

# **Preventive and Planned Maintenance of Elevators**

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## **ABSTRACT**

Maintenance is not only action when damage appears but also contains required operations for establishing and evaluating the current situation of elevator installations. By applying planned and periodical maintenance, continuous and reliable service time of elevators will be increased and the need for repair will be reduced. In this study elevator maintenance methods are discussed and preventive maintenance methods of elevator installations are hold and examined considering the regulations and standards.

## **1. INTRODUCTION**

A lot of money is lost annually by the owners of elevators because preventive maintenance was not properly performed. A good portion of the breakdowns of elevators due to electric contact failure could be avoided by proper maintenance. Elevator systems have got many different types of equipment and pieces. This complexity creates different levels of safety and the safety of the total elevator system depends on each element's reliability. If elevators become out of order for any reason, repairs, re-settings or replacement of some parts may be required. By means of applying preventive maintenance, demand for repair should be minimized. To increase the reliability of elevator systems preventive and planned maintenance should be done. Preventive maintenance is one of the important factors mentioned above to obtain safe and reliable elevator operations.

## **2. ELEVATOR MAINTENANCE**

The first elevator maintenance contract was arranged in the early 1920's. They were often limited in scope and consisted of periodic visits to the buildings. A maintenance contract is an agreement between a contractor and the building manager to ensure continuing good service that includes terms and conditions. Most elevator companies have printed forms representing their standard maintenance contracts.

After an elevator installation is placed in operation it begins to wear and require periodic maintenance. Even the most basic elevator equipment probably gets 30 to 40 hours of attention a year while a major sophisticated installation may receive that much attention per month (Aslan and Imrak, 1993).

In the standards, maintenance is described as a total process of cleanliness, lubrication, settings, inspections and experiments, which is done by maintenance personnel. The aim of elevator maintenance work is to obtain the ability and high performance of the systems in service life. It is also amongst the aims of the maintenance activities to ensure that the system should work efficiently and safely.

Preventive maintenance method is used for preventing the equipment from having damaged in order to limit damage level. In addition it reduces frequency of failures. Preventive maintenance procedures also include special inspection and service facilities. Scheduling of preventive maintenance effects reliability of elevator installations from the operational point of view. Preventive maintenance and quality control which are scheduled a head of time should be executed at certain set of time intervals in accordance with the schedule. The quality control performed parallel to preventive maintenance can and should diagnose failures before they occur. (Lustig, 1988).

Maintenance personnel should regularly and systematically examine, adjust, lubricate and replace the parts of the elevator system as required or when conditions warrant repair or replacement. They also examine periodically all safety devices and governors.

### **2.1. Inspection**

Inspection of critical parts is directly proportional to reliability of installation. Throughout the maintenance procedure, the aim of inspection is to find failed parts and parts which could cause possible failures in the near future. The main inspection activities are as follows (Imrak and Ozkirim, 1999):

- to check the broken wires in the suspension ropes and looking at wear
- to check the wear at the grooves of the shave
- to control the guide shoes
- to check the wear at the gears and bearings in drive unit
- to control and set both the hydraulic or spring car and counterweight buffers
- to check the tightness of bolts and nuts
- to check the car leveling between the given limits
- to control leveling of the car and landing doors operation
- to test the mechanical brakes

The inspection is generally done within given periods to find the parts which need to be repaired or replaced. Although this type of inspection may indicate that elevators show "short time" temporary out of order. This reduces total time lost during failure into a reasonable level. Elevator owners and maintenance personnel should try to reduce maintenance expenses because of high cost of spare parts' expenses and workmanship (Godwin, 1986). Periodical cleaning, lubrication and settings reduce wear and minimize the probability of failure. This will be done by means of manufacturer's directions and practical observations. However all of these can not totally prevent the failure.

### **2.2. Lubrication**

Lubrication of parts and section of elevator should be done with suggested lubricants as given by the manufacturer's recommendations. Oil level checking has to be done and the oil has to be changed at given intervals for parts which are working in oil. Parts in friction should be prevented from rusting by means of using preventive grease. Covered sections have to be

opened and cleaned inside with oil. Parts that are cleaned and lubricated in the elevator are listed as follows (Imrak and Ozkırım, 1999):

- Suspension ropes should be lubricated with selected lubricant and then the car will be operated and stopped several times. During these procedures sliding should be checked.
- Overspeed governor's rope should not be lubricated
- Guide rails should be cleaned completely and lubricated once a year
- Safety gear's rotating parts should be cleaned and lubricated periodically
- Hydraulic buffers should be checked at certain periods and the level of hydraulic oil should be checked

### **2.3. Periodical Cleaning and Settings**

On service facilities excluding the lubrication, cleaning, settings of important parts must be done. In elevator installation these parts listed below should be cleaned and done with these items,

- Hoistway should be kept clean, the pit should not be used as a storage area. If there is water, it must be discharged and isolated.
- Machine rooms should be kept clean and tidy. No equipment excluding maintenance equipment should not be stored in this area.
- The top of the car should be clean and emergency the lid and fan systems have to be checked. No equipment should be put in this area.
- The elevator's general surfaces should be painted but working surfaces should be kept unpainted.
- Brake settings
- Door settings
- Automatic doors, the door mechanism has to be inspected and set
- Door locks
- Switch settings

## **3. MAINTENANCE AND INSPECTION OF ELEVATOR ROPES**

Every elevator maintenance plan should include periodical wire rope inspection in order every 3 months. Most common method of inspection uses a ball of waste pressed against ropes and broken strands pick up strings quickly, showing up break locations. A careful visual examination is about the best inspection method known about rope inspection (Imrak, 1997b).

### **3.1. Maintenance and Inspection of Elevator Ropes**

Maintenance is particularly important on multiple rope installation and compensating ropes on traction elevators. Unequal tension can result from improper adjustment at the attachments, but it can also be caused by sheave grooves of unequal depth. There are several methods of checking tension in the ropes such as tension meters.

The entire length of the rope should be inspected frequently and paid particular attention to those sections that experience has proved to be the deteriorating area. Cutting off an occasional few feet or so of rope changes the place of maximum deterioration over sheaves and pulleys. It is sometimes wise to start off with a slightly longer length of rope than is

necessary, in order to allow for this cutting. This is especially valuable where the spliced end of the rope has to work over sheaves. Deterioration is usually excessive at this section, and it is very convenient to cut off and re-splice (Weischedel, 1990).

The excessive wear and portions in need of lubrication it should be checked for broken wires. It should be made sure that the broken wires do not exceed the number laid down in the Regulations. A broken wire in a rope should always receive prompt attention. Delay may lead to serious accidents, and will certainly cause damage to other wires (Imrak, 1998).

The service life of rope depends on the rope tensile stress and the number of reverse bending. The critical number of wire breaks is reviewed for ropes of different constructions. During the tests the number of wire breaks was observed in relation to the number of cycles, for specific load and different ratios sheave diameter / rope diameter. The number of breaks achieved at 80 percent of rope life was taken as critical, decisive for rope replacement. The wire breaks relate to the rope length of  $6 \cdot d$  or  $30 \cdot d$  respectively. Critical number of wire breaks  $6 \cdot d$  and  $30 \cdot d$  specified in ISO 4309 / DIN 15020 as well as those determined by tests are listed in Table 1 (Janovsky, 1993).

*Table 1. Critical number of wire breakes*

Number of wires Of wire ropes	Critical Number of Broken Wires			
	Langs Lay		Regular Lay	
	6 d	30 d	6 d	30 d
6 x 19 = 114	9	18	4	8
8 x 19 = 152	18	36	6	12
6 x 37 = 222	30	60	10	20
8 x 37 = 296	40	80	12	24

As seen in Table 1, the results of tests revealed a good conformity with ISO specification for Regular lay rope with fibre cores, but the specified numbers could be almost doubled for Regular lay ropes with wire cores. Langs lay ropes irrespective of the kind of core did not give reliable results (Imrak, 1999).

The method often used to deal with a broken wire by nipping it off with pliers is by no means the best way, for this leaves a little jagged end. To save time and trouble, simply bend the wire backwards and forwards with the fingers until it breaks, or, in the case of a short end, use a piece of wood. In this way the wire breaks inside instead of outside the rope, and the end is left tucked away between the strands, where it can do no harm to over wires or to machinery or personnel.

#### **4. ELEVATOR MAINTENANCE PROCEDURES AND RULES**

The maintenance procedure has to be convenient according Elevator Maintenance Rules and Standards. Maintenance in passenger elevators and good elevators should be controlled once a month. This maintenance has to be done by authorized and certificated maintenance personal according to the maintenance instructions and the results of maintenance and inspections have to be written in a "maintenance report" (Imrak, 1997a).

Maintenance procedure of lift and its details are determined by instructions. In these instructions, type of maintenance, maintenance period, settings, tolerance values and operation conditions are written. Maintenance has to be done before elevators become out of order. Afterwards it is not preventive process. All parts' maintenance period has to be determined by their manufacturers. Maintenance personal has to be authorized and certificated technician from City Councils or other relevant institutions.

Elevator companies have to select design and install each elevator according to Standards. They also have to take an Operation License as mentioned in the Elevator Regulations border from the City Council in the city and from the Province out of Municipality border. To take this license, four items are checked. One of them is looking for existence of contract of elevator maintenance. The elevator maintenance company has to store the spare parts and use the original materials for replacement. According to Elevator Regulation, the elevator maintenance company should state the maintenance period. Standards give a maximum of 6 months interval for maintenance facilities (Imrak, 1998).

#### 4.1. Elevator Maintenance Book and Maintenance Report

Maintenance and inspections should be done periodically for each elevator according to Standards and Elevator Regulation and maintenance report must be written and kept in a file. In addition every elevator has got its own maintenance book. In this book all failures, maintenance facilities and inspections are written with given dates. The maintenance book which contains information and data about elevators, will be designed and written as mentioned in Standard. From this standard, the main characteristics of elevators and all documents about elevator and its components must be inside the book (Imrak, 1997a). All the information and changes must be updated. In any case elevator maintenance books have to be shown whenever requested by officials. In elevator maintenance book, some items should be written or obtained as follows in Table 2:

*Table 2. Contents of Maintenance Book*

Elevator's technical characteristics	Type control documents for
Installation date	• locking devices
Documents about wire ropes	• landing doors
Major changes	• safety devices
Failures and their dates	• buffers
Installation drawings, circuit plans	Inspection and test reports' copies

A maintenance report has to be written in triplicate format by maintenance personal. One of them will be kept by maintenance personal, the other one is for building manager or owner, and the final one is for attaching to the elevator maintenance book. Also replaced parts should be noted in the maintenance book. General characteristics of elevator installation and maintenance personal name, address and signature must be found in the maintenance report.

#### 4.2. Elevator Maintenance Contract

The building manager or the owner has to sign a contract with an elevator maintenance company and this company will take full responsibility for this elevator. During the guarantee period of elevator, the installation company should be the first maintenance company and take this responsibility. Afterwards the building manager or the owner will sign a contact with

another elevator maintenance company. In elevator maintenance contracts, the maintenance company has to specify the interference time after notifying failures (Gerdemeli et al, 1992).

Elevator companies have to give the instructions and they are notified that elevator users must follow these instructions. In this instruction some matters depend on installations and change from instruction to instruction. General subjects from elevator instruction are listed as follows:

- Rescue facilities should be done according to elevator instruction when stacking between the floors.
- It is for children under the age of 12 to enter the elevator alone.
- It must be checked to see whether the car is on the floor or not when entering the car.
- They must not try to brake and get out the door's window when passengers stack inside the car.
- Passengers must not try to get out through by the emergency lid.
- The load of the car should not exceed the limit requested by the elevator company. If there is a sliding risk, the action against sliding must be taken.
- Except for the maintenance company which is working under an agreement, another elevator company or person should not interfere with this elevator.

#### **4.3. Annual Check of Elevator Installations**

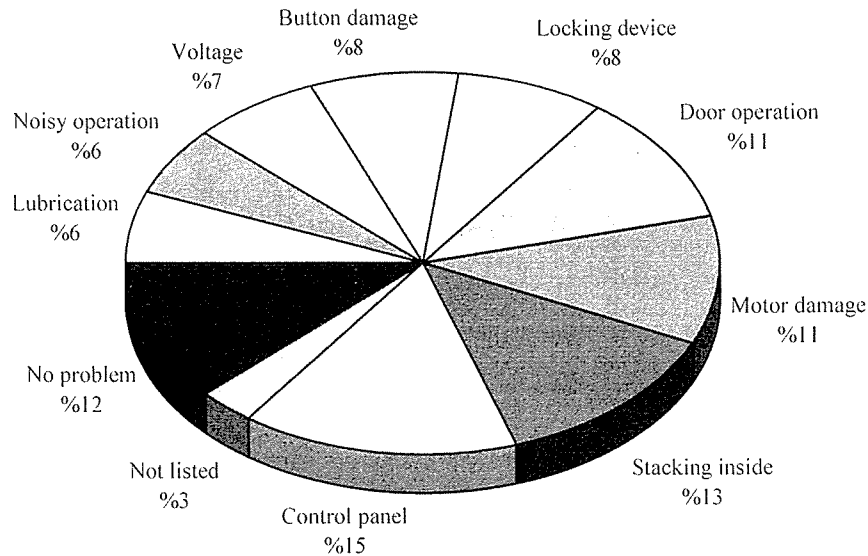
All the elevator installations have to be checked at least once a year by City Council in the city border or Province out of Municipality border every year regularly. If the City Council or Province has not got any qualified technical personal for doing annual control, they must have permission to give this mission to nonofficial mechanical engineers or electrical engineers for annual control (Imrak and Ozkirim, 1999).

During this annual check, elevators should be checked and tested for safety and operation, according to the involved standards. After these controls, a report has to be written and signed by an engineer. After annual controls, technical personnel who have done this control, have to prepare a report about elevator and initiate that it is reliable to use or not, according to the standards and safety rules. The building manager or owner and elevator maintenance company both are responsible for doing annual checks and preparing reports. This report should contain three copies: one of them is for City Council's or Province's records, the other one is for the maintenance company archives, and the final one is for attaching to the maintenance book (Imrak, 1997b).

### **5. A SURVEY OF ELEVATOR MAINTENANCE APPLICATION IN ISTANBUL IN TURKEY**

The Materials Handling Group of Istanbul Technical University carried out a survey of elevator maintenance applications in one district of Istanbul in Turkey in 1995. The details and the results of this survey are given in the following content of this section. Thirty-six buildings with one or two elevator systems installed were visited and their supervisory on duty were interviewed about the elevators currently servicing those buildings and their maintenance facilities. Common contract speed of these elevator systems is 1 m/s and also few of them have the contract speed of 0.63 m/s. The number of floors in the buildings visited are between 11 and 15. The proportion of elevator installations with four person cars is 64 percent of all. The percentage of elevator systems with maintenance book available is 66 and

75 percentage of all the elevators has got Operation Certificates of municipalities. Only 75 percent of the systems are maintained periodically, once a month and the owners of the other 25 percentage of them have not got any maintenance agreement arranged and signed. 90 percent of the elevator systems surveyed are maintained by the same company which has installed them. The pie chart of major failures and problems observed is shown in Figure 1.



*Figure 1. Major Failures and Problems observed in this study*

This survey shows that the doors, guide rails and control systems create most of the serious troubles. Overloading of elevators, choosing low contract speeds, not responding calls in a reasonable time, vibrations during operations are the other major problems in most of the elevator systems.

## CONCLUSIONS

The continuous maintenance of elevator has become an important part of elevator companies. A service contract avoids the necessity of owners setting up their own preventive maintenance program, ensures that the equipment will be maintained in an operating condition of high efficiency and extends the life of the equipment. Performance of preventive maintenance can reduce to a minimum the number of failures and time intervals that the elevators are out of service.

A simple maintenance includes cleaning, lubricating and minor re-settings. In some cases, it also contains repairs and replacements of broken or worn parts. In modern elevator systems however this simple maintenance procedure is not sufficient so preventive and planned maintenance should be carried out according to updated standards and Elevator Regulations. Trained and experienced personnel should maintain the elevators monthly according to the maintenance instructions. A survey of elevator users in Istanbul also proved that the elevator maintenance is a very important public issue. It is important to choose the kind of maintenance procedure in elevator systems. There may be more than one elevator in some buildings and they may fail together. If all elevators' behaviors were monitored, the maintenance and repair efforts would be much easier and efficient.

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