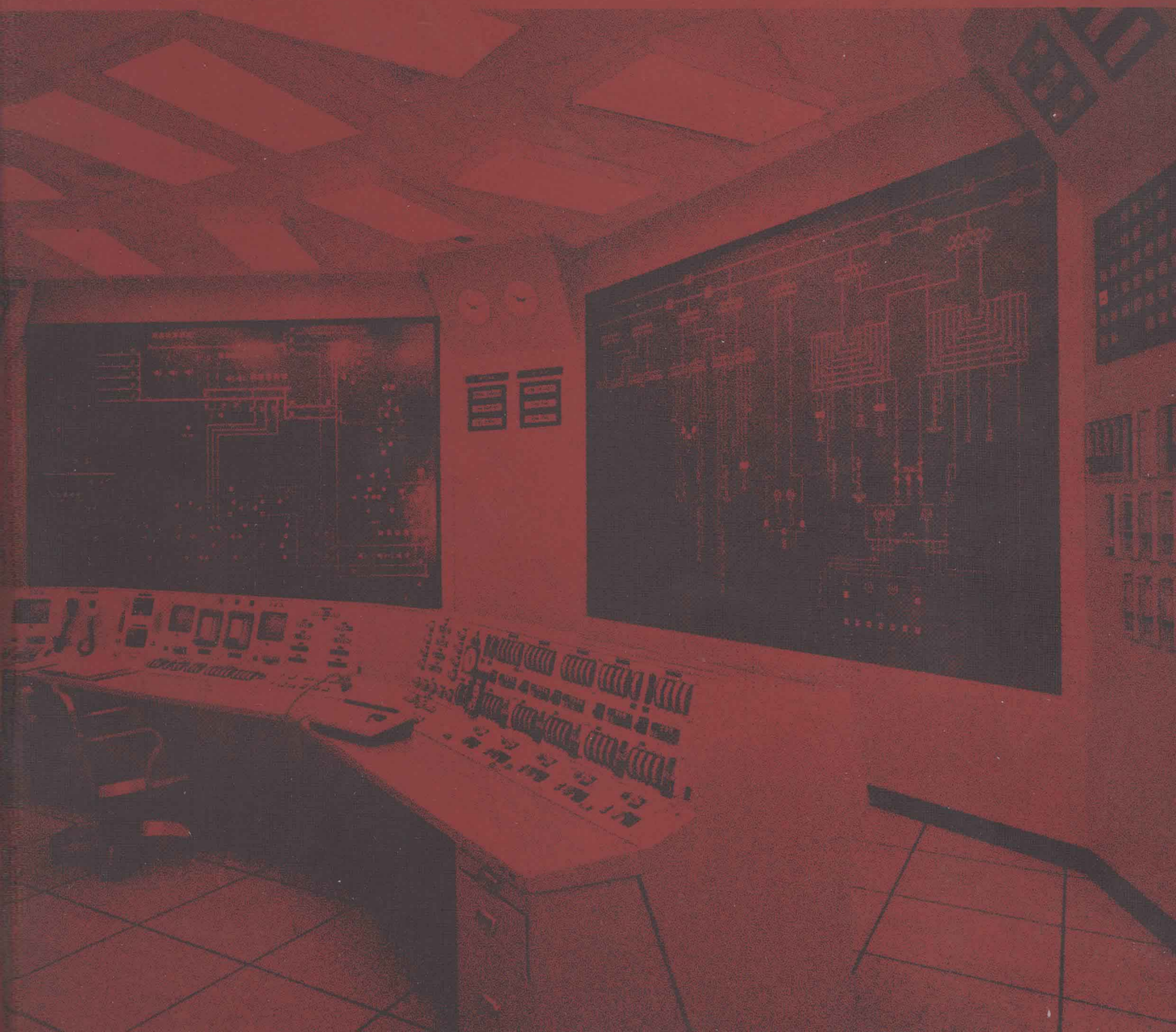
Applied Instrumentation in the Process Industries

Volume II Practical Guidelines



Applied Instrumentation in the Process Industries

Volume II Practical Guidelines

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Preface

Volume 2, *Practical Guidelines*, is unique in the field of instrumentation literature. In a discipline where so little formal education exists, little writing has been done to communicate the knowledge of the art that accumulates through the experience and knowledge of the practitioners. *Practical Guidelines*, for the first time, formally sets forth information, suggests methods, makes comparisons, issues principles and provides guidelines for those who want to master the field of instrumentation quickly and thoroughly.

The treatment is organized from a practical viewpoint; first suggesting the scope of work to be considered on any project involving instrumentation. Design concepts are covered from a broad view to the small details that are a necessary part of detailed design. Comparisons are made of many measurement and control devices with detailed listings of their advantages and disadvantages. The comparisons include flow, level, pressure and temperature measuring methods and control devices such as control valves and relief valves. One chapter is devoted to the design of relief systems. Another chapter is devoted to comparisons of several control valve sizing formulas. Suggestions are made concerning their use.

Other chapters are devoted to topics that seldom receive broad coverage in trade and professional magazines. Topics discussed are: the design of sample systems for analytical devices, control panel designs, instrument air systems, including compressors, driers and distribution systems.

One chapter lists the variations of accuracies obtainable from most of the measurement and control instruments. It also discusses in considerable detail other sources of error that are associated with control systems.

Chapter 10 places special emphasis on an area that is particularly troublesome for instrument people—the selection of measurement and control devices for slurry service applications. Advantages and disadvantages of different types are compared and helpful suggestions are made for slurry and heavily viscous fluid applications.

The final chapter of this unique book discusses construction, calibration and startup activities. This facet of instrument work is part of every processing plant project. Little is written, however, about the organization and execution of this important phase of activity. This chapter offers many ideas and suggestions that will help the initated as well as the uninitiated to successfully execute this work phase.

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Dedication

**To my wife Betty, and children, Karen, Debbie, and Mark,
for their patience and understanding**

Acknowledgments

Any technical book draws material from a large number of sources. Although many of these are referenced in the text, it is not feasible to include all the contributors to whom the author is indebted. Data and information were furnished by many industrial companies.

The author was encouraged to undertake the work by A.C. Lederer, President of S.I.P., Inc. The cooperation of W.L. Hampton, Manager of Engineering, is gratefully acknowledged in producing the work on schedule.

Appreciation is extended particularly to B.J. Normand and K.G. Rhea for time spent in reviewing and criticizing many chapters and sections of the manuscript. Others who contributed in this area include L. Ashley, W.E. DeLong, D.M. Dudney, L.C. Hoffman, T.E. Lasseter, J.G. Royle, and H.B. Williams.

In addition, the author is deeply appreciative to S.I.P., Inc. and its staff in providing the environment and materials for producing this work.

Contents

1 Instrument Project Control

William G. Andrew

A guide to the overall duties and responsibilities of the instrument group is needed by those who do the work as well as those who must work with them in any way. Probably, the nature of work done by instrument people is more misunderstood than any other discipline in the engineering and building of process units. The misunderstanding comes generally because few people understand the amount of detailed information that must be assembled, digested and used to apply instrumentation properly to a process.

Guidelines and suggestions are given here which outline the organization and execution of an engineering project as it relates to instrumentation. It lists documents which are necessary for communication between owner and builder, communication within the contractor organization during the engineering phase and the necessary information for construction. Coordination requirements with other groups are discussed, planning hints are given, and a check list for project control is suggested to ensure the successful completion of the project. The principles outlined apply to projects whose capital investments range from a few hundred thousand dollars to the largest of projects.

The viewpoint presented is most applicable to the person responsible for the application, selection, purchasing and installation of instruments and control systems. The documentation necessary for a complete record of a project is outlined. Even though the viewpoint is slanted toward the responsible project instrument engineer, other owner and contractor personnel—project managers, process people and leaders of other disciplines—will profit by an understanding of how the job is organized, developed and executed.

Many jobs appear complex until they are organized and broken down into components or units easily understood and accomplished. This is certainly true of instrument work. Specific documents are required for the work—for installation and later for maintenance. Scheduling, purchasing, installation and calibration must be done. The following paragraphs discuss what these functions are and how they are carried out.

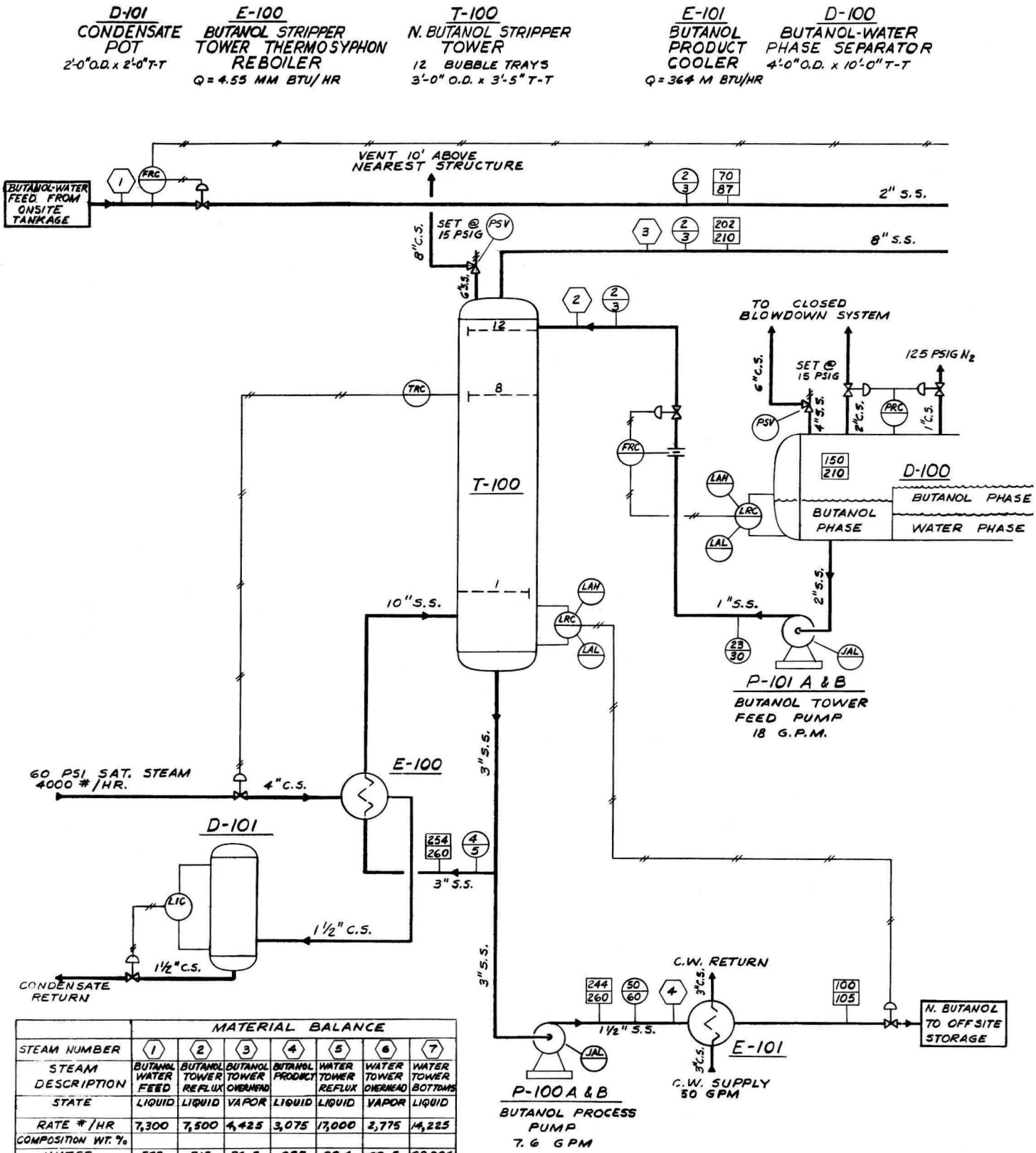
Documents to be Produced

Most projects require the following engineering documents for a complete job. When the job is small, some of the functions may be combined in the interest of space, time and economy. On large jobs, additional documents may be needed. Generally, however, requirements adhere quite closely to those mentioned below.

Process Flow Sheets

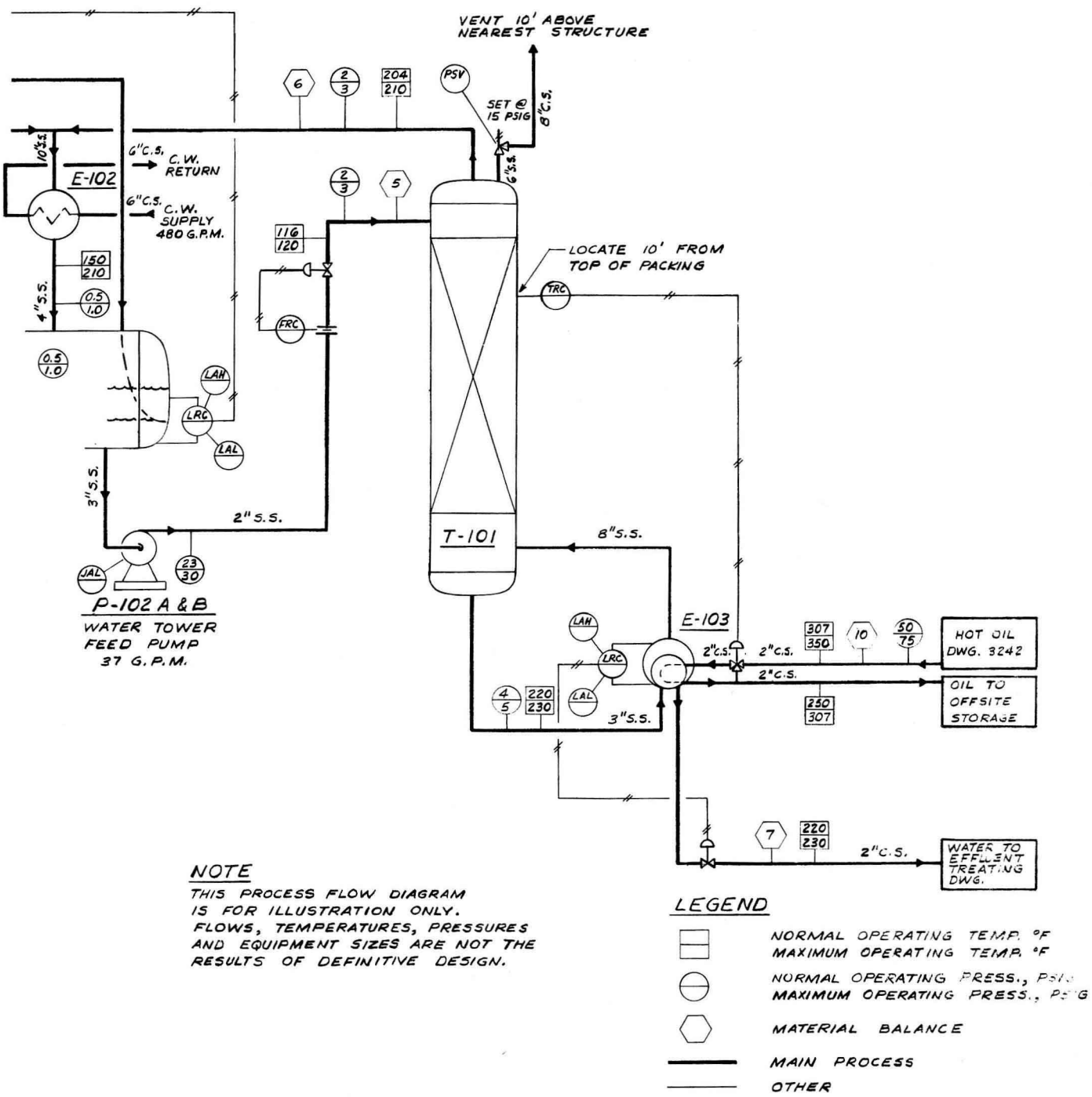
Process flow sheets consist of a pictorial representation of the major pieces of equipment required with major lines of flow to and from each piece (Figure 1.1). Material balances generally are shown. Additional information often given includes operating conditions at various stages of the process (flows, pressures, temperatures, viscosities, etc.), equipment size and configuration and, in some cases, utility requirements. Instrumentation on process flow sheets may or may not be essentially complete. In some instances, practically all of the instrumentation is included; in others, only the major control systems are shown.

In most processes the primary control variables have been determined and verified through laboratory and/or pilot-plant operations if the process is new. On old processes, previous commercial operations have verified proper or improper control techniques. The responsible instrument people may be consulted or may offer suggestions to improve



	MATERIAL BALANCE						
STEAM NUMBER	1	2	3	4	5	6	7
STEAM DESCRIPTION	BUTANOL WATER FEED	BUTANOL TOWER REFLUX	BUTANOL TOWER OVERHEAD	BUTANOL PRODUCT	WATER TOWER REFLUX	WATER TOWER OVERHEAD	WATER TOWER BOTTOMS
STATE	LIQUID	LIQUID	VAPOR	LIQUID	LIQUID	VAPOR	LIQUID
RATE #/HR	7,300	7,500	4,425	3,075	17,000	2,775	14,225
COMPOSITION WT. %							
WATER	522	215	36.8	.025	93.4	60.5	99.996
N. BUTANOL	178	78.5	63.2	99.975	6.60	39.5	0.004
MOLECULAR WEIGHT			29.4			23.9	
DENSITY	2 PHASES	52.0	.0693	50.5	570	.0562	60.0
TEMPERATURE °F	70	116	202	244	116	204	220
PRESSURE PSIG	2.0	2	2	50	2	2	0
VISCOSITY	.0	0.7	–	0.4	0.8		

Figure 1.1. Process flow sheets show major process equipment, major connecting lines, material balances and other process information. (Courtesy of S.I.P., Inc.)



NO.	REVISIONS	DR.	APP'D.	DATE
2	CUSTOMER APPROVAL NOTED	KEB	JR	8/7/67
1	ISSUED FOR APPROVAL	KEB	JR	8/7/67

S.I.P. INC.
Engineers & Contractors
HOUSTON, TEXAS

DR. KEB DATE 7-6-67 JOB No. E-359
CH. JR DATE 7-12-67 APP'D. FOR CONSTRUCTION
APP'D. WP DATE 8-1-67 BY JR DATE 8/7/67

NO NAME CHEMICAL COMPANY
N BUTANOL RECOVERY SYSTEM
PROCESS FLOW DIAGRAM

APP'D. JR DATE 8-7-67 DWG. No. 359-FD-3241 REV. 2
SCALE NONE

Figure 1.1 continued

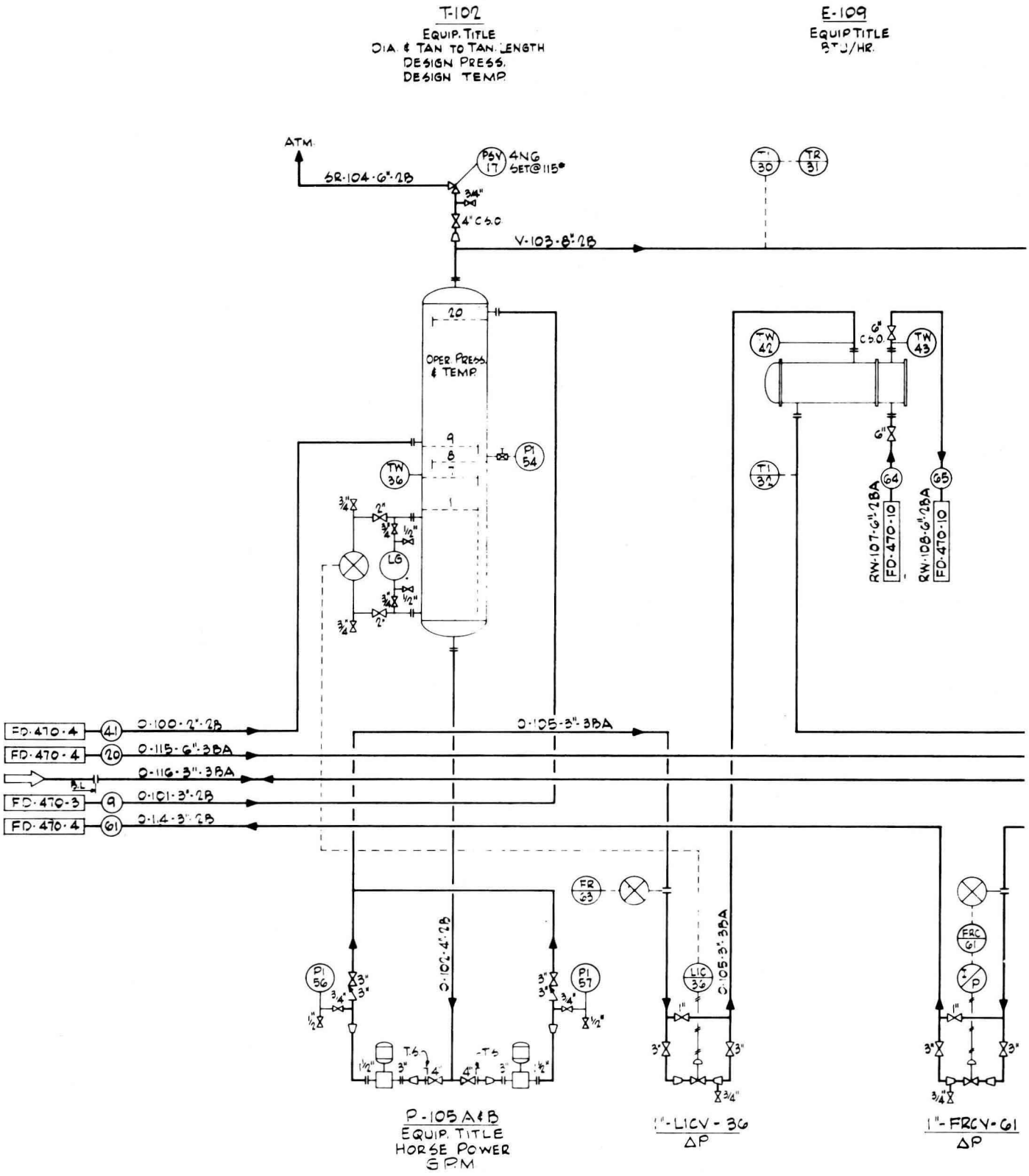


Figure 1.2. Mechanical flow sheets (or P&I diagrams) show detailed mechanical information while omitting much of the process information. (Courtesy of S.I.P., Inc.)

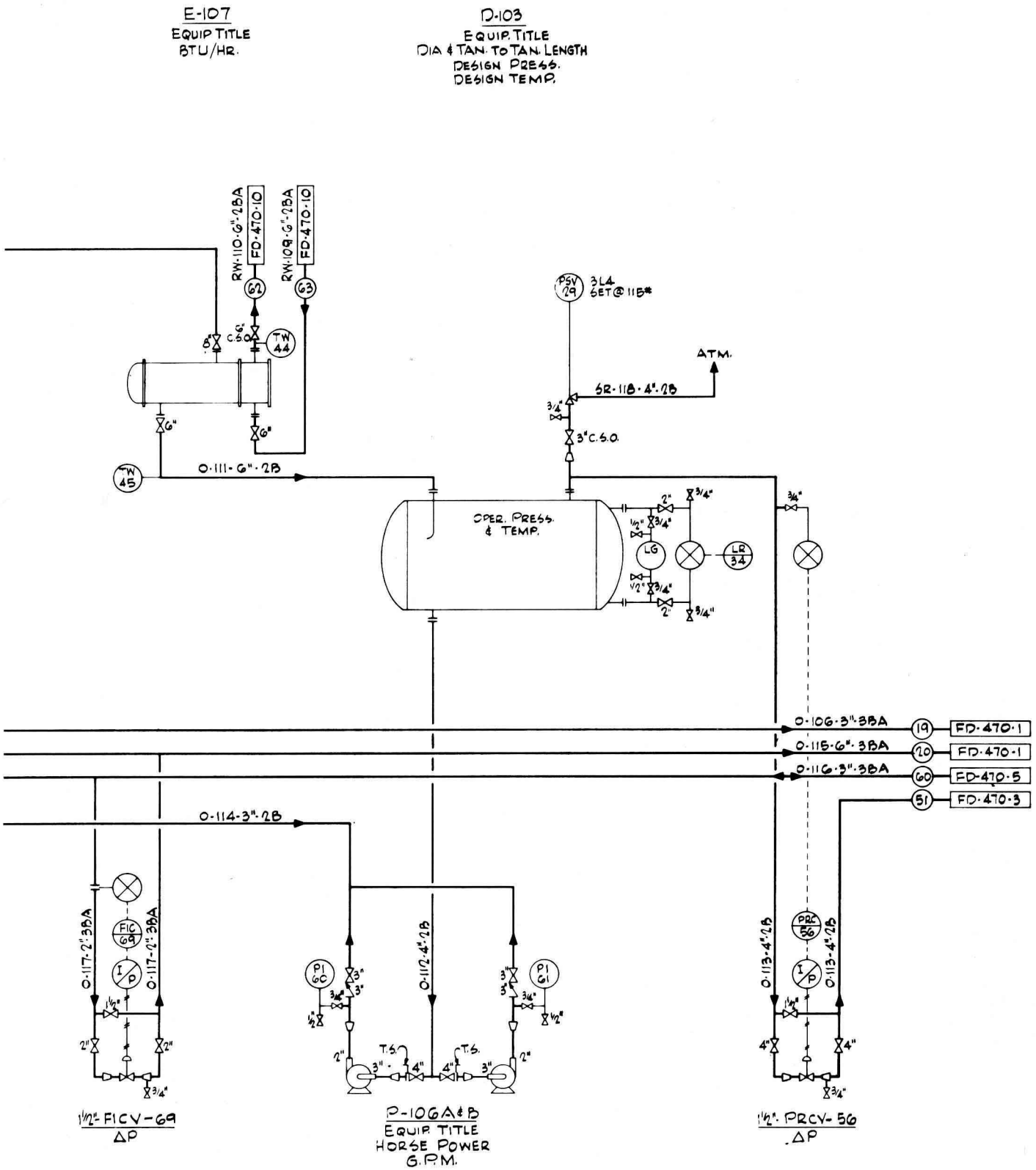


Figure 1.2 continued

control. The extent of involvement depends primarily on the experience backgrounds of the process and instrument people assigned to the job.

Mechanical Flow Sheets

Mechanical flow sheets or P&I (Process and Instrument) diagrams (Figure 1.2) provide much detailed, mechanical information not shown on process flow sheets, while omitting much of the process information shown on the process flow sheets. They repeat all the major equipment and piping lines as well as show:

1. All other equipment items with design temperatures and pressures
2. All interconnecting piping with size, material and fabrication specifications indicated
3. Utility requirements including pipe sizes, materials and fabrication methods
4. All major instrument devices

In many situations, mechanical flow sheets show schematically every process and utility line that appears on detailed drawings. They provide a valuable reference for proper project installation. The instrument engineer uses it as a source for many documents which must be prepared.

Complete process and mechanical flow sheets are needed prior to the bulk of the engineering effort on a job. Changes are often made as jobs progress, however, particularly on mechanical flow sheets.

Instrument Index Sheets

The instrument index sheets provide a summary of all instruments required for the job, listing each number-identified item of each loop (see Figure 1.3). The list should be made near the start of a job and used to check progress in specification writing, purchasing, expediting, delivery and installation. As items are added, the list increases; deletions should be lined out (not erased), thus serving as a record of changes. Even though information is not complete, the list should be issued early in the job so that project engineers and others concerned with the job may use it to gauge the job requirements.

Instrument index sheets may serve strictly as an index of items required and provide minimum information, or they may be expanded to provide a summary of information about the loop itself, including service conditions of the line or vessel with which it is associated.

Instrument Specification Sheets

To facilitate and speed up the specification and purchase of instrument items, forms have been developed which list the main features available and desirable in various categories of instruments. The Instrument Society of America has been instrumental in this effort and has developed standard forms for 18 categories of instrument items. Figure 1.4 is typical—a specification sheet for pressure instruments. One form is made for specifying special devices not covered by any of the other forms.

The ISA forms were developed several years ago and often lack some pertinent and appropriate information that needs to be furnished. Many companies have developed their own design forms to overcome the deficiencies that exist in the ISA forms. A revision of these is needed. The ISA forms, however, are still used extensively.

Specification sheets serve a three-fold purpose.

1. They contain information relating to the process and/or other instruments which is necessary for complete systems engineering.
2. They provide the purchasing department and other interested people information necessary for fulfilling their jobs efficiently—a communications channel.
3. They serve as permanent records for plant use—for installation, production and maintenance groups.

Loop Wiring Diagrams

Electronic loop wiring diagrams are electrical schematic drawings which are prepared for individual (or typical) electronic loops. The simplest loop is one that contains only a transmitter and a receiver. Other loops may contain many items—transmitter, recorder, controller, alarm units, control valve, transducer, integrator and perhaps other items.

The amount of documentation on the schematic varies. Some are relatively simple, showing only the locations of the instruments, their identification numbers and termination of the interconnecting wiring. Cable routing, wire size, intermediate terminal points and other pertinent information are necessarily shown on other drawings.

Other loop wiring diagrams are more comprehensive (Figure 1.5), providing not only the information previously described but also showing intermediate junction box terminals properly identified, wire and cable information, complete terminal layout of individual instruments and other useful information. Included may be the transmitter range and calibration and pneumatic hookup information on the transducer and the control valve.

Some loop diagrams are much more complex, especially if the loop contains several components. Complete documentation, however, makes prestartup checkout and maintenance much easier. Since the loop information is well documented, additional drawings are seldom needed for maintenance of the instruments.

The choice of the form to be used depends on several factors—the needs of the builder, the records required and the extent of information given on other drawings. Loops may be drawn on 8½ x 11-inch sheets, 11 x 17-inch or larger if preferred. Loops similar to that shown in Figure 1.5 are often drawn on "D" size sheets (24 x 32 inches). One to four loops may be shown on a "D" size drawing, depending on the complexity of the loop.

The preparation of loop wiring diagrams normally is needed prior to the purchase of the central control panels to furnish wiring information to the panel fabricator. Complete field wiring identification may not be available at

INSTRUMENT INDEX

SHT.____ OF ____

S.I.P. INC.
Engineers & Contractors
HOUSTON, TEXAS

CLIENT A.B.C. Co.
PROJECT Project "B"
LOCATION United States
CLIENT JOB NO. CAR-0A102 S.I.P. JOB NO. E-783

REV.	BY	DATE	APP'D	REV.	BY	DATE	APP'D

TAG NO.	SERVICE DESCRIPTION	LINE OR EQUIP. NO.	MFG.	MOD. NO.	SPEC. SHT.	P. O. NO.	FLOW SHT.	PIPING DWG.	INSTRUMENT DWG. PLAN	INST'L.	LOOP	LOC.	SIZE	CALB. OR ACTION	REMARKS
FIC-101	WATER TO STG. TANK T-12	---	FOX	52A	I-12	SIP-1321	D-I-1023	D-P-2041	D-I 1332	SKH-102	SKH-114	P		0-102	
FE-101	"	2"-CS-1201	DANIEL	--	I-12	SIP-1419	D-I 1023	D-P-2041	D-I-1332	SKH-2102	SKH-114	F	2"	0-100" H20	VERTICAL RUN
FT-101	"	2"-CS-1201	FOX	13A	I-15	SIP-1101	D-I-1023	D-P-2041	D-I-1332	SKH-2102	SKH-114	F		100" H20	W/AIRSET PRE-PIPED
FV-101	"	2"-CS-1402	F.G.	657 ES	I-72	SIP-1202	D-I-1023	D-P-2041	D-I-1332	SKH-1135	SKH-114	F	1"	A/O	

E-807 8/73

Figure 1.3. Instrument index sheets comprise a summary list of all the instruments required for a job and serve as a check list for job progress. (Courtesy of S.I.P., Inc.)