CIGRE Session 2022

Key Take Aways from B2 - Overhead lines

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cigre

For power system expertise

Preferential subjects 2022

PS1/CHALLENGES & SOLUTIONS IN DESIGN, CONSTRUCTION OF NEW OHL

- Design for reliability, availability, future climate parameters, vandalism, theft…
- AC/DC hybrid lines, multi-purpose utilization
- OHL challenging construction projects (e.g. **BE paper ID 10719**)

PS2/LATEST TECHNIQUES IN ASSET MGT, CAPACITY ENHANCEMENT, REFURBISHMENT

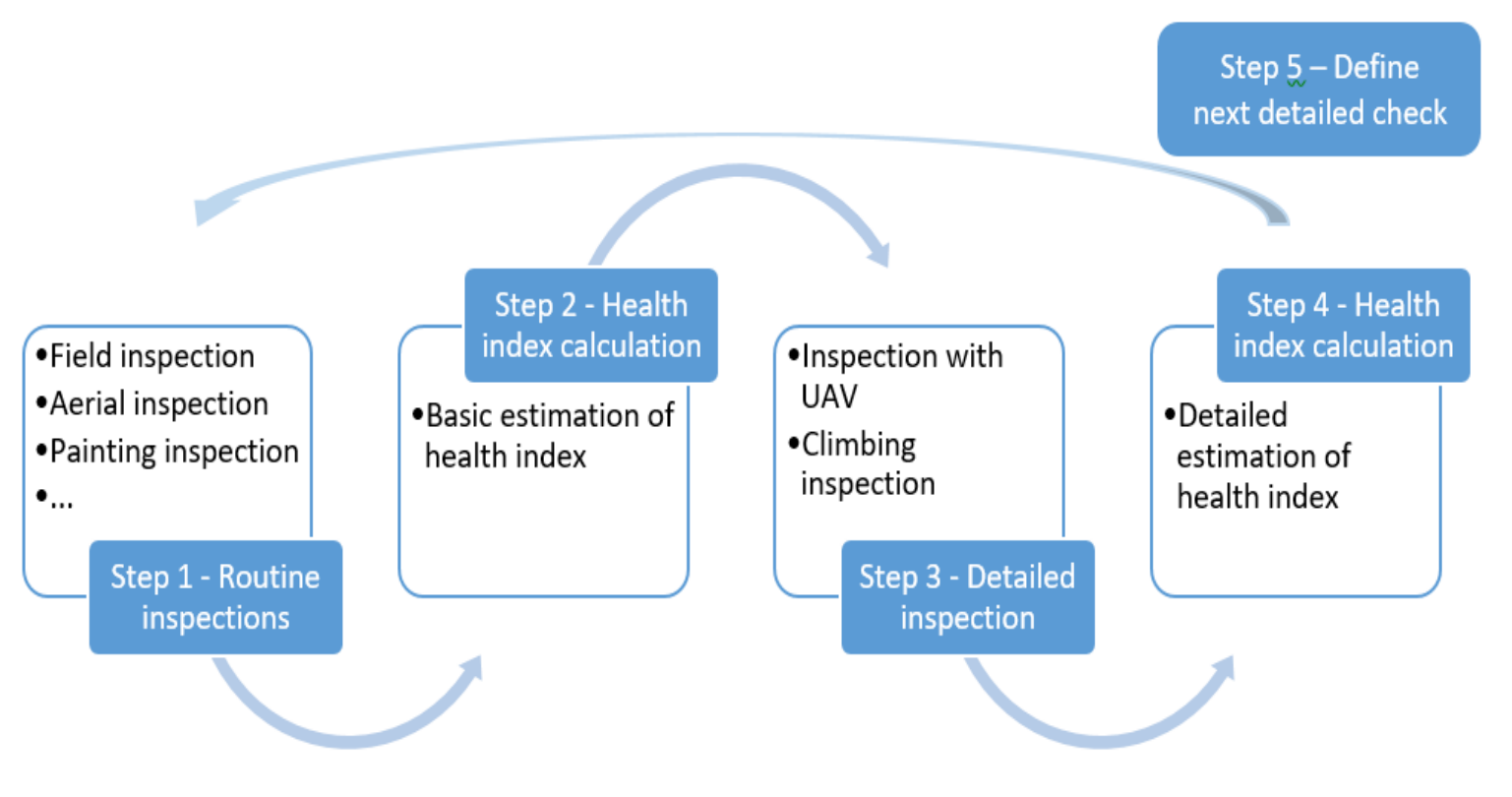
- Preparedness and countermeasures for natural disasters and other emergencies (e.g. **NL/BE paper ID 10540**)
- Decision of replacement based on monitoring, maintenance, operation, historical data (e.g. **BE paper ID 10718**)
- Strengthening of existing lines to improve reliability, ampacity, lifespan

PS3/ENVIRONMENTAL AND SAFETY ASPECTS FROM OHL

- Safety of workers in construction and maintenance of lines (e.g. **NL paper ID 10546**)
- Reducing environmental impacts from new and existing OHL
- Innovative engineering solutions/design to deal with environmental challenges (e.g. **BE paper ID 10719**)

ID 10718 : Innovative inspection techniques and digital tools for condition follow-up of overhead lines in Belgium

Aim of study : Implementation of a dynamic asset management system



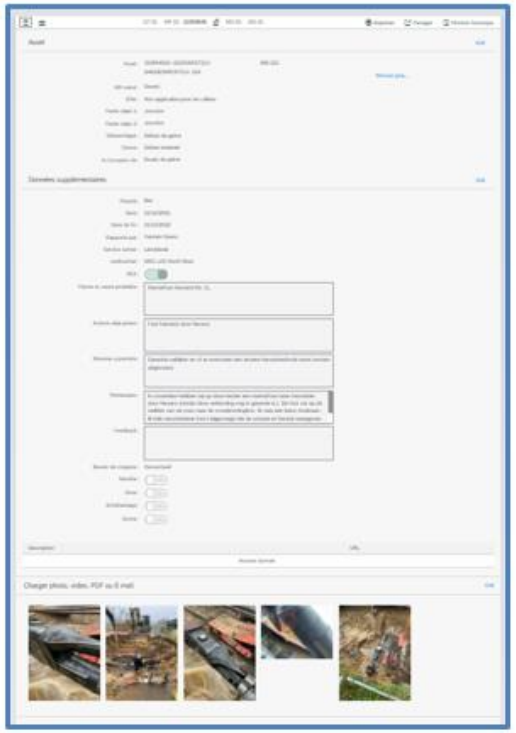
ID 10718 : Innovative inspection techniques and digital tools for condition follow-up of overhead lines in Belgium

Step 1 – Routine inspection

Handbook

eForm

Malfunction Report



ID 10718 : Innovative inspection techniques and digital tools for condition follow-up of overhead lines in Belgium

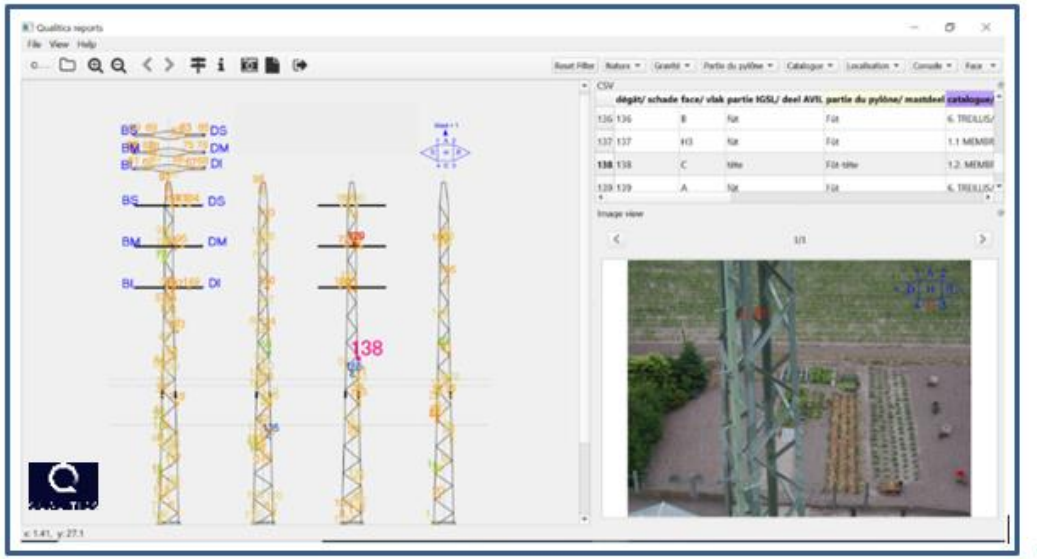
Step 2 – HI calculation

Visual Score – Health Index

	Visual score															
Num Pyl	Date	VS1 Paint Beaconing	VS1 Paint Protection	VS1 Foundation	VS1 Tower Stability	VS1 Corrosion Profiles	VS1 Corrosion Assemblies	VS1 Profiles Condition	VS2 Metallic Tower	VS1 Concrete Parts	VS1 Metallic Parts	VS2 Concrete Pole	VS1 Accessibility	VS1 Intrinsic Safety	HI
156	21/05/2021	White	Red	Green	Green	Orange	Red	Green	White	NA	NA	NA	White	Yellow	Red
164	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
165	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
169	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
171	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
172	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
175	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
176	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
178	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
179	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
180	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
183	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
184	21/05/2021	White	Red	Green	Green	Orange	Red	Green	White	NA	NA	NA	White	Yellow	Red
185	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red
197	21/05/2021	White	Red	Green	Green	Orange	Red	Green	White	NA	NA	NA	White	Yellow	Red
199	21/05/2021	White		Green	Green		Orange	Green	White	NA	NA	NA	White	Yellow	
202	21/05/2021	White	Red	Green	Green	Orange	Orange	Green	White	NA	NA	NA	White	Yellow	Red

Step 3 – Detailed inspection

- UAV + Artificial Intelligence



- Climbing inspection (structural defects)

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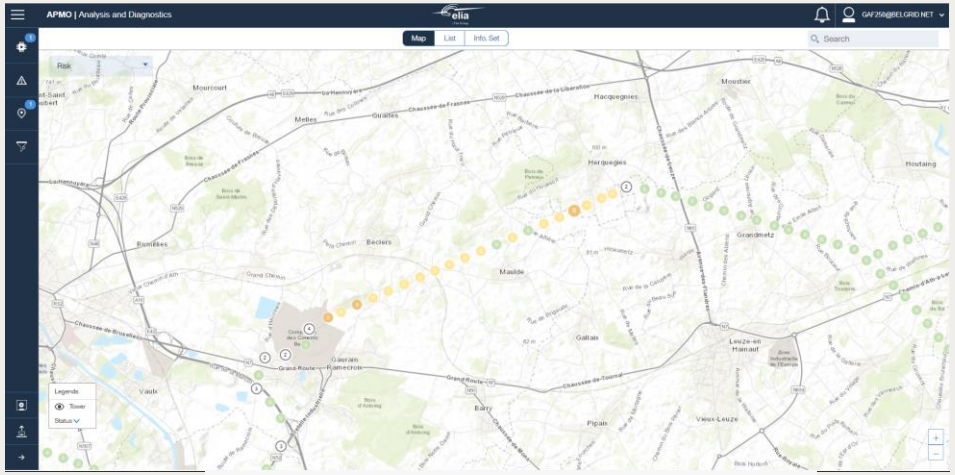
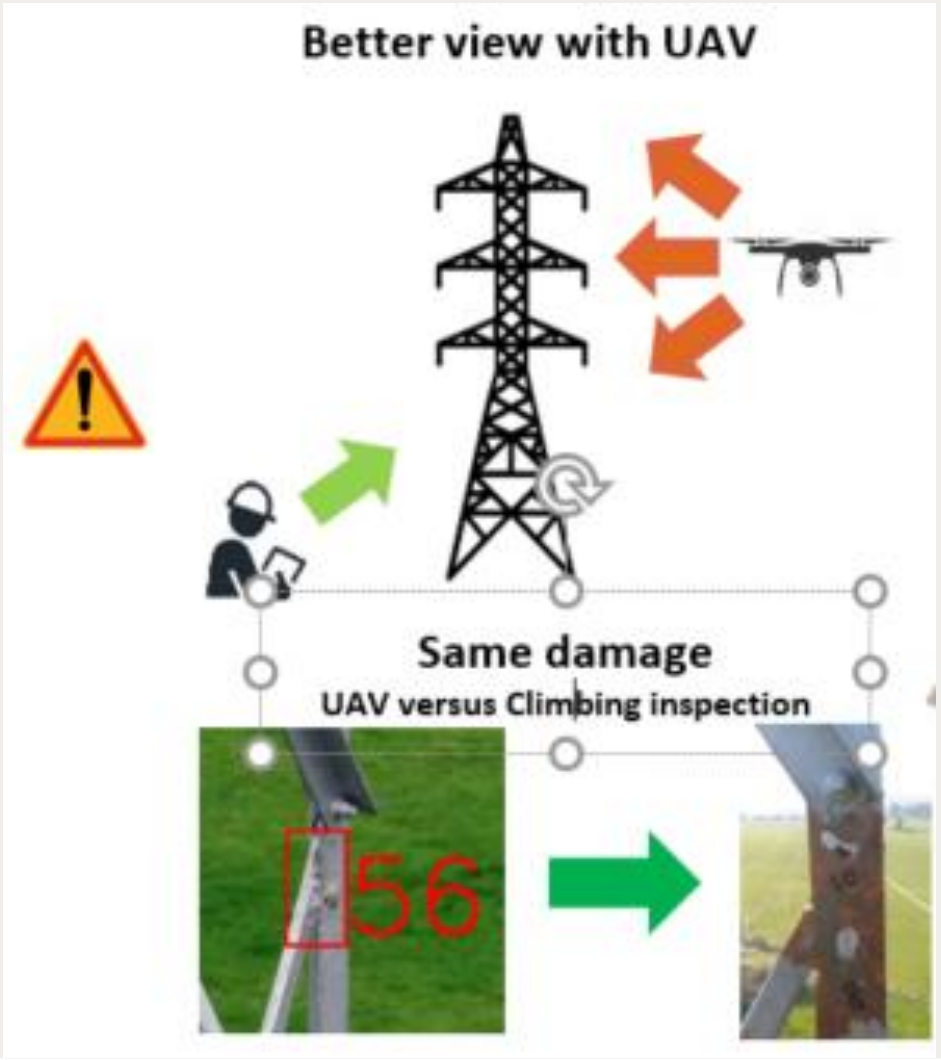
Step 4 Map with supports and associated risks



Risk	A		B		C		D		E		
100	456	1	5	5	4	0	0	0	0	0	E
90	682	8	14	4	0	0	0	0	0	0	
80	1075	29	129	55	0	0	0	0	0	0	D
70	199	0	1	1	0	0	0	0	0	0	
60	191	0	28	47	6	0	0	0	0	0	C
50	0	0	0	0	0	0	0	0	0	0	
40	0	0	0	0	0	0	0	0	0	0	B
30	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	A
10	110	0	12	0	0	0	0	0	0	0	
	0.05%	0.10%	0.25%	0.5%	1%	2%	3.5%	5%	10%	>10%	3372

Criticality

Probability



ID 10719 : Environmental impact mitigation for new 110 kV OHL in natural protected area

Motivation of paper

- Switching a line corridor from 1 x 70 kV to 2 x 110 kV = the East Loop 2 upgrade project with sections in natural highly protected environment
- Development of new types of access tracks to reduce the impact of heavy poles transport and construction machinery on the ground biodiversity
- Compact concrete poles to limit visual impact

Objects of investigation

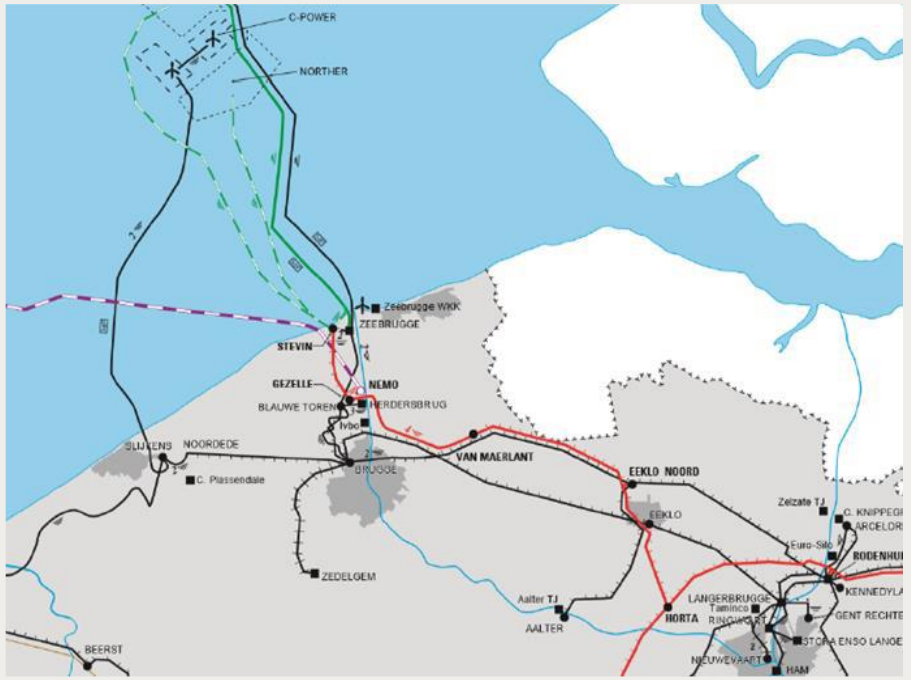
- Creating an access road for heavy poles without any excavation works => STABILITY (13 t/ truck axles) !
- Greatly reducing the impact on the specific ground that could recover after removal of the metaling => BIODIVERSITY

VIDEO

ID 10546: Resilience assessment 400 kV Overhead Line Stevin-Horta in Belgium

Background

- ELIA's network is a key link between France, Europe's largest electricity exporter, and markets in Northern Europe
- Elia is to compensate the market parties in cases of “force majeur” or emergency
- In Q1 2019, the HVDC (High Voltage Direct Current) Nemo link between UK and Belgium came into commercial operation. The Nemo link is connected to the Elia grid via the 380kV Stevin - Horta OHL. In case of unavailability of the 380 kV Stevin-Horta OHL, the offshore wind farms will not be able to inject into the grid and hence have to be curtailed



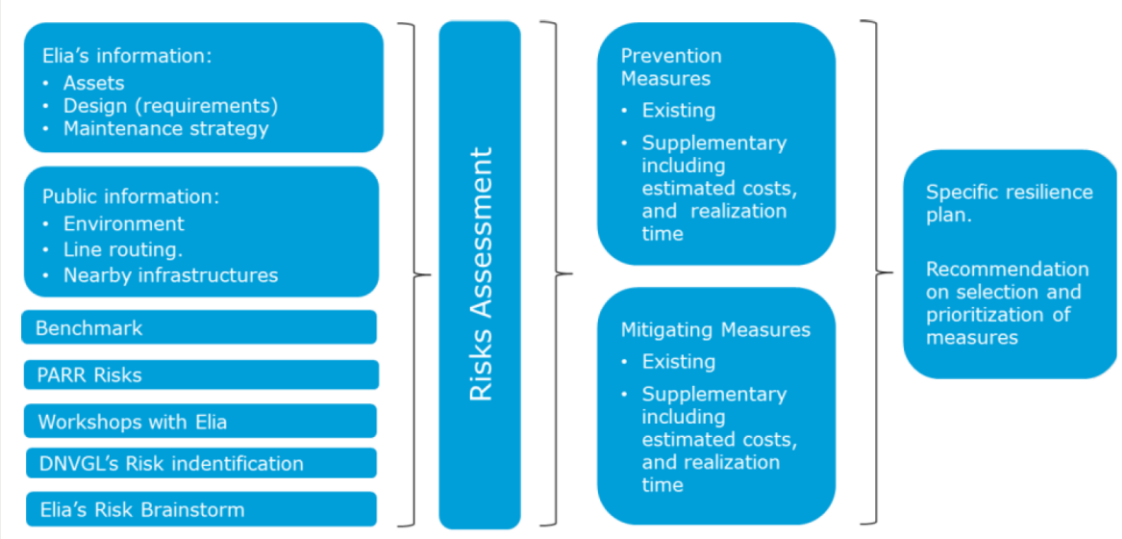
Objectives

- **A prevention plan:**
  To define and prepare the implementation of additional measures on towers, to reduce the risk on unavailability of the Stevin-Horta axis
- **A mitigation plan:**
  To deliver a specific resilience plan (specific emergency plan) to restore the operation and limit the impact in the case of unavailability of the 380 kV Stevin – Horta OHL

ID 10546: Resilience assessment 400 kV Overhead Line Stevin-Horta in Belgium

Methodology

- A qualitative risk assessment was executed. Inputs for this risk assessment were project related documents about installation, maintenance, and operations, and the design information of the overhead line assets
- The assessment also includes some feasibility studies regarding the installation of the available Emergency Restoration System (ERS) at specific sites. Information about Elia's ERS the was used as input
- The qualitative risk assessment prepared inputs for a detailed assessment of the installation risks with respect to the available emergency restoration system for 6 critical locations



ID 10546: Resilience assessment 400 kV Overhead Line Stevin-Horta in Belgium

Results

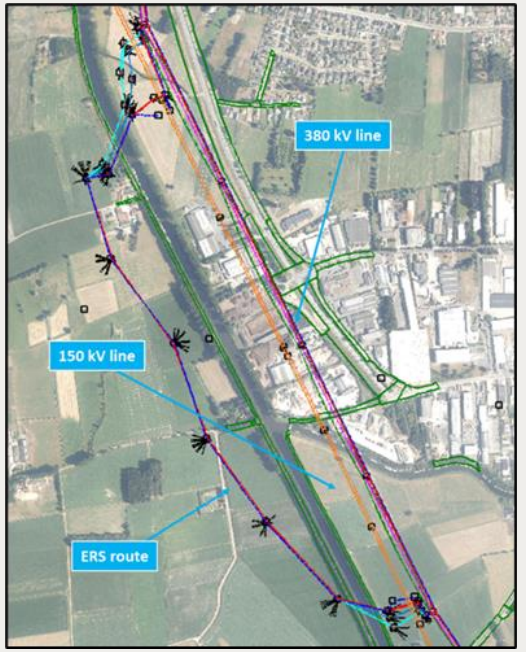
The results of risk inventory is a list of 12 risks divided into two categories:

a) **Primary risks:** risks related to failure of the line or to a damaged line

Example: The existing structures of Horta –Eeklo Noord are re-designed following criteria which differ from the usual practice in Belgium

- **Secondary risks:** risks directly related to the (temporary) restoration of the line after failure. The maximum restoration time after failure is defined as one week for temporary restoration and 6 months for final restoration

Example: ERS towers cross other critical infrastructures and required height of the conductors is not feasible



Unintentinal human acts	Intentional human acts
Collision of a vehicle with foundation and or tower legs	Collision of a vehicle with foundation and or tower legs
Construction work nearby the line	Bullet shooting
Fire.	Fire
Plane hits conductors.	Anti-tank missile
Nearby windturbine failure (rotor blade breakage)	Cutting torch
	Member theft

ID 10546: Resilience assessment 400 kV Overhead Line Stevin-Horta in Belgium

Discussion

- The design of the Stevin-Horta overhead line to withstand environmental loads is adequate including failure containment measures which are qualified as good as reasonably possible
- Some additional measures have to be taken for timely temporary and final restoration in case of unavailability
- The ERS is the key mitigation measure available in case of tower failures . However, for the effective use the system presently owned by Elia, additional components are required. Also, maintenance and contractor crews should receive additional training
- In addition, detailed scenarios have to be prepared for the installation of the ERS for specific critical situations/locations

Conclusion

- The resilience or risk assessment confirmed the structural design
- Input was provided for a plan with specific additional prevention and mitigating measures in case of an exceptional failure. This will further enhance the availability of Stevin-Horta link

ID 10546 : Safe Management of Work in High-Voltage Overhead Lines in The Netherlands

Authors: Rob Meijers (Qirion) / Stijn Gelderblom (SPIE)

Introduction:

The Netherlands has a significant high-voltage network of high-voltage overhead lines. In total there is approximately 4,110 kilometres route-length of high-voltage overhead line with a total of 13,578 high-voltage pylons.

Voltage (kV)	Route Length (km)	Number of Pylons
50	139	585
110	895	2.938
150	1.638	5.794
220	320	936
380	1.118	3.325

As a result of the significant growth of activities in the high-voltage overhead lines, more and more activities are being outsourced, with more frequent use being made of foreign parties. The Netherlands has a high safety culture, which is why high demands are made on working on and near high-voltage overhead lines.

ID 10546 : Safe Management of Work in High-Voltage Overhead Lines in The Netherlands

Education and Training of Employees:

The Netherlands has a long tradition of educating and training employees in high-voltage overhead lines:

- Before the 1990s, the training and education of (new) line workers was arranged by companies themselves;
- A number of serious accidents (with fatalities) occurred in the early 1990s, after which the Labor Inspectorate summoned the parties to increase safety when working in high-voltage overhead lines.

  In response, the parties involved jointly issued a letter of intent in which they stated that they would increase safety when working by taking the following three measures:
  - Improving the training of the personnel involved, both theoretically and practically (VHS-training);
  - Pay special attention to the safety aspects in the construction of new pylons to be built;
  - Compare existing pylons with the new standard and add additional safety provisions;
- In 2006 the introduction of the “Eindtermen” in order of the Dutch Network Operators. The aim of the “Eindtermen" is to formulate uniform basic requirements with regard to safety, knowledge (theory) and skills (practice) that persons must demonstrably meet as a minimum before they are allowed to perform work on or in the vicinity of high-voltage overhead lines.

ID 10546 : Safe Management of Work in High-Voltage Overhead Lines in The Netherlands

Safety Features in High-Voltage Pylons:

In 1995, the Dutch standard for the design of high-voltage overhead lines was further expanded with a number of regulations for additions to the high-voltage pylon construction for the purpose of working safely in high-voltage pylons for executives.

- Installing handrail in the cross-arms;
- Step distance in the cross-arms;
- Profile distance in the pylon body;
- Climbing facility;
- Rest platforms / Step-up platforms.

Before 2000, employees in the Netherlands did not climb secured to the workplace in the high-voltage pylons. At the workplace, the employee was secured to fall, but that did not happen during climbing. Under pressure from the then 'Labor Inspectorate' a cable fall protection system for safe climbing has become standard in the Netherlands.
Assembly of the first systems started in 2002 and the entire overhead network of high-voltage overhead lines was completed in 2012

ID 10546 : Safe Management of Work in High-Voltage Overhead Lines in The Netherlands

Safety Procedures for Work in High-Voltage Overhead Lines:

- Flagstaff Holders
  The de-energized circuit must be visible and this is done by placing a green flag on the main leg of the de-energized circuit;
- Rescue Set
  At least 1 rescue system per pylon should be available for all work on or in high-voltage overhead lines';
- Gate Instruction
  At all high-voltage substations, - connections and construction sites in the Netherlands it is mandatory for visitors and employees to follow an E-learning gate instruction.

Impact High Voltage Overhead Lines on Living Environment:

- Precautionary Policy The Netherlands;
  The network operator has to avoid that new situations arise in which children stay for a long time in the area around high-voltage overhead lines where the annual average magnetic field is higher than 0.4 microtesla
- Cabling or moving existing high-voltage lines;
  A total of 135 kilometres of high-voltage overhead lines within built-up areas are eligible for relocation or cabling.

ID 10546 : Safe Management of Work in High-Voltage Overhead Lines in The Netherlands

Safety near High-Voltage Overhead Lines:

To avoid incidents near to high-voltage overhead lines several regulations have been introduced:

- Safety at Work under and near High-Voltage Overhead Lines;
- Safety when Working in an Agricultural Environment;
- Vegetation Under and Near High Voltage Overhead Lines;
- WIBON- law.

Incidents High Voltage Overhead Lines:

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021
In Towers	1	0	1	0	1	1	1	1	2
Near Overhead Lines	5	0	1	0	1	0	1	2	0

Since the registration in 2013 of the incidents, no fatal incidents have been reported during work on high-voltage pylons and activities near high-voltage overhead lines


Thank you for your Attention
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