APPENDIX 2-5

CONTROL SYSTEMS ENGINEERING DESIGN CRITERIA

1.0 INTRODUCTION

Control of the design, engineering, procurement, and construction activities on the project will be completed in accordance with various predetermined standard practices and project specific programs/practices. An orderly sequence of events for the implementation of the project is planned consisting of the following major activities:

- Conceptual design;
- Licensing and permitting;
- Detailed design;
- Procurement;
- Construction and construction management;
- Testing and checkout, start-up; and
- Project completion.

The purpose of this appendix is to summarize the codes and standards and standard design criteria and practices that will be used during the project. The general control design criteria defined herein form the basis of the design for the control systems of the project. More specific design information is developed during detailed design to support equipment and erection specifications. It is not the intent of this appendix to present the detailed design information for each component and system, but rather to summarize the codes, standards, and general criteria that will be used.

Section 2.0 summarizes the applicable codes and standards and Section 3.0 includes the general design criteria for general conditions, instruments, modulating type control systems, motor controls, and control equipment locations.

2.0 DESIGN CODES, STANDARDS, LAWS AND REGULATIONS

The design specifications for all work will be in accordance with the applicable laws and regulations of the federal government, the State of California, and applicable local codes and ordinances. A summary of codes and industry standards applicable to design and construction follows:

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- The Institute of Electrical and Electronics Engineers (IEEE)
- The Instrumentation, Systems, and Automation Society (ISA)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Scientific Apparatus Makers Association (SAMA)
- American Society for Testing and Materials (ASTM)

Other recognized standards will be utilized as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.

The codes and industry standards used for design, fabrication, and construction will be the codes and industry standards, including all addenda, in effect as stated in equipment and construction purchase or contract documents.

3.0 CONTROL SYSTEMS DESIGN CRITERIA

3.1 GENERAL REQUIREMENTS

3.1.1 Ambient Conditions

All field-mounted instruments and control devices will be designed to withstand extremes of the outdoor ambient temperatures and relative humidities found at the site.

All instruments and control devices installed in air-conditioned areas will be designed for an operating condition of 75 deg F ambient temperature and 50 percent relative humidity. ln case of an air-conditioning failure, they shall operate in temperatures ranging from 50 deg F to 100 deg F for extended periods of time (several hours to several days) and 110 deg F transients.

3.1.2 Power Supplies

All instruments and control devices will be designed to operate using the following power supplies:

- Electric
  - 120 volt alternating current (ac), 60 hertz, single-phase for logic and low torque drives
  - 24 volt direct current (dc) for logic
  - 480 volt ac, 60 hertz, 3-phase for high torque drives

Any voltage required other than the above will be furnished by the equipment supplier.

- Pneumatic
  - Clean, dry, and oil free instrument air at 70 to 125 pounds per square-inch gage (psig). All necessary pressure reducing controls, where required, will be furnished by the equipment supplier.

3.1.3 Standard Ranges of Analog Signals

The ranges of analog signals will normally be as follows:

- Electric
  - 4 to 20 mADC
- Pneumatic

- 3 to 15 psig

The use of any signal range other than the above will be avoided.

3.1.4 Contact Ratings

The ratings of all instrument contacts used for alarms and interlocks will have a minimum rating sufficient for use on microprocessor based systems.

The ratings of all microprocessor output contacts will be the supplier's standard rating.

3.2 INSTRUMENTS

3.2.1 Instrument Primary Piping/Tubing (Impulse Lines)

Instrument primary piping/tubing is defined as the piping directly connected to the process (the outlet of the root valve), and terminating at the blowdown valve and at the point of connection to the instrument itself.

3.2.1.1 Sizes of Instrument Primary Piping/Tubing

Instrument primary piping/tubing for process connections will be in accordance with the following guidelines:

- One-half inch outside diameter (O.D.) with a wall thickness of 0.065 inches.
- Three-eighth inch outside diameter with a wall thickness of 0.065 inches may be used for those parts of a sampling system within a panel or a rack.
- Float-actuated level switch devices will be supported on connecting piping not smaller than one inch.
- Level controllers and transmitters of the displacement float type will be supported on connecting piping not smaller than two inches.
- Instrument columns for float actuated level switches and displacement float devices will be piping of not less than two inches.

3.2.1.2 Materials for Instrument Primary Piping/Tubing

All primary sensing, sampling, and control systems will use stainless steel tubing conforming to ASTM A213, Grade TP 316, with compression type fittings. Instrument air supply will use Type K drawn temper copper tubing or stainless steel tubing.

3.2.1.3 Insulation and Freeze Protection of Instrument Primary Piping/Tubing

Instrument primary piping or tubing connecting to high temperature systems, which might become hot enough to injure personnel during blowdown of the instrument line, will be insulated where such hazard exists. Insulation materials, exterior finish, and metal lagging will conform to the standards adopted for the process piping.

All water-filled primary piping or tubing in plant areas subject to freezing will be insulated and freeze protected.

3.2.1.4 Criteria for Routing of Instrument Primary Piping/Tubing

Routing of instrument primary piping, including piping from the process connection through the root valve and the instrument primary piping, will be in accordance with the following criteria.

Special fittings such as reservoirs and other devices will be installed at flow primary element connections as required by the design of the instrument, in accordance with instructions of the instrument supplier.

Instrument primary piping for liquid flow, and manometer level measurement systems should preferably slope downward from the primary element connections to the instrument. Instrument primary piping for flue gas and airflow measurement systems should preferably slope upward from the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 1/2 inch per foot and must be adequately supported to maintain a constant slope.

3.2.1.5 Support of Instrument Piping

Instrument primary piping and stainless steel tubing will be supported in accordance with support requirements for process piping. Pneumatic signal and air supply tubing will be continuously supported. Continuous support will normally be provided by tubing tray.

3.2.2 Thermowells and Protecting Tubes

Fluid system temperature sensors will be equipped with 1-1/2 inch flanged or 1 inch threaded thermowells and will be made of one piece, solid bored Type 316 stainless steel (unless process conditions dictate other materials) of stepless tapered design.

Temperature detectors in exhaust gas ducts will be mounted to permit replacement while in operation. Duct connections will consist of screwed couplings or adapter flanges welded to the ducts, into which the bushings on the protecting tubes can be threaded. Duct connections will be located to minimize the effect of temperature stratification within the ducts.

3.2.3 Thermocouples And Resistance Temperature Detectors

Temperature detectors will preferably be chromel-constantan type (ISA Type E) thermocouples with Type EX extension cable or chromel-alumel (ISA Type K) with Type KX extension cable. The elements, as a rule, will be separate from ground (ungrounded). A ground lug shall be provided in the thermocouple head.

Resistance temperature detectors (RTDs) will be of the three-wire 100 Ohm platinum type. All RTDs for measurement of fluid system temperature will be ungrounded, metal sheathed, ceramic packed, and suitable for the design temperature, pressure, and velocity of the fluid system.

Thermocouples and RTDs will have sheathed elements spring-loaded to provide good thermal contact with the well or protecting tube.

3.2.4 Transmitters

Transmitters will be used to provide the required 4 to 20 maDC signals for all control systems. Transmitters will be of the electronic two-wire type, capable of driving a load up to 750 Ohm, designed with provisions for tamper-proof zero and span adjustments. They will be microprocessor based (“smart”) to allow for ease of operation and maintenance.

3.2.4.1 Static Pressure and Differential Pressure Transmitters

Sensing elements for static pressure and differential pressure transmitters will be of either the capacitance or strain gauge type.
For water services, static pressure transmitters will be equipped with a two-valve manifold, and differential pressure transmitters will be equipped with a three-valve manifold.

3.2.4.2 Level Transmitters

Sensing elements for level transmitters will be of the following types:

- Static head devices for vessels exposed to atmospheric pressure; capacitance type devices; or air bubbler type devices if absorption of air by the liquid is not objectionable.

- Differential pressure type with constant head chamber for high pressure and temperature applications where installation of float cage becomes impractical. (Level transmitters of this type are the same as differential pressure transmitters.)

- Displacement float type or differential pressure type for enclosed vessels.

- Moving float type for fuel oil storage tanks.

3.2.4.3 Flow Transmitters

Flow transmitters for general applications will be of the differential pressure type.

- **Primary Elements.** Flow nozzles or venturis will be used for feedwater flow and other critical measurements where weld-in construction is required. Installation of flow nozzles and pressure taps will be made in the pipe fabricator's shop.

- Paddle type orifice plates will be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice flanges will be of the raised face weld neck type with dual sets of taps.

- **Secondary Elements.** Secondary elements for differential type flow sensors will be strain gauge or capacitance type differential pressure (DP) transmitters. Square root extraction required for the DP transmitters will be performed electronically in the control system which receives the transmitter output signal.

3.2.5 Temperature, Pressure, Level, and Flow Switches

Temperature, pressure, level and flow switches will generally have double-pole, double-throw (two Form C) contacts for each actuation point and will be equipped with screw type terminal connections on a terminal block for terminating field wiring. Dual setpoint switches will not be used.

3.2.5.1 Temperature Switches

Temperature switches will be actuated by filled-bulb type elements equipped with standard length armored capillary tubing.

3.2.5.2 Pressure Switches

Pressure switches will be actuated by disk or diaphragm type elements.

3.2.5.4 Level Switches

Level switches will be actuated by elements of the following types:

- Static head devices for vessels exposed to atmospheric pressure; air bubbler type devices may be used if absorption of air by the liquid is not objectionable. (Level switches of this type are the same as static pressure switches.)
- Differential type for high-pressure and high temperature applications. (Level switches of this type are the same as differential pressure switches.)
- Displacement float type or differential type for enclosed vessels
- Moving float type for open tanks and sumps
- Thermal or ultrasonic type for specialized applications

3.2.5.4 Flow Switches

Variable area or differential pressure type actuating elements will be used for low flow and low pressure applications.

3.2.6 Local Indicators

3.2.6.1 Local Temperature Indicators (Thermometers)

Thermometers for local mounting will be 5 inch dial gas-actuated thermometers, or an acceptable equal. Thermowells will be furnished for all thermometers.

3.2.6.2 Local Pressure Indicators (Pressure Gauges)

Gauges for control air supply and signal pressures integral to an instrument will be in accordance with the instrument supplier's standards. All other gauges will be 4-1/2 inch minimum dial size, or an acceptable equal. Dial scales will be so that the normal operating range is in the middle third of the dial range. Gauges for fluids which may be corrosive to the gauge internals will be furnished with diaphragm seals. Gauges in pulsating service will be furnished with liquid filled cases or pulsation dampeners.

3.2.6.3 Local Level Indicators (Gauge Glasses)

Tubular gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves including a safety ball check. Magnetic style level gauges may also be used in all services.

3.2.6.4 Flow Indicators

Sight flow and variable flow indicators will be used for low-pressure and low temperature applications. The use of sight and variable flow indicators will be restricted to applications where quantitative measure of flow is not required.

Flow indicators for high-pressure and high temperature applications are not anticipated.

3.2.7 Solenoid Valves

Solenoid coils will generally be high temperature low wattage construction and will be designed for continuous duty. Three-way solenoid valves will be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures will be NEMA 4.

3.3 MODULATING TYPE CONTROL SYSTEMS

3.3.1 Electronic Control Systems

A distributed microprocessor-based control system will be used to implement plant controls strategies. This Distributed Control System (DCS) will integrate coordinated control motor control data acquisition, and annunciation functions.

Control systems supplied with individual supplier's equipment will, to the extent practical, be designed to be integrated into the plant DCS.

3.3.2 Pneumatic Controllers

The use of pneumatic controllers will be minimized, but may be used for the following applications:

- Control loops which require only proportional or proportional plus reset action, but require no remote manual positioning by the Control Room operator; and
- Control loops that do not require any interface with any receiver installed in the central room.

3.4 MOTOR CONTROLS

3.4.1 Motor Interlocks

Motor interlocks will be designed in accordance with the following criteria and will be implemented in the DCS.

3.4.1.1 Protective Interlocks

The protective interlocks for each motor and its associated equipment will be designed as follows:

- To prevent the motor from being started if the starting permissives required for safe operation are not satisfied;
- To automatically stop the motor under unsafe operating conditions when any action by the operator may be too slow to prevent the motor and its associated equipment from being damaged;
- To automatically start any standby equipment as a result of a motor trip and/or as required by the process; and
- To provide status information to inform the operator of the equipment status at all times.

3.4.1.2 Standby Starts

Components in a system which are paired to back up each other will have a standby mode imposed upon the protective interlock scheme. If the redundant pump is in the standby mode when the operating pump is tripped, or a process parameter indicates that the operating pump has failed, the standby pump will standby-start. After a pump has started in the standby mode, the pump will not stop automatically, except on a trip condition. An alarm will be sounded to alert the operator that the pump has standby-started.

3.4.1.3 <u>Automatic Starts and Stops</u>

Equipment in some systems will operate in an automatic mode in which the starting and stopping of a motor are initiated automatically. An example of the automatic mode would be a tank fill pump that automatically starts at a low level and stops at a high level. Automatic motor actuations will not be alarmed unless the automatic action is initiated by a protective interlock.

3.4.2 Sequential Controls

Sequential controls apply control logic to a system or group. The basic functions are to coordinate the operation of all components within a functional group and to automatically start or stop all components in a predetermined sequence without the operator initiating any step-by-step control during the process. Sequential controls will be used on the various water treatment systems.

3.4.3 Hardware Selection

3.4.3.1 <u>Logic Systems</u>

The main plant controls will utilize DCS type hardware data linked to the combustion turbine control systems. Controls purchased as part of an equipment package may utilize electromechanical or solid-state hardware, or may be hybrid.

3.4.3.2 <u>Local Control Hardware</u>

Small fans and pumps may be controlled by local control switches, if advantageous.

3.5 LOCATION OF CONTROL EQUIPMENT

Control equipment refers to the control devices used to implement the modulating control and motor controls systems.

All pneumatic controllers will be field-mounted locally. All other control devices will be either mounted on a control panel in a control cabinet, or on local stands.

3.5.1 Control Areas

Control areas will include the Control Room, the electronic equipment room, and local areas in which local control stations and local control panels are located.

3.5.1.1 <u>Control Room</u>

The Control Room will contain the desk type control consoles from which the operator will conduct all normal and emergency operations of the unit. The Control Room will contain all auxiliary control panels. The control room will be environmentally controlled.

The alarm, utility, and log printers will also be located in the Control Room.

3.5.1.2 <u>Electronic Equipment Room</u>

The electronic equipment room for the installation of control equipment, computer cabinets, turbine supervisory system, and other solid-state electronic equipment will be provided in an area adjacent to the Control Room. The electronic equipment room will be environmentally controlled.

3.5.1.3 <u>Local Control Areas</u>

Local control areas will be established for systems where it is advantageous to have operator control in the vicinity of the equipment being controlled.