Environmental Concerns in Plant Design

by

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The goal of the engineer in designing a modern treating plant is to reduce or eliminate the potential for release of wood preserving chemicals to the environment and to minimize employee exposure to these same chemicals.

1 Site Selection

1.1 Review of selection criteria

There are more than five pages of site selection criteria outlined in the "RECOMMENDATIONS FOR DESIGN AND OPERATION OF CCA WOOD PRESERVATION FACILITIES" document. All of the considerations detailed in this section are important and worthy of review but the over riding forces for site selection are of a business nature. Location of the site to raw materials, rail siding and truck transportation are of more importance than most technical site characteristics.

1.2 Practical considerations for site selection

From a business stand point an owner must include the sites environmental characteristics in both the short and long term objectives.

The most over riding short term objective is probably immediate capital outlay. The desire to locate a new facility so as to minimize both inbound and outbound transportation costs and to have a supply of affordable labor must be tempered with an estimate of the long term economic effects of the sites features and the plant design.

Given enough money the environmental problems of any site can be mitigated, however, there are certain emotional political public relations factors that must be taken into account. Building a treating plant next to an elementary school, hospital, or city water supply, while possible, is certainly not practical. While no one would select such locations for a treating plant the site must be evaluated as to its desirability and liability years in the future and not only its current value.

2 Design

The basic task of the design engineer is to develop a site and plant layout that minimizes or eliminates the possibility of an environmental or employee accident. Following are some of the many areas that must be considered during the design phase of a new facility.

The primary design criterion is to minimize the possibility for concrete containment cracking and leakage of water containing CCA components into the environment. The ability of a structure to retain water depends on several factors including proper structural design, joint detail, properly placed and compacted concrete, and where necessary surface coatings and underlayments.

2.1 Containment

The design of both surface and subsurface containment systems is undergoing review in an attempt to minimize the potential for leakage. It cannot be stressed enough that attention to details and constant supervision is a must during the installation of the concrete.

2.1.1 Concrete details

The following represents just a highlight of the important items to consider during the installation of the concrete.

2.1.1.1 Pour size/Additives

The size of an individual pour of concrete depends on several factors but in general it is recommended that pours should not exceed 30'. Through the use of additives such as Rheobild* 1000 a super plasticizer it is possible to improve the ease of placement, and overall strength of concrete.

This along with the use of air entrained concrete increases workability and results in well compacted concrete at lower water to cement ratios.

2.1.1.2 Water stop

Properly installed water stop will allow movement of concrete along predetermined control planes while preventing movement of liquid through the concrete. Waterstop is available in many configurations depending on joint requirements. In addition, complex factory made splices are available that eliminate intricate field splices and speed up installation by requiring only straight butt joints to be made at the job site.

For water stop to work properly it must be installed properly. An individual must be assigned the responsibility to follow the placement of the re-bar, waterstop, and concrete.

To keep water, dirt and treating solution from collecting in expansion joints an elastomeric joint compound should be installed in a clean joint. (FIG. 1)

2.1.1.3 Reinforcement

Proper design of steel reinforcement is vital to the long term containment of liquids. The design must conform to local, provincial and federal codes. It must take into consideration the appropriate dead and live loads including stress imposed by moving equipment such as trams and fork lifts. (FIG. 2) The design must take into consideration the soil conditions and seismic requirements of the site.

As part of the design, details such as type and grade of concrete, size and grade of re-bar, and placement specifications must be spelled out. (FIG. 3) It goes without saying that having the most sophisticated design in the world and failing to follow accepted installation and quality control procedures will result in a job that looks good on the surface but may allow contaminated water to escape to the environment.

2.1.1.4 Underlayment

In addition the primary and secondary containment for treating plant liquids, new plant construction should consider the installation of a tertiary containment and monitoring system. This system consists of a liner installed under the concrete along with a french drain system and monitoring wells. (FIG. 4) Periodic inspection of these wells for the presence of water and analysis of this water, if found, will allow the plant to detect a leak in the secondary containment without having a release to the environment.

2.1.1.5 Surface Coatings

The surface of concrete can be attacked when it is subjected to repeated contact with CCA treating solution. The highly acidic and oxidizing nature of CCA will with time deteriorate cement and release the aggregate. To prevent this attack one should consider the addition of surface coatings to protect the concrete. Selection of the surface coating must take into account its suitability for the conditions, ease of application, ease of maintenance, resistance to wear, and of course installed cost.

Surface coatings can be similar to paint in that they have very low build or they may be comprised of multiple layers of resin and chopped fiberglass to form a container within a container.

No matter what coating is selected it is imperative that the manufactures recommended installation procedures be followed in order to assure that a bond is formed between the coating and the concrete. If proper surface preparation details are not followed and bonding does not take place the coating can slough off in sheets and the money spent in purchasing and installing the coating will be wasted.

2.1.1.6 Sump details

Modern plant design must minimize or eliminate any area where contaminated liquids might build up. All liquids must be collected at their source and directed in pipes to sumps.

Sealing water from vacuum pumps, (FIG. 5) drip and track pad run off, rain water if any, and drips from the cylinder door must be collected with a minimum of employee exposure. (FIG.6)

Containment areas such as sumps should be designed to allow visual inspection of the outside of the sump to assure that there is no leakage of contaminated liquids. (FIG.7) While the design and installation of such a sump is expensive it does minimize any chance for a undetected release to the environment.

2.1.1.7 Drainage

The design and installation of the concrete containment must include slopping details to assure that any liquids on the plant floor drain quickly and completely to sumps. This liquid is then pumped to an effluent tank for reuse in the plant.

2.1.2 Design of tank pads

Plant housekeeping is of primary importance to allow rapid detection of the failure of the concrete containment. In addition to installing the concrete with adequate slope for drainage, all tanks should be installed on housekeeping pads to facilitate cleaning and hosing down the floor. These pads elevate the tank support 4 to 6 inches above the floor.

2.1.3 Tank leak detection

As part of the housekeeping pad design for flat bottomed tanks a series of steel strips are installed either on the bottom of the tank or on the top of the pad. (FIG. 8) These strips allow any liquids that may leak from under the tank to drain out and be detected.

2.1.4 Tank hold downs

All tanks should be designed with tank hold downs to resist floating during a spill situation or, when required by code, to resist movement during a seismic disturbances.(FIG. 9) A new type of anchor bolt hold down has come on the market. This system involves the drilling of a slightly oversized hole that is filled with a high strength resin before inserting the anchor bolt. The use of this system will eliminate the need for accurate placement of anchor bolts during the concrete pour and will reduce the cost of installing tank hold downs.

2.1.5 Concrete specification and testing

Specification and implementation of a concrete mix design should follow the guide lines of the appropriate code governing bodies. We specify a 4000 psi 28 day compressive strength concrete to be implemented in accordance with the quality control requirements of ACI 318. These requirements include slump and compressive tests.

2.1.6 Installation monitoring and documentation

It is strongly recommended that photographs be taken of each concrete pour to verify that proper installation techniques were followed. These photographs should have the date, a description of area being photographed and the signature of the photographer written on the back of the picture. Copies of the photographs should be kept at two separate locations so that they can be made available to an inspector if needed.

3 Equipment

3.1. Tank vents

In order to reduce the possibility of employee exposure to mists it has been recommended that process vents be directed outside the plant building. This raises the possibility of CCA emissions to the environment. We have recommended that all tank vents be directed to the effluent tank (FIG. 10) and that tank be vented through a trap to the outside. (FIG. 11)

3.2 Covered truck unloading

The unloading area for the chemical delivery truck should be covered and have side walls and concrete containment to prevent release of chemical in case of a spill.

The truck spill containment should be designed to direct any chemical into the secondary containment pit in the plant. This design feature will assure there is enough containment volume to catch any truck spill.

3.3 Locked valves

The concentrate tank valves that are outside of the plant building must be equipped with a locking handle in order to prevent vandals from opening these lines.

3.4 Emergency truck valve closure

One way to minimize the magnitude of a leak when there is a break in the unloading hose is to equip the truck with a spring to close, hydraulic pressure to open unloading valve. With this system the truck driver can, by flipping a switch, bleed off the hydraulic pressure and immediately close the truck unloading valve thereby stopping flow of the concentrate. These emergency switches are located at the four corners of the trailer so that the driver may operate them without the potential of exposure to leaking chemical.

3.5 Unloading procedures to collect all drips

Most of the environmental problems that exist at plants today are due to small amounts of CCA being released to the environment not large catastrophic releases. One technique to reduce small releases is to require the driver to use a plastic bucket to catch the few drips that come out of the delivery hose when it is disconnected from the truck and tank piping.

3.6 High level alarm and shutdown

The tank and cylinder containment areas provide protection to the environment in case of a spill. All efforts must be directed to preventing such a spill. One such method is through the use of tank high level alarms and in automated plants, shutdown of all equipment and closing of all valves. The shutdown system includes independent sensing of the tank high level and an audible and visual alarm in the event of an emergency. The Hickson system also includes a monitor on the sump pump and filter system. This device senses the plugging of the sump bag filter and shuts down the sump pump before it is damaged by low flow and overheating.

All tanks should have accurate and easy to read tank level gages such as those produced by VAREC. These float gages can be read to one one hundredth of a foot. The plant operators use these gages when making a mix and with some simple calculations be assured that the tank has enough room for the mix.

3.7 Automated mixing system

A potential source for employee exposure exists during the mixing of CCA concentrate and water. An automated mixing system minimizes the potential for employee exposure. The use of mechanical seals will eliminate drips from the pump packing glands and the addition of automated valves and a simple Programmable Logic Controller (PLC) and flow measurement system will allow metering of the components to within 0.5%.

3.8 Mix log

The operators use of a mix log to record tank readings and desired amounts of chemical addition is an invaluable tool not only to verify the accuracy of the metering system but will detect potential tank leaks. (FIG.12) Inspection of this log will indicate if the tank levels change in an unexpected manor over time. Such a log can target small problems for correction before they become big ones.

3.9 Door safety interlock

The treating cylinder door provides the greatest potential for employee injury and sudden releases of treating chemicals to the environment. Bolted doors have an inherent safety feature in that it takes a while to loosen the bolts and if there is liquid in the cylinder it will start to leak out into the pit before the door is fully opened.

Quick opening doors must be fitted with fail-safe interlock devices to prevent opening the door while the cylinder is under pressure or full of liquid.

3.10 Door leaks

A door leak while the cylinder is under pressure can allow the release of hundreds of gallons of treating solution in just a few minutes. Automated control systems should have emergency shut down sequences to automatically de-pressurize, blow back, and drain the cylinder safely. This allows the operator time to contact the appropriate personnel for assistance. These automated sequences also eliminate operator error during times of high stress.

3.11 Manual override with semi-graphic display

The automated control systems that Hickson's supply include a lighted graphic display and a fully manual override. This allows the operator to take control of the plant in the case of a system malfunction. The graphic display allows the operator to visually "walk" himself through the manual operating procedure. Lights indicating open valves and operating pumps minimize the potential for operator error.

3.12 Pipe layout

All pipes running below grade must be installed in well drained concrete trenches with grates that allow visual inspection of the pipe. This assures that a pipe leak will be quickly detected and easily repaired.

3.13 Covered site

As much as possible both new and existing plants should have covered drip and track pads in order to eliminate the collection of water and snow.

RECOMMENDATIONS FOR DESIGN AND OPERATION OF CCA PLANTS suggests that freshly treated wood be held under cover for 48 hours or on uncovered pad for 96 hours. We strongly recommend that all drip and track pads be covered and protected from the elements. This reduces the problems associated with snow and rain.

3.14 Dedicated lift truck / Wash down station

To minimize yard contamination, the drip and track pad drainage must be directed away from normal lift truck traffic areas. Plants should consider the use of dedicated fork lifts on the drip pads and have transfer stations to allow the movement of wood on or off of the pad without using the same fork lift.

Another option is to provide a wash down station at the edge of the pad to allow the operator to hose off the tires before leaving the pad.

4. Management

4.1 Management commitment

One of the most important factors in the safe operation of a facility is Managements commitment. Without this commitment all the design and safety interlock features are of little value.

4.2 Employee training

Employees must be trained in all aspects of plant operation, safety, and environmental awareness. This training must include detailed operating procedure descriptions as well as personal hygiene and safe handling of the product.

Written procedures must include such common sense items as standing out of the way of moving fork lifts, to running a treating cycle and calculating a mix.

In addition the use of personal safety equipment and emergency response procedures must be reviewed over and over again.

4.3 Enforcement

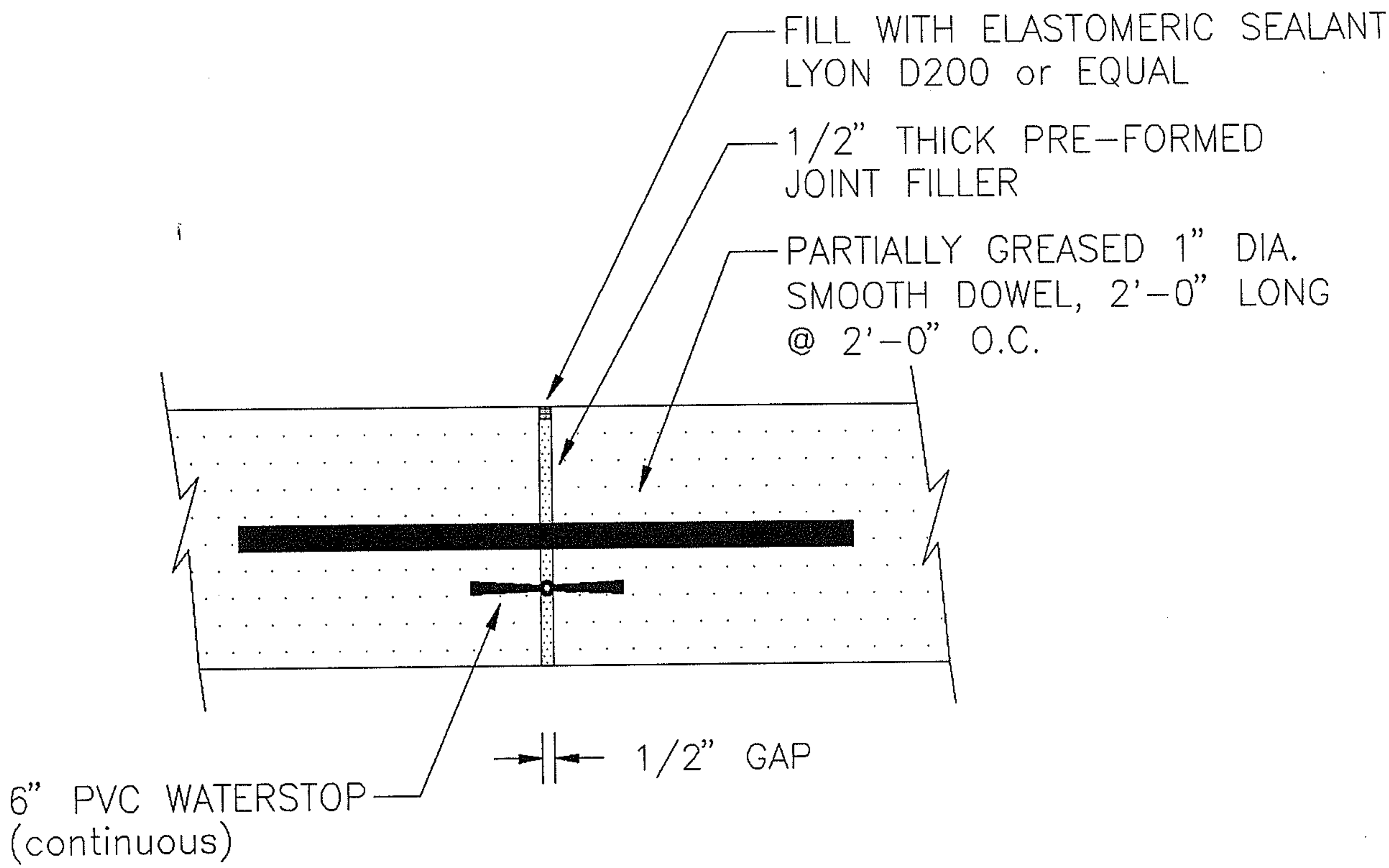
Besides training, management must continually and consistently enforce plant procedures and rules. Any infraction, no matter how small, must result in immediate corrective action. This should start with a one on one discussion with the employee, identifying the infraction and pointing out the correct procedures. Continued infractions must result in disciplinary action.

4.4 Systems maintenance

Maintenance and housekeeping have to be high on managements priority list. Both people and money must be available to keep the plant clean and operational. A clean plant is easy to inspect and cracks in the containment can be detected and repaired before problems develop. Leaking valves and seals are readily noticed and can be repaired before employee exposure becomes an issue.

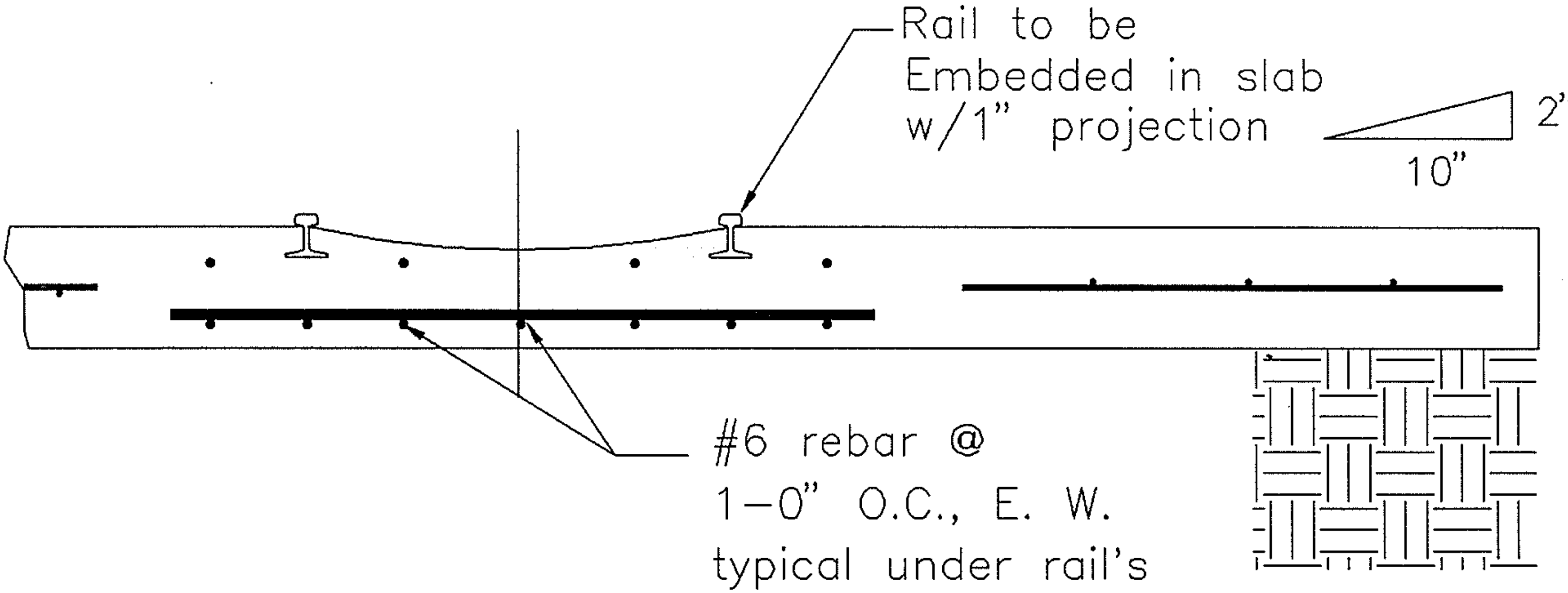
5 Conclusion

Cooperation between the owner, designer, and contractor can and will result in the construction of an environmentally acceptable plant. But only through a long term commitment by the owner to operate the plant in a responsible manner will the efforts of the designer and contractor be fulfilled.



TYPICAL EXPANSION JOINT DETAIL

FIGURE #1



TYPICAL TRACK PAD SECTION

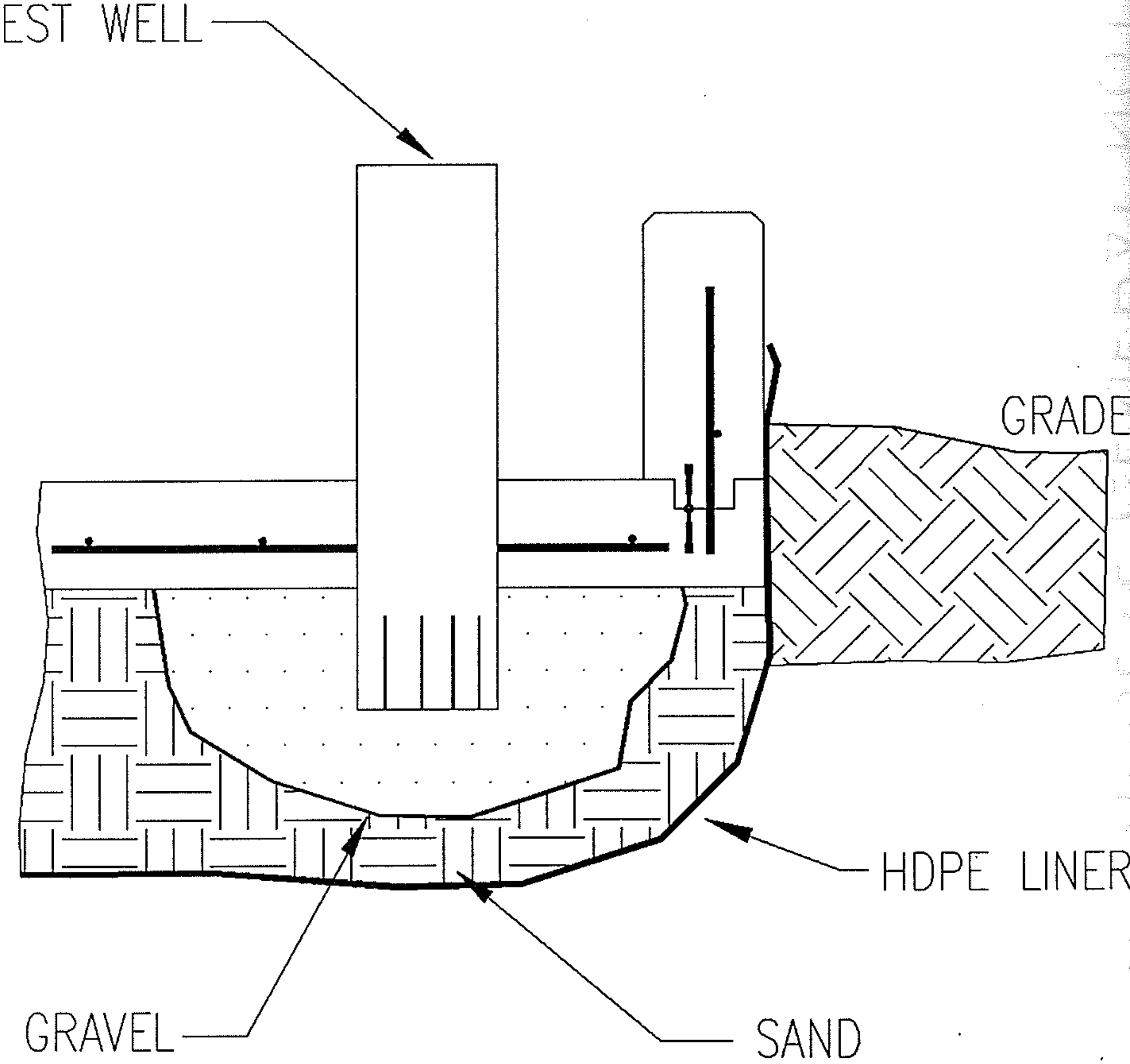
FIGURE #2

FIGURE #2

TYPICAL CONCRETE GENERAL NOTES

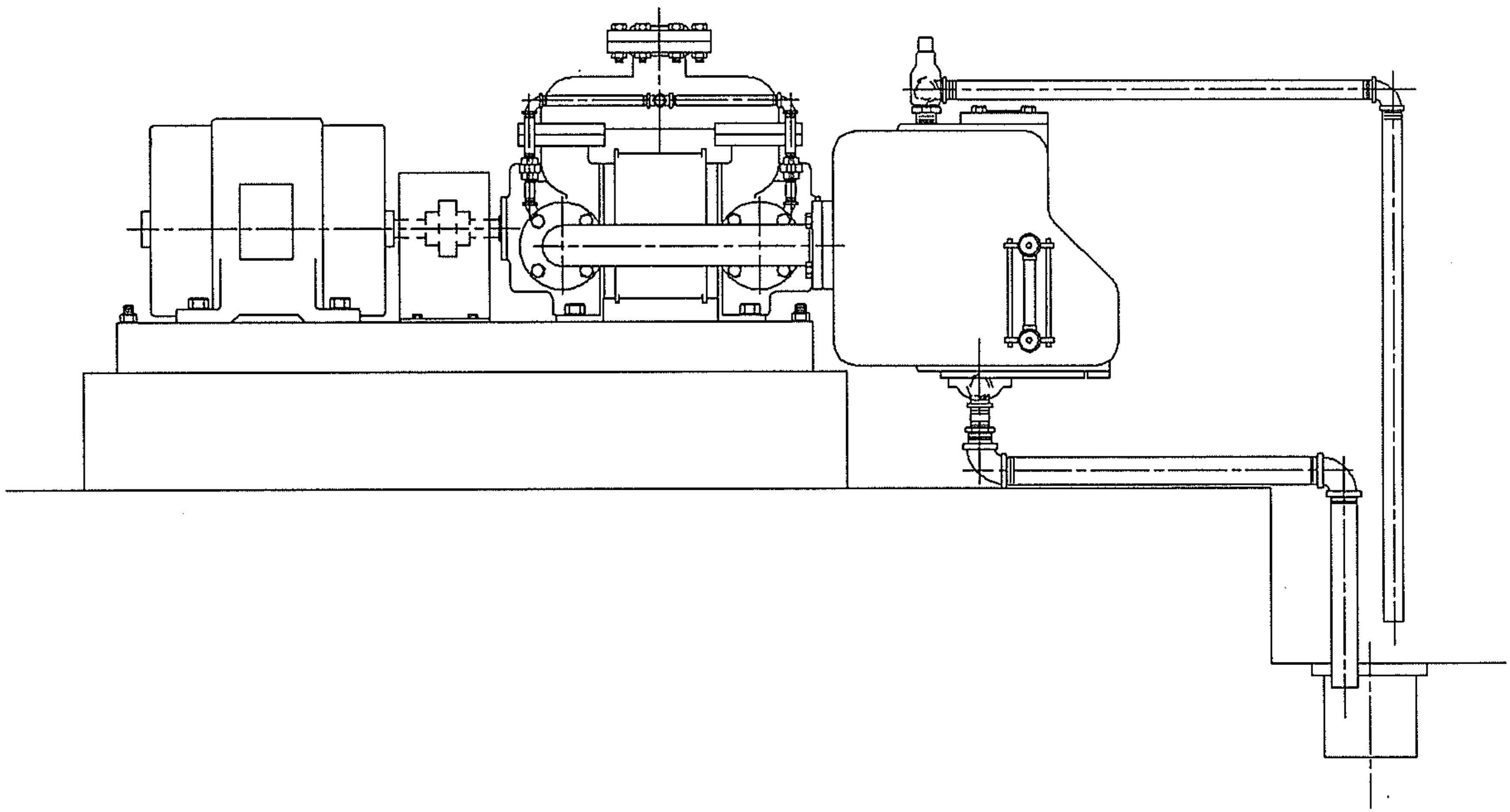
FIGURE #3

1. MINIMUM SOIL LOADING SHALL BE 2500 P.S.F., COMPACTION SHALL BE 95%. SOIL BEARING AND COMPACTION TO BE DETERMINED BY ON-SITE TESTING PRIOR TO CONSTRUCTION.
2. ALL FOOTINGS SHALL REST ON UNDISTURBED SOIL BELOW FROSTLINE.
3. ALL STRESSES IN CONCRETE AND REINFORCING DESIGN PROCEDURES AS APPLICABLE SHALL CONFORM TO A.C.I. BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (A.C.I.318)
4. CONCRETE SHALL BE AIR ENTRAINED AND SHALL DEVELOP 4,000 P.S.I. @ 48 DAYS. (THIS REQUIRES AN AVERAGE COMPRESSION STRENGTH OF 5,200 P.S.I.) ACI 318 4.3.2.2
5. CONCRETE SHALL NOT CONTAIN ANY FLY ASH MATERIAL.
6. SLUMP SHALL NOT EXCEDE 2" AT POINT OF PLACEMENT.
7. INCLUDE SUPER PLASTICIZER IN MIX TO IMPROVE WORKABILITY.



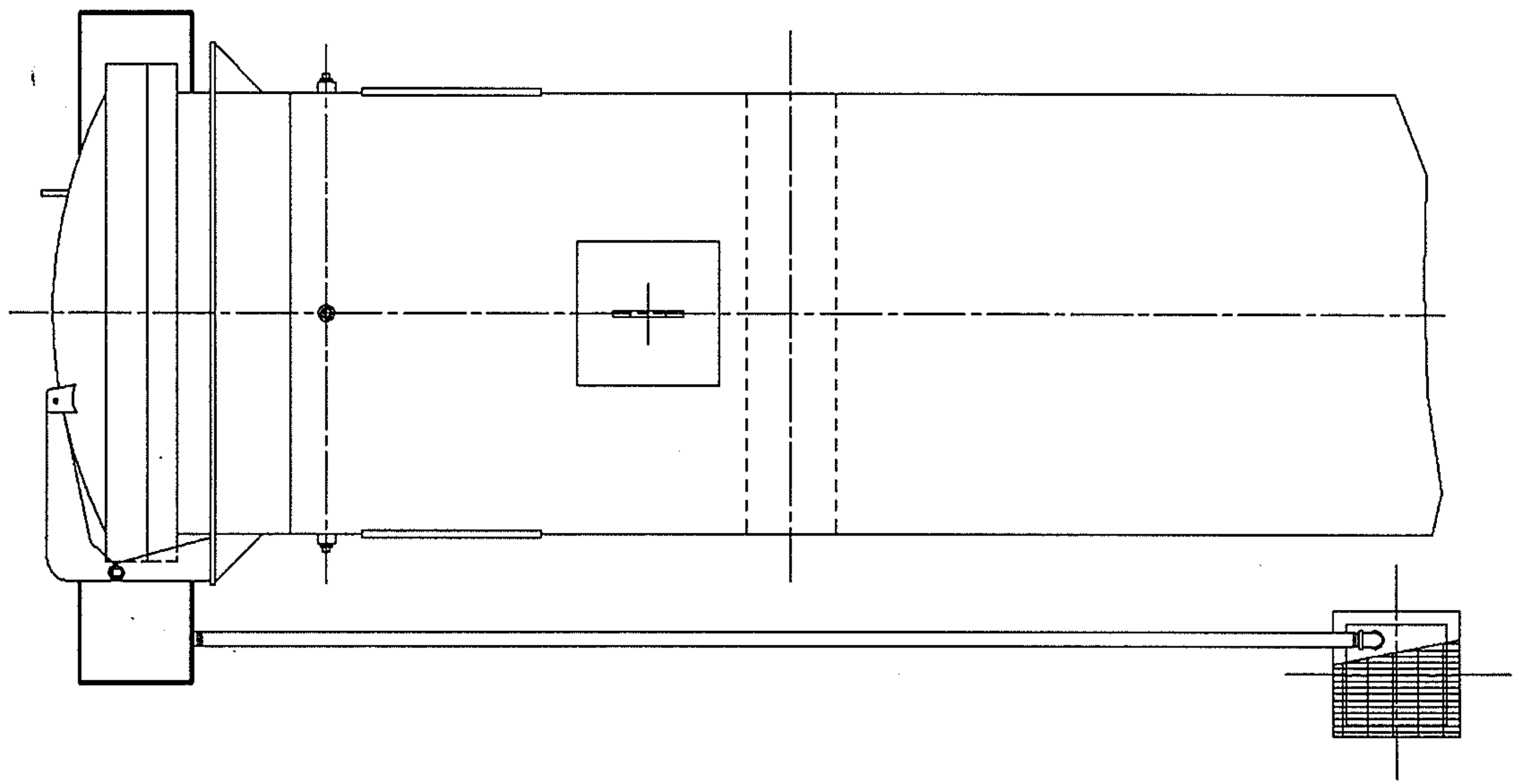
TYPICAL HDPE LINER DETAIL

FIGURE #4



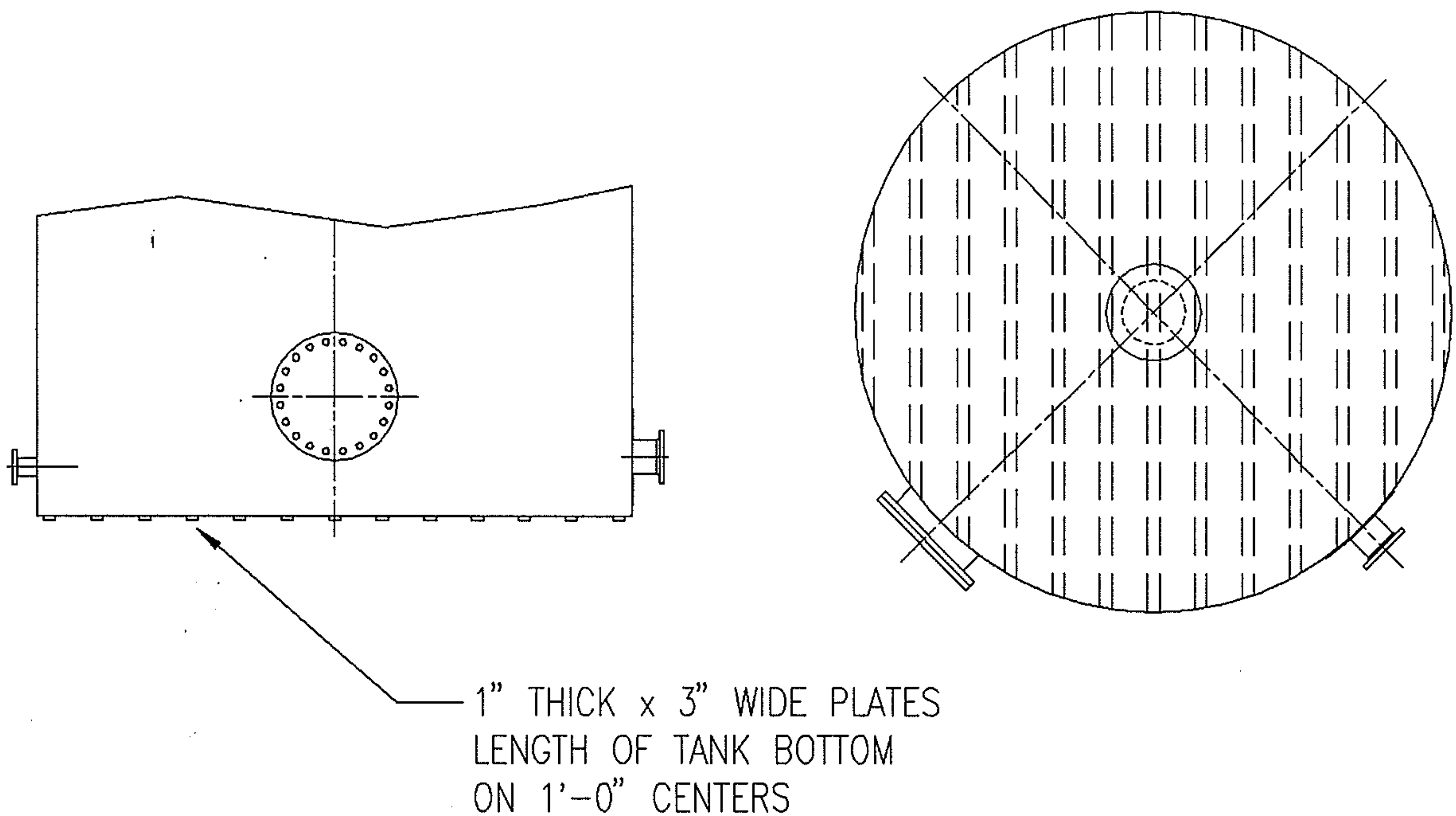
TYPICAL VACUUM PUMP
SEPARATOR DRAIN TO SUMP

FIGURE #5



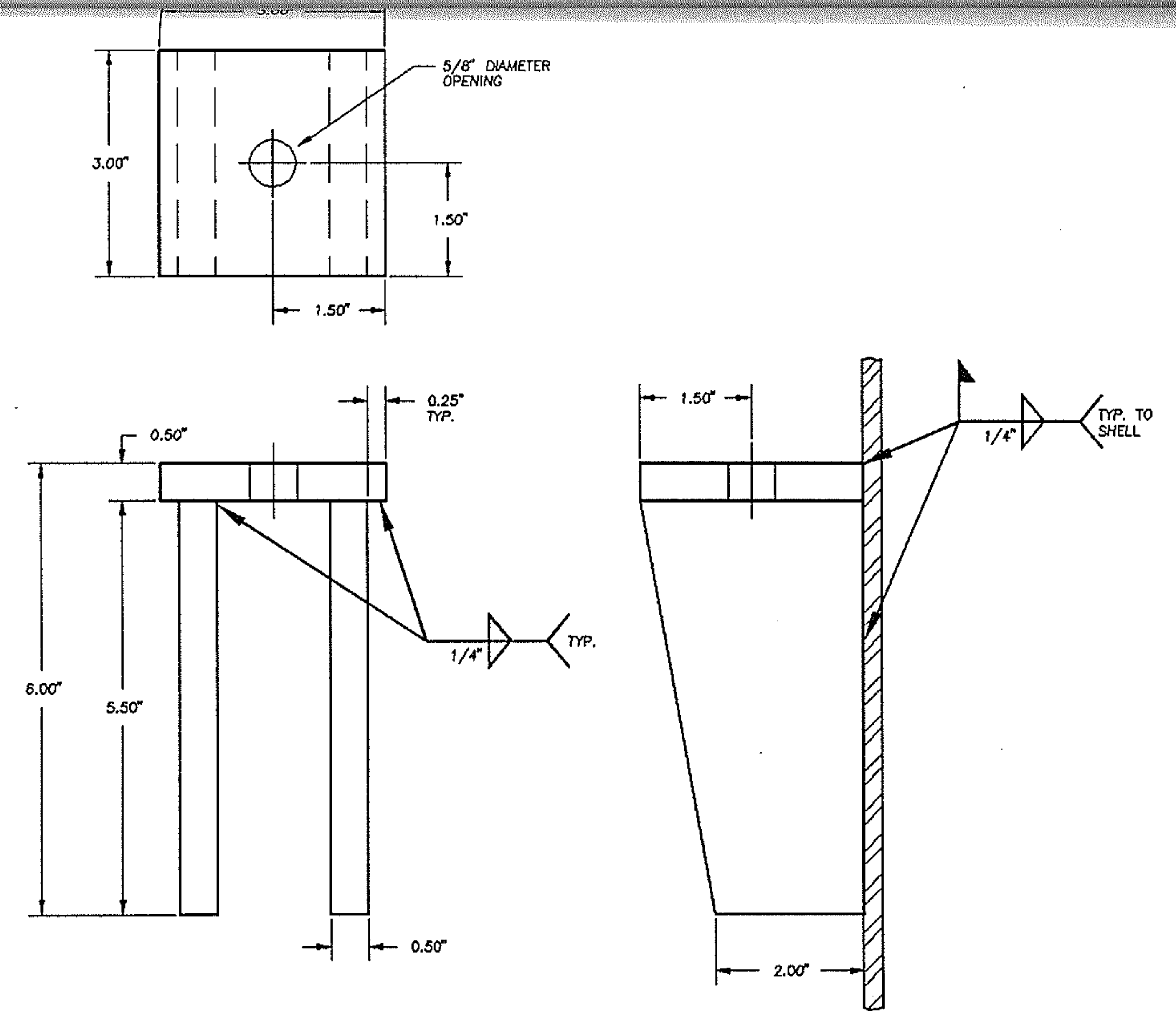
CYLINDER DOOR CATCH PAN
TYPICAL DRAIN DETAIL

FIGURE #6



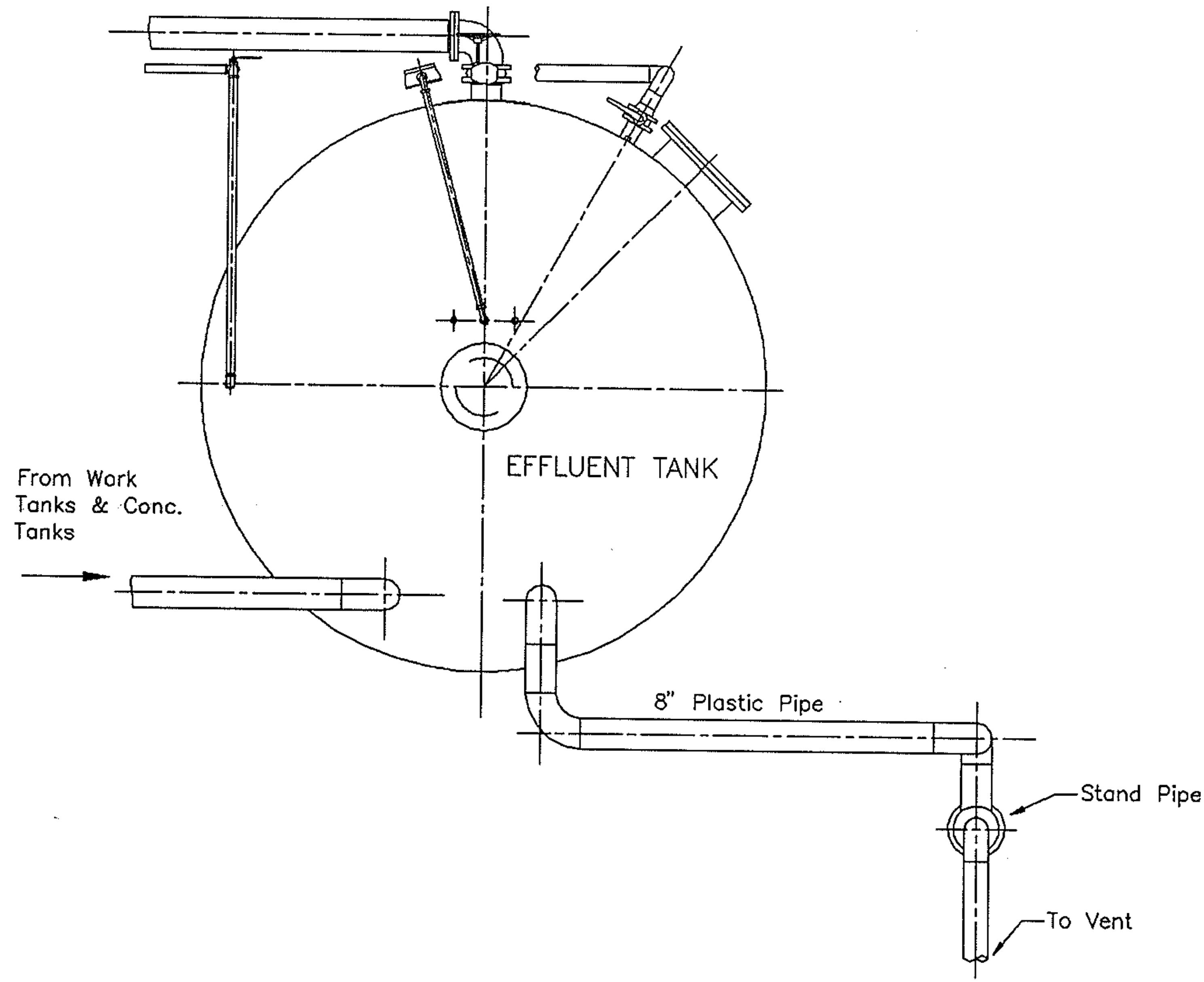
TYPICAL TANK HOUSE KEEPING PADS

FIGURE #8



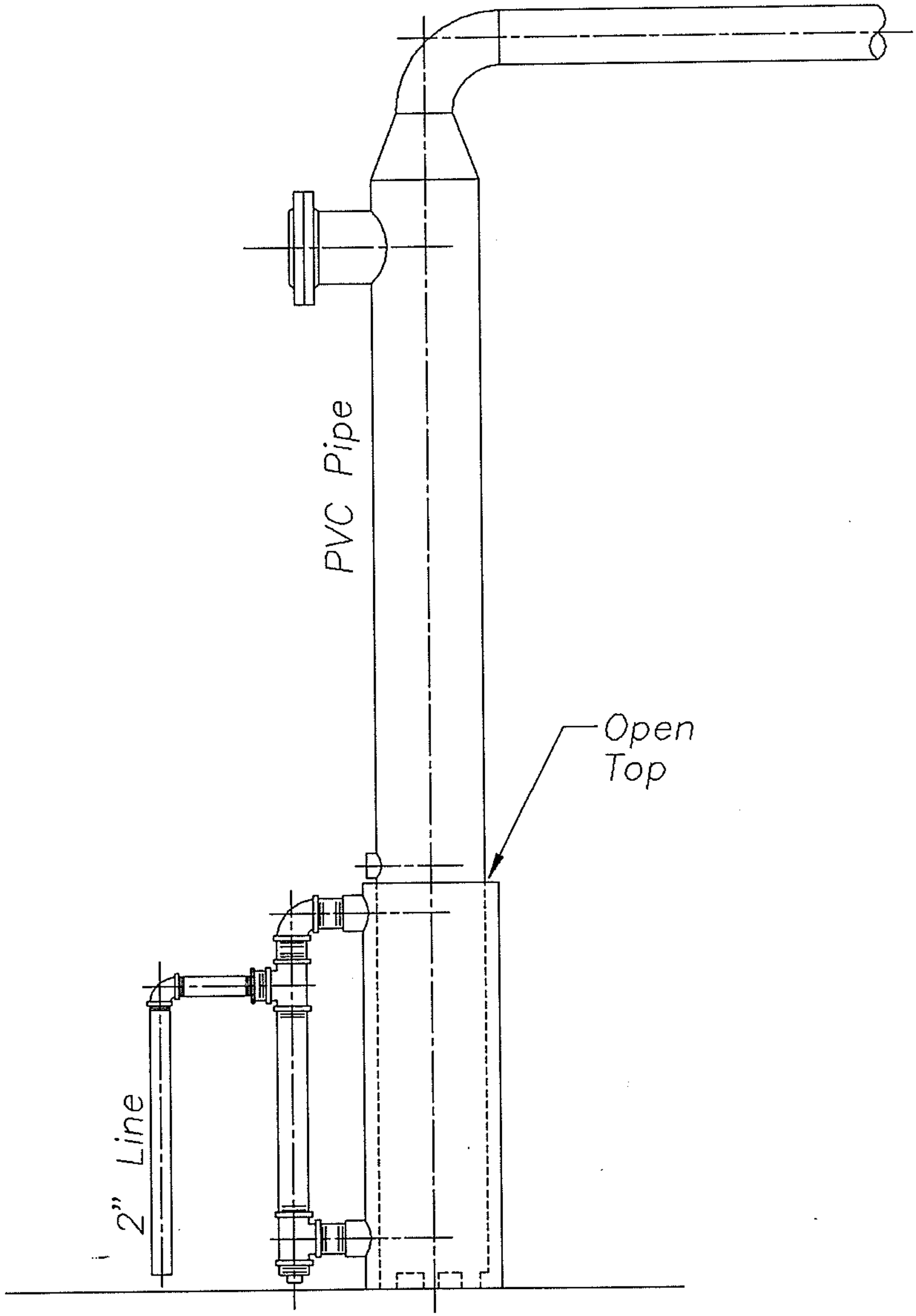
TYPICAL TANK HOLD DOWN

FIGURE #9



TYPICAL TANK VENT DETAIL

FIGURE #10



TYPICAL STAND PIPE DETAIL

FIGURE #11

HICKSON CORPORATION

CCA/K18500 MIX LOG

FIGURE #12

CHARGE NUMBER	DATE	GALLONS WATER USED	GALLONS 50% CONCENTRATE USED	TANK LEVEL	POUNDS OF K-18500 NEEDED FOR 7.5 PPM CONC.	PLATFORM SCALE READING IN POUNDS