



**Fire &
Rescue NSW**

Fire research report

E-Cigarette Fire Risks and Reported Incidents



This fire research report provides an introduction to e-cigarettes. Included is an initial analysis of fires caused by e-cigarettes, a listing of some of the safety concerns that have been raised internationally, and a selection of case studies.

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Background

FRNSW has recently attended the first identified and reported e-cigarette fire incident in Australia. The incident (FireCad Incident Number 217806) occurred at the Port Macquarie Base Hospital and involved the use of an e-cigarette by a patient who was receiving oxygen therapy via a nasal applicator at the time. This incident, and the increasing prevalence of e-cigarettes in Australia, has raised interest and concern regarding the safety of these new electronic devices, and questions surrounding the number of incidents that have occurred globally to date.

Requests for information have been sent out to other fire services both within Australia and New Zealand by the Manager of the FRNSW Fire Investigation and Research Unit to determine if this is an isolated and first incident, or one of many. At the time of writing this report, this incident remains the first in the Australia/New Zealand region.

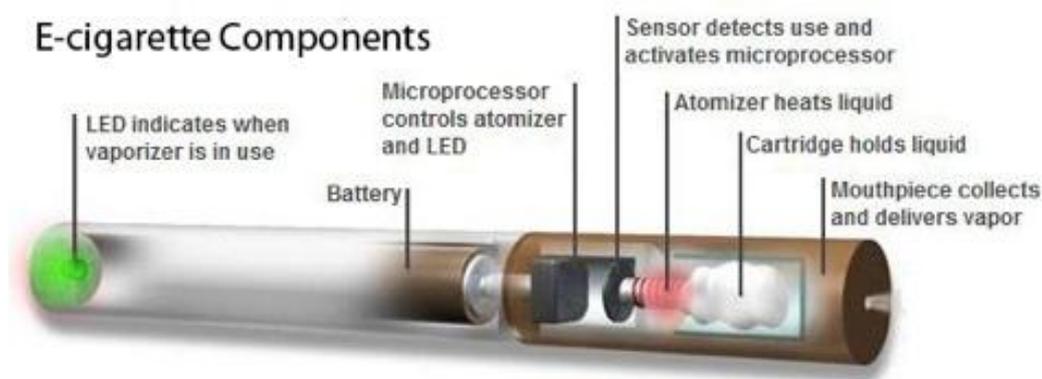
As e-cigarettes remain fairly new (invented in 2003 in Chinaⁱⁱ, initially available for sale in Europe in 2005ⁱⁱⁱ and the USA in 2007^{iv}), comprehensive data and information relating to fire risks has as yet not been thoroughly researched and published. Much information is available regarding the potential health risks of direct and indirect “vaping” (inhalation of the e-cigarette vapours), but little formal research appears available surrounding potential fire risks and hazards.

Internationally there have been numerous reports of fires and subsequent injuries associated with e-cigarettes via the media, international fire services, and to some extent via both local and national governments.

To date there have been at least 111 fire incidents in the UK^v and 25 fire incidents in the USA^{vi}, with the vast majority relating to battery issues and recharging. The data presented is at risk of being incomplete as much of the information has been gathered by local fire services reporting independently on incidents, and through independent media stories. At present, as in Australia, neither the UK nor USA national fire service reporting systems have specific itemisation within their systems for e-cigarettes.

As e-cigarettes already present a multibillion dollar industry internationally it is likely that Australia will see rapid growth in e-cigarette uptake as both the UK and USA have. To date e-cigarettes and other electronic vaporisers have been designed to replicate everything from an actual cigarette, pipe or cigar, to a usb stick or hookah. Some work by pressing a button to initiate internal heating, others simply by inhaling through the device as shown below in Figure 2.

Figure 2: E-cigarette Components^{vii}



Analysis of issues

E-cigarettes are often not manufactured by the tobacco or pharmaceutical company. Instead, they are manufactured by independent factories around the world with a significant lack of quality control in the production of both the electronic device and related battery.^{viii}

Multiple agencies have released statements regarding the concern for the risk of fire from e-cigarettes, which mainly focus around the charging process. At present there are three major issues with regard to the recharging of an e-cigarette:

- 1) the use of incorrect chargers
 - a. there are reports of non-standard chargers being used which are not designed specifically for e-cigarettes, but are cheaper to purchase
 - b. there are reports of charging by USB from another device including laptops and computers^{ix}
- 2) over tightening the screwed connection to the reusable battery
- 3) over charging the e-cigarette
 - a. unlike mobile phones, some e-cigarette lithium-ion batteries within e-cigarettes offer no protection to stop the coil overheating^x
 - b. e-cigarettes left charging for long period, especially when unattended, have led to fires in homes and cars (see Case Studies on page 7 for examples)

Further issues relate to the risks associated with a damaged or wet charger, as with any electronic device. Merseyside Fire and Rescue Service in the United Kingdom released a statement in June 2014 outlining 10 incidents known to have occurred since October 2012 involving e-cigarettes, and has listed case studies with photographs. For more information please directly visit the Merseyside Fire and Rescue Service report via this web address: www.esfrs.org/document/pdf/blackmuseum/electronic_cigarettes_MFRS_June_2014.pdf.

An identified risk related to the use of e-cigarettes surrounds “vaping” in oxygen rich environments. The UK Department of Health has issued a policy statement preventing the recharging of e-cigarettes on premises, or within vehicles. The policy statements have also prohibited using e-cigarettes in oxygen rich environments due to the heating coil, and offering safety advice to patients receiving oxygen treatment at home.^{xi}

The European Industrial Gases Association recommends that the same safety procedures apply to e-cigarettes as to conventional tobacco products. This includes not using them in any oxygen rich environments. Although no instances of fires within industry had been reported at the time of this statement, the safety advice refers to fires in home environments whilst using oxygen medical equipment.^{xii}

With regard to general use and risks, the United States of America FAA Office of Security and Hazardous Materials Safety issued a report on fires caused by batteries and battery powered equipment in aviation cargo and passenger baggage. Of 146 incidents from March 1991 to Nov 2014, at least two were determined as caused by e-cigarettes. The first was 8/14/09 on a FedEx flight, the second was 8/14/14 on a JetBlue flight.^{xiii} Although it has been difficult to confirm, the latter incident may have been caused by the button of the e-cigarette being inadvertently pressed for an extended period of time whilst in a bag in an overhead compartment, and therefore overheating and starting a fire.^{xiv}



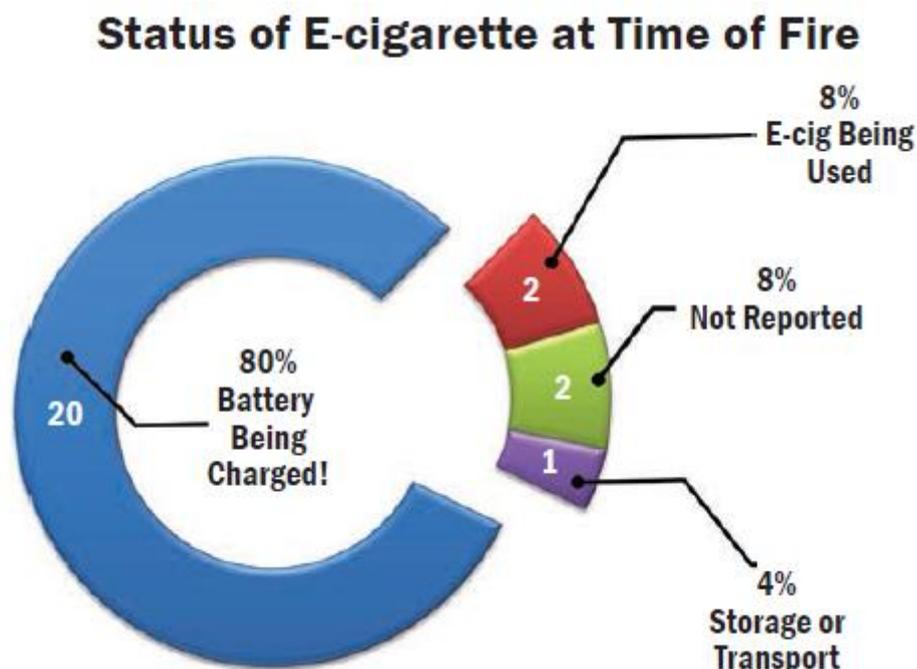
In October 2014 the US Fire Administration published a report^{xv} outlining the following facts related to e-cigarettes:

- 25 separate incidents have been reported between 2009 and Aug 2014 including explosions and fires involving an e-cigarette
- 9 injuries (no fatalities) have been associated with the aforementioned incidents, two involved serious burns
- Most incidents (80%) occurred while the battery was charging
- 8% occurred during e-cigarette use
- The cylindrical shape and design of the e-cigarettes increases the risk of “flaming rocket” explosions when the lithium battery fails.

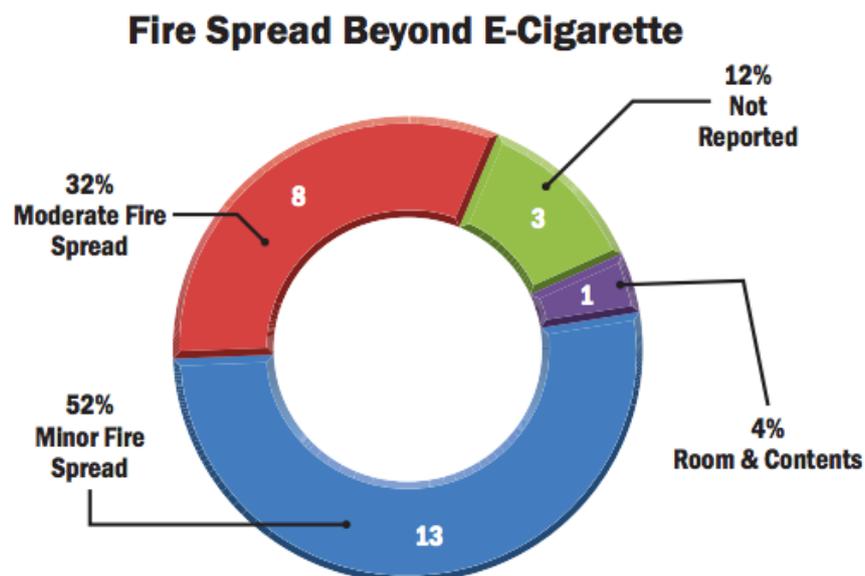
At the time of publication of the US Fire Administration report there was no regulation, code or law that applied directly to the safety of the electronics or batteries in e-cigarettes in the United States.^{xvi} The aforementioned 25 incidents may present an incomplete data set as the information was stated to have been collected via internet searches of media reports due to the National Fire Incident Reporting System (NFIRS) not collecting specific information relating to e-cigarettes. Therefore, the actual number of incidents may be significantly higher.

Figure 3 below shows the status of e-cigarettes at the time of the reported fires. Fires were reported to have occurred with as little as 10 minutes of charging time.^{xvii}

Figure 3^{xviii}



The report also published a donut chart detailing fire spread beyond e-cigarette failure. See Figure 4 on the following page.

Figure 4^{xix}

The information in the two figures was gathered mainly through assessment of photos attached with the assessed media articles. Thus, until more formal reporting systems are in place within the various national fire services, exact information is unlikely to be available.

E-cigarette internet forums and some retail website advise the risks of explosion due to overcharging, charging with an incompatible charger, or using a powerful electrical source.^{xx} As there are multiple usb power standards for power output^{xxi}, there is a high risk that an inappropriate power level will be used when charging an e-cigarette with a usb charger other than the manufacture specific charger.

It is impossible to presume to what extent these issues would be reduced if there were a higher level of regulation on e-cigarettes and their chargers; however, it is hoped that there would be some effect towards the reduction of incidents.

Case Studies

UK Case Studies:^{xxii} (note the following have been directly cut and pasted in)

Merseyside

Merseyside Fire & Rescue Service issued safety advice about charging e-cigarettes after the death of a Merseyside man following a fire involving an e-cigarette. An e-cigarette that had been charging in a bedroom exploded and caught fire. An inquest into the man's death was held in October,

2014. www.merseyfire.gov.uk/asp/pages/LatestNews/NewsDetail.aspx?id=631

South Yorkshire

Fire officers are warning about dangers posed by electronic cigarettes, in the first week UK TV advert featuring one of the devices airs. A Ford Transit van was destroyed by fire after an e-cig had been left on charge, exploded and caused nearby paperwork to catch fire.

www.syfire.gov.uk/3659.asp

West Yorkshire

Two e-cigarette batteries exploded and started fires in two West Yorkshire homes in just 24 hours. West Yorkshire Fire Service has warned it is now being called out to e-cigarette fires more than once a month. In an incident in Bradford, a battery exploded and shot across the room, coming to rest at the foot of a wardrobe, which caught fire. www.wyfs.co.uk/news/fire-service-issues-safety-warning-after-two-e-cigarette-incidents-in-just-over-24-hours

London

Fire chiefs have highlighted concerns over the safety of e-cigarettes following a blaze believed to have been caused by an exploding e-cigarette in east London. Firefighters wearing breathing apparatus rescued a woman from the ground floor flat. She was suffering from smoke inhalation and shock and was taken to hospital.

www.london-fire.gov.uk/news/LatestNewsReleases_15041420_explodingecigcausesfire.asp

West Midlands

A young mum scooped up her sons and fled in terror as the flames engulfed her bedroom. The fake fag exploded as it charged.

www.birminghammail.co.uk/news/midlands-news/exploding-e-cigarette-sets-shard-end-7173178 www.wmfs.net/content/new-e-cigs-warning

See more at: www.local.gov.uk/media-releases/-/journal_content/56/10180/6724160/NEWS#sthash.XSNvLA2n.dpuf

US Case Studies:

A detailed list of US case studies has been lifted from the US Fire Administration FEMA report, and is displayed on the following pages in Figures 5-7.



Figure 5^{xxiii}

Date	Location	Charging?	Charging Source	Fire Beyond E-Cig?	Injuries?	Notes	Source URL
Aug-09	Minneapolis, MN	NO	NA	Moderate	None	Fire in a cargo container on a FedEx jet discovered during approach to landing. Fire suppression system activated. Fire was linked to Li-ion batteries in box of Ruyan Inhalers, model RappE-Mystick.	
Nov-11	Greeley, CO	NO	NA	No	Severe	A man was hospitalized for eight days after an electronic cigarette exploded in his face, sending burning debris and battery acid into his mouth, face, and eyes. Prodigy V3.1 e-cig cited, as well as Radio Shack Energcell battery.	https://www.consumeraffairs.com/news04/2012/04/e-cigarette-exploded-in-mans-face-suit-charges.html
Feb-12	Niceville, FL	NO	NA	No	Severe	E-cigarette explodes in mouth causing severe burns, lost teeth and part of tongue. Lots of press coverage on this one. Some stories report that the device may have been modified by the user.	http://www.cbsnews.com/news/electronic-cigarette-explodes-in-mans-mouth-causes-serious-injuries/
Apr-13	Glendale, AZ	Y	USB-Car	Moderate	None	Exploded while charging from USB adaptor in car. Hot fragments ignited back seat upholstery.	http://www.kpho.com/story/22066822/unattended-electronic-cigarette-charger-explodes-car-catches-fire
Apr-13	Oklahoma City, OK	Not Reported	Not Reported	Moderate	Minor	Explosion of Li-ion battery in e-cig in office. Occupant treated for inhalation.	http://www.koco.com/news/oklahomanews/okc/Police-Explosion-at-apartment-complex-came-from-e-cigarette/19768650#t8hDI
Jun-13	Sherman, TX	Y	USB-Macbook	No	Moderate	Battery into 2-hour charge exploded in user's hand. 2nd & 3rd degree burns on hand and smoke inhalation.	http://www.kxii.com/news/headlines/E-cigarette-explodes-in-Texoma-mans-home-215771641.html
Jul-13	Corona, CA	Y	USB-car	Minor	Moderate	Charging in car led to 'blowtorch' fire and explosion. Debris flew into occupant's lap, resulting in 2nd degree burns on upper thighs and lower buttocks. VapCig brand is cited.	http://losangeles.cbslocal.com/2013/07/11/corona-couple-sues-after-e-cigarette-battery-explodes-in-car/
Jul-13	Tulsa, OK	Y	USB-Laptop	Minor		Fire while charging off laptop.	http://www.newson6.com/story/22536957/tulsa-mans-e-cig-catches-fire-while-charging

Figure 6^{xxiv}

Date	Location	Charging?	Charging Source	Fire Beyond E-Cig?	Injuries?	Notes	Source URL
Aug-13	Phoenix, AZ	Y	USB-Macbook	Minor	None	This one ignited carpet, was put out by resident. Video shows plugging into white laptop for charge.	http://www.azfamily.com/news/consumer/Exploding-electronic-cigarette-blamed-for-fire-231499581.html
Aug-13	Phoenix, AZ	Y	Not Reported	Major	Minor	Resident states in article that e-cig started TWO fires in their bedroom in recent days. They just exploded... charging for about 20 minutes. First incident scorched carpet, second gutted the bedroom. Resident treated for smoke inhalation. Smokin' T Smokin Time brand is cited.	http://www.kptv.com/story/23785774/phoenix-fd http://www.kpho.com/story/23273275/e-cigarette-nearly-sparks-fire-at-phoenix-apartment
Sep-13	Binghamton, AL	Y	Not Reported	Moderate	None	Fire in home caused by charging e-cig.	http://www.wbng.com/news/local/Fire-Marshals-charging-electronic-cigarette-sparked-fire-222081441.html
Sep-13	Grant Park, GA	Y	USB-Desktop	Moderate	None	Unattended charging via USB port on computer. Spread to couch and rug.	http://www.wsbtv.com/news/news/local/woman-says-e-cigarette-exploded-shot-flames-4-feet/nZkC/X/
Sep-13	Provo, UT	Y	USB-Car	Moderate	Moderate	Explosion while charging in car. Hot fragments ignited baby's car seat in back seat resulting in 1st and 2nd degree burns to 3 yr old.	http://newsone.com/2724915/e-cigarette-fire-utah-kinzie-barlow/
Oct-13	LaCrosse, WI	Y	Wall	Minor		Story highlights several incidents during charging. Lack of overcurrent/overheat circuitry implicated.	http://www.dailymail.co.uk/news/article-2442715/E-cigarette-explosion-causes-Wisconsin-home.html
Oct-13	Valparaiso, FL	Y	USB-Wall adaptor	Moderate	None	Explosion while charging from USB port, igniting curtains. Occurred after 10 minutes charging.	http://www.nwfdailynews.com/local/electronic-cigarette-explodes-catches-curtains-on-fire-1.214335
Oct-13	Blaine, MN	Y	USB-Desktop	Minor	None	Exploded while charging on USB plugged into computer.	http://www.myfoxtwincities.com/story/23584719/minnesota-e-cig-explosion-charging#ixzz2gh7xFIF
Nov-13	Kootenay County, ID	Y	USB-Laptop	Moderate	None	Explosion while charging from USB port of laptop. Ignited couch. Smoke alarm alerted the sleeping family of four.	http://www.wptv.com/news/local-news/water-cooler/e-cigarette-blamed-for-house-fire-in-idaho-electronic-cigarette-battery-overcharged-and-exploded http://www.nwcn.com/news/230720191.html

Figure 7^{xxv}

Date	Location	Charging?	Charging Source	Fire Beyond E-Cig?	Injuries?	Notes	Source URL
Nov-13	Warren, MI	Y	Wall	Minor	None	Device blew out of wall socket in ball of fire. Scorched hardwood flooring before occupant extinguished it. TV video report shows a USB wall charger that does not match those supplied by the manufacturer (Bulldog).	http://www.wxyz.com/news/warren-woman-says-electronic-cigarette-caused-small-explosion-and-fire
Nov-13	Eugene, OR	Y	Auto	Moderate	None	Device failed after about 2 hours charging. Fragments flew to back seat, igniting seat of truck.	http://www.kval.com/news/local/E-cig-explodes-damaging-truck-231482791.html?tab=video&c=y
Nov-13	Colorado Springs, CO	Y	Not Reported	Moderate	Moderate	Unattended while charging on floor. Ignited bed. Home occupant burned arms, hands & face while using blanket to smother flames.	http://www.krdo.com/news/ecigarette-blamed-for-mattress-fire/23206306
Dec-13	Springfield, MO	Y	USB-Laptop	Moderate	Moderate	Failure while charging on laptop USB port. Ignited bedding, 2nd degree burns on leg and foot. User quoted as saying he likely used the wrong charger.	http://www.ky3.com/news/local/man-experiences-explosive-consequence-from-using-electronic-cigarette/21048998_24083270
Mar-14	Medford, OR	Y	Not Reported	Minor	None	Exploded while being charged, sending bits of burning battery flying into the ceiling and walls. One hot piece of battery landed on a pillow, causing it to smolder and filling the house with smoke.	http://www.katu.com/news/local/Fire-marshall-E-cigarette-batteries-cause-fires-in-Medford-248274331.html
Mar-14	Medford, OR	Y	Not Reported	Minor	None	The lithium batteries that power the vaporizers in electronic cigarettes caused two recent fires in Medford. In this second case, a mattress caught fire but a resident put it out.	http://www.katu.com/news/local/Fire-marshall-E-cigarette-batteries-cause-fires-in-Medford-248274331.html
Mar-14	Lompac, CA	Y	Wall	Moderate	None	Started kitchen fire while charging unattended.	http://www.ksby.com/news/e-cigarette-blamed-for-kitchen-fire/
Mar-14	Syracuse, NY	Not Reported	Not Reported	Moderate	Moderate	Patient on oxygen in a hospital suffered 1st and 2nd degree burns. Patient had e-cig, but investigation has not yet tied e-cig to the ignition. Hospital has banned e-cigs out of caution.	http://www.foxnews.com/us/2014/04/22/ny-hospital-reinforces-ban-after-e-cigarette-fire/

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