

MANUAL
ON
INSTALLATION OF REFINERY INSTRUMENTS
AND CONTROL SYSTEMS

PART I—PROCESS INSTRUMENTATION AND CONTROL

SECTION 12—CONTROL CENTERS

THIRD EDITION
1977

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API RP 550

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FOREWORD

This recommended practice is based on the accumulated knowledge and experience of engineers in the petroleum industry. Its purpose is to aid in the installation of the more generally used measuring, control, and analytical instruments; transmission systems; and related accessories in order to achieve safe, continuous, accurate, and efficient operation with minimum maintenance. Although the information contained herein has been prepared primarily for petroleum refineries, much of it is applicable without change in chemical plants, gasoline plants, and similar installations.

Successful instrumentation depends upon a workable arrangement that incorporates the simplest system and devices that will satisfy specified requirements. Sufficient schedules, drawings, sketches, and other data should be provided to enable the constructor to install the equipment in the desired manner. The various industry codes and standards, and laws and rulings of regulating bodies should be followed where applicable. The information contained in this publication does not constitute, and should not be construed to be, a code of rules or regulations.

For maximum plant personnel safety, transmission systems are employed to eliminate the piping of hydrocarbons, acids, and other hazardous or noxious materials to instruments in control rooms. Proper installation is essential in order to utilize the full capabilities which are built into the instrument or transmission system.

In the installation of an instrument, the various components must be accessible for efficient maintenance and certain of these elements must be readable for good operation. Orifices, control valves, transmitters, thermocouples, level gages, and local controllers, as well as analyzer sample points, generally should be readily accessible from grade, permanent platforms, or fixed ladders. In this manual, special consideration is given to the location, accessibility, and readability of the elements.

Users of the various sections of this manual are reminded that in the rapidly advancing field of instrumentation no publication of this type can be complete, nor can any written document be substituted for qualified engineering analysis.

Certain systems are not covered herein because of their very specialized nature and limited use. When one of these systems gains general usage and installation reaches a fair degree of standardization, this section will be revised to incorporate such additional information.

Acknowledgment is made of the work of all the engineers and operating and maintenance personnel who, through years of study, observation, invention, and sometimes trial and error have contributed to the technology of instrumentation.

Suggested revisions are invited and should be submitted to the director of the Refining Department, American Petroleum Institute, 2101 L Street, N W, Washington, D. C. 20037.

PREFACE

This section is one of a series which make up RP 550, *Manual on Installation of Refinery Instruments and Control Systems*. RP 550 is composed of four parts:

- Part I—Process Instrumentation and Control
- Part II—Process Stream Analyzers
- Part III—Fired Heaters and Inert Gas Generators
- Part IV—Steam Generators

Part I assays the installation of the more commonly used measuring and control instruments, as well as protective devices and related accessories; Part II presents a detailed discussion of process stream analyzers; Part III covers installation requirements for instruments for fired heaters and inert gas generators; and Part IV covers installation requirements for instruments for steam generators. These discussions are supported by detailed information and illustrations to facilitate application of the recommendations.

The format of RP 550, Part I has been changed to facilitate continuity of presentation, convenience of reference, and flexibility of revision. Each section is now being published individually as follows:

- Section 1—Flow
- Section 2—Level
- Section 3—Temperature
- Section 4—Pressure
- Section 5—Automatic Controllers
- Section 6—Control Valves and Accessories
- Section 7—Transmission Systems
- Section 8—Seals, Purges, and Winterizing
- Section 9—Air Supply Systems
- Section 10—Hydraulic Systems
- Section 11—Electrical Power Supply
- Section 12—Control Centers
- Section 13—Alarms and Protective Devices

In the preparation of these documents, it was necessary to decide on a logical method of presentation: should each point be explained as fully as possible, or should extensive cross-referencing be done between sections?

The final documents contain a combination of these methods of presentation. An attempt has been made to make each section as complete as possible, with cross-referencing done only where very extensive repetition would have been required.

Users of this recommended practice are cautioned to obtain a complete set of sections in order to efficiently accomplish any cross-referencing that is required for a full understanding of the subject matter.

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PART I—PROCESS INSTRUMENTATION AND CONTROL

SECTION 12—CONTROL CENTERS

12.1 Scope

This section presents recommended practices for the design and installation of control centers for processing operations. The term *control center*, as used in this section, defines a building which encompasses the control room with control panels and other associated control equipment, termination room, computer equipment room (if required), associated offices, utility and mechanical equipment, and any other facilities housed within the building.

The section covers guidelines for locating the control center in reference to the processing units controlled from it; discusses factors associated with the design and installation of the building, primarily as these factors affect the instrumentation within the building; and presents common practices for the construction and installation of the various types of control panels and auxiliary control equipment.

12.2 General

It is current industry practice to centralize control of process units, particularly when their operations are integrated. Some refineries that previously had a number of control rooms have now consolidated these controls into one control center. Centralization of control requires a careful choice of control center location, evaluation of control center building design factors, and regulation of the building internal environment for the comfort of operating personnel and protection of the control equipment.

The ability to increase the degree of centralization of control is the result of several factors. The most important are discussed in 12.2.1 through 12.2.4.

12.2.1 ELECTRONIC INSTRUMENTATION

The availability of well-engineered electronic transmission and control equipment has extended the distance from process unit to control center over which good process control could be obtained.

12.2.2 EXPERIENCE

Satisfactory experience has been achieved in the operation and control of grass roots integrated refineries and petrochemical plants with a single control center.

12.2.3 INFORMATION DISPLAY IMPROVEMENTS

Significant improvements have been made in methods of presenting control room information to operators. The use of high-density display, shared recording, and cathode ray tubes has resulted in more data being presented in less total control panel length. In several recent installations, digital computers have been used to (a) reduce (or even eliminate) the number of individual controllers needed and (b) provide the operator with all the information formerly obtained from a long panel of conventional instruments.

12.2.4 ECONOMIC JUSTIFICATION

Centralization of an existing decentralized refinery demands a large instrument engineering effort, with a corresponding capital expenditure for new instruments. Such expenditures have been justified through improved coordination of unit operations, increased manpower productivity, and improved control.

12.3 Control Center Location

In selecting a control center location, the factors described in 12.3.1 through 12.3.4 should be considered.

12.3.1 CONTROL CENTER SIZE

Control center size will vary in accordance with the number of process units to be controlled from that location. It must not only contain all instrumentation associated with those units, but also auxiliary equipment such as termination racks, communications systems, power supplies, logic cabinets, auxiliary equipment racks, air conditioning, and so forth.

The control center should be sufficiently large to accommodate future expansion, specifically with respect to terminations for signal lines, electrical power supplies, and panel requirements.

Since it is the working quarters for operators, process engineers, and mechanics, it is usually necessary to

provide such facilities as offices, conference rooms, storage space, locker areas, toilet and shower facilities, eating facilities, and possibly instrument repair space.

The installation of a computer may require a separate computer room along with offices for analysts or programmers, or both. The computer should be located so as to minimize cabling lengths between the computer room and both the terminal and control rooms.

12.3.2 SAFETY ASPECTS

12.3.2.1 Area Classification

In classifying areas, the latest edition of API RP 500A, *Classification of Areas for Electrical Installations in Petroleum Refineries* should be used. It would be very costly and, in many cases, very restrictive if it were necessary to install explosionproof equipment in the control center. Therefore, the building should be located in an unclassified area if at all possible. However, in many cases, regardless of area classification, it has been considered advisable to maintain the building at a slight positive air pressure to prevent hydrocarbons from entering. With this provision it is possible to obtain a nonhazardous electrical rating which permits the use of standard electrical enclosures in the center. Refer to 12.4.3.4 for details concerning a pressurizing system. Although this is not a new consideration, it is perhaps of greater significance now that there are more people and more equipment involved in the consolidated control centers.

The General Purpose classification of the control center permits the location of various electrical devices which are difficult to house in explosionproof enclosures. It also provides a location for power supplies, switchgear, building air conditioning, and a terminating point for incoming and outgoing signal lines.

12.3.2.2 Recommended Distance from Process Units

If possible, the control center should be located far enough from the operating areas so that the vapors will be dispersed before reaching the control center.

Most petroleum refining companies have standards for determining the location of the control center in relation to the operating areas. In general, these requirements are based on the National Electrical Code, API RP 500A, or the Oil Insurance Association Bulletin No. 631 (*General Recommendations for Spacing*).

Usually the minimum distance between the control center and process units is 100 feet. Some companies permit distances as short as 50 feet from pipe racks.

Control centers should be located away from sources of vibration.

The control center should preferably be located on high ground so that open drainage lines or hydrocar-

bon spills will not carry hydrocarbon vapors to the control center. Elevation above the source of hydrocarbon vapors can affect the area classification.

12.3.2.3 Protection from External Explosions

Large control centers created to consolidate operations have also created a consolidation of risk. Damage to the building containing all the control systems necessary for the operation of a complete refinery or a large number of process units could result in a very costly shutdown of a tremendous amount of equipment. This situation has made it advisable to consider constructing these control centers with an appropriate degree of blast resistance. Refer to 12.4.2.1 for further details concerning blast-resistant construction.

12.3.3 ACCESSIBILITY AND COMMUNICATION

Location of the control center near the physical center of the plant will reduce signal transmission distances and the time it takes for an operator to reach the more remote areas. This may not be a factor if there are outside operators. It could, however, limit future expansion and increase the location hazards.

Location of the control center on the periphery of the plant will increase the average signal transmission distances and could curtail operator inspection of the more remote areas. The use of electronic transmission systems and radio communication will circumvent these problems. However, cost factors could influence a decision in this respect. Peripheral location will likely prove to be less of a problem from the viewpoint of future expansion and hazard criteria.

A means of communication between the control center and the plant must be provided. Telephone, intercom, PA (public address), and radio communications may be used. Two-way FM radio communication provides for a very efficient and effective system.

12.3.4 ENVIRONMENTAL FACTORS

The direction of the prevailing winds should be considered when locating the control center. The control center should be located upwind from cooling towers, possible sources of hydrocarbon vapors, or other hazardous and/or corrosive gases such as hydrogen sulfide or chlorine.

Another factor which is becoming more important when locating a control center is noise from the process areas. The control center should be located remote from areas of high noise levels, unless attenuation of the noise source is more practical.

The control center should be located in an area where the water table is below the entrance of cables into the control center. A high water table makes it difficult to keep the cable entry points sealed.

12.4 Control Center Building

12.4.1 INTERIOR SPACE CONSIDERATIONS

12.4.1.1 Panels

Panels should be arranged to permit the operator to survey the maximum panel area. The length of the panel should first be determined, either by estimate or actual design, depending on the status of the project. With this length, scaled panel arrangements can be made to determine an optimum configuration. With this configuration and with allowance for auxiliary equipment, the control room floor plan can be determined. It is desirable to design the control room around a control panel rather than design the control panel into a control room.

12.4.1.2 Consoles

Where consoles (such as for multipoint temperature indicators, computer displays, and keyboards) are installed as separate components from the panels, they should be located in front of the control panel, with a minimum aisle of 6 feet between the console and the panel. If necessary, these devices can be integrated with the panel instruments into one console or panel. It is generally assumed that an operator will normally sit at the console and survey the panels for status of operating conditions.

12.4.1.3 Auxiliary Equipment and Utilities

Space must be provided for auxiliary control equipment and other control center facilities. Consider the following list of the most common requirements.

1. Auxiliary equipment racks with or without field wiring terminals are normally located in a separate room or directly behind the panel section with which the auxiliary rack equipment is associated.
2. Termination cabinets when used, are located at a convenient location for control center wiring entry from the field. This may be a separate room.
3. Computer main frames may be located in a separate room. Auxiliary computer equipment may also be located in this room.
4. Power handling equipment (such as motor controls, power supplies, and so forth) could be located in the control center but should be in a separate room away from electronic equipment. The size of the electrical loads handled, the degree of shielding provided, and the effectiveness of the grounding system will determine how far away from the electronic gear it must be located. The physical size of the equipment will determine the room size required or whether a separate

motor control center building is needed. Depending on the size, number, and type of batteries, a separate battery room is sometimes provided with an exhaust fan to isolate gas evolved during battery charging.

5. Consideration should be given to wiring or tubing, or both, between the auxiliary equipment and the main panel or console and field termination areas. It is important that the routing of signal lines be included in the building design. Lack of planning in this area will result in last minute trenches, or overhead cable trays being installed with the attending deterioration in appearance. A computer or raised floor should be considered to provide additional flexibility, both in the control room itself and for computer or other electronic systems rooms. Refer to 12.4.2.5 for details on floor design.

6. Office space for personnel is generally included within the control center. The number and size of the offices is a function of company policy and should be discussed with the management that staff these complexes prior to completing the floor plan. To provide the greatest degree of future flexibility, it is practical to use movable wall partitions for the office area.

7. A mechanical equipment room should be provided to house the air conditioning units with associated equipment and power distribution system for lighting and so forth. If the air conditioning unit is mounted on the roof of the building, this room may not be required. However, this arrangement leaves the system vulnerable to fire or explosion.

8. Housekeeping facilities to be provided within the control center are

- a. Sanitary facilities in accordance with local, state, and federal codes
- b. Lockers and change rooms (Facilities for personnel to store personal items are generally dictated by plant custom. The quantity of lockers is determined by the number of personnel that the control center serves.)
- c. Kitchen facilities with an apartment-type electric stove, sink, and refrigerator
- d. Drinking water fountains
- e. A storage area for miscellaneous supplies
- f. A janitorial supply closet

9. Where space and organization allow, a room within the control center for a "light repair" instrument shop is desirable. Space for storage of spare parts, a work bench, and an area for specialized test equipment should be allowed.

10. Where blast-resistant designs are used, a generous allowance for future needs and forecasted space requirements should be provided. Future space is al-