

NASA COVID-19 Response Plan

**Current as of
25 January 2021**



Overview

To combat the COVID-19 virus, NASA has employed a combination of policies, procedures, working groups, and plans created and vetted by the agency leaders who comprise the NASA COVID-19 Task Force. The agency also has leveraged its engineering and technical prowess to devise new and innovative technologies aimed at preventing the spread of the virus, treating COVID-19 patients, and modeling the virus, while simultaneously moving the agency's mission forward.



Protecting the Workforce

NASA considers the safety of the workforce paramount, because without them, there is no NASA mission.

The agency created a website specifically to share information with employees and contractors: nasapeople.nasa.gov/coronavirus. This provides a single location where employees can find all information related to the agency's response to COVID-19, and has aided in maintaining a very low on-site transmission of the virus at NASA.

Enabling the Mission

NASA has implemented high controls, like filtered masks, antigen testing, fever checks, vital signs monitoring, use of the NASA aircraft to limit exposures, and other controls as needed to enable the NASA mission while simultaneously protect the workforce.

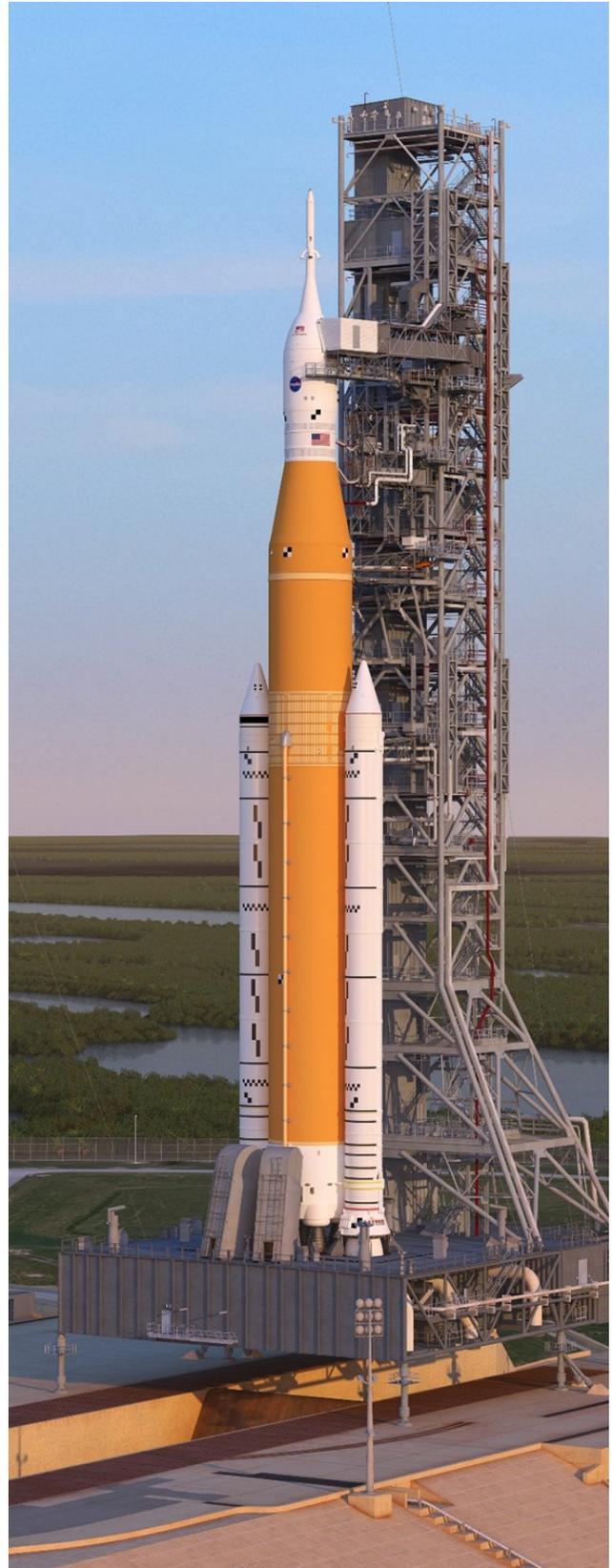
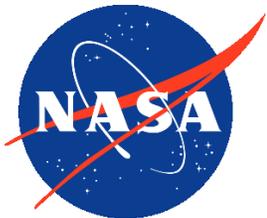
Workplace Controls

NASA has implemented public health controls such as handwashing stations, mandated mask usage in public areas, and physical distancing. NASA will ensure heightened controls in compliance with OMB 21-15.

NASA also has instituted heightened monitoring in the form of surveys or temperature checks, rapid antigen testing, and vital signs monitoring to identify "silent" cases of asymptomatic spread. NASA developed and deployed its own case tracing application to allow up-to-the-minute case tracing and deployed proximity technologies in areas where foot traffic is high to aid in case tracing.

In addition, NASA has implemented engineering controls, such as increased air handling, HEPA filtration, UV light usage, water monitoring, electrostatic sprayers, and established a Clean Team Task Force that meets regularly to address issues related to maintaining a safe and clean workspace.

**NASA is
balancing the
COVID-19 risk
while moving
the mission
forward.**



Protecting the Workforce

NASA has implemented a multi-disciplinary approach to protecting the workforce. NASA utilizes public health safeguards such as physical distancing, handwashing stations, and mandating mask wearing when on NASA centers. In addition, engineering controls such as air handling, HEPA filtration, water filtration, UV light, and electrostatic disinfection also are utilized. NASA devised and implemented its own case-tracing application and took on case tracing for the entire agency as local public health entities were overwhelmed. NASA uses data from the CDC, local hospitals, and other sources to create an integrated site picture of the risk in the areas that surround NASA centers. The agency also maintains frequent contact with the CDC, DHS, State Department, and other federal, state, and local partners.



PREVENTION

NASA implemented a mask mandate early in the pandemic, acquired PPE, and put technologies in place for temperature taking, vitals monitoring, case tracing and testing to prevent on-site spread of the virus.



POLICIES and STRATEGIES

NASA policies and strategies are aimed at protecting the NASA workforce, both civil servant and contractor, and simultaneously finding methods to safely execute our mission.



CASE-BASED RISK

The NASA Stages are based on rising and falling of COVID-19 cases, hospital capacity, and risk in the community. NASA maintains an “executive decision lens,” a digital dashboard, to monitor the situation and cases surrounding NASA centers.

COVID-19 Task Force

In March of 2020, NASA stood up a multidisciplinary leadership task force to address issues and develop strategies and policies related to COVID-19. This team meets no less than twice a week and ad hoc as policy changes and events require.

This COVID-19 Task Force is comprised of agency leadership in the following areas:

- a) Associate Administrator
- b) Deputy Associate Administrator
- c) Office of the Chief Health and Medical Officer (OCHMO)
- d) Designated Safety and Health Official
- e) Office of the Chief Financial Officer (OCFO, to include the Travel Office)
- f) Office of the Chief Human Capital Officer (OCHCO)
- g) Office of the Chief Information Officer (OCIO)
- h) Office of Communications
- i) Office of the General Counsel
- j) Office of International and Interagency Relations
- k) Office of Legislative and Intergovernmental Affairs
- l) Office of Procurement

Framework for the Return to On-Site Work

Introduction

In developing guidelines and making decisions on restarting on-site work, NASA worked to balance mission priorities and the health and safety of the workforce – the latter continuing to take priority.

NASA originally defined their stages based on epidemiologic data and virus cases close to a NASA center. NASA did several Information Technology and telework drills in early February 2020, in preparation for potential large-scale telework. This was an extremely beneficial exercise that allowed the Chief Information Officer to address areas that needed to be bolstered (e.g., Virtual Private Network bandwidth).

The Office of the Chief Health and Medical Officer was following the threat of the virus with the Department of Homeland Security's National Biosurveillance Integration Network and had raised the potential of the pandemic and NASA readiness very early on. In addition, the Office of the Chief Human Capital Officer began addressing the tools (telework policies, family leave policies, union discussions, etc.), and potential gaps in policies, and working with the Office of Personnel Management to identify strategies for telework/remote work. Simultaneously, NASA began evaluating contracts and procurement strategies in case a large portion of the workforce was working offsite, and the potential impacts to our on-site contractors. When the decision was made to move to higher stages, with more employees teleworking, NASA was ready.

NASA created an "Executive Decision Lens" – a digital dashboard that enables agency leadership to evaluate the trends in COVID-19 cases, hospital capacity, and various federal, state, and local determinations and orders, in order to give agency decision-makers the most up-to-date site picture on risk possible.

Because the mission profile of each center is different, and because the medical capabilities and threats imposed by the virus were different across the nation, each center developed its own specific guidance based upon the agency's overarching guidance. These plans were reviewed and approved by the COVID-19 Task Force.

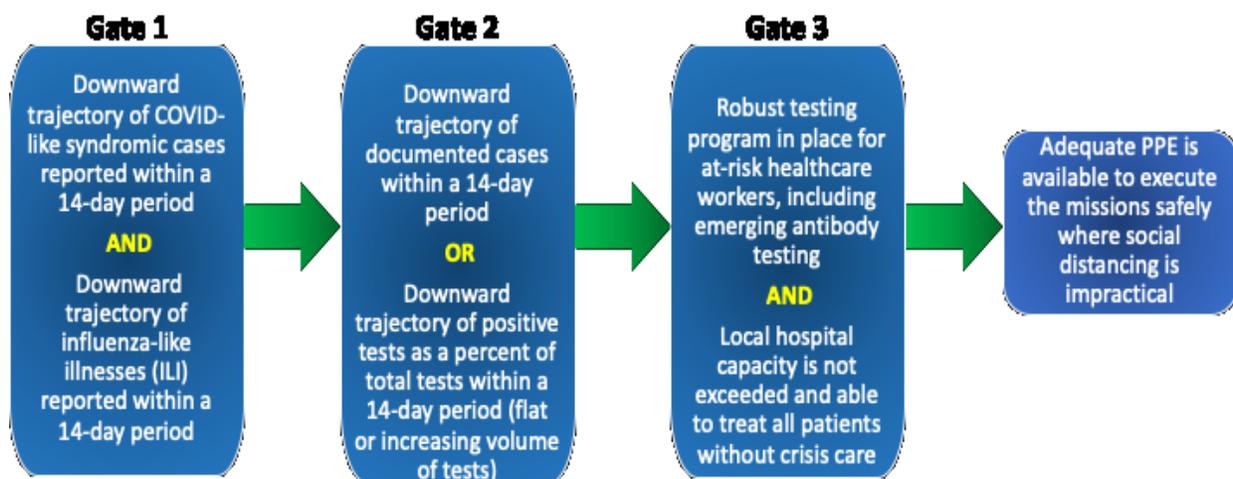
Guidelines for Returning to Site

Currently, 86% of our civil service workforce is teleworking, and doing so effectively. We track this via the "Webtads" pay and leave system. Each of the NASA centers are currently in Stage 3, which has a decreased footprint that matches the 25% requirement mentioned in Memorandum 21-15. Each NASA Center Director must coordinate with and receive concurrence from the NASA Headquarters COVID Task Force to increase their numbers of personnel on-site, or to change stages.

The plan to return federal government operations to normalcy currently parallels the national guidelines put forth by the previous administration and easily can be modified based on new guidance. Our plans assume the federal government, and thus NASA, will calibrate its transitional strategy to return to normal operations to the phase of a state, county, region, or metropolitan area determined by the state or territorial assessment of COVID-19 cases.

This NASA strategic guidance provides the framework for centers to return to normal operations and aligns with the three-phase "gating period" framework and in general is based on a consistent decrease in COVID-19 cases in a region. Obviously, the more individuals that receive the vaccination against COVID-19, the more likely cases will decrease in that given area. However, NASA is not basing its stage transitions on the number of employees vaccinated. Rather, it is assumed that as vaccinations increase and cases decrease in the local area, a safe return to work will be possible. This three-phase framework provides the gates to allow NASA centers to back through the established stages toward normal operations.

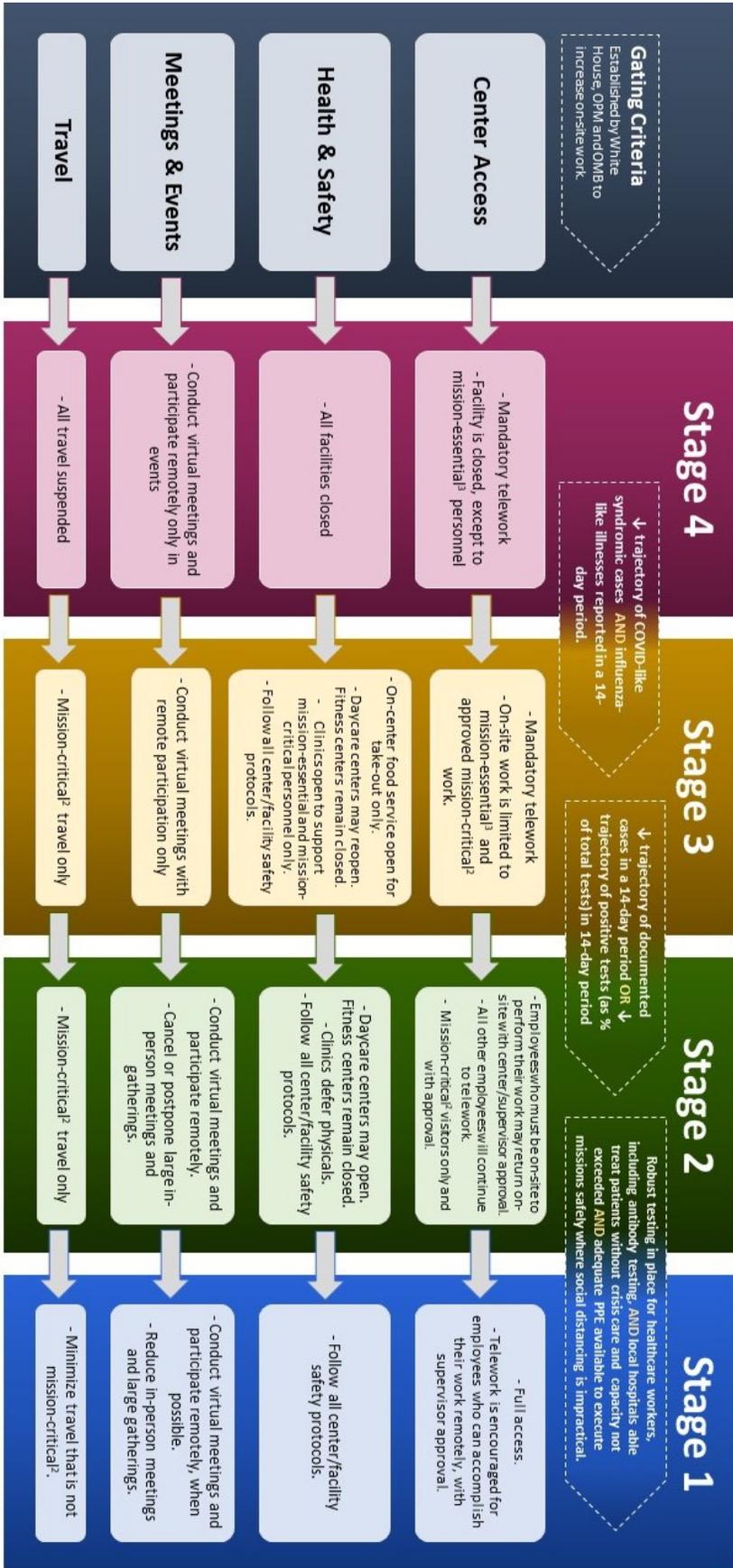
Proposed State and Regional Gating Criteria



NASA believes a fourth gate could be added – vaccination. Although vaccination is not deemed mandatory currently, especially with the vaccines currently approved under Emergency Use Authorization, the availability and penetrance of the vaccine in the community will no doubt impact the local case counts. As the vaccination penetrance increases in an area, the cases and transmission of the virus should decrease. Federal, state and regional assessments should be the starting point for discussions and decisions related to center operations, but additional factors may include school and daycare closures, mass transit availability, parking availability,

facility requirements, testing availability, vaccination penetrance, medical care saturation, and criticality of the NASA missions. It must also be stressed that if there is an abrupt increase in cases in a community after it has entered a phase, that a pause and reassessment will occur. This could entail retreating into the previous phase if the gates for that phase are no longer satisfied. Center Directors should be prepared to pause and reassess the conditions in the community should the need warrant.

NASA's Framework



1. All travel to or from centers at Stage 3 or higher, or to countries at Level 3 or higher, requires an approved Request for Travel Exception form. The Request for Travel Exception form is available on the NASA People website. For the latest CDC international travel information, go to <https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.html>.

2. Mission critical work (on NASA activities or those supporting our federal agency partners) that needs to be performed to minimize the impact on mission/project operations and/or schedules and cannot be performed remotely/virtually.

3. Mission essential functions: As described in the COOP, during an emergency, NASA's Primary and Mission Essential Functions (P/MEFs) must be continued with minimum interruption and are focused on protecting life and property as well as insuring agency leadership and control of the agency.

Moving Through the Framework Stages

The Framework defines Stage 4 activities as those limited to protection of life and critical infrastructure, which includes the agency's mission essential functions (MEFs) as defined in the NASA Continuity of Operations (COOP) Plan. For Stage 3, activities are allowed if they fit the following definition of mission critical: work that must be performed to minimize the impact to mission/project operations and/or schedules and cannot be performed remotely/virtually.

Per the Framework, Stage 3 means mandatory telework, mission-critical work can resume, including hosting visitors to support mission-critical work. Travel should be limited to that which is necessary for an employee to perform mission-critical work that requires their physical presence at another location. Going to Stage 3 at the appropriate time means access still would be controlled, and leaders would be able to approve mission-critical on-site work.

Stage 3 Guidance

- a. Although case counts are falling, the relative risk to high risk/vulnerable individuals is such that they are encouraged to continue to shelter in place and telework, if able to do so. The definition for high risk/vulnerable individuals is based on CDC guidance.
- b. All NASA employees and contractors, when in public (e.g., parks, outdoor recreation areas, shopping areas, common areas), should maximize physical distance from others and must wear a mask.
- c. Maintain six feet physical distancing, whenever possible. Social and workplace settings of more than 10 people, where physical distancing is not practical, should be avoided unless precautionary measures or appropriate PPE protocols are available and observed.
- d. Avoid socializing or gathering in groups of more than 10 people in circumstances that do not readily allow for appropriate physical distancing (e.g., receptions, trade shows, conferences, large meetings). Make use of electronic means for meetings such as WebEx, TEAMS, telecons, etc., when able.
- e. Minimize non-essential travel and adhere to CDC and NASA guidelines regarding isolation and testing following travel.
- f. Continue to encourage telework and bring back critical work in a risk-based, phased approach. Consider beginning with a small percentage of the center population, e.g., 20%, and increasing only where necessary. Maintain a consistent footprint of less than 25% of personnel on the center at any time.
- g. Consider rolling occupancy, where half of an office or group is brought back one week, and the other half the following week. This may decrease the overall risk to the entire group by avoiding exposure of the entire office and allows for decontamination between shifts.
- h. Clinic personnel will be on-site to support the mission-critical workforce and on-site vaccination efforts when vaccine is received. Additional clinic personnel may be needed to help augment case-tracing.
- i. Acquisition and dispensing of PPE to on-site personnel is commensurate with the risk associated with their work.

Within Stage 3, consider:

- a. Convening a virus executive team and a separate working group to gather relevant local data and non-intrusively look at how many are quarantined and new cases or re-infections.
- b. Safety inspections of unoccupied buildings should include life safety critical items and critical preventive, and corrective maintenance of systems needed to support occupancy.
- c. Security should prepare for increased visitor and gate traffic and surges in badge renewals. This effort may require changing current security and access policies.

- d. Enhanced cleaning protocols and documentation by custodial and grounds maintenance should be implemented for high-traffic and common areas for some time (e.g., conference rooms, building entrances, lobbies, cafeterias, collaborative workspaces, and badge and pass offices). Enhanced cleaning should occur prior to the resumption of mission-essential work.
- e. Based on possible future virus exposure, in coordination with NASA health care professionals, other buildings and facilities should be prepared for “stand-by” status.
- f. Screening water supplies, disinfecting areas that have had non-use or still water, such as bathrooms, ice machines, coffee makers, etc.
- g. Being prepared to support mission-essential tenant operations.
- h. Being prepared to use handheld forehead thermometer screening, temperature kiosks, and/or symptom surveys prior to access.
- i. Being prepared to provide and require employees to wear face covers/masks and maintain physical distance in public areas or work areas while on federal property.
- j. Being prepared to schedule periodic checks on facility assets using a controlled approach.
- k. Being prepared to develop a list of needed facilities in which maintenance is done by a staggered and limited staff.
- l. Being prepared to develop a list of equipment needing calibration and schedule offsite calibrations of essential equipment to prevent backlogs.
- m. Being prepared to survey certifications for operational, safety, medical, and technical employees that may have lapsed and adjudicate how such lapses are handled. In some cases, grace periods could be allowed. In other cases, refresher courses could be tailored and taken.
- n. Being prepared to leverage already developed relationships with local emergency management organizations to share information and lessons-learned during this challenge.
- o. Re-assessing who is on the access list.
- p. Being prepared to start planning and preparing for mission and support work to be added in Stage 2 as well as an assessment of workforce availability and readiness for Stage 2 tasks.
- q. Being prepared to gradually and safely increasing the amount of excepted work under Stage 3, if permitted by the NASA Headquarters COVID Task Force, and under OMB 12-15 guidelines.

Moving from Stage 3 to 2 in localities that satisfy the National Gating Criteria or when permitted under Administration guidance

Per the NASA Framework, Stage 2 encourages telework for employees who can continue to do so. For this stage, the framework is not explicit in defining the exact scope of work envisioned, but the intent is to approach normal on-site operations and perform nearly the full scope of mission and project work. A much higher activity level should be allowed during this stage. However, it is possible that a significant portion of the workforce may not be available for on-site work. Travel still should be limited to those activities where physical presence is required at another location.

Stage 2 Guidance

- a. As in Stages 3 and 4, high risk/vulnerable individuals still are encouraged to continue to shelter in place and telework, if able to do so.
- b. All individuals, when in public, should maximize physical distance from others and are mandated to wear a mask while on federal property.
- c. Social settings or meetings of more than 50 people (conferences, large gatherings), where physical distancing may not be practical, should be avoided unless precautionary measures are observed.

- d. Non-essential travel may resume, with the exception that travel to an area that has not progressed in its gates or experiences a rebound of cases should not be approved.
- e. Cafeterias should be take-out only to avoid congregation of large groups.
- f. Gyms may re-open only if enhanced hygiene procedures, physical distancing, and sanitation can be maintained.
- g. Maintain adequate sanitation and disinfection of common areas.
- h. Maintain adequate hand hygiene stations.
- i. On-site daycare facilities may re-open only if enhanced hygiene procedures and sanitation can be maintained.

Within Stage 2, consider:

- a. Assembling an executive team to coordinate information, balance competing priorities, and ensure the safest approach to quickly resuming on-site work.
- b. Resuming support of commercial customers and tenant operations.
- c. Resuming construction projects, prioritizing those that support mission-essential work.
- d. Planning and preparing to support full resumption of site operations, while continuing public health preventive measures as appropriate and per CDC guidance.
- e. Allowing adequate time for the operations and maintenance workforce of mission-essential functions to prepare equipment, facilities, and processes for increased operations. Then, identify the next workforce group to return on-site.
- f. Adding food options and service vendors to support increased site population.
- g. Restricting the re-opening of on-site services, such as cafeterias, carry-outs, gift stores, daycare, and credit unions, which may include identifying the PPE required for those on-site services, closing common spaces, reconfiguring spaces, or prohibiting communal food in cafeterias.
- h. Deploying custodial support to address higher populations on site.
- i. Expanding vaccination efforts beyond mission-critical personnel tiers if permitted and vaccine is received.
- j. Initiating discussions with Human Capital and Occupational Health about employee concerns including working in cubicles or open offices.
- k. Most people are using new virtual engagement skills so, if practical, the benefits should continue.
- l. Requiring all employees to take their IT equipment home each night should conditions change.
- m. Being prepared to provide opportunities for at-risk employees and those with personal exigencies to continue long-term telework or other remedies if their work cannot be done remotely.
- n. Increasing security presence.
- o. Reopening appropriate gates and scanning employee badges on entering and exiting.
- p. Staggering initial arrivals and departures.
- q. Continue rotating teams for access to highly secured areas like SCIFs.
- r. Continue to remind employees to review CDC guidelines on how to protect themselves.
- s. Continuing with alternating work schedules if it does not impact operations.
- t. Planning and preparing for the full scope of mission and support work to resume in Stage 1 and an assessment of workforce availability and readiness for that transition.

Moving from Stage 2 to 1 in localities that satisfy the National Gating Criteria

Per the NASA Framework, Stage 1 is a return to full operations, with resumption of mission, project, and mission support work. Stage 1 means: full access; telework ready; practice physical distancing and increased handwashing; mandatory mask wearing (if still indicated by the CDC); transition from virtual-only meetings to

a blended in-person and virtual environment; travel for work that is mission critical and cannot be remotely accomplished.

Stage 1 Guidance

- a. With the move to Stage 1, the relative risk for high risk/vulnerable individuals is such that they are encouraged to return to on-site work, but should practice physical distancing, minimizing exposure to social settings where distancing may not be practical, unless precautionary measures are observed. Follow OPM guidance if continued accommodation is requested.
- b. Assure vaccination access to all workers who have not yet been vaccinated.
- c. Resume unrestricted staffing at worksites.
- d. Maintain adequate sanitation and disinfection of common areas.
- e. Maintain adequate hand hygiene stations.
- f. Require mask wearing, if still indicated by the CDC.
- g. Attendance at conferences may be approved if physical distancing and hand hygiene precautions are undertaken.
- h. Update pandemic plans with lessons learned.

Considerations in All Stages

Enable good hygiene practices:

- Make liberal use of hand sanitizing stations and encourage handwashing.
- Routine disinfection and cleaning of high traffic areas, surfaces, and frequently used items.
- Mandate face coverings on federal property and when in public and especially when on mass transit.

People who have ANY symptoms or feel sick should stay home.

- Screening, either at home, via an app, or at the NASA Center to identify those who could be potentially infectious.
- Supervisors will need to send any individuals home who may be symptomatic.
- Encourage telework for individuals whose positions are telework eligible with even mild symptoms if the employee wishes to work and is well enough to work. Employees are not expected to telework if sick and have the option to take annual leave, sick leave, credit hours, comp time, etc. If the position is telework ineligible, supervisors continue to have the discretion to offer weather and safety leave.
- Self-quarantine for potential exposures, those with households with someone who has tested positive, and those with symptoms who are unsure of their diagnosis or do not have access to testing.
- Provide COVID-19 testing strategies for mission critical work, astronauts in quarantine, and employees engaged in mission critical government sponsored travel.

Develop and implement appropriate policies and practices ensuring the ability to:

- Prioritize critical NASA mission activities for return.
- Prioritize work and tasks that have lower individual risk (outdoors, decreased contact) for return.
- Maintain social distancing where practicable and heightened use of personal protective equipment where impractical or risks are higher.
- Identify local testing centers for referral of employees, contact tracing of potential cases, and isolation of those potentially exposed.
- Encourage “rolling returns” where an entire office does not return at once, but half of the personnel in an area alternate weeks to decrease the footprint and risk of quarantine of the entire office if there is an exposure.

- Frequently clean and disinfect high traffic areas, and a plan for cleaning areas where a potential case or contact has occurred.
- Continue to limit travel to mission essential travel until nominal operations is achieved.
- Utilize NASA aircraft where appropriate, to maintain safety of critical mission personnel where a COVID-19 positive case could have a cost or schedule impact to the government.
- Protect the workforce while simultaneously preventing discrimination.
 - Protect employees from the direct threat of COVID-19 while exercising reasonable care to prevent, and promptly correct, any incidents of discrimination or harassment, including based upon race, national origin, or protected Equal Employment Opportunity activity.
 - Ensure equitable policies and inclusion, to make sure that no community of color is impacted adversely and that social determinants of health are taken into consideration.
 - Continue providing inclusive work environments for the diversity of the workforce, including removal or prevention of exclusionary practices or incidents involving stigmatization associated with COVID-19 (e.g., race, national origin, medical condition relating to COVID-19, non-vaccination, or association with another individual (e.g., living with an individual at high-risk such as a senior citizen or a health-care provider/first-responder).

The NASA COVID-19 Task Force conducts a readiness review before a center can change stages to ensure we move at the speed of employee safety. The status and availability of the workforce, facilities, equipment, logistics, and work plans are covered in this review.

NASA has asked that centers consider requiring individual facilities to conduct safety and operational readiness reviews and provide time for staff to inspect and test equipment, and review procedures. Also, the adequacy of personal protective equipment (PPE), cleaning and disinfecting, medical facility readiness, test kit availability, and relevant state and local health care and community status should be addressed.

Headquarters and centers that host other agencies or house commercial companies are additionally challenged in their complex planning efforts. These agencies and companies may have their own policies for infrastructure protection, mission essential work, case screening, contact tracing, and return to work screening. The White House executive order will be helpful in assuring compliance of these companies or tenants when on federal property. If there are conflicts or non-compliance, center directors may raise these issues for decision-making to the chief health and medical officer, if appropriate, and then to the associate administrator.



Prioritizing Mission-Critical Work

Prioritizing mission-critical, or “excepted,” work requires good communications between centers, mission directorates, OICs, and agency leadership. The response times may vary as conditions evolve. Match the pace of the work with the needed support. While increasing efficiencies to accomplish what is important and urgent, consider eliminating what is inconsequential and less pressing. Mission directorates should provide prioritization and mission-critical work considered to be time critical. Centers should balance the proposed mission-critical work with the risk to personnel and facilities.

If work is designated as mission critical, then, in consultation with the Safety and Mission Assurance Directorate, the executing organization should develop a safe plan of action to accomplish the work. That plan should address all the factors that would be addressed pre-pandemic in addition to the factors driven by our response to the pandemic (e.g., social distancing, personal hygiene, PPE). The final authority to proceed rests with the center director, in consultation with the agency associate administrator.

A combination of priorities and methods to limit risk are needed to help develop risk assessments on restarting on-site work on a case-by-case basis. If this approach does not create too much strain on the workforce or the systems, where possible, try to get started. For example, with limited on-site staffing and the use of PPE, restarting some priority testing in low-risk areas or resuming test facility operations that are not mission critical still may be reasonable.

Recognizing that milestones have slipped, and the further impact of delays is dependent on program management, and starting with the highest priority, consider applying the following criteria:

- a. Agency priorities (e.g., Artemis, ISS, CCP, Mars Perseverance, JWST, LBFDD)
- b. Missions with defined, fixed launch windows
- c. Missions with firm partner commitments (NOAA, DOD, international)
- d. Missions in the public interest (science products)
- e. Work required to maintain critical research, fundamental science, and technology development
- f. All others

Since some major facilities may have backlogged testing needs Centers and their customers may require scheduling arrangements. Finally, until work has returned to nominal operations, travel should be avoided if possible. After taking into full consideration employee health and safety, mission critical travel should be prioritized.

Protecting High-Risk/High-Cost Missions

NASA leadership has met specifically to discuss high-profile, high-risk, and/or high-cost missions and how best to mitigate impacts to these missions. Several strategies have been deployed to ensure that these missions continue and to prevent a mission impact from a potential COVID-19 case. To this end, NASA has implemented the following strategies:

- a) Enhanced PPE for those in mission-critical areas.
- b) Enhanced testing, including antigen and PCR testing, for high-risk areas and missions.
- c) Use of Case Tracing Proximity Bracelets in high-traffic, mission-critical areas where physical distancing may not be possible.
- d) Use of vital signs monitoring devices to identify COVID-19 cases still in asymptomatic phase.
- e) Use of NASA aircraft to limit personnel exposure in critical missions, such as astronauts who are assigned missions, critical flight controllers, and critical engineering teams.
- f) Vaccination priority to those critical mission and national security mission teams.

Travel Policies

NASA's travel policies are updated on a continual basis, in accordance with federal guidance. The travel policies align with CDC and State Department guidance and are updated on the agency coronavirus response website.

Travelers are provided instructions on how to get reimbursed for COVID-19 tests related to NASA travel, as well as how to order a no-cost COVID-19 test via the Quest contract prior to travel and after return from travel.

Centers, Mission Directorates, and Officials-in-Charge (OICs)

For NASA centers, the risk-based phased approach outlined in the framework has allowed each of the centers to take consistent approach based on the different circumstances in their local areas, centers may be in different stages of the framework. Mission directors should continue to work with each of the implementing centers as return-to-site mission priorities are decided. Priority lists will naturally evolve and be assessed as NASA proceeds and it is determined what is mission critical.

Each center director coordinates with mission directorates and OICs to define expectations for a safe work environment and behavior while working under these circumstances. This gradual implementation must be comprehensively developed in a collaborative way to allow for the most impact with the smallest possible footprint.

As a reminder, the term “**mission essential**” is a term used in the Continuity of Operations Plans (COOP) for the completion of tasks needed to guarantee life, limb, and property in the interest of the United States government and the agency. Whereas the term “**mission critical**” is work that must be performed to minimize the impact to mission/project operations and/or schedules and cannot be performed remotely/virtually.

In the near term, minimizing the workforce density is considered as a measure of safe work practices. If possible, the return-to-site approach should be gradual in nature for all NASA organizations. NASA may operate under these conditions for prolonged or intermittent periods of time. This is done in several ways. For example, normally Mission Control personnel have a shift handover in person, sitting side by side. For the pandemic, NASA stood up additional control rooms, so that now the first shift in mission control hands over to the second shift that is located in another control room. The handover is accomplished through the open loops of communication. This virtual handover and separate control rooms has allowed for social distancing and decreased contact and risk to the flight controllers in mission control. NASA also has used “rolling attendance,” where one set of employees in a given section are on-site one week, and the other half the next week. This decreases the personnel footprint and prevents an entire team from being taken out by an exposure or case tracing.

Center directors, mission directorates, and OICs will consult and inform the NASA associate administrator of all plans to make appropriate stage migrations or modifications based on their assessment of their responsibilities and, in the case of centers and headquarters, the surrounding communities.

Headquarters will continue to provide to center directors, mission directorate associate administrators, and OICs:

- a. Routine OCHMO communications to the entire NASA workforce on nasapeople.nasa.gov by providing tools to support the phased transitions back on-site.

- b. Communications from OCHCO providing guidance to supervisors and employees on policies and flexibilities to accommodate teleworking, returning to work on-site, annual leave, weather and safety leave, caregiving leave, and other leave and work schedule options and personnel matters such as pay and benefits.
- c. Communications from other functional organizations to accommodate continued teleworking and returning to on-site work, such as the OCIO on additional capabilities to accommodate working remotely and on-site effectively.
- d. Agencywide communications to convey NASA status and assist with awareness.

Temperature Checks and Physiologic Assessment of Risks

With guidance updated on March 18 and April 23, 2020 (EEOC-NVTA-2009-3, amended), the Equal Employment Opportunity Commission (EEOC) confirmed the authority of employers to monitor employee temperatures to mitigate the spread of COVID-19. Because the CDC and state and local health authorities have acknowledged the seriousness of community spread and life-threatening risks of COVID-19, EEOC has announced that employer monitoring of employees' body temperature is an appropriate practice that is job-related and consistent with business necessity to prevent a direct threat to employees.

- Employers should be aware, however, that some individuals with COVID-19 do not have a fever, and some individuals with a fever do not have COVID-19. Caution should be taken in making any assumptions as to the infectiousness of someone based on a temperature alone. Although permitted, NASA centers use temperature taking technologies, symptoms screening, testing strategies, vital signs monitoring strategies, and other mitigations, in a concerted effort to reduce the risk to the critical missions and protect the workforce.
- A center may ask an employee to screen their temperature at home, and all employees have been informed that an oral temperature greater than 100.4 F is grounds to stay home and seek the advice or care of a medical professional. The risk in home temperature checks is that there is no way to guarantee an employee took their temperature and/or did so as directed, or that their thermometer is in good working order. The advantage is that it maintains privacy and eliminates the logistics of having personnel and equipment available to perform this task at the workplace.
- If a center implements workplace temperature screening, there are several areas to pay close attention to.
 - Thermal scanners typically are more accurate if scanning within an inch or two of the forehead. Thus, these scanners, as well as oral probes or ear probes, require the person doing the scanning to be in close proximity to the employee, which requires heightened PPE protocols.
 - The results must be maintained as confidential as possible and not declared aloud.
- NASA has implemented hand-held temperature scanners for mission control and launch control in critical phases of flight or when increased personnel are in the control rooms for critical operations.



- NASA deployed temperature kiosks at Stennis Space Center, where the B2 rocket test stand is located. Even though this is an outdoor test stand with lower risk than an indoor facility, NASA still used antigen testing, vital signs tracking, escalated PPE in the form of N-95 masks, and temperature kiosks to reduce the risk to personnel on the test stand.
- Secondary screening is an option if using hand-held thermal forehead scanners. Because the accuracy of non-contact thermal scanners can vary, the center may set up a secondary screening protocol where those identified as having an elevated temperature are taken for a more accurate oral temperature screening. It should be noted that secondary screening areas should have personnel in heightened PPE due to the increased potential of coming into contact with a febrile employee.
- In cases where an elevated temperature is detected during a worksite temperature screening, the center provides a handout to the employee that describe the risk, why the employee was turned away from the worksite, their rights and obligations, and recommended follow-up and course of action for their further medical evaluation, and options for continued work from home.
- Pulse oximetry (noninvasive method for monitoring a person's oxygen saturation), respiratory rate, symptom surveys, and heart rate have been shown to change in patients in the 48 hours prior to the onset of COVID-19 symptoms. Because nearly 50% of COVID-19 infected individuals may be asymptomatic, these vital sign changes may help identify an asymptomatic patient. NASA deployed a pilot program using FitBit Charge 4 wrist monitoring technology and a mobile app provided by FitBit. Via the app, participating employees enrolled perform a daily check-in. The technology already has yielded a return on investment by identifying COVID-19 patients before they can infect other employees.
 - Just in December 2020, more than 40 of the 400 participants reported abnormal vital signs. Ten of these individuals sought testing and seven of those tested positive.
 - This technology equipped these 40 participants to make an informed decision not go into the workplace.
- Acute testing for COVID-19 by employers, although permitted by the EEOC, should be undertaken on site with extreme care to ensure protection of additional clinic patients and the healthcare workforce, and isolation of any suspected COVID-19 case from other employees. The agency currently tests active astronauts every two weeks and mission-critical personnel as needed, and performs surveillance testing on critical mission areas such as the B2 test stand, the launch control, and mission control.
- NASA began deploying tests for those on official travel orders Jan. 26.

Addressing Additional Virus Cases

Due to a possible rebound of the virus or a new virus variant, NASA is taking care not to return on site too quickly, which could cause a rebound or return to a higher stage of the NASA Framework should the outbreak worsen. Going back and forth between stages could be even more disruptive to work and employees.

If necessary, current restrictive policies and procedures can be re-deployed in a targeted manner. Consider maintaining new practices for a longer period until there is certainty that a rebound or new virus cases will not occur. These practices include teleconferencing, home delivery of IT equipment, and continuing to allow certain government equipment at home offices.

Contingency plans should be prepared. Advanced planning may allow more activities to progress with the proper processes and equipment. Now is the time to mitigate known issues.

Processes/steps to consider include:

- a. Adequate triggers in Return to On-Site Work plans to rapidly increase restrictions, if needed.
- b. Case tracing teams and procedures should be organized or contracted out.

- c. For “pop up” cases, deploy the contact trace team, shut down potentially contaminated spaces for cleaning, and have potentially-exposed individuals identified in the case tracing process self-isolate.
- d. Investigate case clusters to assure compliance with public health controls, environmental controls, and risk factors.
- e. All facilities visited by confirmed newly-infected individuals should be cleaned by professional services using occupational and safety health standards.
- f. Provide PPE and cleaning supplies to employees if not practical to shut down work in the area.
- g. Flexibility is permitted in interpreting stage guidelines to fit the unique missions and conditions of each NASA facility. Use a “modified stage” as situations dictate. Depending on future case tracing, not all buildings and facilities may need to be shut down.
- h. For critical functions, use split attendance on site to the extent practical.
- i. Acquire and maintain adequate supplies of PPE, disinfectants, and other consumables needed to respond to on-site cases.
- j. Plan for and acquire advance availability of rapid response virus testing capabilities so that uncertainty is minimized and actions are taken only after acquiring good data.

Prevention and Mitigation

Cleaning and Addressing Contamination

NASA’s Clean Team Task Force, created in April 2020, consists of occupational health, industrial hygiene, safety, and management professionals from all NASA centers and component facilities. This team is responsible for evaluating the environmental health aspects of our pandemic response including disinfection methods, PPE requirements, use of new control technologies, employee training, community surveillance issues, and proper cleaning techniques required after a presumptive on-site case and/or prior to employees reentering sites.

As conditions allow and the agency eventually moves forward with plans to bring more employees safely back on site, the Clean Team will evaluate options in support of the agency’s goals and programs. This group exemplifies the true team spirit by supporting the entire agency, as members not only help their respective facilities, but also use this team as a forum to discuss and share resources with other centers in support of the agency as a whole. This team has been responsible for creating awareness training for COVID-19 return-to-work activities and members currently are in discussions with the Environmental Protection Agency on the evaluation of sprayers and foggers to efficiently clean and disinfect high-traffic areas in NASA buildings.

The following COVID-19 efforts were accomplished, and expert information presented in the past 10 months:

- a) Teamed with the NASA Safety Center on the COVID-19 Telework Safety and Health Page and the Return to On-site Work (RTOW) page, designed to support employees both at home and as they potentially return to work to maintain a clean and safe workspace.
- b) Employee training for RTOW
- c) Workplace COVID-19 signage to remind employees of the required mask usage, hand washing, and physical distancing
- d) Evaluation and procurement of COVID-19 cleaning technologies (cold foggers and electrostatic sprayers)
- e) IEQ/HVAC/HEPA and ventilation recommended practices to enhance airflow and filtration
- f) COVID-19 Webinars: Building Operation Practices/ASHRAE Presentation on Infectious Aerosols
- g) Wrote and released the Occupational Safety and Health Guide for Surface Disinfection Practices using Germicidal Ultraviolet Radiation UV as a possible COVID-19 control
- h) Lecture series on Reducing the Risk of COVID-19 Using Engineering Controls

- i) Evaluations of portable air filtration units: comparison of technologies, costs, performance, type of filter
- j) A focus on telework ergonomics with the OCHMO Ergonomic Team

The Clean Team Task Force meets every two weeks, or more often as required, to address specific issues related to environmental health and safe worker environments.

Personnel Protective Equipment (PPE)

NASA made several strategic bulk buys of PPE early in the pandemic. The agency provides high-quality N-95 masks to employees when physical distancing is not practicable, such as while working on a Mars rover, critical telescope, or rocket engine test stand where personnel are in close contact. Surgical masks are used in areas such as aircraft transport, mission control, and areas where some physical distancing is possible. Employees can use cloth face coverings they purchased while in common areas, hallways, etc., and while transiting to and from work. NASA also consulted with OSHA to gain relief from some requirements such as fit testing and respiratory testing where appropriate.

To date, NASA procurement of PPE is as follows:

- | | |
|----------------------|---------------|
| a) Surgical Masks | 434,000 units |
| b) N95 | 18,880 units |
| c) HHS Masks (cloth) | 48,000 units |

Guidance was also given on what type of mask to use in one situation or another, how to clean or recycle a mask, and reporting those who were non-compliant.

Contact Tracing

The NASA Office of the Chief Health and Medical Officer and the Office of the Chief Information Officer developed a contact tracing application to help monitor and control the spread of COVID-19 among its workforce. NASA's contact tracing is used to identify employees, both civil servant and contractors, who may have been in contact with a COVID-19 case at a NASA facility.

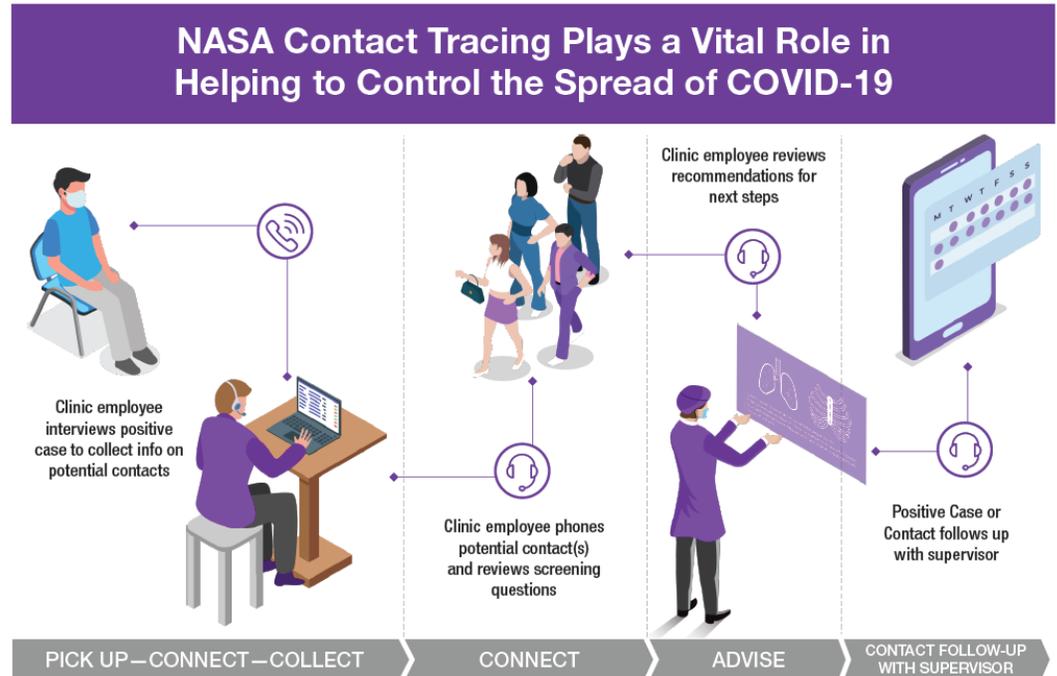
Trained NASA clinic staff interview the index case to trace back who they may have had recent contact with while at work. Subsequently, people who may have been exposed are contacted, interviewed about their symptom status, and encouraged to self-quarantine to prevent further spread. Of those contacts tested, if there is a new confirmed case of the virus, the process of contact tracing continues.

NASA does not try to replace contact tracing performed by the local public health departments. It is used only to prevent or minimize exposure at agency facilities or in proximity to agency missions. Based on current recommendations, and for the protection of employees and the mission, NASA clinics are using this central tracking tool to manage contact tracing. To learn more about contact tracing at NASA, visit <https://www.youtube.com/watch?v=aP1VcvMKH9s>

Employees identified as COVID-19 positive should immediately contact their supervisor, who will notify the center clinic of the positive case and coordinate next steps. The clinics then will proceed with contacting and informing the positive employee and all exposed contacts who are at risk or suspected positive.

NOTE: Clinics only will gather essential privacy or health information and the initial positive employee's identity is not shared with any of the contacts

[Additional guidance](#)



COVID-19 Testing

Testing at NASA is based on mission criticality. Community testing capacity varies by location, and some centers are able to get testing rapidly while others are not. For this reason, NASA has embarked on a multi-phased testing approach that involves the following:

- a. Abbott ID Now testing for the astronauts every two weeks. Astronauts with mission assignments also are tested while in quarantine, and then several days before lift-off.
- b. Rapid antigen testing has been used in mission-critical areas in close proximity to a critical event. For example, testing of the SpaceX launch controllers for the DM-2 and Crew-1 missions, testing of the Mars 2020 consoles for the February Mars landing, testing and surveillance of the crews performing critical tasks on the B2 Test Stand.
- c. With the recent change to CDC guidance adding a suggestion to “consider” testing before and after domestic travel, NASA embarked on a testing contract with Quest Labs that will allow us to perform PCR testing both before and after an employee travels for work. This contract allows the test to be delivered overnight by FedEx to the employee’s house. They may swab themselves, return the test kit in a FedEx drop, and get test results within 24-48 hours. This test is paid for by NASA.
- d. Symptomatic individuals are not tested on-site in order to avoid contact with security, NASA medical personnel, or others. These



individuals are requested to seek testing at community testing sites. Because they are symptomatic or exposed, their insurance will cover the test.

NASA mission-related testing is followed up upon by NASA. Positive results are conveyed both to the patient and to the county health authorities in which the patient resides. On-site contact tracing is performed by NASA.

NASA Vaccination Tiers and Current Plans

Overview

It was recommended that NASA prioritize vaccinations based on risk to the NASA mission, versus the triage currently used by the states and territories, which is population-based risk. This will differ from the priorities of the Advisory Committee on Immunization Practices (ACIP) that the CDC is following but is not meant to compete with those priorities. NASA employees are encouraged to rely on state and local distribution and triage plans. If permitted, the agency should place in higher triage and tiers employees performing mission-essential and mission-critical work to reduce the risk to NASA's mission and national infrastructure. It is assumed supply of the vaccine will not meet initial demand.

Although the ACIP has an ethical framework and construct, this is aimed at population health and the most vulnerable populations. NASA's plan prioritizes risk to the most critical NASA operations. This does not mean NASA is ignoring the ethical constructs, but rather, NASA will rely on community distribution in each state for those ethical constructs and distributions to the highest population risks and concentrate solely on mission risks.

Mission Criticality Tiers

Tier 1: NASA employees performing mission-critical work that must be performed on site.

- a) Space Communications and Navigation Capabilities/Networks;
- b) Mission operations and their associated personnel (e.g., International Space Station, Mission Control Center, etc.);
- c) Active astronauts assigned to a mission that will launch within the next 365 days, their back-ups, and all staff in close proximity, as well as their immediate family members (to maintain health stabilization and decrease the risk to the astronaut);
- d) Launch operations (e.g., launch control centers, launch pad preparation and processing, integration of spacecraft, etc.);
- e) Employees working on the B2 Test Stand and Green Run test required to keep the Space Launch System/Artemis mission moving forward;
- f) James Webb Space Telescope employees who are working on that hardware and mission;
- g) Personnel necessary to support launch and landing operations (e.g., flight surgeon, flight operations directorate management, rescue personnel, etc.);
- h) Security/cyber/counterintelligence personnel who are required for maintaining security or must come on site to safeguard national interests;

Tier 2: NASA employees who are critical to the mission, have frequent contact with those in Tier 1, or in whom the likelihood of frequent contact or mission risk is high.

- a) Senior managers who have frequent in-person contact with Tier 1, travel or meet in-person for flight readiness, maintain continuity of operations, are involved in critical decision making for the agency, and in whom sickness or absence may cause a mission impact;
- b) Custodial and support staff who service mission control, launch control, astronaut crew quarters, or critical operations buildings and service structure;
- c) Medical personnel who have frequent contact with, examine, or provide medical support to those in Tier 1 (these individuals may be vaccinated as part of a communities Tier 1a group);
- d) NASA employees who are either required to travel or live OCONUS in support of NASA operations (e.g., ISS personnel in Russia);
- e) Communications personnel and others who may have brief, intermittent contact with the crew.

Tier 3: NASA employees who are deemed critical in Phase 3, such that they are coming on site to execute their work but are not in the previous two tiers.

- a) Infrastructure and support personnel (engineers, electricians, etc.);
- b) Research personnel, animal lab personnel, and those involved in executing research for the ISS or other critical research;
- c) Additional personnel required to maintain IT infrastructure;
- d) Other personnel required to do their work on site in Stage 3 or are not able to perform their duties remotely;

Tier 4: All remaining NASA civil servants and contractors who would return to work at lower stages, and who otherwise have been able to work remotely.

Implementation to Date

NASA created a spreadsheet to track personnel at each NASA center who are in Tier 1 critical mission priority. We also sent letters to each state vaccine point of contact, informing them that our understanding is our tiers will not begin or fold into the state plans until the state Tier 1C category, and providing them points of contact at the NASA centers in their respective states.

Each NASA occupational health clinic completed their respective state forms to become a closed pod where the vaccine will be delivered to NASA and distributed to critical personnel.

NASA is a closed pod due to HSPD-12 requirements and security constraints that prevent NASA from being a community-wide distributor. However, should a state or community declare a disaster and the Stafford Act be invoked, NASA will aid the community in any way possible and coordinate with the Federal Emergency Management Agency.



Employee Engagement & Welfare

As schools and daycare and eldercare facilities began closing and employees had to assume additional dependent care responsibilities, agency leadership immediately took steps to ensure its workforce had access to the tools, policies, and support systems to balance these demands with their work.

We increased outreach to ensure employees were aware of, and felt comfortable using, NASA's Employee Assistance Programs, including suicide prevention and depression awareness training and programs. Agency leadership also prepared for the high likelihood that employees may return mentally distracted and/or exhibiting anxiety or other such conditions, and reinforced the importance that supervisors be patient as employees ease back into their normal routine. Employees or managers with questions about related policies and effects on applicable collective bargaining agreements received information from their human resources offices.

If employees do not feel comfortable returning to work on-site or continuing to work on-site, or if they have specific medical conditions that they believe put them at higher risk, they are encouraged to talk to their supervisor or contract management about options to address their concerns. This is reiterated in every agency town hall and on the NASA website at <https://nasapeople.nasa.gov/coronavirus>. If an employee is not satisfied, they then can talk to the center safety director or safety manager at their site. If that is not satisfactory, then the employee can directly contact NASA's Chief of Safety and Mission Assurance at Headquarters. Alternate work arrangements should be made without reservation or reprisal.

As mentioned above, the NASA stages initially were devised into a framework based on epidemiologic data, taking into account the known transmissibility of the virus, and proximity and number of cases close to a NASA center. NASA quickly aligned guidance on travel, safety, numbers of on-site workforce, and other aspects to the NASA stages so employees could look at that the matrix and immediately know what each stage meant. This was published on the nasapeople.nasa.gov/coronavirus website and communicated by email, through supervisors, and via an agencywide town hall.

NASA can easily incorporate gates and percentages to the NASA framework in order to align with the policies and direction from the White House, OMB 21-15, and CDC guidance.

Communications

An essential element of NASA's COVID-19 response is maintaining the workforce's trust and confidence and equipping them with the information they need to work safely and effectively. Transparent, open, regular, and consistent communication is critical to this effort.

Communications should:

- Emphasize that employee health and safety is the top priority.
- Convey calm, steady leadership.
- Assure employees that all necessary measures are being implemented to mitigate risk.



- Provide clear guidance.
- Address and convey empathy for employee concerns.
- Provide advanced notice of changes in operations or guidelines.

NASA has deployed an agencywide website (<https://nasapeople.nasa.gov/coronavirus>) to serve as a single information source for all aspects of the agency's COVID-19 response and is divided into the following information categories: Health & Safety; Return to Site; Telework; Leave & Pay; Travel & Training; NASA IT; and, Contractors. In addition, most centers have a webpage dedicated to center-specific COVID-19 information. Links to these center webpages are on the homepage of the agency site.

In addition to online information, leadership is encouraged to use email messages and town halls to communicate and field questions and concerns of the workforce.

Alternate Work Strategies

Since the start of the pandemic, the Office of the Chief Human Capital communicates regularly with the workforce through numerous methods such as the Coronavirus website, emails through our internal messaging system, and briefings and ask me anything sessions on a variety of topics. The website and messages contain numerous easy-to-understand documents created for employees and supervisors to assist with understanding how the pandemic affects leave, telework, benefits, etc. Further, we developed working remotely resources and conducted supervisory sessions on a myriad of topics

Some of the policies and/or procedures we created or modified during the pandemic include:

- Excused Leave for Caregiving
- Families First COVID response act
- Virtual onboarding of new employees
- What If Scenarios (Leave and Telework)
- NASA Telework Program Policy
- NASA Telework FAQs
- Telework Agreement Guidance
- General Telework, Leave, Pay and Benefits FAQs for Employees during the Pandemic
- General Telework, Leave, Pay and Benefits FAQs for Supervisors during the Pandemic
- Alternative Tasks for Civil Servants who cannot Telework

We put our employees first by maximizing flexibilities for employees to enable caring for self and families (e.g. flexible work hours/days, telework and remote work and excused leave for caregiving and weather and safety leave where applicable). We encourage employees to talk with their supervisors about using the flexibilities to help balance work/personal needs.

NASA worked closely with the Office of Personnel Management, Congress, and the General Services Administration to all find methods to protect the critical contractor workforce and infrastructure. This allowed us to pay the contractor workforce through methods such as “stop work” and “weather and safety leave”. This allowed our contractor workforce to avoid mass layoffs, and also maintained critical aerospace and national security workforce infrastructures.

Counseling, Employee Assistance Programs (EAP) and Occupational Health Resources

Families have been disrupted during this pandemic. Although an employee may not have lost work, wages or health, their family member may have. The loss of employment for a spouse or child, death of a loved one, and/or necessary withdrawal from society can have profound impacts on an employee's health. NASA centers may need to bolster EAP efforts for a period during and following the pandemic, which may include hiring additional counselors.

Testing requirements, case tracing, and surveillance may require centers also to bolster occupational health services for a period during and immediately following the pandemic.

Higher Risk/Vulnerable Populations

High risk or vulnerable populations, as defined by the CDC, include individuals for whom their age or medical condition may increase the threat to their lives if they contract COVID-19. In the early stages of the plan, it is not mandated that employees with such conditions stay home, but employees have been informed that people with certain conditions are at higher risk of more severe COVID-19 outcomes and must make a personal risk decision with regards to on-site work versus telework. Therefore, these individuals are encouraged to telework and to shelter in place when community case counts are high or until a community reaches the appropriate gates. Contractors need to work with their contracting supervisor and the NASA COTR to address available options. Employees with a vulnerable individual in their household should be aware that by returning to work, or other environment where physical distancing is not feasible or practical, they could carry the virus back home. In such instances, precautions should be taken to isolate from vulnerable members of the household. Consistent with federal guidelines, employees who believe they are in a higher risk category should discuss with their supervisors if it would be appropriate for them to continue teleworking or whether they may require some other workplace modification until National Phase 3/NASA Stage 1 is reached.¹ Those who are in this category, as defined by the CDC and the White House National Plan, may include:

- Older adults (aged 65 and over)
- People who have serious underlying health conditions
 - High blood pressure or heart disease
 - Diabetes, obesity, or
 - Chronic lung disease (asthma, emphysema, chronic obstructive pulmonary disease)
- Those on immune lowering medications for chronic disease or cancer chemotherapy
- Much is unknown regarding the risk of this virus for women who are pregnant or breastfeeding.

If an employee or their primary care physician believe the employee's personal health risk may fit into one of the above categories, or that they have additional risk factors not mentioned here but which their physician believes places them at a higher risk, the employee should engage their supervisor.

Employees who have a medical disability, also may make a request for a reasonable accommodation under the Rehabilitation Act consistent with NASA's Reasonable Accommodation Process and should contact their supervisor and center EEO Office. <https://www.nasa.gov/offices/odeo/center-EO-offices>.

¹Some individuals in the high risk population may be individuals with disabilities under the Rehabilitation Act; whereas some individuals will not be. The decision of whether they are legally entitled to an accommodation will be made on a case-by-case basis consistent with NASA's Reasonable Accommodation Process.

NASA Innovations Applied to the COVID-19 Response

NASA is a science and technology organization that attracts incredible, innovative, and passionate talent. Although we never received a mission assignment from FEMA or Health and Human Services, we used our abilities and funding within our allowed scope to work on technologies that would both benefit human spaceflight and apply directly to the pandemic. A few of these innovations and work projects are:

1. NASA's Jet Propulsion Laboratory in Pasadena, California, built a **ventilator** at half the cost and using one-third the parts of a normal ventilator. This impactful invention does not compete with the supply chain and was aimed at the specific physiologic challenges of COVID-19. NASA was able to get the ventilator prototypes built and certified by the FDA within 37 days of project start. This rapid process included field testing at Mt. Sinai Medical Center. The plans for the ventilator were made available at no cost to those who bid and could show that they could produce the ventilator.
2. NASA's Glenn Research Center in Cleveland worked with University Hospitals in Cleveland to devise a technology using **atomic oxygen to clean PPE** so that it could be re-used. Additional technologies were deployed in order to be able to use atomic oxygen to clean ambulances and helicopters that transport COVID-19 patients.
3. NASA's Ames Research Center, in California's Silicon Valley, used its **supercomputer** – one of the largest in the world – to help the CDC and National Institutes of Health model the virus and its changes. Monte Carlo simulations performed by the computer can run millions of runs and simulations in a very short time, helping researchers to understand changes in the virus.
4. NASA's Marshall Space Flight Center in Huntsville, Alabama, used 3D printing to develop plans for **printing PPE**, including masks, visors, and other critically short supplies.
5. NASA's Armstrong Flight Research center in Edwards, California, created a **CPAP helmet** to provide critical pressurized oxygen that could keep a patient off a ventilator. The helmet has an exhalation filter to prevent room contamination or infection of health care providers.
6. NASA Ames and NASA's Goddard Space Flight Center in Greenbelt, Maryland, have been working on an **"e-nose"** project, which is essentially a breathalyzer that can detect COVID-19 instantaneously by recognizing the antigens in the breath and volatile organic compounds consistent with infection.
7. NASA's Johnson Space Center in Houston developed a **large oxygen concentration system** that could run on less power and produce more oxygen than standard concentrators. These units could literally provide a small community hospital with its oxygen supply, provide remote or third world clinics with oxygen that otherwise may not be available, and be critical sources of oxygen for the national stockpile. Discussions were underway with the U.S. Agency for International Development for funding.