

Contents

Preface *xi*

Part I Introduction to EPCC Industry 1

1	Introduction	3
1.1	What Is EPCC Industry	3
1.2	Types of Projects	4
1.2.1	Cost of a Project	5
1.2.2	Purpose of a Project	7
1.2.3	Engineering Needs	8
1.2.4	Licensors Need	8
1.2.5	Profit Based	8
1.2.6	Schedule Based	9
1.3	Function of Different Disciplines	9
1.4	Different Phases of the Project	11
1.5	Importance of Chemical Process Engineers	14
1.6	Interaction with Operating Industry or Customers	15
1.7	Interaction with Vendors	15
1.8	Workshare with Multiple Offices	17
1.8.1	Importance of Workshare	17
1.8.1.1	Low-Cost Services	17
1.8.1.2	Labor Shortages	18
1.8.1.3	Level the Workload	18
1.8.1.4	Time Differences in Countries	18
1.8.2	Types of Workshares	19
1.8.2.1	Workshare with an Individual	19
1.8.2.2	Workshare a Piece of a Project	19
1.8.2.3	Workshare Part of the Engineering Team	19

Part II Roles of Chemical Engineers in Different Phases of the Project 21

2	Phase 1 (Scope Planning)	23
2.1	Perform Feasibility Studies	23
2.1.1	Study Types	23
2.1.2	Study Duration	24
2.2	Interaction with Customer, Recommendations, and Meetings	24
2.3	Preparation of Preliminary Scope Reports	25
2.3.1	Assumptions Required	25
2.3.2	Basis of Design Document	26
2.3.2.1	Contents	26
2.3.2.2	Comparison of Study Report with the Design Basis Document	26
2.3.2.3	Basis of the Equipment	26
2.3.2.4	Report Format	27
2.3.2.5	Study Report Tracking	27
2.4	Technology Selection	28
2.4.1	Technology Options	28
2.4.2	Meeting Between Customer and EPCC	28
2.4.3	Initiate a Study Contract with Technology Companies	28
2.4.4	Review Report from Technology Companies	29
2.4.5	Customer and EPCC Make a Technology Selection	30
2.4.6	Technology Selection Based on Other Criteria	30
3	Phase 2 (Scope Definition)	31
3.1	Develop a Block-Flow Diagram	31
3.1.1	What Is a Block-Flow Diagram (BFD)	31
3.1.2	Information Needed to Develop a BFD	31
3.1.3	Utility Block-Flow Diagrams	31
3.1.4	Examples	31
3.1.5	Uses of BFD and UBFDs	31
3.2	Develop a Process-Flow Diagram	32
3.2.1	What Is Process-Flow Diagram	32
3.2.2	Information Needed to Develop a PFD	33
3.2.3	Utility Flow Diagrams	35
3.2.4	Example	35
3.2.5	Uses of PFD and UFD	35
3.2.6	Distinguishing New Scope from Existing	35
3.2.7	Revisions to the PFDs and UFDs	36
3.2.8	Titleblock for the PFD	36
3.3	Prepare IFE Quality P&IDs	36
3.3.1	IFE Quality P&IDs	36
3.3.2	Uses of IFE P&IDs	37
3.3.2.1	General Uses	37
3.3.2.2	Estimating Uses for Phase 2 Estimate	37

3.3.2.3	Reviews with the Customer	37
3.3.3	Example of a P&ID	38
3.4	Identify Major Pieces of Equipment, Instruments, and Electrical	38
3.4.1	Identification of Major Pieces of Equipment	38
3.4.2	Controls and Electrical Estimate	39
3.4.3	Mechanical Engineering Estimate	39
3.5	Estimate Preliminary Sizing of Major Equipment and Instruments	40
3.5.1	Preliminary Sizing of Major Equipment	40
3.5.2	Instrument Sizing	41
3.5.3	Estimation of Electrical Loads Based on Preliminary Horsepower	41
3.6	Metallurgy Selection of Major Equipment	42
3.6.1	Provide Preliminary Information on the Stream	42
3.6.2	Special Consideration for the Metallurgy	43
3.6.3	Most of the Services in Refinery Are Carbon Steel	43
3.6.4	Importance of a Metallurgy	44
3.7	Complete Simulations for Different Cases and Prepare IFE Quality HMB	45
3.8	Complete Studies	47
3.9	Preliminary Estimate of Utility Summary	47
3.9.1	Introduction to Utility Summary	47
3.9.2	Use of Utility Summary and Value Plus Suggestions	47
3.10	Participation in LOPA	49
3.10.1	What Is LOPA	49
3.10.2	Format of LOPA	49
3.10.3	LOPA Team	49
3.10.4	Difference Between LOPA and HAZOP	49
3.11	Prepare IFE Quality Design Basis	50
4	Phase 3 (Scope Development)	51
4.1	Perform Detailed Hydraulics	51
4.1.1	What Is Detailed Hydraulics	51
4.1.2	Examples of Criticality of Hydraulics	52
4.1.3	Importance of Design Safety Margin	52
4.1.4	Battery Limit Table Coupled with Hydraulics	53
4.1.5	Line Sizing Criteria for Hydraulics	54
4.2	Detail Design of Other Equipment	54
4.2.1	Heat Exchangers	54
4.2.2	Vessels	56
4.2.3	Columns	56
4.3	Input to Line List and the Process	57
4.4	Create Change Orders and Report Any Changes to Project	63
4.5	Process Data for Inline Instruments	64
4.5.1	Input to Inline Instrument Datasheets	64
4.5.2	How Process Engineers Get the Data	64
4.5.3	How Control System Use the Data	65

4.5.4	Data Checking and Work Process	65
4.6	Prepare Preliminary Safety Valve Evaluations	66
4.7	Prepare and Issue Equipment Datasheets	68
4.8	Communication with Other Disciplines, Projects, and the Customer	70
4.9	Participate in HAZOP	70
4.10	Follow Up and Implementation of HAZOP Items	71
4.11	Issue and Prepare IFR/IFH/IFA/IFD Quality P&IDs/PFDs/MSDs (Including Tie-in/Demo P&IDs)	72
4.12	Complete and Lead Line-by-Line Reviews of P&IDs	73
4.13	Prepare IFD Quality Design Basis	74
4.14	Issue IFD HMBs	74
4.15	Utility Summary IFD	75
4.16	Prepare DPDT Diagrams	75
4.17	Prepare Material Selection Diagram	76
4.18	Drafting of the Drawings and Backchecking	77
4.19	Input to 30% Model Reviews and Plot Plan Development	79
4.20	Input to Cost Estimate	80
4.21	Budget Estimate, Schedule, and Staffing Plan	80
4.21.1	Interactive Schedule Planning Meetings	80
4.21.2	Budget Preparation	81
4.21.3	Schedule and Dates	81
4.21.4	Staffing Plan	81
4.21.5	Project Status Progress and Tracking	86
4.22	Lead Workshare Meetings	87
4.23	Input to Internal Meetings with Project and Discipline Teams	88
4.24	Plant Visits	89
4.25	Input to Preparation of Demolition and Tie-in P&IDs	89
4.25.1	Tie-in P&IDs	89
4.25.2	Demo P&IDs	89
4.26	Preparation of Pipe Service Index	90
4.27	Process Audit	91
5	Phase 4 (Detailed Design)	95
5.1	Participate in the Final HAZOP	95
5.2	HAZOP Action Item Closeout and Hold Items	95
5.3	Project Support as Needed	96
5.4	Provide Offline Instrument Data	96
5.5	Squad Check of Process and Vendor Data	98
5.6	Finalize Safety Valves Design and Issue IFD Datasheets	99
5.7	Closeout of Documents	101
5.8	Input to 60% and 90% Model Reviews	101
5.9	Lead Workshare Meeting	102
5.10	IFC and IFC-R P&IDs	102
5.11	Line List Updates and Input to New Lines	103
5.12	Leading MOC Meetings	103

5.13	Cause-and-Effect Table	105
5.14	Input to SP Items and Tie-in Forms	106
5.14.1	SP Items	106
5.14.2	Tie-in Forms	106
6	Phase 5 (Construction and Support)	109
6.1	Preparation of Procedures and Manuals	109
6.2	Tie-in Execution	109
6.3	Provide Answers to the Construction Team	109
6.4	Updating P&IDs as Needed	111
7	Phase 6 (Commissioning and Startup)	113
7.1	Perform General Process Activities	113
7.2	Prepare and Complete Pre-startup and Safety Checklists	114
7.3	Check Performance Test of All the Equipment	116
7.4	Participate in Control System Loop Testing	116
7.5	Leak Testing	117
7.6	Drying-Out and Oxygen Freeing	118
7.7	Startup Assistance	118
 Part III The Process Engineer 119		
8	Role by Process Engineer's Position	121
8.1	Entry-Level Process Engineer – 0 Years Experience	121
8.2	Junior Process Engineer – 1–2 Years Experience	121
8.3	Mid-Level Process Engineer – 3–6 Years Experience	121
8.4	Lead Process Engineers – 7–10 Years Experience	122
8.5	Senior Process Engineers – 10–15 Years Experience	122
8.6	Process Managers – 15+ Years Experience	122
8.7	Competency Guide for Process Engineers	122
9	Interaction of Process Engineers with Others	137
9.1	Project Tree	137
9.2	Customer	138
9.3	Mechanical Engineer	139
9.4	Projects	140
9.5	Piping Design	140
9.6	Piping Engineering	141
9.7	Control System Engineer	141
9.8	Electrical Engineer	142
9.9	Civil Engineer	142
9.10	Construction Team	143
9.11	Cost Estimating	143
9.12	Project Controls	144

- 9.13 Licensor 144
- 9.14 Other EPCC Engineer 145
- 9.15 CAD and Drafting Coordinator 145
- 9.16 Document Control 146

Questions 147

Answers 149

Acronyms 153

Appendix 155

Appendix A Project Conceptual Diagram 157

- A.1 Explanation of Figure A.1 157
- A.2 Explanation of Figure A.2 158
- A.3 Explanation of Figure A.3 158
- A.4 Explanation of Figure A.4 159
- A.5 Explanation of Figure A.5 160
- A.6 Explanation of Figure A.6 161
- A.7 Explanation of Figure A.7 162

Appendix B Project Schedule Diagrams 163

- B.1 Explanation of Figure B.1 163

Appendix C Project 3D Model and Plot Diagrams 165

- C.1 Explanation of Figure C.1 165
- C.2 Explanation of Figure C.2 166
- C.3 Explanation of Figure C.3 167
- C.4 Explanation of Figure C.4 167
- C.5 Explanation of Figure C.5 168

Appendix D Process Engineering Diagrams 171

- D.1 Explanation of Figure D.1 171
- D.2 Explanation of Figure D.2 171
- D.3 Explanation of Figure D.3 171

References 175

Index 177