

# 2024 FRONT END/ CONCEPTUAL ESTIMATING

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(5) The following historical return cost data

reflects a chemical process facility (liquid / solid process) built in S.E. USA calibrated to the mid point of 2006. M.E. / Process Equipment multipliers / benchmarks, data is based on average direct labor hourly rate \$36, to establish union all in rate add 80 - 90%, for union application. For open shop all in rate add 40 - 75% uplift. Cost model is based on 86 # M.E. items costing \$9,954,000.

• Total Project = \$35.689 million divided by Major Equipment = \$9.954 million = 3.58 (note: offsites not included – off-sites were a separate contract – valued at \$4.70 million)

### (6) Refinery / Petro-Chemical Expansion

(SRU) USA Gulf Coast (2004 Costs) Constructed on an established operating site with adequate utilities (needing some upgrading) Costs are based on final close out report:

Excludes: Owner corporate engineering \$298,000 and Front End Study \$445,000:

Demolition could be an expense item. Refer to previous L & M ratio's to determine man-hours and material splits.

# Table 5 HISTORICAL RETURN COST DATA OF A CHEMICAL PROCESS FACILITY (LIQUID / SOLID PROCESS)

		\$ MILLIONS BULK MATERIA	L	\$ MILLIONS BULK LABOR	\$36/ HOUR LABOR HOURS	TOTAL IN \$ MILLIONS
MAJOR EQUIPMENT (86 IT	EMS)					\$9.954
Freight	3.15% Of M.E.					\$0.314
ME install	0.97%	\$0.097	3.95%	\$0.393	10,922	\$0.490
Demolition	0.00%	\$-	2.03%	\$0.202	5,625	\$0.202
Site Works	2.17%	\$0.216	2.80%	\$0.279	7,754	\$ 0.495
Foundations /	3.97%	\$ 0.395	2.57%	\$0.256	7,117	\$0.651
Concrete work						
Building structure	9.39%	\$0.935	8.59%	\$0.855	23,758	\$1.790
Pipe	23.09%	\$2.298	29.95%	\$2.981	82,819	\$5.280
Electrical	11.09%	\$1.104	14.12%	\$1.405	39,040	\$2.509
Instrumentation / Control	16.60%	\$1.653	5.68%	\$0.566	15,718	\$2.219
Paint	2.26%	\$0.225	2.65%	\$0.264	7,326	\$0.488
Insulation	3.89%	\$0.387	3.86%	\$0.384	10,674	\$0.772
Fire protection	2.06%	\$0.205	2.16%	\$0.215	5,981	\$0.421
Refractory / Misc items	2.45%	\$0.244	3.41%	\$0.339	9,424	\$ 0.583
TOTAL DIRECTS (A)	77.95%	\$7.759	81.79%	\$8.142	226,157	\$26.167
FIELD IN DIRECTS						
Field supervision	16.04% Of labor					\$1.306
Field admin / secretary	1.69% Of labor					\$0.138
Field establishment	2.46% Of materi	al				\$0.191
Field establishment	2.57% Of labor					\$0.209
Consumables	0.87% Of materi	al				\$0.067
Small tools	0.88% Of materi	al				\$0.068
<b>Construction equipment</b>	7.67% Of labor					\$0.624
Construction maintenance	1.45% Of labor					\$0.118
Material handling	2.23% Of materi	al				\$0.173
Clean up	1.85% Of labor					\$0.151



# Table 63BUS & HEAVY TRUCK TIRE PRODUCTION FACILITY - INDIANA USA

### 194,560 SF MID-2022 COST BASIS 10 ACRES SITE ADJACENT TO EXISTING PRODUCTION FACILITY

#		Ś COST	
	SCOPE OF WORK DESCRIPTION	5 (051	
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,	3,659,300	18.81
	Fencing & Employee Parking area		
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)	5,703,260	29.31
	6 Truck Loading Docks		
8	Internal Office Partitions & Doors, Finishes, Toilets Stalls, Reception Area $m{arepsilon}$	1,860,300	9.56
	7 Offices - Cubicles & 2 Conference Room - Security - Medical Station -		
	Truck Driver waiting area		
9	Re-Furbished Production Equipment from other location	852,000	4.38
10	Production Equipment / Support items (Tanks, Blenders, Extruders, Vats,	13,297,500	68.35
	Pumps, Molds, Heat Exchangers, Forklifts, Charging Stations)		
11	Mechanical Systems - Plumbing, Process Pipe, HVAC, AHU's, Natural Gas,	8,222,175	42.26
	Fire Protection, Toiles & Safety Showers		
12	Electrical / Instrumentation, Control Room, Bar Coding, CCTV's Security	7,041,986	36.19
	Systems & Fire Alarms		
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



# Table 73

# LITHIUM BRINE HYDROXIDE FACILITY 2024 EPC BECHMARKS:

#	TONS OF PRODUCTION PER YEAR	LOW CAPEX COST RANGE	HIGH CAPEX COST RANGE		LOW \$ COST PER TON	HIGH \$ COST PER TON	
А	25,000	650,000,000	715,000,000		26,000	28,600	
В	50,000	900,000,000	990,000,000		18,000	19,800	
С	75,000	1,100,000,000	1,210,000,000		14,667	16,133	
D	100,000	1,220,000,000	1,340,000,000		12,200	13,400	
#	DESCRIPTION			LOW %	соѕт	HIGH % COST	
1	Major Equipment - Tanks, heaters, pumps, grinders, condensers, mixers, agitators, modules (includes freight) the value for freight to jobsite is 3%.			25.6		33.5	
2	Materials (Bulks (Stone, Concrete, Structural Steel, Insulation, Refractory & Paint etc., / Instrumentation).			17.7		21.7	
3	Labor costs – including sub-contractors.			22.5		25.7	
4	Field In-directs / General Conditions / Preliminaries / Construction Equipment.			8.7		10.1	
5	Detailed Design / H O support / Pr	ocurement / PM se	ervices	9.6		12.3	
6	Construction Management			5.1		5.7	
7	Miscl items.			0.8		1	
8	TOTAL %			90		110	



#	DESCRIPTION	UNIT	MATERIAL	LABOR	TOTAL
CONTIN	IUED				
31	Crane, hydraulic, gantry, 4000 lb	EACH	5,126.59	-	5,126.59
32	Crane, monorail, overhead, 200 # L/F, manual	LF	43.95	116.05	160.00
33	Crane, monorail, overhead, 100 # L/F, manual	LF	28.43	116.05	144.47
34	Bridge Crane, 1 ton	EACH	12,832	-	12,832
35	Bridge Crane, 2.5 ton	EACH	26,180	-	26,180
36	Bridge crane, 5 ton	EACH	40,468	-	40,468
37	Man lift, 2 stop	EACH	30,862	-	30,862
38	Man lift, 3 stop	EACH	35,661	-	35,661
39	Man lift, 4 stop	EACH	36,836	-	36,836
40	Escalator, 12' floor to floor, 24" wide	Floor	217,639	-	217,639
41	Escalator, 12' floor to floor, 32" wide	Floor	224,389	-	224,389
42	Escalator, 12' floor to floor, 36" wide	Floor	238,914	-	238,914
43	3" round C.S. single tube	LF	36.28	20.71	56.99
44	4" round C.S. single tube	LF	40.19	24.84	65.04
45	6" round C.S. single tube	LF	67.41	27.87	95.28
46	3/16th lead lining to walls	SF	15.60	4.32	19.91

# Table 8CSI DIVISION 15 PLUMBING & FIRE PROTECTION

#	DESCRIPTION	UNIT	MATERIAL	LABOR	TOTAL
1	CS A53 1" diameter schedule 40 including fittings / hangars and erection n/e 20' from FFL (4 fitting per 100' of pipe, valves not included)	LF	11.51	15.71	27.22
2	Ditto 2":	LF	15.72	24.71	40.43
3	Ditto 4"	LF	32.41	61.81	94.22
4	Ditto 6"	LF	62.59	129.36	191.95
5	Water heater, commercial, electric, 50 gallon, 100 GPH	EACH	4,085.54	933.50	5,019.04
6	Water heater, commercial, gas, 80 gallon, 100 GPH	EACH	6,695.30	1,010.39	7,705.69
7	Interceptor grease, cast iron, 50 gallons per minute	EACH	4,289.70	1,588.02	5,877.72
8	Pump, circulating, in line, flanged, iron body, 3/4" to 2"	EACH	822.76	276.78	1,099.53
9	Pumps circulating, in line flanged, iron body, 3/4" to 2"	EACH	2,603.61	377.78	2,981.39
10	Pumps sewage ejector, w/tank & fittings, single, 2 horsepower, 4"	EACH	14,002.37	2,165.70	16,168.07
11	Pump, sewage ejector, w/tank & fittings, duplex 5 H.P.	EACH	24,873.36	4,107.30	28,980.66
12	Pressure booster system, 2 pump, 100 GPM, 50 psi	EACH	25,984.06	4,107.30	30,091.36
13	Pressure booster system, 3 pump, 250 GPM, 100 psi	EACH	39,661.66	5,732.72	45,394.38
14	1" diameter sch 40 including fittings / hangars and erection n/e 20' from FFL	LF	6.36	2.86	9.22
15	Ditto 1.5"	LF	6.56	3.28	9.84
16	Ditto 2"	LF	8.99	3.68	12.68
17	Ditto 4"	LF	23.89	5.20	29.10
18	Ditto 6"	LF	40.59	9.11	49.70
19	Copper "L" including fittings / hangars and erection n/e 20' from FFL $\frac{1}{2}$ dia	LF	2.33	7.72	10.05



**Tons of Structural Steel per piece of Major Equipment (I.S.B.L.):** For applications where the M.E. count is less than 25 use 3.0 tons per M.E. item.

NO. OF M.E. ITEMS	TONS OF S.S. / PER M.E. ITEM
25	69 / 2.76
50	117 / 2.34
100	221/2.21
200	423 /2.11
300	689 / 2.2

### LF of pipe per piece of Major Equipment

**(I.S.B.L.):** For applications where the M.E. count is less than 25 use 650 LF per M.E. item.

NO. OF M.E. ITEMS	LF OF PIPE / PER M.E. ITEM
25	14,370 / 575
50	26,370 / 527
100	48,760 / 488
200	73,830 / 369
300	94,167 / 313

### Heat Exchanger (S & T) C.S.:

AREA	COST PER SF
100	\$96 - \$152
500	\$65 - \$114
1,000	\$42 - \$78

### Heat Exchanger (S & T) Polished S.S.:

AREA	COST PER SF
100	\$430 - \$800
500	\$190 - \$340
1,000	\$160 - \$210

### Vessel Atmosphere / Pressure, C.S.

GALLONS	COST PER GALLON
100	\$67 - \$116
500	\$34 - \$60
1,000	\$19 - \$34
5,000	\$8 - \$16
10,000	\$6 - \$8

# Tower (Distillation) with 20 – 30 trays 60' to 70' high

DIA. / INCHES	100 PSI MATERIAL ONLY \$ COST	250 PSI MATERIAL ONLY \$ COST
24	\$76,594	\$102,221
36	\$97,250	\$112,321
48	\$102,334	\$135,611
60	\$113,605	\$160,478
72	\$156,654	\$227,083

**Direct Field Construction Hours per piece of M.E. (I.S.B.L.):** For applications where the M.E. count is less than 25 use 1,750 M.H. s per M.E. item.

NO. OF M.E. ITEMS	NO. OF PIPING LINES PER M.E.
25	189 / 7.9
50	346 / 6.9
100	678 / 6.8
200	873 / 4.4
300	1,065 / 3.5

# **Typical Facilities / Buildings**

# THAT WOULD BE FOUND ON A TYPICAL PROCESS / REFINERY / MANUFACTURING FACILITY

#	FACILITY TYPE	SF / \$ COST	TYPICAL SIZE IN SF
1	Warehouse	\$95 - \$155	5,000 / 25,000
2	Control room (3 operators)	\$125 - \$275	500 / 750
3	MCC room	\$160 - \$280	250 / 400
4	Operating facility (3-5) person admin offices	\$175 - \$285	750 / 1,000
5	Field laboratory (2 people)	\$155 - \$260	200 / 350
6	Lunch Room	\$105 - \$190	300 / 500
7	Change / wash room	\$130 - \$185	400 / 600
8	Reception / waiting area	\$135 - \$225	250 / 350
#	FACILITY TYPE	\$ COST (LOW)	\$ COST (HIGH)
1	Garage / Parking Stall R.C. open Structure cost per car	\$14,900	\$24,500
2	Hospital cost per bed / patient	\$61,700	\$87,950
3	Hotel / Motel cost per room (2 Star)	\$31,500	\$71,250
4	Hotel / Motel cost per room (3 Star)	\$45,000	\$123,000

# O.O.M. Air Conditioning / Cooling Values

FACILITY TYPE	SF PER TON	M2 PER TON	COST PER TON
Apartment (3-5 story)	500	46.5	\$5,415
Computer / Data Processing Center	100	9.3	\$9,206
Manufacturing Facility / Factory	300	27.9	\$3,689
Hospital (3-5 story)	250	23.2	\$9,472
Hotel (3- 5 story)	350	32.5	\$7,803
Office Building (3 - 5 story)	300	27.9	\$8,308
Refrigerated Warehouse	500	46.5	\$10,696

# O.O.M. Air - Handler Units

## **DX - CHILLED WATER INCLUDES COILS, BLOWER & DRIVES**

TONS	HP	СҒМ	MATERIAL COST	MAN-HOURS
10	1	5,000	\$6,750	6
25	2.5	10,000	\$15,690	12.5
50	10	20,000	\$30,555	30

# **O.O.M. Packaged Water Chiller / Recip. Compressor** C / W CONDENSER / H.E. / CHILLER / PIPING & LOCAL CONTROLS

TONS		MATERIAL	MAN-HOURS	MISC. HOOK-UP MATERIALS
25	2.5	\$43,100	18	\$250
50	10	\$74,135	22	\$250
100	15	\$112,520	36	\$350

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**Piping** BLACK IRON WITH SCREWED FITTINGS IN-**CLUDES FABRICATION & ERECTION LABOR, MATERIAL & HANGARS.** 

DIAMETER	\$ COST PER LF	\$ COST PER M
1" (25 mm)	\$29.85	\$97.92
2" ditto (50 mm)	\$48.14	\$157.91

# **Glass Pipe**

**INCLUDES FABRICATION & ERECTION LABOR, MATERIAL & HANGARS.** 

DIAMETER	\$ COST PER LF	\$ COST PER M
1" (25 mm)	\$47.01	\$154.20
2" ditto (50 mm)	\$57.94	\$190.05
3" ditto (75 mm)	\$63.98	\$209.86
4" ditto (100 mm)	\$88.32	\$289.70

# Piping DITTO WITH WELDED FITTINGS

DIAMETER	\$ COST PER LF	\$ COST PER M
1" (25 mm)	\$24.95	\$81.84
2″ ditto (50 mm)	\$37.65	\$123.49
3" ditto (75 mm)	\$45.85	\$150.39
4" ditto (100 mm)	\$55.25	\$181.22

# **CPVC Natural Gas Pipe EXCLUDES TRENCH WORK**

DIAMETER	\$ COST PER LF	\$ COST PER M
1" (25 mm)	\$47.22	\$154.88
2" ditto (50 mm)	\$58.20	\$190.90
4" ditto (100 mm)	\$64.27	\$210.79
Add 20 – 40% for fittings		

# **CPVC Diesel / Gas Pipe** EXCLUDES TRENCH WORK

DIAMETER	\$ COST PER LF	\$ COST PER M
1" (25 mm)	\$9.37	\$30.72
2″ ditto (50 mm)	\$12.77	\$41.90
4″ ditto (100 mm)	\$17.42	\$57.14
Add 20 – 40% for fittings		

# Labor & Materials STEEL TUBING (304 L) 2024 BASIS

DIAMETER	\$ COST PER LF	\$ COST PER M
0.25″	\$9.96	\$32.67
0.50"	\$13.58	\$44.56
0.75″	\$18.52	\$60.76
1.00"	\$13.01	\$42.68
For the installed cost with	fittings, valves, ha	ingars etc,
multiply by 2.0 to 4.0		



## Horizontal Screw Press 12" Diameter WITH 15 HP VARIABLE SPEED DRIVE

COST PER LF - LOW	COST PER LF - HIGH	COST PER M - LOW	COST PER M - HIGH
\$4,596	\$7,470	\$15,075	\$24,501
• 5 – 7% of Screw purchase cost should	provide an adequate installation budget f	or setting screw press, includes	drives, frames and final alignment.

# Communintors SOLIDS / LIQUIDS

INLET / OUTLET DIAMETER	GALLONS PER DAY	\$ EQUIPMENT COST	HP	# OF ITEMS	INSTALLATION MAN-HOURS	COST PER HP \$
4″	70,000	5,780	0.5	4 to 6	16	11,559
6″	120,000	7,286	1	4 to 6	20	7,286
8"	180,000	9,310	1.5	4 to 6	24	6,207

# **Diesel Generator** SKID MOUNTED UNIT 50 HZ

KW	COST PER KW (LOW)	COST PER KW (HIGH)	INSTALLATION MAN HOURS
650	\$333	\$489	0.07 – 0.15 hours per KW
1,250	\$297	\$416	0.07 – 0.15 hours per KW
2,000	\$277	\$357	0.07 – 0.15 hours per KW

# **Aerators**

H.P.	MATERIAL COST	HOOKUP MATERIALS	MAN HOURS	COST PER H.P.
10 HP	\$20,983	\$2,293	28	\$2,328
25 HP	\$43,405	\$3,794	38	\$1,888
50 HP	\$61,996	\$5,171	44	\$1,343
COST PER HP				\$1,343 - \$2,328

# (4) AGITATORS / BLENDER / MIXERS / EMULSIFIER

### (A) AGITATOR:

Installation man-hours include unloading, temporary warehousing, site transportation 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 manhours. 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) Material / Equipment Budget Cost:

- Propeller: \$2,390 \$3,320 / per H.P.
- Turbine: \$5,370 \$6,970 / per H.P.

### (N) Horizontal Batch Centrifuge

• Cost Range \$9,551 - \$10,596 / SF

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

**(O)Reciprocating, Compressor with Motor**: Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).

(P) Reciprocating Compressor C.S – 500 PSI: Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).

(Q) Rotary Blower, C S A 285C, 1,800-RPM Motor: Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost).

(R) Rotary Vacuum Drum: (multi section) CS / SS - (25' X 15' high): see chart next page.

### (S) PORCELAIN SADDLE PACKINGS: MATERIAL COST \$90 - \$105 / C.F.

**(T) CEMENT PLANT:** 2024 construction cost basis: \$355 - \$575 per ton to engineer, procure and construct a fully operational facility.

### (65) MOTOR CONTROL

(A) Motor Control Center (600V): Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost). See chart next page.

### (66) MOTORS

(A) Electric Motor, explosion proof: Add 3% for transport to site for US and overseas applications (ocean freight would increase freight cost). See chart next page.

# Table 64L

TONS / HOUR	MATERIAL COST \$ / TON	MAN HOURS
5	167	4
10	219	4
15	281	6
20	319	8
25	418	8

# Table 64M

CFM / HP	\$ COST	MAN-HOURS
1,000 CFM, 2.5 HP	2,672	14
10,000 CFM, 20 HP	5,448	32
100,000 CFM, 200 HP	61,079	76

# Table 64N

SF	\$ COST	MAN-HOURS
10	\$105,956	88
25	\$207,170	154
50	\$477,551	410

# Table 640

<b>BRAKE H P</b>	\$ EQUIPMENT COST	MAN HOURS
250	\$395	104
500	\$774	260
1,000	\$1,050	750

# Table 64P

НР	\$ EQUIP. COST	\$ COST PER HP	MAN HOURS
100	\$116,350	\$1,164	65
250	\$282,124	\$1,128	112
500	\$519,987	\$1,040	230
1,000	\$899,010	\$899	346

# Table 64Q

CFM	\$ COST	MAN-HOURS
150 CFM, 7.5 HP	\$10,833	17
1,500 CFM, 75 HP	\$36,604	54
3,000 CFM, 150 HP	\$50,091	72