EUROPEAN MATERIALS HANDLING FEDERATION

Product Group Cranes and Lifting Equipment

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Position paper / Assessment
FEM Product Group Cranes and Lifting Equipment
Sub-Group Mobile Cranes

Avoiding Contact to energized Power Lines

1 Introduction

During the development of the new Machinery Regulation (in near future substituting the existing Machinery Directive) a new essential safety and health requirement related to contact to energized power lines has been introduced into the draft document.

The proposed new essential safety and health requirement “clause 3.5.4” addressing the design of the mobile machines does not take into account persons in the vicinity of the equipment. For mobile cranes (as well as for many applications of construction equipment) the operation is closely monitored by supervisors and/or signalers and a load is guided by physical contact or by means of tag lines. Supervisors and signalers may stand close to give indications to the operator during the lifting operation to ensure safe execution.

So far, risks of contact to energized power lines were handled related to the use of the equipment, which included everybody involved in the operation.

Shifting the current practice into a legal requirement for the design of machinery is a significant change and needs to be evaluated in terms of impact and effectivity.

This document has been developed to summarize discussions and investigations of the manufacturers of mobile cranes in relation to accidents caused by potential contact to energized power lines. It provides comprehensive information on the current situation and the impact to the industry when imposing the new requirements to prevent powerline contact by mobile cranes

In this document, the proposed new essential requirement in the machinery detective is compared with the experience of mobile crane manufacturers and with the discussion on contact to live power lines in the United States (significantly more overhead lines than in the EU) which took place when reviewing legislation on cranes and derricks.

2 Summary

This document provides information about the discussion on the application of measures to prevent contact to energized power line and/or mitigate the effects off such contacts. It describes discussions mobile crane manufacturers had over many years and which are backed up by official discussions of industry stakeholder in the US with the US Occupational Safety and Health Administration described in the extensive documentation of the law introduced.

For the time being there is no technology or state-of-the-art (at least for mobile cranes) existing to prevent contact to energized power lines or to prevent any hazards arising from such contact.

3 General

Mobile cranes are designed according to the harmonized European Standard EN 13000:2010 A1:2024. They are high performance equipment capable of carrying high loads (compared to their dead weight) at required radii and height. Typical examples of mobile cranes are shown in the table below.

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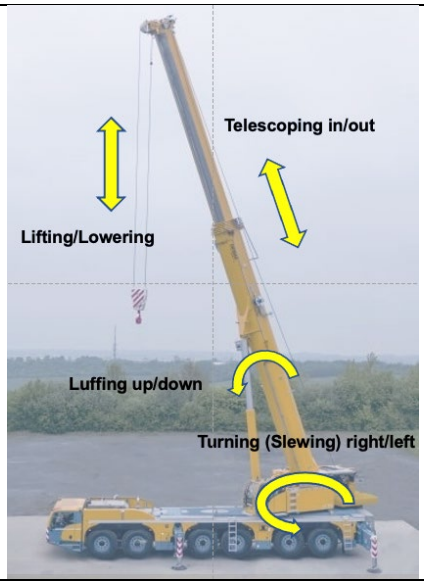
<tr><td>  </td><td> 
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<tr><td>Fig. 1.1 Telescopic Crane on Outriggers</td><td>Fig. 1.2 Typical Movements, Mobile Crane</td></tr>
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<tr><td>Fig. 1.3 Crawler Crane</td><td>Fig. 1.4 Rough Terrain Crane</td></tr>
<tr><td colspan="2">Figure 1 – Examples of mobile cranes</td></tr>
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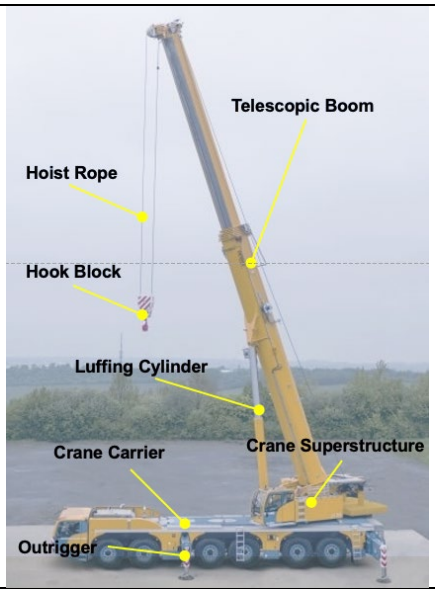

Figure 2 – Typical Elements of Mobile Cranes (Example Telescopic Crane)

Mobile cranes are "non-stationary" cranes as they change location depending on the job site requesting a lift. They may be set up in a "quasi-stationary" position on outriggers (Fig. 1.1) and move the lifted load by combination of movements (i.e., turning (slewing), changing radius (luffing), changing height (lifting), see Fig. 1.2). As a result, the lifted load is transported horizontally and vertically. Some types of mobile cranes are even designed to travel with a lifted load, e.g., crawler cranes (Fig. 1.3), rough terrain cranes (Fig. 1.4).

4 Assessment of Risk – Powerline Contact with Mobile Cranes

4.1 Overview

Any potential contact to energized power lines may affect workers. These workers are the persons operating the equipment/machines as well as persons in the vicinity which e.g., are guiding a load by direct contact or by means of conductive tag lines.

The situation is similar to the US where contact to power lines happens more often than in Europe due to much more power supplies by overhead power lines. Contact to power lines in the US is a major contributor to injuries and fatalities for people and employees in the construction industry.

The United States OSHA (Occupational Safety and Health Administration, part of the Department of Labour) has reworked the entire legislation on "Cranes and Derricks in Construction" over the period from 2002 to 2009, the result was published on August 9th 2010, see [1].

This final report established the rules (the law itself) to prevent powerline contact and a very comprehensive description, why and how some issues are addressed by the law.

Studying the comprehensive description in [1] reveals that currently there are no other means available – in particular no design measures – than measures and procedures when preparing and doing the work.

For better understanding, the technical background of theoretically possible solutions is discussed below and can serve as a guidance for the decisionmakers in the development of the new Machinery Regulation.

4.2 Avoidance by Inherent Safe Design

The purpose of mobile cranes is lifting and moving loads up to a certain position, defined by turning angle, radius and height, some mobile cranes – depending on their design – are even capable of traveling with a lifted load. On certain jobs sites mobile cranes will be moved partially assembled into their final working positions as the assembly in the final working position is not feasible.

Mobile cranes have a generic design, and the intended use enables them to carry out various lifting operations in various configurations.

The details of the specific lifting operations are decided by the job site responsible person. The particular configuration of the mobile crane (i.e., boom length, boom extensions, counterweights etc.) as well as other parameters depend on the condition of the job-site and the lifting job to be executed. The user of the equipment will conduct a job and job-site specific risk assessment to determine measures and procedures required for this specific job.

Such risk assessment will include the risk of contact to energized power lines. Three different situations are typically possible:

a) the intended working area of the mobile crane is not affected at all, as the next energized power line is far away,

b) the intended working area of the mobile crane is okay as long as a certain position is maintained, e.g., the job planning establishes a position with center of slewing of the crane maintaining a safe distance even if the boom points directly to the power line,

c) the intended working area of the mobile crane requires additional measures to prevent contact of crane parts or the load to energized power lines as the crane could come into contact. The additional measures could be e.g., limiting slewing, limiting max. radius, etc.

These risk assessments are common practice and the methods and procedures to prevent contact to power lines are in more detail documented in national regulations of countries with significantly more overhead power lines prone to contact.

A potential contact to energized power lines by mobile cranes (structure of the crane, the hoist rope and/or the lifted load) cannot be avoided by inherent design of the structure due to the purpose of equipment.

4.3 Protective Measures

If the purpose of the machinery does not allow an inherent safe design (see 5.2 above), preventing contact when working close to energized power lines would be the “next level” of prevention to be discussed, followed by other protective measures.

4.3.1 Protective Measure – Avoidance of Contact by Detection

To avoid powerline contact, the electric and/or electromagnetic fields created by high voltage shall be reliably detected.

Manufacturers of mobile cranes have investigated over many years in detection technologies to determine the proximity of a high voltage object close to the mobile crane. The request was raised by e.g., energy providers and railway builders.

Unfortunately, up to now, no reliable technology exists which ensures the detection early enough whilst at the same time preventing false alarms. A detection coming too late creates a safety risk, a detection coming too early will affect the availability of the machine, which will, as a consequence, lead to users ignoring or bypassing such alarms.

It was observed that the detection systems accuracy changed with the position of the mobile crane components compared to their initial position during calibration. Furthermore, the proximity of those systems to several power lines created additional erroneous read-outs. These observations were confirmed by several OEMs testing different devices and the situation has not changed since then.

The observations of mobile crane manufacturers in Europe on the unavailability of a reliable detection technology is backed up by:

a) Manufacturers of concrete pumps organized in the German VDMA organized a study which was carried out at the University of Dresden in 2006 [7]. The study involved representatives of the German HSE. Four different devices sold as detectors for high voltage were tested with regard to their ability of reliably detecting power lines when used on mobile machinery, with the focus on mobile concrete pumps. These pumps comprise knuckle booms and are as such of same design as many loader cranes and similar to mobile cranes. The test results did not qualify these systems as reliable detectors for high voltage.

b) US OSHA findings in [1], with comments on a study [1] regarding “Paragraph (b)(4)” (see page 51), it reads:

“Proximity alarm performance was the subject of a study conducted by the National Institute for Occupational Safety and Health (NIOSH) published in January 2009, and submitted as an exhibit to this rulemaking. (ID–0141.2.) This study tested the efficacy of two proximity alarm models under various simulated construction conditions. The study indicated that the accuracy of the proximity alarms could be adversely affected by such factors as: (1) Operating the equipment with a boom angle and length significantly different than that used for the device’s last sensitivity adjustment; and (2) operating the equipment on sites with multiple overhead power lines, especially where those power lines had differing voltages or involved intersecting installations. Two other commenters also questioned the efficacy of proximity alarms. (ID– 0118.1; –0206.1.)

OSHA shares the concerns expressed by NIOSH and other commenters over the accuracy of currently available proximity alarms.[49] However, such concerns are addressed by the definition of ‘‘proximity alarm’’ in § 1926.1401, which states that the term refers to a device ‘‘that has been listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with § 1910.7.’’ To be so listed, labeled, or accepted, the Nationally Recognized Testing Laboratory (NRTL) must determine that the device works properly by concluding that it conforms to an appropriate test standard. Accordingly, no proximity alarm can be listed, labeled, or accepted by a Nationally Recognized Testing Laboratory (NRTL) in accordance with § 1910.7 until the problems identified by the commenters have been rectified. OSHA concludes that retaining this option in the final rule will provide an incentive for proximity alarm manufacturers to improve these devices to the point where they will meet the definition’s criteria.”

FEM research shows that since the studies cited above were published the technology has not progressed.

The application of a proximity alarm technology on a real machine – provided a reliable detection would be available – will be an additional challenge; in principle all parts of the mobile crane including the hoist rope and the load may come into contact with an energized power line and could endanger as such people.

No dedicated single location can be identified and the detection technology would need to create an "no-go-envelope" around the moving crane and load. Such envelope will change with relative movements of crane parts and would require to determine or input the dimensions of the load and its orientation in relation to the mobile crane. Today the mobile crane "knows" the load only by its mass which is monitored by the loading control.

Avoidance of contact of energized power lines by detection is (at least today) not a possible solution.

4.3.2 Protective Measure – Remote Control

The usage of remote controls to operate the mobile crane is a technology available. It allows putting the operator into a safe position off the crane. It will not protect other people handling or observing the load, and the operator always needs to maintain a certain distance to the mobile crane and load to be protected.

The operator will lack the overview of the entire situation from the crane and will miss the cabin as protected space in case of electrocution.

Using remote controls is not completely solving the issue of contact to power lines as it requires additional adapted behavior (i.e., continuously maintaining a safe distance to crane and load). Being in the open environment instead of being in a cabin will create other issues for the operator related to ergonomics and protection.

As a result, remote controlling a mobile crane cannot be considered a solution.

4.3.3 Protective Measure – Isolation against Contact

If the physical contact to the power line cannot be prevented (see above) and the operator stays on the equipment, electrical isolation of the entire equipment may be considered.

The high performance of mobile cranes requires using metal structures and joints in the highly loaded areas. These metals are conducting electric currents when coming in contact to energized power lines. Electrical isolation of all potential contact points/surfaces for the various configurations and isolation of all joints which is sufficiently reliable for mobile cranes which are assembled/disassembled when changing job-sites and which have components moving relatively to each other is in general not possible.

Only for small, specialized equipment isolation is a technology used, but requires in addition people following special procedures.

So called utilities, isolated platforms or baskets on (partially) nonconductive telescopic booms are used to work on energized power lines in the US (see as example [6]).

Workers can work on energized power lines from the isolated basket. There are different technologies to work from those baskets involving isolating clothes or even conductive clothes and bringing the body of the worker to the same electrical potential than the power line. Discussing these technologies would be by far too broad, but all of these methods require specialized personnel which is extensively trained for these jobs.

Working with isolated equipment additionally requires PPE for each worker and requires strictly adhering to procedures applied by trained and experience personnel. Any unintended contact of conductive material connecting different electrical potentials will have serious consequences. Isolation is not considered a feasible technology for mobile cranes to prevent contact to power lines.

Isolation of the mobile crane overall is not possible and requires additional training and adapted behavior. The use of isolated tag lines or links will fail in case of high humidity and rain or dirt.

Thus, isolation of mobile cranes cannot be considered as solution.

4.3.4 Protective Measure – Grounding the entire Equipment

Grounding requires constant reliable contact to ground potential which may limit the mobility of the mobile crane. Such grounding requires regular automatic monitoring of its quality (resistance) during operation of the mobile machine to be readily available when needed. All parts of the machine need to be well connected to ensure a low electrical resistance and prevent the current seeking its “own way”.

Whereas grounding will help to dissipate the energy of a lightning hitting a mobile crane during a thunderstorm, it may provoke problems when grounded equipment contacts an energized power line.

The fuses of the power supply (e.g., at a power station) may or may not switch off!

The overall resistance of the grounded equipment will limit the current running through the equipment in case of contact. Depending on the amount of power supplied in combination with this current the fuses of the supply may or may not react. In many cases the fuses will not react (cut the supply), although a significant current is running through the equipment.

Such current bears the immanent risk of starting fire on the equipment when, at the same time, the operator should be safely kept in his cabin.

Grounding of the equipment as protective means when contacting an energized power line is not considered an appropriate measure for mobile cranes.

4.4 Avoidance by Information

With no technical solution available to prevent power line contact for mobile cranes and no technical means available to prevent any electrical hazards in case of contact this scenario belongs to residual risks. Manufacturers of mobile cranes inform their customers already.

For mobile cranes in Europe there is only an extremely small number of accidents caused by contact to power lines known over the recent 30+ years. In all of these cases people were negligent of even the basic rules of prevention and resolving the cases did not involve the manufacturer of mobile cranes.

If, nevertheless the number accidents with machinery in general requires further action, the information required for machinery in the US may be introduced as requirement in Europe via law and product safety standards.

Even the extensive discussion in the United States when revisiting crane related legislation shows that avoidance by information is currently the only solution, with a potential solution of prevention if a reliable detection of high would be available in the future (see [1]).

The information of users about potential contact to energized power lines including the potential consequence as residual risk is needed. Appropriate countermeasures to be taken are job-site and lifting job specific and need to be developed by the user based upon a risk assessment.

In the documents [3], [4] and [5] actual warning statements of authorities in the US and Australia are published, they may serve as further information. The US standard ANSI B30.5 [2] provides supplementary information to the federal legislation by OSHA [1].

5 Annexes

5.1 Draft revision European Machinery Regulation (2021), Annex III clause 3.5.4

The following text is copied from the draft of the new Machinery Regulation, based upon the published document COM(2021) 202 ANNEX - Annex to the Proposal for a Regulation of the European Parliament and of the Council on machinery products .

[...]

3. SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS TO OFFSET RISKS DUE TO THE MOBILITY OF MACHINERY

[...]

3.5. PROTECTION AGAINST OTHER RISKS

[...]

3.5.4. Risk of contact with live overhead power lines

Depending on the height of the machinery products, mobile machinery product shall, where relevant, be designed, constructed and equipped, so as to prevent the risk of contact with an energised overhead power line or the risk of creating an electric arc between any part of the machinery or an operator driving the machinery and an energised overhead power line.

When the risk of contact or electric arc with an energised overhead power line cannot be fully avoided, mobile machinery products shall be designed, constructed and equipped in such a way that all hazards of an electrical nature are prevented or can be prevented in the event of contact or electrical arc with an energized power line.

[...]“

6 References

[1] Cranes and Derricks in Construction, Final Rule, Department of Labour, OSHA Federal Law 29 CFR part 1926.1400 ff, published 2010.08.09

[2] Mobile and Locomotive Cranes, ANSI B30.5, published 2018.08.06 (next revision is scheduled for 2023)

[3] Preventing Electrocutions of Crane Operators and Crew Members working near Overhead Power Lines, NIOSH Publication 95-108, published May 1995, last reviewed 2014.06.06 (still refers to NIOSH Safety Alert from 1995, see [4] below)

[4] Preventing Electrocutions of Crane Operators and Crew Members working near Overhead Power Lines, NIOSH Alert – Worker/employer Summary Sheet, published 1995.05

[5] Deadly Power Line Contact with Cranes, DOSH Hazard Alert, published 2012.07
ESV urges caution after crane hits powerlines, Media Release Energy Safe Victoria, published 2021.04.13

[6] Examples for specialized equipment with isolated work baskets to perform work on energized power lines, aka utilities, see:
https://www.terex.com/utilities/en/products/overview

[7] Bericht über messtechnische Untersuchungen an Hochspannungswarneinrichtungen im Einsatz an mobilen Arbeitsmaschinen, insbesondere an Betonpumpen – Technische Universität Dresden, 2006 („Report, Measurements of High Voltage Detection Devices used on mobile Machinery, in particular Concrete Pumps“)

Established by the Technical Committee of Product Group Cranes and Lifting Equipment of the European Materials Handling Federation (FEM)

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