Understanding the Requirements of the New EN-81 Standards with Respect to Speed Monitoring, Speed Reducing and Prevention or Stop Devices

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1 ABSTRACT

Standard documents are industry guidelines rather than legislation to be enforced; standard publications do not act as industry police, but rather advice to be discussed by those involved in the industry. Manufacturers and producers are not obliged to adhere to them, but can fully expect to find themselves at the mercy of the law should consequences arise from any negligence, neglect or malpractice. Designers, however, are free to have their design tested by another notified body, should they desire. Thus, they are widely followed, and the source of much discussion and debate. This piece examines sections of the latest set of standards, EN81-20 and 50, to be released by British Standards Institute (BSI), governing the safety rules for the construction and installation of lifts.

2 INTRODUCTION

In August 2014, BSI published their new standard documentation covering safety rules for the construction and installation of lifts. The aim of this paper is to assist in the cause of understanding a few key areas of the publication.

The first part of the paper examines what the new standard defines as the difference between ascending car overspeed (ACO) and unintended car movement with doors open (UCM), in the context of the speed monitoring, speed reducing and prevention or stop devices allowable.

It considers the nature of each situation and how the standard deals with them accordingly. It ponders apparently contradictory sections of the standard before attempting to clarify them, and also casts doubt over common ways of complying with the standard such as doubling or tripling up on lift machine brakes. Having done this, the document then proposes standard-compliant systems for protection against excessive speed in the up direction and unintended movement with car doors open respectively.

The paper then moves on to the matter of the application of the speed monitoring, speed reducing and prevention or stop devices and looks at what the requirements are for testing and certification, examining certain sections of the standard. Once again, it picks out passages of the standard that could be construed as ambiguous and unclear, considers the implications of what the standard says and attempts to elucidate the abstruseness. This section is slightly more technically involved, considering calculations to determine permissible mass and energy absorbed by safety gears as well as looking at type testing procedures, before eventually drawing conclusions as to the author's interpretation of the standard as well as compliant safety systems.

3 UNDERSTANDING THE REQUIREMENTS OF THE NEW STANDARDS

3.1 What is the difference between excessive speed in the up direction and unintended car movement with doors open in terms of the speed monitoring, speed reducing and prevention or stop devices allowable by the standard?

Protection means against excessive ascending car speed and unintended movement are covered in the BS EN81-20:2014 [1] standard publication, sections 5.6.6 and 5.6.7 respectively. To the casual observer, protective means against excessive speed in the up direction and unintended movement with doors open could be seen as needing, fundamentally, to do the same thing – stop or slow the lift upon detection of an undesirable situation. Be it “the lift is moving when it should not be” or “the lift is moving too quickly”, the objective is to then stop the lift as quickly as is safe. While this is true to an extent, it does not take into account important differences between the two situations.

Although both are hazardous, unintended movement with car doors open is a more dangerous and serious situation than excessive speed in the up direction – primarily because the car doors are open and people may have been getting in and out of the lift when it started to move. The means for protection against unintended car movement needs to be able to detect a certain amount of movement with the car doors open, whereas ascending car overspeed protection needs to detect a certain speed in the up direction. As such, the standard appears to place tighter constraints on unintended movement protection means. It says the means must detect unintended movement of the car, stop the car and keep it stopped. This is as opposed to the excessive speed detection means, which is to detect excessive speed of the ascending car and stop or reduce its speed to that for which the counterweight buffer is designed.

A potential area for debate pertains to the causes of unintended car movement. This is covered in EN81-20, clause 5.6.7.1. It says:

> “Lifts shall be provided with a means to prevent or stop unintended car movement away from the landing with the landing door not in the locked position and the car door not in the closed position, as a result of any single failure of the lift machine or drive control system upon which the safe movement of the car depends.
>
> Excluded are failures of the suspension ropes or chains and the traction sheave or drum or sprockets of the machine, flexible hoses, steel piping and cylinder. A failure of the traction sheave includes a sudden loss of friction.” [1]

The question is whether it is fair and responsible of the standard to discount failures of the suspension ropes, chains and traction sheave, including a loss of friction. Granted, the standard includes design measures for traction which should ensure traction over the range of 0% to an overload, and uncontrolled slipping would not occur without steady deterioration to the ropes and/or sheave, which should be detected by a suitable maintenance regime. Unfortunately, these design principles are not always adhered to and maintenance practice not always followed, especially as lift engineers currently have an average of 12 minutes to perform maintenance checks on lifts, and uncontrolled slipping does occur, albeit seldom.

Section 5.6.7.3 says:

> “The means shall be capable of performing as required without any assistance from any lift component that, during normal operation, controls the speed or retardation, stops the car or keeps it stopped, unless there is built-in redundancy and correct operation is self-monitored.” [1]

This is affected by the issue about neglecting uncontrolled slipping because, obviously, overcoming of friction forces between the ropes and the traction sheave would lead to unintended car movement regardless of whether the sheave is moving. If that was the case, the brakes would be clamped closed on the brake drum and the traction sheave would be stationary, but the ropes would still be moving through the grooves. Then it would not matter how many machine brakes you have, they would all be useless – the ropes are going to continue to run through the grooves and the car would not stop under this means.

The same problem also applies to sheave brakes. They act on the sheave itself so, once again, you can have as many sheave brakes as you like, but they will not make a difference if the suspension ropes have overcome the friction forces and are slipping through the grooves of the traction sheave because the ropes will be moving regardless of whether the sheave is. It is worth noting as well, on the subject of sheave brakes, that, while the standard states that the brakes are to be able to bring the lift to a halt without the need for at least one brake so as to achieve built in redundancy, the reality is that, in a lot of cases, it is unknown by those concerned with the safe operation of the lift whether the lift is being stopped by all of the sheave brakes under normal operation. If all of the sheave brakes are stopping the lift under normal operation, there is no longer any built-in redundancy, so a sheave brake is no longer a compliant means against unintended car movement.

Overspeed governors in tandem with safety gears or rope brakes can be used as a protection means against unintended movement with car doors open, but the governor must be able to detect 150-200 mm of movement with car doors open in order to perform as required and trigger the stopping element of the means. Although standard friction type governors are unable to detect uncontrolled movement, certain types of friction governors as well as drop-jaw and electronic governors are able to detect unintended movement. Drop-jaw governors, for example, incorporate an electrical safety control circuit where a contact is closed upon detection of a 200 mm movement of the governor rope in one direction, triggering the stopping means. An overspeed governor that has been type-tested for use as a detection means and can detect unintended movement in tandem with safety gears or rope brakes is one example of a compliant means of protection against unintended movement, however more often than not, this means consists simply of a safety circuit that de-energises a solenoid when the car skate leaves the landing lock roller.

Another issue that should be confronted, on this matter, is whether the level of safety stipulated in the standard for both UCM and ACO situations are reasonable; is it reasonable to expect a protection system to bring a lift car to a halt in 1200 mm in an unintended car movement situation? At each of the detection, activation and stopping stages of the response, there are systemic delays, from sensor trigger, electrical signals and solenoid delays to overcoming governor rope inertia and physical movement of the stopping means. These delays all add up as well as leading to a higher maximum speed than what would be expected and mean that the **detection** distance and, as a result, the **braking** distance are both increased. As such, the tripping speed of the governor could easily be surpassed in the time taken for the safety gear to start braking, especially in a modern MRL system with a gearless machine and very low system friction and high inertia, where the acceleration in the up direction with an empty lift car could be significant. In the case of ascending car overspeed protection, the tripping speed *is* the activation condition, meaning that there is no question that the trip speed is exceeded by the time the stopping means start to act. Therefore, 1200 mm to stop the lift car could be portrayed as slightly optimistic in a control circuit-solenoid activated system when talked about in this light. The object of the standard is to provide pragmatic regulations that give designers some leeway to achieve them based on the technology available, whilst still maintaining an acceptable level of safety. However, of course, the standard needs to stipulate a stopping distance which ensures injuries (or otherwise) do not occur as a result of UCM or ACO.

Having said this, it could also be argued that to call for 200 mm of movement as the trigger for UCM with car doors open is a somewhat luxurious bearing in mind the accuracy of modern control circuits and self-levelling capabilities of lift systems. Control systems are capable of detecting the tiniest fraction of unexpected lift car movement, and the system is capable of self-levelling to within a fraction of 200 mm. Calling for more tightly controlled trigger conditions, such as a reduced amount of movement as the trigger for UCM, would result in reduced likelihood of exceeding the governor tripping speed in a UCM situation.

The ascending car excessive speed protection means is, understandably, a more straightforward standard to comply with than unintended movement, with less ambiguity. The standard recognises that it is fairly standard practice to use an overspeed governor to detect excessive speed and then trigger a rope brake or safety gear upon detection.

The standard for ascending car overspeed protection means states, in clause 5.6.7.3:

> "In the case of using the machine brake, self-monitoring could include verification of correct lifting or dropping of the mechanism or verification of the braking force." [1]

It is not entirely clear what this passage means; it could be construed as referring to a machine brake as the means for self-monitoring. Of course, the machine brake cannot be used for overspeed detection. The machine brake does not contain a speed monitoring component as standard and would not be able to detect overspeed. A reasonable conclusion to draw would be that it is referring to an overspeed governor.

The standard permits a mechanical linkage to the car to assist the ascending overspeed protection means in its performance. No mention is made of such a linkage in the standard on unintended car movement. If this 'mechanical linkage' is assumed to mean the actuation means, this would, of course, be analogous to the overspeed governor rope in an overspeed governor/safety gear system used for protection means against ascending car overspeed. Whether this means that a mechanical linkage is not permitted on the unintended movement protection means is another area of ambiguity. Since overspeed governor and safety gear systems can be used for protection against unintended car movement, it would seem fair to conclude that this linkage is permitted, or that requirements elsewhere in the standard for the overspeed governor rope would be applied.

To sum up, devices that are definitely compliant for protection against excessive speed in the up direction and unintended car movement with car doors open respectively include:

Table 1: Devices compliant with BS EN81-20:2014 for protection against excessive speed in the up direction and unintended car movement with doors open.

Protection against excessive speed in the up direction	**Protection against unintended car movement with car doors open**

• Overspeed governor in tandem with:
  • Rope brake; or
  • Safety gear
• Other ascending car overspeed protection means
• Counterweight buffers
	• Overspeed governor (such as drop-jaw) that can detect car movement with doors open in tandem with
	  • Rope brake; or
	  • Safety gear
	• Other unintended car movement protection means

3.2 Depending on application of the speed monitoring, speed reducing and prevention or stop devices, what are the requirements for testing and certification?

It should be reiterated, to commence this section, that unintended car movement and ascending car overspeed are two entirely different situations with important differences as far as protection is concerned. The testing and certification standards for all of these devices are laid out within BSI's EN81-50:2014 standard publication, sections 5.3 – 5.5 and 5.7 – 5.8.

Section 5.3.2.2.1 covers the method of type testing for instantaneous safety gears, the standard stipulates that "the deformation of the safety gear block as a function of the force or as a function of the distance travelled" [2]; what this statement refers to could be seen as slightly ambiguous. Without knowing whether "block" refers to a specific component on the safety gear or the safety gear itself, a reasonable guess would be that "deformation of the safety gear block" means the change in distance between the load-bearing side elements of the safety gear throughout the course of the test. Test methodology and instrumentation could be discussed with a notified testing body. This use of the term "blocks" also creates doubt in section 5.3.2.2.2 for the test procedure; the standard reads "reference marks shall be traced onto the blocks".

On the same subject, it is noticeable that there is no mention of exactly how far the distance travelled is, unless that is covered in "the arrangement and fixing details" which, as outlined in 5.3.2.1, are to be determined by the laboratory in accordance with the equipment that it uses.

Section 5.3.2.2.3.2 concerns the measurement of the capacity of the safety gears. It reads:

> "The capacity of the safety gears shall be established by integration of the area of the distance force chart"

Determination of the permissible mass encompasses energy absorbed by the safety gear, and section 5.3.2.3.2 outlines this. The standard gives a formula by which permissible mass,$(P+Q)_1$ is worked out based on the preceding theory around the total energy, K, one safety gear is capable of absorbing. It gives this formula as:

$$2 \cdot K = (P+Q)_1 \cdot g_n \cdot h$$

Although the standard does not explain why the K value is multiplied by 2 on the left hand side of the formula, it would be a more than reasonable assumption that it is because there are (generally) 2 safety gear blocks acting in the same direction on any given lift car.

An area of possible controversy is the dividing safety coefficient on the bottom of the equation for permissible mass. The formula is given by the standard as:

$$(P+Q)_1 = \frac{2 \cdot K}{2 \cdot g_n \cdot h}$$

K is calculated by the integration of the area under the distance-force chart;

2 is taken as the dividing safety coefficient.

Traditionally, safety gear design pre-dates modern techniques such as FEA, and encompasses the potential for a number of activations during the safety gear's lifetime. This is why the safety factor is stipulated as 2. Although taking two as the dividing safety coefficient seems a reasonable approach, in reality there a number of factors that affect the appropriate safety margin in any given case. These include material, stress, geometry, failure analysis and reliability issues. [3] When calculated as a function of all these factors, the safety margin could be anything from around 1.1 to 8 or more. It can be possible to significantly under- or over-estimate the performance of the product if an excessive safety factor is taken on related calculations. It could be argued that, because these calculations are based on experimental findings, no safety factor need be taken at all due to the calculations being based on real performance. Perhaps however, due to the attained K value being put into another formula to find the P + Q mass and theoretical relationships not always being entirely accurate in reality, this would not be advisable.

Section 5.3.3 of the standard covers the testing regulations for the progressive safety gear. The opening section of this reads:

> "If the safety gear shall be certified for various masses, the applicant shall specify them and indicate in addition whether adjustment is by stages or continuous." [2]

Surely, whether the adjustment of the safety gear is continuous or in stages does not make a difference because, ultimately, the only way to carry out testing is to conduct a number of individual tests at incremental masses with the safety gear adjusted according to each mass. Therefore, however small those increments are, it is always going to be adjustment in stages as opposed to continuous. It is not terribly clear how a safety gear can be adjusted continuously – or how this can be accounted for in testing methods, so why the applicant needs to state this is unclear.

The test procedure for the safety gear certified for a single mass is outlined in section 5.3.3.2.2.1 as follows:

> "The laboratory shall carry out four tests with the mass$(P + Q)_1$. Between each test, the friction parts shall be allowed to return to their normal temperature.
>
> During the tests, several identical sets of friction parts may be used.
>
> However, one set of parts shall be capable of:
>
> a) three tests, if the rated speed does not exceed 4 m/s;
>
> b) two tests, if the rated speed exceeds 4m/s." [2]

Carrying out four tests if one set of friction parts is to be capable of either three or two tests, depending on speed seems moot. Whilst it may be argued that conducting four tests for units intended to be used two or three times provides an additional assurance about their longevity, it would seem more sensible for the number of tests carried out to correspond with the number that one set of friction parts should be capable of; then if deemed necessary, an additional run of the same number of tests can be carried out using new braking parts.

It could be argued that the same set of friction parts should be capable of more than two or three tests anyway. The problem with this arises when one considers that safety gears installed on site are tested once at an acceptance test and, sometimes, another time at a witness test, which means that after one more engagement, the braking parts may need to be changed. Some safety gears are capable of upward of 100 tests without changing the friction parts, or any component for that matter. Among these are the VG (variable geometry) range of safety gears supplied by Atwell International, as demonstrated at the 2007 Interlift Trade Fair in Augsburg, when 121 tests were carried out without loss of performance.

This also relates to a later section of the standard, contained within section 5.3.3.2.3.1. It says:

> "NOTE Tests have shown that the coefficient of friction could be considerably reduced if several successive tests were carried out on the same area of a machined guide rail. This is

> attributed to a modification in the surface condition during successive safety gear operations." [2]

As already alluded to, the 2007 Interlift Trade Fair in Augsburg saw a VG4 safety gear supplied by Atwell International work repeatedly without a reduction in braking performance over the course of 121 drop tests followed by similar performance over 30 more tests at Atwell International premises. This phenomenon is most likely due to the type of friction that occurs between the braking parts and the guide rail. When the safety gear first brakes on a new section of guide rail, the toothed carbide inserts are "cutting through" the rail as they travel. Hence, there are two types of friction acting between the inserts and the guides over these tests: ploughing friction and sliding friction. The teeth of the inserts are both "ploughing" a groove into as well as "sliding over" the guide rails. After the first few tests (how many depends on the guide rail characteristics and the load being put upon each insert by the spring force), the teeth will have penetrated to their full capacity and the only type of friction that will be taking place is sliding friction. It is, if anything, slightly more efficient to have simply sliding friction taking place than a combination of that and ploughing friction. In my opinion, the statement in section 5.3.3.2.3.1 may not be the case in all circumstances and this is backed up by the test results gained in Augsburg in 2007.

The next section, 5.3.3.2.2.2, covers the testing procedure for safety gears certified for different masses. It states that "two series of tests shall be carried out" for the maximum and minimum values applied for. The terminology is quite vague and open to interpretation. It would be reasonable to assume that, as in the previous section of the standard, a "series of tests" means 4 tests, with one set of friction parts being capable of either 2 or 3 tests depending on speed.

Moving on to type testing of overspeed governors, and section 5.4.1 of the EN81-50 standard, which covers the general provisions for testing. The standard calls for the applicant to indicate the type of safety gear to be used with the governor. While this is understandable, as the co-ordination between overspeed governor and safety gear is crucial, section 5.4.2.1, which covers the test samples to be submitted, does not list a safety gear. If the standard considers the safety gear sufficiently crucial to the operation of the overspeed governor to merit the applicant disclosing the type of safety gear, it would seem logical that the test also demonstrate this co-ordination in physical terms as well.

Section 5.4.2.2.2 relates to test procedure of the governor and states that:

> "The acceleration to reach the tripping speed of the overspeed governor should be as low as possible, in order to eliminate the effects of inertia.
>
> In addition a minimum of two tests shall be made with an acceleration of between $0.9g_n$ and $1g_n$ in order to simulate a free fall situation and prove no further deterioration of the governor has been caused." [2]

It is not made fully clear whether the acceleration of the governor rope or the governor pulley shall be measured. It would, perhaps, be a reasonable assumption that this arrangement is flexible dependent on the individual set-up of any given test. Although, in any system involving friction, true free fall is not possible due to what is known as 'system losses' (hence the standard stipulating a minimum of $0.9g_n$), what is not clear is how the oft-uncontrollable, or at least difficult to control and quantify, system losses can be limited with any reasonable certainty to no more than 10%.

Section 5.5.3.1.1 of the standard deals with the test procedure for energy dissipation buffers. In it, it says:

> "The acceleration and the retardation shall be determined as a function of time throughout the movement of the weights." [2]

This is all very well and good but section 5.5.3.1.2.4, dealing with the measurement of the retardation of energy dissipation buffers, says:

> "If there is a device for measuring retardation (see 5.5.3.1.1), it shall be placed as near as possible to the axis of the buffer, and shall be capable of measurement with the tolerances of 5.1.2.6." [2]

The fact that it says *if* there is a device for measuring retardation seems slightly contradictory when put into the context of the earlier section dealing with the test procedure. The retardation clearly is to be determined, but not necessarily by measuring it directly, it would seem. It would probably be fair to say that one of the key objectives of the type examination is to measure the retardation supplied by the buffer. Surely this cannot be done, at least with the required accuracy, without a device for measuring retardation first-hand. Sensors, load cells or other instrumentation devices that calculate deceleration from other measured parameters generally lose a certain degree of accuracy as a result of these calculations in this author's experience. Elevator buffers have to meet with a variety of specifications but, surely, the most important of these is the manner in which the buffers must bring an impacting elevator car to rest. Not measuring the retardation supplied by the buffer directly during testing seems not to be conducive to finding out if the buffer meets with specifications on bringing an impacting elevator car to rest.

I notice that in section 5.7.2 relating to the statement and test sample of the ascending car overspeed protection means type examination, the standard says:

> "As defined between the applicant and the laboratory:
>
> - either a complete assembly consisting of both elements, braking device and speed monitoring device; or
> - only that device which was not subject to verifications according to 5.3, 5.4 and 5.6;
>
> shall be provided by the applicant." [2]

To put this into context, earlier in the standard, in section 5.7.1.2, it says:

> "The applicant shall state the range of use provided:
>
> a) minimum and maximum masses, or torque;
>
> b) minimum (if applicable) and maximum rated speed;
>
> c) use in installations with compensating ropes." [2]

If the applicant has already had the braking device certified and, therefore, only the speed monitoring element is the subject of the examination, surely it is no longer necessary for the applicant to provide the maximum and minimum masses. Mass does not have any effect on the operation of an overspeed protection means. The function of any excessive speed protection means, taken in isolation, is to trigger a braking device upon detection of a certain speed, regardless of the mass of the lift car. If the applicant was providing both elements, they would need to state the range of masses because the mass does affect the performance of the braking device, but the same cannot be said for the overspeed protection means alone.

The type examination of unintended car movement protection means is covered in section 5.8, and section 5.8.1 concerns the method of the test:

> "The unintended car movement protection means shall be type tested as a complete system or the subsystems for detection, activation and stopping may be submitted to an individual type examination." [2]

The standard guidelines for this is phrased very differently compared to the equivalent standard for overspeed protection means; the standard refers to three subsystems, for detection, activation and stopping, which is understandable, because protection means against unintended movement needs to incorporate a control circuit to detect movement with the car doors open, whereas the means for protection against ascending car overspeed does not. However, what is not so clear is what the standard for unintended movement means by "interface conditions between the subsystems if integrated into a complete system". [2]

Despite acknowledged critical differences between the two, protection means against unintended movement and ascending car overspeed have, in essence, to perform fairly similar functions. Protection means against unintended movement has to detect 150-200 mm of car movement with doors open and stop it according to the guidelines laid out in the standard. Meanwhile, protection means against ascending car overspeed has to detect excessive speed of an ascending car and stop or slow the lift to such a speed for which counterweight buffers are certified. The relative similarity of these two means is demonstrated by the earlier discussion in this report as to the difference between excessive speed in the up direction and unintended car movement with doors open in terms of the speed monitoring, speed reducing and prevention or stop devices allowable by the standard. The conclusion was drawn that identical devices, namely an overspeed governor in tandem with a rope brake or safety gear, can be used for both scenarios. The only differences are that for unintended movement the means has to incorporate a control circuit to detect movement with the car doors open before actuating of the stopping means when the doors are open. The fact that such similar devices are interchangeable for dealing with the two situations speaks for itself.

The unintended movement standard also states that, among others, the minimum and maximum fluid pressure, if applicable, and limits of temperature and humidity of the design and any other relevant information agreed between the applicant and test laboratory shall be stated by the applicant. None of this is mentioned in the section of the standard covering protection means against ascending car excessive speed. Firstly, it is unclear to what fluid pressure the standard is referring here and why it does not apply to the standard for ascending car overspeed. In addition, what is meant exactly by the temperature and humidity of the design is not clear: does it refer to one or more of the components, the lift car itself, the lift machine, or an amalgamation of these? The fundamental differences between the two scenarios do not seem to merit such discrepancies in standard guidelines between them.

Another difference between the two standards concerning unintended movement and ascending car overspeed comes in the method of test section. The unintended movement section calls for measurements to be made of the stopping distance, response time of the detection, actuation, stopping element and control circuits, whereas the ascending car overspeed section does not. In addition, a figure is provided showing the acceleration and deceleration of the lift car with response times labelled, but no equivalent figure is given for the section of the standard covering ascending car overspeed. Control circuits apart, it appears not to make sense that ascending car overspeed protection tests do not require these measurements and figures. Whilst the two situations are different with fundamentally different requirements, and unintended movement is a potentially more dangerous and serious situation than ascending car overspeed, the extent of the inconsistency between the two standards it is somewhat surprising. Surely, the detection device is a fundamental aspect of the unintended car movement protection means and it would go without saying that, as it does in the standard for the ascending car overspeed protection means, its operation is to be tested.

Another inconsistency crops up in the next two sections, dealing with devices certified for a single mass, torque or fluid pressure (5.8.3.2.2 and 5.8.3.2.3). [2] Once again there is a mention of fluid pressure, to which the same query raised earlier applies. Additionally, this title makes reference to torque. Again, the reasons for including torque in this title are not clear. At what stage in the detection, actuation and braking process there is torque involved for unintended car movement that there is not for ascending car overspeed protection is a mystery. If this title is as it is, why is the corresponding title in the ascending car overspeed section not "Device certified for a single mass or torque" instead of "Device certified for a single mass". [2]

Staying with this particular section of the standard (5.8.3.2.2), the standard defines that:

> "The laboratory shall carry out 10 tests with the system mass or torque or fluid pressure representing an empty car in up direction and 10 tests with the system mass or torque or fluid pressure representing an empty car carrying the rated load in down direction." [2]

The unintended car movement protection means is to act in both directions, whereas the ascending car overspeed protection means only acts in the up direction, so the fact that this section of the standard dictates tests are to be carried out both with the equivalent of an empty car in the up direction and the rated load in the down direction is plausible. However, one disparity between the two standards that is not is the fact that 10 tests are to be carried out for each, when only 4 are carried out for the ascending car overspeed testing. That unintended car movement testing is deemed to require six more tests being carried out in each direction than ascending car overspeed testing is mysterious. What is also strange is that one set of friction parts must be capable of 5 tests minimum here, in comparison to 2 or 3 (depending on speed) for ascending car overspeed.

Comparison of the two sections dealing with checking after the tests in the two standards yields more apparently unnecessarily pronounced differences. Although points a), b) and c) appear to roughly correspond to each other, the unintended movement standard has an extra aspect to it:

> "d) it shall be checked that the retardation with the minimum mass has not exceeded 1 g_n." [2]

Again, the fact that is stated as a constraint for this standard but not for the device for protection against ascending car overspeed appears illogical; surely this is a criteria that either applies to all speed monitoring, speed reducing and prevention or stop devices, or none of them. It is clear that unintended car movement and ascending car overspeed protection are fundamentally different situations, and unintended car movement is a potentially more serious and dangerous situation than ascending car overspeed, for one, because people may have been getting in and out of the lift when it started to move. However, despite this, the nature and extent of many of the inconsistencies in the standards is very strange and surprising.

4 CONCLUSION

Bearing in mind the key differences between unintended car movement and ascending car overspeed, the devices that are allowable for each are slightly different accordingly, although they need, in essence to perform similar functions of detecting the situation and stopping or slowing the lift. To conclude, an overspeed governor that can detect 150 mm of movement with the car doors open in tandem with a rope brake or safety gear is one example of a compliant protection means against unintended car movement with car doors open, along with electronic control circuits, shave brakes and, potentially, solenoids. Again, an overspeed governor in tandem with a rope brake or safety gear, in addition to counterweight buffers is a compliant means for protection against ascending car overspeed.

A mechanical linkage to the car to assist the means in its performance is permitted for ascending car overspeed protection, and it would seem also for unintended car movement, as long as it meets requirements called for elsewhere in the standard.

As well as discussing the implications brought about by the wording of the standard in certain sections, as throughout the paper, section 3.2 mused what this means as far as testing and certification of the compliant devices is concerned, which is covered in EN81-50. In addition to this, details of test procedures were confronted and evaluated, such as factor of safety on calculations, and first-hand measurement of deceleration. This analysis incorporated energy dissipation and accumulation buffers as well as detection and stop devices.

The number of tests to be carried out on both ascending car overspeed protection (ACOP) and unintended car movement protection (UCMP) means was also appraised. Arguments were put forward regarding the number of tests carried out in relation to the number of tests one set of braking parts should be capable of. This, in turn, brought up issues of friction between braking parts and the braking surface; including how some safety gears are capable of many more tests than called for by the standard, even over used sections of surface. Finally, the paper examined and compared the testing procedures laid out in the standard for both ACOP and UCMP means, with respect to the devices allowable by the standard for each, and questioned the, what it deemed, relatively large disparities between them.

GLOSSARY

MRL: machine room-less lift

ACO: ascending car overspeed

UCM: unintended car movement

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