



# Interagency Roadmap to Support Space-Related STEM Education and Workforce

*A Report by the*

National Science and Technology Council

of the

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

September 2022

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### **About this Document**

This document describes the goals and objectives of the Federal departments and agencies represented in the Space STEM Task Force to drive outcomes that bolster the United States (U.S.) capacity to grow, diversify, and strengthen the STEM workforce in response to Vice President Kamala Harris' charge to U.S. space ecosystem stakeholders. The activities put a spotlight on U.S. space efforts and create learning opportunities to inspire people to explore STEM, provide resources and opportunities to better prepare learners for space-related careers, and place a focus on strategies to better support, retain, and advance STEM professionals already in the space STEM workforce, including in the Federal workforce. The Roadmap represents the initial coordinated steps that the Federal government can take and will inform future space STEM education and workforce strategy. Implementing this roadmap will advance ongoing work and create new opportunities to reach people of all backgrounds and create pathways into space careers for those historically left behind and ensure

growth and diversity of the space workforce. This document is consistent with CoSTEM interagency coordination of STEM education programs, investments, and activities and with the National Security Memorandum on Revitalizing America's Foreign Policy and National Security Workforce, Institutions, and Partnerships (NSM-3) issued on February 4, 2021.

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**Abbreviations and Acronyms**

|                |   |             |   |
|----------------|---|-------------|---|
| <b>BLS</b>     | Bureau of Labor and Statistics                      | <b>NOAA</b> | National Oceanic and Atmospheric Administration   |
| <b>CoSTEM</b>  | Committee on STEM Education                         | <b>NSC</b>  | National Security Council                         |
| <b>DHS</b>     | Department of Homeland Security                     | <b>NSF</b>  | National Science Foundation                       |
| <b>DOC</b>     | Department of Commerce                              | <b>NSPC</b> | National Space Council                            |
| <b>DoD</b>     | Department of Defense                               | <b>NSTC</b> | National Science and Technology Council           |
| <b>DOE</b>     | Department of Energy                                | <b>OMB</b>  | Office of Management and Budget                   |
| <b>DOI</b>     | Department of the Interior                          | <b>ODNI</b> | Office of the Director of National Intelligence   |
| <b>DOL</b>     | Department of Labor                                 | <b>OSTP</b> | Office of Science and Technology Policy           |
| <b>DOT</b>     | Department of Transportation                        | <b>STEM</b> | Science, technology, engineering, and mathematics |
| <b>ED</b>      | Department of Education                             | <b>U.S.</b> | United States                                     |
| <b>FAA</b>     | DOT Federal Aviation Administration                 | <b>USDA</b> | United States Department of Agriculture           |
| <b>FC-STEM</b> | Federal Coordination in STEM Education Subcommittee | <b>USGS</b> | United States Geological Survey                   |
| <b>JCS</b>     | Joint Chiefs of Staff                               | <b>USSF</b> | United States Space Force                         |
| <b>MSI</b>     | Minority Serving Institution                        |             |   |
| <b>NASA</b>    | National Aeronautics and Space Administration       |             |   |
| <b>NIST</b>    | National Institute of Standards and Technology      |             |   |

## Introduction

Our universe is filled with a wealth of knowledge that informs our understanding of our own planet, solar system, and deep space. Space education, research, and workforce development in the public and private sectors are core components of the U.S. national interest, with the potential to drive exploration and scientific discovery, to find new solutions for pressing challenges, including climate change, to strengthen American national security, and to provide good-paying jobs for Americans.<sup>1</sup> To harness the full potential of space, it is essential to grow, diversify, and strengthen our Nation's space-related industries and workforce.

On December 1, 2021, the Biden-Harris Administration held its first National Space Council (NSpC) meeting, chaired by Vice President Kamala Harris.<sup>2</sup> At that meeting, the Biden-Harris Administration's priorities for space were released as the United States Space Priorities Framework.<sup>3</sup> Among the themes in the framework, this first meeting highlighted three initial areas: 1) building our science, technology, engineering, and mathematics (STEM) workforce; 2) addressing the climate crisis using data collected from space; and, 3) promoting the rules and norms that govern space activities.

Further, the Vice President's STEM-focused remarks underscored the need to: 1) use space activities and missions to inspire more people to explore STEM fields; 2) increase the number of Americans who acquire skills and training needed to advance U.S. interests in space; and, 3) increase the number of Americans employed in the space workforce by reducing barriers to employment and career advancement. The charges from the Vice President are distinct but closely related. They draw from the premise that because our Nation and our world are now more active in space than ever, it is imperative to ensure people of all backgrounds, particularly from underrepresented communities, have equitable access to STEM and space workforce opportunities. Moreover, it is critical to understand how space can benefit all of humanity and increase our Nation's capacity to innovate.

Following the Vice President's charge, the White House Office of Science and Technology Policy established the interagency Space STEM Task Force to develop and facilitate the coordination and implementation of Federal actions to grow, diversify, and strengthen the space workforce. Under the guidance of the Committee on STEM Education (CoSTEM), Federal departments and agencies engaged in space-related STEM education and workforce development have come together to form the Space STEM Task Force. The members of the Task Force represent a broad range of interests in space including transportation, commerce, agriculture, energy, health, telecommunications, climate, national security, education, labor, and aerospace.

This report describes the Federal interagency goals and implementation activities in response to the Vice President's charge to the space ecosystem stakeholders. This Roadmap represents the initial coordinated steps that the Federal government will take and will inform future space STEM education and workforce strategy. The Federal government cannot independently tackle these complex education and workforce issues. The Task Force members will work collaboratively with industry and academia to address the challenges for the good of the Nation.

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<sup>1</sup> [The Good Jobs Initiative | U.S. Department of Labor \(dol.gov\)](https://www.dol.gov/eis/whats-new/the-good-jobs-initiative)

<sup>2</sup> [National Space Council - The White House](https://www.whitehouse.gov/the-press-office/2021/12/01/national-space-council)

<sup>3</sup> <https://www.whitehouse.gov/wp-content/uploads/2021/12/United-States-Space-Priorities-Framework--December-1-2021.pdf>



## Background

### Space STEM Priorities

Cultivating and sustaining a robust and equitable STEM workforce, including within the Federal workforce, is crucial to the Nation's ability to address the complex challenges of today and in the future. The U.S. science, technology, engineering, and mathematics (STEM) ecosystem holds the promise of innovations that will lead to breakthroughs in areas such as healthcare, energy, and the environment. Similarly, space-related activities are essential to everyday lives, economic prosperity, and national security, and form the basis for Space STEM Task Force activities. Space STEM Task Force members from across the Federal government have come together to coordinate with one another, and with industry, PK-12 education systems, academia, and the non-profit sector to promote space-related STEM education and career pathways inside and outside the Federal government. This initiative is an opportunity to mutually enrich education, workforce development, and career readiness in these sectors. The Task Force will identify sustainable efforts within the Federal Government and in collaboration with industry, academia, and the non-profit sectors to ensure expansion of opportunities and equitable participation in space-related education and careers. The Task Force is focused on four areas that represent a cross-cutting set of space-focused priorities to inspire, prepare, and employ the current and future space workforce:

**Pioneering New Horizons of Space Exploration and Space Science** – The United States seeks to maintain its global leadership in science and engineering by pioneering new areas of space research and technology that enables the United States and its allies to explore the Moon, Mars, and beyond.

**Creating New American Jobs in a Thriving U.S. Space Industry** – Since landing on the Moon, U.S. commercial space activities have come to be on the cutting edge of space technology, space applications, and space-enabled services. The Federal government will facilitate the rapid growth of U.S. commercial space industries and support the creation of new good-paying American jobs to enable that growth.<sup>4</sup>

**Tackling the Climate Crisis**– Collaboration between the public, private, and philanthropic sectors will accelerate the development and use of space-based Earth observation to support climate change mitigation and adaptation.

**Preserving National Security**– Information collected from space informs national decision makers about evolving threats to U.S., allied, and partner interests. Space capabilities enable the U.S. military to protect and defend the U.S homeland and advance the national and collective security interests of the United States and its allies and partners. These capabilities must also be protected from cyber threats by ensuring proper cyber hygiene, effective cybersecurity programs, and a workforce trained to respond to cyber incidents.

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<sup>4</sup> [The Good Jobs Initiative | U.S. Department of Labor \(dol.gov\)](https://www.dol.gov/eis/whats-new/the-good-jobs-initiative)



**Figure 1.** Space STEM Cross-Cutting Priorities include four areas that represent space-focused priorities to inspire, prepare, and employ the current and future space workforce

### Space STEM Scope

“Space” encompasses a wide range of endeavors. Throughout this document, the term “space-related” refers to the vast array of activities that are connected to space. These include activities devoted to: science missions for research to better understand planet Earth and its place in the universe; human exploration to push beyond low-Earth orbit; technology development to drive innovation; and the development and operations of space assets that provide data and services for a variety of sectors. All these space activities yield societal benefits for people in our Nation and around the globe including navigation, agriculture, emergency services, weather forecasts, and communications. These activities can be categorized as:<sup>5</sup>

1. **Space-Direct:** Activities that occur either in space or directly support goods and services used in space, e.g., space vehicles, launch pads, payloads, etc.
2. **Space-Enabled:** Activities that require direct input from space to function or directly support those that do, e.g., satellite telecommunications and broadcasting, GPS and positioning, navigation, timing equipment, and weather forecasts.
3. **Space-Research:** Activities associated with studying space, e.g., research and development, educational services, planetariums, observatories, and interplanetary exploration.

Across these three categories, the U.S. space economy components, including advanced manufacturing, information technology, government, trade, professional and business services, and other services, supported an estimated 354,000 non-government full- and part-time jobs and produced

<sup>5</sup> [Space-Economy-Infographic.png \(1201x1501\) \(bea.gov\)](#)

a gross output of \$195 billion in 2019.<sup>6 7</sup> Though astronauts may be the most well-known space workers, this vast space workforce includes thousands of scientists, engineers, and technicians who are equally essential. They contribute a variety of skills and expertise to research, design, build, implement, and evaluate technology and systems that are critical to U.S. space activities. In addition, there are space workers employed in occupations that include a broad range of disciplines, degree-levels, work-related credentials, and skills that may not be typically represented as “space STEM” careers. Our Nation’s future work in space is reliant on the ability to build a diverse, skilled STEM workforce that is trained and equipped to advance efforts to enable innovation, exploration, and discovery. The appendix includes a snapshot of some skilled technical occupations for which a high school diploma or equivalent, associate degree, or postsecondary nondegree award are the typical credentials of new entrants. Future work will include ongoing engagement with the space ecosystem and an in-depth analysis of the current and future space workforce needs.



**Figure 2.** United States Space Economy Components as articulated by the Bureau of Economic Analysis Space Economy Report<sup>8</sup>

<sup>6</sup> <https://apps.bea.gov/scb/2020/12-december/1220-space-economy.htm>

<sup>7</sup> <https://www.bea.gov/system/files/Space-Economy-Infographic.png>

<sup>8</sup> [Space-Economy-Components, from bea.gov](https://www.bea.gov/Space-Economy-Components)

## Space STEM Focus Areas

This Roadmap presents a vision for ongoing and coordinated interagency efforts to advance equity in STEM education and workforce development, specifically as it relates to the space ecosystem. This begins with the early spark of inspiration for students to explore space and STEM, and continues through their equitable participation into the space-related workforce, and the STEM workforce, more broadly. For the Nation to succeed, the space industry must create a skilled and diverse workforce that fosters the leadership, collaboration, and participation of individuals who are members of groups that are historically underrepresented and/or underserved in STEM programs and careers, including the Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, and Agender (LGBTQIA+) community; persons with disabilities; and individuals from underrepresented racial and ethnic groups, including those who are Black or African American, Hispanic or Latino, and Native American or Alaska Native; and women from all backgrounds, who are underrepresented in the STEM workforce relative to their proportion within the U.S. population.<sup>9</sup>

The Space STEM Task Force will focus on three areas:

**Inspire.** Space provides a unique and exciting lens to inspire people of all ages by sparking their curiosity and engaging them to experience the wonder of the unknown. This inspiration can be leveraged to cultivate interest in seeking a career in space-related STEM fields. However, because of disparate access to educational opportunities, including in STEM, as well as structural barriers and historical exclusion in our Nation’s education system,<sup>1011</sup> armed services,<sup>1213</sup> and American industry,<sup>141516</sup> space-related fields were not always accessible to all who were interested in them.<sup>1718</sup> The Task Force’s initial goals seek to increase awareness about the breadth of space-related careers and increase the reach and equitable access of PK-12 space-related education materials to individuals, communities, and geographic regions that have been traditionally under-engaged.

**Prepare.** Inspiration, however, is not enough to move someone from interest to employment. The opportunity for people to engage in hands-on activities and experiential learning opportunities like internships, apprenticeships, and fellowships is critical. To address systemic education and training opportunity inequities and ensure that the space workforce reflects the diversity of America, the Space STEM Task Force aims to increase equitable participation--of a broader range of geographic regions, including urban and rural communities, and underrepresented institutions, including Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and minority servicing-institutions (MSIs), community colleges, and trade/vocational schools—in space-related educational STEM activities, opportunities, and recruitment, through relationships with the

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<sup>9</sup> [Women, Minorities, and Persons with Disabilities in Science and Engineering: 2021 | NSF - National Science Foundation](#)

<sup>10</sup> [In Pursuit of Equality - Separate Is Not Equal \(si.edu\)](#)

<sup>11</sup> [Separate Is Not Equal - Brown v. Board of Education \(si.edu\)](#)

<sup>12</sup> [U.S. Army Corps of Engineers Headquarters > About > History > Historical Vignettes > Women Minorities > 011 - Army Integration](#)

<sup>13</sup> [A short history of integration in the US armed forces > Air Force > Display \(af.mil\)](#)

<sup>14</sup> [Occupational segregation and earnings differences by sex \(bls.gov\)](#)

<sup>15</sup> [Equal Pay Day 2022: Actions include US Department of Labor report on occupational segregation; report explores women’s wage dynamics | U.S. Department of Labor \(dol.gov\)](#)

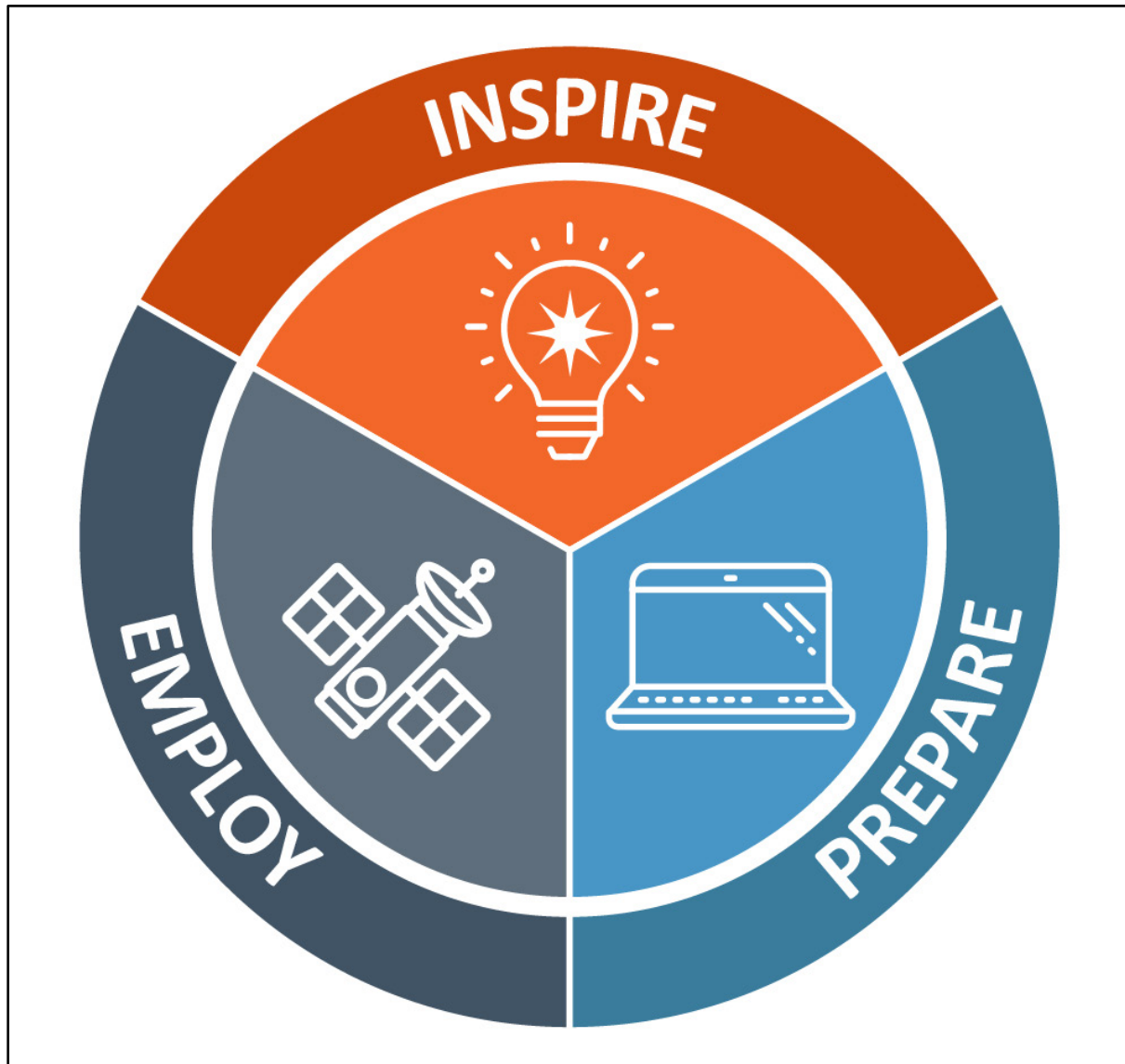
<sup>16</sup> [96331b \(archive-it.org\)](#)

<sup>17</sup> [NASA Helped Kick-start Diversity in Employment Opportunities | NASA](#)

<sup>18</sup> [How NASA Joined the Civil Rights Revolution | Air & Space Magazine | Smithsonian Magazine](#)

Federal government, labor advocates, private industry, and across the STEM ecosystem. Equally important are reskilling and upskilling opportunities available for those who missed opportunities or lack access through traditional education structures so they are able to join the space workforce at any career or educational stage. The Prepare focus area includes coordination across Federal agencies and departments to strengthen the onramps and bridges to the space workforce and provide the STEM research, education, and training opportunities that lead to space-related careers.

**Employ.** To ensure U.S. competitiveness in the space industry, career pathways into all occupational tracks, especially advanced manufacturing and engineering, must be clear, accessible, and desirable because having STEM experts, at all levels, with a diversity of backgrounds, experiences, and ideas is essential to innovation. However, research has revealed that preparation alone does not guarantee access to or continuation in a STEM career. Persistent obstacles encountered by some workers include practices like biased hiring and unequal compensation practices, inequitable access to development opportunities, and identity-based harassment and discrimination. To improve retention in the space workforce and address occupational segregation there must be targeted strategies enacted to mitigate these barriers. In addition to recruitment and retention efforts, career growth initiatives are important for promotion and advancement to leadership positions throughout the industry.



**Figure 3.** Space STEM Taskforce Focus Areas of Inspire, Prepare, and Employ

**Space STEM Task Force Goals and Objectives**

Stakeholder engagement across the space ecosystem reveals areas of opportunity to drive growth and diversity in the workforce. These opportunities range from increasing awareness of the breadth of existing and future opportunities; focusing on workforce manufacturing and automation skills development; supporting PK-20 STEM education, reskilling, and retraining the current jobseekers including veterans; addressing geographic constraints of space jobs that are concentrated in parts of the country; addressing immigration policy to attract and retain non-citizens; and increasing diversity among the space workers at all levels. This document represents only the beginning of this interagency initiative and includes a focus on diversity, equity, inclusion, and accessibility, as one means to address challenges and scale efforts to develop and expand the space workforce.

The Space STEM Task Force will complete activities in the short-term (up to 1 year) and longer-term (1-2 years) to accomplish three goals. This roadmap describes initial actions toward each objective that

the Task Force members have agreed to contribute to and complete. To maintain U.S. leadership in space, future work of this Task Force includes quantitative and qualitative analysis to understand the scale and the scope of space workforce gaps, and engagement with industry and academia to identify opportunities to address identified gaps and challenges.

**Goal 1: Inspire greater engagement from educators and learners in space-related STEM content and fields**

There are longstanding racial and gender achievement gaps for students in STEM subjects, beginning in elementary and continuing through postsecondary education.<sup>19,20,21,22</sup> These gaps have widened during the COVID-19 pandemic, exacerbating the existing STEM achievement gaps for students from low-income households, students from racial and ethnic backgrounds historically underrepresented in STEM, and girls of all backgrounds.<sup>23,24,25</sup> To address these widening gaps and continue U.S. leadership in space research and exploration into the next generation, the Task Force will increase the reach of and equitable access to PK-12 space-related education materials, resources, and activities.

Federal agencies have a deep reserve of space-STEM content designed to spark the interest of students to pursue careers in STEM. While there are a wealth of resources and opportunities provided by individual agencies, they are disparate and are not always easy for educators to access. Thus, there is potential to increase the reach and impact of ongoing efforts and create targeted initiatives for diverse PK-12 student and educator populations. This includes better equipping educators to do what they do best – exposing their students to the vast possibilities in the space ecosystem, including the wide diversity of space jobs inside and outside of the Federal government that go far beyond being an astronaut, to those in STEM fields that yield direct impacts on tackling the climate crisis, improving communities, and serving our country. This work is also supported by Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government.<sup>26</sup>

The first goal, and its corresponding objectives, inspire greater engagement in space-related STEM fields and center on a whole-of-government approach to leverage the Federal agencies’ collective networks and relationships to magnify the reach of space-related STEM content and create new space-related STEM activities, programs, and collaborations that will be deployed or scaled to a national level.

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<sup>19</sup> [Methodology Studies - Achievement Gaps | NAEP \(ed.gov\)](#)

<sup>20</sup> [NAEP blog - The Great Divergence: Growing Disparities Between the Nation’s Highest and Lowest Achievers in NAEP Mathematics and Reading Between 2009 and 2019 \(ed.gov\)](#)

<sup>21</sup> [Trends in Average Achievement by Gender – TIMSS 2019 International Reports](#)

<sup>22</sup> <https://nces.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force>

<sup>23</sup> <https://nces.nsf.gov/pubs/nsb20211/online-education-in-stem-and-impact-of-covid-19#education-during-covid-19>

<sup>24</sup> [U.S. GAO - K-12 Learning Loss During the Pandemic, 1.1 million teachers had students who did not show up for school](#)

<sup>25</sup> <https://nces.nsf.gov/pubs/nsb20211/online-education-in-stem-and-impact-of-covid-19#sidebarCtr6109>

<sup>26</sup> [Advancing Equity and Racial Justice Through the Federal Government | The White House](#)

**Objectives and Supporting Actions:**

|  |  |                |
|--|--|----------------|
| Objective 1.1: Increase awareness of the breadth of space-related careers. |  |                |
| Action 1.1.1   | Create a compendium of “Space Careers” to provide a comprehensive picture of the diversity of careers and people in the space workforce. | September 2022 |
| Action 1.1.2   | Launch an awareness campaign, including materials for departments and agencies to use in their outreach and engagement activities.       | March 2023     |
| Agencies: DOC, DoD, DOE, DOI, DOT, ED, NASA, NSF, ODNI                     |  |                |

|  |  |                |
|--|--|----------------|
| Objective 1.2: Provide a coordinated set of resources for educators to use in providing STEM content through a space lens. |  |                |
| Action 1.2.1   | Create an online repository of space-focused teaching and learning resources for students, educators and families. | September 2022 |
| Agencies: DOC, DoD, DOE, DOT, ED, NASA, NSF, USDA  |  |                |

|  |   |              |
|--|---|--------------|
| Objective 1.3: Support space-related STEM educator professional development. |   |              |
| Action 1.3.1   | Create a compendium of space-related teacher professional development opportunities for teachers and educators.                             | January 2023 |
| Action 1.3.2   | Establish and expand public-private collaborations in support of space-related teacher professional development for teachers and educators. | March 2023   |
| Agencies: DOC, DOE, DoD, DOT, ED, NASA, USDA                                 |   |              |

**Goal 2: Prepare educators, training providers, learners, and job seekers through experiences that support the transition into the space workforce**

Government agencies and companies that rely on a workforce in the space sector face complex challenges in an increasingly competitive global marketplace, where there is an urgent demand for and lack of skilled technical workforce talent in the space sector. Specifically, as the demand for space economy goods and services continues to scale, policymakers and other stakeholders should ensure that growth in the space-related sectors does not become constrained by a lack of workers with appropriate skills and training. The space workforce needs highly-skilled STEM specialists who are trained across a range of technical skills and disciplines that include information technologists, computer scientists and data analysts, hardware and product designers, skilled technicians engaged in manufacturing and testing, and scientists and engineers. These space STEM professionals receive their preparation from career and technical education schools, community colleges, and four-year institutions across the Nation as well as the military, apprenticeships, and other training programs that engage people with skills and interests outside of traditional routes.

There are persistent disparate outcomes in the postsecondary STEM landscape, including lack of access to space careers and limited diversity of the space workforce which stifles innovation. The space



industry can address these disparate outcomes by providing more inclusive access to career entry points to the workforce, such as paid work-based learning opportunities including, internships, apprenticeships, and on-the-job-training. There is also an opportunity to build inclusive bridges to provide people with connections between institutions and jobs through social support structures, organizations, and other wrap-around services that meet people where they are and support them through career transitions. This is especially important for mid-career and senior experts in different fields who seek opportunities to transition into the space workforce at advanced career stages.

The inequitable access to onramps and bridges as well as unequal postsecondary program completion patterns in STEM fields, have also contributed to the underrepresentation of persons from the LGBTQIA+ community,<sup>27</sup> persons with disabilities, women of all backgrounds, and those from three racial and ethnic groups — including Black or African American, Hispanic or Latino, and Native American or Alaska Native<sup>28</sup> in the space workforce. For example, there are gaps in STEM degree attainment for Hispanics, who are 18.5% of the overall population, earning only 12% of bachelor’s STEM degrees<sup>29</sup> and African Americans, who are 13.4% of the overall population, earning 1.1% of doctorates in computer science.<sup>30</sup> Similar patterns exist within technician, science, and engineering programs at community colleges: Hispanic students are more likely to enroll in community colleges than four-year institutions and technician programs, where students are overwhelmingly white and male.<sup>31</sup> Patterns of inequitable investments also exist at the institutional level with HBCUs, TCUs, and MSIs serving an outsized role in preparing Black or African American, Hispanic or Latino, and Native American or Alaska Native STEM professionals,<sup>32,33,34</sup> highlighting the need for government and industry to invest in institutions that serve students from backgrounds underrepresented in the space workforce. There is also under-enrollment in the precision manufacturing training programs that are a critical occupation in the industry.

This second goal, and its corresponding set of objectives, is focused on the experiences that support learners’ and jobseekers’ transitions into the space workforce. This Pathways paradigm builds on the inspiration based Objectives 1.1-1.3, moving to focus on the occupational career pathways, so that learners and job seekers understand the programs, education, and training needed to obtain space jobs. Moreover, this goal aims to put policy into practice to facilitate career pathways to the space workforce and increase the number of learners who complete paid work-based learning opportunities including internships, apprenticeships, and on-the-job-training for whom unpaid opportunities are a barrier to participation (e.g., low-income, persons with disabilities, members of the LGBTQIA+ community, and people with multiple marginalized identities).

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<sup>27</sup> Freeman, J. (2018). LGBTQ scientists are still left out. *Nature*, 559(7712), 27–28. <https://doi.org/10.1038/d41586-018-05587-y>

<sup>28</sup> [Women, Minorities, and Persons with Disabilities in Science and Engineering: 2021 | NSF - National Science Foundation](#)

<sup>29</sup> [STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity | Pew Research Center](#)

<sup>30</sup> [Doctorate Recipients from U.S. Universities: 2020 | NSF - National Science Foundation](#)

<sup>31</sup> [Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways | The National Academies Press](#)

<sup>32</sup> [https://www.nsf.gov/news/special\\_reports/announcements/081920.jsp](https://www.nsf.gov/news/special_reports/announcements/081920.jsp)

<sup>33</sup> <https://sites.ed.gov/hispanic-initiative/hispanic-serving-institutions-hsis/>

<sup>34</sup> <https://sites.ed.gov/whiaiane/tribes-tcus/tribal-colleges-and-universities/>

HBCUs comprise 2% of the Nation’s colleges and universities and prepare 18% of Black STEM BS degree holders in 2018 while Hispanic-Serving Institutions enroll nearly two million students, and Tribal Colleges and Universities collectively offer more than 300 programs including apprenticeships, diplomas, degrees and certificates to American Indian and Native Alaskan students who represent nearly 80% of their total enrollment.

**Objectives and Supporting Actions:**

|  |  |            |
|--|--|------------|
| Objective 2.1: Increase awareness of pathways to careers in the space workforce. |  |            |
| Action 2.1.1   | In collaboration with partners in academia and industry, create a coordinated campaign to increase awareness of space-related pathways and learning opportunities for the space workforce. | March 2023 |
| Agencies: DHS, DoD, DOE, DOI, ED, NASA, NIST, NSF                                |  |            |

|   |   |               |
|---|---|---------------|
| Objective 2.2: Increase the number of learners who complete space-related work-based learning opportunities through programs such as internships, apprenticeships, and fellowships. |   |               |
| Action 2.2.1  | Directly host space-related work-based learning opportunities.  | August 2023   |
| Action 2.2.2  | Fund programs that provide learners of diverse backgrounds with paid work-based learning opportunities in space-related fields. | November 2023 |
| Agencies: DHS, DoD, DOE, ED, NASA, NIST, NOAA, NSF, USDA  |   |               |

|  |  |               |
|--|--|---------------|
| Objective 2.3: Facilitate a Space Workforce career pathways project focused on advanced manufacturing. |  |               |
| Action 2.3.1   | Design and facilitate a Space Workforce career pathways project focused on critical in-demand occupations in the space sector. <sup>35</sup> | November 2023 |
| Agencies: DOC, DoD, DOE, DOL, DOI, ED, NIST, USDA  |  |               |

**Goal 3: Employ a diverse workforce to bring the benefits of space to more communities**

The space industry is essential to American innovation and prosperity and is poised to serve as an engine for economic opportunity. To realize this potential, the civil, commercial, and national security space sectors must have an expanded and diverse workforce that drives innovation and strengthens the entrepreneurship ecosystem in space the sector. The space workforce offers opportunities for people with a range of educational backgrounds and preparation. Common pathways include those that typically require a bachelor’s degree, or similar skill designation, as well as highly skilled technical pathways rooted in the array of relevant degrees and credentials offered in community and technical colleges, and in extensive on-the-job-training, including apprenticeships and certifications. The workforce demand is increasing so it is necessary to focus on employment along all pathways for in-demand jobs.<sup>33</sup> Similarly, it is vitally important that people from all backgrounds and communities have access to all occupations and are an integral part of the space workforce.

The systemic and persistent challenges, including bias, harassment, and discrimination, that prevent people from entering the space workforce are similar to those challenges that lead people to leave the

<sup>35</sup> See the Space Sector Occupational Appendix to review the Department of Labor’s initial assessment of in-demand space sector occupations, with a focus on occupation in the skilled technical workforce.

space workforce.<sup>3637</sup> This attrition needs to be curbed. Like in other parts of the science and technology ecosystem, stakeholders must collaborate to address persistent inequities and ensure that the space workforce affords opportunities for all, free of harassment and discrimination. The Employ focus area of the Space STEM Task Force will address these barriers, with a specific focus on hiring, retaining, and advancing veterans and military spouses,<sup>38</sup> the LGBTQIA+ community, persons with disabilities, those from underrepresented and/or underserved racial and ethnic groups — including Black or African American, Hispanic or Latino, and American Indian or Alaska Native — who are underrepresented in the STEM workforce relative to their proportion within the U.S. population, and women of all backgrounds.<sup>39</sup>

While space companies and Federal agencies have made a commitment to diversity, equity, inclusion, and accessibility, the limited data on the participation of the LGBTQIA+ community, persons with disabilities, Black or African American, Hispanic or Latino, and American Indian or Alaska Native people, and women from all backgrounds suggest there is significant room for improvement, particularly among leadership. One step in promoting equity in the space industry is to regularly gather the data, disaggregated by race, ethnicity, gender, disability, income, veteran status, or other key demographic variables, identify gaps and develop strategies to address them, and to continuously assess progress. Another step is for organizational leadership at all levels to implement, allocate resources toward, and monitor progress on policies and strategies that foster inclusive and equitable workplaces and lead to systemic change.

This third goal and corresponding set of objectives focus on the Federal government as model employer with equitable and inclusive hiring, upskilling, training, and development and retention practices. To further the Biden-Harris Administration’s focus on worker empowerment and commitment to creating jobs with fair pay and good benefits that can support a family, the space sector has an opportunity to extend these principles across the space industry to all communities. This work is also supported by Executive Order 14035, Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce<sup>40</sup> and the National Security Memorandum on Revitalizing America’s Foreign Policy and National Security Workforce, Institutions, and Partnerships (NSM-3)<sup>41</sup> whereby agencies recognize and work to redress inequities in their policies and programs that serve as barriers to equal opportunity.

**Objectives and Supporting Actions:**

|   |   |               |
|---|---|---------------|
| Objective 3.1: Expose individuals to the breadth of opportunities for employment and leadership in the Federal space workforce. |   |               |
| Action 3.1.1  | Facilitate new space-focused professional development programs or fellowships, that would lead to “immersion assignments” at all career levels in different Federal agencies. These would be followed by professional | November 2023 |

<sup>36</sup><https://nap.nationalacademies.org/catalog/25585/promising-practices-for-addressing-the-underrepresentation-of-women-in-science-engineering-and-medicine>

<sup>37</sup><https://nap.nationalacademies.org/catalog/24994/sexual-harassment-of-women-climate-culture-and-consequences-in-academic>

<sup>38</sup>[https://www.whitehouse.gov/wp-content/uploads/2021/12/12-21\\_CoSTEM-STEM-Vets-Plan.pdf](https://www.whitehouse.gov/wp-content/uploads/2021/12/12-21_CoSTEM-STEM-Vets-Plan.pdf)

<sup>39</sup><https://nces.nsf.gov/pubs/nsb20221/executive-summary>

<sup>40</sup>[Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce - The White House](#)

<sup>41</sup>[Memorandum on Revitalizing America’s Foreign Policy and National Security Workforce, Institutions, and Partnerships - The White House](#)

|                                |  |            |
|--------------------------------|--|------------|
|                                | development opportunities that would include mentorship, sponsorship, and continuous professional development.                                 |            |
| Action 3.1.2                   | Publish a Dear Colleague Letter (DCL) to highlight and encourage submission to existing opportunities for space-related programs and projects. | March 2023 |
| Agencies: DOE, NSF, NIST, ODNI |  |            |

|  |  |                |
|--|--|----------------|
| Objective 3.2: Highlight practices that build and incentivize community-building and leadership pathways for diverse individuals in the Federal space workforce. |  |                |
| Action 3.2.1   | Support participation in employee resource groups (ERGs) and facilitate sharing of resources among ERGs. | September 2023 |
| Agencies: DOE, NASA, NIST  |  |                |

|   |  |               |
|---|--|---------------|
| Objective 3.3: Support and scale interventions that assess workforce culture and climate and set vision for a more inclusive, diverse, and equitable workplace culture. |  |               |
| Action 3.3.1  | Establish and build interventions that assess culture and climate using indicators from surveys. | November 2023 |
| Agencies: DOE, NASA, NIST   |  |               |

### Closing Summary

The future of Earth is intrinsically connected to the future of space. The Vice President’s charge calls on public and private stakeholders in the space ecosystem to leverage their collective strength to increase our Nation’s capacity to innovate. The research, development, and applications needed to maintain our leadership in low Earth orbit, cislunar, and deep space exploration also have potential to contribute to solutions for complex challenges on Earth including food security, healthcare, telecommunications, and mitigating climate change.

Realizing the vision put forth by the Vice President begins with ensuring that people from across the Nation are aware of the career possibilities, inside and outside the Federal government, that space can offer and makes resources and opportunities widely available to those who support, nurture, and educate the learners and workers of today and future generations. The space industry is at an inflection point with expanded growth and scientific breakthroughs that lead us to new understandings of the universe and unlock solutions to challenges experienced on Earth. To thrive, the space ecosystem will require contributions and innovations from those with skills, talents, and passions in traditional STEM areas, as well as other expertise from individuals such as technicians, machinists, communications experts, and finance specialists. This Roadmap lays out a set of initial actions that address critical areas and responds to the Vice President’s charge and provides the necessary foundation for future coordinated Federal action, as well as collaboration with industry and academia.

**Appendix: Space Sector Occupational Data**

The following table summarizes occupational data related to current and evolving workforce needs across the space sector. This is *not* an exhaustive list of space sector occupations and primarily reflects a focus on skilled technical occupations for which a high school diploma or equivalent, associate degree, or postsecondary nondegree award are the typical education credentials of new entrants.

This list of occupations was derived from the Bureau of Labor Statistics (BLS) Occupational Employment and Wage Statistics staffing pattern of occupational employment within the Aerospace Product and Parts Manufacturing industry, the industry that encompasses the largest component of the space sector. A staffing pattern illustrates which occupations are employed in relevant industries and their share of total employment within those industries, which can be used to identify key occupations and workforce needs. Additional occupational data were identified and combined from publicly available sources including:

- Employment Projections from BLS (for typical education upon entry)
- Education and Degree completions from the Department of Education
- O\*NET occupational profiles of tasks and other characteristics
- Occupational Employment and Wage Statistics from BLS

The list was then refined through qualitative conversations with stakeholders in the space sector, including trade associations and industry groups, and hiring and shift managers at various space sector companies. Ongoing engagement with the space sector will continue to inform this understanding.

The table provides links to the O\*NET profiles for each occupation and degree completion data from 2020, the most recent year available. O\*NET is a primary source for descriptive information on occupational characteristics and requirements (e.g., Tasks, Knowledge, Skills, Abilities, Work Styles). The O\*NET profiles cover over 900 occupations, and are used by various stakeholders, such as Employers, Educators, Students, Job Seekers, and Workforce Professionals.

| Standard Occupation Title  | O*NET Link   | Additional Reported Titles  | Typical Education Upon Entry | 2020 Education and Degree Completions | 2021 U.S. National Median Wages |
|--|--|---|------------------------------|---------------------------------------|---------------------------------|
| Aerospace Engineering and Operations Technologists and Technicians | <a href="#">Aerospace Engineering and Operations Technologists and Technicians</a> | Avionics Installation Technician, Avionics Technician, Avionics Test Technician, Engineering Technician, Engineering Test Technician, Flight Test Instrument Technician, Instrumentation Technician, Systems Test Technician, Test Technician | Associate's degree           | 8,320                                 | \$35.37 hourly, \$73,580 annual |
| Aerospace Engineers  | <a href="#">Aerospace Engineers</a>  | Aeronautical Engineer, Aerospace Engineer, Aerospace Stress Engineer,   | Bachelor's degree            | 84,303                                | \$58.78 hourly,                 |

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| Standard Occupation Title                                      | O*NET Link  | Additional Reported Titles   | Typical Education Upon Entry      | 2020 Education and Degree Completions | 2021 U.S. National Median Wages  |
|--|---|--|-----------------------------------|---------------------------------------|----------------------------------|
|  |   | Avionics Engineer, Design Engineer, Flight Controls Engineer, Flight Test Engineer, Structural Analysis Engineer, Systems Engineer, Test Engineer  |                                   |                                       | \$122,270 annual                 |
| Aircraft Mechanics and Service Technicians                     | <a href="#">Aircraft Mechanics and Service Technicians</a>                    | Aircraft Maintenance Technician (Aircraft Maintenance Tech), Aircraft Mechanic, Aircraft Restorer, Aircraft Technician, Airframe and Powerplant Mechanic (A and P Mechanic), Aviation Maintenance Technician (AMT), Aviation Mechanic, Helicopter Mechanic             | Postsecondary nondegree award     | 9,630                                 | \$31.43 hourly, \$65,380 annual  |
| Assemblers, Aircraft Structure, Surfaces, Rigging, and Systems | <a href="#">Aircraft Structure, Surfaces, Rigging, and Systems Assemblers</a> | A&P Technician (Airframe and Powerplant Technician), Aircraft Line Assembler, Assembler, Assembly Riveter, Helicopter Technician, Sheet Metal Assembler and Riveter (SMAR), Sheet Metal Mechanic, Structures Mechanic, Structures Technician                           | High school diploma or equivalent | NA                                    | \$23.79 hourly, \$49,480 annual  |
| Avionics Technicians   | <a href="#">Avionics Technicians</a>  | Aircraft Electrical Systems Specialist, Aircraft Technician, Aviation Electrical Technician, Aviation Electronics Technician, Avionics Electronics Technician, Avionics Installer, Avionics Systems Integration Specialist, Avionics Technician, Electronic Technician | Associate's degree                | 330                                   | \$33.31 hourly, \$69,280 annual  |
| Electrical Engineers   | <a href="#">Electrical Engineers</a>  | Circuits Engineer, Design Engineer, Electrical Controls Engineer, Electrical Design Engineer, Electrical Engineer, Electrical Project Engineer, Instrumentation and Electrical   | Bachelor's degree                 | 30,345                                | \$48.28 hourly, \$100,420 annual |

INTERAGENCY ROADMAP TO SUPPORT SPACE-RELATED STEM EDUCATION AND WORKFORCE

| Standard Occupation Title  | O*NET Link  | Additional Reported Titles   | Typical Education Upon Entry      | 2020 Education and Degree Completions | 2021 U.S. National Median Wages |
|--|---|--|-----------------------------------|---------------------------------------|---------------------------------|
|  |   | Reliability Engineer (I&E Reliability Engineer), Power Systems Engineer, Project Engineer, Test Engineer   |                                   |                                       |                                 |
| Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers | <a href="#">Electrical and Electronic Equipment Assemblers</a>                        | Assembler, Assembly Worker, Electrical Assembler, Electronic Assembler, Electronics Assembler, Factory Assembler, Manufacturing Assembler, Production Worker, Transformer Assembler  | High school diploma or equivalent | NA                                    | \$18.01 hourly, \$37,460 annual |
| Heating, Air Conditioning, and Refrigeration Mechanics and Installers                                | <a href="#">Heating, Air Conditioning, and Refrigeration Mechanics and Installers</a> | A/C Tech (Air Conditioning Technician); HVAC Installer (Heating, Ventilation, Air Conditioning Installer); HVAC Mechanic (Heating, Ventilation, Air Conditioning Mechanic); HVAC Specialist (Heating, Ventilation, and Air Conditioning Specialist); Refrigeration Mechanic; Refrigeration Operator; Refrigeration Technician (Refrigeration Tech); Service Technician (Service Tech); Systems Mechanic; Transportation Refrigeration Technician (Transportation Refrigeration Tech) | Associate's degree                | 26,106                                | \$23.38 hourly, \$48,630 annual |
| Industrial Engineers   | <a href="#">Industrial Engineers</a>  | Continuous Improvement Engineer, Engineer, Facilities Engineer, Industrial Engineer, Operations Engineer, Plant Engineer, Process Engineer, Project Engineer, Quality Engineer, Research and Development Engineer (R and D Engineer)   | Bachelor's degree                 | 19,754                                | \$45.82 hourly, \$95,300 annual |
| Industrial Machinery Mechanics   | <a href="#">Industrial Machinery Mechanics</a>  | Industrial Machinery Mechanic, Industrial Mechanic, Loom Fixer, Loom   | High school diploma or equivalent | NA                                    | \$28.77 hourly,                 |

INTERAGENCY ROADMAP TO SUPPORT SPACE-RELATED STEM EDUCATION AND WORKFORCE

| Standard Occupation Title                            | O*NET Link   | Additional Reported Titles   | Typical Education Upon Entry      | 2020 Education and Degree Completions | 2021 U.S. National Median Wages |
|--|--|--|-----------------------------------|---------------------------------------|---------------------------------|
|  |  | Technician, Machine Adjuster, Machine Mechanic, Maintenance Technician, Mechanic, Overhauler, Sewing Machine Mechanic  |                                   |                                       | \$59,840 annual                 |
| Inspectors, Testers, Sorters, Samplers, and Weighers | <a href="#">Inspectors, Testers, Sorters, Samplers, and Weighers</a> | Inspector, QA Auditor (Quality Assurance Auditor), QA Inspector (Quality Assurance Inspector), QA Technician (Quality Assurance Technician), QC Technician (Quality Control Technician), Quality Auditor, Quality Control Inspector (QC Inspector), Quality Inspector, Quality Technician, Test Technician | High school diploma or equivalent | NA                                    | \$18.55 hourly, \$38,580 annual |
| Machinists   | <a href="#">Machinists</a>   | CNC Machinist (Computer Numeric Controlled Machinist), CNC Machinist (Computer Numerically Controlled Machinist), Gear Machinist, Machine Repair Person, Machinist, Maintenance Machinist, Manual Lathe Machinist, Production Machinist, Tool Room Machinist   | High school diploma or equivalent | NA                                    | \$22.95 hourly, \$47,730 annual |
| Mechanical Engineers                                 | <a href="#">Mechanical Engineers</a>                                 | Application Engineer, Design Engineer, Design Maintenance Engineer, Equipment Engineer, Mechanical Design Engineer, Mechanical Engineer, Process Engineer, Product Engineer, Project Engineer, Test Engineer   | Bachelor's degree                 | 47,558                                | \$45.82 hourly, \$95,300 annual |
| Non-Destructive Testing Specialist                   | <a href="#">Non-Destructive Testing Specialists</a>                  | Industrial Radiographer, Non-Destructive Evaluation Technician (NDE Technician), Non-Destructive Testing Specialist (NDT Specialist),  | High school diploma or equivalent | NA                                    | \$29.78 hourly, \$61,950 annual |



INTERAGENCY ROADMAP TO SUPPORT SPACE-RELATED STEM EDUCATION AND WORKFORCE

| Standard Occupation Title                | O*NET Link   | Additional Reported Titles   | Typical Education Upon Entry      | 2020 Education and Degree Completions | 2021 U.S. National Median Wages  |
|--|--|--|-----------------------------------|---------------------------------------|----------------------------------|
|  |  | Non-Destructive Testing Technician (NDT Technician)  |                                   |                                       |                                  |
| Quality Control Analysts                 | <a href="#">Quality Control Analysts</a>                 | Lab Analyst, Lab Technician (Lab Tech), Laboratory Analyst, Microbiology Lab Analyst, QA Auditor (Quality Assurance Auditor), QA Lab Tech (Quality Assurance Lab Technician), QA Tech (Quality Assurance Technician), Quality Control Analyst (QC Analyst), Quality Control Lab Technician (QC Lab Tech), Quality Control Technician (QC Tech) | Associate's degree                | 8,025                                 | \$23.57 hourly, \$49,030 annual  |
| Software Developers                      | <a href="#">Software Developers</a>                      | Application Developer, Application Integration Engineer, Developer, Infrastructure Engineer, Network Engineer, Software Architect, Software Developer, Software Development Engineer, Software Engineer, Systems Engineer  | Bachelor's degree                 | 105,625                               | \$58.05 hourly, \$120,730 annual |
| Welders, Cutters, Solderers, and Brazers | <a href="#">Welders, Cutters, Solderers, and Brazers</a> | Aluminum Welder, Assembly Line Brazer, Brazer, Fabrication Welder, Fabricator, Maintenance Welder, Solderer, Sub Arc Operator, Welder, Wirer   | High school diploma or equivalent | NA                                    | \$22.60 hourly, \$47,010 annual  |