

Westinghouse Electric Corporation
Nuclear and Advanced Technology Division

AP600

Program Operating Procedure

Subject:

AP600 PLANT INSTRUMENTATION & CONTROL
SYSTEMS

Approved:

H. J. Bruschi, Director, AP600 Program

Effective Date:

10-31-91

**AUTHOR/COGNIZANT
FUNCTION**Contact Manager, Plant Instrumentation and Control Systems
(PI&CS) on question concerning this procedure.**PURPOSE**This procedure provides specific requirements, as well as
guidelines, for work done by PI&CS personnel.**SCOPE**This procedure is applicable to the PI&CS group responsible for the
scope under their cognizance for the AP600 Program. It contains
both mandatory requirements (denoted by the verb shall) as well as
non-mandatory guidelines (denoted by the verb should).The work performed by PI&CS for the AP600 project is categorized
as Man-Machine Interface Systems design. This work includes the
following:

- a) Man-Machine Interface Design of Control Rooms and Control
Boards;
- b) Instrumentation and Control (I&C) Design;
- c) Control Room/Equipment Design.

The general PI&CS activities are summarized in Appendix A, titled
"PI&CS General Work Activities".**DEFINITIONS****I&C Architecture Diagram**A diagram that depicts the I&C architecture. It is a system
block diagram that represents the top level view of the system
and its interconnections.**Instrument Lists**Lists that contain information about the plant process
parameters. This information usually includes channel
numbers, system, type, range, description, safety class,
electrical train, alarms, set points, indicators, recorders, and
preferred failure states.

Process Block Diagrams

Diagrams depicting the implementation of the I&C system functional requirements, functional diagrams, flow diagrams, channel lists and other key documents, in both hardware and software. All system protection and control functions are to be identified in Process Block Diagrams.

Specification Sheets

Sheets created in accordance with ISA-S20 (1981) for individual instruments, as necessary, and identified by the design engineer. Note that the Specification Sheets may differ in format and content from that identified in ISA-S20 so long as sufficient information is provided.

System Documentation

Documentation that comprehensively describes the design of the product. The system documentation includes design specifications that ensure that the end product will meet all of the established design criteria and functional requirements.

Systems Engineering

The engineering function that organizes and integrates concepts and technologies into total systems and ensures their technical integrity.

PROCEDURE**General****INTERFACE MANAGEMENT**

PI&CS shall be responsible for coordinating and integrating AP600 I&C and Man-Machine Interfaces with groups that support the AP600 organizations. This includes systems provided by others through the appropriate Westinghouse interface organization.

DOCUMENTATION REVIEW PROCESS

Reviews of the PI&CS documentation shall be performed by internal personnel (within PI&CS) and/or external personnel (non-PI&CS). In either case, the personnel reviewing the documentation shall be approved by the PI&CS group manager. The review process shall include, as a minimum, the following elements:

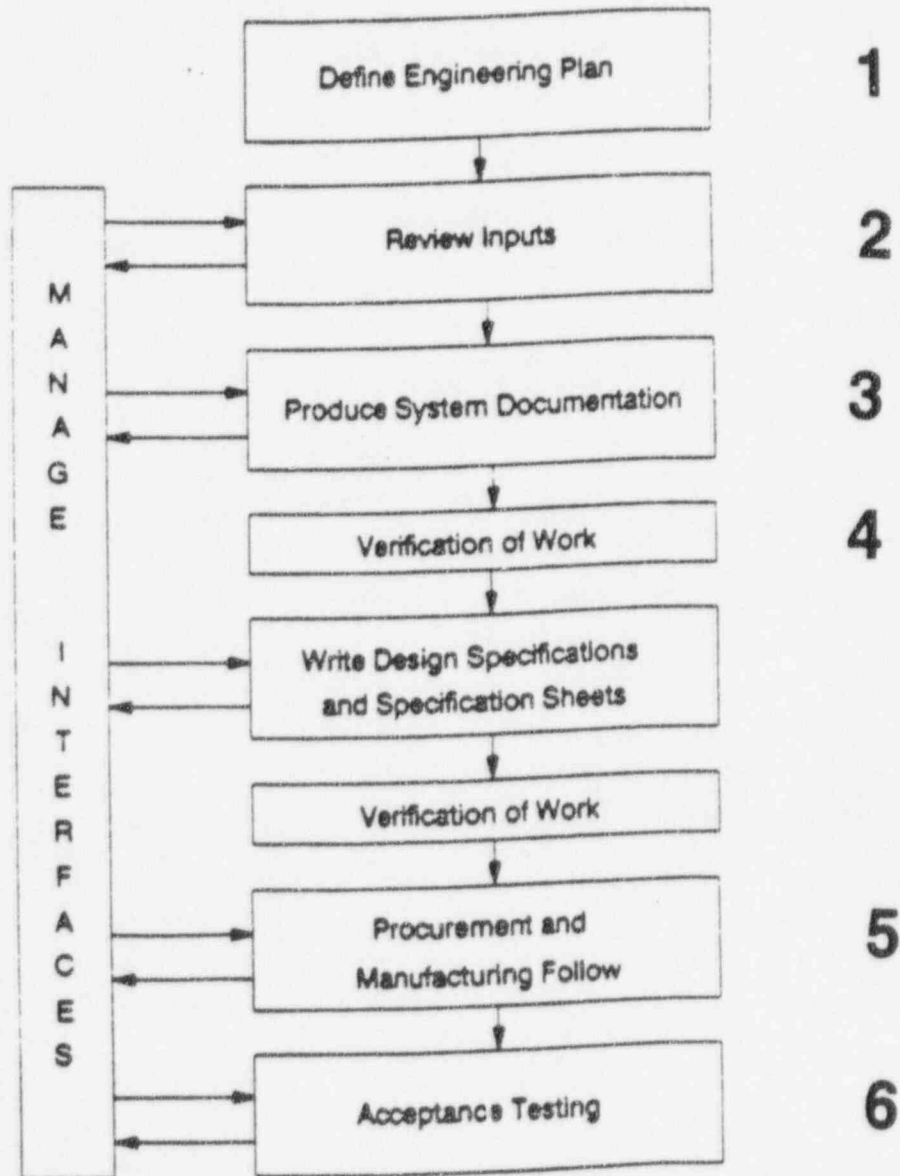
- a) Review of document for completeness, accuracy, and feasibility;
- b) Issuance of a PI&CS letter to file documenting all comments with distribution to appropriate personnel for resolution;
- c) Resolution of comments;

- d) Obtaining management decision on unresolved comments;
- e) Issuing a letter to file identifying the resolutions and results of the review and distributed to concerned parties.

SPECIFIC WORK PROCEDURE ELEMENTS

The following Specific Work Procedure Elements are defined in Figure 1 and are discussed below in more detail.

FIGURE 1
AP600 FLOW CHART FOR PI&CS ENGINEERING WORK



1. Definition of an Engineering Plan

An Engineering Plan that details the scope of the work should be established at the discretion of the AP600 PI&CS Manager. This plan is to be developed by the responsible engineer and approved by the AP600 PI&CS Manager. Several of the inputs listed under typical inputs of the Review Inputs section below will be necessary to perform these tasks. The Engineering Plan should take into account the following:

- a) Work Objectives
- b) Required Inputs
- c) Commitments/Milestones
- d) Required Outputs
- e) Schedule
- f) Funding/Resource Requirements
- g) Supporting Organizations/Groups
- h) Time-Phased Manpower Distribution

2. Review Inputs

Based on the required work to be done, the inputs shall be checked for completeness, accuracy, and feasibility. The inputs shall be reviewed in accordance with the documentation review process detailed in this procedure to assure that:

- a) All necessary information has been supplied;
- b) Requirements are accurate and complete;
- c) Implementation is feasible.

The input information required to define an Engineering Plan and perform the engineering work should typically address the following items:

- a) Goals of the system and desired outcomes of the work to be performed;
- b) The date when the work is required to be completed;
- c) Interfaces with other systems and the nature of those interfaces;
- d) Requirements on system inputs and outputs;
- e) Applicable government regulations and industry codes and standards;
- f) Dimension and configuration envelope constraints such as size, orientation, location;
- g) Environmental and power source envelopes or constraints;
- h) Requirements related to access control, redundancy, independence, identification and test capability;

- i) System classification and applicable quality assurance, reliability goals, verification and validation;
- j) Environmental qualification requirements based on its classification.

The typical inputs include the following:

- a) System Specification Documents, particularly the following portions: Interlock Sheets, Channel Lists, and Load Lists;
- b) Protection Functional Requirements;
- c) Control Functional Requirements;
- d) Protection Functional Diagrams;
- e) Control Functional Diagrams;
- f) Engineering Flow Diagrams and P&IDs (Reference AP-3.15);
- g) Customer (e.g. contract) Requirements;
- h) Subcontractor Requirements;
- i) Government Regulations and Industry Codes and Standards.

3. Produce System Documentation

The system documentation shall be produced as required and shall be reviewed and approved by a second engineer.

Figure 2, titled "I&C Design Process" shows the typical output documents produced by PI&CS, as well as the inputs that are required. The processes that produce the outputs given the inputs compose the PI&CS Transformation Matrix. These processes consist of dynamic tasks and differ for the various outputs produced.

Figure 3, titled "PI&CS Information Transformation Matrix" further relates the information that is required as inputs to produce the PI&CS outputs. The output documentation normally includes the following:

- I&C Architecture Diagram (see Appendix C)
- Process Block Diagrams (or equivalent) (see Appendix C)
- Equipment (Instrument) Lists
- Logic Diagrams (see Appendix C)
- Design Specifications
- I&C Databases
- Standard Safety Analysis Report Input

- System Specification Documents (SSDs)
SSDs shall be prepared in accordance with procedure AP-3.1. However, when preparing PI&CS SSDs, the breakdown of each section defined by AP-3.1 shall be done in an equivalent sub-category format identified in Appendix B.
- Specification Sheets
Created in accordance with ISA-S20 (1981 titled "Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves") for individual instruments, as necessary, and identified by the design engineer. Note that the Specification Sheets may differ in format and content from that identified in ISA-S20 so long as sufficient information is provided. The Specification Sheets shall be reviewed and approved by a PI&CS engineer. Typical equipment requiring Specification Sheets are field mounted instruments and control board instruments. Specification Sheets are not normally required for microprocessor based cabinet mounted equipment or for standardized systems.

4. Verification of Work

The designer shall identify and justify the appropriate type of verification to be used on his work and obtain written management approval. The choice of verification type will be documented and stored in the AP600 file. The types of verification are as follows:

- a) Design Verification by Design Reviews in accordance with AP-3.5;
- b) Design Verification by Independent Review/Alternate Calculations in accordance with WCAP-9565, DP-3.3.2;
- c) Design Verification by Testing in accordance with WCAP-9565, DP-3.3.3;
- d) Design Specifications in accordance with AP-3.8.

5. Procurement and Manufacturing Follow

The procedures defined in section DP-7.0, titled "Control of Purchased Items and Services" in WCAP-9565 shall be followed when performing this work. However, PI&CS shall be responsible for the following:

- a) Providing the Purchase Requisition;
- b) Evaluating the technical capabilities of suppliers;

- c) Recommending acceptable suppliers;
- d) Reviewing procurement documents;
- e) Providing Purchase Requisition Change Notices;
- f) Reviewing supplier documents and approving as required;
- g) Evaluating and approving proposed deviations from specifications by the supplier.

6. Acceptance Testing from Manufacturer

PI&CS shall be responsible for providing the following:

- a) Test requirements;
- b) Review and approval of the test procedures;
- c) Review and approval of the test results.

RESPONSIBILITY

ACTION

AP600 PI&CS Manager

Responsible for administering this procedure, defining and issuing standards to third parties (other Westinghouse organizations, contractors, suppliers) for any information that will be required to be provided by a third party.

Ensures that all interfacing organizations are apprised of key design changes and identifies if Interface Control Documents need to be issued.

Reviews and approves the Engineering Plan.

Reviews, approves, signs-off the design documentation produced by the PI&CS group, ensures that it is verified, and that appropriate personnel within or external to PI&CS are appointed to review documentation in accordance with the Documentation Review Process of this procedure.

Design Engineer

Prepares an Engineering Plan

Responsible for performing the responsibilities outlined in WCAP-9565, procedures DP-3.3.2 and DP-3.3.3.

Ensures that the Design Specifications are prepared in accordance with AP-3.8.

Ensures that the System Specification Documents are prepared in accordance with the format outlined in AP-3.1 and develop a sub-category of each section equivalent to the sample identified in Appendix B.

Ensures that any Interface Control Documents are prepared in accordance with AP-3.7.

Ensures that all final signed off documentation is maintained in the appropriate engineering files and that a copy is sent to the AP600 Central File.

REFERENCES

A. WCAP-12601, AP600 Program Operating Procedures

AP-3.1, System Specification Document
AP-3.5, Design Reviews
AP-3.7, Interface Control Document
AP-3.8, Design Specifications
AP-3.15, System P&ID Preparation

B. WCAP-9565, NATD Quality Assurance Program Plan

DP-3.3.2, Design Verification by Independent Review or
Alternate Calculations
DP-3.3.3, Design Verification by Testing

C. ISA-S20 (1981), Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

FORMS/EXHIBITS

None

APPENDICES

- A. PI&CS General Work Activities
- B. SSD Section Breakdown
- C. Typical Diagrams (Architecture, Process and Logic)

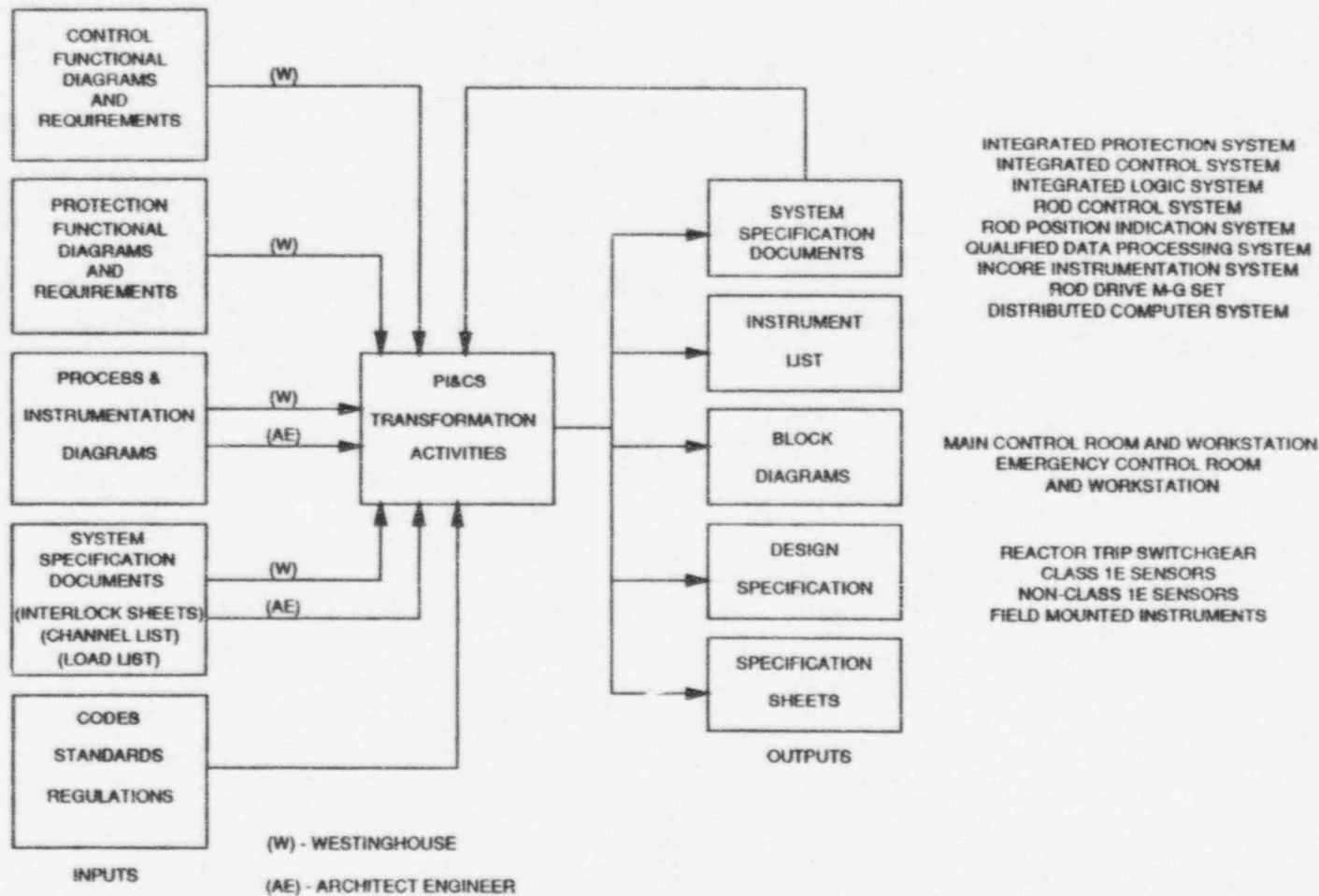


FIGURE 2
INSTRUMENTATION AND CONTROL DESIGN PROCESS

AP-3.14

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FIGURE 3
PLANT INSTRUMENTATION AND CONTROL SYSTEM
INFORMATION TRANSFORMATION MATRIX

PI&CS Information Transformation Matrix						
INPUT DOCUMENTS	OUTPUT DOCUMENTS					
	BLOCK DIAG	LOGIC DIAG	INST LIST	SSD	DESIGN SPEC	SPEC SHEETS
FUNCTIONAL DIAGRAMS	X		X	X		
FUNCTIONAL REQUIREMENTS	X		X	X	X	X
(W) ENGINEERING FLOW DIAGRAMS	X		X	X		X
(B) ENGINEERING FLOW DIAGRAMS	X		X	X		X
(W) CHANNEL LIST	X		X			X
(B) CHANNEL LIST	X		X			X
(W) INTERLOCK SHEETS	X	X				
(B) INTERLOCK SHEETS		X				
(W) LOAD LIST		X				
(B) LOAD LIST		X				
ELECTRICAL REQUIREMENTS	X	X		X	X	
EPRI REQUIREMENTS	X	X		X	X	X
CODES & STANDARDS	X			X	X	
I&C SYSTEM SPECIFICATION DOCUMENTS	X	X		X	X	X
OTHER SYSTEM SPECIFICATION DOCUMENTS	X	X	X	X	X	X
STANDARD COMPONENT SPECIFICATIONS	X	X	X	X	X	X
INTERFACE DETAILS	X	X	X	X	X	X
SPECIFICATIONS FOR COMPONENTS	X	X	X	X	X	X
DESIGN CRITERIA	X	X	X	X	X	X

AP-3.14

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APPENDIX A**PI&CS GENERAL WORK ACTIVITIES**

This appendix is included as a training aid for employees new to PI&CS.

The general PI&CS activities are depicted in Figure 1, titled "AP600 Flow Chart For PI&CS Engineering Work" and are detailed in this procedure.

The work can encompass the total Systems Engineering function or any portion thereof. Figure 2, titled "I&C Design Process" shows the typical inputs and outputs that are used and/or generated by PI&CS.

Figure 3, titled "PI&CS Transformation Matrix" shows the relationships between the inputs required and outputs generated by PI&CS.

The functions of PI&CS include the following:

- Development of the I&C design criteria and requirements reflecting the requesting group's needs and in compliance with the applicable government regulations and industry requirements;
- Providing operating hardware or rendering engineering services in an effective and efficient manner;
- Comparing the final product(s) to input requirements to demonstrate conformance.

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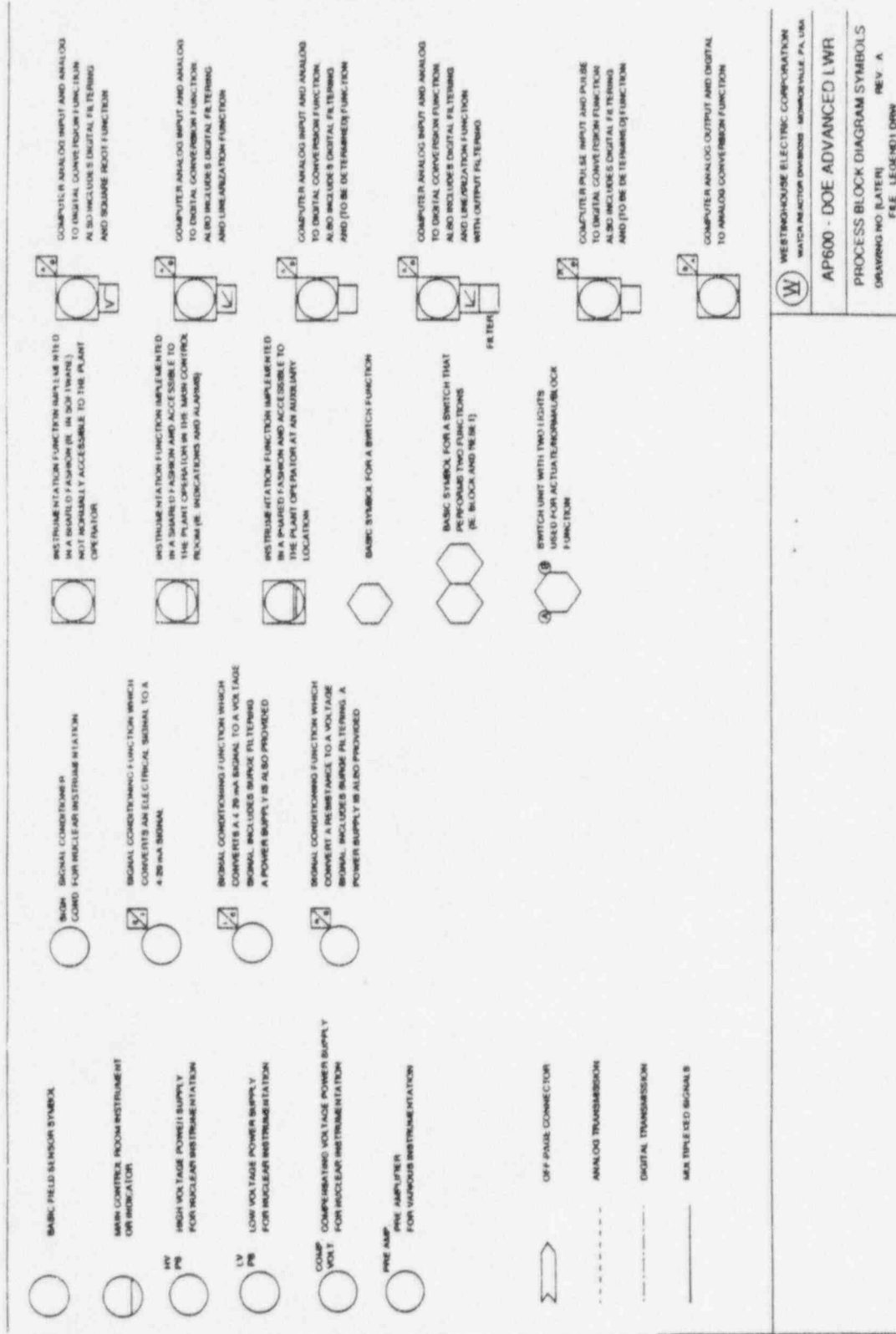
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APPENDIX C

TYPICAL PROCESS BLOCK DIAGRAM



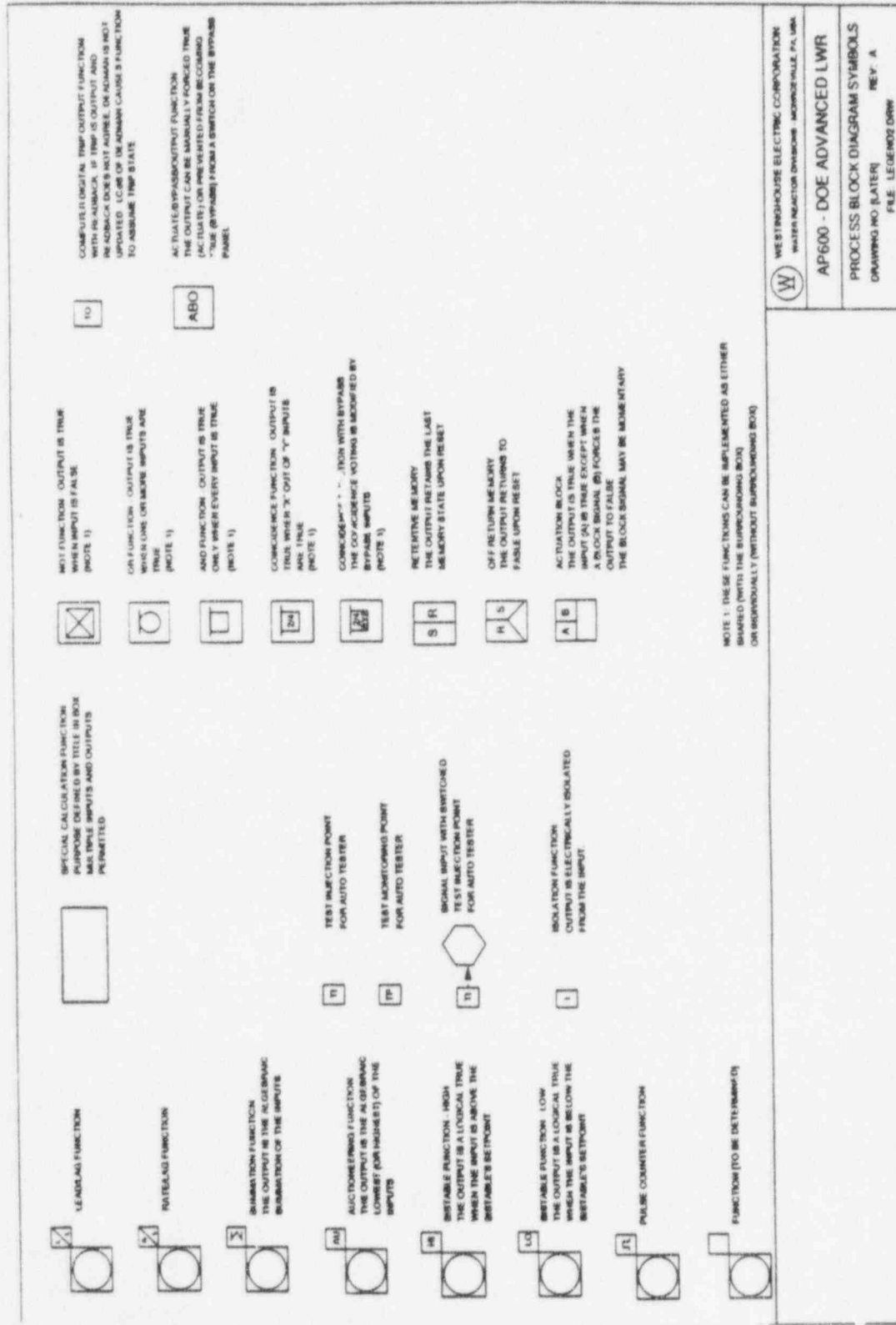
WESTINGHOUSE ELECTRIC CORPORATION
NATICK INDIAN DIVISION MEMPHIS, TN, USA

AP600 - DOE ADVANCED LWR

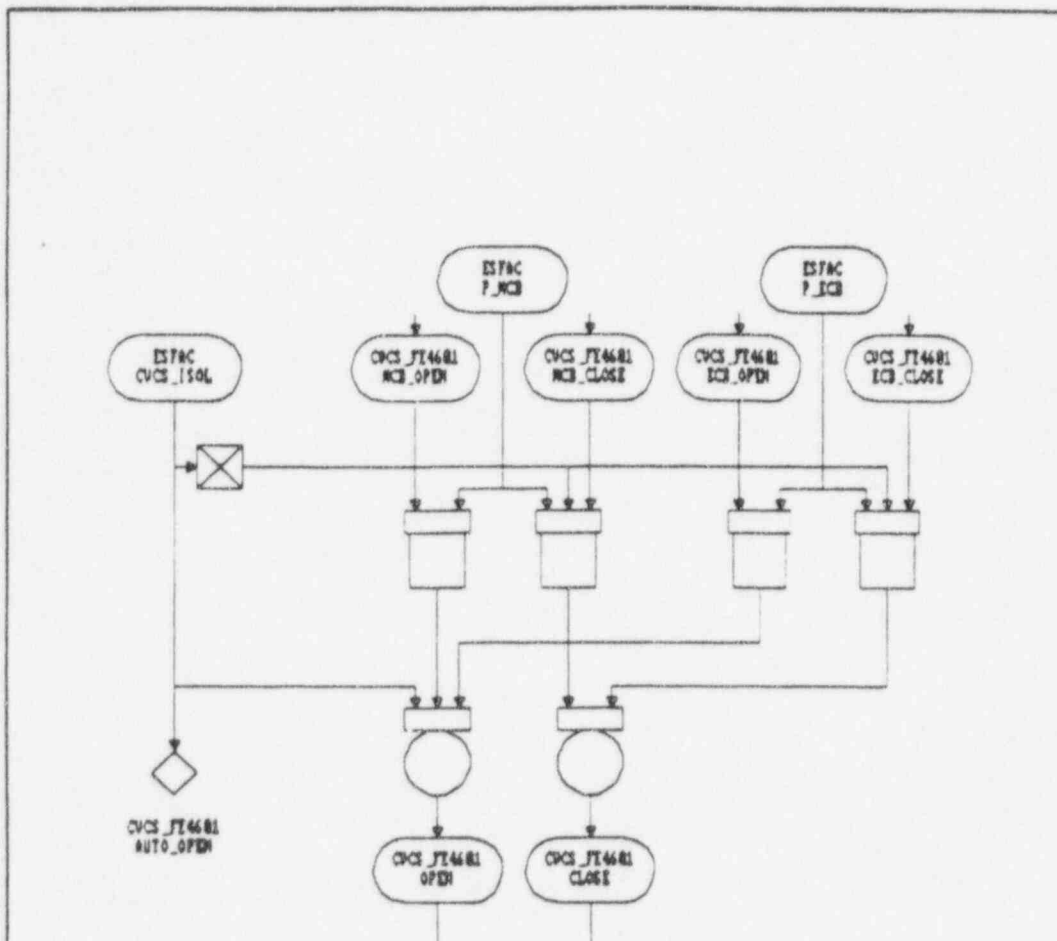
PROCESS BLOCK DIAGRAM SYMBOLS
DRAWING NO. [BLANK] REV. A
FILE: LEOEN01.DWG

APPENDIX C

TYPICAL PROCESS BLOCK DIAGRAM



APPENDIX C TYPICAL LOGIC DIAGRAM



References:

1. ESF_EPO_TEST - EPO ESFAC System Test Request	SH: 31
2. MCB_O06 - MOV OPEN/CLOSE LOGIC	SH: 38
3. MOV_O01 - MOV EPO INTERFACE LOGIC	SH: 39
4. MCB_LAMP_O02 - MOV Status Indication Lamps	SH: 40
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WESTINGHOUSE LOGIC CALC III

APPLICATION LOGIC DIAGRAM

CVCS_FE4601

EXCESS LETDN TO PRT ISOL VLV #1

Train: C Cabinet: 100 Zone: 19

Jerzy Gutman Rev. OXA 12/13/88

DWG-1000

SHEET: 440