

IN THE COURT OF COMMON PLEAS  
ASHLAND COUNTY, OHIO

STATE OF OHIO, ex rel. :  
ANTHONY J. CELEBREZZE, JR. :  
ATTORNEY GENERAL OF OHIO :

Plaintiff,

Case No. 33500

v.

PHILWAY PRODUCTS, INC.,

Defendant.

CONSENT DECREE AND JUDGMENT

WHEREAS, this matter was instituted by Plaintiff, the State of Ohio, on the relation of its Attorney General, Anthony J. Celebrezze, Jr. (the "State" or "Plaintiff"), at the request of the Ohio Environmental Protection Agency (the "Ohio EPA"), through the filing of a Complaint (the "Complaint") alleging violations of water pollution laws contained in Chapter 6111, Ohio Revised Code ("ORC"), to the effect that Defendant Philway Products, Inc. ("Philway") had, at its facility at 701 Virginia Avenue, Ashland, Ohio, inter alia, violated certain requirements of a permit, known as National Pollutant Discharge Elimination System ("NPDES") Permit Number C244CD (the "Existing Permit"). The Complaint also alleges violations of ORC Chapter 3734, including the allegation that Philway had, at its facility at 701 Virginia Avenue, Ashland, Ohio (hereinafter

("Facility"), improperly stored or disposed certain yellow cake byproducts of its wastewater treatment system ("yellow cake") which the State believes is classified as an F006 listed hazardous waste. Philway has denied any violations of any laws including ORC Chapter 6111 and 3734;

WHEREAS, Defendant made various improvements at its wastewater treatment facility which culminated in the facility discharging directly into the Ashland Municipal Treatment System on May 29, 1985, instead of discharging directly to "waters of the state", as that term is defined in ORC 6111.01;

WHEREAS, Defendant submitted a delisting petition for the yellow cake to the United States Environmental Protection Agency ("U.S. EPA") on November 12, 1985, which had as its purpose to delist said yellow cake as an F006 listed hazardous waste. Said petition has not been formally ruled upon;

AND WHEREAS on December 2, 1986 the U.S. EPA issued an Interpretative Rule stating that certain printed circuit board manufacturing was not an F006 listed waste and the parties are in disagreement as to the application of the Interpretative Rule,

NOW, THEREFORE, before the taking of any testimony and without adjudication or admission of any issue of fact or law in connection herewith, and upon the consent of the parties hereto, it is hereby ORDERED, ADJUDGED AND DECREED as follows:

## I. JURISDICTION

This Court has jurisdiction over the subject matter of this action pursuant to ORC Chapters 6111 and 3734. This Court further has jurisdiction over the parties to this Judgment. The Complaint states a claim upon which relief may be granted. Venue is proper in this Court.

## II. SCOPE OF FINAL JUDGMENT

The provisions of this Judgment shall apply to and be binding upon the parties to this action, their officers, employees and successors and the agents of the Defendant or other persons who act in concert with the Defendant and who have received notice of this Judgment. This final judgment covers, and shall apply to, the Philway facility at 701 Virginia Avenue, Ashland, Ohio, as identified in the Complaint, operated by Philway or by any successor(s) in interest.

## III. PROVISIONS OF THE JUDGMENT

(1) Environmental Project to Upgrade Philway's Discharge - The Defendant shall take the following steps which it presently estimates to cost approximately \$60,000.00 to reduce the amount of treated wastewater that is being discharged by Philway into the Ashland Municipal Treatment System:

Phase One: Within 90 days of the Ohio EPA's approval of a Permit to Install, as described below, Philway shall take certain steps as described in Attachment A-1 to reduce the

volume of wastewater which is discharged into its pollution control system.

Phase Two: Within 180 days of the Ohio EPA's approval of a Permit to Install, as described below, Philway shall take certain steps as described in Attachment A-2 to recirculate an estimated 15 to 25 gallons per minute (gpm) of treated water from the discharge of the pollution control system back into Philway's manufacturing operations for use in non-critical rinses.

Phase Three: Within 365 days of the the Ohio EPA's approval of a Permit to Install, as described below, Philway shall take certain steps as described in Attachment A-3 to provide additional filtering or other treatment of the recirculated wastewater of Phase Two to permit some of such recirculated water to be used in critical rinses.

Within 30 days of the effective date of this Decree, Philway shall submit to the Ohio EPA an application for a Permit to Install ("PTI"), with engineering plans and fee, covering the improvements described in Phases One, Two, and Three, above. The application for a PTI and the engineering plans are subject to the approval of the Ohio EPA.

Philway shall provide the Ohio EPA notice upon the completion of each Phase and Philway shall further provide Ohio EPA status reports describing its progress in meeting each Phase. The status reports shall be provided to the Ohio EPA

within 30 days before the completion deadline of each Phase. All material, except as otherwise provided herein, to be submitted to Ohio EPA under this Judgment shall be delivered to Paul Brock (or his designated successor), Ohio Environmental Protection Agency, Northwest District Office, 1035 Devlac Grove Drive, Bowling Green, Ohio 43402. If Philway does not complete the Phases according to the timetable indicated, Philway shall pay to the State of Ohio a stipulated civil penalty of \$500.00 for each week that it is late. The payment of the stipulated civil penalties shall be made by check payable to the Treasurer, State of Ohio, which check shall be delivered to Plaintiff's counsel at the address provided in paragraph III(4), infra, for deposit to the General Revenue Fund.

(2) Delisting Petition - If U.S. EPA denies Philway's delisting petition, Philway shall install and sample at least four groundwater monitoring wells about the perimeter at its Ashland Facility as described in Attachment B. Prior to installing these groundwater monitoring wells, Philway shall submit to the Ohio EPA at P.O. Box 1049, Columbus, Ohio 43216-1049 Attn. Edward Kitchen (or his designated succssor), a description of the proposed location of the groundwater monitoring wells along with a justification for the location of these wells. The location of the groundwater monitoring wells is subject to the written approval of the Ohio EPA. If any well

samples show statistically significant changes as defined in OAC 3745-65-93 for those parameters specified in Attachment B, Philway shall within fifteen days notify the Ohio EPA at the Columbus address set forth in this paragraph in writing of these sampling results. Philway shall submit a plan and conduct an assessment in accord with 3745-65-93. This plan and assessment are subject to the written approval of the Ohio EPA. If the U.S. EPA denies Philway's Delisting Petition, Philway shall, within thirty days thereafter, prepare a deed restriction identifying the nature of the yellowcake, its location and the existence and nature of this order and, after approval of the restriction by the Ohio EPA, cause such restriction to be placed upon the deed of the Ashland facility. Beginning with the effective date of this Judgment and continuing until Philway's delisting petition is either approved or denied, Philway shall sample quarterly the existing floor drain as described in Attachment C. Philway's obligation under the Consent Decree to install and conduct sampling of the wells and floor drains will cease if the U.S. EPA approves Philway's delisting petition, or after well sampling has been carried out for eight consecutive quarters and the results of the sampling do not show statistically significant changes in any well (as defined above), whichever first occurs. If the U.S. EPA denies Philway's delisting

petition, or if well sampling results show statistically significant changes in any well, and Philway's plan or assessment are unsatisfactory to the State, the State reserves the right to administratively order or move the Court for an order requiring Philway or any other responsible party to take remedial action in respect to the yellowcake at the facility. Nothing in this Consent Decree shall be construed as limiting Philway's defenses to any action by the State seeking to require Philway to take such remedial action.

(3) Environmental Project--Spectrophotometer -

Philway shall provide the City of Ashland with a Varian Instrument Group Model SpectrAA-20BQ Double Beam AA Spectrophotometer with emission capability, with Interlocked Gas Control Unit, High-speed Deuterium Arc, Background Correction, four lamp turret, Air/Acetylene Burner, Ceramic Nebulizer, and gas connection hoses. See Attachment D. Philway shall order this machine for the City within 30 days of the Ohio EPA's approval of a Permit to Install. Philway shall request in its order that this machine shall be delivered to the City of Ashland as soon as practicable thereafter. Philway shall provide a copy of its order to the Ohio EPA at the address provided above.

(4) Civil Penalty - Philway shall pay to the State of Ohio a civil penalty in the amount of \$22,500.00, pursuant

to ORC Section 6111.09, which civil penalty shall be credited to the General Revenue Fund. Philway shall pay \$11,250.00 within 30 days after the effective date of this consent decree and Philway shall make a second payment of \$11,250.00 within 90 days thereafter. If the U.S. EPA allows Philway's delisting petition, Philway will within 30 days thereafter pay an additional \$2,500.00 to the State. These payments shall be made by delivering to the Office of Ohio Attorney General, Environmental Enforcement Section, 30 East Broad Street, Columbus, Ohio 43266-0410, Attn: Paul D. Hancock (or his successor), a check in such amount made to the order of "Treasurer of the State of Ohio".

(5) Cost Reimbursement - Within 30 days after the effective date of this consent decree, Philway shall pay to the State of Ohio the sum of \$20,000.00 as a cost reimbursement to the State for expenses associated with this action. The payment shall be made by delivering to the Office of the Ohio Attorney General at the address stated in the preceding paragraph, two checks each in the amount of \$10,000.00 made payable to the order of "Treasurer of the State of Ohio". One of the \$10,000.00 checks will be credited to the Immediate Removal Special Account, created by ORC 3745.12, and the other \$10,000.00 check shall be credited to the Hazardous Waste Clean-up Special Account (623) created by ORC 3734.28. Philway further agreed to and already has paid cost reimbursement to





noncompliance with this Judgment, Philway may raise at that time the issue as to whether the law provides to Philway any defense that its conduct was caused by reason beyond the control of Philway. While Plaintiff does not agree that such defense exist, it is, however, hereby agreed upon by the parties that it is premature at this time to raise and adjudicate the existence of such defense and that the appropriate point which at which to adjudicate the existence of such defense is at the time that an action, if any, is commenced.

(9) Continuing Jurisdiction - This Judgment shall become effective on the date of its entry and filing with the Clerk of the Court. This Judgment shall expire upon the later of two years from its effective date or the completion of the actions required herein. This Court shall retain jurisdiction of this matter until the expiration of the Judgment.

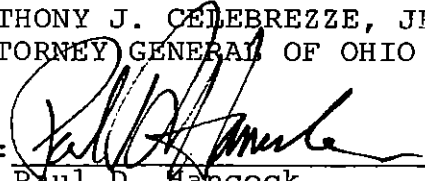
(10) Court Costs - Philway shall pay the court costs of this action.

Date: April 27, 1987

Robert E. Henderson  
JUDGE

ANTHONY J. CELEBREZZE, JR.  
ATTORNEY GENERAL OF OHIO

Date: 4/20/87

By:   
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Sharon Sigler  
Assistant Attorneys General  
Environmental Enforcement  
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PHILWAY PRODUCTS, INC.

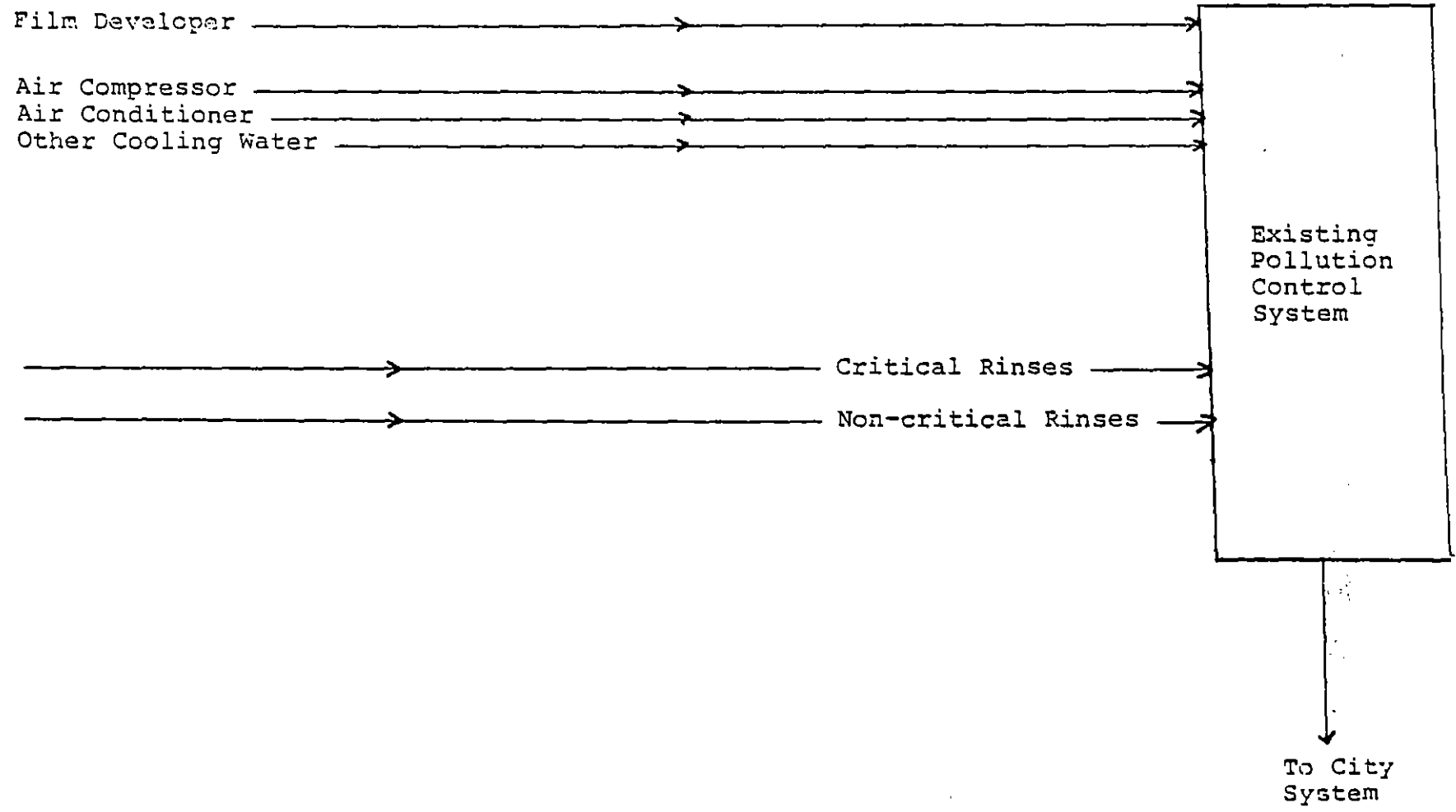
Date: \_\_\_\_\_

By:  4/15/87  
Mr. Mahendra Patel, President

APPROVED BY:

By: WILLIAM S. LIGHTBODY  
William S. Lightbody  
530 National City  
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Cleveland, OH 44114

Attorney for Defendant

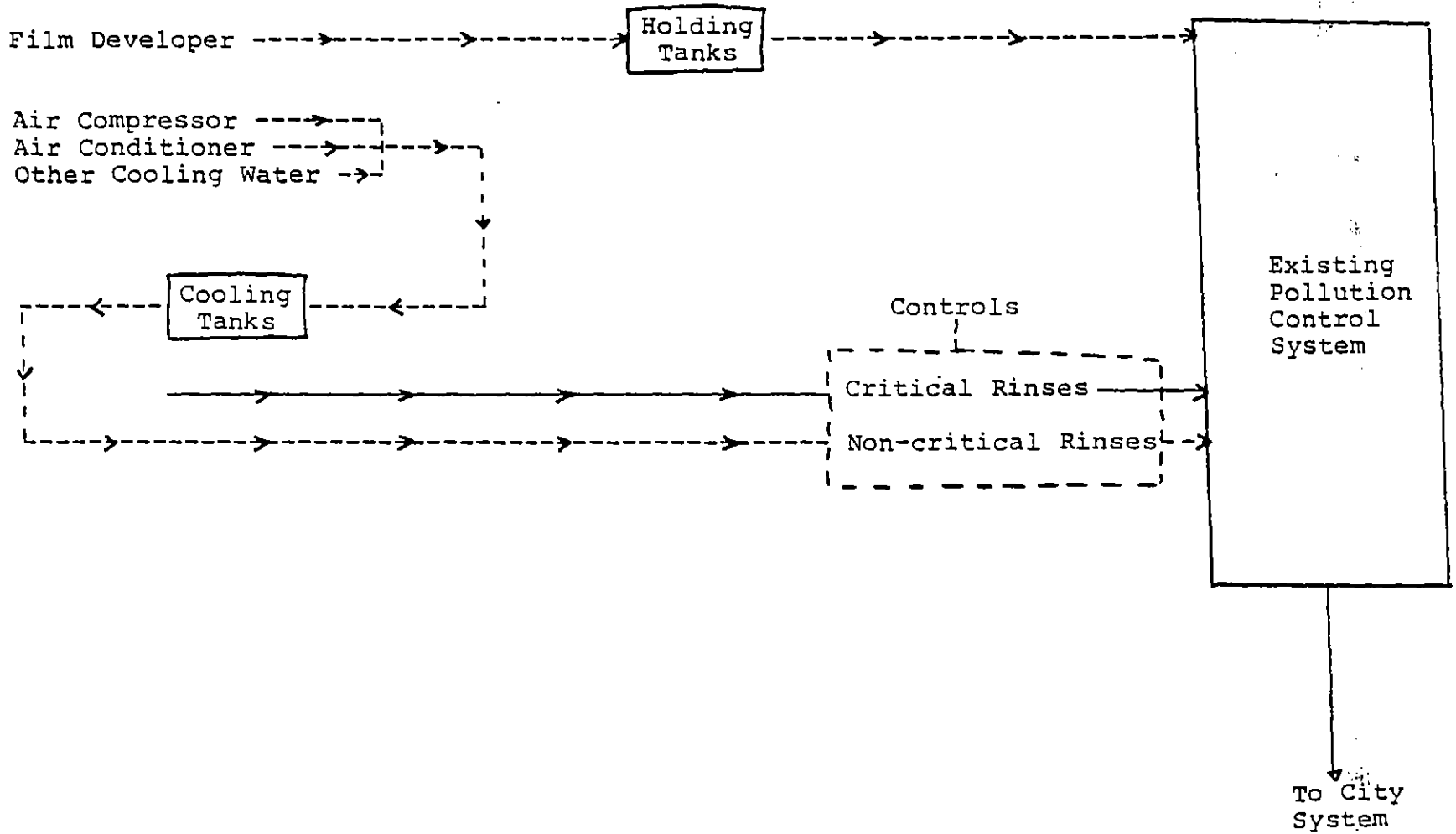


ATTACHMENT A-1

FIRST PHASE

The steps of this Phase are:

repipe plating systems to incorporate cascade and spray rinses; provide and install sensing and control instruments and valves to determine and regulate the water flow to the final plating rinses - both automatic and manual lines; collect and repipe cooling water used for cooling of the air compressor, air conditioners, filters and developer; provide and install cooling devices and de-aerating tanks as required to allow this water to be used for non-critical rinses; and provide and install holding tanks and pump system to meter chemicals from batch dumps of the film developer chemicals into the pollution control system.



ATTACHMENT A-2

SECOND PHASE

The steps of this Phase are:

provide and install a 5,000 gallon tank; three 40 gpm transfer pumps with associated controls; two chemical tanks and feeder pumps for additives; a 40 gpm slant tube clarifier and necessary associated piping, valves, measuring instruments and controls.



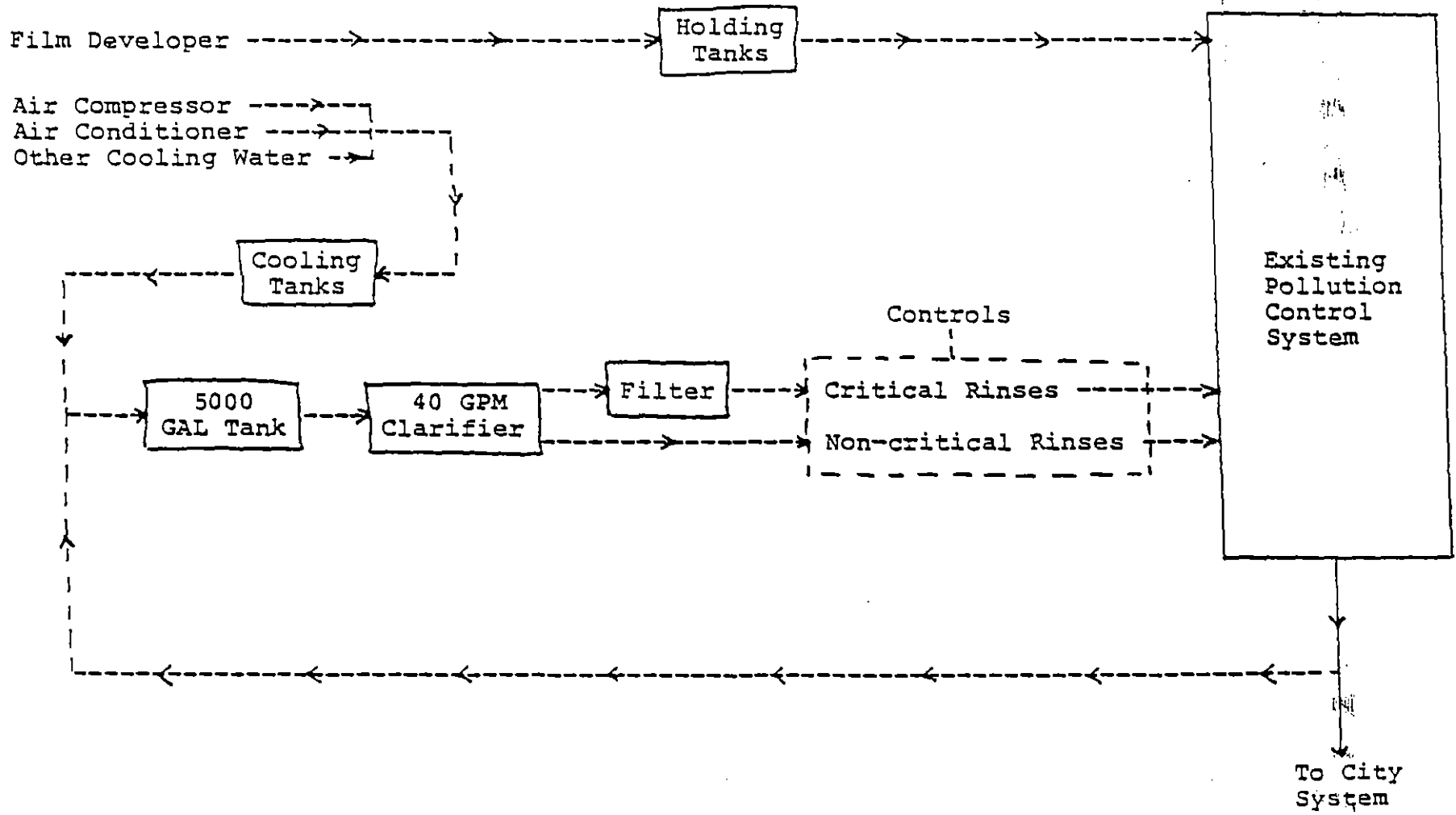
ATTACHMENT A-3

THIRD PHASE

The steps of this Phase are:

provide and install a filter, ion exchanger and/or carbon pack;  
and a further circulating pump together with necessary sensing  
and control instrumentation and piping.



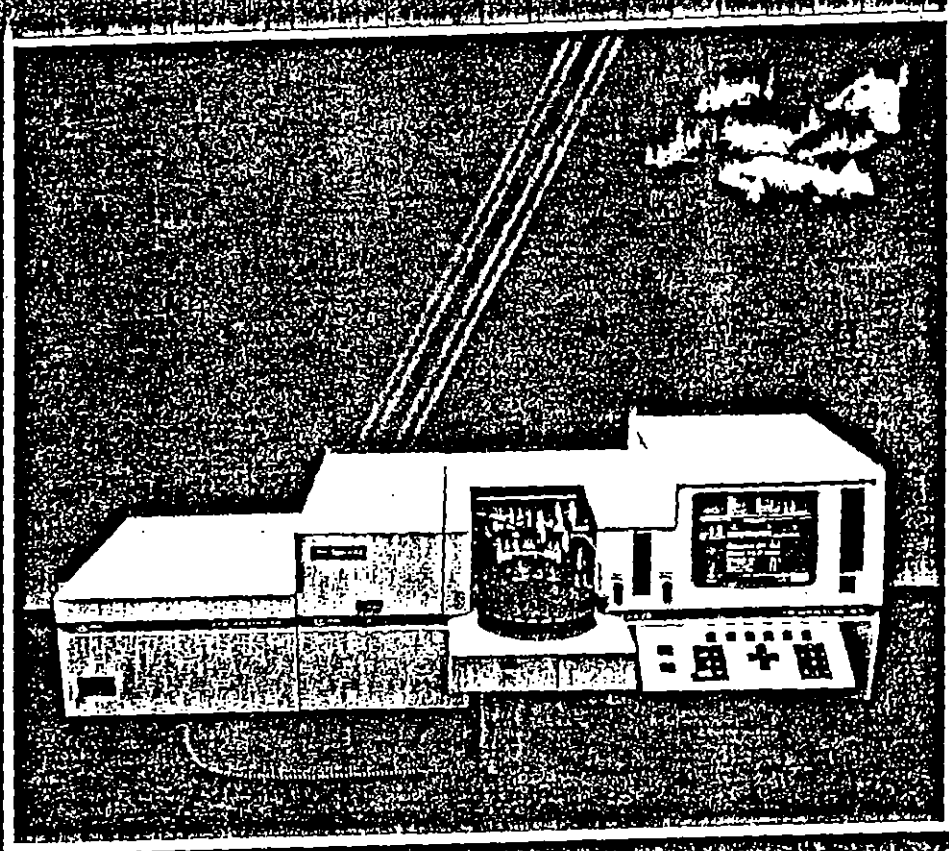


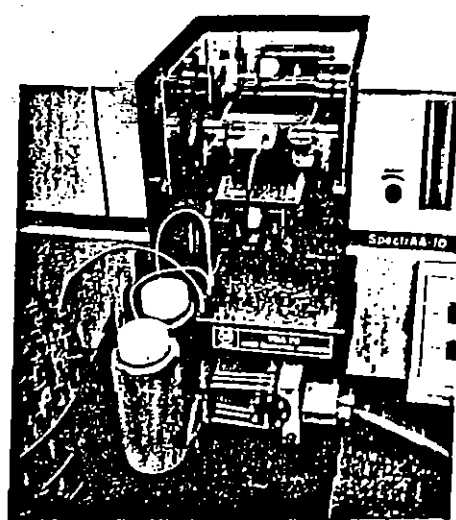
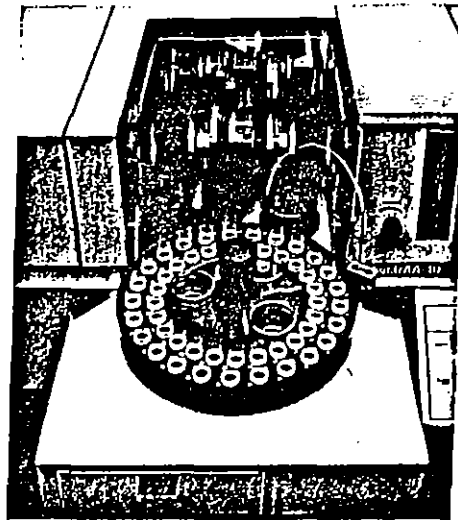
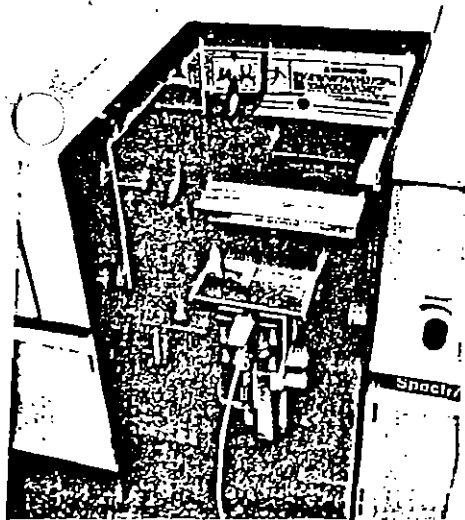
## ATTACHMENT B

If the delisting petition is denied, Philway will install at least four wells at strategic locations about the yellowcake to sample representative groundwater for the purpose of determining whether constituents of the yellowcake in the floor fill area are being released into the groundwater. Of these wells, a control well will be installed upgradient outside a zone of possible contamination from the floor fill. The wells will be screened into the first saturated zone under the facility, 2" i.d., and constructed of plastic pipe, stainless steel screens, gravel packs, and cemented near the surface open annulus. The wells will be sampled quarterly for eight consecutive quarters with the samples analyzed for the EP Toxic metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), copper and ph. These analyses will be performed by an approved independent laboratory with the results reported to the Ohio EPA on a quarterly basis.

Attachment C

Philway shall, following a rainfall event, sample quarterly the existing floor drain system leading from the floor fill area at a location at or near the drain sump on the southern side of the building near to the shipping room door for the purpose of determining whether constituents of the yellowcake in the floor fill area are being released into the drainage system. Samples shall be analyzed by an approved independent laboratory for EP Toxic metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver) copper and ph. Results will be reported quarterly to Ohio EPA.





Varian, with over 25 years of experience in atomic absorption spectroscopy, has been responsible for many of the major innovations and developments in AA instrumentation.

The SpectrAA-30/40 Series of spectrometers, introduced earlier, brought a new level of power, flexibility and automation to atomic absorption analysis. It embodies the concept of centralized control, where the complete instrument system is set up and operated via a single keyboard and screen.

In the SpectrAA-10/20 Series a built-in V.L. and keyboard provide the focus for operation of the spectrometer, sampler and furnace - providing great convenience and simplicity of operation for the budget conscious laboratory.

The SpectrAA-10/20 Series provides extensive data management capabilities - including comprehensive analytical reports tailored exactly to the user's needs.

The design concept provides for even more powerful capabilities to be added simply by the insertion of a floppy disk; or by adding new sample handling or atomization devices, all totally integrated into the single keyboard control concept.

SpectrAA...capability for today, flexibility for tomorrow.

#### Lamp Turret

- element recognition
- lamp warm-up power supply
- optional four-lamp turret

#### Optical System

- rugged double-beam (SpectrAA-20)
- efficient single-beam (SpectrAA-10)
- high energy design
- surfaces protected and sealed

#### Monochromator

- high-efficiency holographic grating
- four slits for flame and furnace
- selected full-range photomultiplier

#### Gas Control

- more interlocks for safest ever flame control

#### Flame Atomizer

- Number One for efficiency
- quick changeover to furnace
- corrosion resistant materials

#### Background Corrector

- fastest correction available
- does not reduce sensitivity or dynamic range
- fully automatic operation

#### Automatic Sampling

- flexible rinse system
- complete recalibration as required
- reslope on any single standard

#### Vapor Generation

- unmatched sensitivity, precision and speed
- automatic calibration and sampling

#### Friendly Assistance

- "Help" provides instant instruction
- inbuilt diagnostics monitor parameter entry during program development and the system during operation

#### Graphics

- high resolution, real-time graphics
- flexible presentation
- hard copy from printer

#### Data Storage

- permanent data storage on disk
- large storage capacity

#### Editing

- remove unwanted readings
- edit and recalculate results

#### Reports

- variety of report formats
- reports generated automatically
- fully documented with record of operating conditions
- sample labels included

#### Graphite Furnace

- unmatched sensitivity for part-per-billion determinations
- totally flexible temperature and gas control
- choice of atomization from pyrolytic platform or graphite tube

#### Furnace Auto-sampler

- automatically prepares standards and standard additions
- adds chemical modifier solution
- minimizes sample handling and avoids contamination
- fully unattended operation

Note: Features described include optional accessories and modules

# Specifications

## **SpectrAA-10/20 Series Spectrometers**

Automated atomic absorption/emission spectrometer with integrated VDU and keyboard providing instrument control data processing as well as control of optional accessories - PSC-56 Programmable Sample Changer and GTA-96 Graphite Tube Atomizer.

### **Four-lamp turret (Option Q)**

Manually operated turret stores four hollow cathode lamps pre-aligned for automatic set-up and operation. In automated analysis, the next lamp in sequence is automatically warmed up. Element coded SpectrAA Lamps are automatically identified. Compatible with conventional uncoded hollow cathode lamps and EDLs.

### **Standard lamp turret**

Turret for one hollow cathode lamp. Automatic identification of element coded SpectrAA Lamps. Compatible with conventional uncoded hollow cathode lamps and EDLs.

### **Optics**

Reflective, hard-dielectric coated mirror system, sealed against dust and vapors. High energy double-beam system using beam switching mirror in SpectrAA-20. Efficient single-beam system in SpectrAA-10.

### **Monochromator**

Czerny-Turner design of 250 mm focal length. Holographic diffraction grating with 1200 lines/mm (developed in collaboration with CSIRO). Wavelength range 190 - 900 nm. Three slits of 0.2, 0.5, and 1.0 nm full height and one reduced height of 0.5 nm for furnace operation.

### **Photomultiplier**

Selected wide range multi-alkali photomultiplier covering range 190-900 nm.

### **Background correction (Option B)**

Synchronously modulated deuterium lamp providing compensation within 2 ms for correction of fast transient signals. Range to 2.0 total absorbance, 190-425 nm.

### **Interlocked flame control**

Manual selection of air or nitrous oxide. Manual selection and control of acetylene. Gas flow displayed on rotameters. Changeover valve from air to nitrous oxide interlocked with burner. Interlocks continually monitor burner type, spray chamber bungs, burner shield and liquid trap level.

### **Automatic flame control (Option A)**

Manual selection and control of gas flows for air-acetylene and nitrous oxide-acetylene flames with flow display on rotameters. Interlocks continually monitor oxidant pressure, mains voltage, burner type, flame condition, spray chamber bungs, shield and liquid trap level.

### **Flame atomizer**

Premix design using pneumatic nebulization. Nebulizer has platinum/iridium capillary and ceramic venturi. Interlocked nebulizer bung with externally adjustable glass impact bead. Interlocked pressure relief bung. Integral liquid trap with liquid level interlock. Titanium burner for air-acetylene flame supplied, optional nitrous oxide-acetylene burner available. Burner interlock system. Height, traverse and rotational adjustment. Easy removal without tools for maintenance or changeover to furnace atomization.

### **Video display unit**

Green phosphor 28.5 cm (12 inch) CRT with high resolution (512 x 240 dot) graphics. High speed 10 MHz clock, 8085A-2 CPU. Single double-sided, double-density disk drive providing 360 K bytes storage. Keyboard with six soft keys and separate numeric and cursor keypads. Centronics output to optional printer/plotter. Optional interface available for IEEE-488, RS-232C and GPIO outputs.

### **Flame system software**

Flame System disk supplied, provides capabilities for analysis using flame or hydride atomization, and includes operation of optional PSC-56. Software is resident on one disk which includes space for storing 30 methods and results from a multi-element analysis. Disk may be copied to provide back-up or to produce personal disks for each operator.

'Cookbook' conditions for all elements may be recalled and modified if required.

HELP key - operation of this key displays instructions for programming the current page and defines the parameters on that page. Effectively it is the operation manual stored on disk.

Operating modes include atomic absorption and flame emission; measurements may be made using multiple integration, 'PROMT' (precision optimized measurement time), peak height or peak area. Calibration may be in absorbance, concentration or intensity (emission) using blank and up to five standards. Standard Additions with up to five additions or Bracketing Standards calibration may be used for highest accuracy.

Graphics include lamp and signal optimization with photomultiplier voltage display, background and corrected atomic signal, calibration curves with error bars.

Reports may be printed during sample analysis or upon completion of a multi-element sequence. Reports include sample labels and batch number, together with operator's identity and date. Operator may choose to include full operating conditions and calibration curves in the report, and may elect to print all readings for every sample, or the concentration and precision, or the concentration alone. Reports may be sequential by element or in multi-element tabular format.

### **Utilities software (option)**

Utilities Disk, compatible with both Flame and Furnace System Disks, provides facility for archival storage of data, including operating conditions and all standard and sample readings from 20 runs. Stored data may be produced as a sequential or multi-element report.

### **Weight correction**

Provides weight correction for automatic adjustment of measured concentration for variations in the actual weight of solid sample taken into solution. Requires optional Utilities disk. Provides 'Edit' facility for removing unwanted readings from archived data. Results from faulty standards may be deleted and samples recomputed using remaining calibration standards.

### **Weight**

Spectrometer module 78 kg (170 lb), shipping weight 110 kg (240 lb). Interface 5 kg (11 lb), shipping weight 6 kg (13 lb).

### **Dimensions**

Spectrometer 108 cm long x 48 cm high x 69 cm deep (42" x 19" x 27"). Interface 26 cm long x 41 cm high x 11 cm deep (10" x 16" x 4").

### **Electrical requirements**

Spectrometer 100/120/220/240 volts ac  $\pm$  10%, 50/60 Hz, 470 VA. Interface 100/120/220/240 volts ac  $\pm$  10%, 50/60 Hz, 40 VA.

### **Gas requirements**

Acetylene (instrument grade) 50-105 kPa (7-15 psi), maximum flow 10 L/min. Air (oil and moisture free) 245-455 kPa (35-65 psi), maximum flow 20 L/min. Nitrous oxide (instrument grade) 245-455 kPa (35-65 psi), maximum flow 16 L/min.

### **Environmental**

Storage 0°C to 50°C at less than 80% relative humidity, non-condensing. Operating 10°C to 35°C, 20% to 90% relative humidity, non-condensing. The concentration of dust and vapors in the instrument environment should comply with the relevant Federal and State health standards for the laboratory workplace.

### **PSC-56 Programmable Sample Changer**

Sample changer for flame or hydride atomization, compatible only with SpectrAA Series instruments. Where depth is limited, an optional trolley (cart) is recommended.

#### **Carousel**

Accommodates 5 test tubes for calibration standards. 67 test tubes for samples. Test tubes (150 mm x 19 mm) not supplied. Also accepts two standard 100 mL beakers for blank and reslope solutions. (Special 200 mL beakers available separately). Carousel dust cover supplied. Optional microvial carousel available for microsampling analysis. Designed for 4 mL disposable vials.

#### **Rinse**

Separate location for beaker for automatic rinsing between samples or during element changeover. Rinse time and frequency are user programmed.

#### **Sampling probe**

Stainless steel sampling probe is provided for neutral or basic solutions. An optional platinum/rhodium acid resistant probe is available.

#### **Weight**

Net weight 15.5 kg (35 lb), shipping weight 24 kg (55 lb).

#### **Dimensions**

56 cm long x 45 cm high x 37 cm deep (22" x 18" x 15").

#### **Electrical requirements**

100/110/220/240 volts ac  $\pm$  10%, 50/60 Hz, 100 VA.

#### **Environmental**

Storage 0° C to 50° C at less than 80% relative humidity, non-condensing. Operating 10° C to 35° C at 20 to 90% relative humidity, non-condensing.

### **ATA-96 Graphite Tube Atomizer**

Furnace atomization system, complete with programmable sample dispenser and furnace system software - compatible only with SpectrAA Series instruments.

#### **Furnace**

Graphite furnace tube situated in enclosed cell with quartz windows. Permanently connected to power supply module by ambilical cord carrying gas, water and electrical supplies. Rapid release mechanism for graphite tube replacement. Accommodates pyrolytic graphite coated tubes, uncoated tubes and total pyrolytic graphite platforms.

Temperature range 40° C to 3000° C, maximum heating rate is controlled 1000° C/sec., cooling time 20 sec.

### **Power supply module**

Provides gas, water and electrical requirements for furnace and sample dispenser under control of SpectrAA Data Station. Using predictive power control and feedback compensation for cooling water temperature provides accurate furnace temperature control over full range from 40° C to 3000° C during both fixed and ramped temperature stages. Interlocked to cooling water pressure and temperature and inert gas pressure. Provides program-controlled regulated flow of inert gas from 0 to 3 L/min and program selection of either of two permanently connected gases.

#### **Programmable sample dispenser**

Accommodates 45 samples in disposable 2 mL microvials, together with up to 5 standard solutions. Has three separate 25 mL vessels for blank, stock standard or reslope standard and chemical modifier solution.

Flow through capillary rinse system, typical capacity 500 rinse operations. Dispensed volume programmable from 1 to 70  $\mu$ L. Repeatability of volume better than 1% RSD (5 to 70  $\mu$ L).

#### **Furnace system software**

Furnace system disk provides capabilities for instrument, furnace and sampler operation and automated analysis with data storage and report generation. Software is resident on one disk which includes space for storing 30 methods and the results from a multi-element analysis. Disk may be copied to provide back-up or to produce personal disks for each operator.

'Cookbook' conditions for all elements may be recalled and modified if desired.

Operating modes include atomic absorption, furnace emission and lamp emission, measurements may be made using Peak Height or Peak Area, with replicates up to 40. Calibration may be in absorbance or concentration using blank and up to five standards. Standard Additions calibration with up to five additions or Bracketing Standards may be used for highest accuracy.

Graphics include lamp and furnace alignment with photomultiplier voltage display, wavelength scan, temperature profile with background and corrected atomic signal, calibration curves with error bars.

Reports may be printed during sample analysis or upon completion of a multi-element sequence. Reports include sample labels and batch description together with operator's name and date. Operator may choose to include full operating conditions and calibration curves in the report, and may elect to print all readings for every sample, or the concentration and precision, or the concentration alone. Reports

may be sequential by element or multi-element tabular format.

Furnace heating programs may include up to 20 temperature stages, each programmable from 40° C to 3000° C, with time 0 to 500 seconds and choice of two gases at flows between 0 and 3 L/min.

Sample dispenser may be programmed for up to 40 replicate analyses. Sample may be injected at a user-selected speed to the furnace pre-heated to between 40° C and 150° C. Multiple injection, to pre-concentrate the sample in the furnace by repeatedly injecting and drying/ashing, may be programmed.

Sample dispenser may automatically prepare standards using blank and stock standard solutions or dispense manually prepared standards. May also automatically prepare standard additions on each of the 45 samples, together with automatic addition of chemical modifier solution. Modifier solution may be injected together with sample, or pre-injected and dried prior to sample.

May be programmed to completely recalibrate at a selected frequency or to perform a reslope calibration using a blank and one standard.

Error protocol permits user to select whether automated analysis continues (in absorbance) should an error in calibration be detected. Following an interruption to mains, system may be programmed to recalibrate or continue with existing stored calibration.

#### **Weight**

Furnace power supply module 43 kg (95 lb), shipping weight 55 kg (120 lb). Sample dispenser 6 kg (13 lb), shipping weight 12 kg (26 lb).

#### **Dimensions**

Furnace power supply module 44 cm long x 30 cm high x 54 cm deep (18" x 12" x 22"). Sample dispenser 31 cm x 33 cm x 37 cm (13" x 13" x 15").

#### **Electrical requirements**

208/220/240 volts ac,  $\pm$  10%, 50/60 Hz. Rated current 15 A, single phase. Surge current 40 A.

#### **Gas requirements**

Inert gas (dry 99.99% pure argon preferred), 140-200 kPa (20-30 psi), maximum consumption 3 L/min.

#### **Cooling water requirements**

Mains or recirculated supply of 1.5 to 2.0 L/min, 200 kPa (30 psi) maximum pressure. Temperature less than 40° C.

#### **Environmental**

Storage 0° C to 50° C at less than 80% relative humidity, non-condensing. Operating 10° C to 35° C, 20% to 90% relative humidity, non-condensing.

Specifications are subject to change without notice.