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Seat Heater Injuries: An Overview

Seat heaters have been installed in automobiles since the 1970s. Today they are commonplace – in about 30 percent of all vehicles in the 2010 U.S. fleet. Despite their increasing ubiquity, seat heaters are not designed to any voluntary or mandatory industry standards, leading some manufacturers to set the maximum temperatures of their seat heaters in excess of human heat tolerances. Others fail to include automatic timed shut-off switches. While most occupants are able to discern when the seat heater has exceeded human limits, occupants who suffer lower body sensory deficits caused by paralysis, diabetes and neuropathy are at risk. These design flaws have resulted in severe burns to disabled vehicle occupants—a problem that has been validated by consumer complaints, the medical literature and demonstrated in testing.

A Documented Injury Hazard

The potential for injury has been recognized by automakers since 1984, when Allison Collision recalled nearly 4,000 seat heater units that could short circuit and overheat.¹ Yet, seat burn complaints remain common on vehicle owner internet forums covering a wide variety of manufacturers and in the consumer complaint data collected by the National Highway Traffic Safety Administration (NHTSA) since the 1980s.² The agency has specifically received seat heater burn complaints from disabled vehicle owners or their advocates:

“My client, [REDACTED] was a passenger in the front passenger seat of a 2009 Ford Taurus. She is paralyzed from the waste [sic] down and was unaware the seat heater was on for the entire 2 hour drive from Phoenix Sky Harbor Airport to Sedona, Arizona. She subsequently discovered that she sustained 3rd degree burns on the bottom of her buttocks from the seat heater being on.... The car seat heater should be recalled before more injuries.”³

These injuries have also been described in publications in the medical literature since 2003. A case described in the *Journal of Burn Care Rehabilitation* by doctors from the Shriners Hospitals for Children in Sacramento, California concerned a 48-year-old male paraplegic with decreased sensation in his buttocks who suffered third-degree burns,

¹ Recall 84E220; Allison Division; September 18, 1984

² Seat heater complaint data to NHTSA; SRS Jan. 2011

³ ODI Complaint 10280134; October 24, 2006

caused by the seat heater in his new minivan.⁴ The patient reported that the heater was on for 20 minutes before he noticed the pain.

A 2005 paper written by German physicians described the severe burn injuries suffered by a 42-year-old paraplegic, who remained in contact with a seat heater for four hours.⁵ His burns covered 6 percent of his body and they were so extensive on his posterior and thighs they required hospital care and surgical skin grafts. The authors noted that seat heaters were now another potential burn injury source for a vulnerable population.

Last year, doctors from the Haydarpasa Training Hospital's Department of Plastic and Reconstructive Surgery and Burn Unit and the Gullhane Military Medical Academy and Medical Faculty in Istanbul, Turkey reported on second and third degree burns suffered by a 38-year-old paraplegic due to prolonged contact with a malfunctioning seat heater in a letter to the editor of *Eplasty*, the *Open Access Journal of Plastic Surgery*.⁶ In September, a trio of British physicians described in the technical publication, *Spinal Cord*, the case of a 50-year-old diabetic woman who suffered burns from prolonged contact with heated seats.⁷

The problem has also been noted in publications aimed at the disabled. In 2008, *New Mobility* magazine featured a story about three paraplegics who suffered burns from car seat heaters, and touched on NHTSA's meager response to seat heater malfunctions.⁸

Some manufacturers build maximum temperature points ranging from 86°F to 113°F into their designs.^{9 10 11 12 13} But, independent testing confirms that in the real world, seat surface temperatures can far exceed their maximum specifications – as well as human heat tolerances. A series of tests performed in 2009 on the seat heater of a 2007 Cadillac Escalade by the Kansas firm, Engineering Design and Testing Corp. showed that the seat heater greatly exceed the maximum temperature specifications. The researchers tested the surface temperatures of seat, while the heater was in the low and high setting; for periods of time ranging from 5-20 minutes; and at ambient temperatures of 70°F-90°F. Regardless of the test condition, the seat reached temperatures in excess of the maximum many manufacturers favor. At the seat heater's lowest setting, the temperature topped out at 115°F after 20 minutes. But at the "high" setting, the seating surface, in

⁴ Car Seat Heaters: A Potential Hazard for Burns; Pirko Maguiña; Tina L. Palmieri; David G. Greenhalgh; *Journal of Burn Care Rehabilitation*; 2003

⁵ Car Seat Heaters – a Potential Danger for Paraplegics; E. Demir1 D. O'Dey; P. Fuchs; F. Block; N. Pallua; *Neurologist* 2005 (Translated from original German)

⁶ An Unusual Burn Caused by Heated Car Seat; Celalettin Sever, MD, Yalcin Kulahci, MD, Fatih Uygur, MD, and Sinan Oksuz, MD; Letter to the Editor; *Eplasty Open Access Journal of Plastic Surgery*; April 8, 2010

⁷ Pain in your buttocks? Check your heated car seat isn't burning you; KRM Rakowski, N Sivathanan and N Sivathanan; Letter to the Editor; *Spinal Cord*; September 14, 2010

⁸ Escaping the Hot Seat; Bob Vogel; *New Mobility*; April 2008

⁹ Heated Seat System; 2000 Jeep Truck Grand Cherokee; AllData; 2010

¹⁰ Owner's Manual; 2006 R-Class; Mercedes; 2006

¹¹ Seat Heater Development for 051A; Toyota Motor Corporation

¹² Seat Climate Specification; Ford Motor Company; July 17, 2006

¹³ Seat NDS Spec Upgrade; Nissan;

places, reached temperatures ranging from 124°F to more than 150°F, depending on the length of time and the ambient temperature of the cabin.

In the course of their 2003 research, Drs. Pirko Maguiña, Tina L. Palmieri and David G. Greenhalgh of Shriners Hospitals for Children tested the seat surface temperature of a Chrysler Town and Country vehicle and found that that one of the vehicle's four heating panels reached a localized temperature of 120°F. At this temperature third-degree burns can occur within 10 minutes.¹⁴

“The car seat heaters should never reach these temperatures,” they wrote in the *Journal of Burn Injury Rehabilitation*. “Because there is no warning light on the dashboard to signal when the heaters are ON, patients with impaired sensation may not be aware that the car seat heater is on. In addition) the heating elements should have a control device to turn them off when they overheat. The seat heaters could be improved if they offered a temperature control instead of just an on/off button that sets to maximal heat every time. Most importantly the seat heaters on every car should be tested to prevent accidents with heaters that come defective from the factory.¹⁵

Seat Heater Recalls and Human Heat Tolerance

NHTSA, the federal agency that regulates motor vehicle safety issues, has narrowly focused its enforcement activities to seat heater malfunctions that result in a fire. In total, the agency has launched six investigations into seat heaters overheating since 1984. Manufacturers, either influenced by an Office of Defects Investigation inquiry or at their own instigation, have recalled more than 600,000 vehicles in 13 campaigns. Since 2000, however, the agency has closed five investigations into seat heater malfunctions, involving Chrysler, Volvo, Mercedes and Volkswagen vehicles, without taking further action. In some cases, NHTSA came to the conclusion that there weren't enough complaints to constitute a trend. In others, it concluded that the harm caused by burning seats was minimal, because the vehicle did not actually catch fire or because the injuries did not require medical attention. The agency has never examined the problem of excessive seat temperatures in the context of human heat tolerances.

Researchers generally agree that normal physiologic temperature for humans averages around 37°C (99°F) at the core and between about 30 and 34 °C (86-93°F) at the skin surface. In the late 1940s, Henriques and Moritz conducted several important studies on the subject.¹⁶ They documented a range of temperature vs. time of exposure for second degree burns. They reported second degree burns at 70°C (158°F) for a 1 second exposure; 60°C (140°F) for 5 seconds; to 52°C (126°F) for 90 seconds; and 44°C (111°F)

¹⁴ Car Seat Heaters: A Potential Hazard for Burns; Pirko Maguiña, Tina L. Palmieri, David G. Greenhalgh; *Journal of Burn Care Rehabilitation*; 2003

¹⁵ Car Seat Heaters: A Potential Hazard for Burns; Pirko Maguiña, Tina L. Palmieri, David G. Greenhalgh; *Journal of Burn Care Rehabilitation*; 2003

¹⁶ Studies of Thermal Injury. II and III: The Relative Importance of Time and Surface Temperature in the Causation of Cutaneous Burns; Henriques and Moritz; *American Journal of Pathology*; September 1947

at seven hours. They documented that third degree burns occur at temperatures around 49°C (120°F) within 10 minutes.

Studies document the threshold for second-degree burns injury in children, whose propensity to burn quickly may mirror that of the frail and injured, from hot water is 45°C (113°F) for an exposure of six hours. It is extrapolated that second degree burns can result from exposure to 54°C (130°F) water for 10 seconds in children and 35 seconds for adults; and 60°C (140°F) for 1 second in children and 5 seconds for adults.^{17 18 19}

Research has shown that initial tissue temperature is the most influential parameter in determining tissue damage from burns followed by thermal conductivity of the epidermal layer and then the blood perfusion rate.²⁰ In effect, the warmer the tissue initially, the greater the temperatures experienced throughout the heating and cooling periods and the greater the threat of burn injury. The physical condition of the subject is extremely important. Henriques and Moritz noted that rate of heating of the skin is dependent on the skin thickness and physical condition of the subject as well as heat capacity and thermal conductivity of the skin layers.²¹ Heat transfer in living tissues is affected by the blood flow through the vascular network, which is a function of the rate of perfusion of the tissues, physical activity, physiological stimuli and environmental conditions.

In addition, health issues such as diabetes and paraplegia which affect perfusion of the skin can significantly alter healing resulting in a worse outcome because of underlying pathophysiologic alterations in vascular supply, peripheral neuropathy, and immune function. Studies demonstrate that paraplegic patients have significantly higher sitting pressures than normal controls, which could be of importance for the development of decubitus ulcers and serious burns when exposed to a heat source.^{22 23}

Other manufacturers and regulatory agencies have used this research as the basis for product design and standards. For example, pulse oximeters have become essential devices for evaluating and monitoring patient oxygenation.²⁴ Under Food and Drug Administration regulations, the maximum allowable temperature of the probe, which emits a small amount of heat into the skin in the process of signal detection, is set at 41°C

¹⁷ Individual Level Injury Prevention Strategies in the Clinical Setting, Future of Unintended Injuries in Childhood; DiGuiseppi, Roberts; 2000; V12. No1

¹⁸ Helfer, Kempe, Krugman, Evaluation of Physical Abuse, The Battered Child;

¹⁹ Prevention of Tap Water Scald Burns -Evaluation of a Mult Media Injury Control Program; Katcher; American Journal of Public Health; 1987; 77:1195-1197

²⁰, Prediction of Skin Burn Injury. Part 2; Parametric and Sensitivity Analysis; Ng, Chua ; Proc Instrn Mech Engineers; Vol 216; Part H: J Engineering in Medicine

²¹ Studies of Thermal Injury. II and III: The Relative Importance of Time and Surface Temperature in the Causation of Cutaneous Burns; Henriques and Moritz; American Journal of Pathology; September 1947

²² Sitting Pressure and Perfusion of Buttock Skin in Paraplegic and Tetraplegic Patients, and in Healthy Subjects: A Comparative Study; Thorfinn, Sjoberg, Lidman; Scan J Plast Reconstr Surg Hand Surg; 2002; 36: 279-283;

²³, Diabetes and Burns: Retrospective Cohort Study; McCampbell, Wasif, Rabb, Staino-Coico, Yurt, Schwartz; J Burn Care Rehab, May/June 2002

²⁴ Temperature Threshold for Burn Injury: An Oximeter Safety Study; Greenhalgh, Lawless, Chew, Crone, Fein, Palmier; Journal of Burn Care Rehabilitation; September-October 2004

(106°F). Experiments show that pulse oximeter probes are safe up to a temperature of 43°C (109°F) for at least 8 hours in well-perfused skin and that above that temperature, there is a risk of burn injury. There are also documented procedures for predicting the expected contact temperature for the system for a given design.^{25 26}

Amerigon, a seat heater supplier to the auto industry, also markets a heating and cooling mattress, under the brand name YuMe. The bed's maximum temperature setting is 104°F.²⁷ The owner's manual contains an explicit warning to certain potential users: "Do not use the heat/cool feature of this bed with an infant, a child, an incapacitated person, a paraplegic, or a quadriplegic. A person who is insensitive to heat or cool, such as a person with poor blood circulation, should not use the heat/cool feature of this product, or anyone who cannot clearly understand instructions and/or operate the controls."²⁸ (This feature is not available on the seat heaters Amerigon supplies for motor vehicles.)

The ASTM standard safe touch temperature for heated surfaces, ASTM C 1055-03 (2009) *Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries*, provides a burn injury threshold from unintentional contact and establishes a means by which the designer can determine the acceptable surface temperature of an existing system where skin contact may be made with a heated surface. The maximum acceptable temperature for a surface is derived from an estimate of probable contact time, surface configuration and acceptable level of injury. For industrial designs, a contact time of 5 seconds is established, but for consumer products, a longer 60 second contact time is proposed, and even longer to reflect the slower reaction times for children, the elderly or the injured.

In addition to setting maximum seat heater temperatures, some auto manufacturers have included in their designs heaters which automatically shut off after a specific period of time, or after the occupant compartment reaches a particular temperature. But others, including some General Motors vehicles, leave it to the occupants to determine when to turn off the heated seat feature and some have no visual telltale to alert occupants that the seat heater is on. The industry's approach to physically at-risk occupants is to include a special warning about the potential for harm to the disabled. The Chrysler Aspen Owner's Manual, for example, contains this warning:

"Persons who are unable to feel pain to the skin because of advanced age, chronic illness, diabetes, spinal cord injury, medication, alcohol use, exhaustion or other physical condition must exercise care when using the seat heater. It may cause burns even at low temperatures, especially if used for long periods of time."²⁹

²⁵ Study of Burn Hazard in Human Tissue and Its Implication on Consumer Product Design; Dussan, Weiner; ASME Journal; 1972 Paper No. 71-WA-HT-39

²⁶ Burn Hazard in Human Tissue and Its Implication on Consumer Product Design; ASME Journal 1972 Paper No. 71-WA-HT-39

²⁷ Frequently Asked Questions; web page; Microclimate Solutions; 2011

²⁸ Climate Control Sleep for You and Me; owner's manual; MicroClimate Solutions; 2010

²⁹ Chrysler Aspen Owner's Manual; 2008

Remedial Actions

Seat heater burns are preventable injuries. Despite chronic complaints, malfunctions, human heat tolerance studies and burn reports in the medical literature, there has been no systematic attempt to address the problem. Warnings buried deep in some owner's manuals are no substitute for temperature limits, timers and public awareness. All major automakers have mobility programs offering rebates for adaptive equipment and referrals to companies that convert vehicles for the use of disabled drivers. They do not, however, address an issue which presents a real danger to that market segment. Nor is there any established protocol among mobility specialists to offer any modifications to the seat heater or to automatically disconnect it. NHTSA has not considered the safety risk to the disabled community in conducting past seat heater investigations.

We recommend that manufacturers, regulators and the mobility community take immediate steps and adopt long-term strategies to prevent further harm:

- Manufacturers should limit the maximum seat heater temperatures to the limits of human heat tolerances and set all seat heaters on a timer. These time and temperature limits should be codified in an industry standard.
- The mobility adapters and automakers' mobility programs should develop a protocol to automatically disconnect seat heaters for disabled drivers with lower body sensory deficits.
- The mobility adapters should immediately send out warnings to their customers alerting them to the dangers of seat heaters.
- The National Highway Traffic Safety Administration should re-examine its approach to seat heater defect investigations and regulations. The FDA sets temperature limits for some medical devices. The Consumer Product Safety Commission does not minimize the safety risk when consumers report even minor burns from a heating-generating product, such as an electric blanket. It persuades manufacturers of defective products with the potential to burn and combust to recall them. A seat heater that gets hot enough to scorch the seat should be considered a threat to auto safety. NHTSA should categorize seat heaters which exceed human tolerance as defective and encourage automakers to recall them.