

# Public Safety related to fast charging zero emission buses in public space

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## ABSTRACT

The energy transition means that The Netherlands reduces, and in the end, eliminates its fossil energy sources, like natural gas and gasoline. One of the focal points is electrification in the transportation area. Public transport, including buses, are part of that focal point. These buses are charged involving high currents. Fast charging, using (direct) high currents takes place in the bus depots as well as in public space. However, fire and electro risk come along with this charging process.

Thorough (inter)national analysis revealed that there are no directives or guidelines available for this. This paper presents a) the safety risks that accompany the fast charging activities in the public space and b) the prevention and emergency procedures to deal with these risks.

## INTRODUCTION

Carbon dioxide is considered to be one of the prime contributors to the warming of the earth. The Dutch government made the energy transition a key topic in its policy to reduce the carbon dioxide emission. The energy transition means that The Netherlands reduces, and in the end, eliminates its fossil energy sources, like natural gas and gasoline.

One of the focal points is electrification in the transportation area. Public transport, including buses, are part of that focal point. Regional and local transport authorities organize electric bus transport. The province of Overijssel is such a regional authority. The province intends to organize zero emission public bus transportation in their region, using electric buses. These buses use lithium-ion battery packs for storing the energy and moving the bus. The battery packs need to be charged (loaded) every couple of hundred kilometres. The province of Overijssel intends to facilitate high power opportunity charging in the public domain. This type of bus charging activity is fairly new in The Netherlands, because it normally takes place in the bus companies private areas / bus depots. The province is aware of the specific safety risks of bus passengers and third parties.

Fast charging, using (direct) high currents takes place in the bus depots as well as in public space. However, fire and electro risk come along with this charging process. The issue here is: how to deal with these risks? What kind of prevention measures are effective and what are the appropriate emergency procedures?

In January 2019, an electric bus caught fire in the municipality of Edam (The Netherlands). The bus was parked below the pantograph. However, the bus was not charged at that precise moment. Despite the fact that the bus was not charged, the firefighting had difficulties suppressing the fire. The reasons were that this was a fairly new situation in which the fire fighters did not have standard operating procedures, and the possibility of being electrocuted was on their minds during the suppression activity.



Photo: Nieuw-Volendam.

## **METHOD AND RESULTS**

We started by searching for legislation regarding this typical charging activity. Subsequently, we interviewed a variety of Dutch municipalities, fire fighters, transport authorities and companies for their experiences, knowledge and guidelines. Both activities made clear that there are no guidelines or whatsoever for public safety as a result of public space fast charging bus activities. In addition, we informed foreign European safety research institutes such as TÜV (Germany) RISE (Sweden) and Ineris (France). The same conclusion: no guidelines available. Hence we developed the guidelines ourselves. Combining engineering knowledge and firefighting experience we developed some concept guidelines.

### **The charging process and safety risks**

Electric buses can be charged in several ways. Panto-down means that the bus is parked below a structure from which a pantograph descends to the roof of the bus making contact to the bus. After a safety check, the bus is being charged. Panto up means that the pantograph of the bus ascends into a hood of a structure above the road. And then, the same communication and charging process is executed.

Three risks go along with this charging process. Fire, an electric arc and electrocution. The latter two are less probably, hence we focus on in this paper on the fire risks. Three mechanisms may injure third parties, including flame contact, heat radiation and toxicity.

### **Incident management procedure**

As mentioned above, standard operating procedures do not exist so far for electric busses involved in an incident being charged in the public domain. There are several organisations who have a responsibility in the incident management process:

- Bus company: responsible for the safety of bus passengers, the bus driver and bus and charging knowledge for the incident management process. The bus company could establish the contact to electrical expertise of the charging company
- Firefighting: suppressing the fire.
- Municipality: responsible for the safety on its road/public domain, however in case of an

accident, the municipality has hardly any role to add to the incident management.

In table 1, we present the activities of the bus company and the firefighting in suppressing the fire.

**Table 1: Fire suppression activities of the bus company and the fire fighting**

	<i>Bus driver/ bus company</i>	<i>Firefighting</i>
<i>Notification</i>	Notices the incident, activates the emergency button, evacuates passengers and report the bus office, firefighting and charging company  Activates the bus companies safety protocol  Informing the companies/ organisation nearby the incident  Pantograph down	
<i>Alarming</i>	Alarming the companies expert and orders him/her to the accident scene	Dispatches of firefighting units and notification of the organisations nearby the incident
<i>driving</i>	Drives to the accident scene, upwind	Drives to the accident scene, upwind
<i>positioning</i>	Upwind	Fire engine upwind
<i>Exploring</i>	-	Fire commander and his/her crew explore the accident scene and close environment Contacts the bus driver and eventually the bus companies expert  Check whether the pantograph is down
<i>Fire suppression</i>	Adds specific bus/charging infrastructure and charging process expertise	Suppresses the fire: low pressure on 2,5m distance from the pantograph (in case the pantograph is still in contact with the charging infrastructure (using the ir own standard operating procedures)
<i>recovery</i>	Makes arrangement to a tow company. Together, the organise the completion of the accident  Organizes the replacement of transport for the passengers	In case of stable battery pack, bus is transferred to the tow company.  Firefighting units return to the fire house  Clean work procedure: decontaminate/disinfect clothes

The bus company and the firefighting have their own responsibilities in the incident management. The bus company needs to have an incident management protocol and organisation The fire brigade needs a standard operating procedure. Both procedures need to be aligned in clear way.

The bus company needs to arrange:

- Emergency button for the bus driver
- Evacuation protocol for bus passengers
- Bus driver notification to the bus company's expert and direct him/her to the accident scene
- Activation protocol for the emergency procedure
- Notification procedure for involved/nearby organisations
- Procedure for descending the pantograph
- Contact to towing company

The fire brigade needs to

- Check pantograph is down:

<b><u>Pantograph down: no contact</u></b>	<b><u>Pantograph in contact with charge infrastructure</u></b>
Suppress fire as an ordinary bus fire: low pressure	Use tied water beam: high pressure
Aligning the bus expert regarding electrical safety	Aligning the bus expert regarding electrical safety

- Bus transfer to the tow company in case of 'thermal runaway' absence
- Clean work procedure: decontaminate/disinfect clothes

## **CONCLUSIONS**

There are hardly any guidelines or whatsoever available for public safety as a result of public space fast charging bus activities. We developed a sequence of major activities to manage the incident, involving the activities for the bus company and the firefighting. It is now to the bus company and the firefighting to further develop the necessary procedures and to align them.

## **REFERENCES**

IFV and Van der Staak, *Veiligheidsaspecten van het laadproces van elektrische bussen in de openbare ruimte in de IJssel-Vecht concessie*, 25 april 2020, Arnhem.