



V ACKNOWLEDGEMENTS

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SECTION 1: GENERAL INFORMATION

Introduction to Front End / Conceptual Estimating:

The General Forecast for 2023 and beyond

The Project Control Cycle / Issues and Factors

Cost breakdown of a Typical Chemical Process Facility

The CAPEX Estimating Process

Capital Cost Estimating the Four Basic Steps

Presenting the Estimate to Senior Management

Optimizing the Estimating effort

Cost Estimating / Engineering terms

Developing An Estimate Plan

Estimating Methods

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SECTION 2: COST-ESTIMATING CONCEPTUAL FRONT-END DATA

Blue Sky / O.O.M. Order of Magnitude Estimate / Factored / Ratio Estimates / Exponent Estimates / Square Foot.

Capacity / Exponent Estimates (6/10th rule) Method (+/- 25% - 30% Accuracy)

Lang, Wroth, Guthrie, Chilton and Hand factors

50+ Typical Ratio Factored / Percentage Values / Historical Facility Cost Close Out Reports

Cost-Capacity equations / exponents (180 +)

177	3 SECTION 3: SQUARE FOOT / SQUARE METER COST DATA New Industrial / Commercial Sq. Ft. – M2 Building Costs (100 + facility examples) Major Revamp / Rehabilitation Issues Moderate Revamp / Rehabilitation Issues Minor Revamp / Superficial Facelift Issues 25 floors - 200 apartments Major N.E. USA City
187	4 SECTION 4: SEMI-DETAILED COST-ESTIMATING DATA General Conditions / Demolition work Site Construction work Civil, Foundations / U.G. Utility work Structural Steel Framing / Platforms External Wall Systems Roofing, Siding & Miscellaneous items Internal walls / Doors / Ceilings / Flooring / Glass Material Handling Equipment and Specialized Equipment Mechanical Equipment / Plumbing / HVAC & Fire protection Electrical / Instrumentation systems Clean room construction items Home Office Engineering, Procurement and Construction (EPC) Staff Rates Typical Engineering Production Hours Process Piping Systems Piping Material adjustments Major Equipment Insulation "All In" Unit Material Price Checklist Budget Pricing Stainless Steel Tubing / Piping Average Number of Fittings / Valves Major Equipment and Piping Insulation Instrumentation Costs Welding metrics Pipeline(s) Metrics Rail Road Cost Benchmarks Robotic systems In-direct Labor Open Shop Benchmarks and Assumptions Warehouse Miscellaneous Equipment

281	5	SECTION 5: ESTIMATING MISCELLANEOUS SUPPORTING DATA
		Check-list of Front End Estimating / Site Management Issues
		Excavation Equipment Production Rates
		Reinforced Concrete 3,500 PSI / 25 MPA Budget Pricing
		Value Engineering / Cost Optimization Methods (COM)
		USA & International Location Factors
		Engineering Productivity V'S USA Standards
		Detailed Design / Engineering / Architectural & CM Fees
		Open Shop / Non - Union Labor Costs
		Material Adjustment Values (Piping)
		Sales Tax (50 US states and 10 Canadian Provinces)
		Production / Utility Equipment Benchmarks (90 + Cost models)
		Inflation / Compass Cost Index

451	6	SECTION 6: EPC HISTORICAL COST MODELS & BENCHMARKS
		General Production Benchmarks (80 +)
		Estimate Assessment Sheet / Ratio Analysis
		Major Equipment delivery times / USA Construction Productivity

471	ABOUT THE FIRM
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- Choice from among alternate layouts / designs / process configuration
 - Board of Director Approval / Appropriation of funds (A.F.E.)
 - Compilation of bids / proposals
 - Funding / Feasibility studies
 - Choice from among varying site / manufacturing locations / countries
 - Choice of alternate investments methods, lease or purchase / toll manufacture, 3rd party outsourcing
 - Claims mitigation / Change order control
 - Value engineering baseline cost model
 - Future benchmarking points / data
- Designing and constructing new process related facilities is a risky undertaking, the individual preparing these CAPEX capital cost estimates should understand the ramifications / risks that could influence and impact the final cost of the EPC effort,

- these risks include:
- The state of the economy
 - Federal and local Government grants / incentives
 - Technology being used (proven or first of its kind)
 - Sophistication of specifications (high end or industry standards)
 - Schedule requirements
 - Current market conditions
 - Union or Open Shop labor utilization
 - Productivity of the workforce
 - Weather conditions
 - Ambiguous site conditions (rock or high water table)
 - Strikes / lock-outs
 - Material / Major Equipment shortages
 - Accidents at the jobsite or accidents to equip-

Major Activities To Consider IN THE CAPEX, I.E. ESTIMATING PROCESS

#	ACTIVITY	ESTIMATING INPUT
1	New needs or demand, for new product / new or expanded or re-vamped building, manufacturing facility or production unit.	Refer to Section 2 and 3 for appropriate estimating method to be utilized.
2	Definition of project goals, scope and mission statement.	
3	Conceptual engineering, planning and Front End / feasibility study including possible Front End estimate.	Refer to Section 2 and 3 for appropriate estimating method to be utilized.
4	Submittal of Approval of Expenditure – AFE. Package.	
5	Commencement of detailed engineering effort if project is approved.	
6	(Optional) Possible milestone to compile CAPEX estimate.	Refer to Section 2 and 3 for appropriate estimating method to be utilized.
7	Production of engineering deliverables.	
8	(Optional) Possible milestone to compile CAPEX estimate.	Refer to Section 2 and 3 for appropriate estimating method to be utilized
9	Start of Procurement effort.	
10	Start of Construction effort.	
11	(Optional) Possible milestone to compile CAPEX estimate.	Refer to Section 2 and 3 for appropriate estimating method to be utilized.
12	Completion of Construction effort.	
13	Start up / handover of completed project.	
14	Close out report.	
15	Collection of historical data for future CAPEX estimating / benchmarks.	

Estimate. (Little or no engineering has been completed)

2. Preliminary Budget / Funding for execution Capital Cost Estimate. (Perhaps 10%-20% of the engineering has been compiled)

3. Control / Definitive / Bid / Lump Sum Capital Cost Estimate. (Possibly 50% or more of the detailed design / engineering has been completed)

The initial CAPEX Estimate be it a Blue Sky / Order of Magnitude or a Scale up Capacity estimate is either the initial pathforward towards a profitable and sustainable project / future profitable asset or the initial step towards a potential business failure – once a number is published it is difficult to re-visit and modify this number especially in the case where the Business Unit has used the initial number in there forecasting / economic models. The following diagram depicts the four basic steps / approach that is common to all estimating efforts, this four step approach will be described in more detail in this section and subsequent sections of this publication.

Items and questions that need to be asked and considered prior to commencing the CAPEX esti-

mating effort includes:

- Has any preliminary engineering / design deliverables been produced specific to this new / proposed project?
- Have any PCA’s (Property Condition Assessment) been produced, many times they have?
- Have any Phase One Environmental Site Assessments been completed in the last 3 – 5 years?
- Who is going to develop a scope of work (corporate engineering, the estimating group or a third party engineering firm)?
- What type of facility is being considered / being - engineered, procured and constructed?
- Is the project a grassroots facility or is it expansion or upgrade?
- What type of estimate is required (level of accuracy) - establish an estimating plan?
- What engineering deliverables need to be produced to match the estimating requirements? Who is tasked with the production of these engineering deliverables?
- How should the estimate be formatted - structured – WBS – COA?

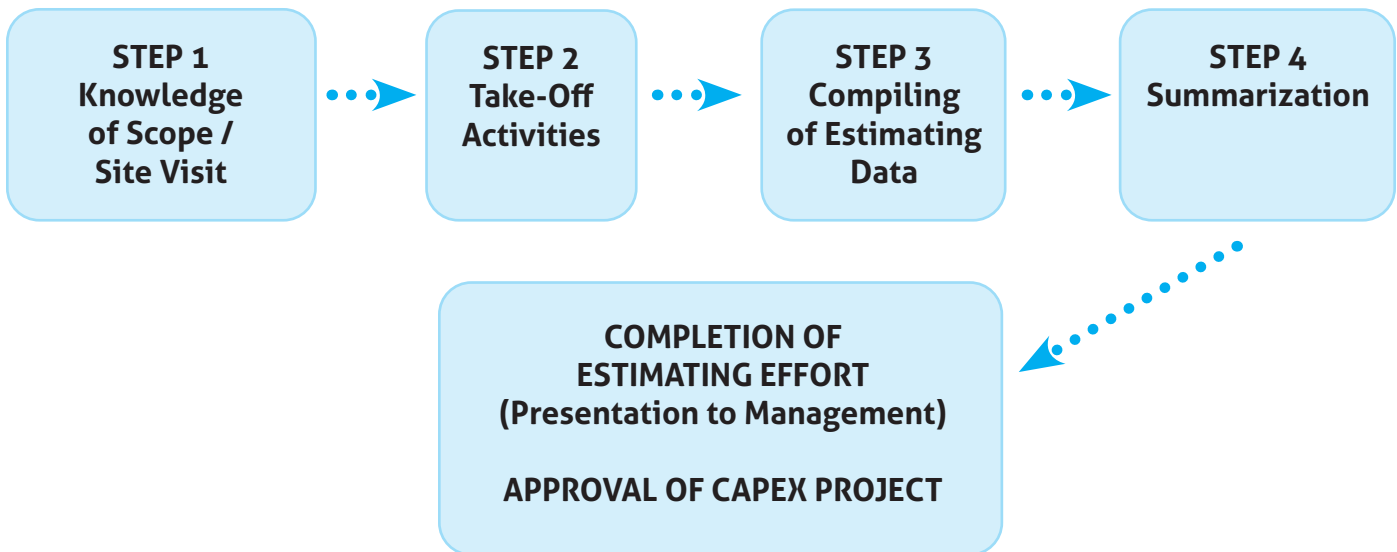


Table 62

REFINERY EQUIPMENT FACTORS / MULTIPLIERS:

MULTIPLY EQUIPMENT ITEM COST (OBTAIN QUOTE FROM VENDOR OR ESTIMATE PURCHASE PRICE OF EQUIPMENT INCL FREIGHT): FACTORS / MULTIPLIERS INCLUDE: SITE CLEARANCE, EXCAVATION, CONCRETE FOUNDATIONS, STRUCTURAL STEEL, PLATFORMS, SETTING EQUIPMENT, PIPING, ELECTRICAL, INSTRUMENTATION, INSULATION, PAINTING, ALL IN-DIRECTS, INCLUDING, SITE ESTABLISHMENT, SUPERVISION, CONSTRUCTION EQUIPMENT, SCAFFOLDING, SUB-CONTRACTORS OVERHEAD & PROFIT. EXCLUDES DETAILED DESIGN, CONSTRUCTION MANAGEMENT COSTS & OSBL (OUTSIDE BATTERY LIMITS) SCOPE.

A. CONTINUOUS CATALYTIC REFORMER PRODUCTION UNIT 30,000 TO 70,000 BARRELS PER DAY

#	EQUIPMENT	LOW FACTOR	HIGH FACTOR	AVERAGE FACTOR
1	Columns / Towers	2.3	2.8	2.6
2	Compressors	1.6	1.8	1.7
3	Fired Heaters	2.0	3.0	2.5
4	Heat Exchangers	2.5	2.9	2.7
5	Other Miscl Equipment	2.5	4.5	3.5
6	Pressure Vessels	2.5	3.0	2.8
7	Pumps	2.4	2.8	2.6
8	Reactors	1.5	1.9	1.7
9	Tanks (Storage)	2.6	3.2	2.9

B. CRUDE UNIT 75,000 TO 250,000 BARRELS PER DAY

#	EQUIPMENT	LOW FACTOR	HIGH FACTOR	AVERAGE FACTOR
1	Columns / Towers	2.4	2.9	2.7
2	Compressors	1.6	1.8	1.7
3	Fired Heaters	1.8	2.3	2.1
4	Heat Exchangers	2.5	2.9	2.7
5	Other Miscl Equipment	2.5	3.5	3.0
6	Pressure Vessels	2.7	3.7	3.2
7	Pumps	2.2	2.6	2.4
8	Reactors	N/A	N/A	N/A
9	Tanks (Storage)	2.6	2.9	2.8

F. NAPHTHA HYDROTREATER UNIT 30,000 TO 70,000 BARRELS PER DAY

#	EQUIPMENT	LOW FACTOR	HIGH FACTOR	AVERAGE FACTOR
1	Columns / Towers	2.4	2.9	2.7
2	Compressors	1.3	1.9	1.6
3	Fired Heaters	2.4	2.9	2.7
4	Heat Exchangers	2.3	3	2.7
5	Other Miscl Equipment	2.3	2.9	2.6
6	Pressure Vessels	2.9	3.6	3.3
7	Pumps	2.3	2.7	2.5
8	Reactors	2.3	2.8	2.6
9	Tanks (Storage)	2.3	2.8	2.6

G. POLYPROPYLENE UNIT 50,000 TO 150,000 MILLION TONS PER YEAR

#	EQUIPMENT	LOW FACTOR	HIGH FACTOR	AVERAGE FACTOR
1	Columns / Towers	2.5	2.9	2.7
2	Compressors	1.4	1.9	1.7
3	Fired Heaters	1.6	2.4	2.0
4	Heat Exchangers	3.3	3.9	3.6
5	Other Miscl Equipment	2.2	2.9	2.6
6	Pressure Vessels	2.7	3.2	3.0
7	Pumps	2.7	3.4	3.1
8	Reactors	3.7	5.2	4.5
9	Tanks (Storage)	1.8	2.2	2.0

H. THERMAL CRACKER 15,000 TO 25,000 BARRELS PER DAY

#	EQUIPMENT	LOW FACTOR	HIGH FACTOR	AVERAGE FACTOR
1	Columns / Towers	2.5	2.9	2.7
2	Compressors	2.4	2.9	2.7
3	Fired Heaters	1.8	2.2	2.0
4	Heat Exchangers	2.7	3.4	3.1
5	Other Miscl Equipment	2.2	2.9	2.6
6	Pressure Vessels	3.4	4.4	3.9
7	Pumps	2.3	2.9	2.6
8	Reactors	N/A	N/A	N/A
9	Tanks (Storage)	2.6	2.9	2.8

Table 63

BUS & HEAVY TRUCK TIRE PRODUCTION FACILITY - INDIANA USA
194,560 SF MID-2022 COST BASIS
10 ACRES SITE ADJACENT TO EXISTING PRODUCTION FACILITY

#	SCOPE OF WORK - DESCRIPTION	\$ COST	COST / SF
1	General Conditions / Preliminaries / Site Offices - Mob - Demob	4,387,500	22.55
2	Demolition of existing structure	105,000	0.54
3	Site works, Earthworks, Excavations, Utility Services, Site Roads, Ponds, Wells, Fencing & Employee Parking area	3,659,300	18.81
4	Facility Foundations - Concrete, Formwork, Rebar, Polished Floor	2,878,200	14.79
5	Structural Steel / Micl steel	6,770,840	34.80
6	Finish & Rough Carpentry - Cabinets	158,202	0.81
7	Exterior Enclosure (Inc. Metal Siding, Roof, Exterior Windows & Doors) 6 Truck Loading Docks	5,703,260	29.31
8	Internal Office Partitions & Doors, Finishes, Toilets Stalls, Reception Area & 7 Offices - Cubicles & 2 Conference Room - Security - Medical Station - Truck Driver waiting area	1,860,300	9.56
9	Re-Furbished Production Equipment from other location	852,000	4.38
10	Production Equipment / Support items (Tanks, Blenders, Extruders, Vats, Pumps, Molds, Heat Exchangers, Forklifts, Charging Stations)	13,297,500	68.35
11	Mechanical Systems - Plumbing, Process Pipe, HVAC, AHU's, Natural Gas, Fire Protection, Toiles & Safety Showers	8,222,175	42.26
12	Electrical / Instrumentation, Control Room, Bar Coding, CCTV's Security Systems & Fire Alarms	7,041,986	36.19
13	Start Up & Commissioning	209,391	1.08
14	BAR Insurance, Bonds, Fees & OH&P	3,395,560	17.45
15	Contingency / Management Reserve	5,500,000	28.27
16	S/T	64,041,214	329.16
17	Detailed Design & EPC HO Support / Procurement activities	6,049,999	31.10
18	Project / Construction Management & Project Controls	3,412,875	17.54
19	Owner Front End Design & Oversight	775,000	3.98
20	TOTAL FACILITY COST	74,279,088	381.78

#	DESCRIPTION	UNIT	MATERIAL	LABOR	TOTAL
CONTINUED					
260	Ditto 50 mm	M	13.47	14.49	27.95
261	Multiply above piping units by 1.35 for fittings / bends for normal applications	M			
262	Ditto for congested / complex application use 1.60	M			
263	Copper pipe type L 12 mm dia including fittings and erection	M	15.72	20.88	36.60
264	Ditto 19 mm	M	25.95	28.44	54.39
265	Ditto 25 mm	M	39.37	34.66	74.03
266	Ditto 40 mm	M	70.41	42.58	112.99
267	Ditto 50 mm	M	119.14	50.33	169.47
268	Copper pipe type K 12 mm dia including fittings and erection	M	18.04	21.72	39.75
269	Ditto 19 mm	M	29.55	29.95	59.49
270	Ditto 25 mm	M	44.96	36.52	81.48
271	Ditto 40 mm	M	78.46	45.11	123.57
272	Ditto 50 mm	M	127.11	51.83	178.95

Table 9**CSI DIVISION 16 ELECTRICAL SWITCHGEAR / CLEAN ROOM ITEMS**

#	DESCRIPTION	UNIT	MATERIAL	LABOR	TOTAL
1	Substation, 150 KVA, 1200 AMP, with transformer, breakers, pad, grounding	EACH	77,015		77,015
2	Substation, 1000 KVA, 3000 AMP, with transformer, breakers, pad, grounding	EACH	143,583		143,583
3	Service switchboard, 600 A, 3PH, 277/480V MCMB, breakers, bus, meter, enclosure	EACH	29,716		29,716
4	Distribution, switchboard, 600 A, 3PH, 120/208 V, enclosure, breakers	EACH	10,904		10,904
5	Distribution, switchboard, 800 A, 3PH, 120/208 V, enclosure, breakers	EACH	13,659		13,659
6	Distribution switchboard, 400 A, 3PH, 277/480 V, enclosure, breakers	EACH	9,054		9,054
7	Transformer, 480/120 V, 3 phase, 500 KVA	EACH	38,258		38,258
8	Transformer, 480/120 V, 3 phase, 750 KVA	EACH	53,569		53,569
9	Transformer, 480/120 V, 3 phase, 1,000 KVA	EACH	64,043		64,043
10	Panel boards, bolt-on breakers, 277/480V, 3PH, 4W, 100 A, 24 circuits	EACH	4,964		4,964
11	Panel boards, bolt-on breakers, 277/480V, 3PH, 4W, 225 A, 42 circuits	EACH	7,575		7,575
12	Panel boards, bolt-on breakers, 277/480V, 3PH, 4W, 400 A, 42 circuits	EACH	8,139		8,139
13	Transformer, 480/120 V, 3 phase, 45 KVA	EACH	5,965.68	954.71	6,920.39
14	Ditto 75 KVA	EACH	7,339.49	1,336.62	8,676.11
15	Ditto 100 KVA	EACH	8,374.56	1,623.02	9,997.58
16	Ditto 150 KVA	EACH	9,315.50	1,928.53	11,244.03

Formwork

COST BASIS 2020

APPLICATION	FABRICATE & ERECT & DISMANTLE 1ST USE	ERECT, CLEAN & REPAIR 2 USES	ERECT, CLEAN & REPAIR 3 USES	ERECT, CLEAN & REPAIR 4 USES	ERECT, CLEAN & REPAIR 5 USES	ERECT, CLEAN & REPAIR 10 USES
Isolated foundations	Materials \$3.10 1.25 hours	Materials \$0.75 1.00	Materials \$0.80 0.90	Materials \$0.80 0.80	Materials \$0.80 0.70	Materials \$0.80 0.70
Walls 10' high	Materials \$3.70 Labor 1.50 hours	Materials \$0.85 1.25	Materials \$0.88 1.15	Materials \$0.88 1.05	Materials \$0.88 0.95	Materials \$0.88 0.95
Elevated columns & beams	Materials \$6.45 Labor 2.25 hours	Materials \$1.37 2.00	Materials \$1.40 1.90	Materials \$1.40 1.80	Materials \$1.40 1.70	Materials \$1.40 1.70
Elevated floor slabs	Materials \$4.90 Labor 1.00 hours	Materials \$0.95 0.75	Materials \$1.00 0.65	Materials \$1.00 0.55	Materials \$1.00 0.45	Materials \$1.00 0.45

Pre-Cast Concrete Floor Slabs (Elevated) 3,000 PSI Concrete: SOLID OR HOLLOW 3,500 PSI CONCRETE STRAPPED AND GROUTED

FLOOR THICKNESS	MATERIAL COST PER SF	INSTALLATION MAN-HOURS PER SF	MATERIAL COST PER M2	INSTALLATION MAN-HOURS PER M2
4"	\$6.80	0.15	\$73.17	1.60
6"	\$8.05	0.17	\$86.62	1.83
8"	\$8.70	0.20	\$93.61	2.15
10"	\$10.65	0.23	\$111.60	2.48

- Excludes crane costs:
- For areas larger than 25,000 SF / 2,323 M2 multiply installation hours by 0.85

Pre-Cast Concrete Wall 3,500 PSI Reinforced Concrete (INSULATED WITH BATT INSULATION 0.50 – 1.00 INCH): TILT –UP AND INDUSTRIAL APPLICATIONS:

FLOOR THICKNESS	MATERIAL COST PER SF	INSTALLATION MAN-HOURS PER SF	MATERIAL COST PER M2	INSTALLATION MAN-HOURS PER M2
3"	\$4.90	0.20	\$52.72	2.15
4"	\$6.00	0.20	\$64.56	2.15
5"	\$7.50	0.25	\$80.70	2.70
6"	\$8.40	0.25	\$90.38	2.70

- Excludes crane costs:
- For areas larger than 25,000 SF / 2,323 M2 multiply installation hours by 0.85

Field erected storage tanks C.S.

10,000 gal	(238 barrels)	Ea	70/90
25,000 gal	(595 barrels)	Ea	120/180
50,000 gal	(1,190 barrels)	Ea	250/400
100,000 gal	(2,380 barrels)	Ea	540/620
250,000 gal	(5,950 barrels)	Ea	700/850
500,000 gal	(11,900 barrels)	Ea	900/1,250

Drum - CS A 515

DATA TABLE

GALLONS	\$ COST PER GALLON TO PURCHASE DRUM D/D TO SITE	\$ COST OF DRUM PER GALLON INSTALLED WITH BULK MATERIALS & FIELD LABOR	\$ COST OF DRUM PER GALLON WITH DESIGN / CM & INSPECTION
250	57.86	394.64	453.83
500	35.97	244.79	281.52
1,000	24.12	141.69	162.93
2,500	14.32	72.95	83.89
5,000	11.84	43.48	50.00
10,000	9.55	30.38	34.95
25,000	6.68	19.87	22.85
50,000	5.89	13.85	15.92
100,000	5.28	11.25	12.95

Heat Exchangers (shell & tube)

Up to 50 SF	Ea	16
50 - 100 SF	Ea	40
100 - 500 SF	Ea	40/80
500 -1,000 SF	Ea	80/100

Horizontal Batch Centrifuge

10 SF	Ea	88
50 SF	Ea	164
100 SF	Ea	420

MISCELLANEOUS ITEMS

(1) AGITATOR / MIXER / BLENDER – VESSEL / POT BLENDER: Installation man-hours include unloading, temporary warehousing, site transportation n/e 0.50 miles – 0.80 km, unpacking, lifting into position, setting, leveling, aligning, and system check out. Excludes cranes, foundations,

grouting, brackets, supports, piping, cable, conduit and electrical hook-up:

(2) BLOWERS & FANS- Suspended Type Fans (ceiling / hung by brackets): Installation man-hours include unloading, temporary warehousing, site transportation n/e 0.50 miles – 0.80 km,, unpacking, lifting into position, setting, leveling, aligning, and system check out. Includes thermostat, holding brackets and fuel pump: Excludes cranes, foundations, grouting, brackets, supports, piping, cable, conduit and electrical hook-up:

(3) FLUID TYPE: Includes installation of motor and drives, controls: Excludes crane rental, foundations, grouting, brackets, supports, piping, cable, conduit and electrical hook-up:

Table 5D

CFM	\$ EQUIP.	MAN HOURS	HOOK UP MATERIAL
250	\$1,241	4	\$150
500	\$1,877	5	\$150
1,000	\$3,044	6	\$150
2,500	\$10,176	8	\$250
5,000	\$12,710	12	\$250

Table 5E

CFM	\$ EQUIP.	MAN HOURS	HOOK UP MATERIAL
250	\$1,471	4	\$150
500	\$2,046	5	\$150
1,000	\$3,155	6	\$150
2,500	\$7,409	8	\$250
50,000	\$13,077	12	\$250

Table 5F

CFM	\$ EQUIP.	MAN HOURS	HOOK UP MATERIAL
250	\$1,475	4	\$150
500	\$1,908	5	\$150
1,000	\$3,308	6	\$150
2,500	\$7,820	8	\$250
50,000	\$13,892	12	\$250

Table 5G

CFM	\$ EQUIP.	MAN HOURS	HOOK UP MATERIAL
250	\$1,543	4	\$150
500	\$2,256	5	\$150
1,000	\$3,503	6	\$150
2,500	\$8,122	8	\$250
50,000	\$14,510	12	\$250

Table 5H

TONS	\$ EQUIPMENT	INSTALLATION MAN HOURS
5	\$9,347	8
10	\$19,359	11
15	\$24,876	14
20	\$30,084	16
25	\$38,397	22
50	\$76,899	30

(6) AIR DRYERS:

(A) AIR DRYERS: Installation man-hours include unloading, temporary warehousing, site transportation n/e 0.50 miles – 0.80 km, unpacking, lifting into position, setting, leveling, aligning, and system check out. Excludes cranes, foundations, setting holding down bolts, grouting, brackets, supports, piping, cable, conduit and electrical hook-up, refer to productivity adjustments on earlier page to calibrate installation man-hours. The man-hour installation units exclude initial chemical charging, cooling liquids, refrigerant / anti freeze chemicals, M.E. passivation and cleaning (pickling) and M.E. identification / stenciling & subsequent tagging.

(B) Air Dryer, C S A 285C:

- Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).
- Add installation man-hours.
- See chart on the following pages.

(7) AIR HANDLER UNITS:

(A) AIR HANDLERS: includes coils, dampers, controls, etc.

- See chart on the following pages.

(B) CONCEPTUAL ESTIMATING for budgeting Air handling type equipment.

- See chart on the following pages.

(8) BALL MILLS

(A) BALL MILL: Installation man-hours include unloading, temporary warehousing, site transportation n/e 0.50 miles – 0.80 km, unpacking, lifting into position, setting, leveling, aligning, and system check out. Installation man-hours exclude installation of packing's, internals, and brackets and any special testing / inspection if required. Excludes cranes, setting holding down bolts, foundations, grouting, brackets, supports, piping, cable, conduit and electrical hook-up, refer to productivity adjustments on earlier page to calibrate installation man-hours.

Table 79A

AREA / SF-M2	# OF PIECES	M.H.' S	M.H. PER SF
25 / 2.32	4/7	12	0.48
50 / 4.65	4/7	22	0.44
75 / 6.97	4/7	32	0.42
100 / 9.29	4/7	42	0.42
200 / 18.60	7/10	54	0.22

Table 79B

SF	\$ EQUIP. COST LOW	\$ EQUIP. COST HIGH
10	\$156,400	\$264,483
20	\$272,947	\$382,047

Table 80A

CAPACITY IN GALLONS	304 SS	316 SS
1,000	\$26.64	\$38.98
2,500	\$19.40	\$23.06
5,000	\$17.33	\$21.72
10,000	\$13.97	\$17.79

Table 81A

TONS	MAN-HOURS PER TON
1 – 10	12.5
10 – 20	10
20 – 40	8.4
40 – 60	4.35
60 – 80	3.25
80 – 100	2.85

(79) VACUUM BATCH DRYER:

(A) VACUUM BATCH TRAY DRYER:

Installation man-hours include unloading, temporary warehousing, site transportation n/e 0.50 miles – 0.80 km, unpacking, lifting into position, setting, leveling, aligning, and system check out. Excludes cranes, foundations, setting holding down bolts, grouting, brackets, supports, piping, cable, conduit and electrical hook-up:

(B) Vacuum Dryer O.O.M. Equipment Cost:

Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).

(C) Vacuum Pump 200 HP \$140 - \$210 per HP: see chart.

(80) VERTICAL RECEIVER (25 PSI – FULL VACUUM):

(A) Vertical Receiver (Labor & Material):

(81) VERTICAL TOWERS:

(A) VERTICAL TOWERS PRESSURE VESSELS - not exceeding 120' T/T: Installation man-hours include unloading, temporary warehousing,

site transportation n/e 0.50 miles – 0.80 km, unpacking, lifting into position, setting, leveling, aligning, and system check out. Installation man-hours exclude installation of trays, internal packing, internals brackets, and any special testing / inspection if required. Excludes cranes, foundations, setting holding down bolts, grouting, brackets, supports, piping, cable, conduit and electrical hook-up.

(B) Vertical Distillation Tower 1" wall thick A – 515 C.S.

- Cost per pound \$2.75 - \$5.05
- Cost per Kg \$6.05 - \$11.11
- Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).

(82) VESSEL (GLASS LINED)

(A) Horizontal Vessel / Drum, SS 316

- Add installation man-hours
- Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).
- See chart next page.

EPC Historical Cost Models and Benchmarks

The following 80 + benchmarks (on the next pages) should be considered / reviewed and added to the previous cost models if appropriate:

* Current US tax allow for the first \$107.6K of

earnings to be non taxable (2022), however working overseas for periods of more than six months will require US expatriates to pay both US and local country income taxes where applicable.

General Benchmarks

TO BE ADDED TO THE PREVIOUS COST MODELS IF APPROPRIATE

DESCRIPTION	RANGE	FACILITY COST	ACTIVITY COST	COMMENTS
1. Off sites (OSBL)	5% - 50% of Inside Battery Limits (ISBL)			
2. Fringes (vacations, holidays, sick days)	22% - 30% of base wage rate			
3. Worker Compensation Insurance	10% - 17.5% of base wage rate			
4. Inspections / QA-QC services	1.5% of TIC			
5. Front End Studies / Scoping study / BOD	0.5 – 2.5% of TIC of facility.	\$1 - \$100 + million		
6. Builders all risk insurance (BAR)	0.15% - 0.60%	\$1 - \$100 + million		
7. Contractors O/H (Supporting construction / field activities)	4.00% - 15.00%			The larger the TIC value of the project, the lower the % typically is.
8. Profit	3.5% - 15%			Typically on a \$20 million new building / facility a profit margin between 5% - 8.5% can be realized dependent on economic climate and number of bidders - 5 + or more bidders generally translates to lower profit margins.
9. Performance Bond	0.35% - 1.25%			
10. Procurement activities	0.50 – 1.00% of TIC			Purchase orders & contracts
11. Engineering support	0.50 – 1.00% of TIC			Field questions, vendor visits, answers to RFI
12. H.O Project Controls	0.50 – 1.50% of TIC			Estimating, cost engineering and planning activities