Safety For Sale

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ABSTRACT
In Europe, new directives are developed according to the "new approach". The objective of directives is twofold: elimination of barriers for trade between countries and increase of safety. At the same time, competition between Notified Bodies increases by extension of their market from national to international.
Manufacturers have more freedom in the development of new products and the selection of a Notified Body to certify these products. They may even certify products themselves if they comply with a specified quality-assurance system. In this paper, Liftinstituut will present examples which may give reasons to doubt if the objective to increase safety will be realized.

1. INTRODUCTION

Since July 1999, new elevators have to comply with the Lifts Directive. Similar to other directives, the objective of this Directive is to eliminate restrictions for trade between countries of the European Community together with an increase of safety. The introduction of these "New Approach" Directives also enhances other changes:
the requirements in the Directive are obligatory. The use of standards is voluntary. Certification of an installation always requires a Notified Body (Nobo). Each EU member state can assign Notified Bodies (Nobo's). The criteria for these Nobo's are described in the Lifts Directive. For the certification procedures, several options are possible. For Manufacturers with a quality assurance system (which again will have to be certified by a Nobo) there is a possibility to carry out self-certification for safety-components or lifts.
If the installation deviates from the standard, the manufacturer must show that at least the same level of safety compared with the standard has been reached in order to achieve certification. For lifts, these standards are EN 81-1 for traction lifts and EN 81-2 for hydraulic lifts. The risk-analysis is the tool to "prove " this equal safety level.
Market surveillance is necessary to check the functioning of this whole process.

In this paper, each of these elements will be investigated on their consequences towards safety. Finally, some recommendations will be given.

2. APPOINTMENT OF A NOBO

Liftinstituut was the first Nobo in Europe that was assigned for the entire scope of the Lifts Directive. At this moment, there are about hundred Nobo's. Though the criteria for the appointment of a Nobo are described in the Directive, there is no guarantee that these criteria are used on an equal base by the different authorities. In practice, compliance with these criteria is checked by means of accreditation. The basis for this accreditation is usually the ISO 45000 standard. This accreditation is carried out by persons with a lot of experience in quality standards as far as procedures and their implementation are concerned. In the field of Directives however, the accreditation should also have to cover the competence of the candidate Notified Body. If this competence can not be guaranteed, the safety level of the installations can not be guaranteed as well. Recenctly there has been a meeting by the EOTC where this appeared to be a problem, not only for the Lifts Directive but for other directives as well. It is remarkable to see that there are countries with one or two Notified Bodies for lift certification, whereas other countries have more than fifty Notified Bodies.

Apart from the lack of uniformity in the appointment of Nobo's there is another effect of the new approach. It leads to competition among certification institutes who used to be responsible for certification within their country on basis of national regulations. Moreover, it results in the erection of usually more than one Nobo in countries who used to have a single certification institute in the past. The consequence is that the authorities give away a unique possibility to establish market surveillance. With only one certification institute, each installation can be guarded with respect to certification. With more than one certification institute, the authorities can only guarantee the same level of certification (and therefore safety) if extra manpower and procedures are provided by these authorities. It is our experience that these provisions are lacking. Consequently, safety will never benefit from this competition.

3. CERTIFICATION OF AN INSTALLATION

As stated before, the Directive is mandatory, the standards are voluntary. The possibility to deviate from the standard has been used greedily by the manufacturers. Our estimate is that less than five percent of the new installations at this moment is in full conformity with the standard. Especially the machineroomless installations are popular. Usually, the machine is at the top or bottom of the shaft, with the control-unit near the upper or lower stop. Nowadays, even examples with control-unit in the shaft are not an exception any more. Here the famous risk-analysis appears. In our experience, there are several risks related to the use of this risk-analysis. First, these risks will be elaborated. Second, the system of self-certification by manufacturers will be discussed.

4. POTENTIAL ERRORS AND BIAS IN A RISK ANALYSIS

In a new installation design there is little or no empirical information with which frequency risk assessments can be carried out with relation to incidents. The results of a test setup also tell us very little about the actual safety level. It would be too expensive and too time-consuming to follow up a certain number of installations with a representative number of spot checks of setup situations during the course of the life span. What then remains is the quantification of risks in a risk analysis by experts. In this case the risk is indicated by whether the experts believe that an event will occur. Despite the uncertainties and interpretation margin associated with a risk analysis, experts are forced to explicitly explain their risk assessments, and third parties are also able to look at what the risk assessments are based on. Errors and bias in the various phases of the process of a risk analysis are inevitable. Below we examine each phase in the process. This can reduce errors and provide more backup (reserve) with respect to the final results of a risk analysis.

4.1 Design phase and identification of hazards

In this phase, the design must be described accurately and limits set with respect to life span, location, space and users. The actual risk analysis must also be carried out in this phase, so that the risks arising from the identified hazards can be eliminated as far as possible by changing the design. An inaccurate description of the new design and an excessively narrow definition can result in potential hazards being overlooked. Furthermore, any unknown additional dangers will not be apparent, partly on account of the lack of experience with the new design. This is also true of potential hazards posed by the accumulation of events combined with the human factor that are left out of consideration. The two latter problems can be inadvertently reinforced by becoming too involved in the new design. It is therefore advantageous to involve the designers, independent lift safety experts and even lift engineers in the risk analysis.

Restricting the design is another problem. Certain identified hazards cannot be eliminated by altering the design. Risks from some of the identified hazards can then be reduced using suitable safety measures. It is difficult to reduce the risks from other identified hazards that can only be reduced with a limited range of safety measures more independently of the risk analysis. If a higher category of protection out of that range really is required, this may then conflict with the intended benefits of a new design.

The final risk measurement will have maximum validity if this phase is completed as thoroughly as possible.

4.2 Risk assessment

The reliability of the final risk measurement comes into play in this phase. As we know, the risk assessment is carried out within a risk analysis system one chooses oneself. The experts must give their opinion by means of a verbal risk verdict taken from a scale. This scale consists of a number of categories which are subdivided into a number of verbal risk verdicts. This scale must contain the whole range of possibilities of the aspect to be assessed, and the significance and value of the risk verdicts given must be as unequivocal as possible to all concerned. There must also be enough categories to enable the verdict to be given, and there must not be too great a difference in value between the categories. This is not adhered to in the scales used in many risk analysis systems. It appears to be difficult to create a proper scale for indicating minor risks.

A systematic fault in an assessment scale will produce unintended differences of opinion between experts in terms of the risk assessment. A scale with too few risk verdicts will result in the risk assessment tending towards a constant factor. This will ultimately restrict the diversity of protection systems chosen.

The assessor may also assess risks as too high or too low as a result of bias. There is no difference in the bias of laymen and experts when it comes to relative risk assessments. However, as far as estimating the absolute risk is concerned, experts display less bias than do laymen. Experience with safety measures or having trouble using the assessment scales can result in them choosing a particular measure before assessing the risk and its implications.
An inaccurate risk assessment can also be the result of incomplete elaboration and the omission of information on each identified hazard. For example, it is possible to determine to some extent the number of events which occur before a hazardous event and their frequency and duration in the potentially hazardous area. It is also possible to forget to alter the assumptions in the risk analysis if the design is changed. For example, if the assumption is based on the car roof, which is free of obstacles, being used as the working platform and this is no longer the case in a later alteration, this will impact on the assessment of the risk of a possible hazardous event. The ultimate risk is particularly great with a narrow car and a wide well; a 70 cm high railing is permissible when there is an interior distance of 85 cm between the edge of the car roof and the wall of the well.

The scale used to assess the possible consequences in a risk analysis system is much easier to compile and produces fewer unintended differences when different assessors are deployed. However the intention is to indicate the maximum possible damage for each risk identified.

4.3 Calculating the risk

In the report of a risk analysis it is sometimes not clear how the final score of the risk assessment and the assessment of the consequences has been arrived at. This may be a reporting problem, as describing every identified hazard in great detail can be very time-consuming. In that case it is sufficient to provide a description of the procedure used to assess each identified hazard and to give the scores for the other hazards along with the reasons. In order to increase the reliability of the assessments, the intention is that every member of the team of experts should give their verdict independently, e.g. using a score card, and that an average of the assessments of the risks and their implications is then taken. For example, if one or more experts reveal their scores and influence the other team members' assessments, this will detract from the reliability of the assessments. The average final scores obtained can always be discussed afterwards.

4.4 Choice of safety measures

The risk of the various hazards identified is determined by multiplying the values of the risk assessment and its possible implications. In a risk analysis system, after an adjustment has been made using a weighting factor, the ranking of the risks is usually known, so they can be compared to some extent. In some comparative risk analysis methods, the values for the risks can be set out in a table which will indicate which safety measures need to be taken to combat the risk. However, this will not usually indicate which category and type of safety measure need to be selected. Furthermore, the product of the values of the two risk factors and the weighting factor does not appear to be an accurate criterion for choosing a safety measure.
It is also possible to look at the ranking of the individual risk factors in combination with the background factors, and for every team member to first make their own choice of category (importance) of safety measure on this basis.

The categories chosen can be discussed in the team along with the various reasons for their choices. After the category of safety measure has been established, the type of safety measure can be determined in relation to the specific lift installation. In this way it is the experts who are making the decisions on the choice of a safety measure and not the risk analysis system. The risk analysis system is then purely an aid; the experts' knowledge and all the background information collected during the whole risk analysis process are used to the full.

The Lift Directive mentions three categories of safety measures, which have to be used subsequently:

1. the design must be changed in order to reduce the risk (for instance giving a screw a blunt point instead of a sharp point);
2. if a change in design is impossible, an additional measure must be taken to reduce the possibility the risk will occur (for instance if the sharp point of a screw is essential for its application, you could dip the point in wax to avoid injuries during handling);
3. if these additional measures are not possible, procedures can be used (for instance a warning sign on the box containing screws, indicating that they have s sharp point).

It is our experience that both manufacturers and Notified Bodies do not use these measures in the right order and accept the second or even third category even if the former would have been possible. Usually, economical aspects influence this decision.

4.5 Evaluation

After choosing the safety measures based on the assessed risk factors, it is necessary to establish whether the risks have been adequately reduced by running through the risk analysis process again. At this stage there are still some questions to be answered, such as: whether the categories and types of safety measures are suitable, how likely they are to be circumvented, whether the safety measures hinder the execution of work, and whether the safety measures are too cumbersome to use. Finally the procedures for residual risks are drawn up.

It is harder to re-evaluate the safety measures chosen once the installation has been in use for some time. If relatively little work is carried out on the lift installation (particularly mechanical) thanks to low levels of obsolescence, there will usually be no hazardous events for a number of years. It is difficult to obtain data on near-accidents. In this regard it is possible to ask engineers to fill in an anonymous questionnaire on the use of the various safety measures, the work situation and the various procedures.

4.6 Lifts with machine rooms versus machine-room-less lifts

The most important advantages and disadvantages of the two categories are listed below, first in general terms.

4.6.1 Lift installation with machine room

Advantages

- the machinery and switching cabinet are next to each other in a locked room.
- relatively secure working environment for engineers and inspectors

- the top of the well is accessible (the top of the car is the floor of the machine room), so the position of the car can be seen properly (an installation with the machinery underneath is disadvantageous in this case)
Disadvantages
- the machine room takes up space and floor area
- construction and installation costs are often higher
- the machine room is often only accessible via a ladder (max. permissible climbing height 4 m).
- having the machine room on the roof in contemporary designs is not aesthetic.

4.6.2 Machine-room-less lift installation

Advantages
- takes up less floor area
- shorter installation times
- no machine room protruding on the roof
- the relatively compact shape makes it ideal for use in listed buildings, for example

Disadvantages
- less favorable work situation for engineers and inspectors
- more dismantling and assembly because of its relatively compact shape
- there is a relatively poorer view of the car and the machine, and there are fewer ways of communicating between the control cabinet and the car or the well (if no undesired emergency release of the landing door is carried out)
- different procedures have to be followed in case of maintenance, inspection, repair and rescue of trapped passengers
- the design is relatively more risky as far as hazardous events are concerned

We discuss the latter disadvantage of machine-room-less lifts in more detail below.
The starting point is still that a risk analysis must demonstrate that an equivalent safety level is being achieved. In the first instance, one can look at the risk analysis. Then one can look at the final result with respect to the safety measures resulting from the risk analysis. This is being done here. One can also look at the acceptability of the additional risks. The acceptability relates to the risks, the risk-cost ratio of the safety measures and the advantages of a new design. What is socially acceptable in a certain period also has a role to play. Given the complexity and the starting point, the question concerning risk, advantages and acceptability is not answered here.

What can we nevertheless ascertain in general terms in relation to the safety measures applied in the case of machine-room-less lifts, even without looking specifically at the risk analysis? The narrow variation and range of the importance of the safety measures applied is striking. This can be explained partly by changes in the design made during the course of the risk analysis process, as a result of which the diversity of the safety measures is reduced, partly by restrictions in the design and partly by shortcomings in the risk analysis.

The safety measures used to reduce the risks from additional hazards are usually of the so-called "self-service" type, supplemented by a lot of work instructions and inscriptions.
The relatively uncertain human factor is central when it comes to ensuring safety. In addition, part of the intrinsic safety of the machine room is translated into a human factor in the form of monitoring the safety due to the relatively greater amount of activity on the lift in an public place

If safety is the only aspect considered, the above-mentioned tendency runs counter to the intended aim. It is important to eliminate the human factor as far as possible as it is a major contributor to hazardous events. Some factors that can result in accidents are described in brief below.

4.7 Information processed by people

The processing of information involves obtaining, storing and processing data. There are limits to this because people can only retain a limited number of new facts at any one time. This then raises the question as to whether engineers or inspectors can sufficiently absorb the excessive amounts of information relating to different kinds of machine-room-less lifts.

In specific terms, there are increasing numbers of work instructions which take the form of a series of consecutive steps which, if processed properly, are carried out at a routine level of attention. Mistakes that can be made in this regard include carrying out actions in the wrong order, forgetting some of the steps or erroneously deciding to miss out certain steps. A hazardous event may arise if there is insufficient response time for any necessary repairs. An example of a mistake at rule level is the confounding or specific actions to release passengers referring to more compact lifts, only a relatively shorter response time is available in certain situations.

In the case of more compact lifts, a relatively shorter response time should be available in certain situations.

If learned instructions have been properly assimilated, they are applied at the rule level of attention. In this case, actions are chosen with greater awareness, which limits the number of tasks to which attention can be paid. There are even fewer on the cognitive level of attention, in which we work through the process of problem analysis and solution with the greatest awareness. Mistakes made at rule level include carrying out instructions in the wrong order, and mistakes made at cognitive level include making mistakes in problem solving. The risk of making mistakes at rule level and cognitive level is greater if there is a greater possibility of distractions coming from the immediate vicinity and if the information becomes more complex; these two factors apply to machine-room-less lifts to a relatively greater extent. There is also the problem that relatively more care has to be taken when working on machine-room-less lifts, so engineers and inspectors are less able to keep an eye on environmental factors, even though this is particularly important in the case of machine-room-less lifts.

4.7.1 Forming habits

Some additional work procedures generally require periodic training. If this is not done (e.g. as a result of capacity problems or when taking over lifts), people assimilate instructions in their own way and bad habits may be formed. This can result in people making their own assessments of risks – either consciously or otherwise – so that they can skip certain actions.

4.7.2 Motivation

Most people are motivated to organize their work efficiently and carry it out economically. Safety measures (often the "self-service" kind) and procedures that are easiest to circumvent or that are very impractical or very time-consuming are the most likely to be skipped.

4.7.3 Pressure of work

Almost everyone in the lift industry has noticed that the pressure of work has increased significantly over the past few years as a result of greater work productivity and the large amounts of information that need to be processed. Furthermore, there is an increasing shortage of technical personnel in the labour market, capacity problems are putting pressure on training and the time available for training, and there is a greater turnover of engineers. There is also a tendency to match maintenance to the lift's actual period of use or the number of journeys it makes, and also to make it more like an inspection. Engineers then have to attend to even more lifts in the space of a week than before. This applies to all kinds of lifts. The pressure on machine-room-less lifts is also increasing even further because of the following:
- there are relatively more specific information, work instructions and safety procedures.
- engineers have to be relatively more alert at the switching cabinet
- more environmental pressure in the event of trapped passengers / breakdowns and more potential distraction as a result of unexpected noises from the hall, stairway or corridor, for example
- potentially greater differences in temperature if the switching cabinet is in a hall or corridor. Spending time in a cold room affects one's ability to concentrate, one's ability to carry out tasks and in particular one's ability to carry out tasks with one's hands. Low temperatures and draughts also make one rush one's work.

4.7.4 Ergonomics

Ergonomic aspects also sometimes cause accidents. The design and operation of additional aids for a new model of lift, such as hoisting equipment in a new building, are important in this regard.

4.7.5 Working environment

Finally we would like to briefly discuss the fact that the control cabinet or the control panel for a machine-room-less lift are often located in a corridor or hall. With this arrangement, activities such as maintenance, repairs and the elimination of faults are relatively more visible in a public area that is accessible to the inhabitants, lift users or visitors to the building. This may bring about a hazardous event as a result of an interaction between an incorrect action and the negative impact caused by one of any of the potential environmental or human factors. However, the risk of a hazardous event is usually very small due to the product of several risks in one period of time. But the greatest possible negative implications may be great.

Furthermore, in the case of machine-room-less lifts, the emergency release on the landing door is more likely be activated unnecessarily in the open space in front of the terminal landing (depending on where the control cabinet is located) for the following reasons:
- looking for the position of the car relatively more often (i.e. there is only unlocking zone identification)

The most favorable position for seeing and hearing is chosen; in the case of machine-room-less lifts this is usually on the landing.
- looking for machinery components; possibly touching them if they are within reach.
- communication between the engineer at the control cabinet or control panel and a engineer in the well.

In view of the above, the secondary aim of the Directive, which is to maintain or improve the level of safety in Member States, is achieved by improving harmonized lift standards and by bringing the safety level up to the same level by entering into agreements. Being allowed to deviate from the harmonized standard in a risk analysis has implications. Machine-room-less lifts are still generally accepted as being safe. However, the design is generally more risky and has relatively more uncertainties and (environmental) factors, and the risk is more difficult to assess. In this sense, there is more support for the Gestalt theory when applied to this scenario, i.e. that the whole of the safety measures offered by the machine room is more than the sum of the safety measures implemented to cover the additional risks of machine-room-less lifts.

5. SELF-CERTIFICATION BY MANUFACTURERS

So far, we have concentrated on the risk analysis. This risk analysis is used in situations of deviations from the harmonized standard. Manufacturers which have a certified quality-management system including the requirements of module H of the Lifts Directive are allowed to use self-certification of products complying the Directive. Deviations have to be approved by the Notified Body which has approved their quality-management system. From practice we have examples that a manufacturer declares a design to be in compliance with the Directive, although there are obvious deviations. It is very well possible that these installations are released for use without any check of a Notified body, which would have been required.

6. CONCLUSION

Theoretically, the Lift Directive should not only reduce the barriers for trade but it also should result in an increased level of safety for lifts. This safety level is determined by several factors: the way in which Notified Bodies are appointed, the judgment of manufacturers concerning deviations from the harmonized standard and the correctness of the risk-analysis. In this paper examples are described which give reason to doubt whether the safety level will really be increased. The elimination of barriers for trade has resulted in increased competition. Moreover, competition between Notified Bodies is introduced. If safety has to compete with costs, the risk of safety to loose is not unlikely. In this paper several examples have been presented, especially for machine-room-less installations. The reduction of safety level is more evident for the maintenance people and inspectors than for the users. Of course the degree of reduction in safety also depends on the former safety level for lifts. This on its turn depends on the standards which were in use before the Lifts Directive was implemented, the reliability – and number of the existing certification institutes before the appointment of Nobo's and the former quality of market surveillance by the authorities.

If we want to prevent serious accidents in the near future, the following measures should be taken:

1. make sure that the accreditation of Notified Bodies is not only based on procedures but also on competence;
2. make sure that the EU member states provide adequate market surveillance. This requires more quantity and quality in the evaluations (especially of risk-analyses) in the field by the authorities;
3. introduce a common database on accepted deviations from the harmonized standard including the motivation.