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Testing of Elevator In-ground Hydraulic Jacks and Piping

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Subject of Revision:

Updated with latest codes.

In-ground Hydraulic Jack Basic Construction and Operation

An in-ground elevator hydraulic jack consists primarily of a cylinder (large pipe) with a plate or disc welded to the bottom, a plunger (similar to a piston), and a ring-shaped jack head with an oil seal. The cylinder may be made of several sections of pipe welded together.

The assembled cylinder, plunger and head are lowered into a vertical hole drilled or bored in the soil beneath the elevator. The top of the cylinder is supported at the pit floor by steel channels. The top of the plunger is attached to the underside of the elevator car. When oil is forced into the cylinder under pressure by the elevator hydraulic pump the plunger is displaced causing the plunger and the elevator car to rise.

Advancements in Elevator Hydraulic Jack Safety

For many years hydraulic cylinders were made with one plate or disc welded to the bottom of the vertical cylinder. Investigation of failures of these single-bottom jacks found that failures due to corrosion tended to occur at this weld joint. Failure at the bottom can result in a rapid loss of oil causing the elevator to drop suddenly. Injuries and deaths have been reported in other states as a result of such failures. To address this, the double-bottom (safety-bulkhead) cylinder was developed.

A double-bottom or safety bulkhead cylinder has one bottom or disc welded just inside the bottom of the vertical pipe. Then a cap or second bottom is welded below the first bottom. Since the welded joint attaching the second bottom is exposed, it may be prone to corrosion and failure. The first bottom is provided with a small orifice or hole so a failure of the second bottom will be indicated by the elevator descending in a controlled manner as oil escapes the cylinder through the orifice (the safety bulkhead). New elevator in-ground hydraulic cylinders have been required to be of the double-bottom type in Wisconsin since January 1, 1975.

The safety bulkhead improved reliability but cylinders were still susceptible to corrosion and failure at the joints where sections of pipe were welded together. Effective January 1, 1994 Wisconsin code began requiring the in-ground portion of elevator hydraulic jacks to be completely surrounded by a rigid material to protect the cylinder from corrosion. Polyvinyl chloride (PVC) pipe, including bottom cap, has been commonly used for in-ground elevator jack protection.

Elevators Requiring Testing

In an effort to verify the condition of existing single-bottom cylinders, the March 2004 Wisconsin Administrative Code SPS 318 required jacks and piping installed prior to January 1, 1975 to be tested annually.

In an effort to also verify the condition of existing double-bottom or safety bulkhead type cylinders not installed in PVC protection, the December 2008 SPS 318 began requiring jacks installed prior to January 1, 1994 to be tested annually. Testing of post-January 1, 1994 jacks is recommended but is currently not required.

With the adoption of the ASME A17.1 (2013 edition) effective September 1, 2014, in-ground hydraulic piping that is not in PVC or similar protection, is required to be tested.

Persons Performing Testing

Pressure tests are to be conducted by licensed elevator personnel in accordance with ASME A17.1 (2013), requirements 8.6.5.14.1 and 8.6.5.14.2. Licensing of elevator personnel can be found in Wisconsin Administrative Code ch. SPS 305, Subchapter X.

Testing Oil Hydraulic Elevators (Nearly All Hydraulic Elevators)

Requirement 8.6.5.14.1 requires pressurizing the elevator system to the system relief pressure. This is the pressure at which the relief valve operates and is not to exceed 150% of the normal system working pressure.

For elevators with unknown working pressure or where there is a disparity between a previously recorded working pressure and the actual working pressure, licensed elevator personnel must load the elevator with test weights equal to the full capacity of the elevator (rated load). The elevator must lift the rated load at normal rated speed to determine the system working pressure. If necessary the relief pressure must be adjusted and sealed. The working pressure and relief pressure must be recorded in the maintenance record and should also be recorded permanently on the tank cover or similar location. Form SBD-3E Category 1 Periodic Hydraulic Elevator Test, Section 1 must be completed. As long as the seal remains in place subsequent annual tests may be done without re-establishing the working pressure using test weights.

For an older elevator that has a relief valve but no means to seal the relief valve pressure setting, the system must be pressurized to relief pressure as described above. The working pressure and relief pressure must be recorded in the maintenance record and should be recorded permanently on the tank cover or similar location. Form SBD-3E Section 1 must be completed. As long as the relief pressure is not changed, subsequent annual tests may be done without rechecking the working pressure.

After the test in req. 8.6.5.14.1, req. 8.6.5.14.2 requires the elevator to be parked for a period of 15 minutes (no load is required). The starting and ending positions of the car, oil levels and other information are recorded on form SBD-3E, Section 2. If the elevator changes position (downward) and the change cannot be explained by visible oil leakage, leakage through the control valve or temperature change, a leak is occurring in the portion of the cylinder or piping below ground.

For an older elevator that does not have a pressure relief valve, the elevator must be operated with rated load at rated speed along its full travel. Form SBD-3E Section 1 must be completed as applicable. This must be followed by the test in Req. 8.6.5.14.2 except the elevator must remain fully loaded.

Testing Water Hydraulic Elevators (Old, Very Uncommon)

Water hydraulic elevators use water under pressure from a municipal or on-site water system or from a pressure tank pressurized by a pump. These elevators must also be tested to provide a reasonable assurance that they will not fail while in use. Testing water hydraulic elevators presents unique challenges due to lack of design safety factors, seals made of leather and surface rust on pistons that could cause damage if tested similarly to oil-hydraulic elevators. This department has determined that water hydraulic elevators with in-ground jacks or pressure piping not exposed for inspection must be tested as follows:

The elevator must be loaded at some point above the bottom landing (such as the next landing above) to 110% of rated load. A valve isolating the unexposed piping and jack must be closed. After 15 minutes at rest, no unexplained loss of water may occur. For water hydraulic elevators using a pump, the pressure setting at which the pump shuts off must be sealed or the point of adjustment must be in a sealed box or under a sealed cover.

Test Failure

Failure of either test will likely warrant immediate shut-down of the elevator by elevator personnel or an inspector according to SPS 318.1011(8)(c) 2. Replacement or qualified repair of the leaking in-ground cylinder or piping will be required before the elevator may be returned to service.

Approval must be applied for by a licensed elevator contractor prior to replacement or repair of a cylinder. (See form SBD-22).

Deadline for completing the testing

Failure to show satisfactory completion of these tests within the calendar year prior to the expiration of the PTO (permit to operate) will result in withholding of the PTO.

Alternatives to testing

Testing of an in-ground hydraulic cylinder or piping is not required for a cylinder or piping installed prior to January 1, 1994 if:

- 1). PVC or similar protection of the entire below-ground portion of the cylinder or piping has been provided per SPS 318.1703(1) and is visible at the floor. Tape wrap, tar, paint or other materials are not acceptable substitutes for approved materials. A means must be provided to monitor the protection for the entrance of ground water. The means to monitor must extend to the bottom of the cylinder and should be sealed at the pit floor.
 - 2). A satisfactory application has been submitted to install a car safety device or plunger gripper meeting A17.1 (2013), 8.6.5.8(a) or 8.6.5.8(b) per SPS 318.1703(2)(h). Note: If installation of a plunger gripper will result in reduction of runby below allowed limits, a petition for variance must be submitted showing runby, clearances and operation providing an equivalent degree of safety.
- or,
- 3). A satisfactory application has been submitted to replace the existing jack or piping and provide PVC or other protection per SPS 318.1703(1).

Record of oil usage

The owner of a new or existing elevator with an in-ground hydraulic jack or piping is required to keep a record of oil usage per req. 8.6.5.7 and SPS 318.1708(2)(g). If unexplained loss of oil (or in very cases, water) occurs, the tests in 8.6.5.14.1 and 8.6.5.14.2 must be performed immediately.