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Underwriters Laboratories Inc.®

16 March 1999

Danfoss Electronic Drives
Mr. Jerry Pilling
2995 Eastrock Drive
Rockford, Illinois 61109

Our reference: E134261 Vol Sec. 8,9; E70524 Vol. 2 Sec. 9; Project 98NK40134

Subject: Power Conversion Equipment for Installation in Air Handling Compartments

Dear Mr. Pilling,

We have completed our investigation and this letter will serve as our Report.

The purpose of this investigation was to determine whether any additional requirements are applicable to Listed power conversion equipment, namely the VLT 5000 and VLT 6000 AC Drives, when being installed inside of an air handling compartment. These drives are provided with a complete electrical enclosure, which includes a polymeric cover and is available in Types 1 and 12. The drives are intended to be permanently connected via conduit within the duct. These drives are provided with a display and keypad on the front of the device that may be used to program the drive and to determine fault codes and/or reset the drive after an abnormal condition. The following UL Standards were reviewed under this investigation: UL181, the Standard for Factory-Made Air Ducts and Air Connectors; UL181A, the Standard for Closure Systems for Use with Rigid Air Ducts and Air Connectors; UL1096, the Standard for Electric Central Air Heating Equipment; and UL1995, the Standard for Heating and Cooling Equipment.

UL181 contains construction and performance requirements for the actual duct but does not include any requirements for the inclusion of components to be mounted in the duct. UL181A pertains to adhesive-backed tapes used to seal joints of two pieces of duct. Therefore, the requirements to UL181 and UL181A are not appropriate for the type of installation described above.

UL1096 contains requirements for enclosing equipment within a duct (such as duct heaters) and also for protection of service personnel. Pertinent requirements are as follows:

Par. 5.5: openings in the enclosure of an externally mounted component shall be located so that they will not vent into concealed spaces in a wall, false ceiling, etc., when installed as intended.

Par. 6.1: uninsulated live parts shall be located, guarded or enclosed to reduce the risk of injury as the result of contact by service personnel.

Par. 7.1: materials in a compartment handling conditioned air for circulation through a duct system shall not have a flame spread rating over 25 nor a smoke developed rating over 50.
Exception: polymeric material where the total exposed surface area of such components in the compartment does not exceed 10 square feet (and complies with the enclosure 5 inch flame test).

The Models VLT 5000 and VLT 6000 AC Drives comply with the above requirements as it is totally enclosed within the duct and does not exhaust air into concealed spaces, all live parts are enclosed, and the polymeric cover complies with the 5 inch flame test and is less than 10 square feet in surface area.

While Article 300-22(b) of the NEC does not generally allow for the inclusion of any electrical equipment to be enclosed within ducts for environmental air unless necessary to directly act upon (heat, cool or movement) or sensing (temperature) of the contained air, the NEC handbook clarifies the intent of the requirement is to limit the use of polymeric materials that would contribute smoke or propagate fire into the duct system. The flame spread and smoke developed ratings mentioned in par. 7.1 of UL1096 are the same requirements applied in UL181 to the ducts themselves. Therefore, even though the installation of the drive within an environmental air duct conflicts with the wording of Article 300-22(b), we believe that the intent is being met by complying with par. 7.1 of UL1096.

UL1995 has requirements that are substantially similar to those of UL1096.

In addition, the original parameters considered during the Listing evaluation of the drives to UL508C are not changed as a result of the installation in a duct as the ambient temperature is lower, ventilation through the control compartment containing the printed circuit board is forced and, due to constant operation of the control, would prevent the formation of condensation on surfaces which is consistent with the pollution degree 2 definition from UL508C.

Regarding the environmental type rating of the drive enclosure in this application, Table 430-91 of the NEC allows for the use of a Type 12 enclosure under conditions where falling liquids or light splashing may occur, whereas the Type 1 enclosure is suitable as protection against falling dirt. The suitability of the enclosure environmental rating will need to be determined in the field either by your customer and/or the authority having jurisdiction over the installation of the equipment. We feel a Type 1 enclosure may be adequate as long as the duct air would not tend to create significant condensation on the inside of the duct that would drip down on the drive. This would assume that the room temperature surrounding the duct would be approximately the same temperature as the duct air. The decision to use Type 1 enclosures would be largely dependent on the

specific conditions where each drive is installed. For example, if the duct air is mixed with humid outside air, and/or the room containing the drive inside an uninsulated duct is air conditioned, these conditions may allow for significant condensation to occur on extremely hot and humid days to the point where an accumulation of water may be able to enter the enclosure and contact electrical parts. For installations where heavy condensation may be expected, the Type 12 enclosure would exclude any build-up of water from contacting the electrical parts of the drive.

Additionally, any installation instructions are to be revised to include field wiring methods per Article 300-22 of the National Electrical Code.

The following statements have been added to the above referenced Sections:

To Engineering Considerations: Devices covered by this report have also been found suitable for installation in air handling compartments.

2. To Test Records: No tests were considered to be necessary for the suitability of use in air handling compartments because:

   A. The total exposed surface area of polymeric components does not exceed 10 square feet.
   B. The polymeric covers comply with the 5-Inch Flame Test.
   C. Pollution Degree 2 environments are maintained to prevent the formation of condensation on surfaces by constant operation of the control circuit (even though ventilation is not fan forced).
   D. Results of the Breakdown of Components tests showed that no live or burning parts were discharged to the atmosphere.

This completes our work under the above referenced assignment. We are closing project 98NK40134 with this letter and instructing our Accounting Department to bill you for the charges incurred.

Should you have any questions or comments concerning the above, please feel free to contact me.

Sincerely,

Nick Boten

Nick Boten (ext. 43279)
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Engineering Services, 418A

Reviewed by:

Tim Lueck

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