Appendix 2-5

Control Engineering Design Criteria

2.5.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of control engineering systems for the Kings River Conservation District Community Power Plant (KRCD CPP). More specific project information will be developed during execution of KRCD CPP to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

2.5.2 Codes and Standards

The design of control engineering systems for KRCD CPP will conform to the laws and regulations of the federal government and the State of California, the County of Fresno, and applicable industry codes, standards and practices. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used. A summary of general codes and industry standards applicable to the control engineering 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 Safety Code (NESC);
- National Fire Protection Association (NFPA); and
- American Society for Testing and Materials (ASTM).

2.5.3 Control Systems Design Criteria

2.5.3.1 General Requirements

Pneumatic signal levels, where used, will be 3-15 pounds per square inch gauge (psig) for electric-to-pneumatic converter outputs, and valve positioner inputs. The primary sensor full-scale signal level, other than thermocouples, will be between four and 20 milliamps Direct Current (mADC).

2.5.3.2 Pressure Instruments

In general, pressure instruments will have linear scales with units of measurement in psig. Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face. Pressure gauges on process piping will be resistant to plant atmospheres. Siphons will be installed on pressure gauges in steam service as required by the system design. Steam pressure sensing transmitters or gauges mounted above the steam line will be protected by a loop seal. Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.

2.5.3.3 Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit (°F). Exceptions to this are electrical machinery resistance temperature detectors (RTDs) and transformer winding temperatures, which are in degrees Celsius. Dial thermometers will have 4½- or 5-inch-in-diameter (minimum), dials and white faces with black scale markings and will be every-angle type and bimetal actuated. Dial thermometers will be resistant to plant atmospheres. Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs. RTDs will be either 100 electrical resistance (ohm) platinum or 10 ohm copper, ungrounded, three-wire circuits (R100/R0-1.385). The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly. Thermocouples will be single-element, ungrounded, spring-loaded, Chromel-Constantan (ANSI Type E) for general service. Thermocouple heads will be the cast type with an internal grounding screw.

2.5.3.4 Level Instruments

Reflex-glass or magnetic level gauges will be used. Level gauges for high-pressure service will have suitable personnel protection. Gauge glasses used in conjunction with level instruments will cover a range that is covered by the instrument. Level gauges will be selected so that the normal vessel level is approximately at gauge center. A single remote water level indicating system will be provided for each heat recovery steam generator (HRSG) drum.

2.5.3.5 Flow Instruments

Flow transmitters will be the differential pressure type with the range matching the primary element. In general, linear scales and charts will be used for flow indication and recording. The flow element for feedwater flow to each HRSG will be laboratory calibrated venturi flow nozzles. In general, feedwater flow meters will be temperature compensated when the water temperature is greater than approximately 250°F, critical steam flow meters will be temperature and/or pressure compensated, and airflow measurements will be temperature compensated.

2.5.3.6 Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (e.g., butterfly, eccentric disk) may also be used when suitable for the intended service. Valves will be designed to fail in a safe position. Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping. Control valves in 600 class service and below will be flanged where economical. Where flanged valves are used, minimum flange rating will be ANSI 300 Class. Critical service valves will be defined as ANSI 900 Class and higher valves in sizes larger than two inches. Severe service valves will be defined as valves requiring anticavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 pounds per square inch differential (psid). In general, control valves will be specified for a noise level no greater than 85 decibels "A" scale (dBA) when measured three feet downstream and three feet away from the pipe surface. Valve actuators will use positioners and the highest pressure, smallest size actuator, and will be the pneumatic-spring diaphragm or piston type. Actuators will be sized to shut off against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 60 to 125 psig.

Handwheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain plant operation) and do not have manual bypasses. Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected. Solenoid valves supplied with the control valves will have Class H coils. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation. Terminations will typically be by pigtail wires. Valve position switches (with input to the Distributed Control System (DCS) for display) will be provided for motor operated valves and open/close pneumatic valves. Automatic combined recirculation flow control and check valves (provided by the pump manufacturer) will be used for pump minimum-flow recirculation control. These valves will be the modulating type.

2.5.3.7 Instrument Tubing and Installation

Tubing used to connect instruments to the process line will be 3/8-inch or 1/2-inch outside diameter, copper or stainless steel as necessary for the process conditions. Instrument tubing fittings will be the compression type. All materials used and construction performed for instrument primary piping and tubing shall be in accordance with ASME B31.1 – Power Piping. One manufacturer will be selected for use and will be standardized as much as practical throughout the plant.

Differential pressure (flow) instruments will be fitted with three-valve manifolds; two-valve manifolds will be specified for other instruments as appropriate. Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves. Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

2.5.3.8 Pressure and Temperature Switches

Field-mounted pressure and temperature switches will have either NEMA Type 4 housings or housings suitable for the environment. In general, switches will be applied such that the actuation point is within the center one-third of the instrument range.

2.5.3.9 Field-Mounted Instruments

Field-mounted instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment. Freeze protection will be provided. Field-mounted instruments will be grouped on racks. Supports for individual instruments will be prefabricated, off-the-shelf, two-inch pipestand. Instrument racks and individual supports will be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected. Local control loops will generally use a locally mounted indicating controller (pressure, temperature, flow, etc.). Liquid level controllers will generally be the nonindicating, displacement type with external cages.

2.5.3.10 Instrument Air

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served. Each instrument air user will have a shutoff valve and filter at the instrument.