OITAF Congress 2024 Vancouver : « Ropeways – Smart transport solutions »

Session 3
Ropeway technology, new developments

Fire risk under ropeways – a new approach to fly over difficulties

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Urban projects and new ropeways between valleys and ski resorts have been developping quickly the last years in France, with ropeway installations going over more and more complex areas. Roads, railway tracks, various buildings, specific vegetation, ... every such installation has its specific topics as far as fire risk is concerned.

This article will aim at showing how french professionnals handled this subject, in order to guarantee an homogeneous acceptable level of safety without blocking these innovative new projects, defining precise criteria and measures to be implemented depending on the installation type and potential fire sources overflown.

1. Existing rules adapted to new project types, but more and more complex to implement

In France, the regulation was updated in 2016 in order to be more flexible and to adapt to specificities of emerging projects, mainly urban ropeways. In addition to the existing simple measures based on distances and systematic fire detection in some cases, a specific safety analysis on fire risk was asked in some cases where potentiel fire sources were judged more complicated to handle. This rule was especially designed and applied for urban projects.

In the same time, the European standard EN 17064 *Safety requirements for cableway installations designed to carry persons - Prevention and fight against fire*, released in 2018, took similar measures, defining a study zone around / under the installation in which to consider potential fire sources, with the risk taken care of by a specific safety analysis.

The first urban projects in France were quite simple :

- For the jigback in Brest, a military marine base is flown over, with the only risks being military buildings and vehicles, flown over from comfortable distances ;
- A jigback project in Orléans (cancelled since then) would have been going over the tramway, a road and mainly a very large railway with passenger and freight trains ; once the case of a hazardous material train was discussed and treated, the other subjects were easy.

But then arrived some projects with longer lines, going over more complex zones, just to cite a few :

- Gondola « Papang » in Saint Denis on Réunion island, going over numerous very varied buildings, and roads of all sizes,
- 3S « Téléo » in Toulouse, going over buildings, medium roads and vegetation,
- Gondola project in Créteil, going over buildings, roads, motorways, railways, and scattered vegetation that the project initiators wanted to avoid cutting as much as possible,
- Gondola project in Grenoble, going over a similar combination of buildings and roads of all size.

In 2021 and 2022, when the first specific safety analysis for fire risk were made for these bigger projects, some points were quite homogeneous, for example the criteria considered for the temperature of the rope and for the thermal flow under the vehicle.

But when some criteria were exceeded and specific approaches had to be tackled to accept these situations, some very complicated and sometimes philosophical discussions occurred, with the french control authority trying its best to take a coherent approach between these projects.

The most complicated discussions were on the fire risk linked to vehicles on a road under the installation :

- What fire sources (fire length and power) should be considered depending on vehicle types ?
- Depending on the road size, which types of vehicles should be considered ?
- If there is a traffic ban for a certain vehicle type but not enforced physically, is it possible to consider the risk covered ?
- Is it possible to reason with probabilities linked to traffic ? based on which fire rate ? to which limit values ? for which vehicle types ?
- Is a fire detection enough in all cases ?
- …

2. Discussions among french professionnals in order to provide a framework

In the idea to try to be as coherent as possible and to try to avoid having such complex discussions again for every following projects after 2022, the french authority decided to initiate a discussion on the subject with french professionnals : manufacturers, operators, project contracting authorities, ropeway project management firms, expert fire risk laboratory and control authorities. The goal was to provide a more detailed framework for the content of specific fire risk analyses, and agree on a shared philosophy on how to handle fire risk, with most discussions linked to the environment under the line.

Following some productive meetings with interesting and precise ideas from all professionnals, new rules were established in the update of STRMTG guidelines for new installations « RM2 », published in September 2023. They were also written in compliance with european standard on fire risk on ropeways EN 17064, and featured several additional measures not covered by this article.

This new text has several aims :
- setting a common methodology for fire risk analysis so as to avoid too much dispersion in content and reasoning on the projects,
- setting objective acceptable criteria for output values from fire studies (for example critical scenarios to consider, static and dynamic thermal flow, temperature, probabilities, …),
- allowing more precise cases of flat-rate values for stand-off distances, not only for buildings and vegetation, but also for transport infrastructures depending on allowed vehicles on them,
- defining cases in which automatic fire detection is unavoidable,

- taking into account stations without operator on site,
- and in the same time still allowing simple rules, applying on more standard installations with small or no particular fire hazard.

3. A range of options to cover fire risk under the line

For every installation, the first step is to identify all the potential fire sources under the line in a proximity zone described very closely to standard EN 17064 definition :

- Under the line, laterally until 12m from the axis of the exterior of the rope, without rope deviation,
- Less than 12m around the buildings necessary to run the installation.

3.1 Flat rate distances

If a potential fire source is identified, the first and most simple possibility is to fly over it as high as possible. The existing « simple » rules for fire risk were already based on this principle, but rules were completed with aditionnal possible measures.
If the installation is far enough from the potential fire source and respects these values, it is not needed to perform any other complex calculation or analysis to cover the risk, as it has been verified on various projects that these height values led to acceptable values on the temperature and thermal flow criteria.

3.1.1 Flat rate distances for buildings

The existing rule was more detailed and completed, the end result being vertical flat rate limit distances of :

- 20 meters from the rope position (existing value),
- 16 meters from the bottom of the vehicle (new value).

Also, the notion of « specific building » was added, to consider for example facilities classified for industrial risks, for which specific more detailed analysis are needed.

3.1.2 Flat rate distances for vegetation

The existing rules were also more detailed and completed, the end result the following distances :

- Clearing layout going at least until 1,5 meter from the end of the envelope space (existing value),
- Going over tree tops with a height of more than 30 meters (existing value),
- In order to enable to keep small groups of tress, aditionnal possibility to go with envelope space 2,5 meters above groups of trees, in the condition that specific measures are taken to maintain / cut the vegetation in the spirit of legal obligations to clear overgrowth. After some reflexions, more precise criteria were added on the basis of the detail of these obligations in some areas in the south of France with many forest fires : eliminating bushes under trees, spacing tree crowns by 3 meters or more, or keeping groups of trees < 50m² at a distance of more than 5 meters from any other tree.
- In the same idea, it is allowed to go with envelope space 2,5 meters above tree lines, as long as tree crowns are distant 3 meters or more, and no vehicle is allowed to park under the trees.

3.1.3 Flat rate distances for transport infrastructures

These are totally new values, which were determined by a fire engineering laboratory, on the basis of calculation of acceptable thermal flow on the floor of a vehicle (most difficult criteria to respect), with some margin.
These values were determined for different vehicle types (on roads and on the installation) :

Vehicle categories	***Ropeway with cabins***	***Ropeway with chairs***
	Height road / cabin	***Height road / chair***
Cars	13 meters	14 meters
Buses Trains with passengers	19 meters	20 meters
Trucks <26T	25 meters	This would be too high for a chairlift, as other rules limit its height to 25 meters.
Trucks 35T Fret trains solid goods	33 meters	
Trucks or trains carrying hazardous materials	40 meters	

3.2 Framing of specific safety analysis on fire risk and associated criteria

It was first clarified that this safety analysis is needed in the following cases :
- If flat rate distances could not be reached,
- In case of specific buildings such as buildings with industrial hazard,
- In case of specific vegetation,
- If the project goes over complex areas with numerous potential fire sources under the line : typically, this applies to urban ropeway projects and some « valley lifts ».

Then, some methodology aspects are set :
- Fire sources for buildings must be taken in the Eurocodes,
- Fire sources for vehicles must be taken in some guidelines by the french center for tunnel studies, service handling vehicle fire hazard in road tunnels,
- Vehicles must be modelized by parallelipipeds and be positionned in the right direction on the road.

In general, the specific fire analysis relies heavily on some modelling and calculations determining a thermal field, making it possible to determine temperature and thermal flow values at different points.

This is where criteria come into play with a definition of limit values :
- Structural integrity of the rope relies on the properties of steel depending on the temperature, so the criteria was fixed at 350 °C based on Eurocode values for steel ; however, it is possible to go higher in case of succesful tests ;
- The main and rather limiting criteria is static thermal flow on the bottom of the vehicle : this characterises the thermal danger for passengers if the vehicle stops over a fire ; its maximum acceptable value is fixed at 2 kW/m² for an open vehicle such as chairs on chairlifts, and at 3 kW/m² for closed vehicles such as gondolas, taking into account the separation offered by the floor ;
- Another criteria on thermal flow is dynamic thermal flow, with a limit value fixed at 600 $[(kW/m^2)^{(4/3)}.s]$; generally, it is much easier to reach than the static thermal flow, and so dynamic thermal flow is mainly calculated in order to verify that if the safety demonstration is based on a fire detection and organizationnal measures to recover the vehicles over a potential fire, the dynamic thermal effects of the fire on the vehicle in movement are acceptable for the passengers ;

- If the installation is to be kept in motion in case if a fire, it must be checked that the temperature on the towers still enables the passage of vehicles ; typically, on monocable installations, this is intended to check whether the rollers are still performing their function and to what extent their tyres may be deteriorating ;
- Maintaining support conditions on line structures following a fire at the foot of a tower : a justification is required for non-tubular towers only, as such justifications were already given for quite high monocable gondolas tubular towers, with little effect on the rope support forces.

Of course, the ideal situation is to fulfill these criteria and obtain acceptable values. But in the reality of projects, there are often a few zones where it is not technically possible to respect them on the project, for example going over a road close from a station, or being very restricted in the height due to a crossing of electrical lines.

Some possibilities are made available to accept to exceed criteria values :

- through a combination of technical and organisational measures, such as the installation of automatic fire detection systems combined with keeping the installation running in case of fire, or the installation of specific fire protection devices ; in the case of the use of fire detection, there are some conditions :
    - as already explained, the criteria on dynamic thermal flow must be fulfilled in operation,
    - if the fire detection covers an exceed over the temperature criteria for the rope, an organization must be put into place to monitor fire alarms also out of operation, so as to be able to put the rope in motion and avoid its falling on dangerous areas such as roads or buildings ;
- through a probabilistic approach, for which acceptable values are clearly defined, and with some conditions :
    - if the fire could jeoparadize the whole installation in case of exceeded criteria (mainly if the temperature on the rope is too high), the limit value is 10^{-8}/h, corresponding to the equivalent of safety integrity level SIL4 already much used for example on railway systems to cover risks jeoparadizing an entire train ;
    - if the fire could jeoparadize one or only a few vehicle (typically if static thermal flow is too high), the limit value is 10^{-7}/h, corresponding to the equivalent of SIL3 used to cover individual severe accidents on railway systems ;
    - typical fire rates for road vehicle types are defined in a guideline by the french center for tunnel studies, and shall be used in calculation hypothesis ;
    - in addition, traffic hypothesis must be evaluated again periodically, to identify for example a situation in which a probability calculation would be just acceptable and the traffic would double in 5 years, case for which new discussions about fire risk would need to be held and potentially additionnal measures taken.

3.3 Particular cases

We have seen that these rules, although quite clear, are also complex, and potentially difficult to apply or too time-consuming for some « medium simple » projects, for example an installation in a ski resort going only over a road leading to a few chalets.

To enable a simpler reasonment for this type of case, some more rules were added. A first one is based on probability calculations with some margin, and leads to the following traffic limits, reasoning on a notion of « marginal traffic » :

Vehicle category	*Max mean trafic for monocable ropeways*	*Max mean trafic for bicable ropeways*
Cars, buses considered separately	200 vehicles / day	20 vehicles / day
Trucks considered separately	100 vehicles / day	10 vehicles / day
Consideration of total traffic	250 vehicles / day	25 vehicles / day

Another simplified rule was elaborated for ropeway installation with chairs going over roads with a height superior than 10 meters : in this case, it is possible to avoid the complicated fire analysis with temperature and thermal flow calculations, and to cover fire risk directly by putting a fire detection and organizationnal measures to prevent the installation from stopping in fire conditions : this rule was determined by a dynamic thermal flow calculation with a truck burning under the line.

4. Specific rules for fire detection

If an automatic fire detection is put into place, it must trigger a specific alarm in the control center of the installation ; logigrams were established to clarify who should do what and when.

Also, it was decided to make fire detection mandatory in the following cases :

- For buildings with a criteria exceeded,
- For various cases, specifically for urban installations :
    - To cover roads with buses, because of potential hazards due to some bus technologies (electric, natural gas) ; the detection can be avoided in case of a convention between bus and ropeway operators in order to be sure what kind of buses can circulate under the ropeway ;
    - To cover roads with trucks, on which either a criteria was not respected or the notion of marginal traffic was used : this was implemented to be sure to have a fire detection in place when a probabilistic approach was used to cover fire hazard linked to trucks ; in urban areas, the risk and the general truck traffic is judged higher ; same goes for railways with fret trains ;
    - To cover public, office or industrial buildings closer to the installation than flat rate distances ; the detection can be avoided in case of a convention with the ropeway operator, to ensure that the use of the building remains the same in the long term, or be aware of it and re-assess the risk.

5. First feedbacks on the application of this approach

All these dispositions have been enforced by « RM2 » guide only since September 2023, but these new principles have been applied to various real projects, complicated and simple.

To give a few examples :

- On a complex « valley lift » currently built in Saint Gervais going over various roads and buildings, almost all the possibilities of the rules were used (flat rate distances, determination of criteria, some not reached trated with fire detection, others with marginal traffic), and the discussions were much simplified and reduced to only a few points ; without the new rules, discussions would surely have taken three or four times more.
- On the project of Créteil, the rules on groups of trees may have enabled to spare some trees on the project, and justify it in an acceptable way.

- On a fixed chairlift in Vars, the simplified rule enabling to put a fire detection without any complicated thermal flow calculation was applied, and it saved time and complex justifications just for one road.
- On usual mountain installations, the old rules are still applied and unchanged in the new text, and it does not change anything on the projects.

A feedback with french professionnals will be organized in 2025 to identify potential problems with some specific measures, or to identify points that might not be clear or which might have been missed.

In the end, as projects got more and more complicated regarding fire risk under the line, it was possible to handle reflexions with all professionnals, to add in parallel more and more complicated rules, but which helped to clarify the situation in many cases. The future will tell if this approach can adapt to the various situations of every project, in urban areas, touristic areas and mountains.

If you want to read all the detail of these new rules, you can go to STRMTG website and download RM2 guide (in french only), prevention of fire risk under the line is covered in chapter A3-7.7.3 : https://www.strmtg.developpement-durable.gouv.fr/reglementation-technique-des-telepheriques-des-a300.html