Heller Industries	Project Title: Condenser Tube Air Flux System	
Project No: M-931100-1199-T001	Project Revision: B	Date: 19-Apr-2000

Function and Operational Theory of Condenser Tube Flux Collection System

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Heller's new Condenser Tube Flux Recovery System is designed to provide more efficient flux collection than earlier Heller flux collection systems; while providing minimal down time for inspection and cleaning. The entire system easily fits within the rear of the top shell of an 1800-EXL oven. The system utilizes a different set of top shell caps specially designed to provide the best serviceability of both the flux collection system and maintenance of the heater zone blower motors.

FLUX CONDENSER / COOLING MODULE

The operating principle of the new Condenser Tube Flux Collection System is a series of thin wall heat conductive condenser tubes over a series of collection sumps in the condenser base. The condenser tubes provide approximately 3780 in^2 (24387 cm^2) of primary cooling surface to condense hot flux vapors onto the tube walls. The tubes are positioned vertically in a "U" shape to allow condensed liquefied flux to drain into the collection sumps under the tubes (see Figure 1).

Cooling air from outside the oven cools the external surfaces of the condenser tubes. The flow direction of the cooling air is opposite the direction of the flux vapor flow to provide the most efficient cooling. The flux vapor exhaust volume is approximately 100 to 125 scfm (2.8 to 3.0 m^3/min) maximum, while the waste cooling air volume is approximately 200 to 225 scfm (5.6 to 6.2 m^3/min) maximum.

The extracted flux vapor enters the removable flux cooling modules at temperatures ranging from 160 °C to 200 °C. Within the cooling module the flux vapor is cooled to between 45 °C to 55 °C and condenses inside the cooling modules. Remaining diluted vapor is then ducted to an exhaust port at one end of the oven's top shell and is mixed with the clean waste cooling air which ranges from 55° to 65 °C.

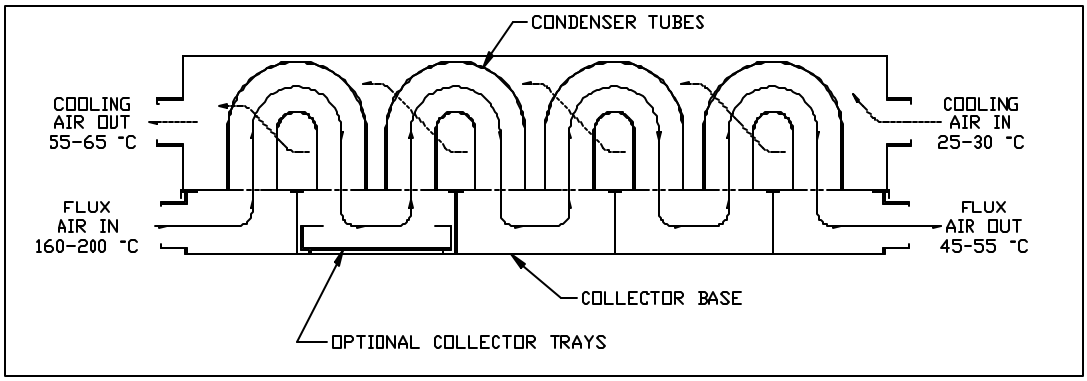

Figure 1: Condenser Cooling Tube Diagram

The volume of flux vapor flow is controlled through the flux extraction boxes by means of individual flow damper plates at each flux extraction box. The design intent is to minimize flux vapor flow while maintaining desired oven zone temperature, net flow through the entrance and

exit tunnels, and customer's desired product temperature profile. Obtaining the minimum total flux vapor flow out of the oven results in maximum residence time within the cooling module which in turn maximizes condensation efficiencies of the system.

The flux cooling modules are easily removed by lifting straight up and out of rear of the oven's top shell. The weight of each clean cooling module is 19.5 lbs (8.8 kg). Each cooling module is equipped with two handles on its top surface.

Each cooling module is secured to the collector base with a set of four screw-style clamps. The clamps require the use of a flat head screwdriver, to prevent operators from accidently opening the modules. Each cooling module is also equipped with a safety interlock switch. Since hot flux vapor enters the cooling modules at temperature ranging from 160 to 200 °C, these switches turn off the flow of flux out of the oven to prevent an operator or technician from contact with flux vapor. Removal of a cooling module while running product through the oven may result in flux vapors escaping out the end tunnels and may also affect zone temperatures within the oven.

SELF-CLEANING OF COOLING MODULES & COLLECTOR BASE

Over time, the inside surface of the cooling module tubes will collect a layer of flux film or crystals (snow flakes), decreasing cooling and condensation efficiencies. The time period for this may vary depending on the type of solder paste flux used, the weekly consumption rate of paste, and oven temperature profiles. Removal of this thick film or crystals in the condensation cooling tubes is performed automatically within the oven with or without any operator or technician intervention.

This automated self-cleaning process resides within the oven's software; not requiring any operator intervention. The initiation of the self-cleaning cycle is recorded in the process job's event file. The automated self-cleaning cycle timer is factory programmed to be initiated every 168 hours (weekly) to 672 hours (monthly) of oven operating time. The length of time between cleaning will depend on the average solder paste consumption rate. Most industry solder paste consumption rates range from 6.0 to 14.0 kg per week.

When the self-cleaning cycle is initiated, flux cooling air blowers B4, B5, and B6 (refer to Figures 5 thru 9) are turned "OFF." The flow of flux vapor continues to be pulled out of the oven through the flux collection system without disturbing the oven's internal temperature profile. The cooling blowers remain "OFF" for the duration of the cycle (20 to 40 minutes depending on oven configuration and zone temperatures). During this time the incoming hot vapor liquefies any thick flux film or crystals within the cooling tubes. The liquefied flux drains from the tubes into the bottom of the collection chambers. When the cycle time is completed, the cooling blowers are turned back "ON" automatically.

Figure 3 is illustrates a photo of a condenser tube after 30 days of flux accumulation and processing of 56.0 kg of solder paste. Figure 4 illustrates the same condenser tube after the self-cleaning cycle. Figure 2 illustrates the flow diagram of the self-cleaning process.

A technician or process engineer can choose to change either the duration or the time between self-clean cycles through the oven's operating system via a password protected command. The cycle can also be manually initiated from the oven's operating software tool bar

via a password protected command. When the cycle is manually initiated, the cycle still operates for the same time period as the fully automatic cycle. Also, a manually controlled "autoclean" recipe can be accessed from either a Calendar Start or Manual Load process. This recipe does not use the processor's automatic timing periods used for the fully automatic cycle; but, continues to operate as long as the "autoclean" recipe is controlling the oven. To discontinue the manually controlled "autoclean" recipe, another recipe must be loaded. Heller Engineering should be consulted to determine which clean process is most efficient for the customer's specific operating parameters.

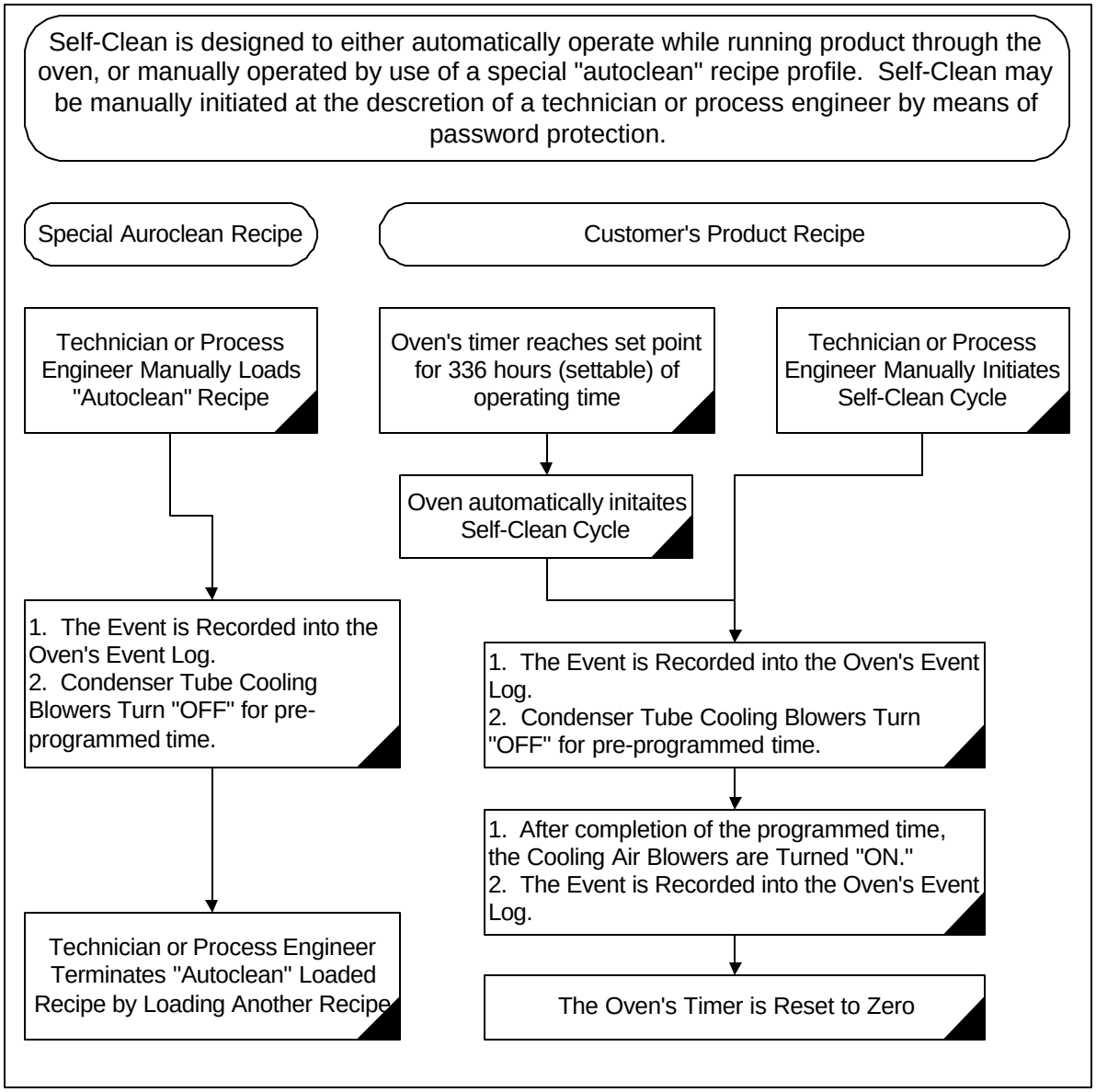

Figure 2: Self-Clean Cycle Control Flow Diagram.

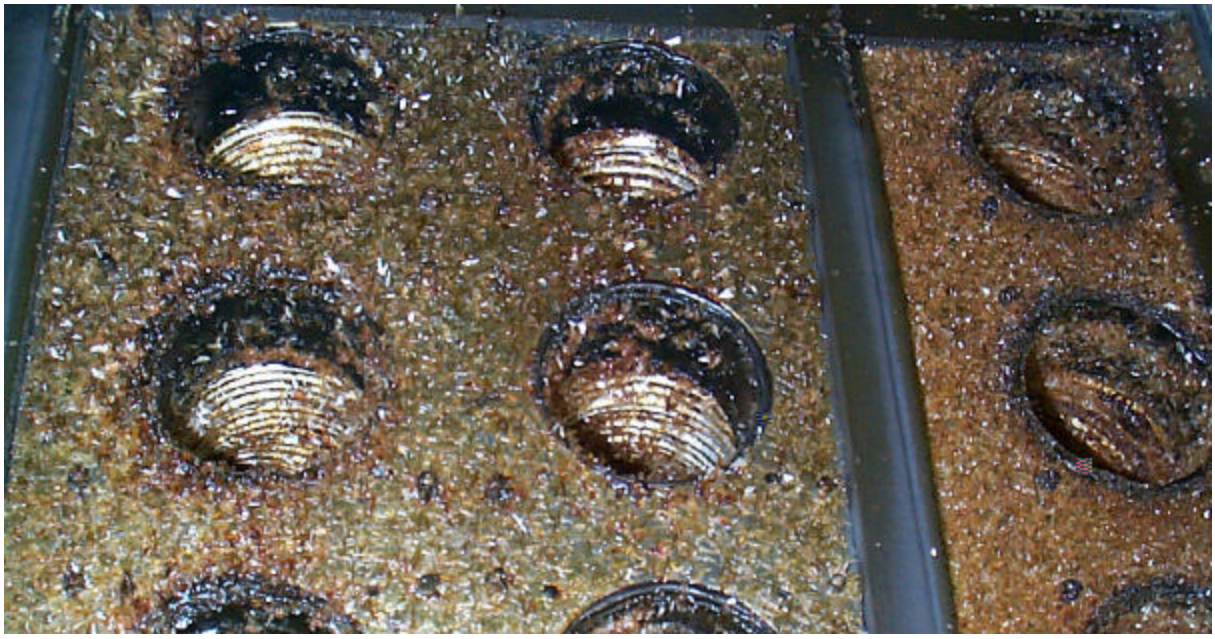

Figure 3: Flux accumulation within the condenser tubes after 30 days and processing of 56.0 kg of solder paste.

Figure 4: the same condenser tube after the self-cleaning cycle

FLUX COLLECTION TRAYS

Optional disposable flux collection trays can be supplied with the system. These trays are placed in each of the collector base chambers under the condensation tubes to minimize manual cleaning of the collection base under the cooling modules (see Figure 1). The trays are designed to capture liquid flux dripping out of the condensation tubes. The chambers of the collection base will still require periodic manual cleaning however, the trays will minimize the amount of chamber cleaning. Manual cleaning of flux from the collector base and replacement of the trays is recommended every one to six months depending on solder paste consumption rates.

THREE AVAILABLE FLUX COLLECTION SYSTEMS

Basic Air Oven Flux Collection System

The operating goal of the basic air oven flux collection system is to collect a significant amount of the flux; permitting a minimum amount of flux vapor from escaping into the customer's plant exhaust system. Remaining cooled and dilute flux vapor passing through the cooling modules is ducted directly into the customer's plant exhaust system. The remaining flux exhaust vapor is then mixed with the clean waste cooling air in a single exhaust. This system is typically configured with either one (1) or three (3) flux vapor extraction locations within the oven. See Figures 5 and 6. Total exhaust flow from the combined exhaust port is approximately 350 cfm maximum.

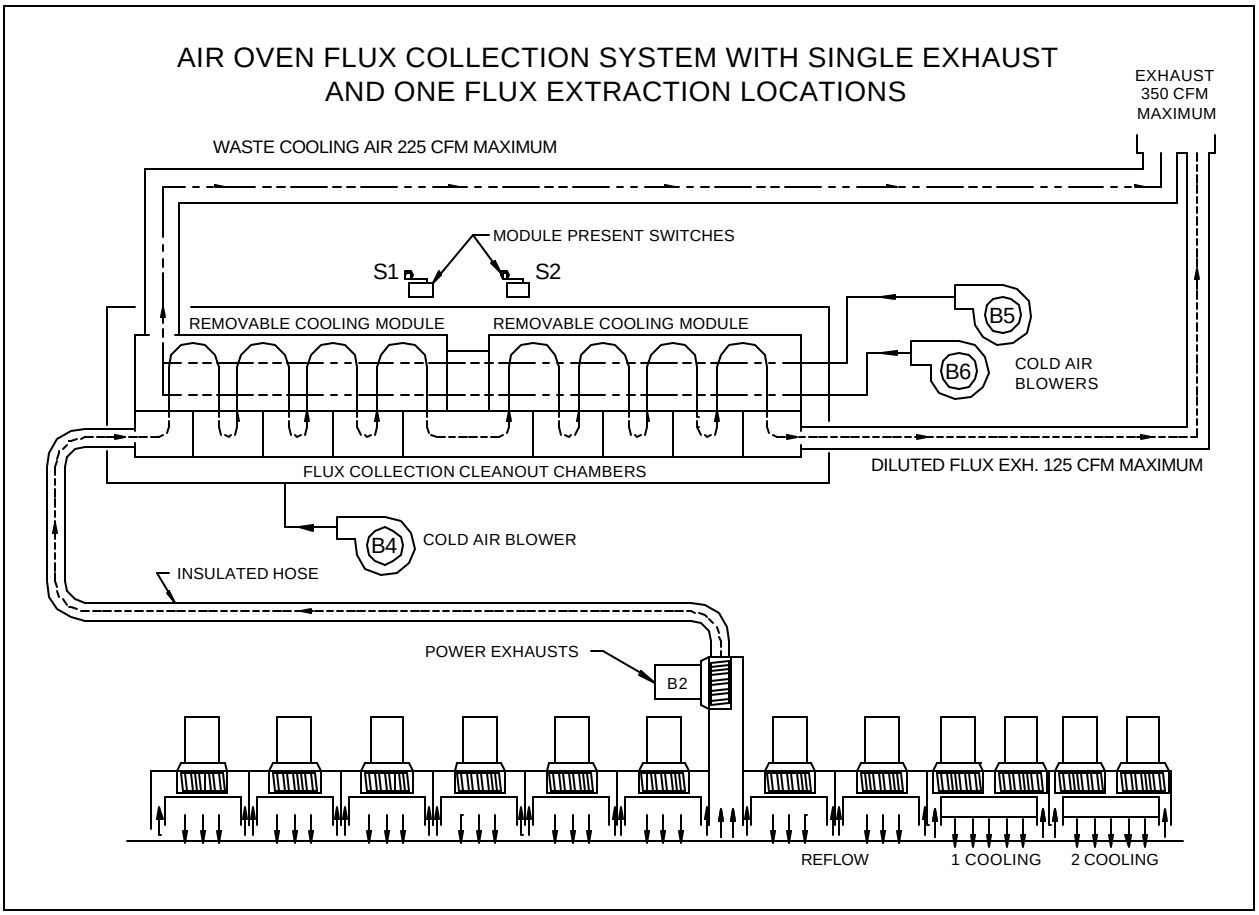

Figure 5: Basic Air Oven Flux Collection System with One Extraction Location.

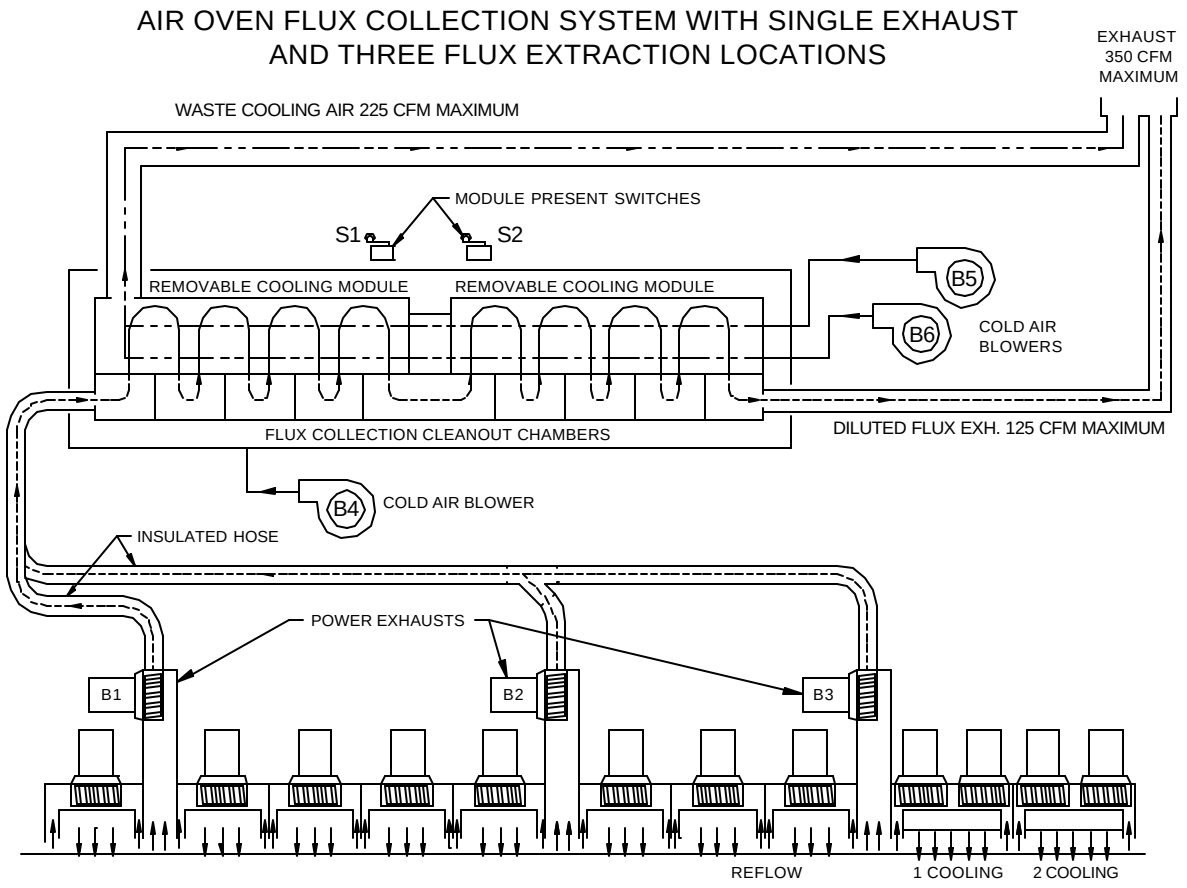

Figure 6: Basic Air Oven Flux Collection System with Three Extraction Locations.

Filtered Air Oven Flux Collection System

The operating goal of the filtered air oven collection system is to collect virtually 100 percent of the flux vapor extracted from the oven. Remaining cooled and diluted vapor passing through the cooling modules is ducted to a filter box which contains either a replaceable HEPA filter or and activated charcoal adsorption filter. The clean flux exhaust air is then mixed with the clean waste cooling air in a single exhaust. This system is typically configured with either one (1) or three (3) flux vapor extraction locations within the oven. See Figures 7 and 8. Total exhaust flow from the combined exhaust port is approximately 350 cfm maximum.

The filter box access cover is also equipped with a safety interlock switch, like the cooling modules, to prevent an operator or technician from having flux vapors blow into their face while inspecting or replacing filters.

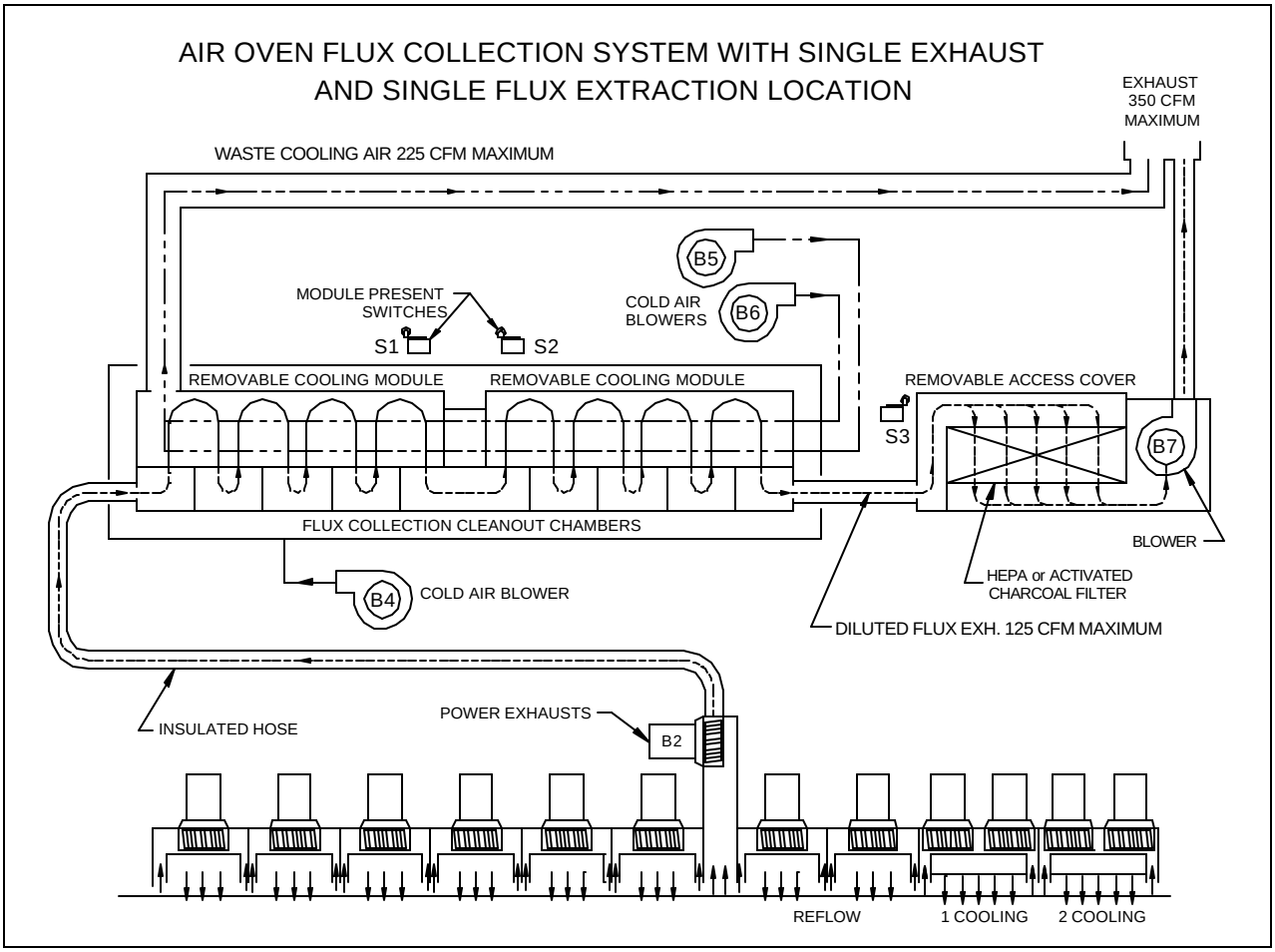

Figure 7: Filtered Air Flux Collection System with Single Extraction Location.

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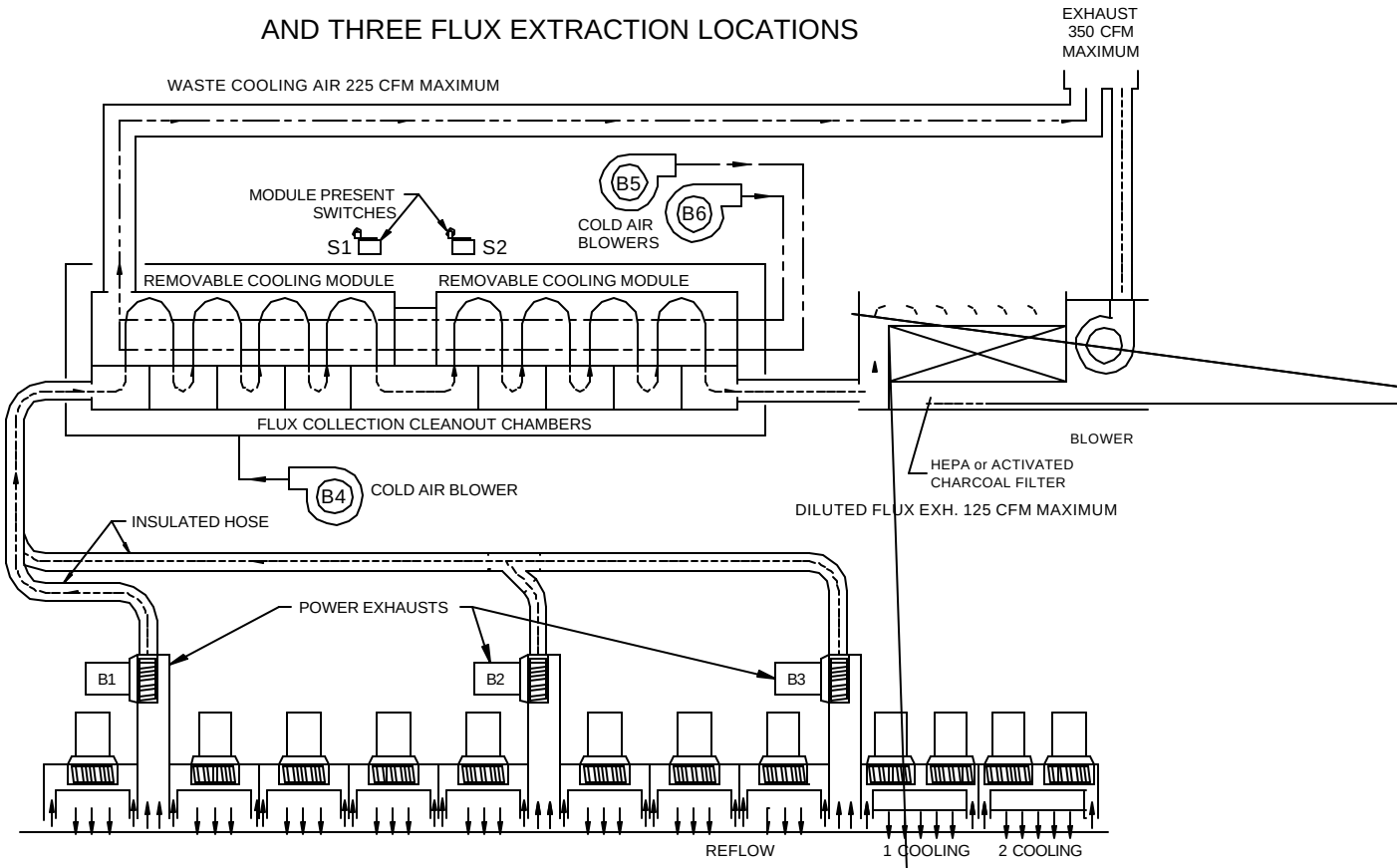
AND THREE FLUX EXTRACTION LOCATIONS



Nitrogen Oven Flux Collection System

The operating goal of the nitrogen oven collection system is to collect a significant amount of the flux; permitting a minimum amount of flux vapor from returning to the oven. Remaining cooled and diluted vapor passing through the cooling modules is ducted back into the oven through the first cooling zone. The cooling zone is equipped with internal heaters to prevent the occurrence of flux condensation within the cooling zone. The oven also includes standard external nitrogen exhaust hoods at each end of the oven to capture escaping nitrogen. This escaping nitrogen atmosphere may contain some flux vapor which will be ducted to the combined exhaust port. Total exhaust flow from this combined exhaust port is approximately 650 cfm maximum of nitrogen ladened waste air. See Figure 9.

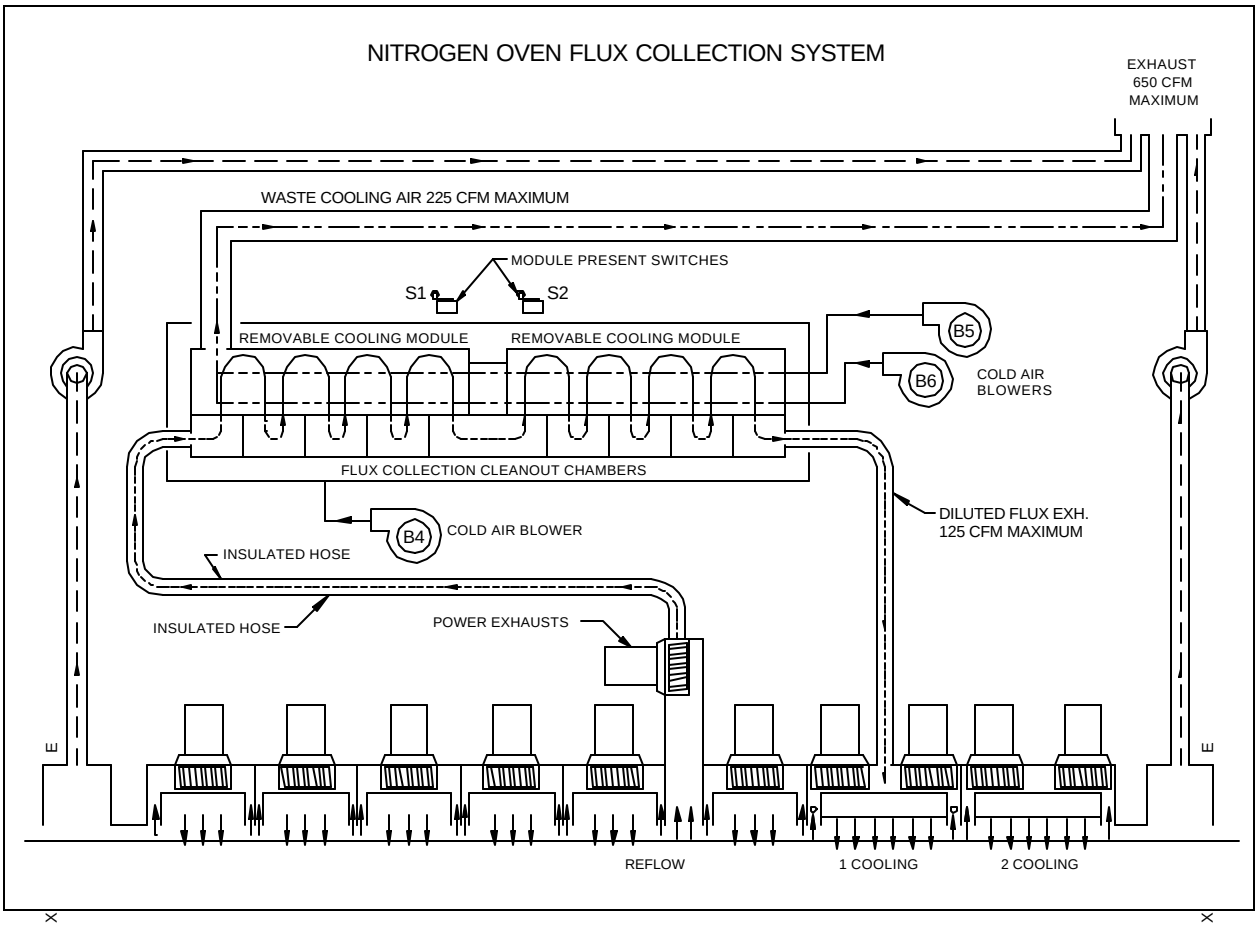


Figure 9: Nitrogen Oven Flux Collection System with Single Extraction Location