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NSF/ANSI 49 -2010a Standard
Two ways to perform a CD decontamination.
Method 1 – Fixed amount of CD
Method 2 – Fixed concentration of CD

Note: We will use "CD" as the format for indicating chlorine dioxide (ClO_2)

Method 1 – Fixed amount of CD

In this method (which is utilized with the MCS) a set quantity of 0.13g/ft^3 (4.7g/m^3) CD gas is generated, proportional to the volume of the cabinet. The duration of the decontamination will be a fixed time (85 minutes), independent of the cabinet size or volume. The concentration of gas will vary with time, initially increasing with its generation and then potentially decreasing through a combination of leakage, absorption, and/or decomposition. This is similar to the old method of formaldehyde gas usage, where a measured quantity of paraformaldehyde, 0.3g/ft^3 (11 g/m^3) is placed within a BSC prior to decontamination with varying contact times from six hours to preferably overnight.

To determine the amount of CD generating chemicals required for the decontamination:

1. Calculate the total volume (ft^3 or m^3) of the cabinet by multiplying the height, width, and depth.

   Example: 60" height x 72" width x 36" depth = 155,520 in^3 / 1728 = 90 ft^3

2. Calculate the amount of CD generating chemical required for the decontamination.
   a. Multiply the total volume of the cabinet by 0.13 g/ft^3 (4.7 g/m^3) to determine the mass of CD required to be generated.

      Example: 90 ft^3 x 0.13 g/ft^3 = 11.7 grams

3. Multiply this value by the value of mass of CD per unit mass of generating chemicals, as given by the supplier of the generating chemicals.

   DRS CD generation chemicals generate between 0.134 g/ft^3 and 0.163 g/ft^3 grams of CD
   - 0 – 25 ft^3 = 25 x 0.134 g/ft^3 = 3.34 total grams of CD or (1) A / B packs
   - 25 - 60 ft^3 = 60 x 0.150 g/ft^3 = 8.99 total grams of CD or (2) A / B packs
   - 60 - 90 ft^3 = 90 x 0.163 g/ft^3 = 14.69 total grams of CD or (3) A / B packs

   Note: This variation of CD grams generated is dependent upon the packs of part "A" and part "B" or quantity of chemical(s) in relationship and/or maximum size or volume of the cabinet under decontamination. It was found not to be a linear curve.

DRS has calculated this for you, see chart below which can be found in the owner's manual, MCS synopsis and affixed directly on the MCS itself.

Chlorine Dioxide Generation Chemical Table:

Minimum Volume - ft^3 (m^3)	Maximum Volume - ft^3 (m^3)	BSC Size Width – ft. (m)	CD Generation Chemicals (packs)
0 (0)	25 (0.7)	0-2 ft. (0.0-0.6)	(1) A / B
25 (0.7)	60 (1.7)	3-4 ft. (0.91-1.22)	(2) A / B
60 (1.7)	90 (2.5)	5-6 ft. (1.52-1.83)	(3) A / B

This method with the MCS and DRS chemicals, following the NSF values you will be around 5.53 mg/L (1980 ppm) with a contact time of about 90 minutes, will give you a final dose (time vs. concentration) that will produce a 6 log reduction of bacterial spores as a challenge organism as per the NSF validated procedure. The validation work was performed at a lower concentration, shorter time interval, with loaded HEPA filters and had acceptable results.

Supplemental Information as related to the CD Decontamination Process:

CD Gas Generation Times, Peak Generation, Recirculation, Timing, Scrubbing, STEL limits, Uniformity, Dead Legs all which are required in the NSF standard.

Temperature, humidity and especially safety requirement are mentioned but not addressed with this information.

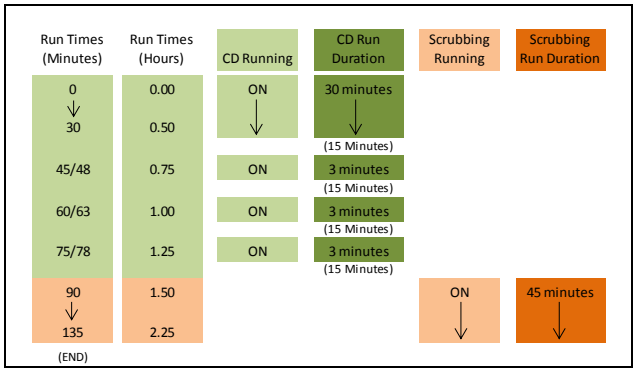
1. The cabinet blower (if available)* and CD recirculation blower shall be operating during the entire CD gas generation period which is 25 minutes.
    - DRS uses 30 minutes

2. Following the completion of CD gas generation, the cabinet blower and/or CD recirculation blower should be energized for at least 1 min during every 15 min of contact time.
    - DRS MCS auto function will recirculate for 3 minutes every 15 minutes.

3. Allow the cabinet to stand a minimum of 85 min from the initiation of CD gas generation.
    - DRS uses 90 minutes or 1.5 hours

4. The chemical generation duration until peak concentration will be under 10 minutes.
    - DRS generation chemicals and MCS performance meet this criterion.

5. Activate the system (scrubber) for removal of CD gas from the cabinet. Have the cabinet blower (if available)* and CD recirculation blower energized during this period. Allow sufficient time for the CD level within the cabinet to decrease to its STEL, the Short-Term Permissible Exposure Limit.
    - DRS uses 45 minutes for the scrubbing cycle
    - DRS tested to ensure that this criterion is met after MCS scrubbing is completed.



*NOTE: DRS tested and met complete CD gas uniformity within all areas of the cabinet when the internal blower(s) *"cabinet blower (if available)"* is or are not operational.

- This also applies to Type B1 cabinet exhaust HEPA filters and Type B2 cabinets, this is due to when one seals the BSC under decontamination, for Type B1 and Type B2 cabinets, the cabinet itself has no way to circulate the CD gas and humidity. Also applies to Type A1, A2 sealant of the exhaust HEPA filter which creates a "dead leg'.

Method 2 – Fixed concentration of CD

In this method, the decontamination cycle is conducted with a fixed concentration of CD gas for specified time duration. The concentration and time duration are independent of the cabinet volume. This method requires the constant measurement of the CD gas concentration (utilizing a CD Photometer) throughout the entire decontamination and requires a means to add more CD gas if the concentration value drop during the exposure time limit.

1) Generate and/or inject the CD gas into cabinet.
   a) There are two concentrations and corresponding time limits that are available.

      i) 3.0 mg/L @ 60 minutes
      ii) 5.0 mg/L @ 45 minutes

2) Monitor the CD concentration within the cabinet, utilizing a CD Photometer, stop the CD generation when the concentration has at least achieved the targeted CD concentration of 3.0 or 5.0 mg/L.

3) Continuously monitor the CD gas concentration, utilizing the CD Photometer, during the entire decontamination. Whenever the CD concentration falls below the target concentration level of 3.0 or 5.0 mg/L, generate and inject more CD gas until the CD concentration has at least attained the targeted concentration level.

4) Continue the decontamination for duration for the designated time frames:

      i) 60 min for a targeted concentration of 3.0 mg/L
         Measured or start from the time that the targeted concentration was first achieved.
      ii) 45 min for a targeted concentration of 5.0 mg/L
         Measured or start from the time that the targeted concentration was first achieved.

5) Activate the system (scrubber) for removal of CD gas from the cabinet.

As stated with fixed method above, recirculation, scrubbing, STEL limits, dead legs all which are required in the NSF standard shall be addressed as with temperature, humidity and especially safety requirements.

Note: 1.0 mg/L is equal to 362 PPM ClO_2

So the above concentrations, if to be measured in PPM are as follows:

i) 3.0 mg/L = 1086 PPM
ii) 5.0 mg/L = 1810 PPM

Conversion from percent (%) to mg/L				ClO2 MW	67.5
Since ppm and % are both volume relationships, there is a simple arithmetic relationship between the two.					
1%=10,000ppm					
ppm=%x10,000		PPM	multplication factor	%	
		362	10000	0.0362	
%=ppm/10,000		%		PPM	
		4	0.0001	40000	
				PPM	
ppm=1X24,450 / Molecular weight		24450	67.5	362.22	
1% = 10,000ppm					
1mg/L = 1,000 mg/M3					PPM
ppm = mg/L X 24,450 / MW		1.0	67.5	24450.0	362.2
					Mg/l
Mg/L = ppm X MW / 24450.0		362.0	67.5	24450.0	1.0
The constant 24,450 comes to us from a principal in chemistry known as the ideal gas law. It is the molar volume of a gas corrected for normal encountered temperature and pressure. (You don't have to remember that. Just use it! The molecular weight gives us grams per mole and the 24,450 figure is in liters per mole, so the two together give us the density of the substance in g/L).					