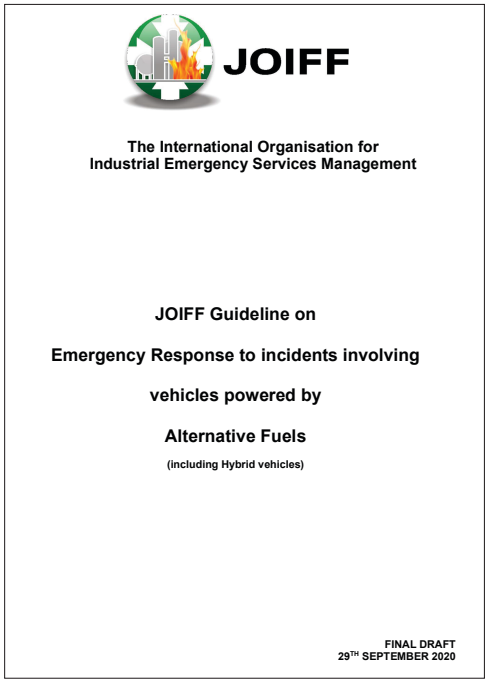
JOIFF Guideline on emergency response to incidents involving vehicles powered by alternative fuels, including hybrid vehicles


JOIFF

The International Organisation for Industrial Emergency Services Management

JOIFF Guideline on

Emergency Response to incidents involving

vehicles powered by

Alternative Fuels

(including Hybrid vehicles)

FINAL DRAFT
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JOIFF, the International Organisation for Industrial Emergency Services Management, through their shared learning committee, compiled this Guideline to assist emergency services in responding to incidents involving vehicles powered by alternative fuels including hybrid vehicles. JOIFF gave special permission to Fire and Rescue International to publish the Guideline in order to assist our emergency services in dealing with the challenges they face during these incidents.

Due to the length of the Guideline, it will be published in three sections, with this section including its first four sections.

Section 1: Foreword

JOIFF, the International Organisation for Industrial Emergency Services Management, is a not-for-profit organisation dedicated to developing the knowledge, skills and understanding of emergency services personnel by working to improve standards of safety and of the working environment in those sectors in which its members operate.

JOIFF's prime activity is Shared Learning aimed at driving inherent safety, continuous risk reduction and safe management of residual risk in industry. JOIFF Guidelines are an important part of JOIFF's Shared Learning philosophy, to increase the JOIFF Shared Learning knowledge base in line with new developments requiring different approaches to emergency response to assist its members to work to current levels of Good Industry Practice within their own sites and to ensure that emergency responders are well informed, competent and correctly equipped to deal with potential accidents/incidents to which they may be required to respond within their Area Emergency Response Plan.

This JOIFF Guideline has been developed to support those whose responsibility in their Area Emergency Response Plan includes dealing with incidents involving vehicles powered by alternative fuels. The number and types of vehicles using alternative fuels is growing rapidly leading to growth in the number of incidents, including fire, involving these vehicles. Good Industry Practice requires emergency services management which might be faced with having to provide emergency response to these incidents, to have a full understanding of the hazards and risks so that they can develop suitable standard operating procedures (sops)/standard operating guidelines (SOGs) and training materials and provide effective training for responders.

> *"Emergency responders dealing with incidents in alternative fuel vehicles need to carry out their own Hazard Identification and Risk Assessment exercises before they begin operations at each incident"*

JOIFF hopes that this Guideline will provide information and background detail necessary to enable emergency services management to identify the hazards, assess the risks and decide the action necessary to take in dealing with such incidents in their Response Area.

JOIFF recommends that those who may be required to respond to incidents involving vehicles powered by alternative fuels should ascertain if any local/national rules/regulations pertaining to vehicles powered by alternative fuels are in place in the country/region in which they operate. These may take precedence over any comments/recommendations in this Guideline.

The directors of JOIFF extend their thanks to the JOIFF Working Group of experts who developed this Guideline.

Section 2: Introduction

One of the major targets towards helping combat climate change today is the reduction or elimination

of the use of vehicles powered by petrol and diesel products and replacing them with vehicles referred to as "alternative fuel vehicles". Alternative fuel vehicles currently include vehicles powered by batteries (high voltage fuel cells), compressed natural gas (CNG), liquid natural gas (LNG), biofuels and hydrogen fuel cells, cylinders/tanks.

The use of alternative fuel vehicles of all types is a growing exponentially and includes not only passenger cars but also light and heavy commercial vehicles, busses, coaches, fire and rescue appliances, specialist vehicles etc. The increasing number and type of these vehicles will require emergency responders to be competent in dealing with vastly different hazards than those encountered at incidents involving petrol and diesel-powered vehicles.

This Guideline provides information on some of the hazards that responders may have to identify when they have to respond to an incident involving these vehicles and discusses some important response issues and techniques. Emergency responders dealing with incidents in alternative fuel vehicles need to carry out their own Hazard Identification and Risk Assessment exercises before they begin operations at each incident and act in accordance with their own standard operating procedures (sops)/standard operating guidelines (SOGs).

Section 3: Terms and definitions

For the purposes of this Guideline, the following terms and definitions apply.

3.1 Alternative fuels

Alternative fuels are fuels or power sources which serve, at least partly, as a substitute for fossil oil sources in the energy supply to transport and which have the potential to contribute to its decarbonisation and enhance the environmental performance of the transport sector. They include electricity, hydrogen, biofuels, natural gas compressed and liquefied and liquefied petroleum gas (LPG) and their possible simultaneous and combined use by means of, for instance, dual-fuel technology systems. (From EU Directive 2014/94/EU).

3.2 Battery

A primary battery is one that is not rechargeable, a secondary battery is one that can be re-charged. A battery is a combination of electrochemical cells which convert chemical energy into electrical energy to provide electricity to items such as electric motors. Secondary battery cells can be as small as the standard cell used to power torches etc. but unlike this type of cell, which is usually a primary battery and cannot be recharged; secondary cells used in vehicle batteries can be re-charged many times according to manufacturer's instructions.

A battery module is a battery assembly comprising a fixed number of cells put into a frame to protect the cells from external shocks, heat and vibration. A battery pack, which is the final shape of a battery system, is composed of modules and various control/protection systems including a battery management system, a cooling system etc.

One of the most popular electric cars internationally uses a battery pack encased in protective steel comprising four modules containing 1 000 cells each.

3.3 Electrolyte

An electrolyte is a compound which in a solution conducts electricity and is decomposed by it. ▶

- The electrolytes of all batteries, primary, secondary and whether they are alkaline, lead acid or lithium ion etc. present the hazard of being corrosive and/or toxic.

3.4 Exothermic reaction

An exothermic reaction is a chemical reaction that releases energy through light or heat.

3.5 Hybrid vehicle

A hybrid vehicle is a vehicle with more than one method of propulsion. Each method can be powered or charged by another method or can be totally independent of the other method.

If one of the methods of propulsion in a hybrid vehicle is a battery system, a similar hazard is present as in a vehicle fully propelled by batteries. Subject to a risk assessment, recommended emergency response actions where a hybrid is involved may be as set out in this Guideline, primarily in Section 5: Operational response for fires/incidents involving electrically powered vehicles.

3.6 Stranded energy

Stranded energy is energy remaining in lithium ion (li-ion) cells after efforts to safely discharge the stored energy in damaged cells. Significant fire and shock hazards are presented by stranded energy as it is difficult to know when and how the batteries can be safely removed from their installation and then transported and disposed.

3.7 Thermal runaway

Thermal Runaway is an exothermic reaction that can occur in any battery. For the purposes of this Guideline, thermal runaway relates specifically to lithium ion (li-ion) batteries.

The anode breaks down to liberate methane and ethane gas, the electrolyte expands and evaporates, creating a vapour of flammable gases and as the temperature continues to rise, the energy stored in the battery is released, the cathode breaks down releasing oxygen and therefore provides all elements necessary for a fire.

The risk of thermal runaway begins at a temperature of around 60°C (140°F) and eventually temperatures can exceed 600°C (1112°F) as the battery becomes gaseous and a fire erupts. The time taken for a li-ion battery to go into thermal runaway is entirely dependent on the rate of heat absorption into the cell. When the increasing temperature nears 120°C (248°F), batteries may emit gas and/or rupture. If the threshold temperature near 120°C (248°F) is not crossed, the battery may smoulder and gas but may not ignite unless an external spark ignites the flammable gasses emitted from it.

The exothermic reaction in a cell can drag adjacent cells into a thermal runaway and may cause li-ion cells to ignite within a battery, hours or even days after an initial fire, crash or technical failure/production fault. The spread of thermal runaway to adjacent cells depends on a number of factors amongst which are the distance between cells, the presence of heat insulating material that may prevent spreading or the presence of means of active cooling, eg with a coolant etc. The amount of energy remaining in the battery when it is damaged can greatly affect the severity and duration of this reaction.

Thermal runaway can be stopped by deep cooling the battery pack or by immersing it in water – salt water is recommended (see clause 5.5.3). It can also be stopped by draining the battery of the energy causing the reaction but this is a very specialist task.

Section 4: Lithium batteries

The difference between primary lithium batteries - "non-rechargeable" or "disposable" - and secondary lithium batteries - "rechargeable" - is the form of the lithium that they contain. A primary lithium battery is a battery that has lithium metal or lithium compounds as the anode. Primary lithium batteries are also known as lithium metal batteries or "Li-Metal batteries."

A secondary lithium battery is a battery that contains lithium ions that move from the negative electrode to the positive electrode during discharge and back again when charging. Secondary lithium batteries are also known as lithium ion batteries or "li-ion" batteries.

Li-ion batteries offer excellent power and energy density; they have a large operating temperature range and are lightweight. Low voltage li-ion batteries are widely used in portable devices such as watches, mobile phones, computers etc.

High voltage li-ion batteries are used to power electric vehicles as they are much more flexible for use than the more traditional batteries like lead acid. It is usual that all of the constituent component battery cells in an electric vehicle are sealed within a pack as inter-connected subgroups in what are called pods/modules. The exterior of each pod/module is isolated from internal components and the pod/module is then installed in a rigid metal enclosure called a battery pack. A battery pack, even in a normally discharged condition is likely to contain substantial electrical charge and can cause injury or death if mishandled. This risk increases if the outer enclosure, pod/module enclosures and/or safety circuits have been compromised or have been significantly damaged.

Li-ion batteries require a good battery management system to protect circuits to prevent thermal runaway if stressed.

The next edition will feature Section 5: Operational response for fires/incidents involving electrically powered vehicles.

Visit the JOIFF web site for information on membership: www.joiff.com or watch their introductory video: https://www.youtube.com/watch?v=lkzpYzrSHf4.

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