

# COVID-19 Mitigation With Appropriate Safety Measures in an Essential Workplace: Lessons for Opening Work Settings in the United States During COVID-19

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**Background.** Nonpharmaceutical interventions (NPIs) mitigate coronavirus disease 2019 (COVID-19). Essential workplaces remained open during COVID-19, but few US-based settings detail outcomes.

**Methods.** Mercury Systems is a US-based manufacturing company that remained open during COVID-19. NPIs—distancing, masking, hand hygiene, ventilation—were successively deployed from March to August 2020. The company expanded sick leave, asked employees to report work outages from illness, and administered employee satisfaction surveys. Three sites in Arizona, Southern California, and New Hampshire administered testing campaigns via reverse transcription polymerase chain reaction (PCR) of nasal swabs in late July to early August for all employees at work or at home self-isolating due to symptoms. Descriptive statistics summarized findings.

**Results.** Among 586 employees at 3 sites, only 1.5% employees developed severe illness over the study duration. Testing campaigns revealed 44 with positive PCR results at a cycle threshold (CT) <37 (likely infectious) and 61 with a CT ≥37 (low-level viral load). True positivity rates were consistent with community prevalence at the time: 1.1% in New Hampshire, 6.2% in California, 12.9% in Arizona. Of all employees with positive tests, 99% were asymptomatic. Employee surveys showed high satisfaction.

**Conclusions.** In a multisite US company that instituted NPIs for COVID-19 mitigation, the proportion of asymptomatic COVID-19 infections on surveillance testing was high (99%). Although surges in community transmission were seen in 2 sites during the study, employee prevalence reflected community prevalence, despite daily workplace presence. This study demonstrates that NPIs likely mitigate severe COVID-19 illness, that PCR tests should incorporate CT values, and that expanded sick leave likely encourages self-isolation, suggesting strategies for work re-openings.

**Keywords.** asymptomatic infection; COVID-19; masking; mitigation; nonpharmaceutical interventions; workplace safety.

The coronavirus disease 2019 (COVID-19) pandemic moved with breathtaking speed across the planet and the United States, shuttering many schools and workplaces in March as shelter-in-place orders and lockdowns were instituted. The United States became the epicenter of the pandemic on March 26, 2020, and has maintained that position since, with 27 million cases and 447 000 deaths reported as of early February [1]. Essential workplaces either shut down temporarily or never shut down at all as the country's needs for food distribution, health care, and some essential business functions could not completely cease.

Many workplaces—such as hospitals, grocery stores and food processing plants—were required to continue functioning

during the pandemic, and initial reports demonstrated transmission and severe illness among employees in these settings [2, 3] before the deployment of now-established public health measures, such as social distancing and universal masking. The importance of facial masking became more apparent [4] when the degree of transmission from asymptomatic individuals was demonstrated [5]. However, there have been very few systematic reports from the United States about how well these principles have fared in keeping employees safe. One report demonstrated that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections decreased among health care workers in Boston-based hospitals once universal masking was instituted across all health care settings in the municipality on March 25 [6]. Another showed that in the setting of universal masking by both hair stylists and clients in 2 hair salons in Missouri in May, clients exposed to 2 stylists with active COVID-19 infection remained completely asymptomatic; of the 139 clients exposed, 67 agreed to testing, and all were SARS-CoV-2 negative [7]. A third report examined risk factors for symptomatic COVID-19 across the United States using a case-control design. This study found that eating in restaurants/bars, where masking cannot be maintained consistently, is more significantly associated with symptomatic COVID-19 than activities where

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masking can be maintained [8]. A recent report from health care settings in Detroit demonstrated that masking reduced both transmission and symptomatic infection [9]. As workplaces contemplate reopening with safety strategies, comprehensive studies of outcomes in these work settings are needed.

Much has been learned about SARS-CoV-2 since it first burst onto the world scene in late 2019, including how to mitigate transmission and severe disease by applying nonpharmaceutical interventions (NPIs) such as universal masking [4, 10], social distancing [11], hand hygiene [12, 13], and ventilation [14] within settings such as workplaces. Face masks likely protect others [5] and the wearer [15] from transmission and acquisition, respectively [16]. Moreover, social distancing [17] and masks [9, 18, 19] may reduce the severity of disease by reducing the viral inoculum to which one is exposed [20, 21]. Symptom screening before work entry is also recommended by the Centers for Disease Control and Prevention [22], although the high prevalence of asymptomatic illness attenuates the effectiveness of this strategy [23]. Periodic SARS-CoV-2 surveillance testing can both allow for identification and isolation of positive cases and a determination of how well safety protocols are working.

In this report, we describe a multisite essential workplace setting in the United States that deployed multipronged NPIs for employee safety. We then describe the results of surveillance testing campaigns and rates of illness across the company, even during the second surge of COVID-19 in the United States, to help inform US workplaces on re-opening.

## METHODS

### Description of Company and Safety Provisions

Mercury Systems, Inc., is an electronics manufacturing company serving the aerospace and defense industry. Mercury produces a variety of electronics materials and has sites across the

United States and internationally. This paper focuses on the manufacturing facilities and the 586 employees who were required to work on-site at 3 domestic locations in Phoenix, Arizona, Ventura County, California, and Hillsborough County, New Hampshire, for ongoing operations over the study period of March to August 2020. A series of safety protocols were deployed for on-site employees in spring 2020, as shown in Figure 1.

### Communication Campaigns

From the outset, timely and transparent communications were critical to Mercury’s response. The message from the executive leadership team was geared toward protecting the health, safety, and livelihoods of employees. Mercury’s communications objective was to achieve transparency in mandatory policies enacted by Mercury during COVID-19 (eg, masking, symptom screening, symptom reporting, etc.). Persistent communications, translated in multiple languages and distributed through all available channels, were intended to ensure that messaging was clear and to help address confusion from disparate local, state, federal, and media-based messages. Communication channels included company-wide emails, emails from direct managers, posting policies and information on the company website, videos playing on-site, company team video meetings, and on-site posters.

Of import for a work setting, Mercury increased sick leave allowances, overtime pay, and established an emergency support fund for employees to reduce employee stress. Periods of isolation and quarantine for those with COVID-19 or those exposed, respectively, were fully paid, and this was messaged via the above strategies.

### Early Mitigation Procedures

The focus in late February was to reduce exposure by stopping international travel and asking employees to self-quarantine after

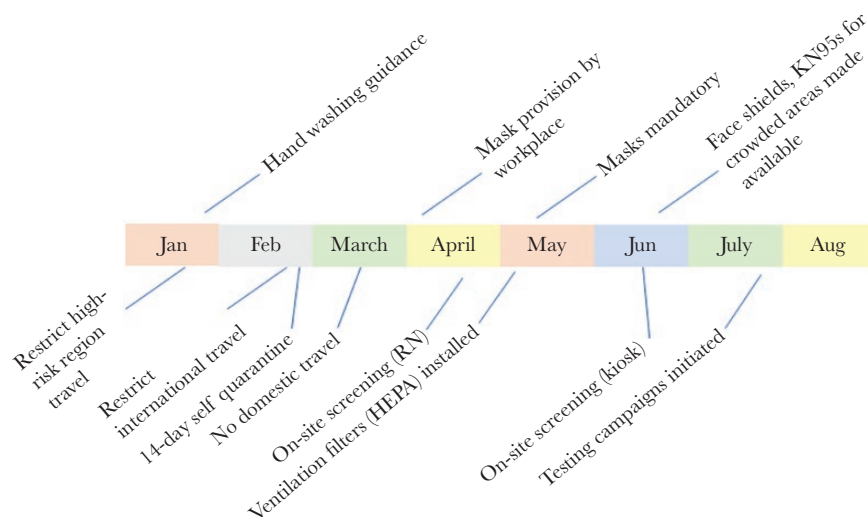


Figure 1. Steps taken for coronavirus disease 2019 mitigation over time at Mercury Inc.

all travel, including domestic. By mid-March, Mercury restricted all travel and nonessential visitors, including for job interviews or onboarding of new employees. At that time, Mercury issued a mandatory work-from-home policy to all employees who did not need to be on-site at the factories; this action resulted in over half of the employees working from home, so the focus of this analysis is on the cohort of on-site employees.

To reduce overall density, Mercury adjusted schedules for on-site employees and increased spacing in offices, conference rooms, and production workbenches (where most on-site employees work). Mercury created guidance for social distancing by at least 6 feet during working, frequent hand hygiene, usage of personal protective equipment (PPE), and exposure protocols, with employees being asked to self-isolate in the event of any symptoms that could be consistent with COVID-19, including fever, cough, shortness of breath, anosmia, dysgeusia, etc. Eating on-site occurred in conference rooms with distancing of  $\geq 8$  feet. Mercury ordered surgical masks, sanitizers, thermometers, and wipes for distribution at critical facilities. Moreover, Mercury engaged a third party to perform “deep cleaning” on a monthly and as-needed basis at Mercury sites.

### Second Phase of Mitigation Procedures

In April, Mercury started initiating facility upgrades, including 1-way walking paths where possible, installing no-touch hardware in restrooms and on doors, increasing airflow via HEPA filters, and installing plexiglass shields between workbenches. By mid-April, Mercury strongly encouraged face masks at all facilities and during personal (nonwork) activities. On April 22, Mercury started distributing KN95 masks at all sites to facilitate compliance; by May 26, mask wearing with the distributed masks became mandatory for all employees at all sites, and Mercury monitored compliance. In mid-April, Mercury initiated mandatory daily symptom screening for on-site employees, performed by registered nurses at first and then with a kiosk added for self-screening.

### Testing Campaigns

Mercury performed surveillance screening for COVID-19 on-site in the Arizona facility on July 24, at the California facility on August 6, and at the New Hampshire site on August 13. Matrix Medical Network performed the testing using standard polymerase chain reaction (PCR)-based methods on nasopharyngeal swabs. The cycle threshold (CT) for the TaqPath assay used by Matrix is 37 cycles, so results were provided around this threshold (with a high CT indicating low-level viral loads, likely noninfectious, and a low CT indicating higher viral loads) [24]. Positive results must have 2 of the 3 virus genes below that threshold, and an inconclusive test is recorded if only 1 gene is below the CT threshold.

### Regulatory Approval

Mercury summarizes employee data without identifying information for a variety of business and other purposes in its sole

discretion. In connection with Mercury Systems SARS-CoV-2 testing, employees consented to Mercury Systems’ access to results on an individually identifiable basis. This information is presented in this manuscript in an aggregate, de-identified basis without employee identifiers. The UCSF Institutional Review Board verified that this research was exempt as it represented an analysis of previously collected, de-identified data.

## RESULTS

### Demographics of Workforce

Of the 586 employees working on-site and tested across all 3 sites, 222 (38%) are female and 364 (62%) are male (Table 1). In terms of race/ethnicity, 260 (44%) are White, 130 (22%) are Asian, 163 (28%) are Latinx, and 33 (6%) identified as other (mainly Black or Native American). Table 1 presents the age distribution, with 56% of employees  $\geq 50$  years of age.

### Results of Testing Campaign

Table 2 summarizes the results of the first testing campaign among 586 on-site employees at all 3 sites (performed July 24, August 6, and August 13 in Arizona, California, and New Hampshire, respectively), along with case prevalence rates per 100 000 individuals in each of the associated counties on the day of testing. All employees entering the facility were tested, and additionally Mercury asked any employees with respiratory symptoms staying home to come in for testing with masks on the day of the testing campaign. Of 586 employees tested, 44 had a positive test for SARS-CoV-2 (CT threshold  $< 37$ ), and 61 had an inconclusive test, indicating low SARS-CoV-2 viral loads.

### Symptom Screen and Reports of Illness

Table 2 shows reports of symptoms on the day of testing by employees across the 3 sites with symptom screens performed by an RN. Only 4 employees reported respiratory symptoms on the day of testing (1 in Phoenix, 1 in Ventura, and 2 in Hillsborough). The median number of days of symptoms among these 4 individuals was 3 (1–5). Of these, 3 tested negative by PCR for SARS-CoV-2; the Phoenix employee test was

**Table 1. Demographics of On-site Employees Across the 3 Mercury Sites (n = 586)**

Gender	222 (38%) female
	364 (62%) male
Race/ethnicity	260 (44%) White
	130 (22%) Asian
	163 (28%) Latinx
	33 (6%) Black/Native American/other
Age	75 (13%) $\leq 29$ y
	71 (12%) 30–39 y
	114 (19%) 40–49 y
	226 (39%) 50–59 y
	100 (17%) $> 60$ y

**Table 2. SARS-CoV-2 Testing Results at 3 Mercury Sites and Rate of Symptoms on Day of Testing**

	No. of Employees Tested	Date of Testing Campaign	% Reporting Symptoms	Positive PCR Test, %	Inconclusive Test, <sup>a</sup> %	County No. of New Cases on Test Date	County No. of New Cases/100K on Test Date
Phoenix, AZ	249	2020-07-24	0.4	12.9	14.1	2587	41.3
Ventura, CA	162	2020-08-06	0.6	6.2	12.3	922	17.5
Hillsborough, NH	175	2020-08-13	1.1	1.1	3.4	1514 <sup>b</sup>	4.36

Abbreviations: PCR, polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

<sup>a</sup>Inconclusive tests represent low-SARS-CoV-2 viral loads, likely noninfectious.

<sup>b</sup>Approximately 66% of Hillsborough, NH, employees live in Massachusetts, and the other 33% in New Hampshire. Cases/100K represents a blend of Hillsborough and Middlesex counties.

inconclusive. Therefore, of the 105 individuals with positive or inclusive tests, 99% (104) were asymptomatic when tested.

### Workers Reporting Sick Leave From March to August 2020

During the period of study from March to August 2020, a total of 55 employees self-reported COVID-19-related symptoms across all 3 sites, with an average of 2.8 employees/week in March and April, 2.1 employees/week in May and June, and 1.4 employees/week in July and August. Employees with symptoms during the conduct of the testing campaigns at all 3 sites were asked to come in for testing; 42 of these 55 came in for testing and became part of the sample of 586. Of these 42, 3 tested positive, 5 inconclusive, and 34 had negative results.

Finally, 4 employees in Phoenix self-revealed that they were diagnosed with COVID-19 during this 6-month period from March to August 2020 and were hospitalized. The longest hospital stay was 10 days in early June; the other 3 were 1 day, 2 days, and 1 day in late June and July. None of these 4 were treated in the ICU. Across all 3 sites, no other employees self-reported serious illness requiring hospitalization.

### Employee Satisfaction With the Campaign

Mercury conducted an anonymous employee satisfaction survey in the first half of August on items such as PPE availability, the mask policy, and ability to socially distance at work; 76% of employees responded. The survey asked 25 questions that employees could rate on a Likert scale of 1–5; the favorability score indicates what percentage of employees scored the question with a 4 or 5. As shown in Table 3, ≥85% of employees surveyed were comfortable with reporting symptoms, the expanded sick leave policy, PPE availability, the mask policy, and the outside cleaning company. Around 80% of employees were satisfied with the ability to socially distance at work, the temperature testing kiosks, and the testing campaign.

## DISCUSSION

Workplace closures likely contributed to reductions in community transmission when COVID-19 first entered the United States. However, workplaces performing essential functions could not close, and therefore employed nonpharmaceutical interventions, such as social distancing, face masking, hand

hygiene, ventilation, and surveillance testing, when possible, to reduce transmission and illness during ongoing work. Very few papers from the United States have reported on the success of applying these principles to settings remaining open since the start of the pandemic, but such reports can inform public health authorities on how to re-open other workplaces. We therefore provide here a descriptive analysis of outcomes among >580 employees working on-site across 3 diverse communities (in Arizona, Southern California, New Hampshire) in the United States from March to August 2020. We believe our study has 3 main findings to apply to other settings: (1) nonpharmaceutical interventions have been hypothesized to reduce the severity of illness [17–20] as well as reduce transmission, and NPIs in this cohort seemed to mitigate illness and lead to high rates of asymptomatic infection; (2) if NPIs are applied correctly in a workplace setting, the prevalence of infection may reflect community trends but will not be increased; (3) the cycle threshold of PCR tests should be incorporated into decisions on isolation.

This study found that ~10% of employees stayed home for respiratory symptoms that could be consistent with COVID-19 from March to August 2020. Instructions to stay home from work if ill seemed to be effective, as evidenced by the fact that the nurse and self-screening kiosk recorded no symptoms or fevers. Increasing paid sick leave hours likely increased the willingness of symptomatic employees to stay home. Human Resources encouraged employees to report any significant illness to Mercury, and only 4 of 586 individuals (1.5%) across the United States reported severe illness from COVID-19 requiring

**Table 3. Employee Satisfaction Survey With Deployed Safety Measures**

Question	% Favorable
PPE availability	90
Expanded sick leave policy	90
Mercury response to COVID-19	89
Mask policy	87
Comfort reporting symptoms	85
Outside cleaning services	85
Site density and other social distancing	83
Temperature testing kiosks	82
Testing campaign	79

Abbreviations: COVID-19, coronavirus disease 2019; PPE, personal protective equipment.

hospitalization over 6 months. Satisfaction scores with masking policies, mask provision, social distancing guidelines, and the expanded sick leave policy were all high. And, finally, during the testing campaigns in late July to mid-August across the 3 sites, the prevalence of test positivity for SARS-CoV-2 reflected community prevalence in the 3 regions at the time. If significant SARS-CoV-2 transmission had been occurring as a result of these employees being in the workplace, SARS-CoV-2 prevalence would have been expected to be higher among the employees than the community. Moreover, the rate of asymptomatic SARS-CoV-2 infection in this cohort with mandated masking and social distancing, was >99%. This low rate of severe illness in the workplace occurred even during surges in the summer of 2020 in community cases, with high rates of COVID-19 hospitalizations and deaths in 2 of the communities.

Although settings in which nonpharmaceutical interventions are not deployed appropriately are often covered by media outlets [25], there are very few examples in the literature to date in the United States that document successes in settings in which masking and other public health measures are followed in terms of keeping rates of transmission and illness low [6, 7]. Although not sensational in terms of headlines, such reports provide guidance and confidence on how to re-open safely after COVID-19 lockdowns. This report describes a single company with multiple sites around the country that deployed known public health measures for safely staying open during the COVID-19 pandemic, including social distancing, hand hygiene, mask mandates with provision, and limits on gatherings. Despite a large workforce and surges in cases in the surrounding communities during the time of this analysis, the overall rate of self-reported illness was very low. Moreover, mass surveillance testing for SARS-CoV-2 by PCR in nasal swabs across 3 sites showed high rates of positivity (>10%) in 1 site (Arizona) in late July, despite little symptomatic illness.

Symptom screening at entry is unlikely to be very effective for SARS-CoV-2 [23], given the high rate of asymptomatic disease [5], but raises awareness. Deep cleaning, given the low likelihood of transmission from surfaces [26], is also unlikely to significantly impact transmission. Adequate ventilation of indoor spaces is likely important [14]. Finally, face coverings and social distancing have increasing evidence of their impact on reducing COVID-19 transmission and, likely, disease severity [4, 6, 7, 9, 16–19, 27–30]. Of note, Mercury developed mask policies before municipal and state mask mandates; California mandated face coverings on June 18, and Arizona followed on June 19, 2020, while New Hampshire did not have a state-wide policy at the time. However, 60% of employees at the Hillsborough, New Hampshire, work site live in Massachusetts, which has had a mask mandate since May 6. The high rate of asymptomatic infection across all 3 sites on surveillance testing is suggestive of high mask compliance [18, 20]. Moreover, mask provision at workplaces, as employed by Taiwan early on in the

pandemic [31], can be helpful in terms of increasing compliance with policy.

Our study has several limitations. Actual compliance with social distancing and masking is difficult to assess in large workplace settings, including this one, and we have no information about mask compliance outside the workplace. Second, the high proportion of “inconclusive” tests across all 3 sites likely indicates low-level viral loads in the nasal swabs, suggestive of resolving infection. Incorporation of cycle threshold values, as used here by the testing company, when interpreting PCR-based tests [24] or use of rapid antigen-based screening [32] may minimize these types of test results when using highly sensitive PCR reactions. Third, we relied on self-report of severe illness, and although the employee satisfaction survey indicated that employees were comfortable sharing symptoms with Mercury (Table 3), we cannot rule out instances of illness without reporting. Finally, although 99% of employees who tested positive/inconclusive for SARS-CoV-2 in the testing campaigns were asymptomatic on the day of testing, we cannot rule out presymptomatic illness, as employees stayed at home for 14 days after testing positive/inconclusive. However, severe disease in the population testing positive/inconclusive was unlikely given that severe disease was most often reported to Mercury’s Human Resources Department and all SARS-CoV-2-positive/inconclusive employees returned to work after the policy-mandated isolation period.

In conclusion, we present details on the successful deployment of the nonpharmaceutical interventions that lead to COVID-19 mitigation, including social distancing, hand hygiene, ventilation, and universal population masking, within enclosed workplaces in diverse settings across the United States. Expanded paid sick leave policies by this workplace may have enhanced comfort with staying home when ill and participating in testing campaigns. In this analysis, >99% of all documented infections (with high or low CT values on PCR, a metric that should be included in testing results) in a mass testing campaign across all 3 sites were asymptomatic on testing. Testing prevalence at each site reflected community prevalence at the time. Our report provides increased confidence in the pillars of COVID-19 mitigation for workplace settings and suggests strategies for work places as they re-open during the ongoing COVID-19 pandemic.

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**Patient consent.** In connection with Mercury Systems SARS-CoV-2 testing, employees consented to Mercury Systems’ access to results on an individually identifiable basis. This information is presented

in this manuscript in an aggregate, de-identified basis without employee identifiers. The UCSF Institutional Review Board verified that this research was exempt as it represented an analysis of previously collected, de-identified data. This work conforms to standards currently applied in the United States and by the UCSF Institutional Review Board.

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