CITY OF EVERETT FLUORIDE FEED FACILITY
REVISED PRE-ENGINEERING RESEARCH REPORT

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I. INTRODUCTION

A September 18, 1990 city counsel advisory referendum determined that a simple majority of Everett's voters approve of fluoridation of the city water supply. Approximately one year prior to the vote, the City of Everett Utilities Division began researching the type, cost, availability, safety and effectiveness of the equipment and chemicals necessary to feed fluoride into the city water supply. Two operators from the water treatment plant where fluoride would be fed, were assigned the task of reasearching what fluoridation chemical and feed system would be most appropriate for the Everett facility. This document is a revised compilation of their research.

In this report, sources of information about fluoridation include: tours and interviews with the operators of other plants, conversations with representatives of several chemical suppliers, discussions with sales representatives and installation/service technicians of various feed equipment manufacturers, talks with design engineers, attendance at a USPHS, fluoridation engineering course and review and study of available, existing literature (See Appendix C-List of References).

After an initial evaluation, two fluoride chemicals are selected for comparison; sodium silicofluoride in powder form and hydrofluosilicic acid in liquid form. Due to ease and safety of handling, comparatively lower potential operational costs and similar availability constraints to the other chemical, the liquid acid feed is recommended as the system of choice. A rough engineering schematic, a list of required specifications and details, a chemical cost and availability comparison table, a list of references and an itemized cost estimate have been included as appendices to this report.

II. COMPARISON OF FLUORIDE CHEMICALS/FEED SYSTEMS

Three chemicals are typically used for fluoridation of drinking water in the United States. They are sodium fluoride(SF), sodium silicofluoride(SSF) and hydrofluosilic acid(HFS). Suitability for use in Everett's system will be based on estimation of operator safety, ease of handling, water quality effects, chemical costs, chemical availability, and costs of system operation and maintainence.

Sodium fluoride has been eliminated from consideration, mainly due to fluctuating availability and significantly higher costs as a result of it's only being sourced from domestic markets. The U.S. has apparently imposed trade restrictions and tariffs on foreign sodium fluoride, because it is somehow associated with the production of chemical weapons overseas. Domestically produced sodium fluoride is significantly higher in cost compared to HFS or SSF. Hydrofluosilicic acid is a by-product of phosphate fertilizer production. Sodium silicofluoride is formed from HFS acid as an extension of the same process.

A. Safety

Operator safety is a high priority in choosing a fluoride feed system for use at the water treatment plant. Minimizing operator exposure to acute or chronically high concentrations of fluoride must be addressed in choosing and designing a system.

Sodium silicofluoride is shipped, stored and fed as a powder. There are significant problems associated with control of the associated dust when handling this chemical. Two of the utilities visited and/or interviewed, reported problems with handling and controlling the dust(San Andreas and Denver.). SSF is shipped, either in 100 lb. bags or in bulk, 50,000 lb., tanker truckloads. In either case, there is a reasonable chance for long term chronic exposure of the operators to fluoride containing dust, even if the proper respiration and dust collection equipment is used. In addition, if fed from bags there is a disposal problem with the empty sacks once they are used, because they are considered to be hazardous waste and must be disposed of according to the state and federal regulations for such materials.

Hydrofluosilic acid is a highly corrosive, fuming liquid that would be delivered in 5000 gallon, tanker truckloads. It is a safer chemical to handle since it is always handled indirectly by the operators through piping, pumping and tank storage equipment. It's relatively small amount of fumes can be easily handled with a simple ventilation system at the feed/storage site.

B. Ease of handling(Operational cost).

Ease of handling refers to how much work is involved in feeding a particular chemical and how much of an operator's time (in manhours) is consumed keeping the system operational. Since payroll is one of the major costs of operating a plant, this parameter also relates to operations costs.

Either chemical requires the use of a fluoride residual analyzer. These devices require more frequent attention and calibration than the more familiar chlorine analysis equipment.

In bulk form, sodium silicofluoride may present particular problems at the Everett site because it is susceptible to moisture uptake. The treatment plant is in a high humidity, high rainfall area. When the powder gets damp it frequently sticks, "bridges" and/or cakes in the feed chute and requires constant attention to keep it feeding. The existing dense soda ash feed system has had similar operational problems. Freeing stuck powder from a feeder also represents an additional exposure hazard.

The operators at the treatment plant would prefer to avoid feeding SSF from bags on any long term basis. This is due to the increased exposure hazard, extra manhours required to load the bags into the feeder and as mentioned, disposal problems with the empty bags. Operators would be required to handle large numbers of bags of SSF on a daily basis to keep the feeder hopper filled.

It is estimated that an HFS system, if properly designed and built, will have relatively low operational costs similar to other pumped, liquid chemicals. The system would consist of large storage tanks feeding a small "day" tank. The acid would be metered into the water with a small, easy to control, metering pump, paced to the plant flow.

C. Water quality effects.

Feeding either chemical will most likely result in suppression of the pH of the finished water. This would require the feeding of additional soda ash to compensate and to allow meeting corrosion control goals. Hydrofluosilicic acid has a very low pH (1.2) and would require from 0.2 to as much as 3.0 ppm of additional soda ash. Sodium silicofluoride in saturated solution has a pH of 3.5 to 5.5 and would require less soda ash to compensate for the pH supression it would cause. Overall chemical costs would increase in either case. If carrying water is used to move the acid to the feed point care must be taken to avoid dilutions that produce precipitates that would add turbidity to the finished water.

D. Availability.

Availablity appears to be similar for both chemicals. Both are by-products of phosphate fertilizer production. During the summer when flows are high and the amount of fluoride required would be greatest, no fertilizer is produced and periods of extreme shortages can and do occur. This requires designing adequate storage and stockpiling of supplies prior to the summer to avoid downtime.

The major supplier of acid for the Pacific Northwest, Comminco American, is uncertain at this time if it can produce enough to supply Seattle, Tacoma and Everett from it's Trail, B.C. phosphate plant. All other suppliers (see Appendix B and C-B) source all of their fluoridation chemicals from the Gulf Coast and/or Florida. Comminco would have to obtain any supplements to its regular supply from there also. In the future, if large numbers of utilities and communities begin fluoridating, there may be periods of extreme shortage until the chemical industry can react to the demand and begin producing additional chemicals.

The delivery time for all suppliers except Comminco, would be 5 to 7 days. Comminco would be shipping from Spokane or Trail, B.C. in two or three days.

The SSF suppliers interviewed gave conflicting reports on the availabilty of bulk quantities of the chemical. Denver, Colorado feeds bulk SSF at two of their facilities. The researchers assume that it could be obtained for a facility in Everett. The representative for Chemtech, one of the largest suppliers, indicated they would probably only ship bagged SSF due to the extra costs of shipping the bulk chemical to the Pacific Northwest and the lack of a bulk storage railroad transfer point for the chemical when it arrives there.

E. Chemical costs.

Cost estimates for 1991 for HFS range from $185 to well over $300 per ton (see Appendix B for cost estimate comparisons). SSF cost estimates were around $700 per ton. When the concentration of available fluoride ion is considered, SSF is cheaper than HFS. For example the cost of treating 38 MG would be approx $185 with SSF and $293 with HFS (This example is based on a per ton cost of $702 for SSF and $326 for HFS.) Costs could vary condsiderably, dependant upon the demand for phosphates by the agricultural industry, source of supply, the costs and restrictions associated with interstate trucking of hazardous materials and the availabilty of a regional railroad transfer and storage point for bulk truck shipments. Most of the chemical suppliers interviewed indicated that the trucking cost is greater than the cost of the chemicals. Distance from the supply point therefore is significant. To avoid contamination, all shippers would be required to dedicate a trailer to haul the chemicals. This will add to the cost due to loss of backhaulage on the part of the trucker. If demand for chemical increases significantly, increased chemical cost should be expected.

F. Maintenance costs

As long as workable, effective design principles and specifications are followed and quality materials are used, maintenance costs relative to other costs will be insignificant for either system .

III. CONCLUSIONS/RECOMMEDED CHEMICAL AND FEED SYSTEM

Hydrofluosilicic acid is the recommended choice for fluoridation of Everett water. The paramount consideration for this choice is operator safety. The liquid HFS acid feed systems observed at Seattle's Landsberg, San Francisco's San Andreas and East Bay MUD's Orinda plants have given years of relatively trouble and hazard free operation. In contrast San Francisco abandoned SSF feed in favor of liquid acid due to dust problems and Denver reported that they are having problems with dust control at their Foothills plant. Darrell Sanders, the fluoridation engineer for the Centers for Disease Control, indicated that most large systems use the acid.

In the researchers' opinion, the use of SSF stored in 100 lb. bags at large plants utilizing dry chemical feeders is impractical and is at best, only a temporary, interim, solution until a more permanent bulk facility can be installed. Tacoma is using this approach at their Green River facility by feeding SSF through an old powdered activated carbon volumetric feeder. This capability exists at the Everett plant. An existing PAC feeder could be used to feed SSF on a short term basis and as a back up to an acid feed system (this use also results in the loss of the feeder for feeding PAC for taste and odor control.). Small systems, like Lynden, Washingon, safely use bagged SSF, since the number of bags handled is relatively low and the exposure to dust reduced. This is not the case for a facility of Everett's size. In addition, operators at acid feed facilities reported that acid systems were easy to operate and with the exception of correcting design flaws, required very little maintenance. Many of their suggestions for effective design have been included in the list of details and specifications in the appendices.

Availability of HFS is estimated to be the same as SSF. The summer shortage resulting from annual shutdown of phosphate plants that produce both chemicals, requires having a large amount of chemical stored on site each spring. SSF's sensitivity to moisture very possilbly would make it difficult to feed after having been stored for two or three months in the damp environment found at the EWTP. HFS is readily and easily stored in inert plastic or rubber lined stainless steel tanks.

The researchers have prepared a list of details and specifications to be included in any engineering design of a hydrofluosilicic acid feed system for the Everett Water Treatment Plant. Many items on that list are a direct result of the advice and suggestions provided by people who are already operating acid feeds and/or by direct experience with other similar chemical feed systems already on line at the EWTP. Please see Appendix D for specifics.

APPENDIX A

COST ESTIMATE OF A FLUOSILICIC ACID FEED SYSTEM LOCATED AT THE EVERETT FILTER PLANT

Design capacities are for a 2-3 month supply at 100 MGD flow rate.

Containment building 30'x 40'x 17' high $11/sq ft. (Permabilt quote). This is a steel building. A more permanent structure of concrete blocks is strongly recommended as it would be more durable and less susceptable to corrosion and weather. Est. cost, add $20,000.00 to total cost.	$13,500.00 or $33,500.00
Spill containment cement structure/foundation. $300 per sq foot. (Tom Thetford, Utilities Div. engineer, quote.).	$37,000.00
Crosslinked polyethylene storage tanks 40,000 gals. storage (B-2 Eqipment quote).	$23,000.00
Power drop and pump control signals to site (Gerry Crum, EWTP UMT quote).	$4,500.00
Water piped to building, backflow preventer, emergency shower and eyewash (Gerry Crum, EWTP UMT quote.).	$1,000.00
Installation of pump and tank controls (TMG Services quote.).	$10,000.00
Coating of containment structure walls and floor with epoxy sealer/protectant. (Aquata Poxy).	$6,000.00
Two 5KW electric heaters (North Coast Electric quote.).	$1,200.00
Wallace and Tiernan fluoride residual analyzer. (Jim Hughes/W&T rep. quote.).	$4,000.00
Transfer pump (estimate).	$4,000.00
Pipe existing compressed air to site. (Estimate. 30 psi at an unknown cfs is required to unload acid from truck. If current supply is insufficent,an	$1,500.00

APPENDIX A (cont.)

additional compressor will be required. This estimate is only for piping existing air to site.).

Site preparation. Estimate 15% to 20% profit by contractor.	$15,800.00
Engineering. (Dan Lowell estimate)	$40,000.00
Construction management. 5% of cost. (Dan Lowell est.)	$10,000.00
Contingencies, oversights, etc. 20% of cost	$34,300.00
State sales tax. 8.2%	$16,875.60
TOTAL COST	$222,675.60
	or
	$242,675.60

APPENDIX B

CHEMICAL COSTS COMPARISON

COMPANY	CHEMICAL	EST. 1991 COST/ton
Cominco American(Trail, B.C.)	HFS	\$185-\$195
Cominco American(Florida supplement)	HFS	\$230-\$240
Chemtech Industries	HFS SSF	\$300 \$720
Harcross Chemical	HFS	\$300+\$.05 per lb for shipping
Jones Chemical	HFS SSF	\$326.16 delivered \$702.17 delivered

COST COMPARISON EXAMPLE

Assume lowest quotes for each chemical, a flow of 50 MGD and a dose of 1.0 ppm.

$$\frac{\text{Dose x MGD x 8.34 lbs/gal}}{\text{\% Fl ion x \% Chemical purity}} = \text{lbs of chemical fed}$$

HYDROFLUOSILICIC ACID (25% pure)(79.2 % F ion)

$$\frac{1.0 \times 50 \text{ MGD} \times 8.34}{.792 \times .25} = 2289 \text{ lbs}$$

$$\text{Cost per million gallons} = \frac{2289 \text{ lbs} \times \$185.00}{2000 \text{ lbs} \times 50 \text{ MG}} = \$4.23/\text{MG}$$

SODIUM SILICOFLUORIDE (98.5% pure)(60.7% F ion)

$$\frac{1.0 \times 50 \text{ MG} \times 8.34}{.607 \times .985} = 697 \text{ lbs}$$

$$\text{Cost per million gallons} = \frac{697 \text{ lbs} \times \$702.17}{2000 \text{ lbs} \times 50 \text{ MG}} = \$4.90/\text{MG}$$

APPENDIX C

LIST OF REFERENCES

A. TREATMENT PLANTS VISITED AND/OR PERSONNEL INTERVIEWED

Tom Robinette telephone interview
Operations Supervisor
Foothills Treatment Plant
Denver, CO

Terry Klimpel
Operations Manager
Public Utilities
323 Front Street
Lynden, WA 98264

Mary P. Hicks
Operations Supervisor
Russ Bowen
Operations Manager
Orinda Water Treatment Plant
East Bay M.U.D.
PO BOX 24055
Oakland, CA 94263

Steve Shaw
Operations Manager
Paul Mazza
Sr. Stationary Engineer
San Andreas Treatment Plant
2901 Crystal Springs Road
San Bruno CA 94066

Darrell H. Sanders Jr.
National Fluoridation Engineer
U.S. Public Health Service
Centers for Disease Control
Atlanta, Georgia 30333 (404) 639-1833

Alan Sweet
Water Treatment Supervisor
Landsberg Treatment Plant
1509 S. Spokane Street
Seattle, WA

Marty Ellis
Operations Supervisor
Green River Headworks (Tacoma)
36932 Green River Headworks
Palmer, WA 98051

APPENDIX C (cont.)

A. PLANTS VISITED/PERSONNEL INTERVIEWED (cont.)

Bob Myrick P.E. telephone interview
Tacoma Public Utilities-Water Division
PO BOX 11007
Tacoma, WA 98411

B. CHEMICAL COMPANY REPRESENTATIVES INTERVIEWED

Tom Chase (PNW region rep.)
Ashland Chemical Co.
PO BOX 2219
Columbus, OH 43216

Bill Clary
Harcros Chemical Co.
2450 8th South
Seattle, WA

Bob Dardis (NW region rep.)
Chemtech Industries
PO BOX 31000
St. Louis, MO 63131

Bob Nelson (NW region rep.)
Jones Chemical
80 Munson Street
LeRoy, NY 14482

Warren Woodward
Cominco American Inc.
W. 601 Riverside Ave.
Spokane, WA 99220-3087

C. LITERATURE REFERENCES

American Water Works Association, Water Fluoridation Principles and Practices, Manual of Water Supply Practices (M4), 1988.

Culp, Gordon L. and Williams, Robert B. edit., Handbook of Public Water Systems, pp. 645-652, Van Nostrand Reinhold, 1986.

Kerri, Kenneth D., etal., Water Treatment Plant Operation Vol. II, pp 25-59, Hornet Foundation, California State University, 1988.

APPENDIX C (cont.)

C. LITERATURE REFERENCES (cont.)

New York State Department of Health, Manual of Instruction for Water Treatment Plant Operators.

Reeves, Thomas G., P.E.; Water Fluoridation, A Manual for Engineers and Technicians; U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, Dental Disease Prevention Activity; September, 1986.

1989 Public Works Manual, Public Works; City, County and State. Vol. 120 No.5, p. C-21, H-89, H-104, H-248, April 15, 1989.

D. EQUIPMENT SALES AND SERVICE REPRESENTATIVES CONSULTED

Thomas Gazdik
TMG Serivices (feed equip. install. service)
21635 Maple Valley Hwy. SE
Maple Valley, Wa 98038

Jim Hughes
Regional Sales Representative
Wallace & Tiernan, Inc.
300 120th Ave. NE, Bldg 1, Suite 209
Bellevue, WA 98005

E. OTHER SOURCES

Basic Fluoridation Engineering Course
Dental Disease Prevention Activity
Centers for Disease Control (Atlanta, Georgia)
July 9 through July 13, 1990
State of Tennessee Operator Training Center
Murfreesboro, Tennessee

APPENDIX D

LIST OF SUGGESTED ENGINEERING DETAILS AND SPECIFICATIONS FOR A HYDROFLUOSILICIC ACID FEED FACILITY AT THE EVERETT WATER TREATMENT PLANT

Included below is a simple listing of materials, equipment and design details that the researchers developed as a result of the information obtained from the various sources.

A. Pumps.

The facility is to have a pair of metering pumps installed in parallel.

The EWTP has several surplus, Wallace and Tiernan Series 44, dual head, diaphram pumps on hand. In order to standardize and simplify maintenance and assuming their materials are suitable for use with HFS, these pumps are recommended for use as metering pumps. Changeover of the internal parts of these pumps to acid resistant ones may be necessary.

Each pump is to be placed on a raised platform or stand that is one inch higher than the overflow level of the containment structure. In the event of a major spill or leak the pumps would remain intact. These platforms will be built of concrete. Platforms and bases of steel or aluminum are unsuitable in this application.

A transfer pump is to be placed such that acid can be pumped from one storage tank to the other(s). The piping to this pump is to include a valved suction line to the containment sump and a connection to the delivery area piping. This allows for easy pumping of acid from the tanks or the sump to a tanker in the event of a leak. This pump will also require a raised base that is one inch higher than the containment walls. Acid resistant pumps such as the ARO diaphram series will be considered.

Metering pumps will be flow paced to the raw water flow meter (FE-10) or to the filter effluent flow totalizer (FY-20) for auto control and will have control capability for optional manual feed control. No compound loop controls to the fluoride residual analyzer are to be installed.

B. Piping

The attached "rough" schematic will be consulted with regard to placement of valves and piping.

APPENDIX D (cont.)

B. Piping. (cont.)

All piping to carry acid is to be constructed of shedule 80, CPVC pipe.(Recommended by San Andreas Plant operators). Although none of the acid feed facilities contacted experienced serious leaks using standard PVC, the CPVC would be even more resistant to the corrosive effects of the acid.

Carrying water from the plant supply system is to be provided with a backflow prevention device and pressure regulating valve and connected to the common discharge line to the chemical feed point. An inline rotometer will be installed with a valve to regulate the flow of the carrying water.

Flushing water will also be plumbed into the suction line of both transfer pumps, so as to aid in flushing the pump of acid for safe repair, disassembly and maintenance.

A graduated pump calibration cylinder is to be installed on the common pump suction line. The cylinder must be capped with a spill catchment line that leads to a 5 gal. carboy.

Isolation valves are to be installed on the intake and discharge lines of each pump, between intakes and discharges to the storage tanks, on the carrying water line, and at the intake and discharge to the day storage tank.

A double-valved line from the storage tank discharge header to the metering pump intake(s) will be installed such that it bypasses the day storage tank.

The fluoride diffuser in the clearwell intake structure is to be placed a minimum of two feet away from any concrete (San Andreas reported severe concrete damage to their outlet structure as a result of having a feed point placed too closely to it.).

A provision shall be made in the feed piping design such that siphoning and subsequent overdosing cannot occur. An example of this might be a solenoid valve placed such that the valve shuts off flow to the feed point when the pump is not running.

All piping shall be contained in heated areas that do not reach freezing temperatures or where exposed insulated and heated with heat tape to prevent freezing.

APPENDIX D (cont.)

C. Chemical storage and feed tanks.

Poly Cal Plastics' crosslinked polyethylene Zorb tanks with appropriate gaskets and fittings are to be used (Recommended by the staff at San Andreas plant.). Rubber lined stainless steel tanks with similar fittings would also be acceptable. Assistance from the manufacturer will be sought as to the appropriate type and composition of the gaskets connecting these tanks to the piping system. Bulk storage tanks will be sized to store a minimum of 90 days of material at peak plant flow (Peak flow is yet to be determined due to current plant expansion planning.). The day feed tank will be sized accordingly.

All storage tanks will be housed in a walled, slope roofed, heated, and vented structure, such that they are not exposed to ultraviolet light or freezing temperatures. Darrell Sanders at CDC indicated that all of the cross linked polyethylene tank cracking problems he has seen were the result of exposure to UV light. He also indicated that the tanks, piping and feed equipment must be protected from freezing temperatures.

Storage tank fittings to include those necessary for filling, connection to feed line to day tank and transfer pump and for installation of a clear CPVC sight gauge (if available, PVC if not.). The day tank shall also have fill, sight gauge and discharge piping connections. All tanks will have fittings for vent piping to atmosphere. All tanks shall also have high and low level sensor fittings and alarms, if such devices are available in a acid resistant design.

The preferred storage tank configuration is to use two vertical tanks. Storage building constraints may not allow this.

In the event that storage requirements exceed the volume that can be contained in two tanks, the next preferable configuration would be two pairs of vertical or horizontal tanks.

The day feed tank is to be equiped with a Chlor-Scale hydraulic load cell scale and analog readout. High and low pressure switch alarm contacts are to be included.

All storage tanks shall be vented to atmosphere.

Storage tanks are to be configured such that gravity feed can be used to fill the day feed tank.

APPENDIX D (cont.)

D. Containment structure/basin.

A steel reinforced concrete containment structure or basin shall be constructed as a base housing for the feed facility. The feed and transfer pumps, storage and day tanks, and most of the piping and valving are to be housed within the confines of this structure. The dimensions of the structure shall be sufficient to contain the volume of both storage tanks and the day feed tank in the event of a maximum spill.

The floor of the containment shall be sloped to a central sump that will be below floor grade. The sump shall not have a drain. Mounted in the sump will be suction piping which will be plumbed to feed the transfer pump. This sump will be 4'x 4'x 3'deep. Covering the sump will be a fiberglass grate that can support a minimum of 400 lbs or more.

All surfaces of the structure that would directly contact acid in the event of a spill(basically the interior walls, floor and pump platforms.), shall be coated with a potable water grade epxoy coating. (The San Andreas plant had a small leak at a tank gasket that "ate" an inch into the concrete base below the gasket. Epoxy (Aquatapoxy in this case) coating of the surfaces solved subsequent problems of this type.)

The structure /basin shall be constructed so as to act as a foundation to a building to be built over the facilty. The materials for the covering structure are not yet specified. The structure will most likely be either a steel pole or a concrete block slope roofed building.

E. Ventilation and heaters

A ventilation fan and accompanying intake and exhaust vents sufficient to exchange the volume of air in the building and containment base in a reasonable amount of time shall be installed in the building walls (reasonable = 5 to 30 min.). This system shall also meet any confined space ventillation requirements should the containment be classified as such.

Exhaust vents shall be to atmosphere and away from any nearby structures (corrosive fumes).

Exhaust fans will be wired into a programmable 24 hour on and off timer.

APPENDIX D (cont.)

E. Ventillation and Heaters (cont.)

Optimal configuration of intake and exhaust will be used if feasible. (ie. intake on one side of the building and exhaust on the opposite side such that there is minimal short circuiting and areas of "dead" air.)

Forced fan electrical heaters will be sized so that the building will maintain 50 degrees F throughout the winter months.

Electrical heaters will be wired to a thermostat control

F. Delivery area.

Consideration will be given to delivery truck spill containment. The climate of this location must be considered however. Due to the high annual rainfall, any uncovered and undrained area will become a small pond for much of the year.

Truck delivery area is to be sloped to a sump. A valved drain line shall be connected from the sump to the wash water drain line. During deliveries this valve will be closed to contain a possible spill. At all other times the valve would be left open to carry site runoff to the WWP.

A compressed air hookup with 30 psi and yet to be determined flow requirements will be installed for offloading of the tankers.(This may require a compressor installation at the fluoride feed/storage/delivery site if current compressor system proves to be inadequate.)

Two parallel hookup points and attendant delivery piping to the storage tanks will be installed at the delivery point. These piping hookups shall include the appropriate flanges for tanker delivery. The above ground portions of the delivery piping shall be protected from accidental breakage from trucks by construction of concrete enclosures or steel pipe pylons.

Provision will also be made to prevent the delivery piping from freezing.

Provision will also be made to prevent excessive restriction of flow in the delivery lines.

G. Instrumentation and control.

The signal from the raw water flow meter (FE-10) or from the filter effluent totalizer (FY-20),shall be connected to the

G. Instrumentation and control (cont.)

appropriate control gear for flow pacing of the metering pumps.

The necessary elecrical switch gear and panels shall be installed for control of the pumping equipment. This equipment may require an electical room be built as a separate environment from those that would be exposed to the acid fumes. The equipment is to be selected and/or installed such that it is protected and/or resistant to the corrosive effects of the acid's fumes.

A fluoride residual analyzer(ie. Wallace & Tiernan model Depolox 3 or it's equivalent from Orion.) shall be installed to monitor the clearwell effluent stream. This equipment could be most easily installed in the sample pump #12 line in the WQ lab. A continuously operating chart recorder will be included with the analyzer. The chart recorder will be installed in the main control panel of the operations building and wired to provide continuous readout of the clearwell effluent fluoride residual.

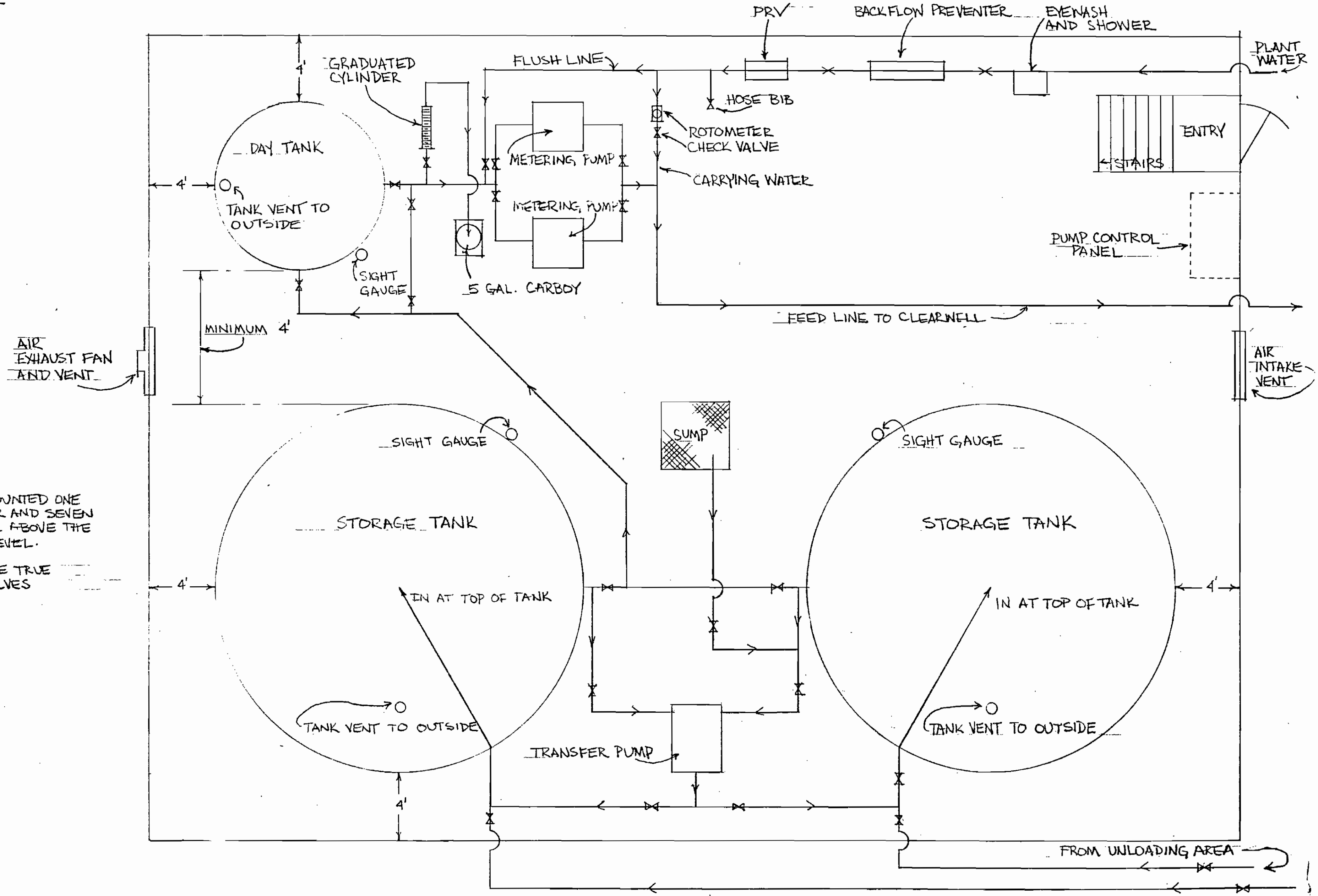
Telemetering signals will be sent from the containment structure to the main control panel in the ops. building. There signals will be wired into the control panel to produce the following lighted and audible alarms:

1. Fluoride metering pump running or failed.
2. Day tank high and low levels.
3. Sump high level, use a float switch of appropriate materials to generate this signal.
4. Storage tanks high and low level.
5. Fluoride residual strip chart will have high and low alarm lights and sound.

H. Miscellaneous.

All pipes and plumbing that will contain acid outside the containment structure must be of double wall construction. (This is particularly important for the delivery piping.)

SCHEMATIC LAYOUT OF FLUORIDE BLDG.
SEPTEMBER, 1990
NOT TO SCALE



1. PIPE WILL BE MOUNTED ONE FOOT OR LOWER AND SEVEN FEET OR HIGHER ABOVE THE FLOOR GRADE LEVEL.
2. ALL VALVES TO BE TRUE UNION BALL VALVES

MKW AND LJL