VERTICAL TRANPORT SYSTEMS

This Week's Presentation

> Review Worksheet #11: Life Safety and Electrical Systems

> **MEEB:** *Vertical Transportation*

> Worksheet #12;

> This Week's Media Material: *NOT Green, Again*
> *Denver Art Museum*
> *"Defying Gravity"*

> Semester Retrospective, and next week's plan.

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 1. The three elements of the fire "triangle of needs" are:

(a) fuel, high temperature, and oxygen
(b) fuel, ignition, and combustion
(c) detection, signaling, and response
(d) carbon, oxygen, and smoke

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 2. In terms of building design, smoke differs from fire mainly because:

(a) fire is much more hazardous to occupants than smoke

(b) smoke always moves upward, but fire moves in all directions

(c) barriers to fire spread are not good barriers to smoke spread

(d) smoke is much more difficult to detect than fire

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 3. When a conventional automatic sprinkler system operates during a fire:

(a) all the sprinkler heads in the building go off

(b) all the sprinkler heads on the floor of the fire go off

(c) only the sprinkler heads in the fire zone go off

(d) only a very few sprinkler heads go off

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 4. Match each of the four main types of sprinkler systems noted (column 1) with its typical application (column 2):

(a) wet-pipe
(b) deluge
(c) preaction
(d) dry-pipe

(1) buildings subject to freezing
(2) areas where water damage is a concern
(3) everyday building occupancies
(4) areas with very high fire hazards

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 5. The three basic parts of any fire alarm system are:
(a) manual, automatic, and hybrid devices
(b) fire, smoke, and all-clear signals
(c) signal initiation, signal processing, and alarm indication
(d) people, equipment, and interfaces

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 6. An ionization type fire detector will be used to sense:

(a) products of combustion generated in the early stages of a fire

(b) the radiation developed as a fire produces flames

(c) the temperature rise experienced as a result of a fire

(d) the status of HVAC equipment operation

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 7. Current is the electrical term used to describe:

(a) the potential for electron flow established across a circuit

(b) the magnitude of the flow of electrons through a circuit

(c) the conductor through which electrons flow

(d) the frequency of oscillation of AC power

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 8. Which of the following electric circuit arrangements is most common in buildings:

(a) series circuit
(b) parallel circuit
(c) open circuit
(d) short circuit

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 9. Which of the following statements best reflects the use of direct current in buildings:

(a) DC is the system most commonly used

(b) DC is found mainly in conjunction with battery and PV systems

(c) DC is used primarily for office equipment

(d) DC is prohibited by the *National Electrical Code*

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 10. Which means of service delivery is typically more expensive to install:

(a) overhead service

(b) underground service

(c) neither, overhead and underground service generally cost the same

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 11. The purpose of an electrical transformer is to:

(a) convert utility-provided DC power to AC power for building use
(b) convert high-frequency utility power to 60 Hz building power
(c) change the voltage of electric distribution
(d) remove noise and disturbances from utility-provided power

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 12. Fuses and circuit breakers:

(a) have similar uses but different construction and operation
(b) have very different uses and constructions
(c) are two terms for the exact same device

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 13. A panelboard is typically installed:
(a) at the service entrance to a building
(b) next to the primary building transformer
(c) adjacent to all switchboards
(d) between electrical feeders and branches

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 14. Computer grade power refers to:

(a) high-frequency power needed to operate most laptop computers

(b) power that is generally free of power quality problems

(c) power that is available at all times

(d) low-voltage power used for data transmissions

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

... 15. A conductor is best described as:

(a) a conduit containing an aluminum or copper wire

(b) a material that will generate electricity when exposed to solar radiation

(c) an aluminum or copper wire or cable

(d) a container of any sort for wires or cabless

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 16. "Romex" is a type of:

(a) anti-corrosion coating used on exterior wiring systems

(b) large-capacity busbar (typically used in industry)

(c) light-weight steel conduit (used in commercial/ institutional buildings)

(d) nonmetallic sheathed cable (typically used in small buildings)

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 17. A cable tray is best described as:

(a) a closed protective element, similar to conduit

(b) an open support system for cables

(c) basically the same as a busbar

(d) a type of conduit made to be encased in concrete floor slabs

Last Week: **Life Safety / Electrical Systems**

Worksheet #11

… 18. Which of the following system voltages is most likely to be used in a single-family residence:

(a) 120 volt, 1-phase, 2-wire

(b) 120/240 volt, 1-phase, 3-wire

(c) 277/480 volt, 3-phase, 4-wire

(d) 2400/4160 volt, 3-phase, 4-wire

This Week: **Vertical Transport Systems**

What's so important about elevators?
Why should they be considered an "environmental" system?

This Week: **Vertical Transport Systems**

Without elevators, what does our built environment look like?

> No mid- or high-rises: Less Urban Density

Is this a bad thing? How might our cities appear if their skyline were defined by lower buildings?

> No Accessibility for challenged Users: Less Equity

How does increased HC accessibility allow the use and appreciation for folks' talents otherwise excluded from society?

This Week: **Vertical Transport Systems**

Either way, with elevators, our cities and buildings do look the way they do because of the impact, both direct and indirect, of vertical transportation systems.

Elevators also account for a significant part of the capital investment -- up to 10% of total construction cost and a significant chunk of subsequent operation and maintenance.

Elevators, like stairs, have a significant impact on building planning, due to their spatial requirements and to the logic of circulation planning to which their use relates.

This Week: **Vertical Transport Systems**

What kind of Vertical Transportation Systems are we talking about?

Elevators (Hydraulic or Traction):
- Passenger
- Freight
- Dumbwaiters

Chair Lifts
Escalators
Conveyors
Pneumatic Systems
Container Delivery
Self-propelled Vehicles

This Week: **Vertical Transport Systems - Elevators**

Among Elevators, the words “Traction” or “Hydraulic” refer to the kind of mechanism which pulls -- or pushes -- the passengers up and down. Traction elevators are typically pulled by cables both up and down, and counter-weighted for ease of driving the load of the cab. The cables are driven by a pully-like mechanism, itself powered by a typically electric motor. Traction elevators typically include guides or rails to assure precise motion up or down the elevator shaft.

Hydraulic Elevators use the principal of a piston to push up or or down. Non-compressible fluid either expands or releases a piston, which itself is connected to a cab.

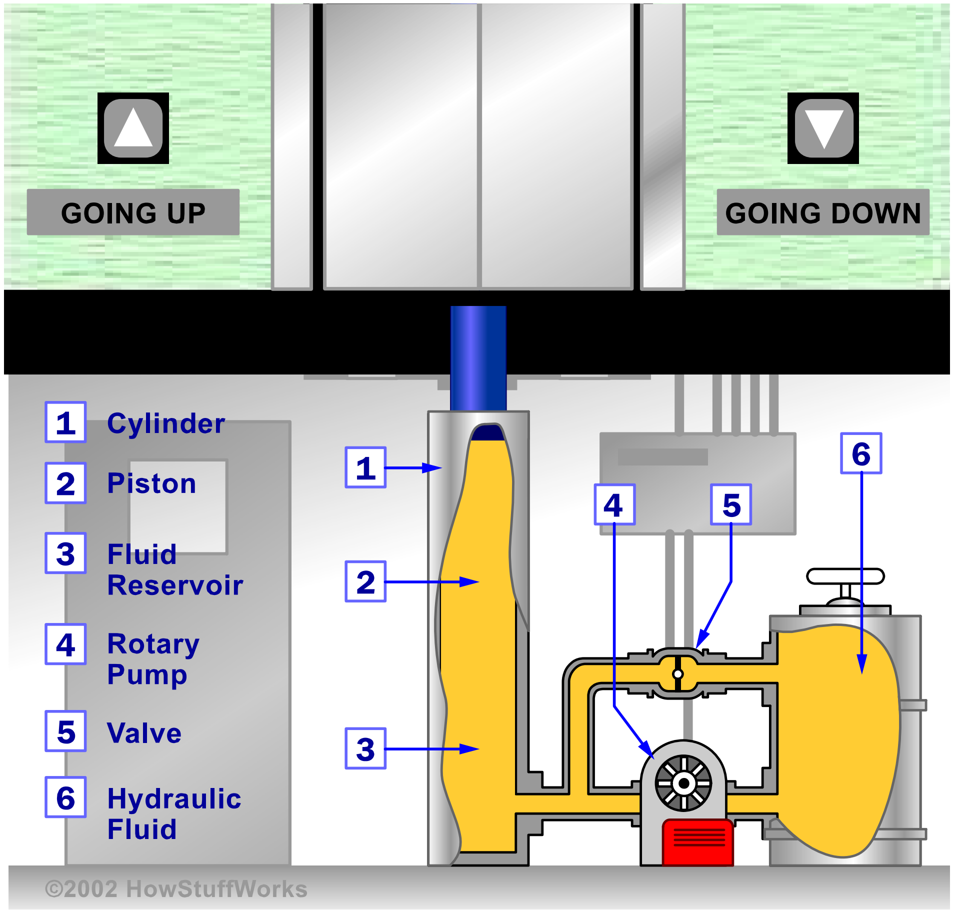
This Week: **Vertical Transport Systems - Elevators**

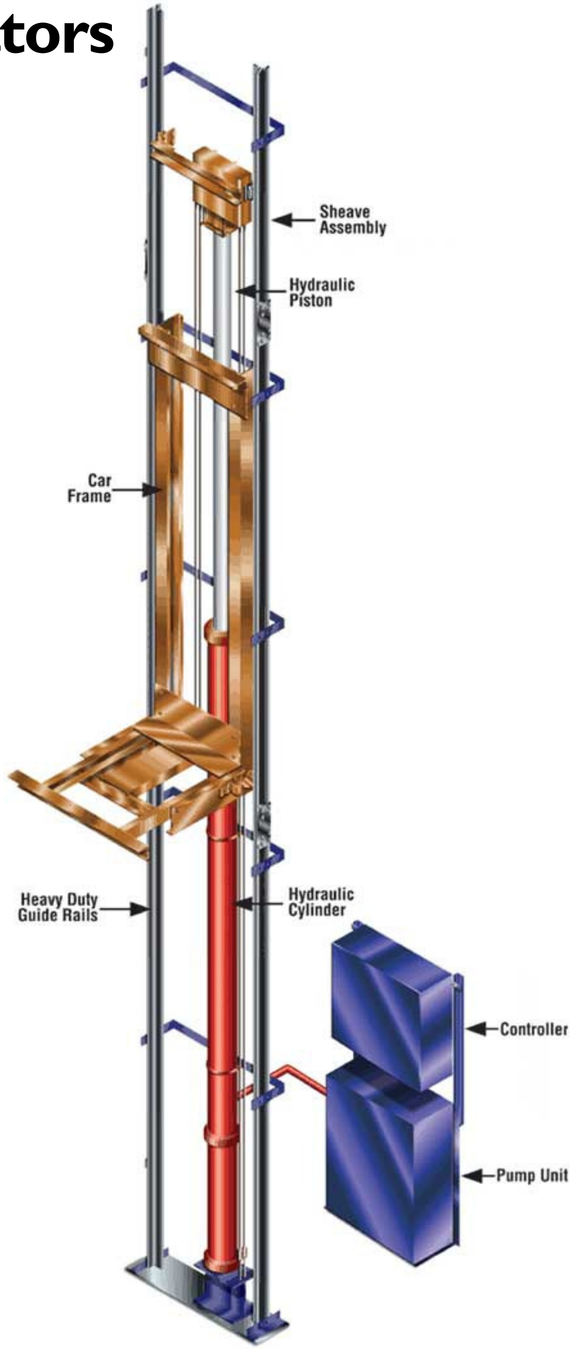
Elevators for small lifts (up to 4 stories), which do not need fast operation, may be *hydraulic*.

Elevators for all lifts, but especially larger ones (more than 4 stories), are usually traction elevators.

This Week: **Vertical Transport Systems - Elevators**

Here's how a Hydraulic Elevator Works:



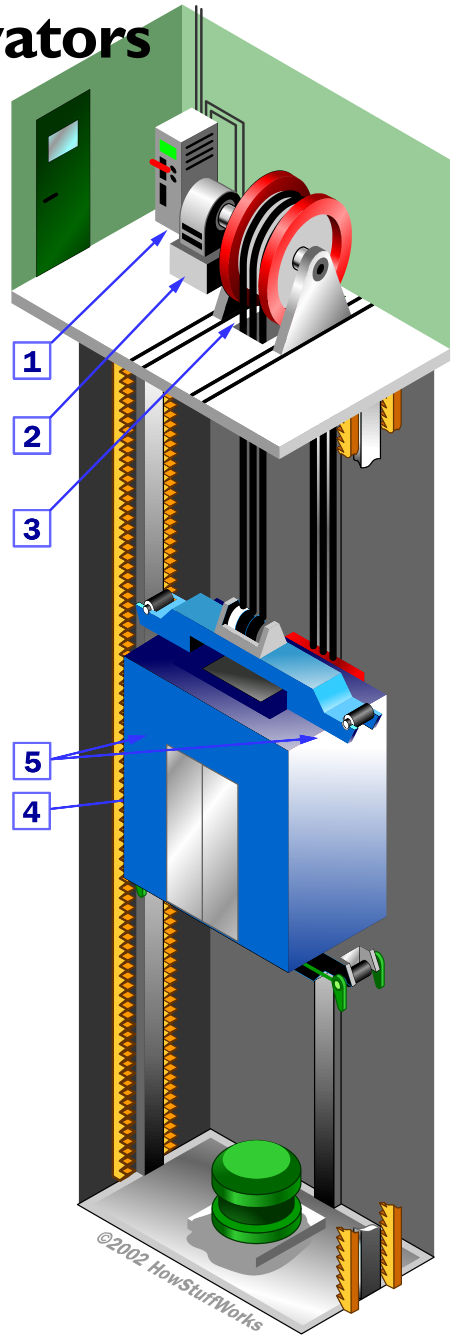


This Week: **Vertical Transport Systems - Elevators**

Here's how a Traction Elevator Works:

1) Control System
2) Motor
3) Sheave (Wheel)

4) Counterweight (behind cab)
5) Guide Rails



This Week: **Vertical Transport Systems - Elevators**

Traction Elevators

The motor is connected to the sheave either directly (gearless) or via a mechanism of gears which coordinates between differing rates of rotation between motor operation and the sheave.

Geared machines: for rates up to ~500 fpm.
Gearless machiens: for higher speeds, up to 2000 fpm.

“A gearless traction machine is considered superior to a geared machine because it is more efficient, quieter in operation, requires less maintenance, and has a longer life.” p 1378

Gearless machines are generally more expensive than geared machines.

This Week: **Vertical Transport Systems - Elevators**

Carrying Capacity is rated in **Pounds**.

Elevator Car Speed is measured in **Feet Per Minute.**

Handling Capacity describes the **Amount of Passengers** which can be transported in a given unit of time. This may also reflect a percentage of the building's population, sometimes called the "percent" Handling Capacity.

Interval indicates the average time between departure of cars from the lobby.

This Week: **Vertical Transport Systems - Elevators**

These and other considerations, including Round Trip Time, Travel Time, and Building Zoning, all factor into the design of an elevator system.

Architects do not, as a rule, design elevator systems. They do, nevertheless, lead the team that includes consultants to aid their design. For any building anticipating the use more than a single hydraulic cab, an elevator consultant works with the architect at an early stage to decide about total system performance, target cost and specifications, number of elevators, and elevator size and capacity.

Construction documents are almost always based on non-binding specifications, so details may vary depending upon the manufacturer who is finally selected.

This Week: **Vertical Transport Systems - Elevators**

Naturally, some rules of thumb may be applied.

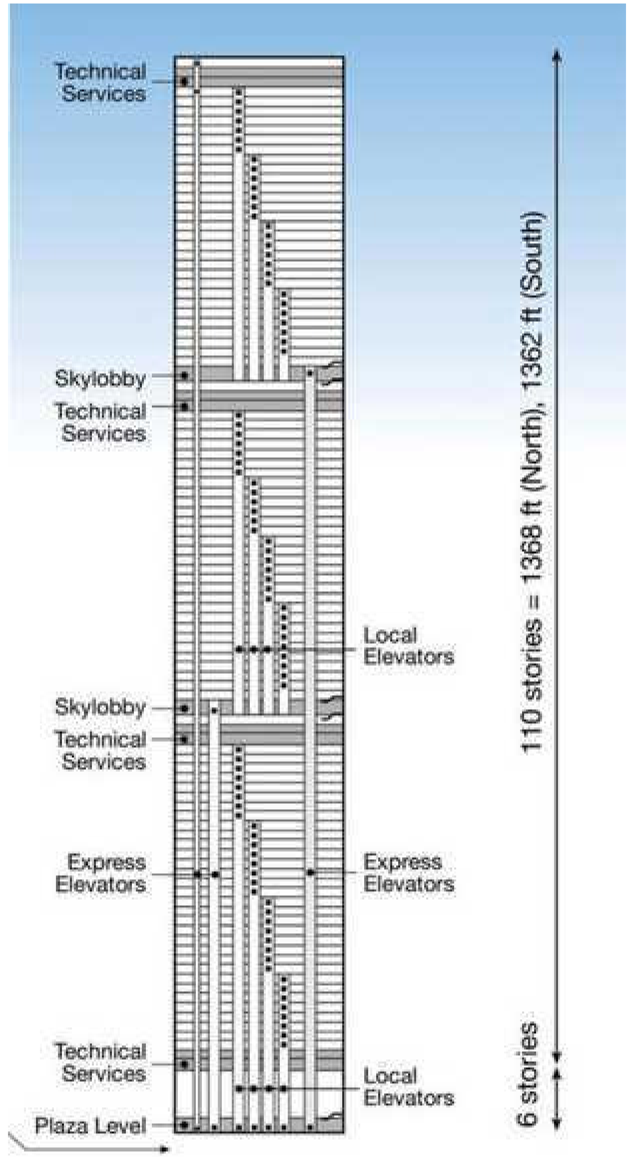
Typically, no bank of elevators should have more than **4** cars in a row.

In office buildings, at least one service elevator should be anticipated for every 10 passenger elevator, or one for every 300,000 sf.

Hospital Elevators require especially large plan capacity for handling large beds and caretakers; these “patient-service” elevators may be distinct from smaller, faster elevators to serve the general public.

This Week: **Vertical Transport Systems - Elevators**

For very tall buildngs, somewhat different organizational rules may apply. When travel distances and required capacity would overwhelm a limited footprint with elevator shafts, a “sky-lobby” system may be introduced, in which express elevators bring passengers to intermediate elevator lobbies, allowing most shafts to be stacked above lower levels.



This Week: **Vertical Transport Systems - Elevators**

On the other hand, as mentioned previously, for very low buildings, Hydraulic Elevators may be more attractive than traction elevators for the following reasons:

1) No penthouse is required;
2) Loading may be Ground-supported;
3) Shafts may be slightly smaller.

In addition, recent technical advances have resulted in "hole-less" hydraulic systems, which avoid the main environmental "hazard" of hydraulic systems. Hole-less systems include those driven by a telescoping jack in the shaft itself, or else a "roped" hydraulic system which allows a piston to move only a small distance with an "inverse pulley" effect to move the roped cab over larger distances.

This Week: **Vertical Transport Systems - Elevators**

Typically, therefore, hydraulic elevators are most commonly seen in low-rise passenger and low-rise freight service.

This Week: **Vertical Transport Systems - Elevators**

Now, although I mentioned that elevator systems are rarely designed by architects, we do get to have a bit a fun with the design of the cab. Like in other environment systems, experts usually tell the architects “hands off” until a time comes to pick out a color or to decide about the applied finish of a thing.

In addition to the “interior” design/decor of the cab, we can can conceive options for the appearance of the elevator. An elevator cab may also be of “observation type,” in which a glass panel allows riders to look out from the cab to either an interior atrium or towards an exterior view. The psychological benefits of looking out are considerable, and there may be additional planning benefits of placing an elevator on an exterior wall.

This Week: **Vertical Transport Systems - Elevators**

I wanted to mention, too, the use of “dumbwaiters,” which are essentially a small elevator car (typically traction, with a very small, geared mechanism) which transports materials or goods from floor to floor. Typical applications include food service or library installations, where food or books need to be brought from level to level.

This Week: **Vertical Transport Systems - Elevators**

But what do you *really* need to know about elevators?

Elevator Machine Rooms
Traction Mechanism Configurations
Shaft Sizes and Structure
Overhead clearances, Pit Clearances, and Pit “furniture”
Cab Sizes, code mandates, and Capacity
Environmental Concerns
Venting
Appropriate Cab Finishes

and... **That Damn Hoisting Beam**!

This Week: **Vertical Transport Systems - Elevators**

Elevator Machine Rooms

The Elevator Machine Room contains power boards, drive machinery, and control equipment. Both are potential fire hazards. The Machine Room must always have fire-rated walls, and a fire-rated door which is both wide enough (3'6" minimum, typ.) and swings out, unless required clearances are otherwise provided.

The location of the Elevator Machine Room for traction systems depends on the mechanism configuration. Typical locations include at the lowest level, to the side of the shaft, or on top of the shaft, in a penthouse.

With hydraulic systems, you have some flexibility. Usually, hydraulic lines can run from locations up to 30' from the shaft.

This Week: **Vertical Transport Systems - Elevators**

Elevator Machine Rooms

Most typically, machine rooms for hydraulic lifts are adjacent to the shaft, at the lowest level.

Machine rooms must be sized sufficient to accomodate all the required equipment. Usually, this is equal to the total area of all the shafts, but this may depend too upon the manufacturer.

Some recent systems boast "machine-room-less" configurations, which are traction mechanisms using flat belts instead of ropes. These require much smaller spaces, such as a "closet" at a certain level adjacent to the shafts. These may be noisier than other kinds of mechanisms, however.

This Week: **Vertical Transport Systems - Elevators**

Traction Mechanism Types

The type of traction mechanism will determine where the elevator machine room needs to be -- or *vice versa.*

The most simple and efficient traction type is overhead. A variation on this is to place the mechanism adjacent to the shaft, which allows the mechanism to be at a slightly lower level.

It is also possible to place the sheave adjacent to the base of the shaft. Often this is desireable to keep height down or for reasons of access. Nevertheless, doing so doubles the effective length of cabling over the height of the shaft, and may be technically infeasible for hight shafts due to cable vibrations.

This Week: **Vertical Transport Systems - Elevators**

Shaft Sizes and Structure

You can usually anticipate a clear shaft size of 8’4” wide by 7’0” deep for a typical passenger elevator. The greater the capacity, the larger these dimensions. Door configuration also makes a difference. Front/back doors may increase the depth without changing the width. Freight elevators are usually deeper, too, extending almost to 10’ depending on the required size of the cab. When I’m starting a plan, I figure 10’x10’ including wall thickness to be sure that I’ll have enough room to manouver.

This Week: **Vertical Transport Systems - Elevators**

Shaft Sizes and Structure

Elevator shafts must be fire-rated, and so are often made from heavy masonry or concrete materials. Doing so allows the elevator shaft to be used structurally as “stiffeners” in buildings, even when the rest of the structure is wood or steel.

Nevertheless, in steel buildings, one may choose instead to effect the fire-rating by dry-wall application to the steel frame. Doing so may be advantageous for reasons of cost, but may result in worse acoustic isolation from the operation of the elevators.

This Week: **Vertical Transport Systems - Elevators**

Overhead clearances, Pit Depth, and Pit "furniture"

Important dimensions in laying out elevator shafts include overhead clearances and pit depth. These are "empty" areas of the shaft, both above and below the minimum extent of travel for the cab itself, which afford a sort of "refuge" so that a person either on top of or below the cab will not be crushed during controlled operation of the elevator. Required "overheads" and "pit depths" are usually given by the manufactures, and depend on the rated speed of the elevator. 4'6 to 5'6 is a good "guess" for pit depth; an overhead of at least 13'4", measure from the level of the final stopping floor, is a good estimate for overhead.

This Week: **Vertical Transport Systems - Elevators**

Overhead clearances, Pit Depth, and Pit "furniture"

Additional architectural concerns include:

Sloping the bottom of the elevator pit
to drain to a sump pit;

A pit **ladder** to allow easy access.

The problem with things like the ladder and the concrete surface of the pit is that these are not in the contract of the elevator supplier or even the elevator consultant!

This Week: **Vertical Transport Systems - Elevators**

Cab Sizes, Code Mandates, and Capacity

Naturally, one wants a cab that's "big enough" but not bigger than required. Typically, a larger cab is rated for a larger weight capacity, on the premise that more area will allow more occupants to enter the elevator. But how *small* can you go?

In fact, the State of Maryland requires a minimum size, based on the need to bring a stretcher into the elevator for evacuating folks who can't otherwise leave a building. This typically determines the capacity of the elevator to be 3500#, due to the increased area of the cab itself. Naturally, larger elevators will suffice.

This Week: **Vertical Transport Systems - Elevators**

Environmental Concerns

I alluded before to a sump at the bottom of the pit. If your pit is leaking, or -- worse -- if something else leaks, what do you do?

The main environmental hazard with elevators, besides the electrical components of its own operation, is the threat posed by hydraulic oil's leaking from the system. Hydraulic elevator pits, fitted either with sump ejector or drain, must also include in-line oil separation tanks to capture the pollutants in case of oil spill in the pit. Furthermore, in traditional hydraulic mechanisms, a very deep bore is required for the installation of the piston. This may affect existing groundwater and may result in either direct ground contamination or else pit flooding, which still requires the oil separator.

This Week: **Vertical Transport Systems - Elevators**

Venting

Another important thing to keep in mind is shaft venting. Just as with plumbing lines, something going up and down in a narrow tube will create “siphon” effects due to plunging -- unless the system is vented.

In elevator shafts, louvers are usually introduced at the top of the shaft; and it is assumed that air will be drawn into the shaft under negative pressure in the gaps left by the shaft doors.

The louvers may need to be fitted with fire-dampers, depending on the configuration of the shaft and the fire-rating requirements.

(On a separate note, many jurisdictions require sprinklering the elevator shaft itself.)

This Week: **Vertical Transport Systems - Elevators**

Appropriate Cab Finishes

Even though we're thrown only the "bone" of decorating the elevator cab, we usually don't even take up the challenge. Most of the time, the elevator cab is a drap, "standard" collection of finishes. When one enters an elevator, the cab of which has been thoughtfully design, finished, and lit, one knows it -- so don't forget it!

Nevertheless, we usually have these elements "off the shelf" to select: Floor finish; Panel; Below-rail finish; Rail; Above-rail finish; Cove; Ceiling. We can also choose button panel styles and door jamb configurations.

This Week: **Vertical Transport Systems - Elevators**

and... That Damn Hoisting Beam!

You'll always see this indicated in drawings, and the elevator guys never want to supply it, even though they're the ones who need it for installation!

Architectural Technology III

Worksheet # 12

Vertical Transportation Systems

NOT Green, Again

Denver Art Museum: ***Defying Gravity***

Semester's Retrospective Theory | Practice | Sustainability

Our Preconceptions; Design Process;

Environmental Resources; Sites;

Comfort and Design Strategies; Indoor Air Quality;
Solar Geometry and Shading;

Heat Flow; Designing for Heating and Cooling;

HVAC (M);
Liquid Waste (P);
Life Safety and Electrical Systems (E);

Vertical Transport.

Architectual Technology III

Next Week's Plan: *Meet me at 6:30pm at 3716 Elm Avenue.*
Bring heavy-soled shoes, good for
mud and metal.

Dinner afterwards at Golden West Cafe.