td>11</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Small liquid rockets</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Propellant tanks</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Small solid rockets</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Large liquid rockets</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Electric propulsion/rockets</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Boosters</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Hypersonic</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Gas turbines</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Liquid propellant and fuels</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Environmentally friendly propellant/fuel</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nuclear thermal/nuclear fusion propulsion</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Financial risk is defined as downside risk, estimating the potential for financial loss and uncertainty about its extent.

**Q11b**

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
R&D, Testing, and Evaluation

Financial Risk by R&D Application Area (Part 2 of 2)

Low/Neutral Risk  Moderate/Elevated Risk  High/Severe Risk  Insufficient Data

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Insufficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large solid rockets</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Sensors</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Missiles - solids</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hybrid rockets</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Storable oxidizers</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Solid propellant and fuels</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retropropulsion</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Missiles - liquids</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Inert propellants</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Casings</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal rockets</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supersonic retropropulsion</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite tethers</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel oils</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydropropulsion</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser thermal rockets</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser electric propulsion</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Responses

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Research, Development, Testing, and Evaluation
Received Federal Research and Development Funding
(Direct and Indirect Funding)

Yes, 56, 31%

No, 122, 69%

Q11c, A

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Research, Development, Testing, and Evaluation
USG Propulsion-Related Spending Practices Adversely Impact Organization’s R&D Activities

USG Propulsion-Related Adverse Practices

- Contract Type
- Decreased Spending
- Fluctuation/Erratic Spending
- Inadequate Guidance/Outreach
- Inadequate Budget
- Program Cancellations
- Domestic Sourcing/Buy America/Set Asides
- Reliance on Prime Contractors
- Revision of Requirements
- No/Limited R&D Reimbursement

Q11c, A

178 Respondents

Research, Development, Testing, and Evaluation
USG-Funded Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Contracts: 128

- **USG Agency**
  - DOD: 54 SBIR, 4 STTR
  - NASA: 56 SBIR, 12 STTR
  - DOC - National Institute of Standards and Technology: 2 SBIR, 0 STTR


**Q11c, C**

- 41 respondents had 1 contract under SBIR funding. 15 respondents had 2 contracts from SBIR funding.

**Number of Respondents**

- 1 Contract: 41
- 2 Contracts: 15
- 3 Contracts: 4 SBIR, 1 STTR
- 4 Contracts: 3 SBIR, 1 STTR
- 5 Contracts: 1
- > 5 Contracts: 2

**Source:** U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
Research, Development, Testing, and Evaluation

SBIR Contract Financial Risk

<table>
<thead>
<tr>
<th>USG Agency</th>
<th>SBIR Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOD</td>
<td>54</td>
</tr>
<tr>
<td>NASA</td>
<td>56</td>
</tr>
<tr>
<td>DOC - National Institute of Standards and Technology</td>
<td>2</td>
</tr>
</tbody>
</table>

Number of Respondents:
- 1 Contract: 29
- 2 Contracts: 14
- 3 Contracts: 3
- 4 Contracts: 3
- 5 Contracts: 1
- > 5 Contracts: 1

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
### Research, Development, Testing, and Evaluation

#### STTR Contract Financial Risk

<table>
<thead>
<tr>
<th>USG Agency</th>
<th>STTR Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOD</td>
<td>4</td>
</tr>
<tr>
<td>NASA</td>
<td>12</td>
</tr>
<tr>
<td>DOC - National Institute of Standards and Technology</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIFA, 2018

**Q11c, C**

8 Respondents
Research, Development, Testing, and Evaluation

Program Technology Transfer

- Program Technology Transfer - defined as the movement of knowledge or technology developed by a federal laboratory for private organizations in the commercial marketplace

- Examples: patent dissemination, licensing of intellectual property, and R&D collaborative relationships such as Cooperative Research and Development Agreements (CRADAs)

- 6 organizations each identified they participated in one propulsion-related technology transfer activity between 2013 and 2016

Research, Development, Testing, and Evaluation

Number of Organizations with Testing Needs

Propulsion-Related

- Both Past & Future Use: 45
- Anticipated Future Use (2017-2020): 2
- Past Use (2013-2016): 7

Engine and/or Motor-Related

- Both Past & Future Use: 27
- Anticipated Future Use (2017-2020): 8
- Past Use (2013-2016): 0

“No” and Blank responses are not included

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

178 Respondents
Research, Development, Testing, and Evaluation
Location of Testing Facilities Used By Testing Needs

- Facilities owned by your company: Past Use (36), Current Use (36), Anticipated Future Use (42)
- Facilities owned by other industry entities: Past Use (28), Current Use (21), Anticipated Future Use (31)
- Non-government facilities: Past Use (19), Current Use (17), Anticipated Future Use (20)
- NASA facilities: Past Use (14), Current Use (14), Anticipated Future Use (19)
- Leased facilities: Past Use (15), Current Use (12), Anticipated Future Use (17)
- Other government facilities: Past Use (11), Current Use (11), Anticipated Future Use (14)
- Other

One additional testing facility was reported as “Other” as it fell outside the types listed (Test Launch application)
Research, Development, Testing, and Evaluation
Organization’s Ability to Perform Test Type (Internal/External)

An additional 40 test types (23 internal and 17 external) were reported as “Other” as they fell outside the listed test types (i.e. altitude electric engine, nuclear fusion, cryogenic fueled stages, etc.)

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Sales
Total U.S. and Non-U.S. Sales – 2013-2016

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q9, A

361 Respondents
Sales

Total U.S. and Non-U.S. Propulsion-Related Sales – 2013-2016

- U.S. Propulsion-Related Sales
- Non-U.S. Propulsion-Related Sales

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Sales

U.S. and Non-U.S. Propulsion-Related Sales as a Percent of Total Sales
2013 – 2016

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

Q9, B

361 Respondents
Sales

Total sales can be accounted for in more than one category (e.g. total sales can be both NASA and Propulsion-related)

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Median Net Sales, Gross Profit, EBIT

*Values used are industry medians

Q12  361 Respondents

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Average Gross Profit Margin % by Business Size

*Values used are industry averages

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q12

361 Respondents
Average Net Sales by Business Size

*Values used are industry averages

Change in average net sales (2013-2016):
Small Businesses: +33.2%
Medium Businesses: -13.0%
Large Businesses: -9.6%

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q12
361 Respondents
Current Ratios

*Values used are industry medians

Liquidity ratio - measures if current assets can meet liabilities when due. Includes: current ratio and quick ratio

Current ratio - ability to pay short-term and long-term liabilities through the proportion of current assets to current liabilities. A higher current ratio is better than a lower one

*Data reflects all organizations activities, 25 organizations had insufficient data and were excluded

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Quick Ratios

*Values used are industry medians

Liquidity ratio - measures if current assets can meet liabilities when due. Includes: current ratio and quick ratio

Quick ratio - ability to meet short-term liabilities with quick/near cash assets. Excludes inventories. A higher quick ratio is better than a lower one

*Data reflects all organizations activities, 25 organizations had insufficient data and were excluded

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Debt Ratio by Business Size

*Values used are industry medians

Debt Ratio – capability to pay long-term debt by measuring the proportion of assets financed by debt. Ratio < 0.5 indicates most assets are financed by equity.

*Data reflects all organizations activities, 25 organizations had insufficient data and were excluded.
Debt/Equity Ratio by Business Size

*Values used are industry medians

Debt/Equity Ratio – Extent
debt is utilized to finance
assets relative to value of
equity. Ratio lower than 1
indicates more assets
financed by equity rather than
debt

*Data reflects all organizations
activities, 25 organizations had
insufficient data and were
excluded

Q12

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Asset and Industry Turnover Ratios

*Values used are industry medians

Asset Turnover Ratio - Indicates the efficiency in which an organization utilizes its assets to generate revenue. A higher ratio is better than a lower one.

Inventory Turnover Ratio – Measures the effectiveness that inventory is managed through a comparison of cost of goods sold with average inventory. A lower ratio indicates weaker sales and excess inventory.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Profitability Measures
*Values used are industry medians

Net Profit Margin - Indicates the extent of profit associated with each dollar sold
Return on Assets (ROA) – Indicates the efficiency in which an organization can manage its assets to generate profits

Q12

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Financial Risk and Facility Reduction/Closing

Number of Respondents by Financial Risk - 2013-2016

- Financial risk is defined as downside risk which estimates the potential for financial loss and uncertainty.

- From 2013 to 2016:
  - Total companies identified as moderate/elevated risk and high/severe risk grew by 48.3%.

Propulsion-Related Facility Reductions/Closings (Projected for 2017-2020)

- 3% of propulsion-related facilities (16 of 531) are projected to either reduce operations (9) or close (7) between 2017 and 2020.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Organization Standards/Certifications
Standards/Certifications Organizations are Currently Holding or Pursuing

<table>
<thead>
<tr>
<th>Certification</th>
<th>Currently Holding</th>
<th>In Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 9001</td>
<td>225</td>
<td>12</td>
</tr>
<tr>
<td>AS9100</td>
<td>136</td>
<td>12</td>
</tr>
<tr>
<td>AS9100D</td>
<td>54</td>
<td>84</td>
</tr>
<tr>
<td>NADCAP</td>
<td>68</td>
<td>7</td>
</tr>
<tr>
<td>Independent/Internal (From Customer)</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>ISO 14001</td>
<td>38</td>
<td>3</td>
</tr>
<tr>
<td>FAA</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>J-STD-001DS</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>AMS</td>
<td>13</td>
<td>2</td>
</tr>
</tbody>
</table>

19 of 361 respondents had to requalify for propulsion-related purposes, which cost an average of $33,067 with potentially high variability.
24% of survey respondents utilize additive manufacturing/3-D Printing. Most lower-tier respondents do not. The business types covered include: distributor, holding company, laboratory, manufacturer, non-profit, prototype manufacturer, research and development, service provider, and testing facility.
Additive Manufacturing / 3-D Printing Participation

Participation By Application Area

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Propulsion</th>
<th>Non-Propulsion</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and Development</td>
<td>10</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Prototyping</td>
<td>10</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Tooling/Machining</td>
<td>7</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Direct Manufacturing</td>
<td>6</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Integration into Systems/Subsystems</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>A.M./3-D Design Products/Services</td>
<td>2</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>A.M./3-D Design Outsourcing</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Other

- Fixtures: Prop - Non - Both: 3
- Testing: Prop - Non - Both: 1
- Advisory Services: Prop - Non - Both: 1

88 Respondents

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Additive Manufacturing / 3-D Printing
Participation By Process Type

Machining/Finishing A.M./3-D Products
- Propulsion: 10
- Non-Propulsion: 10
- Both: 13

Powder Bed Fusion
- Propulsion: 4
- Non-Propulsion: 11
- Both: 14

Material Extrusion
- Propulsion: 1
- Non-Propulsion: 10
- Both: 8

Directed Energy Deposition
- Propulsion: 7
- Non-Propulsion: 4
- Both: 6

Other
- Propulsion: 2
- Non-Propulsion: 8
- Both: 3

3-D Welding
- Propulsion: 2
- Non-Propulsion: 3
- Both: 4

VAT Photopolymerization
- Propulsion: 2
- Non-Propulsion: 3
- Both: 1

Material Jetting
- Propulsion: 2
- Non-Propulsion: 4

Binder Jetting
- Propulsion: 2

Sheet Lamination
- Propulsion: 1

Continuous Liquid Interface Production
- Propulsion: 1

Other
- FDM/FFF: Prop 1, Non 2, Both 2
- Plastic-related: Non 3
- SLA Castings: Prop 1, Both 1
- Cold Spray: Non 1
- Composite Lay-up: Non 1
- EBAM: Both 1
- Liquid Additives: Both 1

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Additive Manufacturing / 3-D Printing

Propulsion-Related Investment – 2013-2016

62 respondents listed either “Propulsion” or “Both” to indicate their level of involvement in additive manufacturing/3-D printing.

Investment Spending ($ Millions)

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$511.4</td>
<td>$2,028.6</td>
<td>$1,515.9</td>
<td>$353.3</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Capital Expenditures
Median Capital Expenditures by Year – 2013-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Median Capital Expenditures ($ Thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$374.0</td>
</tr>
<tr>
<td>2014</td>
<td>$474.0</td>
</tr>
<tr>
<td>2015</td>
<td>$610.0</td>
</tr>
<tr>
<td>2016</td>
<td>$595.0</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPDBA, 2018
FOR PUBLIC DISTRIBUTION

Q15a, A

338 Respondents
Capital Expenditures
Average Capital Expenditures by Year – 2013-2016

- 2013: $57.4
- 2014: $51.7
- 2015: $47.5
- 2016: $43.3

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q15a, A
338 Respondents
Capital Expenditures
Median Propulsion-Related Capital Expenditures by Year – 2013-2016

- 2013: $114.7
- 2014: $133.0
- 2015: $172.5
- 2016: $164.7

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Capital Expenditures
Average Propulsion-Related Capital Expenditures by Year – 2013-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Expenditures ($ Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$4.4</td>
</tr>
<tr>
<td>2014</td>
<td>$9.4</td>
</tr>
<tr>
<td>2015</td>
<td>$10.5</td>
</tr>
<tr>
<td>2016</td>
<td>$6.6</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

153 Respondents
Capital Expenditures
Organization CapEx Adversely Impacted by Reductions in USG Spending – 2013-2016

Overall CapEx

- Adverse Impact: 54, 15%
- No Adverse Impact: 307, 85%

Propulsion-Related CapEx

- Adverse Impact: 38, 11%
- No Adverse Impact: 323, 89%

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

361 Respondents
Capital Expenditures

Anticipate Organization’s CapEx Will Be Adversely Impacted by Reductions/Fluctuations in USG Spending – 2017-2020

Overall CapEx
- Anticipate Adverse Impact: 47, 13%
- Do Not Anticipate Adverse Impact: 314, 87%

Propulsion-Related CapEx
- Anticipate Adverse Impact: 35, 10%
- Do Not Anticipate Adverse Impact: 326, 90%


361 Respondents
Production/Capacity
Capacity and Utilization - 2016

• “Utilization” refers to the fraction of an organization’s potential output that is actually being used in current production. Potential output is based on a 7 day-a-week, 3x8-hour shift production schedule

• 311 organizations reported an average utilization rate of 61.4%, with 231 of these organizations reporting a propulsion-related utilization rate of 38.8%

• 262 organizations reported an average of 18 weeks to reach 100% utilization, with 240 organizations reporting an average of 22 weeks to reach 100% propulsion-related utilization

• Some organizations had difficulty reporting utilization rates because they are distributors, service providers, etc.
Production/Capacity

Which constraints listed would your organization face during a surge in demand for propulsion-related products?

Comments:
- Labor, time, and inventory constraints
- Accommodate for recruitment, training, equipment, modification of facilities, suppliers, regulatory approval, and funding
- Need technical skilled workers
- Noted productivity impact of regulatory burdens and audits
- Ability to rapidly shift resources to face a surge in demand due to their small percentage of propulsion-related work
- Already plan for potential surges in demand

Q15a, C

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION 311 Respondents
Participation in Propulsion-Related Cost Sharing Arrangement Types

Most Common Past and Future Cost Sharing Arrangement Types

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Government-Sponsored</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Partnership With Subcontractor</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Public-Private Partnerships</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Partnership With Downstream Suppliers</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Partnership With Subsidiary</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Inter-Agency Cooperation</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>University-Sponsored</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

Examples:
- University-Sponsored: For R&D and nonprofit goals
- Inter-Agency: Reduce risk, leverage investments, utilize different talent and skill sets, required by sponsor
Cost Sharing Arrangements
By Deterrents

- Financial Concerns: 25 responses
- Intellectual Property Concerns: 17 responses
- Contract Vehicle: 13 responses
- Regulatory Burden: 13 responses
- Legal Time/Burden: 11 responses
- Legal Costs: 10 responses
- Logistics/Operations: 10 responses
- Export Control Adherence: 8 responses

28 organizations responded “Yes” for deterrents to cost sharing arrangements.

“The intense requirements and regulations required to obtain and maintain classified computing equipment (are a deterrent)”
- Small Business

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Support to USG


42% of respondents did not support USG agencies

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Support to USG
Top 10 Federal Agencies Supported (All Contracts)

<table>
<thead>
<tr>
<th>Agency</th>
<th>Direct</th>
<th>Both</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA</td>
<td>61</td>
<td>61</td>
<td>88</td>
</tr>
<tr>
<td>USAF</td>
<td>48</td>
<td>57</td>
<td>98</td>
</tr>
<tr>
<td>U.S. Navy</td>
<td>49</td>
<td>50</td>
<td>85</td>
</tr>
<tr>
<td>U.S. Army</td>
<td>38</td>
<td>45</td>
<td>73</td>
</tr>
<tr>
<td>MDA</td>
<td>17</td>
<td>22</td>
<td>62</td>
</tr>
<tr>
<td>DARPA</td>
<td>22</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>DOE</td>
<td>23</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Other/Misc</td>
<td>36</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>USMC</td>
<td>11</td>
<td>11</td>
<td>35</td>
</tr>
<tr>
<td>Intelligence</td>
<td>8</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

Sample does not include “N/A” entries

Number of Responses

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q5a, A

210 Respondents
Propulsion-Related Support to USG

Top 10 Federal Agencies Supported (All Contracts)

<table>
<thead>
<tr>
<th>Agency</th>
<th>Propulsion</th>
<th>Non-Propulsion</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA</td>
<td>74</td>
<td>45</td>
<td>91</td>
</tr>
<tr>
<td>USAF</td>
<td>51</td>
<td>60</td>
<td>92</td>
</tr>
<tr>
<td>U.S. Navy</td>
<td>28</td>
<td>80</td>
<td>76</td>
</tr>
<tr>
<td>U.S. Army</td>
<td>16</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>MDA</td>
<td>37</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>DARPA</td>
<td>17</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>DOE</td>
<td>3</td>
<td>49</td>
<td>17</td>
</tr>
<tr>
<td>Other/Misc</td>
<td>7</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>USMC</td>
<td>4</td>
<td>38</td>
<td>15</td>
</tr>
<tr>
<td>Intelligence</td>
<td>7</td>
<td>11</td>
<td>13</td>
</tr>
</tbody>
</table>

Sample does not include “N/A” entries

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q5a, A

210 Respondents
Support to USG

Programs Supported by 25 or More USG Dependent Respondents

210 respondents supported USG Programs. Some reported supporting multiple USG Programs.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Support to USG

Programs Supported by 25 or More USG Dependent Respondents With Non-U.S. Employees (Top 5 Countries)

- India and China account for 55% of all Non-U.S. employees that support USG programs.
- 33% of Non-U.S. employees were identified as engineers.
- 14% of Non-U.S. employees supported small liquid propulsion systems.

Non-U.S. employees are not program specific and can be accounted for in more than one USG program.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q5c, B

210 Respondents
Support to USG
Propulsion/Non-Propulsion-Related Support to USG JANNAF Agencies

Q5a, A-E

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Financial Risk of Organizations that Support USG JANNAF Agencies

Insufficient data is a result of unavailable/missing data and source data mismatches.

Financial Risk
- High/Severe
- Insufficient Data
- Moderate/Elevated
- Low/Neutral

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
High/Severe Risk Organizations That Support
USG JANNAF Agencies – 2013-2016

4 out of 16 or 25% of high/severe risk organizations support all 4 listed USG JANNAF Agencies across 10 programs

Not Shown:
USAF & NASA: 1
Army & Navy: 1

*Denotes respondents that support all JANNAF agencies

<table>
<thead>
<tr>
<th>USG/Commercial Program*</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpaceX - Falcon 9</td>
<td>2</td>
</tr>
<tr>
<td>M270 MLRS</td>
<td>2</td>
</tr>
<tr>
<td>RAM</td>
<td>2</td>
</tr>
<tr>
<td>Antares</td>
<td>1</td>
</tr>
<tr>
<td>Atlas V</td>
<td>1</td>
</tr>
<tr>
<td>SLS Exploration Upper State</td>
<td>1</td>
</tr>
<tr>
<td>EELV</td>
<td>1</td>
</tr>
<tr>
<td>Griffin</td>
<td>1</td>
</tr>
<tr>
<td>Javelin</td>
<td>1</td>
</tr>
<tr>
<td>MGM-140 (ATacMS)</td>
<td>1</td>
</tr>
</tbody>
</table>

Q5a

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
High/Severe & Moderate/Elevated Risk Organizations that Support USG JANNAF Agencies – 2013-2016

19 out of 63 or 30% of high/severe or moderate/elevated risk organizations support all 4 listed USG JANNAF Agencies across 10 programs

Not Shown:
USAF & NASA: 3
Army & Navy: 3

*Denotes respondents that support all JANNAF agencies

<table>
<thead>
<tr>
<th>USG/Commercial Program*</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlas V</td>
<td>7</td>
</tr>
<tr>
<td>Delta IV</td>
<td>6</td>
</tr>
<tr>
<td>Delta IV - Heavy</td>
<td>6</td>
</tr>
<tr>
<td>Atlas V - Centaur</td>
<td>5</td>
</tr>
<tr>
<td>Atlas V - CCB</td>
<td>5</td>
</tr>
<tr>
<td>Delta IV - CBC</td>
<td>5</td>
</tr>
<tr>
<td>Vulcan</td>
<td>5</td>
</tr>
<tr>
<td>Antares</td>
<td>4</td>
</tr>
<tr>
<td>Blue New Shepard</td>
<td>4</td>
</tr>
<tr>
<td>CST100</td>
<td>4</td>
</tr>
</tbody>
</table>

Q5a

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Support to USG

Participation in Small Solid Engine/Motor Programs – 2017-2018

- SLS Launch Abort: 23 responses, 2 yes
- SLS Jettison Motor: 18 responses
- SLS Booster Separation Motor: 16 responses, 2 yes
- Trident V5 - Launcher System Motors: 15 responses
- SLS Attitude Control Motor: 14 responses, 1 yes
- STAR 48BV Solid Rocket Motors: 12 responses
- NASA Oriole Rocket Motor (second stage): 11 responses
- Trident V5 - Post Boost Motors: 10 responses, 1 yes
- Trident V5 - Vector Control Motors: 8 responses, 1 yes
- Black Brant V (third stage): 6 responses
- Trident V5 - Third Stage Eject Motors: 5 responses
- NASA Peregrine Army Motor: 5 responses
- Trident V5 - Fairing Eject Motors: 4 responses
- Other: 53 responses, 2 yes

An additional 55 responses were reported as “Other” small solid engine/motor programs (53 currently and 2 between 2013-2016). These fell outside the programs listed (ex. THAAD Motors, Hydra Motors, Tomahawk Motors, Atlas Motors, etc.)

These programs are either directly or indirectly related to USG. They may be commercial, but used by the military or other agencies.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
### Support to USG

#### Participation in Small Liquid Engine/Motor Programs – 2017-2018

<table>
<thead>
<tr>
<th>Program</th>
<th>Yes</th>
<th>No, But Supported Between 2013-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpaceX SuperDraco</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>SpaceX Draco Thrusters</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Virgin Galactic NewtonThree</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>SpaceX Kestrel (upper stage)</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Virgin Galactic NewtonFour</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td><strong>36</strong></td>
<td><strong>2</strong></td>
</tr>
</tbody>
</table>

- An additional 38 responses were reported as “Other” liquid engine/motor programs (36 currently and 2 between 2013-2016). These fell outside the programs listed (ex. NASA Lunar Flashlight, Moog Monarc, NASA NEA Scout, etc.)

- These programs are either directly or indirectly related to USG. Participation can be commercial and used by the military or other agencies.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Support to USG
Participation in Large Solid Engine/Motor Programs – 2017-2018

- **Orbital ATK SLS Booster**: Yes - 30, No - 1
- **Orbital ATK GEM 60**: Yes - 25, No - 1
- **Aerojet Rocketdyne AJ-60A**: Yes - 25, No - 1
- **Orbital ATK Castor 30 (A, B and/or XL)**: Yes - 22, No - 1
- **Orbital ATK GEM 63XL**: Yes - 20, No - 1
- **Other**: Yes - 13, No - 3

An additional 16 responses were reported as “Other” large solid engine/motor programs (13 currently and 3 between 2013-2016). These fell outside the programs listed (ex. Super Strypi (Leonidas), Minotaur, Orbital ATK EELV, Atlas 5, etc.).

These programs are either directly or indirectly related to USG. They may be commercial, but used by the military or other agencies.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

361 Respondents
**Support to USG**

**Participation in Large Liquid Engine/Motor Programs – 2017-2018**

<table>
<thead>
<tr>
<th>Engine/Motor Program</th>
<th>Yes</th>
<th>No, But Supported Between 2013-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerojet Rocketdyne RL10 (A, B and/or C)</td>
<td>49</td>
<td>2</td>
</tr>
<tr>
<td>Aerojet Rocketdyne RS-68 (including A)</td>
<td>41</td>
<td>3</td>
</tr>
<tr>
<td>Aerojet Rocketdyne RS-25</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>Aerojet Rocketdyne AR-1 Booster</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>Aerojet Rocketdyne J-2X</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td>SpaceX Merlin 1D</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>Blue Origin BE-4</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>Blue Origin BE-3</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>SpaceX Merlin 1D Vacuum (MVacD)</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>SpaceX Merlin 2 concept</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>SpaceX Raptor</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Vulcan XR-8H21 (TBC)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-180</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-190</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Aerojet Rocketdyne AJ26 (first stage)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>IHI Aerospace BT-4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-181</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-193</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-191</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Energomash RD-151</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

An additional 21 responses were reported as “Other” large solid engine/motor programs. These fell outside the programs listed (ex. Delta IV EELV, Blue Origin Shepard, SpaceX Dragon, etc.).

These programs are either directly or indirectly related to USG. They may be commercial, but used by the military or other agencies.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Support to USG
Top 15 Supported USG Programs and Systems

Number of Primary Product/Service Associated

<table>
<thead>
<tr>
<th>USG Programs and Commercial Systems</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta IV</td>
<td>63</td>
</tr>
<tr>
<td>Atlas V</td>
<td>58</td>
</tr>
<tr>
<td>SLS - Booster System</td>
<td>49</td>
</tr>
<tr>
<td>SpaceX - Falcon 9</td>
<td>48</td>
</tr>
<tr>
<td>Delta IV - Heavy</td>
<td>46</td>
</tr>
<tr>
<td>THAAD</td>
<td>43</td>
</tr>
<tr>
<td>SM - 3</td>
<td>39</td>
</tr>
<tr>
<td>SLS - Orion MPCV</td>
<td>38</td>
</tr>
<tr>
<td>Atlas V - C</td>
<td>36</td>
</tr>
<tr>
<td>Tactical Tomahawk</td>
<td>36</td>
</tr>
<tr>
<td>PAC - 3</td>
<td>35</td>
</tr>
<tr>
<td>Trident D5</td>
<td>34</td>
</tr>
<tr>
<td>SM - 3 Block IIA</td>
<td>33</td>
</tr>
<tr>
<td>Atlas V - CCB</td>
<td>29</td>
</tr>
<tr>
<td>PAC - 3 MSE</td>
<td>29</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q5c, B

361 Respondents
### Support to USG

#### Financial Risk of Organizations by Program/System - 2016

<table>
<thead>
<tr>
<th>Program/System</th>
<th>Low/Neutral Risk</th>
<th>Moderate/Elevated Risk</th>
<th>Insufficient Data</th>
<th>High/Severe Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta IV</td>
<td>45</td>
<td>40</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Atlas V</td>
<td>36</td>
<td>35</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Space X - Falcon 9</td>
<td>32</td>
<td>32</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Delta IV - Heavy</td>
<td>29</td>
<td>29</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>THAAD</td>
<td>24</td>
<td>24</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>SM-3</td>
<td>26</td>
<td>26</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>SLS - Orion MPCV</td>
<td>25</td>
<td>25</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Atlas V - C</td>
<td>23</td>
<td>23</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Tactical Tomahawk</td>
<td>22</td>
<td>22</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>PAC-3</td>
<td>19</td>
<td>19</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Trident D5</td>
<td>21</td>
<td>21</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>SM-3 Block IIA</td>
<td>19</td>
<td>19</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Atlas V - CCB</td>
<td>17</td>
<td>17</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PAC-3 - MSE</td>
<td>17</td>
<td>17</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

- **Insufficient data is a result of unavailable/missing data and source data mismatches.**
- **Financial Risk:** based on profit margins, debt levels, liquidity, product dependence, and performance over time.
- **High/Severe Risk:** organizations with low profit margins, high debt levels, high product dependence, and poor performance over time.

**Q5c, B**

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

210 Respondents
**USG Contract Information**

**Most Common Propulsion-Related Contract Type**

**Types of Contracts Used to Provide Propulsion Support**

- **Fixed Price**: 709
- **Cost Reimbursement**: 163
- **Other**: 43
- **Time and Materials**: 26
- **Best Value**: 23
- **Lowest Price Technically Acceptable (LPTA)**: 22
- **Incentive**: 9

An additional 43 responses were reported as “Other” contract types as they fell outside the programs listed (ex. Indefinite Delivery/Indefinite Quantity [IDIQ], Federal Acquisition Regulation [FAR], etc.)

**Do Particular Contract Types Inhibit/Discourage Ability to Provide Propulsion Products/Services?**

- **Yes**: 30
- **No**: 212

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
USG Contract Information
Most Concerning Contract Vehicles, Ranked 1-3

“Other” included contract types beyond those listed (ex. Indefinite Delivery/Indefinite Quantity [IDIQ], Federal Acquisition Regulation [FAR], etc.)

30 organizations reported particular contract types inhibited/prevented them from providing propulsion-related support to the USG. Some reported multiple contract types as concerning

Fixed Price Comments:
- Reported the high risk put on contractors with this type of contract, especially for small organizations
- Reported the difficulty in accounting for R&D estimates
- Suggested there should be variable scope if utilizing this type of contract

Number of Contract Vehicles

<table>
<thead>
<tr>
<th>Contract Type</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Price</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Cost Reimbursement</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Time and Materials</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Price Technically Acceptable (LPTA)</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Incentive</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Best Value</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
USG Contract Information

Effect of USG Acquisition Reform on Business Lines*

- Helped
  - 13, 7%
  - 17, 9%

- Hindered

- Neither, 151, 84%

Does Your Organization Consider Itself Dependent on the USG?

- Yes, 100, 28%
- No, 199, 55%
- Unsure
  - 35, 10%
  - 27, 7%

* Blank responses were not included

Q16, D-E

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

361 Respondents

“Nobody comes to the small companies to get knowledge. USG not willing to understand lower tier and know who is making the parts for the programs.” – Small Company

Dependency is based on an organization’s own assessment of its sustainability and operations
Perceived Support to USG
Perceived Dependence USG - 2016

Respondents that are USG Dependent by Financial Risk

- High/Severe Risk
- Insufficient Data
- Moderate/Elevated Risk
- Low/Neutral Risk

61
21
13
5

Of the 100 organizations that identified their dependence on USG, 13 respondents did not provide enough data to calculate financial risk.

11 respondents identified being dependent on USG and identified engaging in DMSMS activities.

Financial Risk of Respondents that are USG Dependent and Engaging in DMSMS Activities

- Low/Neutral Risk
- Moderate/Elevated Risk

4, 36%
7, 64%

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Perceived Support to USG
Self-Determined Dependence USG JANNAF Agencies

Dependency is based on an organization’s own assessment of its sustainability and operations.

- **USAF**: 25 Direct, 26 Both, 25 Indirect (76: USAF support)
- **NASA**: 24 Direct, 27 Both, 22 Indirect (73: NASA support)
- **U.S. Navy**: 25 Direct, 22 Both, 24 Indirect (71: U.S. Navy support)
- **U.S. Army**: 20 Direct, 20 Both, 22 Indirect (62: U.S. Army support)

**Q16, E, 1**

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

100 Respondents
Counterfeit Parts

- Six organizations reported identifying counterfeit parts in 2013, 2014, and 2015

- Reported counterfeit parts included bearings, fabrications, electrical systems and components, and igniter systems and components

- Four organizations identified counterfeit parts as originating in the U.S., while two organizations identified counterfeit parts as originating outside the U.S.

- Nineteen organizations identified cyber security breaches as a threat to long-term viability. Of the nineteen organizations identified, three organizations also identify counterfeit parts as a threat
U.S. Air Force Release of Surplus ICBM Motors
Respondent Perspectives - 2016

Are you familiar with USAF plans to release surplus ICBM motors into the commercial market?

- Yes, 52, 14%
- No, 309, 86%

Does your organization perceive the release of ICBM motors as damaging?

- Yes, 36, 10%
- Unsure, 158, 44%
- No, 167, 46%

Indicate your organization’s anticipated harm/benefit resulting from the proposed release of surplus ICBM solid rocket motors by USAF

<table>
<thead>
<tr>
<th>Perceived Harm</th>
<th>Respondents (361)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>14</td>
</tr>
<tr>
<td>Indirect</td>
<td>16</td>
</tr>
<tr>
<td>Both</td>
<td>6</td>
</tr>
<tr>
<td>Unsure</td>
<td>158</td>
</tr>
<tr>
<td>None</td>
<td>167</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perceived Benefit</th>
<th>Respondents (361)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>12</td>
</tr>
<tr>
<td>Indirect</td>
<td>3</td>
</tr>
<tr>
<td>Both</td>
<td>4</td>
</tr>
<tr>
<td>Unsure</td>
<td>82</td>
</tr>
<tr>
<td>None</td>
<td>260</td>
</tr>
</tbody>
</table>
Propulsion-Related Patents

• How many of your organization’s patents registered with U.S. Patent and Trademark Office (PTO) are propulsion-related?

• Thirty (30) respondents reported a total of 1,119 propulsion-related patents from 2013-2017
  • Of the 30 respondents identified: 15 were large companies, 7 were medium companies, and 8 were small companies

• A single organization reported detecting a patent infringement

• The organization reported being unable to resolve the patent infringement issue
  • “They published proprietary information which they were prohibited from doing under an NDA they signed.” – Small Company
Diminishing Manufacturing Sources & Material Shortages (DMSMS)

- 19 respondents indicated their facilities engage in DMSMS activities
- A Diminishing Manufacturing Sources and Material Shortages (DMSMS) issue is the loss, or impending loss, of manufacturers or suppliers of items, raw materials, or software
- Support of U.S. Agencies by those 19 respondents:

Number of Responses

<table>
<thead>
<tr>
<th>Agency</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Air Force</td>
<td>19</td>
</tr>
<tr>
<td>U.S. Navy</td>
<td>17</td>
</tr>
<tr>
<td>NASA</td>
<td>15</td>
</tr>
<tr>
<td>U.S. Army</td>
<td>13</td>
</tr>
<tr>
<td>Missile Defense Agency</td>
<td>12</td>
</tr>
<tr>
<td>DARPA</td>
<td>9</td>
</tr>
<tr>
<td>U.S. Marine Corps</td>
<td>7</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>6</td>
</tr>
<tr>
<td>NOAA</td>
<td>4</td>
</tr>
<tr>
<td>Intelligence Community</td>
<td>4</td>
</tr>
<tr>
<td>DOD Other</td>
<td>3</td>
</tr>
<tr>
<td>DHS</td>
<td>2</td>
</tr>
<tr>
<td>Department of State</td>
<td>1</td>
</tr>
</tbody>
</table>
Diminishing Manufacturing Sources & Material Shortages (DMSMS)
Propulsion Industrial Base Support – By Business Categories

“Other” was most commonly identified by companies who were unsure of how they supported propulsion-related engines and systems

Q17b, C
19 Respondents
Diminishing Manufacturing Sources & Material Shortages
By DMSMS Spending – 2013-2016

Average DMSMS Spending:
$5.76 Million

Average NASA-Related DMSMS Spending:
$0.80 Million

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Security: Cyber/Physical

- **Cyber Security**: The body of technologies, processes, and practices designed to protect networks, computers, programs, and data from attack, damage, or unauthorized access.

- **Commercially Sensitive Information (CSI)**: Privileged or proprietary information which, if compromised through alternation, corruption, loss, misuse, or unauthorized disclosure could cause serious harm to the organization owning it.

- **CSI Can Include**: Customer/client financial records, intellectual property, internal communications, manufacturing and production line information, patents and trademarks, R&D information, and supplier/supply chain information.
Security: Cyber/Physical
Expenditures – 2013-2016

Total Expenditure on Cyber and Physical Security

Average Expenditure on Cyber and Physical Security

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Security: Cyber/Physical
Network Administration – 2016

Responsibility for Computer Networks

<table>
<thead>
<tr>
<th>Responsibility for Computer Networks</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal IT Department</td>
<td>130</td>
</tr>
<tr>
<td>Internal IT Department and external U.S. Service Provider</td>
<td>94</td>
</tr>
<tr>
<td>Only U.S. External Service Provider</td>
<td>46</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>67</td>
</tr>
</tbody>
</table>

Able to Detect the Theft of CSI?

- Yes, 196
- Unsure, 103
- No, 62

Encryption of CSI Data

- In Storage (at rest): 115
- Transmitted Across Internal Networks: 130
- Transmitted Outside Organization’s Networks: 224

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION

361 Respondents
Security: Cyber/Physical
Direct JANNAF Suppliers and CSI Theft Detection

Organizations that Cannot/Are Unable to Detect CSI Theft

Q18, E

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Security: Cyber/Physical
Direct JANNAF Suppliers
Cyber Impacts by Type of DOD Service - 2013-2016

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q18, E

361 Respondents
### Security Measures by Organization Size

**Large:** >$50M  
**Medium:** $10M - $50M  
**Small:** <$10M  
(2016)

#### Large (129)

<table>
<thead>
<tr>
<th>Measure</th>
<th>0% - 60%</th>
<th>61% - 84%</th>
<th>85% - 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Test &amp; Red Team Exercises</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Security Skills Assessments &amp; Training</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Continuous Vulnerability Assessment</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Maintain/Monitor/Analysis of Audit Logs</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Software</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Boundary Defense</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Network Engineering</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Incident Response and Management</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations on Hardware</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Limit/Control of Network Ports/Services</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Application Software Security</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations Network Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Account Monitoring and Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Access for Need to Know</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Protection</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Wireless Access Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Use of Admin. Privileges</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Recovery Capability</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Malware Defenses</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### Medium (104)

<table>
<thead>
<tr>
<th>Measure</th>
<th>0% - 60%</th>
<th>61% - 84%</th>
<th>85% - 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Test &amp; Red Team Exercises</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Security Skills Assessments &amp; Training</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Continuous Vulnerability Assessment</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Maintain/Monitor/Analysis of Audit Logs</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Software</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Boundary Defense</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Network Engineering</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Incident Response and Management</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations on Hardware</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Limit/Control of Network Ports/Services</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Application Software Security</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations Network Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Account Monitoring and Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Access for Need to Know</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Protection</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Wireless Access Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Use of Admin. Privileges</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Recovery Capability</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Malware Defenses</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### Small (127)

<table>
<thead>
<tr>
<th>Measure</th>
<th>0% - 60%</th>
<th>61% - 84%</th>
<th>85% - 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration Test &amp; Red Team Exercises</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Security Skills Assessments &amp; Training</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Continuous Vulnerability Assessment</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Maintain/Monitor/Analysis of Audit Logs</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inventory of Software</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Boundary Defense</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Network Engineering</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Incident Response and Management</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations on Hardware</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Limit/Control of Network Ports/Services</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Application Software Security</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Secure Configurations Network Devices</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Account Monitoring and Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Access for Need to Know</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Protection</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Wireless Access Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Controlled Use of Admin. Privileges</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Data Recovery Capability</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Malware Defenses</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Values denote % of Companies (e.g. 85-100% of Large Companies employ Malware Defenses)**


*FOR PUBLIC DISTRIBUTION*
Companies Seeking Cyber Security Support
Large: >$50M  Medium: $10M - $50M  Small: <$10M  (2016)

- Large: 12, 18%
- Medium: 25, 37%
- Small: 29, 45%

44% of companies seeking additional cyber security support are Small Businesses.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q18, D

66 Respondents
Cyber Security
Impacts and Actions of Malicious Cyber Activity – 2013-2016

Number of Respondents

0 20 40 60 80 100 120

Major New Investment in Cyber Security
IT Downtime
Costs from Damage Assessment/Remediation
Revised Approach to International Partnerships
Loss of Sales/Business Interruption
Significant Change in R&D Strategy
Damage to IT Infrastructure
Damage to Production Capabilities or Systems
Exfiltration of CSI Data
Exit from Foreign Markets or Market Segments
Exit from Product or Business Line
Theft of Software and/or Source Code

Impact Experience
Action Undertaken

Q18, E
361 Respondents

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Top Organizational Challenges
Large-Size Organizations (> $50M) Top 15 Rankings

- Competition - Domestic
- Reduction in U.S. Government Demand
- Government Acquisition Process
- Labor Availability
- Aging Equipment
- Government Purchasing Volatility
- Skills Retention
- High Fixed Costs
- Labor Skills
- Competition - Foreign
- Material Availability - U.S.
- Government Regulatory Burden
- Labor Costs
- Export Controls/ITAR Regulations
- Material Price Volatility

Number of Responses:

- Primary Ranked
- Other Ranked Concerns
- Unranked Concerns

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

129 Respondents
### Top Organizational Challenges

**Medium-Size Organizations ($10M - $50M) Top 15 Rankings**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Primary Ranked</th>
<th>Other Ranked Concerns</th>
<th>Unranked Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Availability</td>
<td>5</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Labor Skills</td>
<td>7</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Government Acquisition Process</td>
<td>2</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>Healthcare</td>
<td>6</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Reduction in U.S. Government Demand</td>
<td>11</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Government Regulatory Burden</td>
<td>5</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Competition - Domestic</td>
<td>3</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Government Purchasing Volatility</td>
<td>2</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Export Controls</td>
<td>1</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Access to USG R&amp;D Funding</td>
<td>3</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Labor Costs</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Taxes</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Supplier Reliability - U.S.</td>
<td>2</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>QA/QC Requirements (sosts, Lead Time, etc)</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Program/System Cancellation</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Number of Responses:
- Primary Ranked: 104 Respondents
- Other Ranked Concerns: 155
- Unranked Concerns: 30

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Top Organizational Challenges
Small-Size Organizations (<$10M) Top 15 Rankings

- Labor Availability: 9 primary, 19 other
- Government Acquisition Process: 6 primary, 16 other
- Competition - Domestic: 6 primary, 15 other
- Labor Skills: 4 primary, 17 other
- Healthcare: 3 primary, 18 other
- Government Regulatory Burden: 6 primary, 16 other
- Government Purchasing Volatility: 6 primary, 15 other
- Availability of Capital: 8 primary, 12 other
- Taxes: 2 primary, 13 other
- Export Controls: 1 primary, 13 other
- Aging Equipment: 4 primary, 13 other
- QA/QC Requirements (Costs, Lead Time, etc.): 1 primary, 13 other
- Program/System Cancellation: 7 primary, 14 other
- Labor Costs: 12 primary, 9 other
- Access to USG R&D Funding: 9 primary, 7 other

Number of Responses

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q17a
128 Respondents
Competitiveness/Long-Term Viability
Export Controls

Sell Product/Services That Are Export Controlled (248)
- Yes - International Traffic in Arms Regulations: 102, 28%
- Yes - Export Administration Regulations: 66, 19%
- Yes - Both: 26, 7%
- Unsure: 11, 3%
- No: 156, 43%

Export Product/Services That Are Export Controlled (158)
- Yes - International Traffic in Arms Regulations: 19, 12%
- Yes - Export Administration Regulations: 35, 22%
- Yes - Both: 104, 66%

248 of 361 respondents reported selling export controlled product/services.

158 of 361 respondents reported exporting product/services that are export controlled.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION

Q17b, A
361 respondents
Competitiveness/Long-Term Viability
Export Controls – 2013-2016

Export Product/Services That Are Export Controlled (158)

- Yes - International Traffic in Arms Regulations: 104
- Yes - Export Administration Regulations: 35
- Yes - Both: 19

Loss of Export Sales Opportunities of Propulsion-Related Products/Services (60)

- Yes - International Traffic in Arms Regulations: 45
- Yes - Export Administration Regulations: 8
- Yes - Both: 6
- Unsure: 1

15 of 158 directly attributed losses in export sales to export controls.

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Competitiveness/Long-Term Viability
Export Controls – 2013-2016

Countries Where Export-Related Sales Were Lost

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>7</td>
</tr>
<tr>
<td>France</td>
<td>6</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5</td>
</tr>
<tr>
<td>Israel</td>
<td>4</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
</tr>
<tr>
<td>Turkey</td>
<td>1</td>
</tr>
<tr>
<td>Russia</td>
<td>1</td>
</tr>
<tr>
<td>Poland</td>
<td>1</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>1</td>
</tr>
<tr>
<td>India</td>
<td>1</td>
</tr>
</tbody>
</table>

Impact of Export Control Reform on Propulsion-related Technology

- Favorable: 96
- Unfavorable: 30
- No Effect: 232
- Unsure: 3

Respondents reported top three countries where sales were lost:
- Germany
- France
- United Kingdom

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
# Competitiveness/Long-Term Viability

## Export Controls – 2013-2016

<table>
<thead>
<tr>
<th>Actions Taken in Response to Export Controls</th>
<th>ITAR</th>
<th>Both</th>
<th>EAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid Exporting</td>
<td>19</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Incentivize &quot;design-out&quot;</td>
<td>14</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Incentivize &quot;ITAR Free&quot;</td>
<td>13</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Engage in Cost-sharing</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Modify to avoid export-control</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Reduce/eliminate investment in R&amp;D</td>
<td>7</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Related production outside the U.S.</td>
<td>6</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Reduce/eliminate investment in production</td>
<td>6</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Discontinue Production</td>
<td>2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Related R&amp;D outside the U.S.</td>
<td>5</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018

FOR PUBLIC DISTRIBUTION
Outreach

Top 10 Areas that Organizations Request Information for USG Programs/Services

- Cybersecurity: 66 responses
- Export Licensing (ITAR/EAR): 55 responses
- Market Expansion/Business Growth: 53 responses
- Continuous Improvement/Lean Manufacturing: 44 responses
- R&D Assistance and Partnership: 38 responses
- Quality Management and Control: 38 responses
- Technology Acceleration: 34 responses
- Export Assistance: 34 responses
- SBIR and STTR Contracts: 34 responses
- Design for Manufacturability: 33 responses

Source: U.S. Department of Commerce, Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
Highlight on China
Highlight
China and the Propulsion Supply Chain

Quotes Regarding China and the Supply Chain

- “Chinese suppliers dump tungsten powders and semi-finished products in the U.S.”
- “Undercutting of price structure by dumping of aluminum powder by China.”
- “Availability of foreign made spherical aluminum powders, particularly in the case of China market dumping practices, in conjunction with the severe export licensing requirements for export of our product renders our Company unable to compete in the non-U.S. commercial market.”

A total of 158 Chinese Nationals (excluding Taiwan, Hong Kong, and Macau) were reported by 17 propulsion-related organizations. However, most do not work in propulsion-related roles for the surveyed organizations.

China and Ownership Structure

- Zero companies reported a Chinese parent company
- One company reported an internal/owned facility in China, with no anticipated change in the next four years
- Zero companies reported using external facilities inside China

Highlight
China and the Propulsion Supply Chain

As a supplier, China provides Raw materials (including Additive Manufacturing Stock), Solid rocket propellant material, Weld wire, Other Systems and Services, and All Other

As a customer, China buys propulsion-related Raw materials (including Additive Manufacturing Stock)

Companies engaging in JVs in China reported “Broaden customer base” and “Improved access to foreign markets” as the top reasons

Companies engaging in MADs in China reported “Broaden customer base” and “Reduce costs” as the reasons

Source: U.S. Department of Commerce,
Bureau of Industry and Security, Office of Technology Evaluation, RPIBA, 2018
FOR PUBLIC DISTRIBUTION
BIS/OTE Contact Information

Brad Botwin
Director, Industrial Studies
(202) 482-4060
Brad.Botwin@bis.doc.gov

Erika Maynard
Special Projects Manager
(202) 482-5572
Erika.Maynard@bis.doc.gov

Jason Bolton
Senior Trade and Industry Analyst
(202) 482-5936
Jason.Bolton@bis.doc.gov

Government Analysts:
Jennifer Rice, Trade and Industry Analyst (Project Lead)
Moriah Phillips, Trade and Industry Analyst

Support Staff:
Alex Csanadi, Alexander Werner, Ashira Naftali Greer, Caela Mandigo, Camden Landew,
Christopher Whittle, Cole Welch, Connie Lee, Gauri Deshpande, Hannah Kim,
Ian Bonanno, Ian Kearns, Kimberly Kruse, Lea Carroll, Lena Richenberg, Morgan Hughes,
Norris Kpamegan, Ormond Derrick

U.S. Department of Commerce, Bureau of Industry and Security
Office of Technology Evaluation
HCHB 1093, 1401 Constitution Avenue, NW
Washington, D.C. 20230
http://www.bis.doc.gov/DIB