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GROUNDWATER
INTERIM REMEDIAL MEASURE
90% DESIGN REPORT
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK

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GERAGHTY
& MILLER, INC.
Environmental Services
A Heidemij Company

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January 1996

Prepared for

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Bethpage, New York 11714

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DISCLOSURE STATEMENT

The laws of New York State require that corporations which render engineering services in New York be owned by individuals licensed to practice engineering in the State. Geraghty & Miller, Inc. cannot meet that requirement. Therefore, all engineering services rendered to Grumman Aerispace Corporation in New York are being performed by GM Consulting Engineers, P.C., a New York professional corporation qualified to render professional engineering services in New York. There is no surcharge or extra expense associated with the rendering of professional services by GM Consulting Engineers, P.C.

Geraghty & Miller, Inc. is performing all those services which do not constitute professional engineering and is providing administrative and personnel support to GM Consulting Engineers, P.C. All matters relating to the administration of the contract with Grumman Aerospace Corporation are being performed by Geraghty & Miller, Inc. pursuant to its Amended and Restated Services Agreement with GM Consulting Engineers, P.C. All communications should be referred to the designated project manager at Geraghty & Miller, Inc.

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INTRODUCTION

Geraghty & Miller, Inc. has been retained by the Grumman Aerospace Corporation (Grumman) to conduct a remedial investigation/feasibility study (RI/FS) and perform remedial design (RD) services at their Bethpage, New York facility (Facility) (see Figure 1). The Facility is situated on approximately 500 acres in east-central Nassau County, in the Hamlet of Bethpage, Town of Oyster Bay, New York. The Facility includes numerous buildings, 14 production wells, and five recharge basins. The RI/FS and subsequent RD evaluations have been conducted pursuant to an October 25, 1990 Consent Order (CO) No. 5 W1-0018-81-01, entered into by Grumman, with the New York State Department of Environmental Conservation (NYSDEC) .

This design report summarizes the background, objectives, design parameters, and 90% complete design of a groundwater interim remedial measure (IRM) that is being implemented at the Facility. This groundwater IRM is being prepared in general conformance to a letter and schedule, dated September 15, 1995, provided to the NYSDEC by Geraghty & Miller, and in accordance with subsequent meetings and correspondence between the NYSDEC, Grumman, and Geraghty & Miller. The IRM consists of the following elements: three extraction wells, a groundwater treatment system, a treatment building, and system controls and appurtenances. Accompanying this design report are the 90% Construction Drawings and Draft Technical Specifications for the NYSDEC's final review and approval. In addition, Appendix A contains Geraghty & Miller's responses to comments received from the NYSDEC on the 35% design submittal.

PROJECT BACKGROUND

Grumman entered into a CO with the NYSDEC on October 25, 1990 (Consent Order No. 5W1-0018-81-01). In conformance with the CO, Geraghty & Miller was retained by Grumman to conduct an RI/FS at the Facility. Data collected during the RI was used to define the nature and extent of impacted soils and groundwater on-site, and to define the nature and extent of impacted groundwater off-site. The recommendations resulting from the RI were summarized in the RI report (Geraghty & Miller, Inc. 1994) as remedial action objectives (RAOs). These RAOs generally consisted of the following :

RAO 1. Remediation of on-site source areas (soil) to prevent them from acting as a continuing source of impact to groundwater.

RAO 2. Elimination of exposure pathways to on- and off-site receptors through groundwater containment.

RAO 1 was accomplished through the implementation of a soil vapor extraction (SVE) IRM at the Plant 2 trichloroethene (TCE) storage tank. This IRM is still being conducted at the Facility. A potential source area near Plant 15 is currently being evaluated to determine if remediation (via SVE) is needed. Activities relating to RAO 2 began in December 1994 when a Feasibility Study (FS) was begun to address the off-site migration of impacted groundwater.

Six groundwater remedial alternatives (RAs) were developed for evaluation during the FS (Geraghty & Miller, Inc. 1995a). In a meeting held on March 22, 1995 that involved the NYSDEC, the New York State Department of Health (NYSDOH), the Nassau County Department of Health (NCDOH), representatives of the Bethpage Water District (BPWD), the United States Navy (USN), and the Occidental Chemical Corporation (OCC), Grumman proposed implementing full on-site containment (RA 5), as a groundwater IRM prior to completion of the FS evaluations. As a result of subsequent discussions with representatives of the BPWD regarding the number and location of the proposed on-site extraction wells, modifications were made in the proposed IRM. These modifications were described and confirmed in a letter from Geraghty & Miller to the NYSDEC on July 20, 1995 (Geraghty & Miller, Inc. 1995b).

On July 27, 1995, in a Technical Committee meeting that was held at the Region II offices of the United States Environmental Protection Agency (USEPA), the IRM was agreed to, in concept, by all interested parties. The NYSDEC approval of the revised IRM was received on July 31, 1995 (NYSDEC 1995). This agreement resulted in Grumman's retaining Geraghty & Miller to design the proposed groundwater IRM. The IRM 35% Design Report (Geraghty & Miller, Inc. 1995c) was transmitted to all interested parties on November 13, 1995; this report describes the conceptual system design. On November 30, 1995 a second technical committee meeting was held at the offices of H2M Corporation, to discuss the 35% design submittal and address any comments that the interested parties had regarding the design.

This 90% Design Report is the second of three transmittals to all interested parties, and it summarizes the detailed system design.

PROJECT OBJECTIVE

The primary objectives for the groundwater IRM are to provide a hydraulic barrier that will prevent the off-site migration of site-related constituents in groundwater and will remove site-related constituents from the groundwater. To accomplish these objectives, groundwater will be pumped at a specified pumping rate from three extraction wells (ONCT-1, ONCT-2, and ONCT-3), treated, and discharged to the south recharge basins. The pumping and treatment of groundwater will result in the mass removal of volatile organic compounds (VOCs) and will also provide on-site containment of impacted groundwater. The impacted groundwater will be contained on-site by maintaining and supplementing the existing hydraulic barriers created by pumping and recharge. The IRM will thus help mitigate impacts to off-site groundwater receptors.

DESIGN CRITERIA

The groundwater extraction system is designed to extract a total of 2,300 gallons per minute (gpm) from three on-site extraction wells: ONCT-1 (1,000 gpm), ONCT-2 (600 gpm), and ONCT-3 (700 gpm). The design flow rate to the proposed groundwater treatment system is therefore 2,300 gpm.

The design constituent concentrations were based on groundwater data collected at the site during the RI (Geraghty & Miller, Inc. 1994), the results of the groundwater modeling conducted by Geraghty & Miller (Geraghty & Miller, Inc. 1995d), and quarterly groundwater sampling events for off-site wells. Table 1 presents the design groundwater VOC concentrations at each of the new extraction wells (ONCT-1, ONCT-2, and ONCT-3) and the blended VOC concentrations from these three wells to the proposed groundwater treatment system. These values represent the maximum projected design concentrations for the groundwater collection system and include safety factors. The total safety factor applied to the influent concentration used in the air stripper design was 4.0. The total safety factor applied to the effluent concentration was 4.0, consisting of a safety factor of 2.0 applied to the air stripper effluent concentration and a safety factor of 2.0 associated with the aeration basin treatment. Therefore, the total design concentration safety factor used for the air stripping system is 16.

Table 1, and the following design parameters, were used to establish the design criteria for the groundwater treatment system:

- Treatment will meet one-half the effluent quality standards set by the NYSDEC for drinking water.

- Operation of the groundwater treatment plant and extraction system will allow easy visual monitoring, testing, and maintenance, with automatic control of the principal equipment units.

- Piping connections and valving will allow for changing the process order or by-passing the treatment system, as well as for overall system flexibility.

- Air discharges will be in conformance with NYSDEC requirements, as specified in NYSDEC Air Guide-1 and its accompanying appendices (NYSDEC 1991). An air treatment system will be used. A regenerable vapor phase granular activated carbon (VPGAC) system has been selected.

- Regenerant condensate from the VPGAC system will be blended with water from the wells and treated by the air stripping tower. The expected design concentrations for the air stripping tower are presented in Table 2 and mass transfer data is included as Appendix C.

DESCRIPTION OF GROUNDWATER IRM

A description of the groundwater IRM is presented in this section. The section includes descriptions of the following: (1) extraction wells and piping, (2) treatment process, (3) treatment facility, (4) treated water discharge, and (5) process controls and operation. A summary of the design parameters for the groundwater IRM is provided in Table 3.

EXTRACTION WELLS AND PIPING

The extraction well configuration has been designed to provide on-site hydraulic control of impacted groundwater. Extraction Wells ONCT-1 (pumped at 1,000 gpm), ONCT-2 (pumped at 600 gpm), and ONCT-3 (pumped at 700 gpm) will be installed at the locations shown on Drawing Number C1 of the 90% design drawing submittal. These wells will be installed approximately 465 feet below mean sea level (bmsl) and screened between 405 and 465 feet bmsl, as described in a letter dated August 10, 1995 to the NYSDEC from Geraghty & Miller (Geraghty & Miller, Inc. 1995e).

Groundwater will be extracted from each well using vertical turbine well pumps and will be pumped through 10-inch and 12-inch diameter mains to the proposed groundwater treatment system. Each well will be enclosed in a well house, where the vertical turbine pumps, piping, valves, electrical devices, well pump controls, and accessories associated with the well, will be housed.

Final hydraulic calculations to determine the dynamic head losses in the extraction system piping have been completed (see Appendix B). The dynamic head losses were added to the static head losses to give the total dynamic head (TDH) loss for each extraction well pump (see Table 3). Each vertical turbine pump will be designed to pump 1,200 gpm at the maximum TDH computed for each well. The wells will be throttled using combined back pressure flow control values with an automatic check valve feature. The back pressure/control valves will be used to maintain the flows specified in the design criteria description.

Power for the wells will be distributed from an on-site substation via underground conduit, with power being supplied to each well at 15 kilo-volts (kV). At each well house, the power will be stepped down to 480/277 volt and 110 volt power for use by the well motors and system controls, respectively.

TREATMENT PROCESS DESCRIPTION

Groundwater from the three ONCT wells will be conveyed via underground piping to a centrally located treatment plant. The treatment processes that will be used as part of the proposed groundwater IRM are described in this section. Packed column air stripping will treat the groundwater stream and regenerable VPGAC will treat the air stripper off-gas stream.

Air Stripping

Air stripping is an effective means of removing VOCs from water and has the advantage of relatively low operation and maintenance (O&M) requirements. A typical air stripping unit consists of a vertical tower partially filled with an inert high surface area packing material. The function of the packing material is to increase the surface area over which the water must flow and thus enhance the opportunity for air/water mixing. Influent water enters at the top of the air stripping tower and flows by gravity down through the packing material while air is simultaneously forced up through the packing material. The VOCs dissolved in the water being treated are driven out of the water stream by the concentration gradient between the water and the air. The VOCs enter the air stream and are discharged from the air stripper. Treated water flows by gravity from the bottom of the air stripper to the treatment building clear well.

The air stripping design concentrations presented in Table 2 were used to size the air stripping and air treatment systems. These values will provide a conservative process system design. Each piece of process equipment was then designed to provide the flexibility necessary to adjust the systems in case of long-term changes in the influent concentrations.

Because TCE is expected to be present at significantly higher concentrations than the other VOCs in the influent groundwater, TCE will control the air stripping system design. By designing the system to meet the required effluent TCE levels, the other VOCs present will be removed to acceptable levels. The system design is thus based on achieving the design stripper removal efficiency for TCE given in Table 2, but will meet the design efficiencies required for all the compounds listed in Table 2.

During the design of the air stripping tower, computer simulations were performed based on the expected maximum influent concentrations of VOCs and the allowable VOC effluent concentrations. Design parameters include the number of air stripping units, tower diameter, tower height, type of packing material, packing material depth, air-to-water ratio, hydraulic loading rate, air flow rate, water flow rate, and water temperature. These design parameters are summarized in Table 3. Modeling data indicate that a packing material depth of 50 feet will be required to remove TCE to less than drinking water standards (2.5 parts per billion [ppb]). Appendix C summarizes the mass transfer data and packed column removal efficiency of the proposed air stripping system.

The air stripping tower shell will be aluminum; the outside diameter of the air stripping tower will be approximately 10 feet, and the total height of the tower will be approximately 64 feet. The air stripping tower will be designed to allow the addition of a 10-foot high spool piece if it should become necessary in the future.

The air stripping tower will be located outside of the proposed treatment building and will be self-supporting. The foundation of the air stripping tower has been designed in accordance with New York State Building Code to withstand the applicable wind and seismic loadings. The tower will be provided with the required connections for influent and effluent water lines, air ducts, access ladders and platforms, lighting, expansive flanges, pipe supports, and required lifting lugs.

The packing material will be 3.5-inch diameter Jaeger Tripack polypropylene packing with a surface area of approximately 38 square feet per cubic foot of packing. The packing material will be randomly distributed. The pressure drop for the operating conditions (9,225 standard cubic feet per minute [scfm] of air and 2,300 gpm of water) will be approximately 0.055 inches of water per foot of packing.

An air blower will be connected at the discharge end of the air stripper to provide an air flow of 9,225 scfm at 9.0 inches of water (vacuum) static pressure. The blower is designed and specified in accordance with applicable standards for industrial fans. The blower housing will be heavy gauge steel suitably braced to resist vibration or pulsation, and also to reduce noise. The air blower motor will be manufactured in accordance with National Electrical Manufacturers Association (NEMA) and Air Moving and Conditioning Association (AMCA) specifications and standards.

Regenerable Carbon

A VPGAC unit will be used to treat the air stripper off-gas. The VPGAC process selected relies on in-place regeneration of the activated carbon to reestablish the adsorptive capacity of the carbon. Steam will be used for regeneration since it is available on-site. The VPGAC will consist of two 11-foot diameter vessels to allow continuous operation while one vessel is off-line for regeneration. Each vessel will hold a single 2 to 2.5-foot deep activated carbon bed.

The regenerable VPGAC unit will operate in two modes: adsorption and desorption. During the adsorption process, the off-gas from the air stripper will be passed through the activated carbon bed. A timer will take the VPGAC unit off-line and steam will be applied for regeneration. The cycle times will be about 8 hours for adsorption and 2 hours for desorption.

The regeneration process consists of forcing steam in a counter-current pattern through the carbon bed. Steam is readily available on-site and access to the steam source will involve minor piping connections to an existing steam line. The steam will desorb the organic molecules from the carbon pores. All the steam used in the desorption process will be passed through a steam/water plate and frame (or crossflow block type) heat exchanger condenser. The subcooled stream will then collect in a decanter to allow free-product and saturated water condensate to separate. The free-product and saturated condensate will flow by gravity to separate storage tanks. The saturated condensate will be pumped to the air stripper tower influent line for treatment. The free product recovered will be pumped to 55-gallon drums and disposed off-site. The regenerated carbon bed will be allowed to cool and then be put back on-line.

The regenerable VPGAC unit will be sized for 9,225-scfm air flow and for the maximum expected organic load removed from the groundwater stream by the air stripping tower. For design purposes, the air stream is assumed to be 50 to 60 degrees Fahrenheit (°F) with a relative humidity (RH) of 100 percent. The air will be preheated prior to the VPGAC beds to reduce the RH to approximately 40 percent. A steam/air heat exchange coil will be used for preheating and will be part of the VPGAC system skid. Based on preliminary calculations, the two-bed VPGAC system will be regenerated three times each day. The projected average condensate production will consist of approximately 0.5 gpm of organic saturated condensate water and approximately 9.8 pounds per hour (lb/hr) of mixed free product. The VPGAC system has been designed and specified so that the system will stay in operation during the regeneration process, with one unit remaining on-line at all times.

Due to the potentially corrosive nature of the regenerant stream, resulting from the desorption of chlorinated organics like TCE, the air treatment system will be manufactured with corrosion-resistant materials to minimize long-term maintenance costs. The construction materials will consist of Hastelloy C-276, titanium, and Teflon-coated steel, as defined in the Technical Specifications. The use of these materials will influence the fabrication and delivery schedule of the system. The impact to the project schedule has been factored into the most recent project schedule (Geraghty & Miller, Inc. 1995f).

TREATMENT FACILITY DESCRIPTION

This section presents a description of the structures and utilities that will be required to construct the process equipment. All facilities have been designed and will be constructed in strict conformance with New York State and federal building code requirements. The proposed groundwater treatment facility will consist of a one-story treatment building with one air stripping tower (as described in the Air Stripping section of this report) located outside of the treatment building, and a clear well located underneath the treatment building. Details for the entire facility can be found in the 90% Construction Drawings and Draft Technical Specifications.

Treatment Building

The proposed treatment building will be a one-story pre-engineered building with a total floor area of approximately 2,000 square feet. The treatment building will house the air blower; distribution pumps; 49,500-gallon clear well (underneath); controls and instrumentation panels; motor control centers (MCCs) and process piping; and the VPGAC unit controls, appurtenances, and equipment. The proposed treatment building will be supported by a reinforced concrete foundation. The foundation design was based on an assumed soil-bearing capacity of 3,000 pounds per square feet (psf). Anticipated equipment weights and structural loadings were used to determine footing and foundation sizes. Foundations will be installed on undisturbed native materials and compacted select fill.

As stated earlier, the air stripping tower will be located adjacent to the exterior of the proposed treatment building. The foundation of the air stripping tower will be a reinforced poured concrete slab, designed using the same assumptions described above.

Clear Well

The clear well will be a reinforced concrete structure located beneath the proposed treatment building. This well will be approximately 15 feet wide by 40 feet long, with an approximate depth to overflow of 11 feet. The design capacity will be 49,500 gallons, with an operating capacity of 46,000 gallons (this corresponds to a 20-minute residence time at a flow rate of 2,300 gpm). An overflow weir will be installed in the clear well and designed for an overflow of 2,300 gpm. The bottom of the weir will be set just above the normal operating water level in the clear well. When water is not needed in the system, the primary discharge point will be via the overflow weir to the facility storm sewer system and the existing aeration basin, via gravity flow.

Utility Service

Electric services will be obtained from an existing substation in the vicinity of the proposed treatment facility. The on-site substation will have sufficient power to handle the additional loads, and spare distribution switches will be available at the substation to supply the proposed loads. Power will be distributed at 15,000 volts or less. This distribution system will consist of a new, medium voltage ductbank with concrete encasement extending from the existing substation to each extraction well and to the treatment plant. This ductbank will be routed alongside the new piping to each extraction well. Instrument and control wiring will also be routed from each well back to the treatment plant. Limited monitoring and control of the proposed system will be provided at the facility steam plant.

The treatment plant will house the clear well and cooling water pumps and the VPGAC system skid. The clear well pump motors (a total of three) will each be 100 horsepower (hp). The cooling water pump for the VPGAC condenser will be approximately 5 hp. The VPGAC skid will hold the process blower (75-hp motor), two small process pumps (each less than 0.5 hp), and a drying blower (15-hp motor), if required. One well pump motor (100 hp), will be located at each of the three wells.

Power, lighting, and heating have been designed for this treatment plant. Lighting included building-mounted exterior fixtures and interior fluorescent fixtures. Power design included all pumps and blower motors, heating, ventilation, and air conditioning (HVAC), lighting, and miscellaneous small electrical loads. Steam heat and forced ventilation will be used for temperature control in the treatment facility building; electric heat will be used at the well houses.

Steam will be required for VPGAC regeneration and building heat. Because steam is already generated on-site, saturated steam will be taken from a steam main that is accessible to the plant at a maximum rate of 3,500 lbs/hr at a pressure of 150 pounds per square inch (psi). The pressure in the line to the new treatment plant will be reduced to 30 psi prior to use in the treatment plant. Steam will be taken from the main via a 3-inch diameter, insulated, carbon steel line to the treatment building. A condensate return line will carry the condensed non-contact steam from the building heat and VPGAC heat exchanger to a steam return main that returns to the facility steam plant.

TREATED WATER DISCHARGE

The IRM implementation plan requires that the extraction wells pump continuously at the specified flow rates (total flow of 2,300 gpm). Extraction wells will not be shut down except in an emergency or as required for normal maintenance. During normal operations, the extraction wells will pump directly to the air stripper for treatment, with the treated water flowing by gravity to the clear well. A bypass line that will allow water to be pumped from any well, directly to the clear well, will also be provided. The bypass line will be used when pumping at the extraction wells is required for hydraulic control, but the groundwater does not require treatment.

Three, identical, 1,500-gpm, short-coupled, vertical turbine clear well pumps will be provided to pump the treated water from the clear well to the existing plant distribution system on an as-needed basis. The existing groundwater supply and distribution is used for non-contact cooling water and other processes. The clear well pumps will discharge to an existing 12-inch diameter cast iron pipe (CIP) main via a new 16-inch diameter ductile iron pipe (DIP) main. The clear well pumps will be vertical turbine pumps sized to overcome a system pressure of approximately 70 psi at the point of tie-in. The clear well pumps will also be utilized to supply recirculation water to the air stripper if cleaning or flushing of the air stripper is necessary.

If the distribution system does not require any additional flow, the treated water will be allowed to overflow by gravity to the existing 36-inch diameter, reinforced concrete pipe (RCP) Facility storm sewer line, using a 24-inch diameter RCP culvert. The culvert will convey flow from the overflow point to a new manhole located approximately 700 feet upgradient of the Facility's existing aeration basins. The discharge from the clear well will be controlled by an overflow weir. The weir will be designed to pass 2,300 gpm, with the total weir overflow capacity of the structure being 4,500 gpm. The clear well will be a sufficient depth to allow for 1 foot of free board with 4,500 gpm passing over the weir. The 24-inch RCP culvert will flow by gravity and will be installed with a sufficient slope to provide a flow capacity for 4,500 gpm. The flow will contribute to the existing flow in the storm sewer system. Based on available information, the capacity of the storm sewer should not be significantly impacted by the increased water flow created by the treatment facility discharge.

Treated water in the storm sewer line will flow by gravity to the existing aeration basins. The aeration basins will provide additional treatment of the VOCs in the water. The water will flow by gravity from the aeration basins to the south recharge basins.

The IRM implementation plan requires the recharge of water into the south recharge basins. This recharge will provide a hydraulic barrier throughout the upper portions of the aquifer; pumpage from the lower portion of the formation will complete the hydraulic barrier. To maintain the upper barrier, a portion of the water in the distribution system will flow to the south recharge basins by way of the existing distribution system or the storm sewer and the aeration basin. The gravity overflow in the proposed treatment system clear well will provide a default that will automatically discharge to the storm sewer, and thus to the south recharge basins, if water is not needed in the plant distribution system.

PROCESS CONTROLS AND OPERATION

The process control system is designed to provide the necessary safeties and interlocks to ensure that the extraction wells, piping, and treatment systems operate smoothly, efficiently, and as a unit. The following sections describe the operation, system monitoring, alarm conditions, system interlocks, and anticipated start-up sequence.

Controls and instrumentation will be interconnected by utilizing instrumentation wiring in the underground conduit. The central control panel, located in the treatment building, will house a Programmable Logic Controller (PLC) to monitor and integrate the operation of the well pumps, VPGAC, clear well pumps, and air stripper. This panel will be directly connected to each major component in the IRM system and will provide an interface to the Grumman steam plant to enable the IRM system to be operated remotely and monitored directly from the steam plant.

Operation and Programmable Logic Controller

Under normal operating conditions the well pumps will be operating at the previously defined design flow rates and will be pumping water through 10-inch and 12-inch diameter DIP to the air stripping system. The flow rate from each well will be monitored and recorded at each well house, and a pressure switch will be used to signal high or low pressure conditions at each of the wells. At the air stripping tower, water collected during the condensation of the VPGAC regeneration steam will be blended into the water stream flowing from the wells. The combined stream will be treated by the air stripping tower. Treated water will flow by gravity from the air stripper into the clear well.

From the clear well, water will either flow by gravity to the storm sewer system and then to the aeration basin and south recharge basins or will be pumped into the Facility water distribution system. The operation of the clear well pumping system has been defined based on discussions with Grumman and a review of the particular demands of the collection, treatment, and distribution systems. The clear well pump/clear well system will be controlled by the PLC, which will interlock the pump/clear well system to the rest of the treatment system.

Remote hand/off/auto switches will be provided for each clear well pump at the steam plant. For any clear well pump to operate, the pump's switch in the steam plant must be in the "hand" or "auto" position and the water level in the clear well must be above a preset point. When the clear well pump's switch in the steam plant is in the "auto" position, distribution system pressure will be used to provide a signal to the pump to start and stop. Pressure settings will be determined by Grumman operations personnel. The selection of the particular distribution pump(s) to be on-line and the use of "hand" or "auto" positions will be determined by Grumman operating personnel.

The PLC will be used to provide the logic to coordinate the control signals from the remote switches and the clear well level sensors for clear well pump operation. The clear well pump(s) will be shut off if any of the following conditions occur: the remote switch(es) at the steam plant is (are) placed in the "off" position; pressure in the distribution system increases and the steam plant's automatic controls send a "stop" signal to the clear well pump(s); the level in the clear well drops to the low water cut-off point; or a high or low pressure signal is sensed in the clear well pump(s) discharge line(s).

The pressure switch at each clear well pump will also be used to indicate high pressure in the discharge line in case the Cla-Val back pressure control valve fails or a butterfly valve is left closed. The switch will transmit a signal back to the steam plant via the PLC and an indicator light will illuminate at the steam plant.

During normal operation, Geraghty & Miller anticipates that the overflow line from the clear well will be handling between 0 and 2,300 gpm. The overflow weir is designed to handle a maximum flow of 4,500 gpm and the overflow design ensures that in the event of a clear well pump failure the clear well will not flood. The clear well will also be fitted with two emergency level control setpoints: (1) a low-low water cutoff to shut down the clear well pumps in case the primary low level sensor fails and thus prevent operation of the distribution pumps below the minimum allowable pump submergence; and (2) a high water level setpoint to shut down the extraction well pumps in case the clear well overflow discharge line is clogged.

The air flowing through the air stripper will be drawn from near ground level through the air inlet port on the air stripper and into the VPGAC system. The air blower on the VPGAC skid will provide the suction head necessary to induce air flow through the air stripper. The vapors from the stripper will be treated and then discharged to the atmosphere at the top of the air stripping tower. The VPGAC skid will be controlled as a separate system, and interlocks and integration with the rest of the treatment plant will be provided by the central control panel PLC. During normal operation, the VPGAC system will be controlled, regenerated, and cycled by the VPGAC system control panel.

Manual overrides will be provided to allow independent, manned operation of the treatment system components during start-up, maintenance, and trouble-shooting activities. Most alarms and interlocks will be suspended during manual operation of system components.

Monitoring

Flow meters and flow recorders (30-day circular charts) will be provided at each extraction well to monitor flow rates, indicate low flow conditions, indicate alarms, and allow adjustment of flow control valve settings. This equipment will help ensure that the proposed pumping rate is maintained at each of the well pumps. A flow meter and flow totalizer will also be provided at the air stripper inlet and at the condensate return line to monitor flow rates and total throughput at these points in the system. A flow meter and flow recorder (30-day circular chart) will also be provided at the distribution end of the clear well pumps to monitor flow into the Facility water distribution system. Additionally, the weir overflow will include an ultrasonic flow element that will measure the depth of the flow over the weir and convert the depth to an instantaneous flow rate. This flow metering device will also totalize flow over the weir.

The VPGAC system will be pre-wired as a separate skid-mounted system with internal process-related controls to monitor and control skid-related operations. Adjustable timers will be used to sequence the regeneration of the carbon beds; pressure switches will be used to monitor steam and condensate cooling water pressure and ensure that they are adequate. Level switches will control the operation of the condensate and product pumps. The effectiveness of the heat exchanger will be monitored with a thermocouple downstream of the heat exchanger; and a pressure switch will be used to ensure that the system blower is operational. A separate VPGAC skid PLC will integrate operation of the skid-mounted devices and will provide an alarm signal to the main control panel in the event of *any* alarm or failure condition on the VPGAC skid.

Alarms and Interlocks

The extraction wells, air stripper, VPGAC system, and clear well pumps will be interlocked and alarmed to ensure that the water is properly treated, that hydraulic control is maintained in the formation, and that the air is treated before discharge. The system interlocks will include the following:

- The extraction wells will be designed to run continuously in order to maintain a hydraulic barrier in the aquifer. If any one or more of the well pumps fail, based on flow or pressure, a failure signal will be generated and immediate attention will be given to the failed component. Well pump failure will not shut down the entire system.

- If the air stripper shuts down due to high water in the sump, the entire treatment plant and all three well pumps will shut down.

- Any failure or alarm condition on the VPGAC skid will lead to a complete system shutdown. These failures include the following:

  - Blower failure.
  - Low steam pressure or flow.
  - Low temperature in the heat exchanger.
  - Condensate return pump failure.
  - High product or condensate level in the product or condensate storage tanks.
  - Condensor cooling water pump failure.
  - Desorption cycle failure.

- The pump that sends the condensate return to the air stripper will not operate unless the well pumps are operating.

- The clear well pumps will operate only if there is adequate water in the clear well and if the remote switch in the steam plant is in the "hand" position or in the "auto" position. If the remote switch is in the "auto" position, there must also be a demand for water in the Facility distribution system.

- Flow rates or operating conditions at various points in the system not within normal operating ranges (pressure and flow) will trigger alarms or shutdown conditions as described previously.

- A high water condition in the clear well will shut down the well pumps.

- A low water condition in the clear well will shut down the clear well pumps.

The control system is defined in the 90% Construction Drawings and Draft Technical Specifications.

System Start-Up Control Sequence

After any system shut-down occurs, the system will require a manual restart. This manual reset procedure will involve a series of steps that the PLC will sequence to restart the system. The steps that would be programmed for execution include the following:

1. VPGAC and regeneration equipment is on-line and operating within design parameters.
2. Steam is available at sufficient quantity and pressure for VPGAC regeneration.
3. Air stripper is on-line and operating within design parameters.
4. Well pumps are on-line and operating within design parameters.
5. Water level in the clear well is adequate for distribution pumping.
6. Clear well pump controls at the steam plant are in the "hand" or "auto" position.

The start-up sequence will be further defined in the system operations and maintenance plan.

AIR PERMIT

An air permit application for the groundwater IRM treatment system was filed with the NCDOH on January 3, 1996. A copy of the permit application is included in Appendix D of this design report. The permit application is presently under review and Grumman anticipates comments shortly.

REFERENCES

Geraghty & Miller, Inc. 1994. Remedial Investigation Report, Grumman Aerospace Corporation, Bethpage, New York.

Geraghty & Miller, Inc. 1995a. Letter to A. Gibson, Grumman Aerospace Corporation, Bethpage, New York, re: RAs.

Geraghty & Miller, Inc. 1995b. Letter from A. Barber to J. Barnes, Grumman Aerospace Corporation, Bethpage, New York, re: Modification of Interim Remedial Measure. July 20, 1995

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Geraghty & Miller, Inc. 1995d. Groundwater Modeling, Grumman Aerospace Corporation, Bethpage, New York.

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Geraghty & Miller, Inc. 1995f. Letter to J. Barnes, New York State Department of Environmental Conservation, Albany, New York. November 30, 1995.

New York State Department of Environmental Conservation (NYSDEC) Division of Air Resources. 1991. Draft New York State Air Guide-1. 1991 Edition.

New York State Department of Environmental Conservation (NYSDEC). 1995. Letter from J. Barnes to A. Gibson. July 31, 1995.

U.S. Geologic Survey. 1979. Amityville, Freeport, Hicksville, Huntington, New York Quadrangle.

TABLES

Table 1. Design Groundwater Volatile Organic Compound Concentrations, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Constituent	ONCT-1 (1,000 gpm) (ug/L)*	ONCT-2 (600 gpm) (ug/L)*	ONCT-3 (700 gpm) (ug/L)*	Flow-Weighted Av. (ug/L)
Trichloroethene	16,000	1,000	1,000	7,520
Tetrachloroethene	500	700	700	615
1,2-Dichloroethene	500	200	200	330
1,1-Dichloroethene	500	100	100	275
1,1,1-Trichloroethane	500	200	200	330

IRM	Interim remedial measure.
gpm	Gallons per minute.
ug/L	Micrograms per liter.
Av.	Average.
*	Estimates based on available hydrogeologic and constituent data upgradient and downgradient of the extraction wells.

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Table 2. Air Stripping Tower Design Concentrations, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Constituent	Flow-Weighted Groundwater Concentrations(1) (2,300 gpm) (ug/L)	Condensate Stream (2) (0.5 gpm) (ug/L)	Air Stripper Design Influent (ug/L)	Effluent Limit (3) (ug/L)	Design Stripper Removal Efficiency (%)
Trichloroethene	7,520	1,100,000	7,760	2.5	99.97
Tetrachloroethene	615	150,000	650	2.5	99.61
1,2-Dichloroethene	330	6,300,000	1,700	2.5	99.85
1,1-Dichloroethene	275	2,250,000	770	2.5	99.67
1,1,1-Trichloroethane	330	1,500,000	660	2.5	99.62

IRM	Interim remedial measure.
gpm	Gallons per minute.
ug/L	Micrograms per liter.
(1)	Refer to Table 1.
(2)	Stream produced by a vapor phase granular activated carbon (VPGAC) system during regeneration cycle. Values obtained from "Practical Techniques for Groundwater and Soil Remediation" by Evan K. Nyer, 1993, Table 3-1, page 49.
(3)	Values represent one-half the New York State guidelines for drinking water.

Table 3. System Design Parameters, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Extraction Well ONCT-1

A. Well Characteristics

Static water level:	45 ft. bls.
Dynamic water level:	95 ft. bls.
Well casing diameter:	16 in.
Top of screen:	405 ft bmsl.
Screen interval:	60 ft.
Screen diameter:	8 in.
Depth:	465 ft bmsl.

B. Pump Characteristics

Type:	Vertical shaft turbine.
Diameter:	10 in.
Design flow:	1,200 gpm.
IRM flow:	1,000 gpm.
Maximum Required TDH:	220 ft.
Pump set at:	120 ft. bls.
HP:	100
Number of stages:	5
Make of motor:	U.S. motor.
RPM:	1770
Manufacturer:	Floway Pumps.
Model #:	12DKH

Extraction Well ONCT-2

A. Well Characteristics

Static water level:	45 ft. bls.
Dynamic water level:	95 ft. bls.
Well casing diameter:	16 in.
Top of screen:	405 ft bmsl.
Screen interval:	60 ft.
Screen diameter:	8 in.
Depth:	465 ft bmsl.

B. Pump Characteristics

Type:	Vertical shaft turbine.
Diameter:	10 in.
Design flow:	1,200 gpm.
IRM flow:	600 gpm.
Maximum Required TDH:	210 ft.
Pump set at:	120 ft. bls.
HP:	100
Number of stages:	5
RPM:	1770
Manufacturer:	Floway Pumps.
Model #:	12DKH

See last page for footnotes.

Table 3. System Design Parameters, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Extraction Well ONCT-3

A. Well Characteristics

Static water level:	45 ft. bls.
Dynamic water level:	95 ft. bls.
Well casing diameter:	16 in.
Top of screen:	405 ft bmsl.
Screen interval:	60 ft.
Screen diameter:	8 in.
Depth:	465 ft bmsl.

B. Pump Characteristics

Type:	Vertical shaft turbine.
Diameter:	10 in.
Design flow:	1,200 gpm.
IRM flow:	700 gpm.
Maximum Required TDH:	217 ft.
Pump set at:	120 ft. bls.
HP:	100
Number of stages:	5
RPM:	1770
Manufacturer:	Floway Pumps.
Model #:	12DKH

Air Stripper

Number of units:	1
Diameter:	10.2 ft.
Tower height:	64 ft.
Hydraulic loading:	28.2 gpm/ft2.
Water temperature:	50° to 60° F
Air/water ratio:	30:1
Packing material depth:	50 ft
Packing material size::	3 1/2 in. dia.
Packing material type:	Jaeger Tripack.
Material of construction:	Aluminum.

Air Stripper Blower

Number of units:	1
Air flow rate:	9,225 scfm.
Static water pressure:	9 in. of water.
Static pressure (VPGAC duct)	23 in. of water.
HP:	75

See last page for footnotes.

Table 3. System Design Parameters, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Regenerable VPGAC

Number of units:	1
Number of adsorbers:	2
Size of adsorber:	11 ft diameter x 6 ft straight shell.
Skid footprint:	15 ft wide x 40 ft long x 15 ft high.
Air flow rate:	9,225 scfm.
Air temperature:	50° to 60° F
Relative humidity:	100%
Loading rate:	80.8 ppmv.
Removal efficiency:	95%
Type:	Steam Regenerable.
Steam pressure:	15 to 30 psig.
Regeneration cycle:	Every 8 hours (approx.).
Regeneration steam flow:	2,000 lbs/hr maximum.
Cooling water temperature:	50° to 60° F
Cooling water flow:	165 gpm maximum.
Materials of construction:	Hastelloy C w/ titanium carbon support screens.
Carbon weight (lbs/adsorber):	6,200
Carbon type:	Calgon BPL or equal.

Clear Well Pumps

Verticle Turbine Pumps

Number of units:	3
Design flow capacity:	1,500 gpm.
Maximum Required TDH:	174 ft.
HP:	100
Number of stages:	4
RPM:	1770
Manufacturer:	Floway Pumps.
Model #:	14DKIH

Cooling Water Sump Pump

Number of units:	1
Design flow capacity:	165 gpm.
TDH:	54 ft.
HP:	5
Number of stages:	NA
RPM:	1750
Manufacturer:	Crane Demming.
Model #:	4511 - 1 1/2M

Clearwell

Volume:	49,500 gallons.
Retention time:	20 minutes.
Water depth (effective):	10 ft.
Dimensions:	12 ft. deep x 15 ft. x 40 ft.
Gravity overflow:	Sharp-Crested Rectangular Weir.

See last page for footnotes.

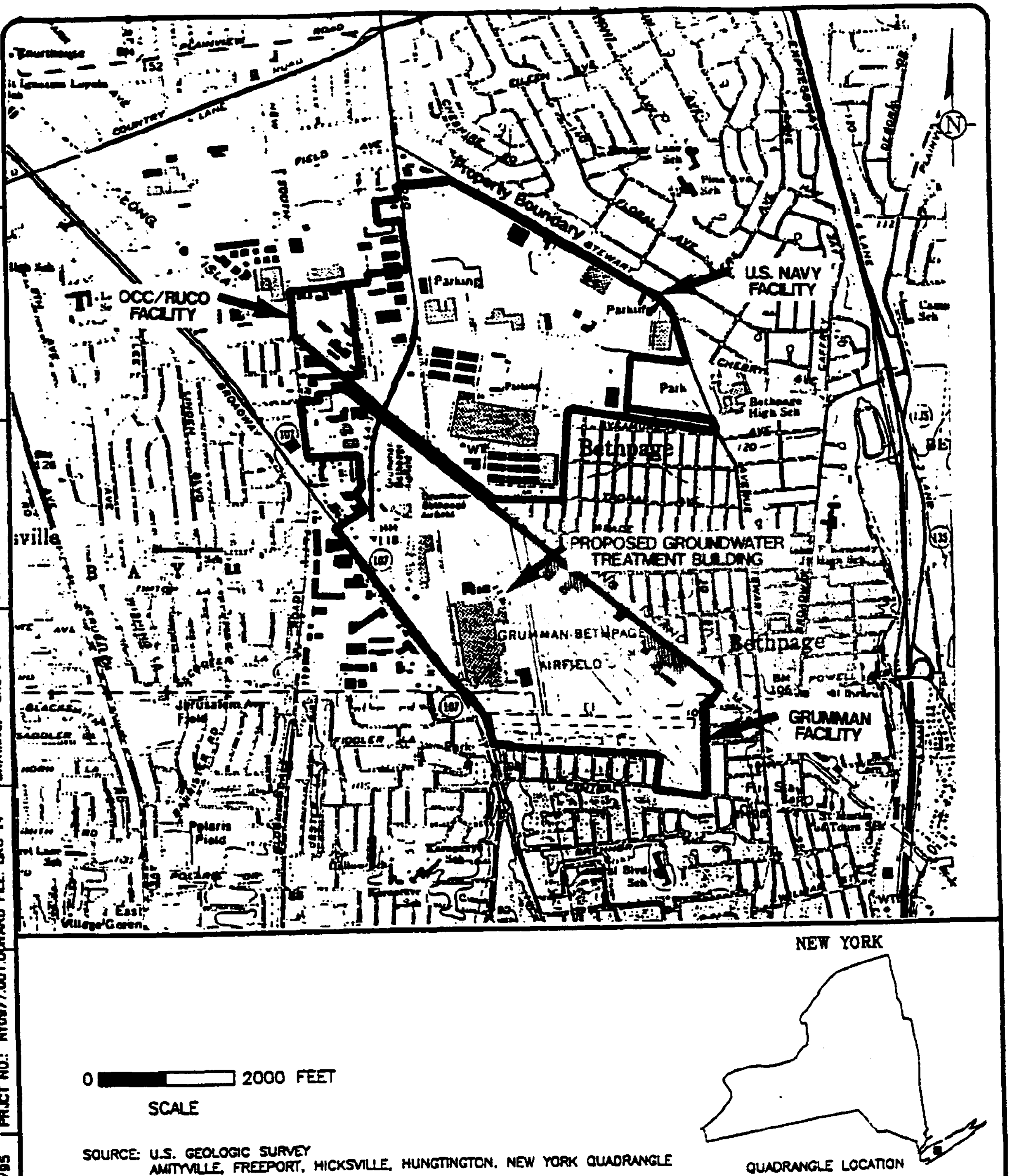
Table 3. System Design Parameters, Groundwater IRM, Grumman Aerospace Corporation, Bethpage, New York.

Piping	
Material:	Ductile iron.
Size:	10 and 12 in. diameter.
Joints:	Tyton type; flanged and mechanical, restrained as needed. 250 psi pressure rating.
Schedule:	Minimum Class 52, 250 psi pressure rating.
Valves	
Material:	Ductile iron.
Size:	To match pipe dimensions.
Joints:	Mechanical and flanged.
Type:	Pressure relief valve, gate valve, check valve, butterfly valve, pump control valves as needed, 250 psi pressure rating.
Make and Model:	Cla-Val, Mueller, Crane, or equal.

IRM	Interim remedial measure.
ft. bmsl	Feet below mean sea level.
ft. bls	Feet below land surface.
gpm	Gallons per minute.
gpm/ft^2	Gallons per minute per square feet.
ppmv	Parts per million in volume.
acfm	Actual cubic feet per minute.
cfm	Cubic feet per minute.
in.	Inches.
dia.	Diameter.
°F	Degrees Fahrenheit.
hrs	Hours.
lbs	Pounds.
lbs/hr	Pounds per hour.
TDH	Total dynamic head.
HP	Horsepower.
RPM	Rotations per minute.
VPGAC	Vapor phase granular activated carbon.
psig	Pounds per square inch gauge.
PLC	Programmable logic controller.

FIGURES

DRAFTER: A. KINOSIAN | APPROVED: F. LENZO | CHECKED: A. OBEID | DRAWING: GRU-14 | HARD FILE: GRU-14 | PRJCT NO.: NY0977.001.00 | DWG DATE: 10/24/95



SOURCE: U.S. GEOLOGIC SURVEY
AMITYVILLE, FREEPORT, HICKSVILLE, HUNGTINGTON, NEW YORK QUADRANGLE

GERAGHTY
& MILLER, INC.
Environmental Services
A Heidemij Company

SITE LOCATION

GROUNDWATER INTERIM REMEDIAL MEASURE

GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK

FIGURE
1

APPENDIX A

APPENDIX A

RESPONSE TO NYSDEC COMMENTS ON 35% DESIGN

APPENDIX A

RESPONSE TO NYSDEC COMMENTS ON 35% DESIGN

The following comments were provided to Grumman by the NYSDEC in a correspondence addressed to John Ohlman (Grumman) from John D. Barnes (NYSDEC) dated December 5, 1995. The comments are repeated below followed by Geraghty & Miller's, response to each comment.

Comment #1: Page 13: Has the local sewer district been notified regarding potential discharges to the sewer system?

Response to Comment #1: Groundwater from the treatment system will be directed either to Grumman's cooling water distribution system or to Grumman's on-site storm sewer collection system and will be ultimately discharged to the south recharge basin. We do not anticipate any discharges to the municipal sanitary sewer and have not included any connections to the municipal sewer system.

Comment #2: Table 2: Please provide the data used to estimate the condensate stream VOC concentrations.

Response to Comment #2: Please refer to the footnotes on Table 2 of the 90% Design Report.

Comment #3: Table 3 and Plan P1: In comparing the conditions in Stream J to those in Stream K, there is a slight increase in temperature (20R) and pressure (0.65 psig). Considering that P_l/T_l is approximately equal to P_x/T_x and that the volumeric flow rate is nearly the same in both streams, where does the difference in the TVOC concentrations come from (80.5 ppm vs 44 ppm)? The TVOC concentrations should be the same in both of these streams.

Response to Comment #3: The TVOC concentrations should be the same for Streams J and K. The Process Flow Diagram (P1) and Table 3 have been updated and corrected to be consistent.

Comment #4: Table 3 and Plan P1: Some of the operating conditions presented in Table 3 do not match those shown on Plan P1. For example, the operating temperature of the VPGAC units is given to be 50°F in Table 3, but on Plan P1 it is given to be 75 °F.

Response to Comment #4: The Process Flow Diagram (P1) and Table 3 have been updated and corrected to be consistent. P1 has also been revised to include additional

data on the flowstream conditions. Because the air and water temperatures will vary over the course of operation, slight inconsistencies in temperature will exist, therefore P1 lists discrete temperatures within the expected range and Table 3 lists the full range.

Comment #5: Plan P1: The Organic Mass Balance Table must be revised in order to make it clearer to the reviewer what is actually intended. For example, Stream R (as we understand) is only to be used during start-up and maintenance activities. This needs to be stated on this drawing. Show Stream R NC, and is only used for above mentioned reason.

Response to Comment #5: P1 has been modified to include additional information and clarifications.

Comment #6: Plan P1: Please provide the mass transfer data used to size the air stripping tower.

Response to Comment #6: The mass transfer data for the air stripping tower is summarized in Appendix C of the 90% Design Report.

Comment #7: Plan P1: What type of separator/condenser unit(s) is contemplated?

Response to Comment #7: The condenser will be designed and selected by the VPGAC vendor to suit the heat exchange demands of the VPGAC system. Based on discussions with various vendors, the condenser is typically a type or a plate and frame dual crossflow block type exchanger. A gravity decanter will be used to separate the product and water after the condenser.

Comment #8: Plan P1: For completeness, the stream exiting the separator/condenser should be labelled, and the stream conditions (e.g. - temperature) must be provided.

Comment #9: Plan P1: What is the flow rate and composition of the liquid phase product stream exiting the separator/condenser? This stream should also be labelled.

Response to Comments #8 and #9: The streams leaving the VPGAC system have been further defined in P1. The product and condensate streams are defined. Please note that average flows and organic loads are presented in P1 for several of the streams.

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APPENDIX B

APPENDIX B

INFLUENT PIPELINE HYDRAULIC CALCULATIONS

GERAGHTY & MILLER, INC.
Environmental Services
A **Heidemij** Company

SUBJECT: Hydraulic Calcs
PROJECT: Grumman IRM
CLIENT/PROJECT NO: NY0089 77.001.001

BY: BO'D DATE: 1/9/96
CHKD: Kumar DATE: 1/18/96
REV: DATE:

PAGE 5

SHEET 5/8

SUMMARY

ASSUMES THE FOLLOWING

- 10" DIP FROM EACH WELL HOUSE TO FP-1 OR BY-PASS
- 12" DIP FROM EACH WELL TO Air Stripper
- 1,200 gpm is Evaluated to the By-Pass Alone, Not to the Top of Air Stripper. (Should be OK. Though)
- BY-PASS LINE LOSSES ASSUMES 3,600gpm
- FP-1 LINE LOSSES ASSUMES 2,300gpm
- TDH WILL EQUAL OUTLET PRESSURE FROM CLA·VAL

WELL	CLEAR WELL 3,600gpm			AIR STRIPPER 2,300gpm		
	H_F	H_S	TDH	H_F	H_S	TDH
ONCT-1 (1,200gpm) (1,000gpm)	90' ✓	104' ✓	194' ✓ 84 psi	51' ✓	169' ✓	220' ✓ 95 psi
ONCT-2 (1,200gpm) (600gpm)	94' ✓	98' ✓	192' ✓ 83 psi	47' ✓	163' ✓	210' ✓ 91 psi
ONCT-3 (1,200gpm) (700gpm)	111' ✓	98' ✓	209' ✓ 90 psi	54' ✓	163' ✓	217' ✓ 94 psi

- PRESSURE RANGE IN PIPE LINE TO BE BETWEEN 80 & 95 ✓ PSI FROM CLA-VAL UPGRADIENT

- PRESSURE RANGE AT WELL HEAD TO BE BETWEEN 105 PSI & 160 PSI ✓

GERAGHTY
& MILLER, INC.
Environmental Services
A Heidemij Company

SUBJECT: Hydraulic Calcs
PROJECT: Grumman IRM NY0977.001.001
CLIENT/PROJECT NO:

BY: BO'D DATE: 1/9/96
CHKD: Kumar DATE: 1/18/96
REV: DATE:

PAGE 1
SHEET 1

Assume Use of 10" Pipe Between Well house & Main Lines

Equivalent Pipe Length In Each Well house

Step

1- CLA-val 10"

5- ELLs - 14.0(5) = 70'

1- Orifice Plate Flow Meter - See Below 50'

1- Butterfly Valve 36' ≃ 40'

Orifice Plate

$\beta = \frac{d_1}{d_2}$ $d_2 = 10"$
d_1 = assume 4.5" $\beta = 0.45$

$C = \frac{C_d}{\sqrt{1-\beta^4}}$ $C_d = 0.62$ Lindeburg

$C = \frac{0.62}{\sqrt{1-(0.45)^4}} = 0.633$ ✓ Crane

$K_{orifice} \simeq \frac{1-(0.45)^2}{(0.633)^2(0.45)^4} = 48.5$ SAY = 50'

For CLA-VAL @ 1200gpm $\Delta p = 1.2$ psi
@ 1000 gpm $\Delta p = 1.0$ psi
@ 700 gpm $\Delta p = 0.5$ psi
@ 600gpm $\Delta p = 0.37$ psi

assumes valve is 80% Full.

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SUBJECT: Hydraulic Calcs.
PROJECT: Grumman IRM
CLIENT/PROJECT NO: NY0977.001.001

BY: BO'O DATE: 1/9/96
CHKD: Kumar DATE: 1/18/96
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PAGE 2
SHEET 1

CLA-VAL senses Inlet Pressure

Self Regulating - System Back Pressure
Acts as Back Pressure Regulating Valve Inlet Pressure will be that required to maintain Flow From Pump. Outlet Pressure will be regulated to that required to push the water through the system i.e. head loss.

COMPUTE STATIC & DYNAMIC HEAD LOSSES FOR EACH WELL PUMP

(H_S) Static Head = Change In Water Surface Elevation.
(H_F) Friction Head = Friction Losses through pipe & Fittings

$$H_F = \frac{4.73 * Q^{1.85} \times L}{C^{1.85} D^{4.87}}$$

Where:
C = Hazen Williams Coeff (Cast Iron Assume 120 5yrs Old) CE Handb.
D = varies (10") (12") (16") (inFt)
Q = varies (1200gpm, 448.83gpm = 1CFS
L = varies (Ft)

For 10" Pipe
$H_F = 0.001669 Q^{1.85} L$
For 12" Pipe
$H_F = 0.0006736 Q^{1.85} L$

For ONCT-1

.010294

	Eg. Pipe L.	HE	1000gpm
Well House	20'	0.21'	0.15
Valves & Fittings	160'	1.65'	1.17'
CLA-Val		2.77'	2.31
		4.63	3.63

4.63 SAY 5' H_L In Well House @ 1200gpm

3.63 SAY 4' @ 1,000gpm.

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SUBJECT: Hydraulic Calcs
PROJECT: GRUMMAN IRM
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PAGE 3

SHEET 1

$$H_f = \frac{(10.44)(\overset{ft}{L})(\overset{gpm}{Q})^{1.85}}{(C)^{1.85}(\underset{in}{D})^{4.87}}$$

Line From Well House to 12" By-Pass Line

$C = 120$, $D = 10"$ $H_f = 2.00546 \times 10^{-8} LQ^{1.}$

$D = 12"$ $H_f = 8.25282 \times 10^{-9} LQ^{1.}$

10" Line 745 LF		745'
(3) 90° ELLS	(12')	36'
(1) Flow Thru Tee 10x12		5' not in FP-1 Line
(1) Gate valves	(3)	3'

Total Equivalent Pipe Length to 12" Main Line. 789'

$H_f = (2.00546 \times 10^{-3})(789)(1200)^{1.85} = 7.9ft$

$H_F = 0.001669\left(\frac{1200}{448.83}\right)^{1.85}(789) = 8.1'$ SAY 8' @ 1200 gpm

$H_F = 0.001669\left(\frac{1000}{448.83}\right)^{1.85}(789) = 5.8'$ SAY 6' @ 1000 gpm

(Approximately Same Eq. Pipe Length)

From Entrance to 12" BP to Clear Well

Q = 3600 gpm Here 3x1,200

Exit Loss Assume (to Clear well)		80'
2-90° ELLS	(15')	30'
3-45° ELLS	(10')	30'
2-Flow thru Tees	(5')	10'
Pipe Length		2270'

Total Equivalent Pipe Length 2420'

$H_F = 0.0006736\,(8.00)^{1.85}(2420) = 76.4'$ SAY 77'

H_F to Clear Well $= 77 + 8 + 4 \cong \underline{90'}$ to bypass

G&M Form 30 6-89

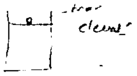
Southprint 95-0070

GERAGHTY & MILLER, INC.
Environmental Services
A Heidemij Company

SUBJECT: Hydraulic Calcs.
PROJECT: Grumman IRM
CLIENT/PROJECT NO: NY0977.004.001

BY: BOD DATE: 1/17/96
CHKD: Kumar DATE: 1/18/96
REV: DATE:

PAGE 4
SHEET 1



H_S = -WL in well + WL in Clearwell

$H_S = (-7) + 110.75 = 103.75$ SAY 104'

Total Dynamic Head (ONCT-1) = $H_S + H_F$ = 90 + 104 = 194' To bypass

104 90

ONCT-1 (to Air Stripper)

Exit Loss		80'
(5) 90° Into & Out of the Building	(5)(15)	75'
(5) 90° Into the Air Stripper	(5)(15)	75
(1) Branch Tees	(2) (34)	68'
(3) 45° ELLs	(3)(10)	30'
(1) Flow Meter (SAY)	(1)(100)	100'
(1) Check Valve	(1)(120)	120'
Pipe Length to Building		2,270
-Into Building to Top Air Stripper		110'

Total Equivalent Pipe Length = 2,928'

12" Main Line Q = 2,300 gpm

$H_F = 0.0006736\left(\frac{2,300}{448.83}\right)^{1.85}(2,928) = 40.53'$ SAY 41'

Total H_F = 41 + 6' + 4' = 51'

H_S = -WL in well + WL in Air S.

$H_S = (-7) + 175.5 = 168.5'$ SAY 169'

Total Dynamic Head = $H_S + H_F$ = 51' + 169' = 220' FP-1

SUBJECT: Hydraulic Calcs
PROJECT: Grumman IRM
CLIENT/PROJECT NO: NY00977.001.007

BY: B O'D DATE: 1/9/96
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PAGE 5
SHEET 1

ONCT-2

Well House		H_F	@ 600gpm .0028555
Pipe	20'	0.21	0.06'
Valves & Fittings	160'	1.65	0.46'
Cla-Val		2.77	0.86'
		4.63	1.38

@ 1200gpm Losses = 5.0'
@ 600gpm Losses = 2.0'

Line From Well House To By-pass Line

10" Line		1080'
(2) 45° ELL'S	9'	18'
(2) Branch Tees	30'	60'
(1) 90° ELL	12'	12'
(1) Gate Valve	3'	3'
		1173'

@ 1200 gpm

$$H_F = 0.001669\left(\frac{1200}{448.83}\right)^{1.85}(1173) = 12.07' \text{ SAY } 12'$$

@ 600 gpm (Approximately Same Eq. Pipe Length)

$$H_F = 0.001669\left(\frac{600}{448.83}\right)^{1.85}(1173) = 3.34' \text{ SAY } 4'$$

ONCT-2 (to Clear Well)

Assume Same H_F as ONCT-1 For By-pass or 77'

in well hse

Total H_F = 5' + 12' + 77' = 94'

SUBJECT: Hydraulic Calcs
PROJECT: Grumman IRM
CLIENT/PROJECT NO: NY00977.001.001

BY: BO'D DATE: 1/9/96
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PAGE 6
SHEET 1

H_S = - WL In Well + WL In Clear Well

H_S = -13 + 110.75 = 97.75 SAY 98'

Total Dynamic Head (ONCT-2) = $H_S + H_F$ = 94' + 98' = 192' To By-Pass

ONCT-2 (to Air Stripper)

Approx, Same as H_F For ONCT-1 = 41'

Total H_F ONCT-2 (to Air Stripper) = 41' + 2' + 4' = 47'

H_S = -13 + 175.5 = 162.5' SAY 163'

Total Dynamic Head to (Air Stripper) = 47' + 163 = 210' to Air Stripp

ONCT-3

Well House		H_F	@ 700gpm
Pipe	20'	0.21	0.08'
Valves & Fittings	160'	1.65'	0.61'
Cla-Val		2.77'	1.15'
		4.63'	1.84'

@ 1200 gpm Losses = 5.0'

@ 700 gpm Losses = 2.0'

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Environmental Services
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SUBJECT: Hydraulic Calc's
PROJECT: Grumman IRM.
CLIENT/PROJECT NO: NY00977.001

BY: BO'D DATE: 1/9/96
CHKD: Kumar DATE: 1/18/96
REV: DATE:

PAGE 7
SHEET 1

Line From Well House to By-Pass Line (10" Line)

(4)	90° ELLs	12'	48'
+(1)	45° ELL @ 6400	9'	9'
(2)	Branch Tees	30'	60'
(1)	Gate Valve	3'	3'
	Pipe Length		2670'
			2,790'

@ 1200gpm

$$H_F = 0.001669\left(\frac{1200}{448.83}\right)^{1.85}(2,790') = 28.7' \text{ SAY } 29'$$

@ 700gpm (Approx. Same Eq. Pipe Length)

$$H_F = 0.001669\left(\frac{700}{448.83}\right)^{1.85}(2790) = 10.6' \text{ SAY } 11'$$

ONCT-3 (to CLEAR WELL)

Approx. Same H_F as ONCT-1 & 2 For By-pass or 77'

Total H_F (to CLEAR WELL) = 77' + 29' + 5' = 111'

H_S = − WL in well + WL in Clear Well

Same as ONCT-2 OR 98'

TOTAL DYNAMIC HEAD
ONCT-3 to CLEAR WELL $H_S + H_F = 111' + 98' = \underline{\underline{209'}}$

G&M Form 30 6-89

Southprint 95-0070

GERAGHTY & MILLER, INC.
Environmental Services
A Heidemij Company

SUBJECT: Hydraulic Calcs
PROJECT: Grumman IRM
CLIENT/PROJECT: NO: NY0977.001.001

BY: BGD DATE: 1/9/96
CHKD: Kumar DATE: 1/18/96
REV: DATE:

PAGE 8
SHEET 1

ONCT-3 (to Air Stripper)

Approx. Same H_f as For ONCT-1 & 2 $= 41'$

Total H_F For ONCT-3 (to Air Stripper)

$H_F = 41' + 11' + 2' = 54'$

H_S = Same as ONCT-3 $= 163'$

Total Dynamic Head - ONCT-3 (to Air Stripper)

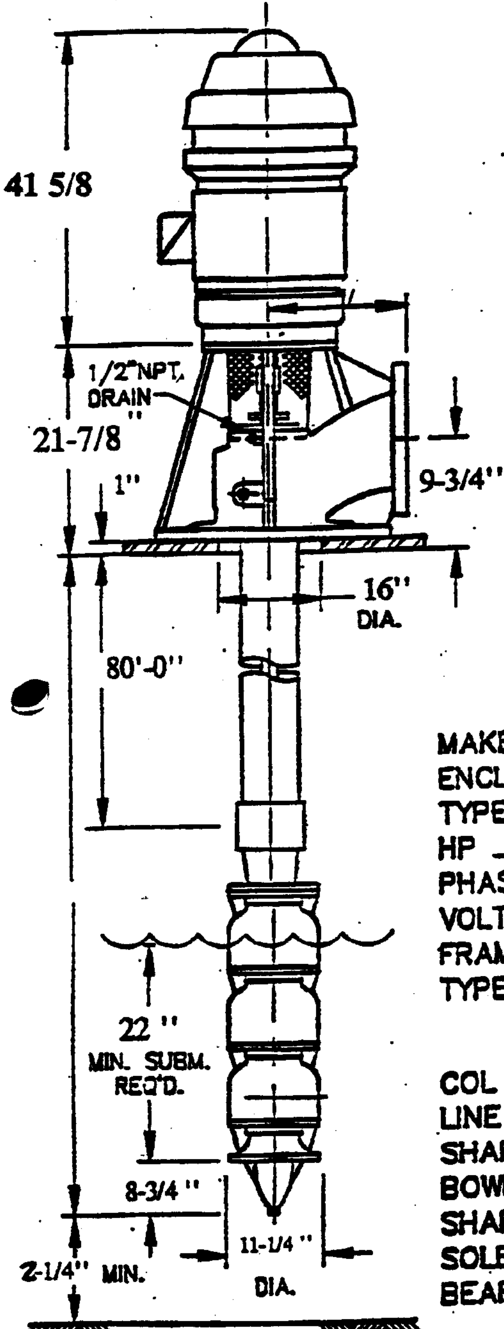
$163' + 54' = \underline{\underline{217'}}$

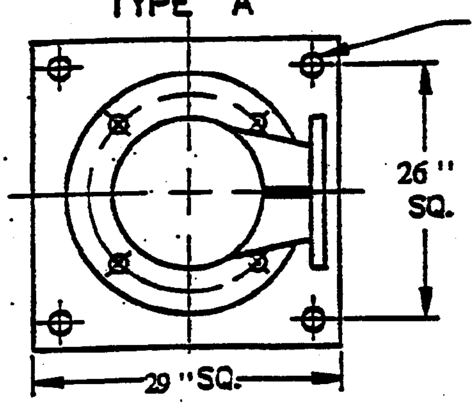
D-1084-E

Peabody Floway

VERTICAL TURBINE PUMP

TYPE "A"





GPM	HEAD	EFF.
1200.	250	83
1000	305	79
800	335	70.50
600	370	59
0	455	N/A

DISCHARGE

8" 250 # ANSI—F.F. FLG.
(12) - 1" DIA. HOLES *
13" DIA. BOLT CIRCLE
15" DIA. FLANGE
* BOLT HOLES STRADDLE VERTICAL ℄

MOTOR (WP-1)

MAKE U.S. MOTORS, HI EFF.
ENCLOSURE
TYPE VHS NRR YES
HP 100 RPM 1780
PHASE 3 HERTZ 60
VOLTAGE 230-460
FRAME NO.
TYPE COUPLING THREADED

PUMP

8X16 1/2 "A" C.I. DISCH HD.
1-1/2" LINE SHAFT 8" COL
N/A SHAFT TUBE
PROD.LUBE XX OIL LUBE
TYPE 12 DKH STAGE 5
GPM TDH SEE ABC TABLE
IMPELLER ENCLOSED
STRAINER NO

MATERIAL

COL PIPE SCH.40 STEEL
LINE SHAFT A582 - 416 S.S.
SHAFT TUBE N/A
BOWL SHAFT A582-416 S.S.
SHAFT PACKING J.C. # 1340
SOLE PLATE A36-STEEL
BEARING RETAINER DUCTILE IRON

PUMP BOWL A48CL.30 C.I.E.
IMPELLER B584-838 BRONZE
BEARINGS (BOWL) B505-844 BRZ
BEARINGS (LINESHAFT) NEOPRENE
STRAINER N/A
BOWL W/R BRONZE
IMPELLER W/R

REMARKS

NO. UNITS REQ'D 3
- BRONZE WEAR RINGS
- 316 STL STL COLLETS
- 316 STL STL BOLTING
- 416 STL STL O.L.S.
- 416 STL STL COUPLINGS
- MACHINED SOLE PLATE
- OSHA COUPLING GUARD

FLUID H2O
SPEC. GRAVITY 1.0
VISCOSITY
TEMPERATURE
PH

CUSTOMER
ORDER NO.
SUPPLIER QUIMBY EQUIPMENT CO.,INC.
PLAINVIEW, NEW YORK
DWG. NO.
SERIAL NO.

NOT TO BE USED
FOR CONSTRUCTION

PUMP NO.: ONCT-1,2 & 3

Functional Data

Model 100 -04

Valve Size		Inches	4	6	8	10	12	14	16
		mm	100	150	200	250	300	350	400
C_v Factor	Globe Pattern	Gal/Min	200	460	770	1245	1725	2300	2940
		Litres/Sec	4.81	11.05	18.50	29.91	41.45	55.26	70.64
	Angle Pattern	Gal/Min.	240	541	990	1575	2500	3080*	4200*
		Litres/Sec	5.78	13.03	23.86	37.96	60.25	73.75	101.22
Equivalent Length of Pipe	Globe Pattern	Feet	106	170	255	316	407	377	462
		Meters	32.30	51.81	77.72	96.31	124.1	114.9	140.8
	Angle Pattern	Feet	74	123	154	197	194*	213*	226*
		Meter	22.55	37.49	46.93	60.04	59.13	64.92	68.88
K Factor	Globe Pattern		6.8	5.7	6.1	5.8	6.1	5.0	5.2
	Angle Pattern		4.1	4.1	3.7	3.6	2.9	2.8	2.6
Liquid Displaced from Diaphragm Chamber When Valve Opens		Fl. Oz	—	—	—	—	—	—	—
		US Gal	0.169	0.531	1.28	2.51	4.0	6.5	9.57
		ml	639.7	—	—	—	—	—	—
		L	—	2.0	4.8	9.5	15.1	24.6	36.2

*Estimated

C_v Factor

US System: C_v = US gal/min @1 psi with 60°F water

Metric System: C_v = litres/sec @ 1 kPa with 15°C water

Formulas for computing C_v Factor, Flow (Q) and Pressure Drop (ΔP):

$$C_v = \frac{Q}{\sqrt{\Delta P}} \qquad Q = C_v\sqrt{\Delta P} \qquad \boxed{\Delta P = \left(\frac{Q}{C_v}\right)^2}$$

Where:

C_v = Number of (US gallons/minute) or (liters/second) of fresh water at one (1) (psi) or (Kilopascal) differential.

Q = Flow Rate in (US gallons/minute) or (liters/second) of fresh water.

ΔP = Pressure Drop in (psi) or (kPa).

Equivalent Length of Pipe

Equivalent lengths of pipe are based on data contained in Hydraulics Institute Pipe Friction Manual. In general, this data is for new, clean wrought iron or steel, schedule 40 pipe with no allowance made for age, differences in diameter, or any abnormal condition of the interior surface. For further details, refer to the above manual.

K Factor

The value of K is calculated from the formula: $h = \frac{KV^2}{2g}$

Where:

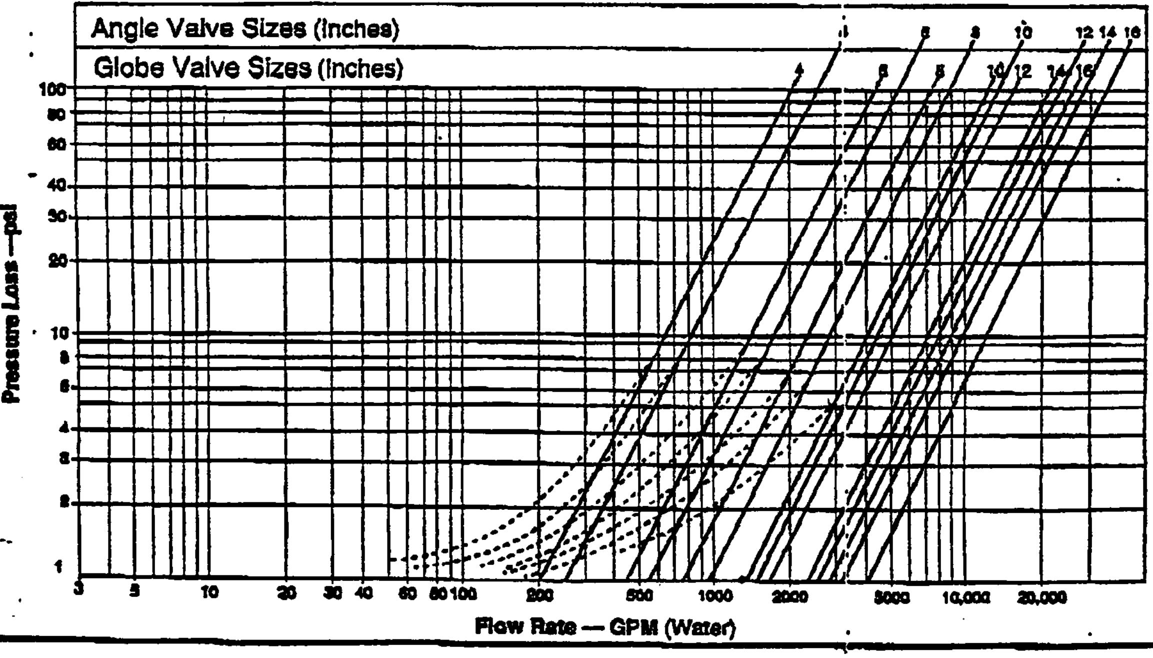
h = Fractional Resistance in (feet/meters) of fluid

v = Average Velocity in (feet/second) or (meters/second) in a pipe of corresponding diameter

g = 32.17 (feet/second/second) or 9.81 (meters/second/second)

K = Resistance Coefficient for valve

Flow Chart-Normal Flow (Based on flow through a wide open valve.)



Appendix L: Equivalent Length of Straight Pipe for Various Fittings (feet)

(turbulent flow only, for any fluid)
c.i. = cast iron

fittings			pipe size																				
			1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12	14	16	18	20	24
regular 90°ell	screwed	steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0										
		c.i.										9.0	11.0										
	flanged	steel			0.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4	5.9	7.3	8.9	12.0	14.0	17.0	18.0	21.0	23.0	25.0	30.0
		c.i.										3.6	4.8		7.2	9.8	12.0	15.0	17.0	19.0	22.0	24.0	28.0
long radius 90°ell	screwed	steel	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.8	4.0	4.6										
		c.i.										3.3	3.7										
	flanged	steel			1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4	4.2	5.0	5.7	7.0	8.0	9.0	9.4	10.0	11.0	12.0	14.0
		c.i.										2.8	3.4		4.7	5.7	6.8	7.8	8.6	9.6	11.0	11.0	13.0
regular 45°ell	screwed	steel	0.34	0.52	0.71	0.92	1.3	1.7	2.1	2.7	3.2	4.0	5.5										
		c.i.										3.3	4.5										
	flanged	steel			0.45	0.59	0.81	1.1	1.3	1.7	2.0	2.6	3.5	4.5	5.6	7.7	9.0	11.0	13.0	15.0	16.0	18.0	22.0
		c.i.										2.1	2.9		4.5	6.3	8.1	9.7	12.0	13.0	15.0	17.0	20.0
tee-line flow	screwed	steel	0.79	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12.0	17.0										
		c.i.										9.9	14.0										
	flanged	steel			0.69	0.82	1.0	1.3	1.5	1.8	1.9	2.2	2.8	3.3	3.8	4.7	5.2	6.0	6.4	7.2	7.6	8.2	9.6
		c.i.										1.9	2.2		3.1	3.9	4.6	5.2	5.9	6.5	7.2	7.7	8.8
tee-branch flow	screwed	steel	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12.0	13.0	17.0	21.0										
		c.i.										14.0	17.0										
	flanged	steel			2.0	2.6	3.3	4.4	5.2	6.6	7.5	9.4	12.0	15.0	18.0	24.0	30.0	34.0	37.0	43.0	47.0	52.0	62.0
		c.i.										7.7	10.0		15.0	20.0	25.0	30.0	35.0	39.0	44.0	49.0	57.0
180° return bend	screwed	steel	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0										
		c.i.										9.0	11.0										
	reg. flanged	steel			0.92	1.2	1.8	2.1	2.4	3.1	3.6	4.4	5.9	7.3	8.9	12.0	14.0	17.0	18.0	21.0	23.0	25.0	30.0
		c.i.										3.6	4.8		7.2	9.8	12.0	15.0	17.0	19.0	22.0	24.0	28.0
	long rad. flanged	steel			1.1	1.3	1.8	2.0	2.3	2.7	2.9	3.4	4.2	5.0	5.7	7.0	8.0	9.0	9.4	10.0	11.0	12.0	14.0
		c.i.										2.8	3.4		4.7	5.7	6.8	7.8	8.6	9.6	11.0	11.0	13.0
globe valve	screwed	steel	21.0	22.0	22.0	24.0	29.0	37.0	42.0	54.0	62.0	79.0	110.0										
		c.i.										65.0	86.0										
	flanged	steel			38.0	40.0	45.0	54.0	59.0	70.0	77.0	94.0	120.0	150.0	190.0	260.0	310.0	390.0					
		c.i.										77.0	99.0		150.0	210.0	270.0	330.0					
gate valve	screwed	steel	0.32	0.45	0.56	0.67	0.84	1.1	1.2	1.5	1.7	1.9	2.5										
		c.i.										1.6	2.0										
	flanged	steel								2.6	2.7	2.8	2.9	3.1	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
		c.i.										2.3	2.4		2.6	2.7	2.8	2.9	2.9	3.0	3.0	3.0	3.0
angle valve	screwed	steel	12.8	15.0	15.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0										
		c.i.										15.0	15.0										
	flanged	steel			15.0	15.0	17.0	18.0	18.0	21.0	22.0	28.0	38.0	50.0	63.0	90.0	120.0	140.0	160.0	190.0	210.0	240.0	300.0
		c.i.										23.0	31.0		52.0	74.0	98.0	120.0	150.0	170.0	200.0	230.0	280.0
swing check valve	screwed	steel	7.2	7.3	8.0	8.8	11.0	13.0	15.0	19.0	22.0	27.0	38.0										
		c.i.										22.0	31.0										
	flanged	steel			3.8	5.3	7.2	10.0	12.0	17.0	21.0	27.0	38.0	50.0	63.0	90.0	120.0	140.0					
		c.i.										22.0	31.0		52.0	74.0	98.0	120.0					
coupling or union	screwed	steel	0.14	0.18	0.21	0.24	0.29	0.36	0.39	0.45	0.47	0.53	0.65										
		c.i.										0.44	0.32										
	bell mouth inlet	steel	0.04	0.07	0.10	0.13	0.18	0.26	0.31	0.43	0.52	0.67	0.95	1.3	1.6	2.3	2.9	3.5	4.0	4.7	5.3	6.1	7.6
		c.i.										0.55	0.77		1.3	1.9	2.4	3.0	3.6	4.3	5.0	5.7	7.0
	square mouth inlet	steel	0.44	0.68	0.96	1.3	1.8	2.6	3.1	4.3	5.2	6.7	9.5	13.0	16.0	23.0	29.0	35.0	40.0	47.0	53.0	61.0	76.0
		c.i.										5.5	7.7		13.0	19.0	24.0	30.0	36.0	43.0	50.0	57.0	70.0
	re-entrant pipe	steel	0.88	1.4	1.9	2.6	3.6	5.1	6.2	8.5	10.0	13.0	19.0	25.0	32.0	45.0	58.0	70.0	80.0	95.0	110.0	120.0	150.0
		c.i.										11.0	15.0		28.0	37.0	49.0	61.0	73.0	88.0	100.0	110.0	140.0

Schedule (Thickness) of Steel Pipe Used in Obtaining Resistance Of Valves and Fittings of Various Pressure Classes by Test*

Valve or Fitting ASA Pressure Classification			Schedule No. of Pipe Thickness
Steam Rating		Cold Rating	
250-Pound and Lower		500 psig	Schedule 40
300-Pound to 600-Pound		1440 psig	Schedule 80
900-Pound		2160 psig	Schedule 120
1500-Pound		3600 psig	Schedule 160
2500-Pound	½ to 6"	6000 psig	xx (Double Extra Strong)
	8" and larger	3600 psig	Schedule 160

*These schedule numbers have been arbitrarily selected only for the purpose of identifying the various pressure classes of valves and fittings with specific pipe dimensions for the interpretation of flow test data; they should not be construed as a recommendation for installation purposes.

Representative Equivalent Length‡ in Pipe Diameters (L/D) Of Various Valves and Fittings

Description of Product				Equivalent Length In Pipe Diameters (L/D)
Globe Valves	Stem Perpendicular to Run	With no obstruction in flat, bevel, or plug type seat	Fully open	340
		With wing or pin guided disc	Fully open	450
	Y-Pattern	(No obstruction in flat, bevel, or plug type seat)		
		– With stem 60 degrees from run of pipe line	Fully open	175
		– With stem 45 degrees from run of pipe line	Fully open	145
Angle Valves		With no obstruction in flat, bevel, or plug type seat	Fully open	145
		With wing or pin guided disc	Fully open	200
Gate Valves	Wedge, Disc, Double Disc, or Plug Disc		Fully open	13
			Three-quarters open	35
			One-half open	160
			One-quarter open	900
	Pulp Stock		Fully open	17
			Three-quarters open	50
			One-half open	260
			One-quarter open	1200
Conduit Pipe Line Gate, Ball, and Plug Valves			Fully open	3**
Check Valves	Conventional Swing		0.5†...Fully open	135
	Clearway Swing		0.5†...Fully open	50
	Globe Lift or Stop; Stem Perpendicular to Run or Y-Pattern		2.0†...Fully open	Same as Globe
	Angle Lift or Stop		2.0†...Fully open	Same as Angle
	In-Line Ball		2.5 vertical and 0.25 horizontal†...Fully open	150
Foot Valves with Strainer		With poppet lift-type disc	0.3†...Fully open	420
		With leather-hinged disc	0.4†...Fully open	75
Butterfly Valves (8-inch and larger)			Fully open	40
Cocks	Straight-Through	Rectangular plug port area equal to 100% of pipe area	Fully open	18
	Three-Way	Rectangular plug port area equal to 80% of pipe area (fully open)	Flow straight through	44
			Flow through branch	140
Fittings	90 Degree Standard Elbow			30
	45 Degree Standard Elbow			16
	90 Degree Long Radius Elbow			20
	90 Degree Street Elbow			50
	45 Degree Street Elbow			26
	Square Corner Elbow			57
	Standard Tee	With flow through run		20
		With flow through branch		60
	Close Pattern Return Bend			50
Pipe	90 Degree Pipe Bends			See Page A-27
	Miter Bends			See Page A-27
	Sudden Enlargements and Contractions			See Page A-26
	Entrance and Exit Losses			See Page A-26

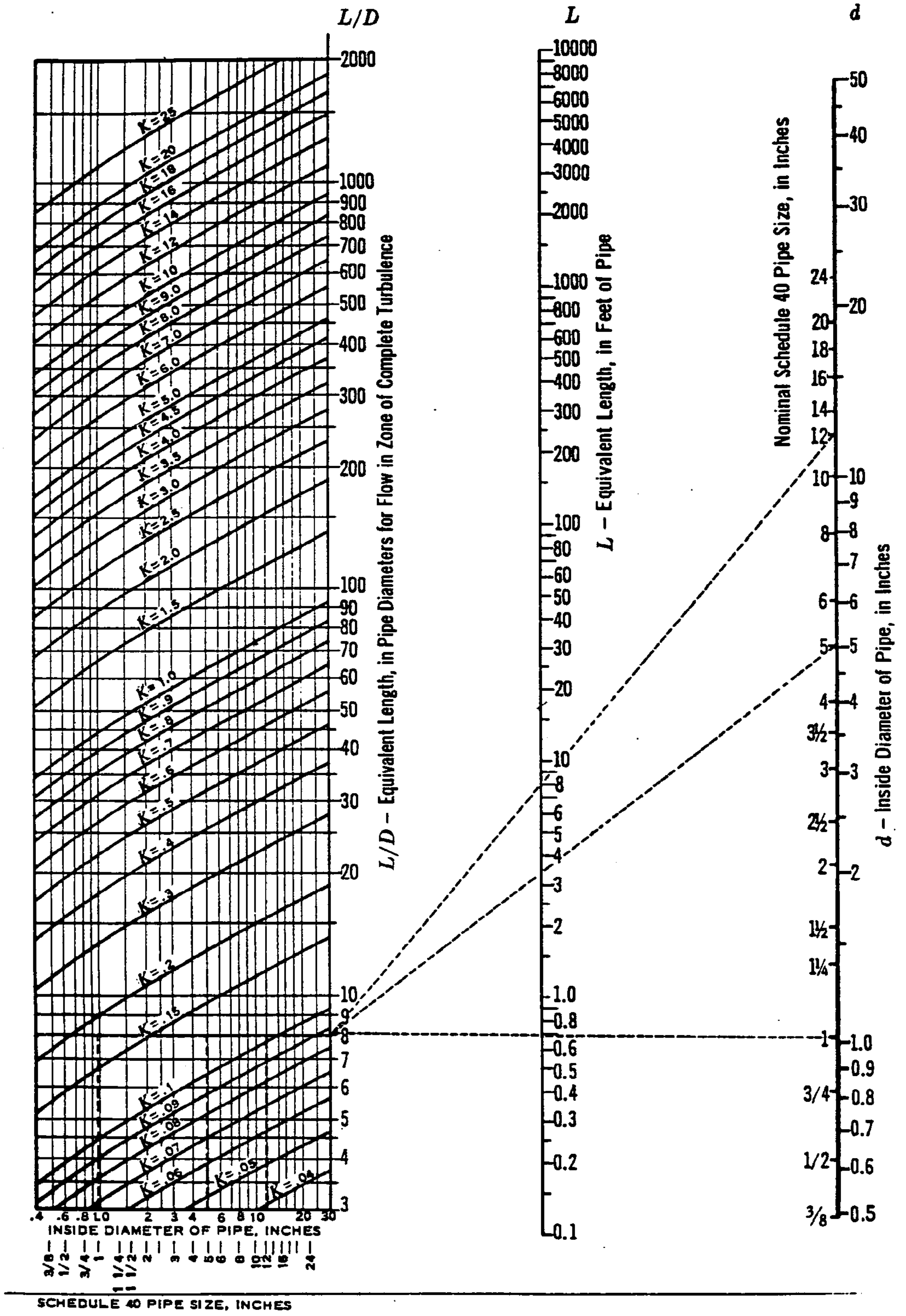
**Exact equivalent length is equal to the length between flange faces or welding ends.

†Minimum calculated pressure drop (psi) across valve to provide sufficient flow to lift disc fully.

‡For limitations, see page 2-11. For effect of end connections, see page 2-10.

For resistance factor "K", equivalent length in feet of pipe, and equivalent flow coefficient "Cv", see pages A-31 and A-32.

Equivalent Lengths *L* and *L/D* and Resistance Coefficient *K*



Problem: Find the equivalent length in pipe diameters and feet of Schedule 40 clean commercial steel pipe, and the resistance factor *K* for 1, 5, and 12-inch fully-opened gate valves with flow in zone of complete turbulence.

Solution

Valve Size	1"	5"	12"	*Refer to*
Equivalent length, pipe diameters	8	8	8	Page A-27
Equivalent length, feet of Sched. 40 pipe	0.7	3.4	7.9	Dotted lines on chart.
Resist. factor *K*, based on Sched. 40 pipe	0.18	0.13	0.10	

APPENDIX C

APPENDIX C

AIR STRIPPING TOWER MASS TRANSFER DATA

PACKED COLUMN AIR STRIPPER MASS TRANSFER DATA

CONTROLLING COMPOUND	TCE
PACKING	3.5" TRIPACKS
AIR TO WATER RATIO	30
TOWER DIAMETER (ft)	10.18
WATERFLOW (gpm)	2300
WATER TEMP (F)	50
MASS TRANS. COEF. KLA (/sec)	0.01316
HENRY'S CONSTANT(atm)	338.0
LLR (gpm/sf)	28.3
AIRFLOW (scfm)	9225
STRIPPING FACTOR	7.63
KLA SAFETY FACTOR	1.15

BED DEPTH (feet)	EFFLUENT (ug/l)	% REMOVAL
0	7760.00	0.00%
5	3252.91	58.08%
10	1426.69	81.61%
15	637.69	91.78%
20	287.40	96.30%
25	130.01	98.32%
26	110.96	98.57%
27	94.71	98.78%
28	80.84	98.96%
29	69.01	99.11%
30	58.91	99.24%
31	50.29	99.35%
32	42.93	99.45%
33	36.65	99.53%
34	31.29	99.60%
35	26.71	99.66%
36	22.81	99.71%
37	19.47	99.75%
38	16.62	99.79%
39	14.19	99.82%
40	12.12	99.84%
41	10.35	99.87%
42	8.83	99.89%
43	7.54	99.90%
44	6.44	99.92%
45	5.50	99.93%
46	4.69	99.94%
47	4.01	99.95%
48	3.42	99.96%
49	2.92	99.96%
50	2.49	99.97%

APPENDIX D

APPENDIX D

AIR PERMIT APPLICATION AND AIR EMISSIONS CALCULATIONS

OP LOCATION FACILITY EMISSION POINT

A ADD
C CHANGE
D DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-12 BEFORE ANSWERING ANY QUESTION

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

COPIES
WHITE - ORIGINAL
GREEN - DIVISION OF AIR
WHITE - REGIONAL OFFICE
PINK - FIELD REP
YELLOW - APPLICANT

PROCESS, EXHAUST OR VENTILATION SYSTEM

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

1. NAME OF OWNER/FIRM: Grumman Aerospace Corporation
2. NUMBER AND STREET ADDRESS: 1111 Stewart Avenue
3. CITY - TOWN - VILLAGE: Bethpage
4. STATE: NY
5. ZIP: 11714
6. OWNER CLASSIFICATION: A ☐ COMMERCIAL B ☒ INDUSTRIAL C ☐ UTILITY D ☐ FEDERAL E ☐ STATE F ☐ MUNICIPAL G ☐ EDUC. INST H ☐ HOSPITAL I ☐ RESIDENTIAL J ☐ OTHER
7. NAME & TITLE OF OWNERS REPRESENTATIVE: John Cofman, P.E., MANAGER
8. TELEPHONE: 516-575-0574
9. NAME OF AUTHORIZED AGENT: GM Consulting Engineers, P.C.
10. TELEPHONE: 516-249-7600
11. NUMBER AND STREET ADDRESS: 125 East Bethpage Road
12. CITY - TOWN - VILLAGE: Plainview
13. STATE: NY
14. ZIP: 11803
15. NAME OF P.E. OR ARCHITECT PREPARING APPLICATION: Arnold S. Vernick
16. N.Y.S. P.E. OR ARCHITECT LICENSE NO.: 39333
17. TELEPHONE: 201-909-0700
18. SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT: Arnold S. Vernick
19. FACILITY NAME (IF DIFFERENT FROM OWNER/FIRM):
20. FACILITY LOCATION (NUMBER AND STREET ADDRESS):
21. CITY - TOWN - VILLAGE:
22. ZIP:
23. BUILDING NAME OR NUMBER:
24. FLOOR NAME OR NUMBER:
25. START UP DATE: 06 / 96 (MO / YR)
26. DRAWING NUMBERS OF PLANS SUBMITTED: C1, C2
27. PERMIT TO CONSTRUCT: A ☒ NEW SOURCE B ☐ MODIFICATION
28. CERTIFICATE TO OPERATE: A ☐ NEW SOURCE B ☐ MODIFICATION C ☐ EXISTING SOURCE

SECTION B

29 EMISSION POINT ID.	30. GROUND ELEVATION (FT)	31 HEIGHT ABOVE STRUCTURES (FT)	32 STACK HEIGHT (FT)	33 INSIDE DIMENSIONS (IN)	34 EXIT TEMP (°F)	35 EXIT VELOCITY (FT/SEC)	36 EXIT FLOW RATE (ACFM)	37 SOURCE CODE	38 HRS/DAY	39 DAYS/YR	40 % OPERATION BY SEASON Winter	Spring	Summer	Fall
02391	115.0	1	60	30	75°	31	9225		24	365	25	25	25	25

SECTION C

41 DESCRIBE PROCESS OR UNIT

Groundwater from the onsite wells is treated using an air-stripper (10ft. dia. x 60ft. height) to remove VOCs The air-stream from the air-stripper is treated using regenerable VPGAC. The air-stream after carbon treatment is discharged to atmosphere. VOCs are recovered during regeneration of VPGAC and sent off-site for disposal.

SECTION D

EMISSION CONTROL EQUIPMENT I.D.	CONTROL TYPE	MANUFACTURER'S NAME AND MODEL NUMBER	DISPOSAL METHOD	DATE INSTALLED MONTH / YEAR	USEFUL LIFE
42	43 17	44 Vara International/Calgon, or equal (2/6200)	45 9	46 06 / 96	47 20
48	49	50	51	52 /	53

SECTION E

CALCULATIONS

SEE ATTACHED CALCULATION SHEETS.

STATE OF NEW YORK
ARNOLD S. VERNICK
No. 39333
LICENSED PROFESSIONAL ENGINEER

SECTION F

CONTAMINANT NAME	CAS NUMBER	INPUT OR PRODUCTION	UNIT	ENV. RATING	EMISSIONS ACTUAL	EMISSIONS UNIT	EMISSIONS HOW DET	EMISSIONS PERMISSIBLE	% CONTROL EFFIC'CY	HOURLY EMISSIONS (LBS/HR) ERP	HOURLY EMISSIONS (LBS/HR) ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	10ˣ	PERMISSIBLE
54 Trichloroethylene (TCE)	55 00079-01-6	56	57	58	59 0.446	60 1	61 6	62	63 95	64 8.90	65 0.446	66 3905.5	67 0	68
69 Tetrachloroethylene (PCE)	70 00127-18-4	71	72	73	74 0.036	75 1	76 6	77	78 95	79 0.72	80 0.036	81 316.1	82 0	83
84 1,2-Dichloroethylene	85 00156-60-5	86	87	88	89 0.100	90 1	91 6	92	93 95	94 1.95	95 0.100	96 876.0	97 0	98
99 1,1-Dichloroethylene	100 00075-35-4	101	102	103	104 0.046	105 1	106 6	107	108 95	109 0.87	110 0.046	111 401.5	112 0	113
114 1,1,1-Trichloroethane	115 00071-55-6	116	117	118	119 0.038	120 1	121 6	122	123 95	124 0.76	125 0.038	126 328.5	127 0	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142	143

SECTION G

SOLID FUEL TYPE	SOLID FUEL TONS/YR	%S	OIL TYPE	OIL THOUSANDS OF GALLONS/YR	%S	GAS TYPE	GAS THOUSANDS OF CF/YR	BTU/CF	APPLICABLE RULE	APPLICABLE RULE
144	145	146	147	148	149	150	151	152	153	154

Upon completion of construction sign the statement listed below and forward to the appropriate field representative

THE PROCESS, EXHAUST OR VENTILATION SYSTEM HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED SPECIFICATIONS AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS.

155 SIGNATURE OF AUTHORIZED REPRESENTATIVE OR AGENT | DATE

AGENCY USE ONLY

156 LOCATION CODE | 157 FACILITY ID. NO. | 158 U T M (E) | 159 U T M (N) | 160 SIC NUMBER | 161. DATE APPL. RECEIVED / / | 162 DATE APPL. REVIEWED / / | 163. REVIEWED BY:

PERMIT TO CONSTRUCT

164 DATE ISSUED / / | 165 EXPIRATION DATE / / | 166 SIGNATURE OF APPROVAL | 167 FEE

168
1. DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2. THIS IS NOT A CERTIFICATE TO OPERATE
3. TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

RECOMMENDED ACTION RE: C.O.

169 DATE ISSUED / / | 170 EXPIRATION DATE / / | 171 SIGNATURE OF APPROVAL | 172 FEE

173
1. ☐ INSPECTED BY ____________ DATE ______
2. ☐ INSPECTION DISCLOSED DIFFERENCES AS BUILT VS. PERMIT, CHANGES INDICATED ON FORM
3. ☐ ISSUE CERTIFICATE TO OPERATE FOR SOURCE AS BUILT
4. ☐ APPLICATION FOR C.O. DENIED ______ DATE ______ INITIALED

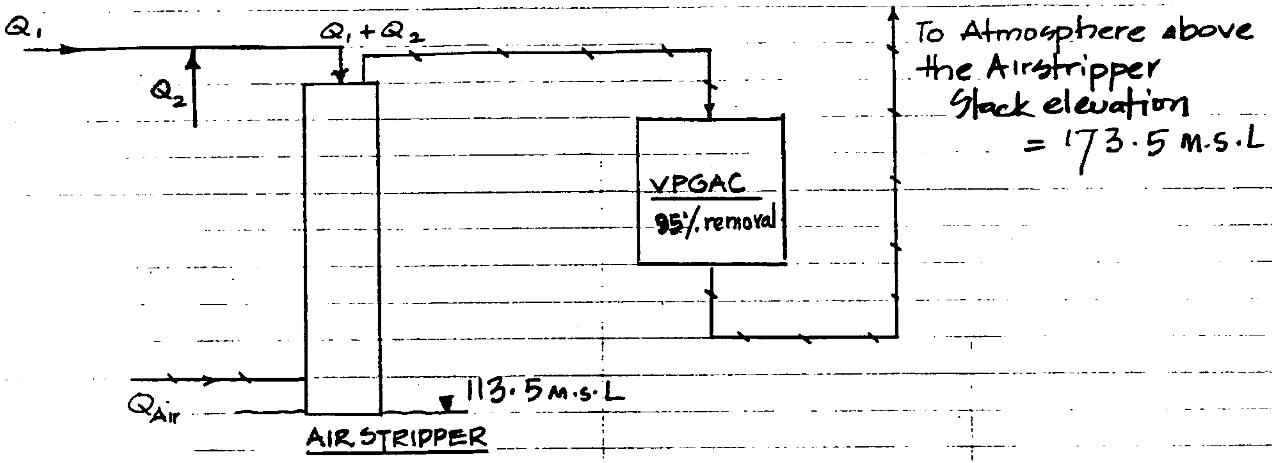
174. SPECIAL CONDITIONS:

1.
2.
3.
4.
5.
6.
7.
8.

76-19-3 (10-79)

Air Emission Calculations
Grumman - IRM
Bethpage, New York

11/15/95 1 3
Kumar
NY09TT.001.003



Q_1 = Flow from Recovery wells = 2300 gpm
Q_2 = Condensate steam = 0.5 gpm

$Q_1 + Q_2$ = Total flow to Air stripper = 2300.5 gpm

Q_{Air} = Air Flow = 9225 cfm

VOC Loading Rates (Table 2)

Compound	Influent ($\mu g/L$)	Effluent ($\mu g/L$)	Removed Compounds in Air stre #/day
TCE	7,740	2.5	213.60
PCE	630	2.5	17.32
1,2-DCE	1,700	2.5	46.86
1,1-DCE	760	2.5	20.91
1,1,1-TCA	660	2.5	18.15

$$\#/day = gpm \times mg/L \times 0.012$$

Sample Calculation:

$$TCE = 2300.5 \times \frac{(7740 - 2.5)}{1000} \times 0.012 = 213.60 \ \#/day$$

11/15/95 2 3
KUMAR

Contaminant	Rating of Contaminant	Loading to VPGAC		After VPGAC (95% Removal)		
		#/day	#/hr	#/day	#/hr	gm/sec
TCE	B	213.60	8.90	10.7	0.446	0.0562
PCE	B	17.32	0.72	0.9	0.038	0.0048
1,2 - DCE	B	46.86	1.95	2.4	0.100	0.0126
1,1 - DCE	A	20.91	0.87	1.1	0.046	0.0058
1,1,1 - TCA	C	18.15	0.76	0.9	0.038	0.0048
			13.2		0.668	

Sample Calculation (for TCE).

Loading to VPGAC $= 213.60$ #/day $= \frac{213.60}{24}$ #/hr $= 8.90$ #/hr.

Emission to Atmosphere
(95% removal) $= 213.60\,(1 - 0.95) = 10.7$ #/day =

$$\text{gm/sec} = \frac{\#}{\text{hr}} \times \left(\frac{454}{3600}\right) = (0.126)(\#/\text{hr})$$

$$= 0.126 \times 0.446 = 0.0562 \text{ gm/sec.}$$

INPUT FOR SCREEN 2.

Stack height = 60 ft = 18.3 m
Stack inside diameter = 2.5 ft = 0.76 m
Air flow = 9225 cfm.

Stack exit temperature = 75°F = 24°C = 273+24°K = 297°K.
Ambient air temp = 50°F = 10°C = 273+10° K = 283°K

Bldg height = 25' = 7.62 m.

Bldg width = 12.0 m
Bldg length = 15.0 m

11/15/95 3 . 3
Kumar

Compound	FROM SCREEN 2		From Air Guide-1	
	C_{ST} (μg/m³)	$C_a = C_p$ (μg/m³)	AGC (μg/m³)	SGC (μg/m³)
TCE	7·683	0·118	0·45	33,000
PCE	0·6562	0·010	0·075	81,000
1,2 DCE	1·723	0·027	360	190,000
1,1 DCE	0·793	0·013	0·02	2,000
1,1,1 TCA	0·6562	0·01	1000	450,000

1. For all compounds $C_a < AGC$.

Hence, the long term impact C_a is acceptable

2. For all compounds $C_{ST} < SGC$

Hence, the short-term impact (C_{ST}) is acceptable.

Southprint 95-C

TCE 1/2

```
                                                                    11/27/95
                                                                    15:14:21
 ***  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Grumman - TCE

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                =        POINT
   EMISSION RATE (G/S)        =      .562000E-01
   STACK HEIGHT (M)           =      18.3000
   STK INSIDE DIAM (M)        =        .7600
   STK EXIT VELOCITY (M/S)=           9.5972
   STK GAS EXIT TEMP (K)      =     297.0000
   AMBIENT AIR TEMP (K)       =     283.0000
   RECEPTOR HEIGHT (M)        =       1.0000
   URBAN/RURAL OPTION         =        URBAN
   BUILDING HEIGHT (M)        =       7.6200
   MIN HORIZ BLDG DIM (M) =          12.0000
   MAX HORIZ BLDG DIM (M) =          15.0000
```

Ca = 0.118 µg/m³

AGC = 0.45 µg/m³

Ca < AGC O.K.

```
   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    9225.0000     (ACFM)

BUOY. FLUX =      .641 M**4/S**3;  MOM. FLUX =   12.673 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC               U10M   USTK  MIX HT   PLUME  SIGMA   SIGMA
   (M)   (UG/M**3)    STAB   (M/S)  (M/S)    (M)   HT (M)  Y (M)   Z (M)  DWASH
 -------  ----------  ----   -----  -----  ------  ------  ------  ------  -----
     1.    .0000        1      1.0    1.1   320.0   38.29    1.58    1.56   NO
   100.    7.317        3      1.5    1.7   480.0   31.23   21.89   20.34   NO
   200.    7.248        4      1.0    1.2   320.0   37.11   31.26   27.72   NO
   300.    5.462        4      1.0    1.2   320.0   37.11   45.67   40.59   NO
   400.    4.748        6      1.0    1.2 10000.0   38.08   41.24   25.92   NO
   500.    4.463        6      1.0    1.2 10000.0   38.08   50.53   30.76   NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND     1. M:
   131.    7.683        3      1.0    1.1   320.0   37.69   28.84   26.98   NO

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

  *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)        =    .0000      CONC (UG/M**3)        =    .0000
   CRIT WS @10M (M/S) =      99.99       CRIT WS @10M (M/S) =      99.99
   CRIT WS @ HS (M/S) =      99.99       CRIT WS @ HS (M/S) =      99.99
   DILUTION WS (M/S)  =      99.99       DILUTION WS (M/S)  =      99.99
   CAVITY HT (M)      =       9.19       CAVITY HT (M)      =       8.56
```

```
   CAVITY LENGTH (M)  =    14.50         CAVITY LENGTH (M)  =     9.96
   ALONGWIND DIM (M)  =    12.00         ALONGWIND DIM (M)  =    15.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC     DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)     MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN        7.683         131.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

$C_{ST} = 7.683\ \mu g/m^3$ ∴ $C_p = \frac{C_{ST}}{65} = 0.118\ \mu g/m^3$

$C_a = C_p$ (∵ no reduction in hrs of operation).

∴ $C_a = 0.118\ \mu g/m^3$

$AGC = 0.45\ \mu g/m^3$

PCE 1/2

$C_a = 0.01 \mu g/m^3$

$AGC = 0.075 \mu g/m^3$

$C_a < AGC$ O.K

```
                                                                11/27/95
                                                                11:25:37
 ***  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Grumman - PCE

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE             =        POINT
   EMISSION RATE (G/S)     =      .480000E-02
   STACK HEIGHT (M)        =      18.3000
   STK INSIDE DIAM (M)     =        .7600
   STK EXIT VELOCITY (M/S)=       9.5972
   STK GAS EXIT TEMP (K)   =     297.0000
   AMBIENT AIR TEMP (K)    =     283.0000
   RECEPTOR HEIGHT (M)     =       1.0000
   URBAN/RURAL OPTION      =        URBAN
   BUILDING HEIGHT (M)     =       7.6200
   MIN HORIZ BLDG DIM (M)  =      12.0000
   MAX HORIZ BLDG DIM (M)  =      15.0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    9225.0000     (ACFM)

BUOY. FLUX =      .641 M**4/S**3;  MOM. FLUX =   12.673 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST     CONC              U10M   USTK   MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)    STAB  (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
 -------  ----------  ----  -----  -----  ------   ------   ------  ------  -----
     1.    .0000        1     1.0    1.1   320.0    38.29     1.58    1.56   NO
   100.    .6249        3     1.5    1.7   480.0    31.23    21.89   20.34   NO
   200.    .6191        4     1.0    1.2   320.0    37.11    31.26   27.72   NO
   300.    .4665        4     1.0    1.2   320.0    37.11    45.67   40.59   NO
   400.    .4055        6     1.0    1.2 10000.0    38.08    41.24   25.92   NO
   500.    .3812        6     1.0    1.2 10000.0    38.08    50.53   30.76   NO

 MAXIMUM 1-HR CONCENTRATION AT OR BEYOND     1. M:
   131.    .6562        3     1.0    1.1   320.0    37.69    28.84   26.98   NO

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

  *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)       =    .0000       CONC (UG/M**3)       =    .0000
   CRIT WS @10M (M/S) =    99.99       CRIT WS @10M (M/S) =    99.99
   CRIT WS @ HS (M/S) =    99.99       CRIT WS @ HS (M/S) =    99.99
   DILUTION WS (M/S)   =    99.99       DILUTION WS (M/S)   =    99.99
   CAVITY HT (M)       =     9.19       CAVITY HT (M)       =     8.56
```

FUL 72

```
  CAVITY LENGTH (M)   =    14.50        CAVITY LENGTH (M)   =     9.96
  ALONGWIND DIM (M)   =    12.00        ALONGWIND DIM (M)   =    15.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION           MAX CONC     DIST TO   TERRAIN
  PROCEDURE           (UG/M**3)     MAX (M)    HT (M)
--------------      -----------    -------   -------
SIMPLE TERRAIN        .6562           131.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

$C_{ST} = 0.6562 \mu g/m^3$

$C_p = \frac{C_{ST}}{65} = 0.01 \frac{\mu g}{m^3}$

$C_a = 0.01 \mu g/m^3$

$AGC = 0.075 \mu g/m^3$

12

```
                                                                 11/27/95
                                                                 11:40:32
 ***  SCREEN2 MODEL RUN   ***
 *** VERSION DATED 92245 ***

Grumman - 1,2-DCE

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE              =        POINT
   EMISSION RATE (G/S)      =      .126000E-01
   STACK HEIGHT (M)         =      18.3000
   STK INSIDE DIAM (M)      =        .7600
   STK EXIT VELOCITY (M/S)=         9.5972
   STK GAS EXIT TEMP (K)    =     297.0000
   AMBIENT AIR TEMP (K)     =     283.0000
   RECEPTOR HEIGHT (M)      =       1.0000
   URBAN/RURAL OPTION       =        URBAN
   BUILDING HEIGHT (M)      =       7.6200
   MIN HORIZ BLDG DIM (M) =        12.0000
   MAX HORIZ BLDG DIM (M) =        15.0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    9225.0000      (ACFM)

BUOY. FLUX =      .641 M**4/S**3;  MOM. FLUX =    12.673 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC               U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)    (UG/M**3)    STAB   (M/S)  (M/S)    (M)    HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----   -----  -----  ------   ------  ------  ------  -----
     1.    .0000         1     1.0    1.1    320.0    38.29    1.58    1.56    NO
   100.   1.640          3     1.5    1.7    480.0    31.23   21.89   20.34    NO
   200.   1.625          4     1.0    1.2    320.0    37.11   31.26   27.72    NO
   300.   1.225          4     1.0    1.2    320.0    37.11   45.67   40.59    NO
   400.   1.064          6     1.0    1.2 10000.0    38.08   41.24   25.92    NO
   500.   1.001          6     1.0    1.2 10000.0    38.08   50.53   30.76    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND     1. M:
   131.   1.723          3     1.0    1.1    320.0    37.69   28.84   26.98    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)      =     .0000       CONC (UG/M**3)      =     .0000
  CRIT WS @10M (M/S) =     99.99        CRIT WS @10M (M/S) =     99.99
  CRIT WS @ HS (M/S) =     99.99        CRIT WS @ HS (M/S) =     99.99
  DILUTION WS (M/S)  =     99.99        DILUTION WS (M/S)  =     99.99
  CAVITY HT (M)      =      9.19        CAVITY HT (M)      =      8.56
```

$C_a = 0.027\ \mu g/m^3$

$AGC = 360\ \mu g/m^3$

$C_a < AGC$. O.K.

```
  CAVITY LENGTH (M)  =    14.50         CAVITY LENGTH (M)  =     9.96
  ALONGWIND DIM (M)  =    12.00         ALONGWIND DIM (M)  =    15.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION         MAX CONC     DIST TO   TERRAIN
  PROCEDURE         (UG/M**3)     MAX (M)    HT (M)
--------------     -----------    -------   -------
SIMPLE TERRAIN       1.723          131.        0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

$C_{ST} = 1.723\ \mu g/m^3$

$C_p = \frac{C_{ST}}{65} = 0.027\ \mu g/m^3$

$C_a = 0.027\ \mu g/m^3$

$AGC = 360\ \mu g/m^3$

1,1 DCE 72

```
                                                                  11/27/95
                                                                  11:32:51
 ***  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Grumman - 1,1-DCE

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE             =        POINT
   EMISSION RATE (G/S)     =     .580000E-02
   STACK HEIGHT (M)        =      18.3000
   STK INSIDE DIAM (M)     =        .7600
   STK EXIT VELOCITY (M/S)=        9.5972
   STK GAS EXIT TEMP (K)   =     297.0000
   AMBIENT AIR TEMP (K)    =     283.0000
   RECEPTOR HEIGHT (M)     =       1.0000
   URBAN/RURAL OPTION      =        URBAN
   BUILDING HEIGHT (M)     =       7.6200
   MIN HORIZ BLDG DIM (M)  =      12.0000
   MAX HORIZ BLDG DIM (M)  =      15.0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    9225.0000     (ACFM)

BUOY. FLUX =      .641 M**4/S**3;  MOM. FLUX =   12.673 M**4/S**2.

*** FULL METEOROLOGY ***

**********************************
*** SCREEN AUTOMATED DISTANCES ***
**********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

   DIST      CONC              U10M    USTK   MIX HT   PLUME   SIGMA   SIGMA
    (M)    (UG/M**3)    STAB   (M/S)   (M/S)    (M)    HT (M)  Y (M)   Z (M)   DWASH
  -------  ----------   ----   -----   -----  ------   ------  ------  ------  -----
      1.    .0000         1     1.0     1.1    320.0    38.29    1.58    1.56    NO
    100.    .7551         3     1.5     1.7    480.0    31.23   21.89   20.34    NO
    200.    .7480         4     1.0     1.2    320.0    37.11   31.26   27.72    NO
    300.    .5637         4     1.0     1.2    320.0    37.11   45.67   40.59    NO
    400.    .4900         6     1.0     1.2  10000.0    38.08   41.24   25.92    NO
    500.    .4606         6     1.0     1.2  10000.0    38.08   50.53   30.76    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND      1. M:
    131.    .7930         3     1.0     1.1    320.0    37.69   28.84   26.98    NO

  DWASH=   MEANS NO CALC MADE (CONC = 0.0)
  DWASH=NO MEANS NO BUILDING DOWNWASH USED
  DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
  DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
  DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

  *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
   CONC (UG/M**3)      =    .0000        CONC (UG/M**3)      =    .0000
   CRIT WS @10M (M/S) =    99.99        CRIT WS @10M (M/S) =    99.99
   CRIT WS @ HS (M/S) =    99.99        CRIT WS @ HS (M/S) =    99.99
   DILUTION WS (M/S)   =    99.99        DILUTION WS (M/S)   =    99.99
   CAVITY HT (M)       =     9.19        CAVITY HT (M)       =     8.56
```

$C_a = 0.013\ \mu g/m^3$

$AGC = 0.02\ \mu g/m^3$

$C_a < AGC$ O.K

```
  CAVITY LENGTH (M)  =    14.50         CAVITY LENGTH (M)  =     9.96
  ALONGWIND DIM (M)  =    12.00         ALONGWIND DIM (M)  =    15.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION          MAX CONC     DIST TO    TERRAIN
  PROCEDURE          (UG/M**3)     MAX (M)     HT (M)
--------------       -----------   -------    -------
SIMPLE TERRAIN         .7930          131.         0.

***************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
***************************************************
```

$C_{ST} = 0.793\ \mu g/m^3$

$C_p = \frac{C_{ST}}{65} = 0.013\ \mu g/m^3$

$C_a = 0.013\ \mu g/m^3$

$AGC = 0.02\ \mu g/m^3$

```
                                                          11/27/95
                                                          11:42:31
 ***  SCREEN2 MODEL RUN  ***
 *** VERSION DATED 92245 ***

Grumman - 1,1,1-TCA

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE                =        POINT
   EMISSION RATE (G/S)        =     .480000E-02
   STACK HEIGHT (M)           =      18.3000
   STK INSIDE DIAM (M)        =        .7600
   STK EXIT VELOCITY (M/S)=          9.5972
   STK GAS EXIT TEMP (K)      =     297.0000
   AMBIENT AIR TEMP (K)       =     283.0000
   RECEPTOR HEIGHT (M)        =       1.0000
   URBAN/RURAL OPTION         =        URBAN
   BUILDING HEIGHT (M)        =       7.6200
   MIN HORIZ BLDG DIM (M) =          12.0000
   MAX HORIZ BLDG DIM (M) =          15.0000

   STACK EXIT VELOCITY WAS CALCULATED FROM
   VOLUME FLOW RATE =    9225.0000     (ACFM)

BUOY. FLUX =      .641 M**4/S**3;  MOM. FLUX =   12.673 M**4/S**2.

*** FULL METEOROLOGY ***

***********************************
*** SCREEN AUTOMATED DISTANCES ***
***********************************

*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

  DIST      CONC               U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)     STAB   (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------    ----   -----  -----  ------  ------  ------  ------  -----
     1.    .0000         1      1.0    1.1   320.0   38.29    1.58    1.56    NO
   100.    .6249         3      1.5    1.7   480.0   31.23   21.89   20.34    NO
   200.    .6191         4      1.0    1.2   320.0   37.11   31.26   27.72    NO
   300.    .4665         4      1.0    1.2   320.0   37.11   45.67   40.59    NO
   400.    .4055         6      1.0    1.2 10000.0   38.08   41.24   25.92    NO
   500.    .3812         6      1.0    1.2 10000.0   38.08   50.53   30.76    NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND     1. M:
   131.    .6562         3      1.0    1.1   320.0   37.69   28.84   26.98    NO

 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

 *** CAVITY CALCULATION - 1 ***        *** CAVITY CALCULATION - 2 ***
  CONC (UG/M**3)       =     .0000      CONC (UG/M**3)       =     .0000
  CRIT WS @10M (M/S) =      99.99      CRIT WS @10M (M/S) =       99.99
  CRIT WS @ HS (M/S) =      99.99      CRIT WS @ HS (M/S) =       99.99
  DILUTION WS (M/S)  =      99.99      DILUTION WS (M/S)  =       99.99
  CAVITY HT (M)      =       9.19      CAVITY HT (M)      =        8.56
```

$C_a = 0.01 \mu g/m^3$

$AGC = 1000 \mu g/m^3$

$C_a < AGC$ O.k.

```
  CAVITY LENGTH (M)  =    14.50        CAVITY LENGTH (M)  =     9.96
  ALONGWIND DIM (M)  =    12.00        ALONGWIND DIM (M)  =    15.00

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S.  CONC SET = 0.0

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION           MAX CONC     DIST TO   TERRAIN
  PROCEDURE           (UG/M**3)     MAX (M)    HT (M)
--------------       -----------    -------   -------
SIMPLE TERRAIN          .6562          131.        0.

*******************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
*******************************************************
```

$C_{ST} = 0.6562\ \mu g/m^3$

$C_p = \frac{C_{ST}}{65} = 0.01\ \mu g/m^3$

$C_a = 0.01\ \mu g/m^3$

$AGC = 1000\ \mu g/m^3$