CO_2 DESIGN GUIDE

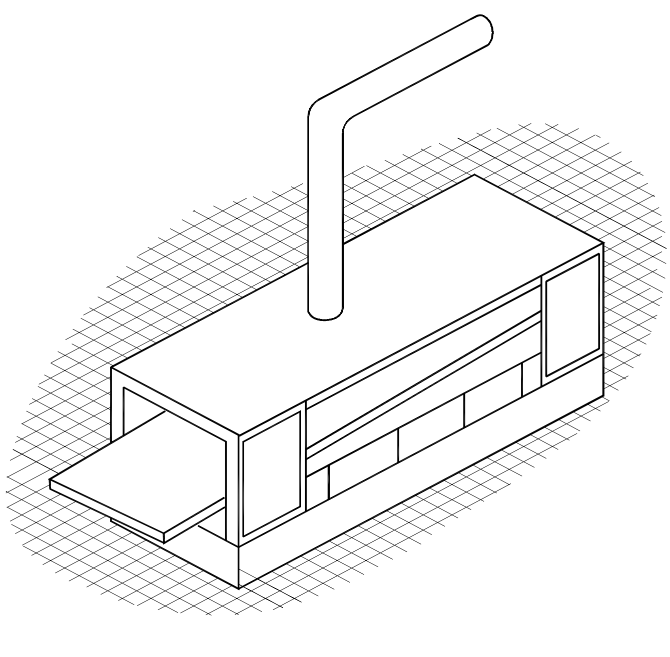
WAVE SOLDER MACHINE

The ***Wave Solder Machine Application Profile*** (AP 007) provides guidance on fire protection requirements for Wave Solder Machine applications. In the event of a fire, the Fike Carbon Dioxide Extinguishing System will protect costly hardware, and will also provide a safe working environment.

This Design Guide provides a step by step design process of a Fike Carbon Dioxide Extinguishing System. There are numerous styles and types of Wave Solder Machines ranging from low to high capacity manufacturing. This Design Guide is intended to be a sample and is not applicable to all Wave Solder Machines. Fike's Carbon Dioxide Design, Installation, and Maintenance Manual and NFPA 12 should be referenced when designing systems.

This Design Guide will be a combination total flood / local application system protecting a Wave Solder Machine. To determine the total carbon dioxide agent supply required for a combined system, calculate the Local Application and total Flood portions of the hazard separately. The Total Flood portion(s) must be adjusted as shown in the following example due to the Local Application requirements regarding vapor compensation and discharge time.

The exhaust ducts will be protected by a Total Flood design and the machine will be protected by a Local Application design. The following application specifications have been taken into consideration to determine the amount of agent, flow rate, quantity of nozzles, and ultimately a Fike CO_2 parts list.



Example: Wave Solder Machine and Exhaust Duct

1. Wave Solder Machine – Local Application
   8.5 ft. long x 2.5 ft. wide x 4.0 ft. high (2.6 m long x .76 m wide x 1.22 m high)
2. Exhaust Duct – Total Flood
   12.0 in. diameter x 20.0 ft long (0.3m diameter x 6.1 m long)

STEP #1 - DETERMINE THE HAZARD VOLUME (MACHINE – LOCAL APPLICATION)

The Rate-by-Volume protection method is used to protect the machine because it is not completely enclosed. The total flow rate requirement for the system will be based upon an "Assumed Volume" that surrounds the hazard. The dimensions of the assumed walls and ceilings of this "enclosure" shall be at least 2 feet (0.61m) greater than the extreme dimensions of the specific hazard itself; unless actual walls are involved.

The "Assumed Volume" must include all sides that have uncloseable openings, or access doors that could be open at the time of system discharge. For this example, a "Worst Case" scenario is used where both ends of the machine are open, and the doors on the front of the enclosure are possibly open. Quite often the front of Wave Solder machines are raised and the soldering process will continue.

"ASSUMED VOLUME"	
English Units	**Metric Units**
Length = 8.5 + 2 + 2 = 12.5 ft. Width = 2.5 + 2 = 4.5 ft. Height = 4.0 + 0 = 4.0 ft. Volume = 12.5 x 4.5 x 4.0 = **225.0 ft^3**	Length = 2.6 + 0.61 + 0.61 = 3.82m Width = 0.76 + 0.61 = 1.37m Height = 1.22 + 0 = 1.22 m Volume = 3.82 x 1.37 x 1.22 = **6.38 m^3**

STEP #2 – REDUCED FLOW RATE FACTOR – LOCAL APPLICATION

The next step is to determine the reduced flow rate factor, which is accomplished by first calculating the open perimeter and total perimeter and is mathematically expressed as 2(LxH) + 2(W+H). The total perimter is then divided by the open perimeter to obtain the total open portion. The open portion of the hazard should be expressed as a decimal.

The open portion is then multiplied by (0.75). This total is added to (0.25). The figure (0.75) is a constant factor used when determing reduced flow rate factors for assumed volumes. The figure (0.25) is the minimum allowed CO_2 /min/ft^3. The discharge rate may be reduced to not less than 0.25 lb/min/ft^3 (16 kg/min/m^3). By adding this factor, we assure we are above the minimum allowable quantity of CO_2.

REDUCED FLOW RATE FACTOR [% open hazard perimeter (expressed as a decimal) x 0.75] + 0.25	
English Units	**Metric Units**
Open perimeter = 2(2.5 x 4) + (8.5 x 4) = 54 ft^2 Total perimeter = 2(8.5 x 4) + 2(2.5 x 4) = 88 ft^2 % open perimeter = 54 ÷ 88 = 0.61 (61%) Reduced Flow Rate Factor = (0.61 x 0.75)+0.25 = **0.71**	Open perimeter = 2(0.8 x 1.2) + (2.6 x 1.2) = 5.04 m^2 Total perimeter = 2(2.6 x 1.2)+2(0.8 x 1.2) = 8.16 m^2 % open perimeter = 5.04 ÷ 8.16 = 0.61 (61%) Reduced Flow Rate Factor = (0.61 x 0.75)+ 0.25 = **0.71**

STEP #3 – DETERMINE THE REDUCED FLOW RATE – LOCAL APPLICATION

After determining the reduced flow rate factor, the next step is to calculate the reduced flow rate. The total discharge flow rate requirement for the system shall be equal to 1 lb./min/ft^3 (16 kg/min/m^3). This is based on the NFPA 12 requirements.

REDUCED FLOW RATE	
English Units	**Metric Units**
0.71 x 1 lb./min./ft^3 = 0.71 lb./min. x 225 ft^3 = **159.75 lbs./min.**	0.71 x 16 kg./min./m^3 = 11.36 kg/min. x 6.38 m^3 = **72.48 kg/min.**

STEP #4 – DETERMINE THE HAZARD VOLUME (EXHAUST DUCT – TOTAL FLOOD)

Now that the machine flow rate has been determined, the next step is to calculate the exhaust duct volume. The volume is calculated by the following equation: • **x (radius^2) x length**

Volume = 3.1416 x (0.5 ft.^{2})x 20 ft. = 15.71 ft^3 [3.1416 x (0.152 m^2)x 6.1 m = 0.44 m^3]

STEP #5 - DETERMINE THE FLOODING FACTOR – TOTAL FLOOD

The flooding factor is based on the hazard being protected. The duct is a specific hazard as per NFPA 12. It is treated as a deep – seated fire. A design concentration of 65% is utilized for exhaust ducts. A flooding factor of 0.125 CO_2 / ft3 (2.00 kg. CO_2/m3) is utilized.

FLOODING FACTOR	
English Units	**Metric Units**
15.71 ft^3 requires volume factor of **0.125 lb. CO_2/ft^3**	0.44 m^3 requires volume factor of **2.00 kg CO_2/m^3**

STEP #6 – DETERMINE THE FLOW RATE FOR COMBINATION APPLICATION

The duct exhaust may contain both Surface Fire hazards and Deep-Seated hazards. The system discharge flow rate must be adjusted to satisfy the Surface Fire requirements first, while still satisfying the requirements for the Deep-Seated fire. Therefore, the carbon dioxide must be discharged within one (1) minute to satisfy the Surface Fire requirements and maintain the twenty (20) minute hold time requirements associated with a Deep-Seated fire.

FLOW RATE ADJUSTED FOR COMBINATION APPLICATION	
English Units	**Metric Units**
15.71 ft^3 x 0.125 lb. CO_2/ft^3 = 2.0 lb. CO_2/min. Minimum Vent Nozzle flow = 10.0 lb. CO_2/min.	0.44 m^3 x 2.00 kg. CO_2/m^3 = 0.89 kg CO_2/min. Minimum Vent Nozzle flow = 4.5 kg CO_2/min.

NOTE: The recommended nozzle for ducts is the Vent Nozzle. This nozzle has a minimum flow rate of 10.0 lbs./min. (4.5 kg/min.). This flow rate **must** be provided.

STEP #7 – CALCULATE THE STORAGE QUANTITY OF CO_2 FOR COMBINATION TOTAL FLOOD / LOCAL APPLICATION

The requirement for the storage quantity of Carbon Dioxide agent, is determined by adjusting the total required flow rate by a vapor compensation factor of 1.4 (40% more Carbon Dioxide) and 0.5 min. (30 second) discharge time.

NOTE: Always round up to the next larger cylinder size. Never round down.

REQUIRED STORAGE QUANTITY OF CARBON DIOXIDE **(Quantity of CO_2 = Flow Rate x Vapor Compensation Factor x Discharge Time)**	
English Units	**Metric Units**
Local Application: 159.75 lbs./min. Total Flood: + 10.00 lbs./min. Total: 169.75 lbs./min. 169.75 lbs./min. x (1.4 x 0.5 min.) = **119 lbs.** (or 169.75 x 0.7 = **119 lbs.**)	Local Application: 72.48 kg/min. Total Flood: + 4.50 kg/min. Total: 76.98 kg/min. 76.98 kg./min. x (1.4 x 0.5 min.) = **53.89 kg** (or 115.4 x 0.7 = **53.89 kg**)

NOTE: In order to simplify the calculation, you may **multiply the flow rate by 0.7** instead of individually multiplying by 0.5 and 1.4 in Total Flood Applications.

STEP #8 – DEVELOP A FIKE CO_2 PARTS LIST.

Fike CO_2 *Sample* Parts List – Wave Solder Application		
Quantity	Description	Part Number
2	75 lb. (45.4 kg) Cylinder w/Brass Valve	C70-075
2	Flexible Discharge Bend w/Check Valve	C70-226
1	24V DC Master Cylinder Package	C85-114
1	Vent Nozzle, Brass (Exhaust)	C80-020-B
2	“S” Type Nozzle (Machine)	C80-010
2	Flange & Seal Kit for “S” type Nozzle	C80-1018
1	2 Cylinder Rack Assembly w/weigh track	C70-040-20
1	SHP Control System, 110 VAC	10-051-R-1
1	SRM4, Relay Module	10-2176
1	Battery Assembly, 7AH	10-2190-1
2	325° Thermal Detector /Rate Anticipated	60-022
1	Pressure Switch – DP/ST	C70-202
1	Manual Release Station	10-1638
1	Horn/Strobe Device, 15/75 Candela	20-098
1	Warning Sign / Manual Actuation	C70-1032

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