Start **Step 1** Select the factor from the table below that best matches the group in the activity.

The group is composed of people who...	Group Factor
Are known to be following all public health guidance.	1
You think are following all public health guidance.	17
Who are from the general public.	50
Includes healthcare workers in contact with diagnosed COVID-19 patients.	58
You suspect are not compliant with public health guidance.	67
Are known to be diagnosed with active COVID-19*	100

*Note: Don't adjust for community's current conditions in Step 10 and 11 if Group Factor=100 is chosen.

Step 2 Ventilation Adjustment

Table 1: Select ACH

	ACH
Medical	**ACH**
General	6
Laboratory	6
Treatment room	6
Examination room	6
Retail	
Sales (except as below)	1.5
Barbershop	1.5
Hair and nail salons	3.75
Supermarket	1
Fast Food	6
Bars	2- 6
Restaurants	2- 4
Education	
Classrooms (ages 5 to 8)	2
Classrooms (age 9 plus)	2
Daycare (through age 4)	2.5
Multiuse assembly	5
Lecture hall (fixed seats)	7
Lecture classroom	3
Libraries	1.5
Music/theater/dance	2.5
Office	
Office space	0.5
Reception Area	1.25
Meeting/ Conference Rooms	2
Manufacturing	
Manufacturing Floor	1.5
Residential	
Homes with closed windows	0.5
Rooms with one open window	1.75
Homes with all open windows	3
Travel	
Aircraft	20
Trains/Buses	6
Cars (Windows Closed)	6
Cars (Windows Open)	10

For Indoor Activities: On Table 1 on left, select the facility type and ACH (Air Changes per Hour) that best matches the activity location. If air is recirculated and filtered, add filter adjustments to the ACH. Next, find the adjustment that matches ACH and duration from table below:

Find the ACH selected in Table 1

Time since activity or event started →

ACH	5 min	10 min	15 min	20 min	45 min	1 hr	2 hr	4 hr	8 hr	12 hr
0.25	-5	-0	+2	+4	+9	+11	+14	+16	+17	+17
0.5	-5	-0	+2	+4	+9	+11	+14	+15	+16	+16
0.75	-5	-1	+2	+4	+9	+10	+13	+14	+14	+14
1	-5	-1	+2	+4	+8	+10	+12	+13	+13	+13
1.25	-5	-1	+2	+4	+8	+9	+12	+12	+12	+12
1.5	-5	-1	+2	+4	+8	+9	+11	+12	+12	+12
1.75	-5	-1	+2	+3	+8	+9	+10	+11	+11	+11
2	-5	-1	+2	+3	+7	+8	+10	+10	+10	+10
2.25	-6	-1	+2	+3	+7	+8	+9	+10	+10	+10
2.5	-6	-1	+1	+3	+7	+8	+9	+9	+9	+9
3	-6	-1	+1	+3	+6	+7	+8	+8	+8	+8
3.75	-6	-1	+1	+2	+5	+6	+7	+7	+7	+7
4	-6	-1	+1	+2	+5	+6	+6	+6	+6	+6
4.75	-6	-2	0	+2	+5	+5	+5	+5	+5	+5
5	-6	-2	0	+2	+4	+5	+5	+5	+5	+5
6	-6	-2	0	+1	+3	+4	+4	+4	+4	+4
6.75	-6	-2	0	+1	+3	+3	+3	+3	+3	+3
7	-6	-2	0	+1	+3	+3	+3	+3	+3	+3
8	-6	-3	-1	0	+2	+2	+2	+2	+2	+2
9	-7	-3	-1	0	+1	+1	+1	+1	+1	+1
10	-7	-3	-1	-1	+1	+1	+1	+1	+1	+1
11	-7	-3	-2	-1	0	0	0	0	0	0
12	-7	-4	-2	-1	-1	-1	-1	-1	-1	-1
20	-8	-5	-5	-4	-4	-4	-4	-4	-4	-4
30	-9	-7	-7	-7	-7	-7	-7	-7	-7	-7

If air is recirculated and filtered, adjust ACH value upward

If MERV 8 filters are used (Typical Home Filters)	If MERV 13 (Commercial)	If HEPA
Add +3 to ACH	Add +5 to ACH	Add +6 to ACH

For outdoor activities: Select wind conditions that best match.

		Beaufort Scale	Adjust
Very Calm	0.8 – 1.5 km/h	No direction or flow observed	-16
Calm	2 - 5 km/h	Direction of wind shown by smoke drift	-21
Light	6 - 11 km/h	Wind felt on face, leaves rustle	-31
Gentle	13 - 19 km/h	Leaves/small twigs in constant motion. wind extends light flag	-35
Moderate	21 - 29 km/h	Raises dust and loose paper; small branches are moved	-38

Step 3

3a. Select Distancing Adjustment

4.5 m	3.0 m	2.0 m	1.0 m	0.5 m
-17	-12	-6	0	+7

3b. Adjust for area and % capacity of the room occupied. Interpolate as needed.

Room Area = 10 m²

Distancing (m)	2 peo	25%	50%	75%	100%	Cap
1.5	-1	-1	-1	-1	0	17
3	0	0	0	0	+1	9
6	+4	N/A	+4	+4	+4	4
10	+10	N/A	N/A	N/A	+10	2
15	N/A	N/A	N/A	N/A	N/A	N/A

Room Area = 50 m²

Distancing (m)	2 peo	25%	50%	75%	100%	Cap
1.5	-3	-2	-2	-2	-1	66
3	-2	-2	-1	-1	-1	34
6	-1	-1	-1	-1	0	15
10	+1	+1	+1	+1	+1	8
15	+3	N/A	+3	+3	+3	5

Room Area = 100 m²

Distancing (m)	2 peo	25%	50%	75%	100%	Cap
1.5	-3	-2	-2	-2	-2	125
3	-3	-2	-2	-2	-1	63
6	-2	-2	-2	-1	-1	27
10	-1	-1	-1	-1	-0	14
15	+1	+1	+1	+1	+1	8

Room Area = 500 m²

Distancing (m)	2 peo	25%	50%	75%	100%	Cap
1.5	-3	-3	-2	-2	-2	575
3	-3	-3	-2	-2	-2	279
6	-3	-2	-2	-2	-2	112
10	-2	-2	-2	-2	-1	53
15	-2	-2	-2	-1	-1	29

If outside, use -3

Table 2: Add values from Steps 1 through 6

STEP	Scenarios A	Scenarios B
1	50	50
2	4	4
3a	-12	0
3b	-2	-2
4a	-5	0
4b	-5	0
5	0	0
6	0	0
Tot.	30	52

If negative, use Zero in Step 7.

Step 4 Mask Effectiveness

	4a. Exhalation: % of People Wearing Masks ALL	75%	50%	25%	4b. Inhalation: % of People Wearing Masks ALL	90%	50%	25%
N95/KN95	-22	-14	-5	-2	-17	-12	-4	-2
Surgical Mask	-12	-9	-4	-2	-8	-6	-3	-1
Average Mask	-5	-4	-2	-1	-5	-4	-2	-1
Cloth Mask	-5	-4	-2	-1	-3	-2	-1	-1
No Mask	0	0	0	0	0	0	0	0

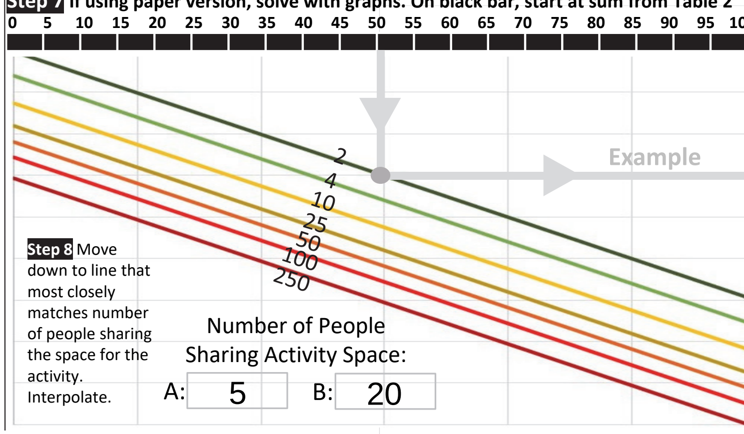
Step 5 Vocalization Intensity

Activity	Exhalation Type	Adjust
Resting	Silent/ Sleep	-13
	Speaking	-1
	Loudly speaking	+12
Standing	Silent	-12
	Speaking	0
	Loudly speaking	+13
	Singing	+18
Light Exertion	Silent	-5
	Speaking	+6
	Loudly speaking	+20
Heavy Exertion	Silent	+1
	Speaking	+12
	Loudly speaking	+26

Step 6 Breathing Rate

Activity	Adjust
Sleep	-8
Resting	-7
Passive	0
Light Exertion	+6
Heavy Exertion	+10

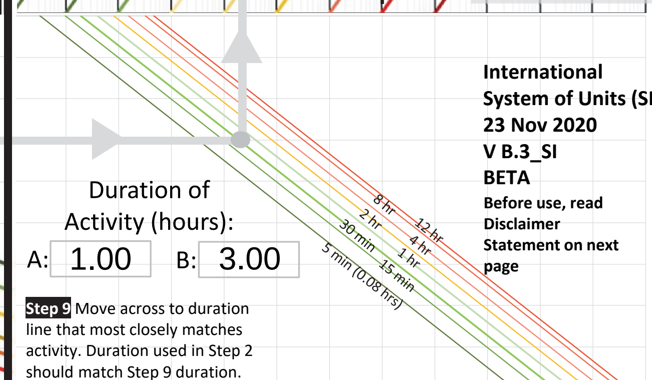
Step 7 If using paper version, solve with graphs. On black bar, start at sum from Table 2



Step 8 Move down to line that most closely matches number of people sharing the space for the activity. Interpolate.

Number of People Sharing Activity Space:

A: 5 B: 20



Duration of Activity (hours):

A: 1.00 B: 3.00

Step 9 Move across to duration line that most closely matches activity. Duration used in Step 2 should match Step 9 duration.

END Take actions to reduce exposure!

MEDIUM: When possible make adjustments to reduce the activity-related exposure. Consider mitigations such as wearing a mask increasing ventilation, increasing distancing, reducing people, or duration of the activity.

HIGH OR VERY HIGH: Make changes to reduce exposure. Rethink the event or activity. Combine multiple mitigations such as using N95 masks, increasing ventilation, holding event outside, greatly increasing distancing, reducing people, or shortening the duration.

Group Exposure

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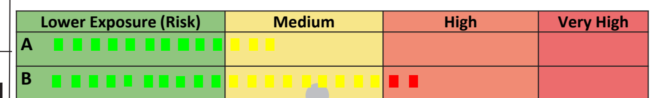
Step 10 Calculate Adjustment to Local Community's Current Conditions

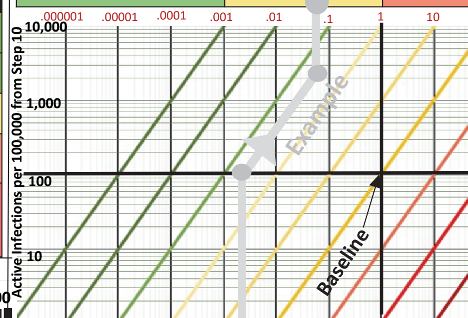
Average Daily Cases per 100,000 in the Last Week*		Average Days Infectious		Undiagnosed Factor for Area (Set to 5 if not known)		Active Infections per 100,000
20	x	5	x	5	=	500

(Use in Step 11)

*Lookup latest data here:
https://coronavirus.jhu.edu/us-map
https://covid.cdc.gov/covid-data-tracker/#cases_casesinlast7days
https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html

Relative Exposure Ratio: A: 0.00789 B: 3.73872





Step 11 Move up to 100 (baseline value), then move up or down from 100, parallel with slanted lines to the active infections per 100,000 value (on left axis) calculated in Step 10. Then move up to **Final Result Table**.

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BETA
Before use, read Disclaimer Statement on next page

A Simple-to-Use Tool (BETA Version) for Comparing Group Exposure to SARS-COV-2 based upon Mechanistic Factors, Group Behavior, and Infection Prevalence in the Community

This simple-to-use nomogram allows users to estimate a group-wide relative exposure to SARS-COV-2 associated with various activities. The tool facilitates understanding of the relative importance of factors that contribute to increased exposure. It incorporates both scientific principals and recent findings regarding virus characteristics to assess relative exposure based on the key mechanistic and epidemiological factors including: 1) the emission rate of virus, 2) viral aerosol degradation and removal, 3) duration of activity/exposure, 4) inhalation rates, 5) ventilation rates (indoors and outdoors), 6) volume of indoor space, 7) HVAC filtration removal efficiency, 8) mask use and effectiveness, 9) distance between people, 10) group population's adherence to public health guidance, 11) size of the group, and 12) prevalence of infection in the population. The nomogram model can be broadly applied to many situations (i.e., worker safety, public events, and schools). The model's results are aligned with the United States Occupational Safety and Health Administration (US OSHA) classifications of exposure risks [1], by benchmarking the exposure calculations to a baseline scenario that is considered high risk by US OSHA. We define the baseline scenario to represent a person (i.e., medical worker) who is exposed to a COVID-19 infected person. We apply assumptions to this scenario, addressing each of the factors in Table 1 to arrive at a baseline inhalation exposure dose value (exposure). The inhalation exposure for other scenarios are compared to the baseline by a ratio of the scenario exposure to the baseline exposure.

The starting point for the mechanistic inhalation exposure model is to use the relationship that defines inhalation exposure as:

$$\bar{E}_{mass} = \bar{C}_{AVE} \times \; Q_{inhalation} \times \Delta t \times Pe_{Exposed}$$

where $Q_{Inhalation}$ is the inhalation rate, $\bar{C}$, is the average concentration, Δt is the duration of exposure, and $Pe_{Exposed}$ is the number of people exposed. $\bar{E}$ is the total quantity of contaminant that enters the respiratory tract through the nose or mouth during inhalation over the duration of a potential exposure [2].

One critical variable that must be estimated by the model is the concentration of virus-containing aerosols that occurs as a result of the exhalation (i.e., breathing and singing) from people in close proximity. The underlying concentration model used in the nomogram assesses both the contributions of concentration of virus due to the "nearness" of people (i.e., people in the Near Field whether indoors or outdoors) and the build up of concentration in a room over time (Far Field - only used indoors) [3] [4].

https://www.cov-irt.org/exposure-assessment-tool

Table 1. Exposure Factor Assumptions used in the Nomogram

Exposure Factors	Range of Values used in the Nomogram	Baseline Assumption
Emission rate of Infectious Aerosols Released through Breath	Range of viral RNA emissions based upon work by Buonanno, et al. [5][6]	11.4 quanta per hour, associated with speaking while standing.
Inhalation Rate	Typical inhalation rates for adults at various activity intensities [7]	0.46 cfm (13 liters per min), based on assumption of light intensity
Duration of Exposure	Varies between 5 minutes and 12 hours	15 minutes, corresponding to the time defined by CDC contact tracing as a significant exposure [8]
Volume of Room or Space	Area varies between 100 ft^2 (~10 m^2) and 5000 ft^2 (~500 m^2). Height is assumed to be 9 ft (2.7 m).	100 ft^2 (~10 m^2), assuming a small room (e.g., a medical examination room)
Ventilation rates (Air changes per hour [ACH])	Values based on published sources [9][10][11]. ACH impacted by outside air, recirculation rate, and effective ACH contribution from viral aerosol degradation and removal by deposition on surfaces.	6 ACH, based on recommendation for medical treatment rooms [9]. Viral aerosol degradation/removal is assumed to be approximately 0.87 ACH for indoors (0.63 for viral degradation due to temperature and humidity and 0.24 due to surface deposition[12]).
Mask effectiveness	Range of mask effectiveness values based on published data for cloth, surgical, and N-95 masks.[13][14]	Assume no masks are worn in the baseline scenario.
Distance between people	15 ft (4.5 m), 10 ft (~3 m), 6 ft (~2 m), 3 ft (~1 m), and 1.5 ft (~0.5 m).	3 ft (~1 m), based on estimated average distance during the event.
Number of people	Ranges from 2 to 250 people.	Two (2)
Likelihood of Infectious persons present	Ranges over 6 orders of magnitude from the lowest (0.0001%) assumed for people adhering to strictly to public health guidance, to the highest (100%) for those known to be infected.	100 percent likelihood of Infectious persons present (1 infected person is assumed)

These concentration contributions are calculated for a person assumed to be at the center of a triangular grid where people are spaced equidistantly (based upon the distancing specified). We assume the concentration at the center is representative for all people in the group since: (1) each person's location is likely not static during the activity and (2) exposure is driven chiefly by the close-in sources (i.e., other people) and all people have close-in sources. The exposure calculation also incorporates the likelihood that people in the group are infected based on the prevalence of infection in the local community and assumed adherence to public health guidance, as well as the air changes per hour associated with the venue, the assumed activity level of individuals (affecting inhalation and exhalation rates) and the duration of the event.

The 11-step tool enables exposure calculations to be done in two ways:

1. Using a graphical nomogram with paper, pen and a straightedge.
2. Using Adobe Reader, enabling Javascript dropdown menus and an interactive bar graph to display results. (Graphs in Steps 7 – 11 can be skipped.)

To accomplish the calculations, the tool uses a log-linear transformation, which allows the calculations of quotients and products to be made by adding and subtracting whole numbers.

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The final results are relative exposure values, which are then categorized exposure into four bins, ranging from "Lower Exposure" through "Very High Exposure." Users can use the tool to assess the impact of changing scenario parameters (e.g., duration, number of people, spacing, mask use) to compare scenarios with the goal of lowering exposure and thereby lowering risk.

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