UNITARY ELECTRIC HEATERS: SAFETY CRISIS

INTRODUCTION

Currently, there are millions of unsuspecting residential and commercial building owners and occupants needlessly exposed to very real risks of fires created by electric heaters that do not incorporate *non-self-resetting thermal cutoffs* (aka: manual or replaceable backup protective devices, backups, fuselinks, hereinafter referenced as "thermal cutoffs"). For the last 5 years (plus), many unitary or central electric heaters distributed in the United States do not incorporate any thermal cutoffs to safely shut down the heaters when the automatically resetting temperature limiting controls predictably fail. Electric heaters that omit thermal cutoffs are defective and unreasonably dangerous, in direct violation of sound engineering principles and the applicable minimum safety standards. Notwithstanding, these defective heaters continue to be manufactured, falsely certified and sold, exposing millions of unwitting consumers and the public to substantial risks of death, grievous injuries and property damage from overheat fires that can and should be avoided.

ELECTRIC HEATERS

The electric unitary heater is incorporated into and operated as an integral part of residential and commercial **electric central "air conditioner"** equipment. The heaters are OEM and aftermarket accessories that are typically field installed in HVAC equipment prior to or at the time of purchase. Millions of these heaters are sold each year and over 30 million are currently installed in U.S. homes and businesses.

Electric unitary heaters primarily consist of heating elements (wire coil) that are mounted inside the air handler. The heating elements are positioned in the supply airflow to warm the air as it is forced by the heating elements. Without proper airflow, heating elements will typically reach temperatures in excess of 2000°F.

All heaters incorporate **automatically-resetting (self-resetting) temperature limiting controls,** which cycle to open and close electric contactors to de-energize the heating elements to maintain acceptable temperatures in the supply-air.[1] These automatically resetting controls *are <u>not</u> safety devices*: they are simply unreliable because the contacts automatically open and close without indication or warning until it fails in the closed position ("sticks" or "welds").[2] When the automatically resetting controls fail temperatures will continue to increase if there is no safety device to de-energize the heating elements before hazardous temperatures are reached.[3]

[1] See UL 1995.30.11, 4th Edition, attached as Exh.1.
[2] See Exh's 2-1 to 2-3, attached.
[3] See Exh 3, attached.

NON-SELF-RESETTING THERMAL CUTOFFS:

The ***non-self-resetting thermal cutoff*** is a safety device that is feasible and reliable that would prevent the risk of overheat fires. Simple logic and sound engineering principles recognize the NECESSITY of thermal cutoffs,[4] and all applicable safety standards specifically REQUIRE that all heaters incorporate thermal cutoffs to de-energize the heating elements before hazardous temperatures are reached when the automatically resetting temperature-limiting controls fail in the permanently closed position.[5]

UL1995.30.16 (4th Edition)

> Except as specified in Clause 30.18, a unit employing electric heaters *shall be provided with one or more manually resettable or replaceable backup protective devices* of the type specified in Clause 30.17 *that will, with the contacts of the automatically resetting temperature-limiting control permanently closed, limit the temperatures* to comply with the requirements specified in the Backup protection tests- Clause 48.

THE MISINTERPRETED EXCEPTION

In the 4th edition of UL1995 (and earlier versions), there was a narrow exception to the requirement that all electric heaters be provided with thermal cutoffs:

> "30.18 The requirement specified in Clause 30.16 does not apply if no part of the automatically resetting temperature-limiting control circuit cycles under intended operating conditions…."

This narrow exception permits the omission of thermal cutoffs in a heater that is simply not capable of producing hazardous internal temperatures even when the airflow is completely blocked (as tested in chapter 47 of UL1995 – "abnormal conditions"). Most if not all UL1995 heaters will reach 2000 degrees or more in restricted airflow and absolutely require thermal cutoffs ("backup protection devices") to be reasonably safe for the intended use.

The argument presented by certain manufacturers and certification companies to defend the omission of the critical thermal cutoffs from electric heaters was that "intended operating conditions" only referred to ideal conditions with full, unrestricted airflow (as tested in chapter 46 of UL1995).[6] Because UL1995 specifically requires that the automatically resetting temperature-limiting control <u>*not cycle*</u> during ideal conditions testing, this interpretation would exclude every electric heater from the critical requirement to incorporate thermal cutoffs.

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[4] See Independent Expert and Investigators Reports, attached as Exh's 4-1 and 4-2.
[5] See UL 1995.30.16, 4th Edition, attached as Exh. 5.
[6] See Exh's 6-1 and 6-2, attached.

Underwriters Laboratories unequivocally confirmed that "intended operating conditions" specifically includes "abnormal operating conditions":

> "where the standard covers the intended use, it addresses both the "normal" and "abnormal" operating conditions of that use….UL 1995 requires electric heaters to comply with Sections 46 and 47, which cover operating conditions for electric heaters. Among these requirements are tests for restricted air inlet, restricted air outlets and fan failure, in both ducted and free air discharge units which supply electric heat."[7]

As conceded, the plain reading and application of the exception to the critical requirement in UL1995.30.16 is limited to heaters that are incapable of producing hazardous temperatures, even under low airflow and no airflow conditions. Accordingly, because all unitary electric heaters sold today are capable of producing hazardous temperatures, every electric heater must provide thermal cutoffs to prevent overheat fire risks.

THERMAL CUTOFFS ELIMINATE SAFETY CONCERNS

Emerson Electric (Therm-O-Disc) is the major producer of control switches commonly used as the automatically resetting temperature-limiting controls in electric unitary heaters. As seen in exhibit 2-1, above, with regard to its automatically resetting switches clearly warns:

> **If failure of the control to operate could result in personal injury or property damage, the user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup controls have been incorporated in a number of applications for this reason.**

Recently, Emerson advised the industry that a significant number of their automatically resetting controls were defective and would fail to operate when ambient temperatures increased. This unfortunate circumstance was a concern because these particular defective controls would fail to shut down the heaters on their very first cycle, unlike non-defective controls that also fail, but intermittently during their life cycle. In addressing the safety concerns of their customers during this crisis, Emerson Electric specifically and unequivocally confirmed:

> **there is no safety issue if there is reliable backup safety protection incorporated in the appliance.** [8]

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[7] See Exh's 7-1 and 7-2, attached.

[8] See Exh 8, attached.

FIRE DANGERS:

The National Fire Protection Association (NFPA) confirms in its 2012 Report, ***Home Fires Involving Heating Equipment***, that hundreds and likely thousands of homes have been damaged, each year, by fires caused HVAC equipment-mounted electric heaters that did not incorporate thermal cutoffs.[9] The NFPA report is based upon epidemiological studies conducted of fires in residential structures requiring emergency response during the previous four years, and is consistent with its findings for similar studies reported each year for over a decade. As long as electric heaters that do not incorporate thermal cutoffs continue to be sold and installed, families occupying residential structures will continue to be substantially exposed to needless fire dangers.[10]

[9] See Exh 9, attached.

[10] Notably, the NFPA estimate regarding residential structures is likely to be substantially underreported considering the specialized knowledge needed to ascertain the specific cause of HVAC fires reported. Although fire investigators often narrow the cause of fire to factors that reduce airflow, and at times recognize the failure of the automatically resetting controls, they typically do not have the knowledge or incentive necessary to identify the specific cause – the omission of thermal cutoffs from the electric heater.

30.4 Coiled wire heating elements may be supported on porcelain, hook type insulators depending upon the stiffness of the coil, the spacing between hooks, and the shape of the hook, etc. Porcelain insulators of all types will normally be required to be retained in place by means other than the heating element.

30.5 Heating elements shall be securely fastened to terminals (under the heads of terminal binding screws) in such a manner that the wire is not be likely to become loosened during the lifetime of the heater.

30.6 If an auxiliary control device, such as a thermostat, or a combination thermostat and control switch in a product with electric heat or remote control assembly, has a marked ON or OFF position, or is marked with another wording or symbol, such as "NO HEAT, COLD, O," or similar wording, that conveys the same meaning as "OFF", it shall disconnect the element or elements and controls from all ungrounded conductors of the supply circuit when placed in that position. This requirement applies to a thermostat in a remote control assembly that is referred to on the product nameplate, but does not apply to a remote auxiliary control device in a Class 2 circuit such as a room thermostat.

30.7 An auxiliary control is considered to be one that is intended primarily for regulating time, temperature, etc, under conditions of intended operation, but is not intended for protection against overload or excessive temperature conditions, etc.

30.8 Electric heaters employing resistance-type heating elements intended for comfort heating shall be protected at not more than 60 A, and the protected circuit shall not have a concurrent load exceeding 48 A. These heating elements shall be connected in protected subdivided circuits if any total concurrent load of the unit exceeds 48 A based on nameplate ratings. If the overcurrent protective devices are in a separate assembly for independent mounting, as described in Clause 30.9, the rating of the overcurrent protective devices also shall not exceed 1.5 times the current rating of the connected load, if such rating is more than 16.7 A.

Exception: If a heater assembly is provided with means for field connection to a power supply for only the resistance-type elements, with or without their control circuit, in a wiring enclosure having a separate cover and physically separated from the power supply for other loads, the rating of the other loads need not be considered in applying this requirement.

30.9 The overcurrent protective devices for subdivided circuits, as required by Clause 30.8, may be provided by the product manufacturer as a separate assembly for independent mounting.

30.10 The overcurrent protection specified in Clauses 30.8 and 30.9 shall be circuit breakers, cartridge fuses, or type S plug fuses, of a type and rating appropriate for branch circuit protection, in accordance with the requirements of CSA C22.1 and ANSI/NFPA No. 70.

30.11 An electric heater shall be equipped with one or more automatically resetting temperature-limiting controls that will disconnect the heating element or elements from the supply circuit to prevent temperatures from exceeding the limits specified in Table 39.5. These temperature-limiting controls shall be factory-installed as an integral part of the heater.

30.12 The temperature-limiting controls shall comply with the applicable requirements of CSA C22.2 No. 24 and UL 353.

Exhibit 2-1

Product Numbering System

60T ___ ___ ___

G – Gold contacts for low electrical loads	**0** – Flangeless airstream mount (.38" depth)	**1** – Normally closed contacts; contacts open on temperature rise
None – 1/8" x 1/4" electrical spacings	**1** – Flanged airstream mount (.38" depth)	**2** – Normally open contacts; contacts close on temperature rise
X – 1/4" x 3/8" electrical spacings	**2** – Surface mount	**3** – Single pole, double throw (SPDT)
XX – 3/8" x 1/2" electrical spacings	**3** – Tube or stud mount	**5** – Manual reset (trip free "M2")
	8 – Flanged airstream mount (.78" depth)	

Example: *60TG11=60T control with gold contacts, airstream mounting bracket and normally closed contacts that open on temperature rise.*

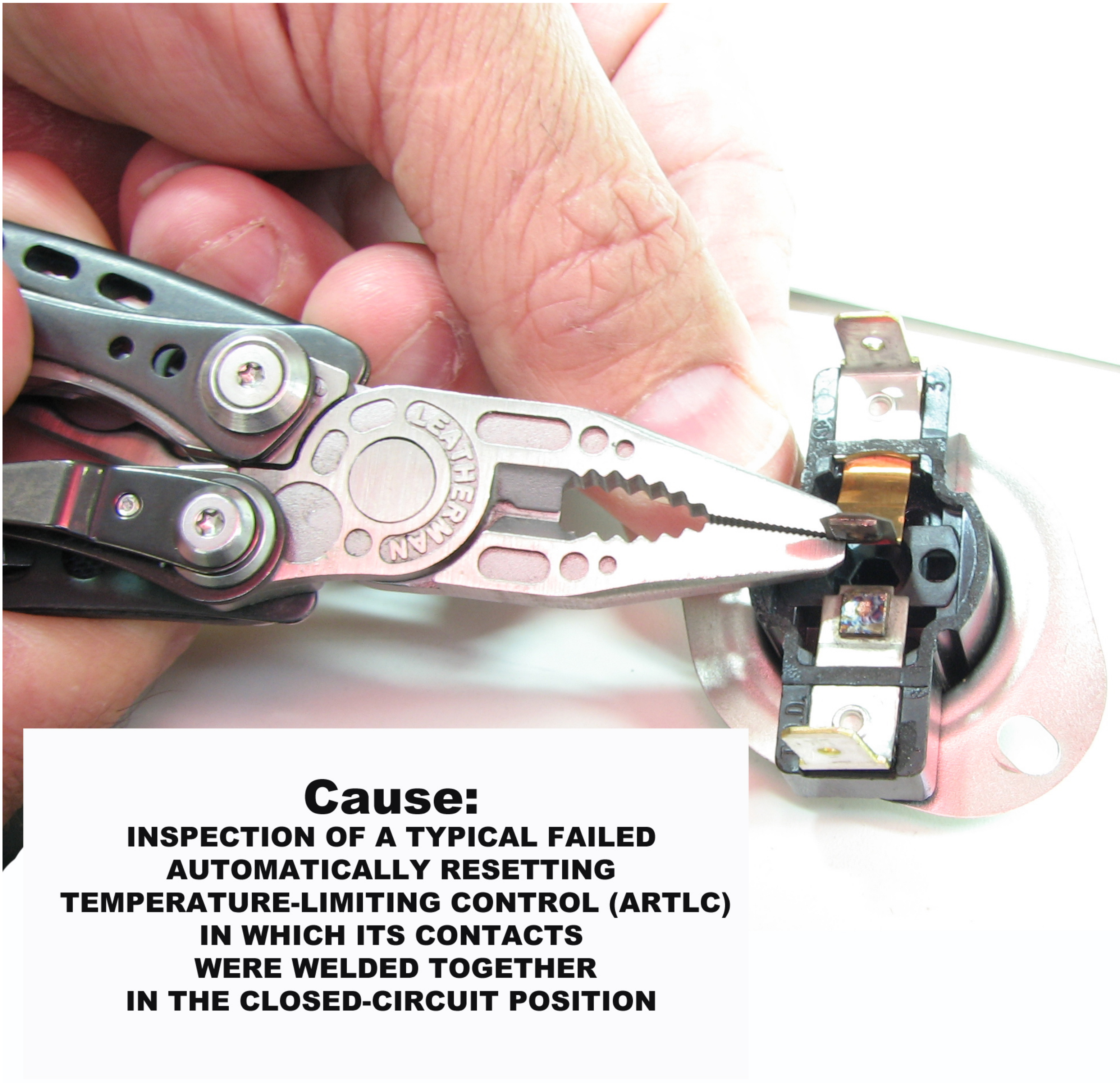
Important Notice

Users must determine the suitability of the control for their application, including the level of reliability required, and are solely responsible for the function of the end-use product.

These controls contain exposed electrical components and are not intended to withstand exposure to water or other environmental contaminants which can compromise insulating components. Such exposure may result in insulation breakdown and accompanying localized electrical heating.

A control may remain permanently closed or open as a result of exposure to excessive mechanical, electrical, thermal or environmental conditions or at normal end-of-life. If failure of the control to operate could result in personal injury or property damage, the user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup controls have been incorporated in a number of applications for this reason.

Exhibit 2-2



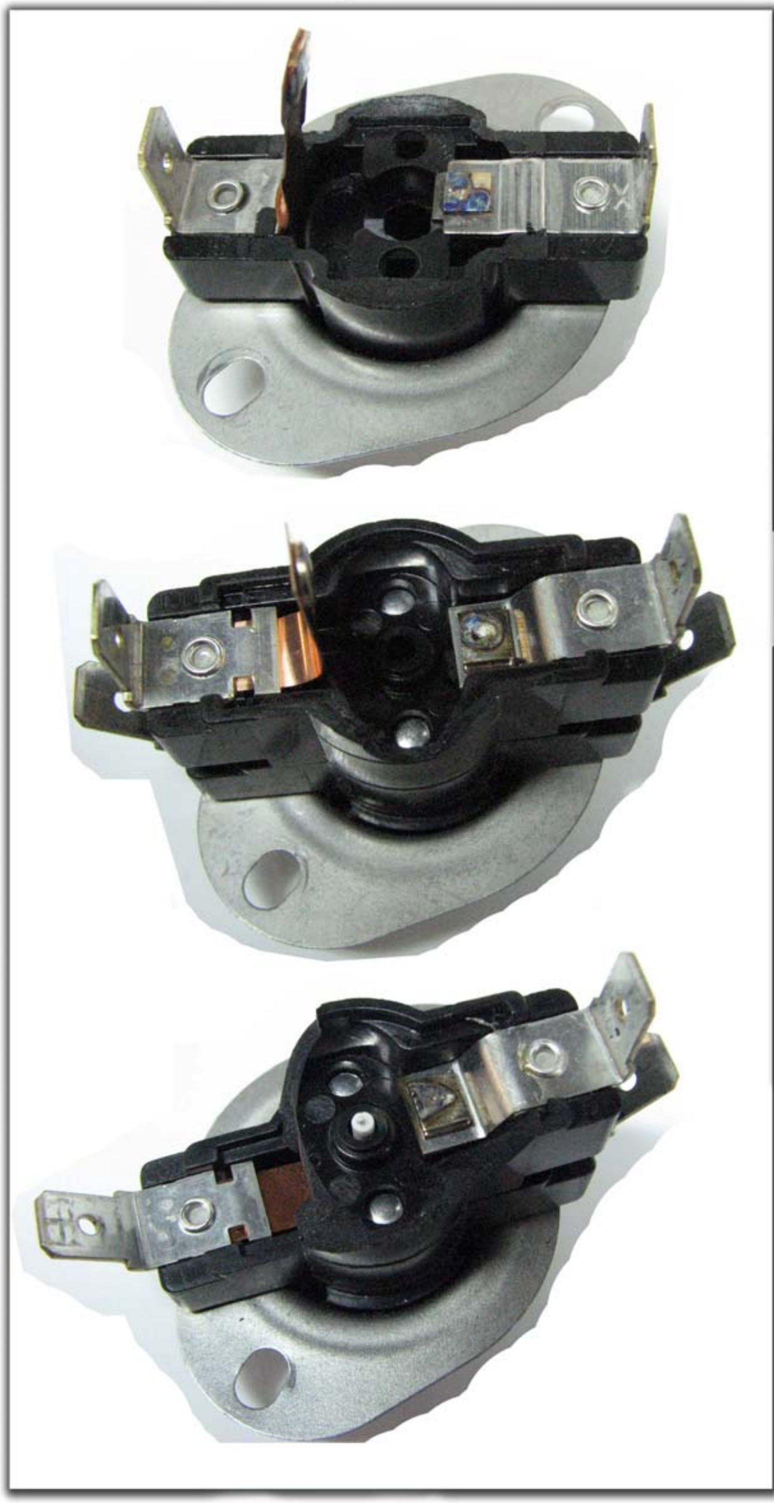
Cause:

INSPECTION OF A TYPICAL FAILED AUTOMATICALLY RESETTING TEMPERATURE-LIMITING CONTROL (ARTLC) IN WHICH ITS CONTACTS WERE WELDED TOGETHER IN THE CLOSED-CIRCUIT POSITION

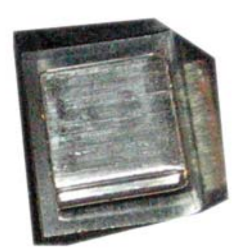
Exhibit 2-3

CYCLED

GOOD



CLOSE UP



CLOSE UP

Rooftop equipment – horizontally-mounted, downflow or horizontal flow equipment, or similar equipment intended to be installed on rooftops; and equipped with means for attaching pipes or ducts for the distribution of the conditioned air.

Secondary loop – a piping circuit containing a fluid circulating within the circuit. The fluid transfers heat from a remote-type refrigerator to a colder heat exchanger located within the circuit. The circuit normally includes a circulating pump as well as other associated fittings. Such a circuit is considered to be equivalent to the low-side parts that are located in a refrigeration system.

Self-contained unit – a complete factory-made and factory-tested unit, in a suitable frame or enclosure, that is fabricated and shipped in one or more sections, and has no refrigerant-containing parts connected in the field other than by companion or block valves.

Start-to-discharge pressure – The pressure at which a relief valve begins to discharge, typically the pressure where the first bubbles can be seen when a valve is immersed in water.

Structural part – a part other than an enclosure or cabinet used in such a manner that failure of the part may present risk of electric shock or personal injury (for example, motor mount, etc).

Temperature-limiting thermostat – a thermostat that functions only under conditions that produce abnormal temperatures. The failure of such a thermostat might result in a hazard.

Temperature-regulating thermostat – a thermostat that functions only to regulate the temperature under normal conditions of use, the failure of which would not result in a hazard.

Ultimate strength – the highest stress level that the refrigeration component or vessel can tolerate without rupture.

Unitary heat pump (or equipment) – a device for circulating, filtering, heating, or heating and cooling the air, that consists of one or more factory-made matched assemblies, which normally include an indoor coil, compressor(s), and an outdoor coil or chiller/condenser, and an electric resistance heater package with controls for automatic heating or cooling functions.

Upflow unit – a forced-air unit intended for installation in a vertical position; and with the heater casing located above the air-circulating blower compartment.

3 Reference publications

3.1 Where reference is made to any Standards (see Clauses 81 and 82) such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified. Also, except as indicated in Clause 3.2, a component of a product covered by this Standard shall comply with all the requirements for that component.

3.2 A component need not comply with a specific requirement that

a) involves a feature or characteristic not needed in the application of the component in the product covered by this Standard; or

b) is superseded by a requirement in this Standard.

Exhibit 4-1

NORMAN A. COPE & ASSOCIATES, INC.

FORENSIC ENGINEERING – RESEARCH & TESTING – CONSULTING ENGINEERING

June 16, 2014

Ed Trout
Warren Technology

Dear Mr. Trout:

Norman A. Cope & Associates, Inc., is a consulting engineering firm which has been in business for 30+ years and investigates the cause of failure of household appliances, HVAC equipment, vehicles, and so forth. As part of the various types of inspections performed by this engineering firm, we investigate the cause of fires in and around HVAC equipment such as electric furnaces, heat pump systems, and gas furnaces. Of the numerous inspections of electric furnaces, we have found that fire and smoke damage to multiple homes has occurred due to the resistance heating coil becoming energized without the blower motor operating and the heat kit not being equipped with thermal fuses or other fail safe devices in the 240-volt power circuits to the heaters. This failure scenario typically occurs from the failure of the blower motor, failure of a control relay, or the failure of the heating coils themselves.

In our failure analysis of HVAC equipment over the lifetime of this company, we have seen this failure mode numerous times. We are currently reviewing records for the past 10-15 years to find cases with this type of failure mode. Below are several summaries of cases where we found this failure mode.

Example 1

1) System Description:
   a) 7 year old unitary heat pump system
2) Background Information:
   a) The tenant was at home and heard a loud noise and then noticed minor smoke through the vents. The circuit breaker to the unit was tripped. The failure of the heat kit had caused heat damage to the adjacent wooden members and smoke inside the house.
   b) The unit was obtained from the tenant property and inspected at the laboratory.
3) Heat Kit Design:
   a) 2 heating coils with an auto-resetting thermal limit in the high voltage circuit to each coil.
   b) No thermal fuses.

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nacaa@normancope.com

   c) No auto-resetting thermal limit in the low voltage control circuit.
4) Cause of failure:
   a) Heating elements became energized without air flow.
   b) The loss of air flow was due to failure of the blower motor or a sticking relay.
   c) The exact failure was not determined due to the extent of damage to the unit. In either case, the heating elements would have been able to become energized without air flow due to the lack of a failsafe device in the high voltage circuit to the heat elements.

<u>Example 2</u>

1) System Description:
   a) 5 year old unitary heat pump system
2) Background Information
   a) The inspection found that a fire had occurred over the location of the outlet duct for the heat pump system. There was no other cause of the fire found at the origin area.
3) Heat Kit Design:
   a) 2 heating coils with no auto-resetting thermal limit in the high voltage circuit to each coil.
   b) No thermal fuses in the high voltage circuit to heat coils.
   c) An auto-resetting thermal limit in the low voltage control circuit.
4) Cause of failure:
   a) A control relay failure allowed one bank of the heating elements to become energized without the indoor blower operating.
   b) The lack of a failsafe device in the high voltage circuit to the heat elements, such as a thermal fuse, allowed the heating elements to remain on and eventually ignite the adjacent wood framing and siding.

<u>Example 3</u>

1) System Description:
   a) 3 year old unitary heat pump system
2) Background Information:
   a) The refrigerant evaporator coil had been replaced by a local HVAC contractor prior to the fire inside the heat pump system.
   b) There was minor heat damage to the vinyl siding and surrounding structure.

   c) Smoke entered house through vents.
   d) The majority of the heat damage was inside the heat pump system.
3) Heat Kit Design:
   a) 2 heating coils with a stacked auto-resetting thermal limit in the high voltage circuit to the coils.
   b) No thermal fuses in high voltage circuit to heat coils.
   c) No auto-resetting thermal limit in the low voltage control circuit.
4) Cause of failure:
   a) The variable speed fan motor failed.
   b) The heating elements were able to operate without airflow due to the lack of a failsafe device in the high voltage circuit to the heating coils.

Example 4

1) System Description:
   a) 6 year air-handling unit with auxiliary resistance heaters for a split heat pump system that was mounted in the attic
2) Background Information:
   a) The air-handling unit had been repaired by a local HVAC company.
   b) Later, a fire originated at the outlet end of the air-handling unit which caused extensive fire damage to the house.
3) Heat Kit Design:
   a) 2 heating coils with no auto-resetting thermal limit in the high voltage circuit to each coil.
   b) No thermal fuses in the high voltage circuit to the heat coils.
   c) An auto-resetting thermal limit in the low voltage control circuit.
4) Cause of failure:
   a) The improper wiring of the blower relay allowed the heating elements to become energized without air flow when the heat pump was operating in the cooling mode.
   b) The lack of a failsafe device in the high voltage circuit to the heat elements, such as a thermal fuse, allowed the heating elements to remain on, burn through the fiberboard duct, and eventually ignite the adjacent roof framing and siding.

The use of a high temperature failsafe device would also prevent fires in and around gas furnaces. The following example is a gas furnace that remained operating without air flow and ignited the condensate pan of the evaporator coil.

Example 5

1) System Description:
   a) 9 year old 80% gas furnace that was mounted in the attic
2) Background Information:
   a) The unit was being serviced by a local HVAC contractor.
   b) The homeowner noticed black smoke from the vents inside the house.
3) Cause of failure:
   a) The control relay on the main control circuit board failed and allowed the gas valve to remain on and gas burning with little or no air flow due to a mechanically failing fan.
   b) The only thermal limit was connected directly to the main control circuit board.
   c) The fire inside the gas furnace could have been prevented if a high temperature failsafe device would have been installed in the wires to the gas valve solenoid.

In all the above examples, the heat and/or fire damage could have been prevented with the use of a high temperature thermal failsafe device.

Respectfully,

Christopher A. Cope, PE,
Consulting Engineer
Norman A. Cope & Associates, Inc.

Exhibit 4-2

Exponent®

Engineering Analysis of Thermal Protection Methods for Electric Heaters Prescribed by UL 1995

Engineering Analysis of Thermal Protection Methods for Electric Heaters Prescribed by UL 1995

Prepared for:

Warren Technology
2050 W 73rd Street
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Prepared by:

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Exponent
149 Commonwealth Drive
Menlo Park, CA 94025

April 14, 2014

Contents

Conclusions

The following conclusions are based on the materials received, analysis conducted, experience of the author and research performed. These conclusions address the safe design of the controls of electric heaters covered by UL 1995. Should additional information be reviewed, or should additional analysis provide further insight, I reserve the right to amend this report.

1. All heater elements (which if unregulated have the potential to cause fire under foreseeable conditions of intended use) must have independent manually replaceable (or resettable) safety protection to interrupt power in the event of a hazardous overheat condition. This requirement would eliminate or substantially reduce the severe risk of fire posed by designs which do not incorporate independent manually replaceable (or resettable) safety protection. Bases include:

    a. Electric heaters that do not incorporate backup protection to cut off power in the event of hazardous overheat conditions expose persons and property to severe dangers from fire.

        i. Heaters typically within the scope of UL 1995 will produce a hazardous overheat condition if powered and unprotected.

        ii. Foreseeable and common use conditions (like improper ductwork, dirty filters, etc.) reduce airflow and increase temperatures. During these high temperature conditions the heater's integral automatically resetting temperature-limiting controls cycle the heater elements off and on to maintain acceptable temperatures during heater operation.

        iii. The automatically resetting temperature-limiting controls cycle without symptoms or notice to the user of the high-temperature conditions that exist (whether due to reduced airflow or other causes), and does nothing to correct the operating conditions. Without the user knowing, a heater could be operating in a potentially unsafe mode for an extended period of time, which can escalate into a dangerous situation.

        iv. Automatically resetting temperature-limiting controls that disconnect power to the heater elements and allow ongoing heater operation can ultimately fail closed and result in an uncontrolled overheat event (described in 30.16).

        v. Automatically resetting temperature-limiting controls that operate contactors or relays that disconnect power to the heaters can also have the contactors or relays fail closed, resulting in an uncontrolled overheat event.

        vi. The automatically resetting temperature-limiting controls do not provide effective safety protection and violate one control manufacturer's application notes.

vii. Use of a control in violation the manufacturer's application notes disqualifies the product from safety listing.[1]

b. Non-resetting controls or replaceable thermal fuse links can be feasibly incorporated in the heater design to effectively and reliably cut off power to the heater elements before a hazardous overheat condition is reached when the automatically resetting temperature-limiting control fails.

c. The requirement for backup protection devices is well supported by sound engineering principles, applicable UL safety standards[2] and the International Electrotechnical Commission (IEC).[3]

2. UL 1995.30.16 requires all heaters to incorporate manually resettable or replaceable backup protective devices unless excepted by 30.18. Bases include:

a. Section 30.11 requires all heaters be equipped with automatically resetting temperature-limiting controls that will disconnect power to the heating elements to prevent temperatures from exceeding the limits specified for heater operation in Table 39.5.

b. Section 30.16 recognizes that the automatically resetting temperature limiting controls can fail in the closed position.

c. The requirement for backup protection devices is well supported by sound engineering principles and applicable UL safety standards.[4]

3. The exception of 30.18 allows the backup protection to be omitted only for those heaters that are not capable of producing enough heat to cause the automatically resetting temperature limiting controls to cycle under "intended operating conditions." The only correct interpretation for this term is that backup protection is required if cycling of the automatically resetting temperature-limiting controls occur during conditions of foreseeable field use including reduced airflow (See 30.18 reference to 30.14). Bases include:

a. The term "intended operating conditions" is not a specifically defined term in the standard. If this term is interpreted to mean ideal operating conditions, then the testing in sections 46.2 and 46.8 would determine whether backup safety protection

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[1] http://www.thermodisc.com/en-US/Products/Bimetal/Documents/Bimetal%20Disc%20Control%20and%20Limit%20Application%20Notes.pdf "A control may remain permanently closed or open as a result of exposure to excessive mechanical, electrical, thermal or environmental conditions or at normal end-of-life. If failure of the control to operate could result in personal injury or property damage, the user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup controls have been incorporated in a number of applications for this reason."

[2] UL 1996 addressing duct heaters, requires backup protection for heater elements.

[3] IEC 60335-2-40 requires appliances with supplementary heaters to be provided with at least two thermal cut-outs. The first is required to be a self-resetting thermal cut-out and the second is required to be an independent, non-self-resetting thermal cut-out (i.e. a manually replaceable or resettable safety protection device)

[4] UL 1996 addressing duct heaters, requires backup protection for heater elements and UL 60335-2-40 addressing appliances with supplementary heaters, also requires backup protection.

is required. However, sections 46.2 and 46.8 specifically require that cycling of temperature-limiting controls not occur. According to this interpretation, no heaters would ever require backup protection which is in conflict with section 30.16, section 48 and sound engineering principles.

b. The term “intended operating conditions” must be interpreted to mean conditions of foreseeable use (such as are described in the testing of section 47 including reduced airflow) to satisfy sound engineering principles and applicable UL safety standards.

c. The exception addressed in 30.18 is not a safety requirement.

In summary, backup protection for heater elements is necessary to prevent hazards based on sound engineering principles and is furthermore required by UL 1995.

Signature

JL102

John Loud, MSEE, PE, CFEI

Introduction

Background

UL 1995 titled "Heating and Cooling Equipment" is a consensus industry standard that is intended to provide minimum safety requirements that manufacturers must meet in the production of such equipment. Electric heaters incorporated in this equipment can be listed by recognized organizations certifying testing and compliance with the applicable safety requirements of UL 1995. Consumers, authorities having jurisdiction (e.g. building code regulation and enforcement) and others on their behalf critically rely upon the certification mark (label) as verification of compliance with minimum requirements for safe operation in intended applications. There is reportedly a lack of consistency in how the safety requirements in the UL 1995 standard are interpreted and applied by the electric heating manufacturing industry.

Retention

John Loud, MSEE, P.E., Principal Engineer employed by Exponent Inc., was retained by Warren Technology to assess the requirements of UL 1995 as they pertain to control of electric heaters. Exponent charges $495 per hour for these services. This report presents Mr. Loud's findings to date in this matter pertaining to the issues he was asked to address.

Report Limitations

Exponent investigated specific engineering issues relevant to this matter as requested by this client. The scope of services performed during this investigation may not adequately address the needs of other users of this report, and any re-use of this report or its findings, conclusions, or recommendations presented herein are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

The findings presented herein are made to a reasonable degree of engineering certainty. We have made every effort to accurately and completely investigate all areas of concern identified during our investigation. If new data becomes available or there are perceived omissions or misstatements in this report regarding any aspect of those conditions, we ask that they be brought to our attention as soon as possible so that we have the opportunity to fully address them.

Engineering Analysis

All citations from UL 1995 are from the 2011 standard (current version).

Scope

UL 1995 purports to apply to stationary equipment for use in non-hazardous locations rated 7200V or less, single or 3-phase, and remote control assemblies for such equipment.

Definitions

Term	Definition	Source
Backup protection	Not specifically defined in UL 1995. Addressed and described by sections 30.16, 30.17 and 48.	UL 1995
Hazardous overheat	High temperature condition created by continued heater operation when the automatically resetting limit control fails in the closed position that may result in a fire. Addressed by 30.16 and section 48.	*Composed
Heating element	The electrical conducting medium that is intended to be heated by an electric current.	UL 1995
Intended operating conditions	Not specifically defined in UL 1995.	UL 1995
Temperature-limiting thermostat	A thermostat that functions only under conditions that produce abnormal temperatures. The failure of such a thermostat might result in a hazard.	UL 1995
Temperature-regulating thermostat	A thermostat that functions only to regulate the temperature under normal conditions of use, the failure of which would not result in a hazard.	UL 1995

*Composed: based on the contents of UL 1995

UL 1995-2011

Selected requirements from UL 1995 and my comments are summarized in Table 1.

Table 1. UL 1995 sections and comments

UL Section	UL Content	Comments
30	Electric Heaters	The subject matter for this engineering analysis
30.11	An electric heater shall be equipped with one or more automatically resetting temperature-limiting controls … to limit temperatures per table 39.5. Must be factory installed as an integral part of the heater.	Temperature-limiting indicates that such a thermostat is only to operate under conditions that produce abnormal temperatures. Automatically resetting devices are permitted.
30.16	Except as specified in 30.18, a unit employing electric heaters shall be provided with one or more manually resettable or replaceable backup protective devices of the type specified in 30.17.	Except as allowed by 30.18, electric heaters must have a backup protective device that requires human intervention to restore heat in the event of a closed temperature-limiting control failure.
30.17	Backup protective devices must be independent of the automatically resetting temperature-limiting controls and must be manually resettable or replaceable. Non-resettable thermal cutoffs comply.	The backup protection must trip once, and thereafter require human intervention to restore heat by manually resetting or replacing the device
30.18	The requirement of 30.16 does not apply if no part of the automatically resetting temperature-limiting control circuit cycles under intended operating conditions.	Where the standard covers the intended use, it addresses both the "normal" (ideal) and "abnormal" operating conditions of that use. UL 1995 contemplates and tests heaters for compliance during "normal" (ideal) conditions in chapter 46 and during foreseeable "abnormal" conditions of reduced airflow in chapter 47. When operated as intended under each of the abnormal conditions, the automatically resetting temperature-limit control must maintain temperatures below those specified in table 39.5. See below comments.

UL Section	UL Content	Comments
Table 39.5	Maximum acceptable temperatures	Temperature limits (at the heater housing and adjacent ducting) established for safe operation.
Chapter 47	Abnormal temperature and pressure tests	Various simulated conditions of reduced airflow designed to verify that the automatically resetting temperature-limit control cycles as required to maintain safe temperatures during heater operation under abnormal but expected conditions of use.
Chapter 48	Backup protection tests	Testing designed with the automatically resetting temperature-limit controls bypassed, to verify that backup protection devices effectively and reliably cut off the heater elements before hazardous temperatures are reached under conditions of reduced airflow.

Section 30.18 comments

30.18 permits the omission of backup protection required by 30.16 only for those heaters that do not cycle on temperature limiting controls under "intended operating conditions." Notably, 30.18 is not a safety requirement.

Misinterpretation of 30.18 to exclude all heaters from the requirement of backup protection in 30.16 has reportedly resulted in the continued sale and installation of heaters capable of producing hazardous temperatures without backup protection. This misinterpretation results from the failure to recognize that "intended operating conditions" includes foreseeable "abnormal" conditions (chapter 47) as well as ideal or "normal" conditions. If it is interpreted to mean that the heaters do not cycle on the temperature-limiting controls during clean-filter, unrestricted airflow operation (ideal conditions), then no backup protection would ever be required. If, however, it is interpreted to include operation during expected real-world conditions including loading filters and restricted airflow, then backup protection would be required.

There are problems trying to assert the first interpretation for a number of reasons, including:

1. The exception would obviate rule 30.16, which is a critical safety requirement based upon sound engineering principles.

2. Cycling indefinitely on automatically resetting temperature-limiting controls without indication or warning to users will result in some number of temperature-limiting control failures which is a hazard.

3. Emerson, a manufacturer of automatically resetting temperature-limiting controls, warns of such failures.[1]

Expanded Synopsis of UL 1995 Backup Safety Protection

Predicated upon sound engineering practices, UL 1995 Safety Standard recognizes and contemplates that temperature-limiting controls will foreseeably fail "with its contacts permanently closed." The temperature-limiting control cycles power to the heating elements on and off, typically during reduced airflow conditions, to maintain safe temperatures for operation (table 39.5). These controls are automatically resetting with no indication to the user of the cycling occurring. Such cycling without notice will continue as long as the reduced airflow conditions persist during the long expected service life of the equipment. The user receives no warning of the substantial dangers of hazardous overheat and fire from continued operation of the heater. UL 1995.30.16 specifically requires heaters to incorporate backup safety protection to safeguard against hazardous temperatures (chapter 48.2) when the automatically resetting control foreseeably fails "with the contacts permanently closed."

The standard permits an exception to this fundamental requirement, allowing backup protection to be omitted provided the temperature-limiting controls do not function to cycle off or on during "intended operating conditions," which would indicate that hazardous temperatures are not a possible risk. [Clause 30.18] Unfortunately, the term "intended operating conditions" is not defined by the standard and therefore must be determined by interpretation of its meaning and intent in context of the standards and consistent with sound engineering principles. The correct interpretation is critical when determining whether backup protection can be omitted: If the exception is interpreted too broadly, heaters capable of producing hazardous temperatures would be permitted to omit safety protection, exposing persons and property to risks that could be easily avoided. Regardless of the standard, prudent and responsible design practices dictate that backup protection not be eliminated unless it is confirmed that the heater will not create risks from hazardous overheat events under foreseeable conditions of use.

With regard to the exception in the standard itself, "intended operating conditions" must include conditions of restricted and blocked airflow due to "loading" of air filters, dirty cooling coils, closed registers, undersized ductwork, etc. all of which cause the temperature-limiting control to cycle. These conditions are foreseeable and commonplace use in field application and are contemplated and tested for (by simulation of failed temperature-limiting controls) in the standard. [Section 47 and 48] In application, all of these conditions will cause the temperature-limiting controls to cycle unless the heater is not capable of producing sufficient heat to create hazardous temperatures. Therefore, backup protection is required by UL 1995 for all heaters that are capable of producing hazardous temperatures when the temperature-limiting controls fail. Only heaters not capable of cycling the temperature limiting controls and not capable of producing hazardous temperatures under the above conditions contemplated by the standard are permitted to omit backup protection.

Most conventional UL 1995 heaters produced and sold are capable of producing hazardous temperatures and therefore require backup protection; and require safety certification labels (marks) for approval by inspection authorities for installation in homes and buildings. Safety labels affixed to heaters capable of producing hazardous temperatures that do not incorporate backup protection are false and deceptive, placing innocent unsuspecting consumers and the public at needless risk of fire without any warning.

Review of UL 60335-2-40 (2012)

UL 60335-2-40, “STANDARD FOR SAFETY, Household and Similar Electrical Appliances, Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers” which adopts IEC 60335-2-40 text with national differences (none of which pertains to backup protection for electric heaters) was reviewed. The following relevant citations apply to the subject matter of this report.

Section 22.102 titled “Appliances provided with supplementary heaters” section 22.102.1 states “Appliances provided with SUPPLEMENTARY HEATERS for air shall be provided with at least two THERMAL CUT-OUTS. The THERMAL CUT-OUT intended to operate first shall be a SELF-RESETTING THERMAL CUT-OUT, the other THERMAL CUT-OUT shall be a NON-SELF-RESETTING THERMAL CUT-OUT.

Section 22.103 states NON-SELF-RESETTING CUT-OUTS shall be functionally independent of other control devices.

Supply Chain Responsibility for Safe Products

Notably, suppliers should design and sell products that are reasonably safe for their intended use, incorporating the safest design feasible to eliminate or reduce foreseeable risks to persons or property, in accordance with basic engineering principles and the legal and ethical responsibilities to consumers and the public. Product designs are obligated to exceed minimum standards if necessary to comply with these precepts. Incorporation of backup protection is the only reasonably safe design for heaters capable of producing hazardous temperatures. In this regard, the non-resetting thermal backup protection devices incorporated should be *fail-safe* or known to be reliable and effective, and feasibly available devices to safeguard against the severe risks of hazardous overheat and fire.

Engineering Analysis/Experience

I have been working with contactors and relays since I first started an electrical apprenticeship learning to repair locomotives in the late 1970s. The locomotives I learned to troubleshoot and repair were largely controlled by relays and contactors of various sizes. Direct control and indirect control in different combinations comprised locomotive controls. I worked on troubleshooting failed locomotives and often found stuck or welded contacts to be the cause of the failure. I also did a session at rebuilding and testing relays and am familiar with contact wear patterns.

I also worked on automated locomotive controls that were added to remotely control locomotives in the middle of a train. It was in this context that I first learned what can and does go wrong with electrical contacts that control critical loads. While working for Q-Tron Ltd, I helped design and test a circuit to apply train brakes in the event of a non-responsive locomotive engineer. Based on what I had learned about contact failures, my design had both a primary and a secondary switch to ensure that a contact failure would not prevent brake application when it was needed. Since starting with Failure Analysis Associates (now Exponent Inc.) in 1995, I have expanded the breadth of my understanding of what can go wrong with electrical contacts that control critical loads. While many of these investigations are confidential in nature, the engineering lessons are not. I am therefore including these lessons as a basis for the recommendations I will make. Examples of serious problems that I have personally worked on over the course of my career involving single contact failures include:

1. Failure of relay contacts in the closed position that resulted in failure of a power contactor to drop out and disconnect the main generator from the locomotive traction motors.

2. Failure of a throttle controller contacts that resulted in a locomotive consist not dropping to idle when the engineer put the throttle control lever to the idle position.

3. The failure of both redundant contacts that provided feedback to a man-lift controller to prevent it from being operated outside of its center-of-gravity stability envelope. The first contact failure provided no feedback to the operator thus routine testing failed to detect the first failure. Once the second failure occurred, protection was lost and the inevitable happened resulting in a tip-over and fatality.

4. Welded contacts in a relay in a fireworks controller that resulted in unintended detonation of a charge which hit an operator in the face as he was replacing spent fireworks. In this case, the backup proximity contacts had been bypassed thus a single point of relay contact failure resulted in this accident.

5. Automatically resetting bi-metal controls in a coffee maker that had its set point drift up over time until it failed closed. Unfortunately, its drift had teased a TCO and caused it to failed closed resulting in a fire. Coffee makers now utilize dual TCOs to provide backup protection to the primary regulating bi-metal control.

6. Contacts welded on a relay that controlled power to a heater which resulted in continuous heat regardless of the input from the thermostat resulting in a fatality.

7. Failure of an automatically resetting backup control in modular heating units. No human intervention was required so it was not readily apparent to anyone that the self-resetting protection device was operating continuously to limit temperature. A number of fires resulted. The solution was to retrofit the controllers with a manually resettable device that would operate in the event of an over-temperature event.

8. Failure of automatically resetting controls in hotel HVAC units due to dirty filters. No indication was provided to the user to show that units were operating on the automatic resetting controls. A number of fires resulted.

9. The main power contactors that switched power to several semiconductor wet benches were found stuck in the closed position. It was not the contacts that welded, but rather the armature became adhered and power was not interrupted to the wet bench when the coil voltage was removed.

10. Power contactor to control lighting at a baseball field had its contacts welded thus keeping power to the lights on after the coil was de-energized. While it was ultimately the lack of bonding on a metal hand-hole enclosure cover that was the proximate cause of the death of an 8-year-old girl, it shows that all switching elements have the potential to fail in the closed position.

Numerous other examples could be cited, but the above list illustrates the engineering reality that virtually all contacts have the potential to fail in the closed condition. It also illustrates that self-resetting, temperature-limiting controls, which allow continued heater operation after their failure may well result in ignition of a fire. A simple Failure Modes and Effects Analysis (FMEA) should provide clear insight to qualified engineers about appropriate control design for each device.

I contend that UL 1995 should and does require that all heaters that are capable of producing hazardous temperatures have manually resettable or replaceable backup protection devices that disconnect power to the heater to safeguard persons and property from a hazardous overheat event.

Notably, while failures of switching devices that are capable of switching the rated load a sufficient number of times are typically less common, there are still very real risks of failure, particularly considering the long equipment life and indeterminate cycling, which would needlessly expose persons and property to danger from fires in the absence of backup safety protection to shut down the heater. My own experience dating back to the late 1970s shows me that such failures have always and continue to occur through today. I therefore advocate use of reliable, fail-safe thermal cutoff devices to shut off power to the heater elements where continued heating will result in fire, death, or other severe outcome. I further advocate that human intervention be required in response to an overheat event since without it, some devices will continue to operate on the self-resetting controls indefinitely and without warning to the user. Since there is no practical means of ensuring that devices which are sold will be retired when they reach the end of their useful life, the design of electric heaters capable of producing hazardous temperatures must consider such failures and reasonably protect against foreseeable and avoidable dangers, as specifically contemplated and addressed by UL 1995.30.16.

Electric heaters that claim to be listed as compliant with all safety requirements in UL 1995 despite omission of backup safety protection is misleading to consumers, the public and others on their behalf who rely upon such certifications. In reality, they directly violate critical safety requirements of sound engineering principles, as well as the specific safety requirements of UL 1995, resulting in heaters that are unreasonably dangerous to consumers and the public.

Appendix A: Resume of John Loud

John Loud, P.E., CFEI
Principal Engineer

Professional Profile

Mr. John Loud is a Principal Engineer in Exponent's Electrical Engineering and Computer Science practice. Mr. Loud specializes in electrical engineering issues. He addresses issues related to electronic systems including printed circuit board problems, electronic component failures, circuit analysis, and propagating failures. He has investigated numerous incidences involving electrocutions and electric shocks and has also conducted many investigations involving electrical/electronic products that are alleged to have caused fires. His expertise further includes work with lighting products, rotating electric machines, as well as secondary battery systems in the area of lithium ion cell testing and protection systems, NiMH, NiCad, and lead acid charging systems. His test results and recommendations for products using lithium ion cells have been used by many in the portable electronics industry. He has performed fault analysis on electrical distribution equipment, breakers, and switchgear. Mr. Loud also has experience with industrial electronic equipment including automated metering equipment, locomotive black-box event recorders, and locomotive control equipment. He is experienced in addressing issues related to electronic manufacturing and service, equipment production, test and circuit board rework and repair. He is also experienced in applying relevant electrical codes and standards including the NEC, NESC, General Orders 95, 128, 165, OSHA, UL, ANSI, etc.

Prior to joining Exponent, Mr. Loud worked for Neta Corporation and Q-Tron Industrial Electronics and worked as a consultant for companies such as General Motors EMD Division, Burlington Northern Railroad, CSX Railroad, and the Atchison Topeka & Santa Fe Railroad.

Academic Credentials and Professional Honors

M.S., Electrical Engineering, San Jose State University, 1995
B.S., Electronics Engineering Technology, Devry Institute of Technology, 1992

4-Year Apprenticed Electrician, Canadian Pacific Railway; Protective Relays and Trip Devices in Electrical Power Systems Course, 1998

Tau Beta Pi; Eta Kappa Nu

Licenses and Registrations

Registered Professional Electrical Engineer, California, #17564

Certified Fire and Explosion Investigator (CFEI) in accordance with the National Association of Fire Investigators, National Certification Board

Publications

Loud JD, Hu X. Failure analysis methodology for Li-ion incidents. Proceedings, 33rd International Symposium for Testing and Failure Analysis, pp. 242–251, San Jose, CA, November 6–7, 2007.

Loud JD, Murray SJ, Ray RM, Iyer M, Jackson O. Shock injury risk assessment of portable and handheld appliances and use environments. Proceedings, 57th Annual International Appliance Technical Conference, Rosemont, IL, March 27–29, 2006.

Loud JD, Murray SJ, Caligiuri RD. Failure modes in Calrod-type heaters used in home appliances. Proceedings, 57th Annual International Appliance Technical Conference, Rosemont, IL, March 27–29, 2006.

Loud JD. Vector control of an induction machine. Master's Thesis, San Jose State University, 1995.

Presentations and Published Abstracts

Loud JD. The science of electric shocks. Guest lecture at Stanford University, 2007, 2008, 2009.

Loud JD. Accelerated stress testing for home appliances. IEEE ASTR Conference, San Francisco, CA, October 2006.

Loud JD. Top ten failures in electronic circuits. Presented to Engineers at Apple Corporation, April 1997 and at Dell Computer Corporation, February 1998.

Loud JD. Electronic case history review—Learn from someone else's design mistakes. Presented to 300 Engineers at Hewlett Packard Corporation, November 1997.

Loud JD. Safety design of electronic circuits. Presented to IEEE in Austin, TX, February 1998.

Loud JD, Hsu P. Evaluation of vector controlled induction motors as joint actuators for industrial robots. Proceedings, IASTED International Conference Robotics and Manufacturing, Honolulu, HI, August 19–22, 199.

Reports

Loud JD. Compact driver and controller Part II—Vector control. Report for General Electric Nuclear Energy, 1995.

Book Chapters

Loud JD, Blanchard R, Mimmack G. Electronic Failure Analysis Handbook. Chapters 16 and 20, McGraw Hill, January 1999.

Loud JD. Operations and Maintenance of the Datacord 2000 Locomotive Crash Recorder. Manual for Q-Tron Ltd., 1988.

Relevant Experience

- 2500 Amp Breaker Failure: Root cause failure analysis.
- Arcing and Fire in Electrical Switch Gear: NEC Violations.
- Hot Tub Controller Failure: Design defect resulted in recall.
- Electrocution: Expert testimony: Cause of death and the role of an electrician's fish tape.
- Electrocution: Investigate the cause of death and document the site.
- Numerous neon sign investigations.
- 100 KVA Distribution Transformer: Document tear down and subsequent testing.
- 4800/240 Transformer: Expert testimony: Evaluate 6 pole-mounted transformers supplying power to a building that caught fire.
- 112kV Transformer: Evaluate transformer windings to determine the root cause of the failure.
- Rice Cooker Electrocution: Identified defect that caused electrical fault.
- Heat Tape Testing: Investigate failure modes and potential for fire initiation.
- Generator Winding Failure: Root cause failure analysis and prediction of susceptibility of remaining population.
- Circuit Board Failure in ATM Machine: Root cause failure analysis and failure projection.
- Lithium ion cell testing: Identify unsafe operating parameters. (Numerous types and form factors)
- Lithium ion cell protective devices for notebook computers: Evaluated failure modes and circuit weaknesses in the protection electronics.
- Metal Oxide Varistors, MOVs: Evaluate performance and failure modes.
- Lithium ion cell protective devices for cellular phones: Evaluated failure modes and circuit weaknesses in the protection electronics.
- AC Adapters: Evaluated for potential failure modes including fire initiation.
- 15kV Vacuum Switch: Determine the root cause of distribution power factor correction control failures.
- Transient Suppressor Failures: Evaluate the performance and failure mode of transient protectors used on wind turbine generating equipment.
- Computer Monitors: Evaluate root cause failure analysis and potential for fire initiation.
- Desktop Computer: Evaluate a burned computer and perform testing to determine whether it was the cause or the victim of a fire.
- 5kV Cable: Root cause failure analysis.

- 5kV Cable Splice: Identified workmanship-caused failure.
- FM Transmitter Fire: Root cause failure analysis for radio station fire.
- Water Level Controller: Identified an installation oversight that resulted in a flood.
- Solar Simulators, Searchlights and Photovoltaic product line review.
- Stepper Motor Failures in Eye Measuring Equipment: Root cause failure analysis.
- Instantaneous Hot Water Heater: Evaluate the controller performance.
- Instrumentation and Controls Evaluation at an Oil Refinery.
- Review of Telephone Switching Equipment involved in a fire.
- Project the reliability of telephone switching subjected to mechanical shock based on Bellcore standards.

Professional Affiliations

- Institute of Electrical and Electronic Engineers—IEEE
- Order of the Engineer (member)

Exhibit 5

30.13 A safety control or a temperature-limiting control intended to prevent heater operation that can result in risk of fire, electric shock, or injury to persons shall be operative whenever the heater is connected to its power supply, and shall interrupt operation of a sufficient number of heating elements to prevent temperatures from exceeding applicable temperature limits.

30.14 A unit employing an automatically resetting temperature-limiting control shall interrupt the power supply to the heater by direct means or by means of a single magnetically operated relay device or contactor that complies with the requirements for the endurance test for the limit control. See Clause 30.18.

Exception: A heater element circuit that incorporates a switching device controlled by both the automatically resetting temperature-limiting control and a temperature regulating control complies if the switching device is rated for 250,000 endurance cycles.

30.15 Limit controls, mercury or magnetic contactors and line break contactors that are used on open electric heaters shall break all ungrounded conductors. Phase break on three phase heaters shall not be permitted. Where silicon controlled rectifiers (SCR's) are used, the safety contactor shall break all ungrounded conductors.

30.16 Except as specified in Clause 30.18, a unit employing electric heaters shall be provided with one or more manually resettable or replaceable backup protective devices of the type specified in Clause 30.17 that will, with the contacts of the automatically resetting temperature-limiting control permanently closed, limit the temperatures to comply with the requirements specified in the Backup protection tests – Clause 48.

30.17 The manually resettable or replaceable protective devices specified in Clause 30.16 shall be functionally independent of the automatically resetting temperature-limiting control. The following types of controls comply with this requirement:

a) One or more thermal cutoffs, nonresettable temperature-limiting controls, or manually resettable limit controls connected to open a sufficient number of ungrounded conductors to permit the unit to comply with the specified temperature limits.

b) A combination consisting of one or more normally open switching device and thermal cutoffs, nonresettable limit controls, or manually resettable limit controls. The thermal cutoff or limit control shall be connected in the coil circuit of the switching device. The combination shall be integral with the product; be able to open a sufficient number of ungrounded supply conductors to permit the product to comply with the specified temperature limits; and be independent of control by an automatic cycling device with the unit.

30.18 The requirement specified in Clause 30.16 does not apply if no part of the automatically resetting temperature-limiting control circuit cycles under intended operating conditions. For example, an automatically resetting temperature-limiting control that directly controls a heating element is not required to be provided with the backup protection specified in Clause 30.16. The backup protection specified in Clause 30.16 is required for a product employing an electric heater that incorporates a switching device whose coil circuit is controlled by both the automatically resetting temperature-limiting control and a temperature-regulating control for the heater, except for products that comply with the exception of Clause 30.15.

Exhibit 6-1

-----Original Message----- From: [*Certification Lab*] September 26, 2012 11:01am To: "royk@warrenhvac.com" <royk@warrenhvac.com> Cc: "Ed Trout" <etrout@warrenhvac.com>, [*Certification Lab employee*], [*Certification Lab employee2*], Subject: RE: Electric Heater Safety Issue

Dear Mr. Kelley,

Thank you for your message and the attached white paper from an expert witness. [*Certification Lab*] greatly appreciates Warren Technology's commitment to public safety, which we quite obviously share.

We are sorry to say that the assertion that standard ANSI/UL 1995 - 2011 requires electric heaters used in Heating and Cooling Equipment is incorrect. The standard requires backup protection for heaters whose primary limit control(s) operate during Heating Operation Test. Note also that all equipment employing electric heaters must satisfy the requirement of the Continuity of Operation Test, Clause 46.2 or 46.8 as applicable.

Standard ANSI/UL 1995 - 2011 contains a number of Abnormal Operation Tests, including but not limited to Limit Control Cutout, Restricted Inlet, Fan Failure, Blocked Outlet and Curtain Drape Test, that are intended to simulate real-world conditions, including overloaded air filters, miswired 3-phase blower motors and slipping drive belts (all covered by Restricted Inlet) and broken drive belts (simulated by Fan Failure). The standard does not prohibit the primary limit control's functioning during these tests, nor does it require the limit control(s) to function. It only limits certain designated temperatures. As long as the equipment sucessfully limits the designated temperatures, the result is acceptable.

One might well ask, "When does standard UL 1995 require backup protection?" The answer to that question resides in Clause 30.16. All heaters except those that satisfy Clause 30.18 are required to have backup protection. 30.18 states, "... Clause 30.16 does not apply if no part of the automatically resetting temperature-limiting control cycles under intended operating conditions." Those intended operating conditions are the Continuity of Operation Test and Heating Operation Test, as is stated above. Your expert witness's contention that functioning of a primary limit control is part of the intended operating conditions is, in all candor, erroneous.

Warren Technology's own experience with [*Certification Lab*] and possibly with other conformity assessment bodies confirms what we have said above. Your heaters have been [*Certification Lab*] Listed (some of them for decades) without backup protection, because the results of tests on heaters without backup were in conformity with the standard. Warren's decision to add backup protection initiated an investigation by [*Certification Lab*] under [Certification Lab Employee's] supervision, because Applicants are contractually required to notify [*Certification Lab*] in advance of product changes, and obtain our acceptance of those changes. We recently tested the heaters with backup protection, and obtained acceptable results. As a consequence, one of more of your listing reports has been revised to include the fusible links.

It may be of interest to you that the *Standard for Electric Duct Heaters*, ANSI/UL 1996 - 2011, does require both automatically resetting primary limit controls and manually-resettable secondary limit controls in duct heaters. This is in contrast to the UL 1995 requirement, and it stems directly from **424.64** of the *National Electrical Code*, ANSI/NFPA 70 - 2011 (**424.57** through **424.66** contain specific provisions relating to duct heaters).

[*Certification Lab's Employee*] is a member of STP 1995, responsible for the standard. I have discussed this matter with [them] (copied) and (s)he concurs with this writer's analysis.

Thank you for your continuing interest in [*Certification Lab's*] services. If there are any questions about this message, feel free to contact us.

Kind regards,

[electronic signature]

[*Employee*], P.E.
Senior Director - Technical Affairs
[*Certification Lab*]
[*Phone number*]

From: royk@warrenhvac.com [mailto:royk@warrenhvac.com]
Sent: Tuesday, September 25, 2012 3:42 PM
To: [*Certification Lab*]
Cc: Ed Trout
Subject: Electric Heater Safety Issue
Importance: High

Dear [*Certification Lab*],

Thank you very much for your assistance to facilitate the approval of Warren's fail-safe overheating protective device in our products. We believe this is a quantum improvement in electric heater safety.

As you know, Warren Technology has made a commitment to include these simple, reliable, and economical backup thermal cutoff devices in its unitary electric heaters. Shortly before making that decision we learned that an automatically resetting temperature-limiting control in a heater failed in the closed position. An investigation confirmed that a significant number of these controls were similarly failing, typically after several years in the field. Recognizing the severity of the hazards created by this condition and reality of such failures, our obligation to make our product safer by incorporating backup safety devices in our heaters was obvious.

Despite the patent benefits of the heaters incorporating the backup safety devices and the industry's obligations to the consumers, the improved design met some resistance from the industry distributors and installers. Many installers were unwilling to purchase or install heaters with manual or non-resettable/replaceable backups due to the "nuisance" of additional service calls and complaints by uninformed consumers (who would be exposed to the serious hazards, but for the shut down by the backup safety device). Certain manufacturers took advantage of the misconceptions of these resistant distributors and installers, representing that backup safety devices were not necessary and continuing to manufacture heaters without backup safety devices to accommodate these demands, without regard for the safety of consumers. Warren Technology did not deter from its commitment to produce the safest product reasonably possible despite the apparent belief by many in the industry that the backups were not required by the Safety Standard, UL 1995.30.

Recently, upon close and careful re-examination of the applicable UL safety standards, it was obvious that the standard does, in fact, require backup safety devices in these heaters. To confirm this conclusion, Warren retained an independent expert to analyze UL 1995 with regard to the requirements for backup safety devices in heaters. Their conclusion confirms that the UL 1995.30 safety standard requires backup safety devices in virtually all electric heaters and is presented in detail in the document attached.

The misinterpretation and misapplication of UL 1995.30.18 has resulted in the design by many manufacturers, as approved by certification labs, of unitary electric heaters without backups over the past decade. Furthermore, these unsafe designs continue to be sold, distributed and installed in consumers[1] homes and buildings in violation of the safety standards. It is indisputable that the dangers associated with heaters would be reduced or eliminated by the simple incorporation of backup safety devices. **The safety standards must be interpreted and applied properly** to require such backups at a minimum. This matter requires immediate attention considering the severity of risks to which consumers and others are being exposed, and the fast-approach of another heating season.

In view of our excellent long term relationship, we would like you to have the opportunity to review this matter and give us your thoughts on how to proceed with appropriate action. I will follow up with more information by the end of this week. In the meantime if you have any questions please feel free to contact me on my direct line, 305-776-8290.

Sincerely yours,
Roy Kelley

Valued Quality. Delivered.

[*Certification Lab's Website*]

Exhibit 6-2

Replies to Issues from the Response of "*Certification Lab*"

1. *Certification Lab* Excerpt/Statement:

"[*Certification Lab*] greatly appreciates Warren Technology's ***commitment to public safety***, which we quite obviously ***share***… ***We are sorry to say that*** the assertion that standard ANSI/UL 1995 - 2011 requires electric heaters used in Heating and Cooling Equipment [to incorporate backup protection] is ***incorrect***."

Response:

The *Certification Lab's* certification is intended to protect consumers by testing products to assure they are reasonably safe for the foreseeable use or application. As we all know, these heater units are capable of producing up to 2,000 °F if not properly controlled during "abnormal", but foreseeable, air-flow conditions.[i] It is recognized that the ARTLCs are unreliable and fail in the closed circuit position, and are specifically considered by the standards as a basis for the backup safety requirement.[ii] It is apparent that you appreciate the engineering integrity of the backup requirement to prevent internal temperatures from reaching ignition or meltdown during these conditions.

Certification Lab, based upon its engineering expertise, is responsible for protecting the public against unreasonable and unnecessary dangers by certifying products evaluated and tested to meet a minimum level of safety. However, if a product is not reasonably safe – it fails to incorporate available technology that would eliminate or substantially reduce anticipated risks of catastrophic injury or damage – *Certification Lab* is obligated not to certify the product as safe.

We appreciate, even rely upon *Certification Lab's* commitment to its responsibility to protect the public against severe risks that are easily preventable.

Assuming for the sake of argument that the application of the standards would result in a dangerous condition – a virtual ticking time bomb - what is *Certification Lab's* responsibility to the public?

Perhaps under such circumstances *Certification Lab*'s commitment to the public safety might be tested, but their responsibilities to the consumers and their safety is very clear. Fortunately, the safety standards do not ask you to expose the public to unreasonable risks. In fact, the plain meaning and intent of the safety standards does not allow certification of heaters as being safe that it knows are very dangerous. We appreciate your articulation of rationale behind the misinterpretation by some manufacturers, and address them accordingly. To do this it is imperative that we look at the specific words and the purpose, intent and necessity of each standard, within the context of the safety standards, and confirm that the resulting interpretation complies with accepted engineering principles, rather than relying upon "the way it has been done" or what it has always been "understood" or assumed.

2. *Certification Lab* Excerpt/Statement:

The standard requires backup protection for heaters whose primary limit control(s) operate during ***Heating Operation Test***…

Response:

It appears that we all agree that the standards clearly state that all heaters require backup protection to protect against hazards when the ARTLC fails in the closed circuit position.[iii] Presumably *Certification Lab* also appreciates the foreseeability of such ARTLC failures during operation, and the validity of the engineering principles/rationale that underlie the backup requirement. You emphasized the exception to this requirement, but the purpose, intent and necessity of the requirement itself – to protect against the hazards that these foreseeable overheat events present if no backup safety device is incorporated – must always be considered primarily.

As you point out, there is an exception to the requirement that every heater incorporate backup protective devices. Pursuant to the exception, those heaters where "no part of the [ARTLC] cycles under *intended operating conditions*" will not be required to incorporate the otherwise required backup protective devices.[iv] (30.18). The question is… what are "intended operating conditions"? The standards do not define, but rather clearly describe the "intended operating conditions" to which this exclusion refers. At this point it should be recognized that any interpretation of "intended operating conditions" that would ignore the foreseeable abnormal conditions specifically considered as the basis for the backup requirement in 30.16 would be contrary to the purpose, intent and necessity of the requirement itself.

For instance, your statement that "the standard [only] requires backup protection for heaters whose primary limit control(s) operate during ***Heating Operation Test"*** is not an acceptable criterion for determination of the heaters which can be excepted from the backup requirement and would create exceptions which are contrary to the purpose, intent and necessity of the 30.16 requirement. The "Heating Operation Test" is set forth in 46.17-22. Pursuant to 46.19 "*the limit controls shall be shunted out of the circuit*" during the Heating Operation Test, and therefore, the ARTLC would *never* be able to cycle during the Heating Operation Test pursuant to the specific design of the test itself. This cannot be the test to determine whether certain heaters meet the exception to the rule, as it would except *all* heaters and nullify the rule. Further, it would not be necessary to shunt out the ARTLCs if it is known they will not cycle during this test.

Additionally, we can assume for the sake of discussion that your reference to the "heating operation test" is intended to consider the temperature range that the test is designed to address as the definition or criteria for "intended operating conditions" -- Specifically, that range of temperatures starting just *below* the point at which the ARTLC is *initially* triggered to cycle. Using this interpretation would again apply the exception to every heater, since by definition the ARTLC will not cycle if the temperatures are deliberately set *below* the temperature that *initially* triggers the ARTLC to function". Once again, if that were the interpretation applied, it would exclude all heaters and create an exception that completely eviscerates/nullifies the rule.[v]

The interpretation of "intended operating conditions" must be in context within the standards and consistent with the purpose, intent and necessity of the safety standards based upon accepted electrical engineering principles, including those clearly stated requirements of 30.16. and must include conditions that are less than ideal such as reduced airflow (from dirty air filters, etc.) which causes higher supply air temperatures.

3. *Certification Lab* Excerpt/Statement:

One might well ask, "When does standard UL 1995 require backup protection?" The answer to that question resides in Clause 30.16. All heaters except those that satisfy Clause 30.18 are required to have backup protection. 30.18 states, "... Clause 30.16 does not apply if no part of the automatically resetting temperature-limiting control cycles under intended operating conditions." Those intended operating conditions are the Continuity of Operation Test and Heating Operation Test, as is stated above.

Response:

This is an interesting way to present the question, but fails to resolve the problem. The requirement – *all heaters* – is not only plainly stated in 30.16, but also is consistent with the purpose, intent and necessity of this requirement, patently based upon sound engineering principles. Clearly there is an exception considered in the standards, and we do not ignore that. However, those exceptions should be based upon interpretations that are similarly supported by sound engineering principles:

> What heaters meet the 30.18 exception, consistent with the purpose, intent and necessity of the safety standards?
>
> *Certification Lab's* answer – "all heaters except those that meet the exception in 30.18" – provides no guidance. And all heaters whose primary limit control(s) operate during Heating Operation Test would result in all heaters meeting the exception, including those heaters that will foreseeably endanger public safety addressed by the 30.16 backup requirements, which is inconsistent with the purpose, intent and necessity of the standards and sound engineering principles.

Your response re-addresses the issue of which heaters are meant to be excepted, focusing on "intended operating conditions", by now adding the "Continuity of Operation Test", to the previously referenced "Heating Operation Test". However, the Continuity of Operation Test fails to address or resolve the problems and inconsistencies that the reliance on the Heating Operation Test alone creates. To demonstrate the inconsistency of using this as the criteria considered to determine the exception in 30.18, consider: The Continuity of Operation Test is a primary test performed on every heater to verify the target temperatures are maintained during ideal conditions. If the ARTLC on any heater cycles during this test then the heater does not meet the minimum standards. But every heater that passes the Continuity of Operation Test – which would include *every heater that could possibly be certified* – would meet the exception in 30.18. The exception cannot be interpreted to nullify such an important rule.

More simply, how would the criteria in the Continuity of Operation Test and/or the Heater Operation Test help to identify those heaters that do not present the dangerous risks that necessitated the backup protection requirement in the first place (i.e. those heaters that should be excepted from 30.18)?

So – When does standard UL 1995 require backup protection?

The purpose, intent and necessity of the backup safety requirements in **<u>30.16</u>**:

> ***To prevent catastrophic injury when the ARTLC fails in the closed position (and the heater exceeds temperatures for intended operation), a backup protective device is required to shut down the heater <u>before</u> the temperature exceeds the dangerous levels considered in clause 48 (Backup Protection Tests).***

What is the purpose, intent and necessity of the exception in **<u>30.18</u>**?

> ***To except <u>only</u> those heaters that are <u>not capable</u> of producing sufficient heat to create the dangerous risks of overheat considered by 30.16.***
>
> Which heaters are not capable of producing enough heat to increase the internal temperatures to dangerous levels?
>
> ***Any heater that will not even trigger the ARTLC/"primary control" to function under any possible <u>intended, foreseeable condition of operation</u>, will present no safety threat requiring a backup that initially functions well above those levels. (and, the ARTLC can become a redundant safety control…if it is linked directly to the heater elements or through a contact rated for 250,000 cycles if shared with the regulating control).***

We submit that this interpretation is based upon the plain meaning of the words in the standards, is completely consistent with the purpose, intent and necessity of each standard within the context of the safety standards framework, and clearly complies with sound engineering principles. We invite any response to this perspective or alternative interpretations of the subject standards based upon sound engineering principals.

4. *Certification Lab* Excerpt/Statement:

"Abnormal Operation Tests… are intended to simulate real-world conditions… The standard does not prohibit the primary limit control's functioning during these tests, nor does it require the limit control(s) to function. It only limits certain designated temperatures. As long as the equipment successfully limits the designated temperatures, the result is acceptable."

Response:

These Abnormal Operation Tests focus on the ability of the ARTLC to maintain the temperature within established acceptable operating temperatures (table 39.5) during various conditions restricting air flow. During these tests, the heater must be maintained, at all times, *within* the *maximum acceptable temperatures*, regardless of the conditions, *normal* AND *abnormal*. We certainly understand that the ARTLC is not required to cycle during these tests, and will not cycle during these tests if the heater being tested is incapable of producing temperatures high enough to trigger the ARTLC. In fact, that is why these are the appropriate tests to determine which heaters meet the 30.18 exception.

The Limit Control Cutout Tests (Clauses 46.10 – 46.16) clearly identify those heaters that are exposed to the severe risks considered by 30.16, as well as those heaters that do not. If the ARTLC does not cycle and the designated temperatures are maintained during the Limit Control Cutout Tests, then that heater could meet the 30.18 exception.[vi] This interpretation is consistent with the purpose, intent and necessity of 30.16 and complies with good engineering practices. As you point out, the Limit Control Cutout Tests simulate ***real-world conditions.*** To carry out the responsibility and commitment to protect the public, we must consider the risks associated with the heaters during ***"intended operating conditions" in the real world.***[vii]

5. *Certification Lab* Excerpt/Statement:

It may be of interest to you that the *Standard for Electric Duct Heaters*, ANSI/UL 1996 - 2011, does require both automatically resetting primary limit controls and manually-resettable secondary limit controls in duct heaters. This is in contrast to the UL 1995 requirement, and it stems directly from **424.64** of the *National Electrical Code*, ANSI/NFPA 70 - 2011 (**424.57** through **424.66** contain specific provisions relating to duct heaters).

Response:

Of course, so does UL 1995.

What engineering principles would justify such an all-encompassing distinction between the backup safety requirements in unitary electric heaters and the duct heaters referenced? There only distinction in the language is the exception in UL 1995.30.18. Correctly interpreted and applied, the exception in 30.18 is simply a convenience to avoid unnecessary redundancy when a heater is incapable of creating temperatures that would approach levels presenting the dangerous risks the backup safety device is otherwise required to prevent. There is no valid reason to require backup safety devices in electric duct heaters and not in UL 1995, which is precisely why there is not a distinction in the standards, but only in the interpretation and application of the standards.

6. *Certification Lab* Excerpt/Statement:

[*Certification Lab's employee*] is a member of STP 1995, responsible for the standard. I have discussed this matter with [*Certification Lab's employee*] and he concurs with this writer's analysis.

Response:

What is *Certification Lab's employee's* responsibility for the UL 1995 standards? Do they suggest that these standards were intended to exclude every heater that has an ARTLC that complies with 30.11 (every heater that could be certified) from the specific requirement that all heaters incorporate backup protection to prevent overheat events from reaching dangerous temperatures when the ARTLC fails in the closed circuit position? Are there any heaters that do not fall within the 30.18 exception, and what distinguishes those from the others with regard to the potential risks addressed by 30.16? Can *Certification Lab's employee* provide any engineering reasoning to justify the interpretation to exclude Backup safety devices on every heater, despite the specific requirement in 30.16? Can *Certification Lab's employee* explain the engineering reasoning behind the distinction between the backup safety requirements in unitary electric heaters and duct heaters previously referenced? Where did 30.18 come from?

ENDNOTES:

[i] The heaters produce these dangerous temperatures under abnormal conditions that are recognized and considered in the standards and its testing protocols. It is notable that over-voltage, not considered by the standards, is a recognized condition to which heaters are exposed that can increase the production of heat and magnify the effects of the abnormal conditions considered.

[ii] The UL 1995 safety standards recognize, in clause 30.16, that it is foreseeable, even expected that the bimetal switch commonly used as the ARTLC will fail in the closed circuit position (also see UL1995 Definitions – "Temperature-limiting thermostat"); and further, a concern that the manufacturer of the switch specifically warns: "*A control may remain permanently open or closed as a result of exposure to excessive mechanical, electrical thermal or environmental conditions or at normal end-of-life…if failure of the control to operate could result in personal*

injury or property damage, the user should incorporate supplemental system control features to achieve the desired level of reliability and safety. For example, backup controls…" (See Emerson's Website Warnings and Application Notes Regarding its Therm-O-Disc "60T" device, typically used as the ARTLC in heaters).

[iii] See 30.16

[iv] See 30.18

[v] Importantly, even assuming that this were the appropriate temperature range to determine whether the heater meets the exception in 30.18, once the ARTLC is initially triggered to function, it will "cycle" again once the internal temperatures fall back within the temperature range associated with normal/ideal conditions, also. Accordingly, even under this interpretation, most heaters would not meet the criteria for the exception in 30.18 requiring that "no part of the ARTLC cycles" during the intended operation.

[vi] Even if temperatures are maintained without triggering the ARTLC to function during the Limit Control Cutout Tests, to meet the 30.18 exception the ARTLC also must control the heater element directly, or through a contact shared with the regulating thermostat that is rated for 250,000 cycles. Under such circumstances, these ARTLC's themselves would be "overkill" considering the likelihood of the temperature triggering an ARTLC (not possible, and still far from any risk of danger) compared to the knowledge/confidence that, under foreseeable conditions considered in 30.16 (abnormal conditions with the ARTLC failed in the closed position), the temperatures in most, if not all heaters currently manufactured will approach dangerous levels requiring reliable backup protection.

[vii] Limit Control Cutout Tests are "intended conditions":

With all the heater elements "on" and gradually reducing the airflow (by restricting inlet air opening) the *heater leaving air temperature* (HLAT) is determined at the point when the ARTLC begins to cycle. If the ARTLC does not to cycle during the reduction of airflow; and the HLAT does not exceed 200 degrees F, °F per clause 46.10, then, and only then, can backup protection be omitted, according to the standard (Clause 30.18). As explained previously, this is only possible if the equipment is designed with a low heat/airflow ratio. Most conventional equipment is designed with the *highest* heat/airflow ratio possible for safe operation; and thus the heater will cycle, as intended, in reduced airflow conditions. If the ARLTC does not cycle during this test, the heater would still have to pass the concurrent Abnormal temperature tests and incorporate switching devices rated for 250,000 cycles if not controlling the heating elements directy, in order to qualify for the omission of backup protection.
It is clear that cycling of the ARTLC's is an "intended operating condition" as evidenced by the fact that the ARTLC's are allowed to cycle while determining that the HLAT does not create

temperatures at critical points in the equipment and ductwork that exceed the maximum allowable for safe operation per Table 39.

Also see the discussion in the initial correspondence relating to abnormal or less than ideal conditions, referencing clause 47.11 and 47.13.

###

Exhibit 7-1

MELVILLE – February 20, 2013

Mr. Roy Kelley
President
Warren Technology, Inc.
2050 W. 73rd St.
Hialeah, FL 33016

Subject: Warren Technology Letter Dated January 23, 2013 & Safety Bulletin Dated January 25, 2013

Dear Mr. Kelley,

This is in response to your letters dated January 23, 2013 and February 15, 2013 addressed to Keith Williams, regarding thermal backup protection for HVAC equipment-mounted heaters. As stated in his acknowledgement letter, Mr. Williams has asked me to reply.

The detailed information you provided in and with your letter is greatly appreciated. These materials and the "*Press Safety Bulletin,*" No. 12813-2, a copy of which was emailed to UL on January 25, 2013, address the interpretation of several clauses in the current Section 30 ("Electric Heaters") of the Standard for Heating and Cooling Equipment, UL 1995.

We understand that Warren Technology has previously submitted a proposal to revise UL 1995, to clarify the requirements in question, in an attempt to eliminate potential misinterpretation of the standard. The proposal has been discussed within the binational technical harmonization committee (THC) responsible for UL 1995, and has been accepted with modifications. The modified proposal is now part of larger group of proposals being finalized by the THC, that will be processed through the respective US and Canadian consensus processes.

In the meantime, the information in your letter (and *Safety Bulletin*) states that certain industry members, including certification organizations, have misinterpreted UL 1995, increasing the risk of fire from equipment without thermal backup protection. Warren Technology is requesting that UL take immediate action to issue notice of a revised or "correct" interpretation of the requirements in question and take other actions consistent with Warren's interpretation. UL has previously indicated that such backup protection is not required except in the circumstance where the temperature limiting control cycles during intended use. This is an interpretation that has been consistently applied by manufacturers and certification bodies using UL1995.

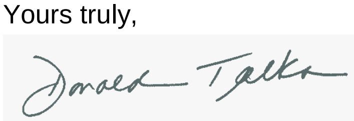
You suggested three alternatives to address this matter in your January 23, 2013 letter. Option one is effectively the status quo, which based upon your comments is unacceptable to you. Option Two deals with formal interpretation of UL1995 as it deals with thermal backup protection. Option Three results in the circumvention of our ANSI approved standards development process. We believe the consensus process must run its course.

Where there is disagreement with respect to the meaning or intent of a published requirement contained in a UL Standard, UL's Standards Development Organization (SDO) has established a Formal Interpretation (FI) process. This process utilizes the technical expertise of the UL Standards Technical Panel (STP), whereby the STP reviews the requirement and any related documentation, and votes on the interpretation of the requirement. A summary of the outcome of the STP vote is published and made available to all interested parties and certification bodies. The FI would become a document to support the application of the Standard until such time as the Standard is revised. If the outcome results in a need for the Standard to be revised for clarity, a proposal is developed accordingly, and processed in a timely manner. Upon publication, action will be taken to address all previously certified products. UL's FI process is part of the "*Approved Regulations Governing ANSI/UL Standards Technical Panels*", Section 7, (available publicly at: http://www.ul.com/global/eng/pages/solutions/standards/developstandards/stps/stpregulations/index.jsp.

In order to assist Warren Technology in the processing of a Formal Interpretation I have asked the STP chair for UL 1995, Joe Musso, to reach out to Ed Trout at Warren. Joe will work with Ed to prepare a letter request outlining the (yes/no format) question(s) to be voted on by the STP. In addition, please note the nominal fee typically associated with the FI process will be waived. Joe will be in contact with Ed shortly.

UL greatly appreciates Warren Technology's commitment to HVAC safety, and we look forward to working with you to resolve your concerns related to interpretation of UL 1995.

Yours truly,



Donald J. Talka
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UL LLC
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Mobile: 631-897-7614

cc: Keith E. Williams - CEO
Robert A. Williams, UL Vice President – Standards
Joe Musso, UL STP 1995 Chair
Brian Rodgers, UL Primary Designated Engineer

Exhibit 7-2

Mr. Roy Kelley
President
Warren Technology, Inc.
2050 W. 73rd St.
Hialeah, FL 33016

December 17, 2013

Subject: Warren Technology Email Dated December 13, 2013

Dear Mr. Kelley,

Your email dated December 13, 2013, addressed to Keith Williams, has been referred to me for response. Thank you for the information provided, and for the opportunity to provide feedback on the proposed warning.

Several statements related to UL's "interpretation" of the *Standard for Heating and Cooling Equipment*, UL 1995, are included in your email. To be clear, it is the Standards Technical Panel (STP) that formally interprets the standard and not UL. Instead, UL and other certification organizations apply the requirements in UL 1995 to products they investigate for certification purposes. The requirements specified in the standard and UL's understanding of their intent are consistently applied. Warren Technology disagrees. UL previously offered Warren Technology the opportunity to submit a request to the STP for a Formal Interpretation of the Standard. Warren Technology declined.

Your email also includes a number of statements regarding the consequence of reduced airflow operating conditions and "intended use." Intended use is typically that for which the manufacturer specifies (e.g. fixed environmental air installation). The product standard cannot reasonably be expected to completely cover other-than-intended use (e.g. manufacturing process heating). But where the standard covers the intended use, it addresses both the "normal" and "abnormal" operating conditions of that use. The type-tests specified in the standard are chosen to be appropriately representative of these uses and are informed by laboratory and field experience with the products.

As you know, UL 1995 requires electric heaters to comply with Sections 46 and 47, which cover operating conditions for electric heaters. Among these requirements are tests for restricted air inlet, restricted air outlets and fan failure, in both ducted and free air discharge units which supply electric heat. Filters and other equipment restrictions are also required to be in place. When operated as intended and under each of these abnormal conditions, a limiting control (required to comply with the *Standard for Limit Controls,* UL 353), must achieve temperatures below those specified in Section 39.

Underwriters Laboratories Inc.
333 Pfingsten Road, Northbrook, IL 60062-2096 USA
T: 847.272.8800 / F: 847.272.8129 / W: UL.com

Warren Technology presupposes that a limit control that complies with the requirements in UL 353 will fail and that adverse consequences will occur before the component failure is noticed and addressed. Warren Technology is entitled to its opinion on this. However, the proposed warning could be considered misleading in that it does not make it clear that a reliable limiting control would still be present and that its purpose is specifically for the operating conditions cited. Instead, the proposed warning suggests that “severe danger of fires” is a de facto consequence of reduced air flow. That stance does not take into account the particular design of the electric heater, the equipment it is installed within or the overall installation itself.

Warren has submitted a proposal to revise UL 1995 that deal with the issues and concerns described in your December 13 email. The Warren proposal is included with other proposals scheduled to reach the US and Canadian consensus bodies for preliminary review during the first quarter of 2014.

UL greatly appreciates Warren Technology’s commitment to the safety of HVAC equipment. As indicated previously, however, Warren is encouraged to allow the standards development process to fully run its course.

Very truly yours,

Robert A. Williams
Vice President – Standards

c. Mr. Keith Williams
Mr. Ben Miller
Mr. Don Talka
Mr. Joe Musso
Mr. Brian Rodgers
Mr. Alan McGrath

Exhibit 8

[Mrs. Doe] [redacted]
[Mrs. Doe] [redacted]

M

[redacted]

-----Original Message-----
From: Jerry.Johnson@emerson.com
Sent: Monday, May 18, 2015 6:13am
To: etrout@warrenhvac.com
Cc: marvin@warrenhvac.com, dariov@warrenhvac.com, dmcconnell@warrenhvac.com, royk@warrenhvac.com, mark@warrenhvac.com, Chuck.Doty@emerson.com, MMiller@emerson.com
Subject: RE: Product Nonconformance L-165

Ed,
Thanks for the update and your request for clarification. With regard to the 3 items you listed the following is our position

1. Last Friday you should have received 14,869 new parts against Po number 58932. We request that any remaining inventory of the suspect lots, be returned immediately for TOD to perform a 100% inspection of the product. It will be marked with a code dot indicating it has been inspected and shipped back on future orders. If you can provide us with a count of parts to be returned Samantha Stoner will issue an RMA for their return.

2. T-O-D does not consider this to be a safety issue if there is reliable back-up protection in the appliance.

3. T-O-D will honor all contractual obligations. It will discuss indemnifying for costs not covered in contracts, but needs to complete its investigation and understand your proposed plan of action before making any additional commitments.

We thank you for your cooperation with this issue and look forward to working with you to address your concerns
Best regards
Jerry

-----Original Message-----
From: Ed Trout [mailto:etrout@warrenhvac.com]
Sent: Wednesday, May 13, 2015 10:37 AM
To: Johnson, Jerry L [COMMRES/TOD/US]
Cc: Marvin Penado; dariov@warrenhvac.com; dmcconnell@warrenhvac.com; royk@warrenhvac.com; 'Mark Frankhouse'
Subject: RE: Product Nonconformance L-165

Limit controls update:

1. We are still checking for non-conforming limits in our inventory, work in process, in quarantine, and in our customer's inventory. So far we have not captured any units but have many more to check and cannot know how many are installed in homes and buildings.

2. We need to notify our customers with a statement from Emerson that this is not a safety issue if the relevant heaters incorporate reliable backup safety protection (similar to limit controls in term of reliability, thermal fuse links with encapsulated mechanically operated contacts used as backup safety protection are not recommended to protect persons or property).

3. We would like to know what Emerson's position is with regard to labor and administration charges; and potential product recall.

Regards,
Ed Trout
VP of Operations
Warren Technology
305-556-6933 Ext. 103
Email: etrout@warrenhvac.com

-----Original Message-----
From: Jerry.Johnson@emerson.com [mailto:Jerry.Johnson@emerson.com]
Sent: Tuesday, May 12, 2015 8:57 AM
To: etrout@warrenhvac.com

To: etrout@warrenhvac.com
Cc: marvin@warrenhvac.com; dariov@warrenhvac.com; royk@warrenhvac.com; mark@warrenhvac.com
Subject: RE: Product Nonconformance L-165

Warren Team,
Do you have an update on the quantity of parts you were able to identify from the suspect Lots?
We would like to get them back as quickly as possible to 100% sort. Please advise ASAP Thanks, Jerry

-----Original Message-----
From: Mark Frankhouse [mailto:mark@warrenhvac.com]
Sent: Thursday, May 07, 2015 1:12 PM
To: Johnson, Jerry L [COMMRES/TOD/US]
Cc: Marvin Penado; Dario Vega; Ed Trout; Roy Kelley
Subject: FW: Product Nonconformance L-165

Can you help identify which purchase order(s) are affected? If not, we have to break down every pallet.

-----Original Message-----
From: Dario Vega [mailto:dariov@warrenhvac.com]
Sent: Thursday, May 07, 2015 12:43 PM
To: 'Doug McConnell'; 'Mark Frankhouse'
Cc: 'Ed Trout'; 'Marvin Penado'
Subject: RE: Product Nonconformance L-165

Doug,

What is the exact manufacturing date for the defective parts, the carton boxes do not show the manufacturing code(see attached picture).

Dario

-----Original Message-----
From: Doug McConnell [mailto:dmcconnell@warrenhvac.com]
Sent: Thursday, May 07, 2015 11:09 AM
To: 'Mark Frankhouse'
Cc: Ed Trout; Dario Vega; Marvin Penado
Subject: RE: Product Nonconformance L-165

These parts need to be identified and pulled from the shelves ASAP.

-----Original Message-----
From: Mark Frankhouse [mailto:mark@warrenhvac.com]
Sent: Thursday, May 07, 2015 10:59 AM
To: Doug McConnell

Subject: FW: Product Nonconformance L-165
Importance: High

From: Jerry.Johnson@emerson.com [mailto:Jerry.Johnson@emerson.com]
Sent: Thursday, May 07, 2015 10:15 AM
To: mark@warrenhvac.com
Cc: etrout@warrenhvac.com
Subject: Product Nonconformance L-165
Importance: High

Dear Mark,

This letter is intended as notification of a nonconformance impacting specific lots of our Type 60T control, built on our machine #4, which shipped to you recently. Product involved was manufactured in our Mansfield, Ohio facility.

The potential nonconformance is a control that will not operate regardless of ambient temperature. If potentially affected controls were assembled in your product, you need to determine whether the nonconformance presents a safety issue in your application.

We detected the nonconformance in a T-O-D Quality Lab check (for another customer's order). After detecting it we 100% checked all suspect lots (not your product) that had not shipped and found the PPM to be 474 (population checked approximately 31,000 units).

We have attached a list of impacted parts that shows:

* Our Type & Style number
* Quantity shipped to you
* Manufacturing lot number that is written on the outside of every
shipping carton:

* Example : 04141M4

* 0414 is ship date (April 14th)
* 1 is shift number (in this case first shift)
* M4 or M4a is machine #4.

* Manufacturing code date is written on the outside of every carton
and is also stenciled on every control.

* Example: 1518 designates 18th week of 2015.

We request that you return any unassembled controls per the attached list so that we can 100% check for this nonconformance. Please email our Customer Service Manager, Samantha Stoner (Samantha.Stoner@Emerson.com <mailto:Samantha.Stoner@Emerson.com>) who will provide you with an RMA number. She can also be reached at 419-525-8249.

Please let us know if you have any question or if we can provide further information.

Sincerely,

Jerry Johnson

District Manager

Therm-O-Disc, Inc.

6121 Sasha Lane

Chattanooga, TN 37416

Office 423-326-0506

Cell Phone 423-762-1492

e-mail: jerry.johnson@emerson.com

Exhibit 9

Table 3.2. Home Central Heating Unit Fires, by Factor Contributing to Ignition
Annual Average of 2006-2010 Structure Fires Reported to U.S. Fire Departments (Continued)

B. Electric-Powered Central Heating

Factor	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified mechanical failure or malfunction	920	(27%)	0	(0%)	2	(12%)	$4	(22%)
Automatic control failure	540	(16%)	0	(0%)	2	(9%)	$3	(17%)
Unclassified electrical failure or malfunction	350	(10%)	0	(0%)	0	(0%)	$2	(13%)
Unspecified short circuit arc	260	(8%)	3	(100%)	3	(17%)	$1	(4%)
Failure to clean	220	(7%)	0	(0%)	0	(0%)	$0	(0%)
Backfire	180	(5%)	0	(0%)	0	(0%)	$0	(1%)
Worn out	170	(5%)	0	(0%)	0	(0%)	$2	(13%)
Arc or spark from operating equipment	110	(3%)	0	(0%)	4	(19%)	$1	(5%)
Short circuit arc from mechanical damage	100	(3%)	0	(0%)	0	(0%)	$0	(1%)
Unclassified operational deficiency	100	(3%)	0	(0%)	0	(0%)	$0	(2%)
Heat source too close to combustibles	90	(3%)	0	(0%)	0	(0%)	$2	(10%)
Leak or break	60	(2%)	0	(0%)	0	(0%)	$0	(1%)
Short circuit arc from defective or worn insulation	50	(2%)	0	(0%)	2	(9%)	$1	(3%)
Arc from faulty contact or broken conductor	50	(2%)	0	(0%)	0	(0%)	$0	(2%)
Improper startup	40	(1%)	0	(0%)	4	(19%)	$0	(1%)
Unclassified factor	40	(1%)	0	(0%)	2	(9%)	$0	(2%)
Installation deficiency	30	(1%)	0	(0%)	0	(0%)	$0	(1%)
Unclassified misuse of material	30	(1%)	0	(0%)	2	(9%)	$0	(0%)
Unclassified design, manufacturing, or installation deficiency	30	(1%)	0	(0%)	0	(0%)	$0	(0%)
Equipment not being operated properly	30	(1%)	0	(0%)	4	(20%)	$0	(0%)
Unclassified natural condition	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Animal	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Construction deficiency	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Manual control failure	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Design deficiency	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Equipment used for not intended purpose	20	(1%)	0	(0%)	0	(0%)	$0	(0%)
Other known factor	70	(2%)	0	(0%)	2	(9%)	$1	(8%)
Total fires	3,390	(100%)	3	(100%)	19	(100%)	$18	(100%)
Total factors	3,600	(106%)	3	(100%)	25	(130%)	$19	(106%)