SAFETY AND SERVICING OF HYDRAULIC ELEVATORS *by Roy W. Blain, Blain Hydraulics*

Abstract

Hydraulic elevators are ideally used up to 6 floors. They are more reliable, safer, require less service and are cheaper than machine-roomless traction elevators. However, the utilization level of the hydraulic elevators is not adequate, especially in countries where natural disasters, such as earthquakes take palace frequently.

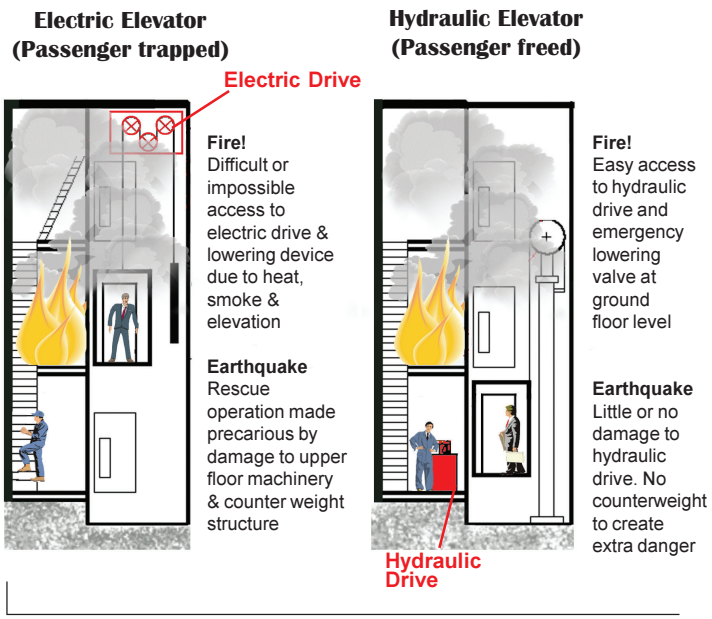
Established in 1970, Blain Hydraulics now produces over 20,000 valves a year, which are the finest elevator valves. This article reflects the experience that Blain H. has gained through the years. Herewith, the elevator safety and reliability are emphasized and easy servicing of valves is presented by giving examples from the Blain H. valves. Finally, the article is prepared such that it offers guidance to the users of hydraulic valves.

1. Constructional safety

For low rise buildings, the elevator customer can choose between the hydraulic elevator with a machine room usually in the basement of the building, or the electric (traction) elevator, increasingly without a machine-room(MRL), with the machine drive in or directly adjacent to the hoistway and normally at the top of the building.

In general, the hydraulic elevator has dominated the low rise market because it is cheaper to build, install and service, and because it has a decidedly better safety record than the electric elevator.

Especially in earthquake endangered areas, the hydraulic elevator has proven itself to be clearly the safer option. Due to the threat presented by swinging counterweights and also because the car is suspended from the top of the hoistway, the traction elevator is particularly vulnerable to a shaking building compared to the hydraulic elevator which is installed practically on the building's foundations.



The Elevator World magazine of July 2002 informs that the Seattle earthquake of February 2001 caused damage to what amounted to only 1 % of the hydraulic elevators in the vicinity, compared to 11 % of the electric elevators!

2. Comparisons of machine roomless traction (MRL) and hydraulic elevators

MRL Traction elevators

The MRL type drive unit is installed in or directly adjacent to the hoistway. Such installations are not only making the installation process more difficult and insecure but also the servicing of the elevator.

The procedure to release passengers from a stalled MRL traction elevator can be complicated, time consuming and physically demanding. A mechanic or fireman requires considerable knowledge and practice to perform a safe and efficient rescue operation on the many different types of MRL elevators with which he may be confronted in an emergency.

Establishing where the machine drive equipment is, may itself cause some delay. How to gain access can add to time lost. Finally, how to safely operate the break release and shift the car either upwards or downwards to a secure landing position is an exercise for specialists. In some cases, it may take hours before the qualified mechanic is even contacted and on the scene.

During the installation and servicing of an MRL elevator, the mechanic is obliged to perform more of his work in or alongside the open shaft. This obviously entails additional risks.

It will be obvious that elevators installed without a machine room, with the main drive operating in the hoistway, will generate noise throughout the building. Especially where people are living and sleeping this can amount to a major disturbance, not easy to eliminate.

Hydraulic elevators

With hydraulic elevators, a safe machine room can almost always be conveniently positioned close to the elevator shaft in the basement or first floor of the building. Opening the manual lowering knob or lever is basically the same with all types of elevator control valves and is a simple matter, even for a responsible apartment care taker, clinic nurse or informed family member in the case of a home lift, taking perhaps one minute to cautiously lower the car to floor level. Through the optional inclusion of a low cost hand pump, the car can also be raised to a higher floor should it be required. This would normally be a mans job requiring 5 to 10 minutes for a distance of one floor.

It is claimed that the MRL traction elevator is more energy efficient and therefore cheaper to operate than the hydraulic elevator. However, when servicing the MRL under less secure conditions, requiring additional safety precautions are considered and when the MRL traction elevator is already accepted as being more service intensive, the total operating cost are generally higher than those of a hydraulic elevator. More frequent servicing journeys involve increased fuel consumption which also effect the energy balance issue in favor of the hydraulic elevator.

The architect as well as the final owner or user of the elevator, should be correctly and thoroughly informed of the alternative rescuing systems of both the MRL traction elevator and the hydraulic elevator.

Hydraulic elevators have properties such as higher reliability, safety and easy servicing, which can not be fulfilled completely by traction elevators. Thus, they can safely be utilized in regions where natural disasters are likely to occur. Particularly, in regions under earthquake threat, buildings up to 5 floors high are ideal for installing hydraulic elevators. Moreover, it should be taken into account that the construction of guide-rails, walls and cars of hydraulic elevators can be reinforced so that cars may be used as an escape room during earthquake disasters.

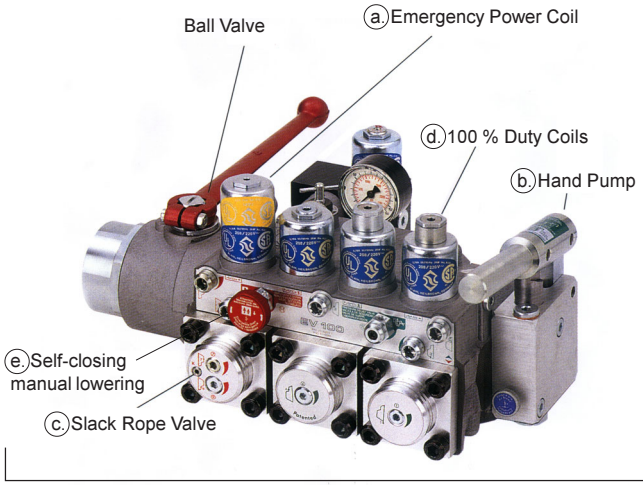
Hydraulic elevators are most suitable for handicapped people. This is because, with existing low rise houses and public buildings, adding a hydraulic elevator is much easier than a traction elevator. Hydraulic elevators can also be built onto the outside wall of a building which otherwise has no hoistway.

3. Emergency situations

In the case of fire, rescue personal have the advantage of working from the ground floor hydraulic machine room, rather than at the top floor or in the hoistway of an electric elevator where smoke and heat can prevent any attempt at rescueing someone trapped in the car. There is also the risk that with a counterweighted electric elevator, releasing the brake to lower the car, may cause the car to go upwards instead of down, possibly increasing the danger to the passenger.
Considering the growing number of residential lifts being built, it is important that a member of the houshold can handle the procedure of manually lowering the car to the ground floor to release a stranded passenger in the event of an electrical power failure or other emergency.

The safest such method is through the slow speed manual lowering system of the hydraulic elevator, easily accessible at the ground floor and simple to operate.

4. Safety features of the EV 100 valve:



a. an Emergency Power Coil ‘EN’, enables the car to be lowered by push button in the car should the main electrical power fail. Optional.

b. an integrated Handpump ‘HP’, for manually raising the car during installation or in an emergency situation. Optional.

c. a Slack Rope Valve ‘K’, used with 1:2 roped hydraulics, prevents the ram from being manually lowered when the car is suspended by the safeties; otherwise slack ropes could become entangled with hoistway equipment. Required by EN 81-2 code.

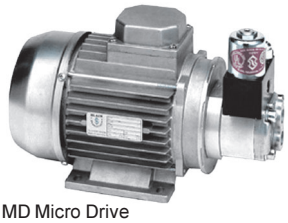
d. 100% Continuos Duty Coils ‘M’ ensure against coil burnout if they are energised for longer periods. Standard.

e. the Manual Lowering Valve ‘H’, with self closing (dead man) function. Standard.

Hydraulic elevator safety products, independent of the control valve are:

1. Pipe Rupture (overspeed) Valves mounted directly on the cylinder which are becoming standard world wide.
2. Hydraulic Microdrive, auxiliary low power raising and lowering unit, ideal for quiet, accurate releveling, or slow speed emergency movement of the car should the main power unit be out of operation.


R10 Rupture and Overspeed Valve


MD Micro Drive
Hydraulic Fine Positioning

5. Preparation for servicing

Because the main drive, cylinder and control valve moving parts of hydraulic elevators are all operating in oil, conditions for a long, trouble free operating life are ideal. When it is reported that the elevator is defective, it often turns out, that the presumed fault is simply a matter of the valve being wrongly adjusted. Friction, in the cylinder head or through misaligned guide rails can be the reason for an uneven ride. Releveling of the car is not always due to leakage in the valve but can be the result of a hot system cooling down. For such reasons, before taking the control valve apart, double check the possible source of the problem and study the manufactures ‘trouble shooting list’, in the case of a Blain EV 100 valve, through the website www.blain.de

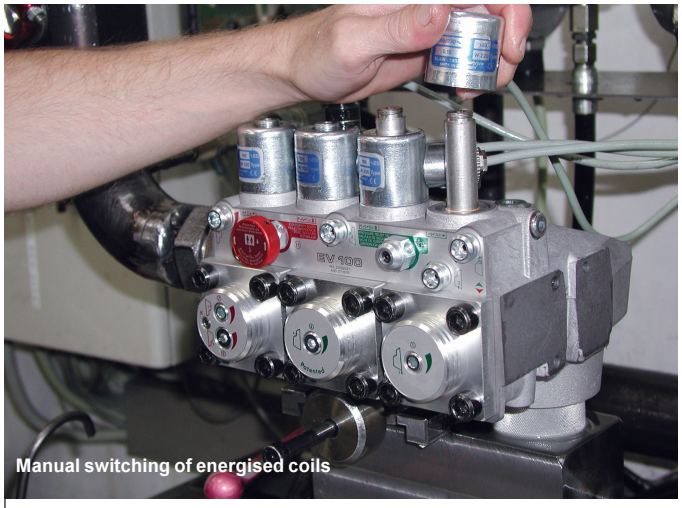
Once trial runs have been made, or a fault, otherwise located, servicing begins with the positioning of the car:
Unless circumstances dictate otherwise, sending the car to between the two upper landings before switching off the electrical mains, has the advantage of eliminating the possibility of the doors being left open at floor level during servicing. It also prepares the way for an initial down travel when servicing is completed, forcing air which may have entered through the valve, out of the cylinder system and not into it, as is the case if the first operation following servicing were to be an up travel.

Prior to opening up the main control valve, the cylinder line shut off valve must be closed and the control valve exhausted of pressure by opening the manual lowering valve.

The mains must remain switched off until the valve is completely re-assembled, otherwise an uninformed person in the building may at any time put in a call for the elevator. Also, through the hydraulic system cooling, the car may shift down and trigger the automatic releveling before the control valve is closed up. An ‘oil shower’ would result!

6. Solenoid coils

During servicing or adjustment of the EV 100 valve, instead of making a full floor to floor travel to check operation, much time can be saved by removing the securing nuts on top of the coils and switching to deceleration or to acceleration by briefly (3-5



Manual switching of energised coils

secs) lifting and replacing the appropriate energised coil by hand, allowing several adjustment corrections to be made during one car travel between floors.

Once removed from the solenoid tube, an energised coil will begin to overheat after about 20 secs. If necessary, to slow the rate of heating, place a 14-17 mm (1/2“ - 5/8“)dia. tool or short steel rod as core thru the coil. Do not lay an energised coil to one side, otherwise it may overheat unnoticed.

If the coil becomes too hot to hold, it must be replaced back over the solenoid tube and any further adjustment carried out with the elevator making normal floor to floor runs.

7. Deceleration switch, distance before landing.

Often, not enough attention is payed to slowdown distances. The following chart will take the guesswork out of switch installation.

With no load in the car, the deceleration time should be 2 to 2,5 secs. from full speed to leveling speed. The constant speed leveling time should be 1 to 2 secs.

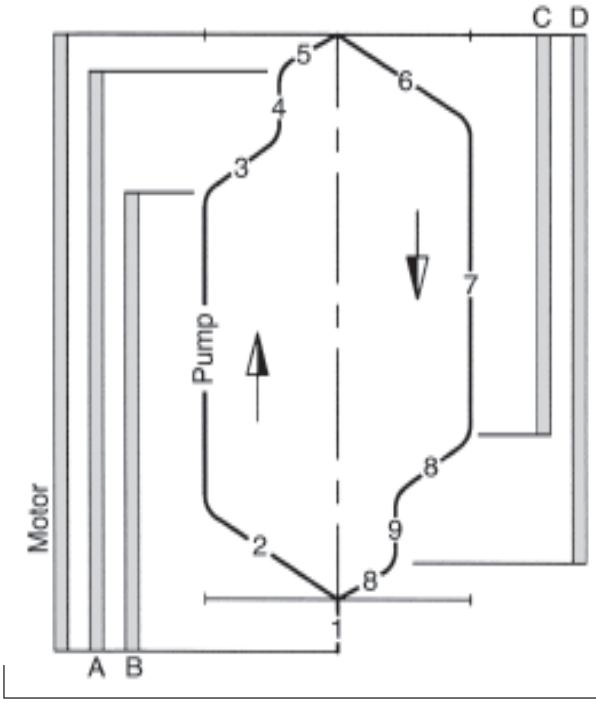
Metric		USA	
Elevator Speed	Switch	Elevator Speed	Switch
mtrs/sec.	approx. cm	ft/min.	approx. inches
0,10	5	20	2
0,20	15	40	6
0,30	25	60	9
0,40	40	80	16
0,50	50	100	20
0,60	70	120	28
0,80	95	160	36
1,00	120	200	48

Table 1. Typical switching distances.

8. Factors affecting accurate landings:

a. If the leveling speed is fast i.e. 0,1 m/sec (20 ft/min), landing will not be as accurate as when the leveling speed is slower i.e. 0,05 m/sec (10 ft/min). A leveling speed between these values should be satisfactory.

b. Following leveling, if the soft stop adjustment ‘5’ is set too soft, stopping will be less accurate than when ‘5’ is set for a quicker stop. 0,2-0,3 secs. (Figure 5,6).



c. A difference in landing accuracy between the elevator being loaded and unloaded, can be due to the car under load, leaning to one side by a few millimeters between the guide rails in the horizontal plane, causing an alteration in the operating of the stop switch by some centimetres in the vertical plane.

d. Particularly when the mechanic can not see directly the operation of the elevator car, it is possible that the elevator has not finished deceleration from fast speed before reaching the floor. In other words, the elevator has not slowed down to its correct leveling speed before the stop switch is actuated. In the machine room, the turbulant noise within the valve during leveling can be heard and should last 1 to 2 secs. following 2 to 2,5 secs. deceleration time (no load in the car).

9. Car not visible from machineroom

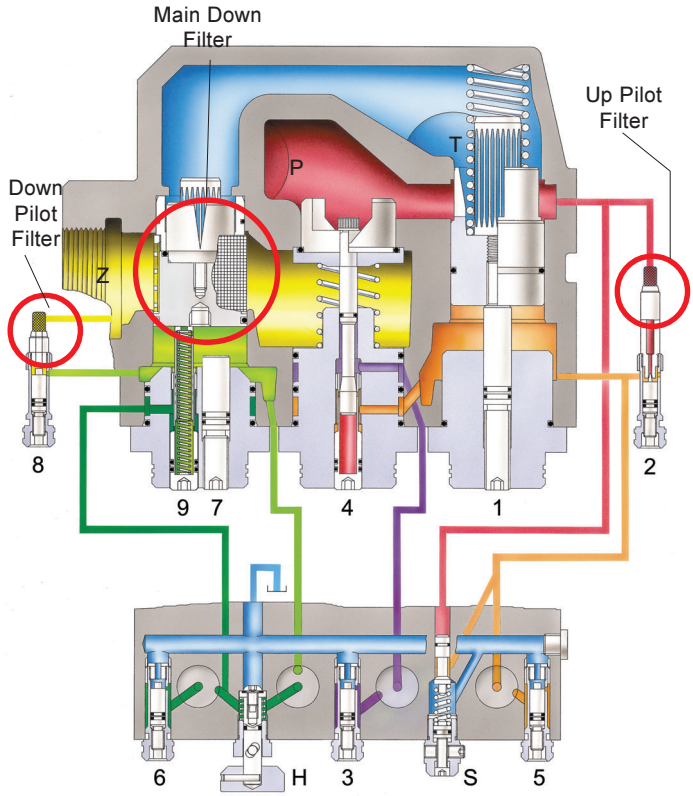
If the car cannot be seen during adjustment of the valve, the acceleration and deceleration times can be heard in the machineroom from the change in sound of the oil flow in the control valve as the speed of the car changes. With no load in the car, the duration of the speed changes should be as follows:

Up acceleration, adjustment 2,	2-3 sec.
Up decelaration, adjustment 3,	2-3 sec.
Up leveling time adjustment 4,	1-2 sec.
Down accelerate adjustment 6,	2-3 sec.
Down decelerate, adjustment 8,	2-3 sec.
Down leveling time, adjustment 9,	1-2 sec.

10. Oil filtration and leakage

In the case of the Blain EV 100 elevator control valve, it is not necessary to install an extra filter into the power unit system. Sensitive sections of the EV 100 are protected against foreign

substances by three built in, self cleaning filters; one in the cylinder main pressure line, one in the cylinder pilot pressure line and one in the pump pilot pressure line.



Clogging of the filters in EV valves is prevented by the filters being positioned in flow turbulent sections of the valve so that contamination cannot settle on the filter's surface. Inspection of these filters need not be more frequent than one time per year, whereby they will normally be found to be clean.

Fine hair like fibres in the oil stemming from cleaning rags, may on rare occasions settle on a sealing surface of a valve or solenoid seat causing a minor down leak and releveling of the car. The EV spare parts list shows the valve parts to check in the event of persistent releveling. Starting with solenoid **D**, cleaning the affected part or turning the solenoid seat over may be sufficient to cure the leak, otherwise its replacement will be necessary.

It is not necessary to strive for perfect sealing in every valve in operation. Because code requirements assure a safe releveling system whether descent of the car of a few millimeters is caused by valve leakage or through the cooling of the oil in the cylinder pressure system, a minor leakage of the control valve can be tolerated.

The European Code EN 81-2 requires that the loaded elevator does not leak downwards by more than 10 mm (3/8") in 10 minutes. This is the standard used to determine if a valve must be serviced for leakage or not.

For practical reasons, a quicker method for judging valve leakage is to close the ball valve in the cylinder line and observe the gauge showing pressure in the cylinder chamber of the valve. If this pressure falls to zero in less than 20 secs, it may be necessary to service the valve, depending on the diameter of the main ram and the sensitivity of the customer.

11. Overheating of the oil

Oil temperatures above 55 °C (130° F) should be avoided, otherwise the efficiency of the pump drops considerably and its life is reduced. Ageing of the oil is also accelerated. Overheated oil also results in frequent releveling. Causes of overheating are:

1. Up leveling being too long due to the leveling speed being slower than necessary or the slow down switch being set too low.
2. Machine room ventilation inadequate.
3. The frequency of operation is too high for the rate of heat dissipation from the installation. As temporary measure to avoid overheating of the oil which would otherwise result in the automatic shut down of the elevator, the down speed can be slowed to reduce the frequency of operation, until a permanent solution is installed.

If the degree of overheating is not excessive and it takes for example two to three hours for the oil temperature to rise from 20° to 55°C (70 to 130°F), it may be sufficient to improve air circulation around the power unit, for example through the installation of a 0.05 to 0.10 kW ventilator extracting air out of the machine room or through a fan of similar power, blowing air over the tank, or both.

Coolers are (rarely) necessary in hydraulic elevators. If extensive overheating nevertheless does occur through continous operation of the elevator, the following measure can be taken.

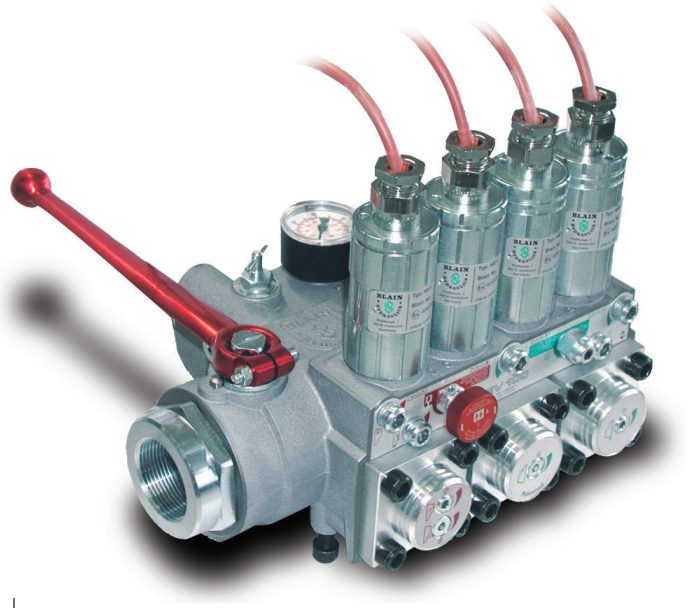
Depending on the size of the elevator, it will be necessary to install a, between 10 and 50 l/min. (3 - 13 gpm) pump, to circulate the hot oil through a fan cooled radiator of about 0.1 to 0.2 fan kW. It remains essential that there is sufficient extraction of warm air out of the machine room or that the cooler is outside of the machine room, for example in the elevator hoistway.
The effective cooling power of a cooler need not be more than 1/4 of the main elevator motor drive and should not be confused with the power of its fan drive which normally need only be 0.1 or 0.2 kW. The cooling system should automatically switch into operation when the oil reaches 30° - 35°C (85° to 95°F). Below these temperatures, the small temperature difference between the air which cools and the warm oil may find the cooler running continually with little effect.

12. Explosionproof elevator valves MEX-EV

The latest safety product to be added to the Blain Hydraulics control valve program is the explosionproof solenoid MEX 24 V DC which has been successfully tested and approved by the internationally recognised German Physical and Technical State Institution in Braunschweig.

The MEX solenoid can be installed wherever the standard Blain solenoid M is employed for its control valves.
The construction and performance of the MEX corresponds to the European standards:

CENELEC	Certificate-No.
DIN EN 50014 and DIN EN 50028	PTB 02 ATEX 2193 X
Ambient Temperature -20°C to 60°C	
⟨Ex⟩II2G EEx m II T4	
Enamelled Wire Insulating Class H	
Housing Protection Class IP 68	
Electrical apparatus for potentially explosive atmosphere	Voltage 24 V DC
Encapsulation m.	Current 1.2 Amps



13. Spare parts

Traveling to the site and searching for the cause of a problem can be expensive. Having to repeat the journey because a simple replacement part is not on hand, can usually be avoided if a complete valve is kept along with the service kit in the truck.

If during servicing, a flange, adjustment, securing bolt or other part is damaged or misplaced, a spare valve in the truck can be a blessing, since it includes all parts. It may also be used for a complete renewal, should it be necessary, provided that any 'borrowed' parts have been faithfully replaced.

A full set of up and down flow guide sizes, a seal kit, two spare solenoid coils, a set of springs and not forgetting the trouble shooting list, should take care of any remaining eventuality.
If a problem could not be solved, call the valve supplier before leaving the site. His experience can often save an extra journey!

14. Conclusions

Hydraulic elevators have shown their advantages by having superior properties of safety, reliability, service life, cost, installation and easy servicing. Therefore, the energy consumption factor is insignificant. Hydraulic elevators are ideal in lands, where the danger of natural disasters are high. They can also be safely and simply integrated into buildings that have no hoistways.

The MRL traction elevator is recommended by some companies because of the extra earnings through more expensive servicing. Through (unworthy) patterns, they can exclude other able servicing companies from competing for service contract. This is not the case with hydraulic elevators.

Blain EV 100's are the finest quality control valves for hydraulic elevators. They function smoothly, are reliable, have self cleaning filtration, guaranteeing a long service free life and are simple to adjust.

Effective operation of hydraulic elevators mainly depends on correct adjustment of accelerations and decelerations according to the velocity-time graph.

References

1- Blain Valves for Hydraulic Elevators, Blain Hydraulics, March 2002
2- www.blain.de

Blain Hydraulics GmbH
Pfaffenstr. 1 • Boellinger Hoefe
D-74078 Heilbronn • Germany
Tel. +49 7131 2821-0 • Fax +49 7131 48 52 16
www.blain.de • info@blain.de