



**VII ABOUT THE FIRM
ACKNOWLEDGEMENTS**

1

1

SECTION 1:

Introduction, General Comments and Calibration Factors:
includes the following:

Location (Calibration) Factors - International values compared to USA Gulf Coast. (Base of 1.00). Calibrations in this application are used to adjust the benchmark prices depicted in the following SECTIONS (1 thru 700).

25 # Country Calibration Factors.

General Conversion Values - Imperial to Metric Units.

Import Duties General Sales Tax / Value. Added Tax / Consumption Tax.

Detailed Design / Engineering / Architectural and CM Fees 51 # Facility Types.

Union Labor Costs / Inflation Cost Indexes.

USA and Canada State & Province Sales Tax / GST.

10

17

SECTION 10:

Major Equipment / Production Equipment

20

41

SECTION 20:

Site, Civil, Piling, Concrete, Masonry and Buildings

30

47

SECTION 30:

Structural Steel

40

49

SECTION 40:

Piping / (ISBL and OSBL)

65	50 SECTION 50: Electrical and Instrumentation
75	60 SECTION 60: Insulation
79	70 SECTION 70: Painting and Coatings
83	80 SECTION 80: Refractory
83	90 SECTION 90: Scaffolding
85	100 SECTION 100: Construction Equipment / Plant Hire
95	110 SECTION 110: Domestic and International Freight
99	120 SECTION 120: Offshore Data
113	130 SECTION 130: Pipelines (Onshore and Offshore)

127	140 SECTION 140: Module Cost and Man hour Benchmarks
135	150 SECTION 150: Wind Turbines (Onshore and Offshore) Benchmarks
139	160 SECTION 160: Mining Benchmarks
147	200 SECTION 200: Home Office Engineering and Support Costs
149	300 SECTION 300: Construction Management Cost Data
151	400 SECTION 400: Temporary Site Facilities
153	500 SECTION 500: All-in hourly labor rates
157	600 SECTION 600: Insurance Data
159	700 SECTION 700: Miscellaneous items, Bonds, Spare Parts, Camp Costs, Construction Consumables, Start up issues, Transmission Line Benchmarks and Camp Costs.

Introduction and Calibration factors

This publication, the 2016 Pipelines, Mining & Offshore Cost Data Yearbook is possibly the most authoritative and up to date construction cost estimating tool specific to the topic of estimating Process Plants, Pipelines & Offshore facilities.

The following Sections (1) through (700) contain U.S. unit costs for materials, labor (union and non-union applications) and construction equipment for construction work associated with Process Plants, Pipelines & Offshore construction work applicable for 2016. This publication answers the questions and issues that are needed in order to produce an accurate domestic or international construction cost estimate. This reference guide is appropriate for construction professionals who are familiar or who are possibly new to the subject of conceptual and detailed construction cost estimating of Process Plants, Pipelines & Offshore construction work.

We are convinced that the following information, data, tables and cost models depicted in Sections (1) through (700) will save the reader time in completing future Process Plants, Pipelines, Mining & Offshore estimating assignments, the completed estimate should be reasonably accurate perhaps better than +/- 10% accurate. An additional attribute of this database is that it can be used to check and assess EPC contractors and fabricators cost estimating submissions as they relate to Pipelines, Mines & Offshore construction work.

The foundation of this publication is based on

Sections (1) through (700) that in many ways follow the basic intent of the 16 Construction Specification Institute (CSI) Master Format Division Format (an industry accepted standard in many parts of the USA and Canada).

The man-hours / unit costs / cost metrics depicted in this publication are based on 25+ Pipelines, Mines & Offshore construction projects valued between \$5 million – \$500 million that were completed between the period 2006 and 2016; in the USA, Canada and overseas.

"We are convinced that the following information, data, tables and cost models depicted in Sections (1) through (700) will save the reader time in completing future Process Plants, Pipelines & Offshore estimating assignments..."

INTERNATIONAL CONSTRUCTION CONNOTATIONS AND IMPLICATIONS

Today's construction professionals are more than ever challenged in locating accurate and current international cost data, that is the # 1 reason for creation of this database. Pipelines, Mining &

Offshore construction projects are being built in just about every country around the world; hopefully this publication will assist the construction professional in pinpointing the cost data he or she is looking for.

An experienced cost estimator can without too much trouble compile a cost estimate for a building, plant or facility in the estimator's native (home) country i.e. the USA, the UK or Canada to name but a few. However, the cost estimating effort that is required for an overseas Pipeline, Mine or Offshore construction project usually creates challenges to an estimator that spends the majority of his or her time compiling "domestic" cost estimates. These challenges include:

Major Equipment & Process Equipment

Table 1
AERATOR CS, SS 304 IMPELLER C/W FIBERGLASS FLOAT, INCLUDES ELECTRIC MOTOR

HP	\$ COST EQUIPMENT	INSTALLATION MAN HOURS	\$ COST PER HP
5	8,764	18	1,753
10	11,299	22	1,130
25	15,844	28	634
50	29,391	34	588

Table 2
AGITATOR TOP ENTRY - IMPELLER, ATMOSPHERIC CS

HP	\$ EQUIPMENT COST	\$ COST PER HP	\$ COST TO SET (EXCLUDES CIVIL, PIPING & ELECTRICAL WORK)
0.5	5,096	10,192	5% to 8% of Equipment Cost
1	8,418	8,418	5% to 8% of Equipment Cost
2	13,624	6,812	5% to 8% of Equipment Cost
2.5	15,839	6,336	5% to 8% of Equipment Cost
5	25,809	5,162	5% to 8% of Equipment Cost
7.5	34,227	4,564	5% to 8% of Equipment Cost
10	41,870	4,187	5% to 8% of Equipment Cost
12.5	48,959	3,917	5% to 8% of Equipment Cost
15	55,715	3,714	5% to 8% of Equipment Cost
20	68,121	3,406	5% to 8% of Equipment Cost
25	79,641	3,186	5% to 8% of Equipment Cost

Table 3
AGITATOR TOP ENTRY - IMPELLER, ATMOSPHERIC SS 304

HP	\$ EQUIPMENT COST	\$ COST PER HP	\$ COST TO SET (EXCLUDES CIVIL, PIPING & ELECTRICAL WORK)
0.5	6,206	12,412	5% to 8% of Equipment Cost
1	10,029	10,029	5% to 8% of Equipment Cost
2	16,291	8,145	5% to 8% of Equipment Cost
2.5	19,062	7,625	5% to 8% of Equipment Cost
5	31,030	6,206	5% to 8% of Equipment Cost
7.5	41,115	5,482	5% to 8% of Equipment Cost
10	50,312	5,031	5% to 8% of Equipment Cost
12.5	58,846	4,708	5% to 8% of Equipment Cost
15	66,825	4,455	5% to 8% of Equipment Cost
20	81,786	4,089	5% to 8% of Equipment Cost
25	95,638	3,826	5% to 8% of Equipment Cost

Table 29**COMPRESSOR - CENTRIFUGAL CS 500 - 1,000 PSI EXCLUDES CIVIL WORK**

HP	\$ EQUIPMENT / MATERIAL	\$ LABOR	\$ CONSTRUCTION EQUIPMENT	\$ TOTAL	\$ COST PER HP
25	29,499	3,498	342	33,333	1,334
50	51,358	6,090	595	58,043	1,161
75	71,076	8,430	823	80,329	1,071
100	89,403	10,604	1,035	101,420	1,010
250	185,109	21,954	2,144	209,206	837
500	326,455	35,498	3,466	365,419	731
750	447,862	48,700	4,756	501,318	668
1,000	562,911	61,210	5,976	630,097	630

Table 30**COMPRESSOR - CENTRIFUGAL CS 500 - 1,000 PSI EXCLUDES CIVIL WORK**

HP	\$ EQUIPMENT / MATERIAL	\$ LABOR	\$ CONSTRUCTION EQUIPMENT	\$ TOTAL	\$ COST PER HP
25	30,062	3,565	347	33,975	1,359
50	56,383	6,687	651	63,722	1,274
75	81,445	9,660	940	92,045	1,227
100	105,751	12,543	1,221	119,515	1,195
250	243,986	28,938	2,818	275,742	1,103
500	458,604	49,867	4,856	513,327	1,027
750	663,221	72,117	7,023	742,361	990
1,000	846,994	92,101	8,971	948,066	948

Table 31**COMPRESSOR RECIPROCATING SINGLE STAGE N/E 100 PSIG**

HORSE POWER	\$ COST FOR PACKAGED UNIT C/W AFTER COOLER & CONTROLS	MAN-HOURS TO INSTALL
5	13,075	4
7.5	19,612	4
10	27,785	6
15	35,956	6
20	38,899	8
25	42,493	8
50	58,836	12
75	73,548	16
100	86,623	24

Structural Steel

Table 1
STRUCTURAL STEEL UNITS

SPECIFICATION	UNIT	MAN HOURS
Fabrication of Structural Steel shapes - Columns and beams for projects larger than 100 Ton - (Man-Hours per Ton)	TON	8 - 12
Ditto Trusses and purlins	TON	8 - 14
Ditto heavy duty pipe racks	TON	10 - 18
Ditto medium duty pipe racks	TON	8 - 16
Ditto Miscellaneous brackets / braces and supports	TON	12 - 22
Ditto Stairs and platforms	TON	16 - 24
Handle and remove from truck bed and lay on sleepers or hard standing	TON	0.80 - 1.24
Handle and stack on truck bed	TON	0.80 - 1.25
Erection of Structural Steel shapes - Columns and beams	TON	6 - 10
Ditto Trusses and purlins	TON	6 - 12
Ditto Miscellaneous (medium sized) brackets / braces and supports	TON	18 - 26
Ditto frames, rails and angles	TON	10 - 20
Ditto Stairs and platforms	TON	12 - 18
Erect heavy pipe rack steel	TON	16 - 28
Erect medium pipe rack steel	TON	24 - 32
Erect light pipe rack steel	TON	30 - 48
Erect circular platforms / bracing	TON	36 - 48
Erect square platforms / bracing	TON	30 - 48
Erect ladders w/o cage	TON	30 - 60
Erect ladders c/w cage	TON	30 - 60
Install galvanized gating and frame	TON	48 - 72
1/4" weld	LF	0.15 - 0.25
3/8" weld	LF	0.20 - 0.30
1/2" weld	LF	0.25 - 0.40
Add 15% - 25% to above hours for projects less than 100 Ton	%	15% - 25%
Labor only m - h to install angle iron - 2" x 2"	LF	0.05 - 0.07
Ditto 3" x 3"	LF	0.06 - 0.09
Ditto 4" x 4"	LF	0.07 - 0.10
Ditto 6" x 6"	LF	0.10 - 0.14
Labor only m - h to install ribbed steel decking 1 1/2" deep 22 g	SF	0.10 - 0.15
Ditto 20 g	SF	0.15 - 0.20
Ditto 18 g	SF	0.20 - 0.25
Ditto 16 g	SF	0.25 - 0.30
Labor only m - h to install ribbed steel decking 3" deep 22 g	SF	0.14 - 0.21
Ditto 20 g	SF	0.21 - 0.28
Ditto 18 g	SF	0.28 - 0.35
Ditto 16 g	SF	0.35 - 0.42
Labor only to install stairway and handrail - 36" wide	RISER	0.50 - 1.00
Ditto 42" wide	RISER	0.60 - 1.10
Ditto 48" wide	RISER	0.70 - 1.20
Labor only to install miscellaneous steel brackets, straps, bollards, gussets, corner guards, embedments, checker plate and other minor metal items	TON	30 - 60 man hours

Offshore and Onshore Construction Cost Data / Benchmarks

The following data portrays Offshore & Onshore Construction cost data specific to the construction / fabrication of Steel Jacketed Platforms, Modules, Pre-Assemblies, Topside Structures, Concrete Gravity Base Structures (GBS), Tension Leg Platform (TLP), Floating Production, Single Point Moorings (SPM), Storage and Offloading Systems (FPSO) and similar facilities.

The cost data is primarily applicable to offshore facilities / installations even though reference is made to onshore construction / fabrication activities also.

This cost data is best used at the front end / early stages of a project(s) lifecycle or a tool to check contractor's budget submissions or cost estimates.

The historical cost estimating database is based on a dozen or more projects worldwide projects that have been executed within the last five years.

It is a well-known fact that the weight of an offshore platform's topsides (i.e. modules and pre-assemblies) influences the total finances of the project being considered.

Engineering and fabricating the topside scope in a way that reduces the number of modules and pre-assemblies needed, that translates into less topside weight is an established methodology to reduce high-priced offshore fabrication work, integration / hookup and commissioning of the new offshore facility. There is a new class of heavy lift ocean going vessels / cranes that can perform lifts

of over 10,000 Tons; usually we see modules / pre-assemblies weighing between 250 and 2,500 Tons. The consensus in the industry is that the larger the module / pre-assembly tonnage will typically optimize the integration / hookup and commissioning activities need at the offshore location.

Topsides (modules and pre-assemblies) for the most part are constructed / fabricated onshore in shipyards or in fabrication facilities with access to a river or the ocean. Once they have been "built" they are rolled out or lifted onto special barges and towed to the offshore platform location and then lifted into position, next to or on top of another module, this integration or joining modules and pre-assemblies together

is known in the trade as "hook-up" work. The hook-up work is extremely expensive compared to work performed on shore, this is because the pipefitters, ironworkers, welders, electrician and other construction workers have to be transported offshore perhaps 50 or 500 miles, productivity suffers significantly, logistics are a challenge, transportation costs are expensive (helicopters or special work boats), the hook-up workforce may need to be housed in a floatel (an offshore accommodation ship or barge) for a couple of weeks or longer.

OFFSHORE PRODUCTION FACILITY FABRICATION / MODULE COSTS

Structural steel construction and the related fabrication man-hours and subsequent costs for the offshore oil and gas production facilities fluctuate

This cost data is best used at the front end / early stages of a project(s) lifecycle or a tool to check contractor's budget submissions or cost estimates.

#	DESCRIPTION	\$ MIN. COST PER DAY	\$ MAX. COST PER DAY	REMARKS
CONTINUED				
44	Ditto as above, c/w 45 to 55 person crew, 8 point mooring system: 750 ton main lift crane, and a 50 ton supplemental crane	293,150	361,825	
45	Remotely operated vessel (ROV) c/w with 10 to 15 person crew	47,970	69,970	
46	Drillship less than 1,000' water depth	154,570	215,250	
47	Drillship 1000' to 2,500' water depth	266,500	430,500	
48	Semi-submersible less 1,500' water depth	159,900	269,065	
49	Tender Vessel / Support Vessel (up to 15 crew members)	79,950	107,625	
50	Drill barge n/e 150' water depth	133,250	162,000	
51	FPSO \$150,000 BOPD, c/w 100,000 storage	239,850	348,500	
52	Jack up rig 250' water	95,940	134,535	
53	Jack up rig 500' water	133,250	199,875	
54	Side Scan Sonar / Radar Vessel c/w 8 to 12 person crew	26,650	37,800	
55	Shear legs 750 ton to 850 ton Lift, 8 point mooring (shear legs is a two-legged lifting support barge) 250' x 125' c/w crew	122,590	156,070	
56	Diving Support Vessel (DSV) c/w 6 to 10 person crew and 4 divers	47,970	70,725	
57	Derrick Barge c/w 35 to 45 person crew, 8 point mooring system: 750 ton main lift crane, and a 50 ton supplemental crane	133,250	146,575	

Offshore Equipment

OFFSHORE JACKETS / FACILITY / MODULE(S) / PRE-ASSEMBLY FABRICATION SINGLE POINT MOORINGS (SPM) & SPAR MAN HOUR BENCHMARKS

#	DESCRIPTION	MIN. MAN HOURS PER TON	MAX. MAN HOURS PER TON
1	Modules	250	350
2	Transition / Rings	175	225
3	SPM / SPAR Head	250	350
4	Column / Base	135	175
5	Major Equipment Installation into a partially completed module	70	100

Offshore Fabrication

OFFSHORE FABRICATION OF SINGLE POINT MOORINGS (SPM) & SPAR HISTORICAL MAN HOUR BENCHMARKS

#	DESCRIPTION	ACTUAL WEIGHT IN TONS	MAN HOURS PER TON	TOTAL MAN HOURS
1	Base	1,402	141	198,110
2	Connection	110	141	15,475
3	Foot	974	143	138,998
4	Lattice	819	139	113,533
5	Main Float	704	141	98,992
6	Chimney	562	163	91,731
7	Head, Equipment and Helideck	539	202	108,897
	TOTAL	5,110	150	765,736

NOTES: North Sea Water Depth 450' • Fabricated in (3 #) sections in UK, Netherlands and Norway

Cost Model "B"

FLOATING PRODUCTION STORAGE & OFFLOADING FACILITY

(FPSO GENERIC NEW BUILD COST MODEL)

FINAL PRODUCTION LOCATION - S.E. ASIA

FABRICATED IN MAJOR SHIP YARD IN ASIA - TOWED TO S.E. LOCATION

DETAILED DESIGN COMPLETED IN ASIA AND SOUTHERN EUROPE

74,597 TON 150 M X 50 M X 25 M FIXED IN 125 FOOT OF WATER

2016 COST BASIS IN US \$'S

#	DESCRIPTION	TONS	\$ COST (L&M)	\$ TOTAL (L&M)	% SPLIT
1	Hull steel, cathodic protection & coatings	39,795	2,144	85,320,480	10.41%
2	Hull outfitting, includes cranes, mooring equipment, life boats, miscellaneous piping	2,345	6,897	16,173,465	1.97%
3	Hull Equipment (pumps minor utility equipment)	320	1,487	475,840	0.06%
4	Hull Engineering (5%) of above	-	-	5,168,000	0.63%
5	Production, Storage & Offloading Scope - Process / Mechanical / E & I Outfitting, emergency generator, lighting, transfer pumps, cable, cable trays, instrumentation, painting	1,890	17,965	33,953,850	4.14%
6	Living quarters / Control room / kitchen for 10 - 15 operators	387	23,445	9,073,215	1.11%
7	Equipment - Piping modules / skid packages	770	13,847	10,662,190	1.30%
8	Upper Deck / Topsides module structural supports	980	1,805	1,768,900	0.22%
9	Gas storage tanks / manifolds	4,620	19,887	91,877,940	11.21%
10	Top side modules	20,656	20,083	414,834,448	50.61%
11	Guide wires / anchors & chains	443	8,730	3,867,390	0.47%
12	Loading arm, turret and helipad	1,356	12,749	17,287,644	2.11%
13	Risers / Manifolds / Emergency shut down systems	1,035	13,774	14,256,090	1.74%
14	Ocean Tow			5,500,000	0.67%
15	Field Installation / Mating / Risers / Hook Up			5,430,000	0.66%
16	FEED Study / FE Engineering			4,860,000	0.59%
17	General Conditions / Preliminaries / Onshore Temporary Establishment / Travel Expenses			2,198,000	0.27%
18	Detailed Design / Procurement / CM / PM-PC-Consultants (excludes Owner Engineering / CM Costs)			56,945,000	6.95%
19	Contingency / Management Reserve			40,000,000	4.88%
TOTAL TONS & COST		74,597	10,988	819,652,452	100%
Cost per Ton \$10,988					
Cost per Ton Range (High) \$15,383					
Cost per Ton Range (Low) \$9,340					

Cost Model #2

ONSHORE WIND TURBINE USA 2012 COST BASIS 2.5 MW TURBINES*

REF #	DESCRIPTION	\$ COST	COMMENTS
1	Drive train / nacelle, includes bearings, gearbox, generator, frame, hydraulic systems, emergency shut down & safety monitoring systems. Blades / Rotor, pitch controls, coils, hub and cone, yaw system and wind vane (anemometer).	1,691,040	Shipping weight approximately 160,000 lbs
2	Tower (265')	303,200	Shipping weight approximately 210,000 lbs
3	Shipping to site from fabrication yard	59,760	200 mile trip (one way)
4	Foundations / piles	92,400	66 CY + 4 # piles
5	Earthworks / ROW / Roads / Hard standings	162,144	Pro rated from total road grid
6	Assemble at site / heavy lifts / helicopter	75,728	Combination of heavy lift crane & helicopter
7	Electrical Connections / grid	253,600	
8	Sub Total before Engineering and CM	2,637,872	
9	Engineering / Detailed Design	44,320	345 hours \$128 Hour
10	Procurement Services	6,400	H.O. and Site
11	Construction Management / Inspection	5,280	50 hours
12	Front End Studies / Permits	3,360	
13	Sub Total	59,360	Support percentage of line item # 8 = 2.2%
14	Grand Total (Onshore)	2,697,232	Includes EPC costs plus Contractors Fee

* Cost for one turbine: \$2,697,232 x 24 turbines = \$65 million. See previous page for details

Cost Model #3

OFFSHORE WIND TURBINE 2.5 MW TURBINE*

REF #	DESCRIPTION	\$ COST	COMMENTS
1	Drive train / nacelle, includes bearings, gearbox, generator, frame, hydraulic systems, emergency shut down & safety monitoring systems. Blades / Rotor, pitch controls, coils, hub and cone, yaw system and wind vane (anemometer).	2,145,500	Shipping weight approximately 200,000 lbs
2	Tower (230')	446,000	300,000 pounds
3	Shipping to site from fabrication yard	43,880	150 mile trip (one way)
4	Driven piles	1,374,980	Pro rated from total grid
5	Harbor costs / barge	199,450	
6	Assemble at offshore site / heavy lifts	693,790	
7	Electrical Connections / grid	993,560	Pro rated from total electrical grid
8	Sub Total before Engineering and CM	5,897,160	
9	Engineering / Detailed Design	88,822	690 hours / \$129 Hour
10	Procurement Services	7,056	H.O. and Site
11	Construction Management / Inspection	17,944	165 hours / \$109 Hour
12	Front End Studies / Permits	8,182	
13	Grand Total (Offshore)	6,019,164	Includes EPC costs plus Contractors Fee

* Cost for one turbine: \$6,019,164 x 60 turbines = \$365 million. See previous page for details

Cost Model #4

42 # 2.4 TURBINES 101 MW USA MIDWEST**

DESCRIPTION	%	TOTAL COST
Land clearance / Gravel roads	2.7	1,600,228
Piling	3.4	2,015,102
Concrete Foundations	8.2	4,859,951
Fence	0.8	474,142
Towers / Lift	65.2	38,642,540
Electric grid	6.9	4,089,471
Pre Eng Control / Electrical Room	0.4	237,071
Detailed Design / Procurement	6.2	3,674,597
Project - Construction Mgmt	4.2	2,489,243
Heavy Lift	1.6	948,283
Contractor Gen Conditions	0.4	237,071
TOTAL	100.0	59,267,700
• Cost per MW	101	586,809
** see previous pages for details		

Cost Model #5

ONSHORE N.E. USA **

#	DESCRIPTION	% SPLIT	MATERIAL	LABOR	TOTAL
1	Land clearance / Gravel roads / Paved roads / Parking areas	2.4	3,821,040	2,547,360	6,368,400
2	Pilings / Caissons	2.9	6,156,120	1,539,030	7,695,150
3	Concrete Foundations / Slab on Grade / Miscellaneous Support Steel	7.2	12,418,380	6,686,820	19,105,200
4	Fence / Gates / CCTV	0.7	1,430,237	427,214	1,857,450
5	Towers / Gearbox / Nacelles & Heavy Lift work	67.4	155,595,933	23,249,967	178,845,900
6	Electric work – hook-up & system check	6.4	12,736,800	4,245,600	16,982,400
7	Pre-Engineered Control / Office / Change Rooms / Warehouse / Electrical Room	0.9	1,743,350	644,801	2,388,150
8	Detailed Design / Procurement	5.1	0	13,532,850	13,532,850
9	Project - Construction Mgmt.	2.4	0	6,368,400	6,368,400
10	Contractor General Conditions	1.3	2,276,703	1,172,847	3,449,550
11	Detailed Design & Contractor Fees	3.3	0	8,756,550	8,756,550
12	TOTAL	100.0	196,178,562	69,171,438	265,350,000
13	COST PER MW (128 MW)		\$1,532,645	\$540,402	\$2,073,047
	Field Labor Rate (Fully Marked Up) = \$56.35 to \$67.66 per hour				
	Detailed Design Rate = (Fully Marked Up) = \$110 to \$118 per hour				
	Construction Management Rate = (Fully Marked Up) = \$105 to \$110 per hour (excludes per diem)				
	** see previous pages for details				