Appendix Q
Control Systems Engineering Design Criteria

APPENDIX Q – CONTROL SYSTEMS ENGINEERING DESIGN CRITERIA **Page**

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
- Project completion

The purpose of this appendix is to summarize the codes, 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 of this appendix summarizes the applicable codes and standards and Section 3.0 of this appendix includes the general design criteria for general conditions, instruments, modulating type control systems, motor controls, and control equipment locations.

2.0 DESIGN LAWS, ORDINANCES, REGULATIONS AND STANDARDS (LORS)

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)
- Instrument Society of America (ISA)
- National Electrical Manufacturers Association (NEMA)
- 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 humidity found at the site.

All instruments and control devices installed in air-conditioned areas will be designed for operating conditions of 25 deg. C ambient temperature and 50 percent relative humidity. In case of an air-conditioning failure, they shall operate in temperatures ranging from 10 deg. C to 40 deg. C for extended periods of time (several hours to several days) and 30 deg. C transients.

3.1.2 Power Supplies

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

3.1.2.1 Electric

- 120VAC, 60 hertz, single-phase for logic and low torque drives
- 125VDC for logic and low torque drives
- 480VAC, 60 hertz, 3-phase for high torque drives.

Any voltage required other than the above 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 Thermowells and Protecting Tubes

Fluid system temperature sensors will be equipped with 1½ inch flanged thermowells and will be made of one piece, solid bored Type 316 stainless steel 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.

3.2.2 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 (RTD’s) 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 RTD’s will have sheathed elements spring-loaded to provide good thermal contact with the well or protecting tube.

3.2.3 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.

3.2.3.1 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.

3.2.3.2 Level Transmitters

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

- Displacement float type or differential pressure type for enclosed vessels. Moving float type for fuel oil storage tanks.

3.2.3.3 Flow Transmitters

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

- Paddle type orifice plates will be used for other flow measurements where flanged construction and higher pressure loss are acceptable for the hydrogen distribution systsem. 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 that receives the transmitter output signal.

3.2.4 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.

3.2.4.1 Temperature Switches

Temperature switches will be actuated by filled-bulb type elements equipped with standard length armored capillary tubing. This will be used on the hydrogen tube buddle Tankage SCADA interconnections.

3.2.4.2 Pressure Switches

Pressure switches will be actuated by disk or diaphragm type elements. . This will be used on the hydrogen tube buddle Tankage SCADA interconnections.

3.2.4.3 Level Switches

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

- 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.

3.2.4.4 Flow Switches

Variable area or differential pressure type actuating elements will be used for low flow and low pressure applications. This will be used in the detection of abnormal flow of hydrogen to the field distribution network.

3.2.5 Local Indicators

3.2.5.1 Local Temperature Indicators (Thermometers)

Thermometers for local mounting will be 4-1/2-inch dial gas-actuated thermometers, or an acceptable equal. Thermowells will be furnished for all thermometers. This will be used in an RTD device that is sealed and closed to atmospheric pressure.

3.2.5.2 Local Pressure Indicators (Pressure Gauges)

Gauges for control air supply and signal pressures integral to an instrument will be in accordance with the instrument supplies standards. All other gauges will be 2 to 4-1/2-inch minimum dial size, or an acceptable equal. Dials will be scaled so that the normal operating range is in the middle third of the dial range. Gauges for fluids that may be corrosive to the gauge internals will be furnished with glycerin filled cases and diaphragm seals.

3.2.5.3 Local Level Indicators (Gauge Glasses)

Tubular gauge glasses will be used for low-pressure applications and will not be used on any hydrogen applications. Transparent or reflex gauges will be used for high-pressure applications and these will be certified for “Hydrogen Use ONLY” . All gauge glasses will be equipped with gauge valves including a safety ball check.

3.2.5.4 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. These applications will be used for water and oil storage at low volumes for inventory management.

3.2.6 Solenoid Valves

Solenoid coils will generally be high temperature and high pressure, low wattage construction and will be designed for continuous duty. Three-way solenoid valves will be designed for universal operation so that the application 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. The individual DCS controls will be apart of the SCADA control network for the power plant.

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/SCADA.

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, such as Fresh water diesel platform with engines over 50 Hp lube oil pumps, 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 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 Automatic Starts and Stops

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 Water Tank fill pump that automatically starts at a low level and stops at a high level. Automatic motor actuation 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 Local Control Hardware

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 control systems.

All fresh water, raw water, septic system, demineralizer system, etc, pneumatic controllers will be field-mounted locally. All other control devices will be mounted either on a control panel in a control cabinet, or on local stands. Where possible the controls will be segmented to the SCADA controls network.

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 Control Room

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 Electronic Equipment Room

The electronic equipment room for the installation of control equipment, computer cabinets, power plant supervisory control and acquisition 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 Local Control Areas

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