



CARBON DIOXIDE APPLICATION PROFILE

WAVE SOLDER MACHINE

Typical Industries Served	Electronics Production Printed Circuit Board Manufacturing	Instrumentation Fabrication Semiconductor
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INTRODUCTION

The electronic systems industry continues to grow year after year, increasing printed circuit board (PCB) use and production. Despite some consolidation among the semiconductor market, the demand for electronic systems continues to soar. According to a study conducted by the NOMURA Research Institute, the demand for PCBs will continue to increase worldwide well into the year 2005, allowing the continuation of wave soldering, which will be the focus of this profile.

The wave soldering process is a very mature assembly technology and many believed it would demise, but the surface mount technology demand has proven them wrong. Today, surface mount technology is still utilized on most manufactured products where size reduction isn't necessary like TV's, videos, audio equipment, and the imminent digital terrestrial television set-top boxes, to name a few. With the high demand for surface mount technology, wave soldering will still remain in use among electronic OEM's and assembly companies.

Wave soldering is a fusing technique using a system that flows solder against the bottom of a printed wire board making connections between solderable surfaces that are close enough for the solder surface tension. PCBs enter the wave solder machine by means of a conveyor. The boards will first move through some form of flux application station, which aids in

the soldering and prevents oxide formation. Prior to entering the wave solder bath, the board will travel through a pre-heat station to reach the flux activation temperature enabling complete joint wetting during soldering. This technique is also referred to as flow soldering

The wave soldering process is very demanding and requires proper fire protection to guarantee production continuation in the event of a fire. Fires during PCB production can lead to extensive downtime, which results in lost productivity and ultimately leads to lost revenue. Knowing fires can and have occurred in wave soldering processes, downtime probability is lessened by the implementation of a Fike Carbon Dioxide Extinguishing System.

The purpose of this application profile is to provide an understanding of the possible hazards associated with wave solder machines and protection strategies utilizing Fike Carbon Dioxide Extinguishing Systems. This document is intended to be a guideline and is not applicable to all wave soldering systems. Fike's Carbon Dioxide Design, Installation, and Maintenance Manual and NFPA 12 should be referred to when designing systems. If you have any questions, please contact the Fike Protection Systems group, or our regional sales manager in your area.

THE PROBLEM: SOLDER & FLUX IGNITION

The wave soldering process is exposed to extremely high temperatures. The solder pot, being the “hot spot” of the process, presents the biggest fire hazard. The normal operating temperature of the solder is between 480 – 500° F (249 – 260° C). Solder pots are generally equipped with high-temperature safety shutdown thermostats shutting down processing if solder temperatures reach approximately 625° F (329° C). The fire hazard associated with solder pots is represented by failure of the temperature safety shutdowns. If this safety measure does not operate, solder, stored in large quantities, will auto ignite and present a fire condition.

The flux material is used to promote wetting during soldering and aids in removing oxides, but also presents a fire hazard as well. A common ingredient in flux is Isopropyl Alcohol, and is a volatile substance. According to NFPA 325, Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids, the use of water on flammable liquids having a flash point below 100° F (38° C) may be ineffective. The flash point of common flux material ranges from 50 – 60° F (10-15.5° C), which awards carbon dioxide gas as the best-suited fire extinguishing system.

Flux material and solder fumes must be exhausted throughout the process. Proper fire protection is required in the exhaust ductwork due to the likelihood of solder residue build-up and the presence of flux vapors.

Fire Hazards associated with the wave solder process:

- Solder Pot
- Flux Module
- Ventilation/Exhaust Duct
- Electrical Cabinet

THE SOLUTION: TOTAL FLOOD / LOCAL APPLICATION

Carbon dioxide extinguishing systems are the agent of choice when protecting wave solder machines. Carbon dioxide gas is effective in areas where flammable solids, liquids, and vapors are present. In the event of a fire, a carbon dioxide system will allow the machine to quickly return to service. There is no clean up associated with a carbon dioxide discharge. Carbon dioxide is an odorless, colorless, electrically non-conductive, and non-corrosive extinguishing agent. Carbon dioxide extinguishes fire by reducing the oxygen content of the protected space and/or local flame front to a point where it will not support combustion.

A wave solder machine presents a unique system design. Essentially, two different types of protection methods are applied: total flood and local application. Both hazards are protected by a single system, however the quantity of agent required must be adjusted due to the local application requirements regarding vapor compensation and discharge time.

The first hazard is the wave solder machine, and is treated as a surface fire. It is protected by a local application / rate-by-volume design method. Wave solder machines are not completely enclosed due to the entry and exit ports, and front panels, which are commonly opened for internal access. When designing the system, a partial enclosure adjustment must be made to calculate the required system flow rate and minimum amount of carbon dioxide agent.

The second hazard consists of the exhaust duct and is protected by a total flooding design method. The materials in the exhaust are subject to deep-seated fire conditions, therefore a concentration of 65 percent by volume is implemented.

The discharge rate of the total flooding portion must be determined in accordance with the local application requirements. The discharge time requirement is thirty (30) seconds for a combined system design.

NOZZLE SELECTION

The Fike Vent nozzle is recommended in the ductwork. The "S" nozzle is used as local application protection in the machine area. Vent nozzles are primarily installed in ductwork and small enclosures, and provide a 120-degree, cone shaped discharge pattern. This narrow discharge pattern will provide adequate coverage in the ductwork. The recommended flow rate for a Vent nozzle is 60 lbs./min (27.2 kg/min.). The "S" nozzle will provide local application protection to the machine in the event the front panel is open. The recommended flow rate for a "S" nozzle is 75 lbs/min (27.2 kg/min.).

Placement of the CO₂ nozzle must not interfere with the operation or maintenance of the machine. Any obstruction that could interfere with the flow of CO₂ from the nozzle to the protected surface must be avoided to ensure proper system performance. Input from the wave solder machine owner or operator is important at the time of system design.

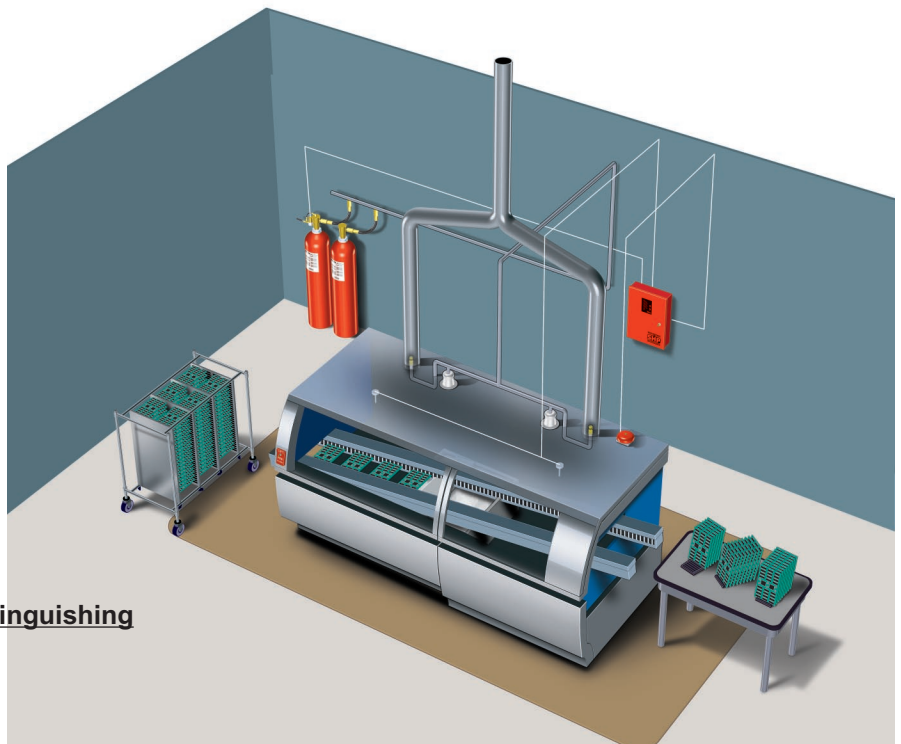
DETECTION AND CONTROLS

Automatic fire protection is implemented when protecting wave solder machines. It is recommended to install rate-anticipated heat detectors in the flux module and near the solder process to detect a fire and release the carbon dioxide system. The detectors must be carefully installed to not interfere with the operation, but must still serve their purpose.

In addition to the detectors releasing the carbon dioxide system, a manual release station should be conveniently located to remote and electrically activate the CO₂ discharge. Audible and visual devices are installed to warn nearby personnel of the CO₂ discharge.

For this application, Fike's Single Hazard Panel (SHP) is the best-suited releasing control panel. A pressure switch is also recommended to provide a positive pneumatic confirmation to the SHP that the CO₂ system has activated. The pressure switch provides the input to the SHP needed to shut down the wave solder process and confine the fire.

A Fike CO₂ System protecting a wave solder machine is provided in the adjacent illustration.



“Wave Solder Machine”
Protected by a Fike Carbon Dioxide Extinguishing
System

References:

- 1) GMM - Technical Report 18 (Fachbericht 18), Printed Circuit Board 97, (Leiterplatte 97)

Fike Corporation

In addition to Fike's CO₂ System, Fike has an extensive product offering for facility and process protection for commercial and industrial applications.

Rupture Disc – A pressure relief device, typically applied to a closed chemical process, will open at a predetermined pressure and temperature to prevent the bursting or explosion of the process.

Explosion Venting/Isolation/Suppression - Total Concept Explosion Protection, including explosion testing, explosion venting, explosion isolation, and explosion suppression systems to mitigate the effects of industrial explosions.

Fire Detection Systems – Fike offers a full line of detection products from single hazard to multi zone analog addressable systems. These controls are suited for fire alarm, agent suppression systems, or sprinkler/pre-action fire detection and control systems. The Cheetah analog addressable control panel can be configured to communicate directly with one or more VESDA LaserPLUS detectors via a High Level Interface (HLI).

Fire Suppression Systems – Fike offers a full range of suppression systems to protect your equipment and/or process. Because Fike offers more than one choice of extinguishing agents you are certain to get the right agent for your hazard. Fike systems incorporate the following agents:

- < HFC-227ea
- < Carbon Dioxide
- < Water Mist



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