Capital Cost Estimating

23rd Jan 2017

ESTIMATING PLANT CAPITAL COST

(Projects Financial Viability)

SO FAR (?):-

- Project has a defined technical solution
    - Flow Sheeting

NOW (?):-

- What is the cost of the project

ESTIMATING PLANT CAPITAL COST

Final Cost Plan Summary Report

This is a + 30% / - 5% estimate.

REF.	PROJECT SECTION	£
	Direct Costs	
	NEW BUILDING	
	SUBSTRUCTURE	66,928
	SUPERSTRUCTURE	490,820
	INTERNAL FINISHES	193,541
	FIITINGS & FURNISHINGS	100,000
	SERVICES	956,759
	REFURBISHMENT	
	DEMOLITIONS & ALTERATIONS	66,800
	SUPERSTRUCTURE	139,485
	INTERNAL FINISHES	182,512
	FIITINGS & FURNISHINGS	100,000
	SERVICES	551,932
	WORKS TO EXISTING PREMISES (M&E Strip out)	125,000
	EXTERNAL WORKS	28,000
	BUILDING CONTRACTOR PRELIMINARIES	750,444
	SUB TOTAL BUILDING	**3,752,221**

- TOTAL PLANT CAPITAL COST TIC =

DIRECT BUILDING COST +

ESTIMATING PLANT CAPITAL COST

709.2-2SC-003-2	PROCESS EQUIPMENT @ 50% Scale Platform	***3,314,660***
709.2-2SC-003-2	UTILITIES @ 50% Scale Platform	4,100,000
HIPPO New MTO	PROCESS PIPEWORK *(**4.5%** of equipment cost)*	335,712
	FEMS - Pharmagraph	30,000
	Delete Chart Recorders	
	Process Control System (***8.9%*** of equipment cost)	660,000
	Process Instruments (***3.4%*** of equipment cost)	250,000
	Process MCC (***1.8%*** of equipment cost)	130,000
	SUB TOTAL PROCESS	**8,820,372**
SUB DIRECT COSTS (DCC)		12,572,593

- TOTAL PLANT CAPITAL COST TIC =

Equipment & Materials Costs +

Direct Cost Value

ESTIMATING PLANT CAPITAL COST

➢ TOTAL PLANT CAPITAL COST TIC =

	ENGINEERING, PROCUREMENT, CONSTRUCTION MANAGEMENT (@20%	2,514,519
	COMMISSIONING & VALIDATION (@ 8%)	705,630
TOTAL CONSTRUCTION COSTS (TCC)		15,792,741
	RISK/DEVELOPMENT ALLOWANCE (@12.55%)	1,981,989
	INFLATION (1%)	177,747
TOTAL INDICATED COST (TIC)		17,952,478
	OWNERS COSTS	EXCLUDED
TOTAL INSTALLED COST (TIC)		**17,950,000**
TOTAL INSTALLED COST LOW (-5%)		17,052,500
TOTAL INSTALLED COST HIGH (+30%)		23,335,000

← Engineering Design Costs +

← Commissioning & Qualification Costs +

← Risk & Inflation +

← TIC

← Accuracy Allowance

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ESTIMATING PLANT CAPITAL COST

- ENGINEERING DESIGN COST =

  DESIGN

  PROJECT MANAGEMENT

  PURCHASE

  CONSTRUCTION SUPERVISION

  COMMISSIONING

  VALIDATION

- FOR BIOPHARM PROJECTS = 15 to 30% of total project cost TIC

ESTIMATING PLANT CAPITAL COSTS

- EQUIPMENT COST = MAIN PLANT ITEMS (MPI's) + PROCESS UTILITY SERVICES
- MATERIAL COST = PIPING, INSTRUMENT, CONTROLS, ELECTRICS etc
- UTILITY SERVICES COST = BUILDING SERVICES,HVAC, COOLING WATER, HOT WATER, COMPRESSED AIR etc.
- CONSTRUCTION & INSTALLATION COSTS = CIVILS, BUILDING, BUILDING FIT OUT/CLEANROOMS INSTALLATION OF EQUIPMENT, MATERIALS & SERVICES

ESTIMATING PLANT CAPITAL COSTS

- CONTINGENCY = A VALUE FOR UNKNOWN SCOPE/DESIGN DEVELOPMENT
- ACCURACY = OOM ESTIMATE = ± 50%

  STUDY ESTIMATE = ± 30%

  BASIC ESTIMATE = ± 20%

  DETAILED ESTIMATE = ± 10% (Cap Authorisation)
- Very the often the minus part is dropped or modified e.g) + 30% - 5%.

SIMPLE TECHNIQUES

- Use of process engineering cost index for equipment or complete industry specific types of plant.
    - Factory cost £260 m in 1980. What is the current price x process index factor = £ 586
- Industry Price Books. SPONS (Architects & building & building mechanical & electrical services and civil engineering). Standard and small jobs.
- [Lang] Factorial Methods – IchemE Blue Book Method
    - Cost estimate is factored on the costs of the main equipment items (MPI's)
- For the facilities consider total installed cost based on floor area.

MAIN EQUIPMENT ITEMS (MPI'S)

- Prepare a detailed specification and ask a vendor of equipment for a fixed price = ultimate accuracy.

- Ask vendor for a budget price

- In-house data banks (estimating departments collect from previous quotations

- Estimating charts based on equipment size.

- Estimating charts based on materials of construction – Material Factors CS x 1.0
  SS X 2.0

- Use of general size factoring exponents 2/3 or six tenths rule.

6/10 Rule & Material Factors

6/10 Rule

- 10 cubic metre vessel = £ A
- 20 cubic metre vessel = $(20/10)^{0.6}$ = 1.5 X A

Material Factors

- 10 cubic metre carbon steel heat exchanger = £A
- 20 cubic metre stainless steel heat exchanger = 2 x £A

Factorial Method 1

Total Plant Cost = Total Equipment Cost x Lang Factor.

Pharmaceutical & Fine Chem.	Petrochemical	Refinery
Lang Factor = 6 – 8	4 – 5	3 - 4

For Biotech facilities is normally in the range 3 - 6

Factorial Method 2

Estimate cost of the main plant items (MPIs)

Add estimated costs for following, factored against the equipment list:

- Erection & Construction: [0.1 to 0.4]
- Piping, insulation & painting: [0.15 to 0.7]
- Electrical: [0.1 to 0.15]
- Instrumentation: [0.1 to 0.35]
- Utilities: [0.3 to 0.75]

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

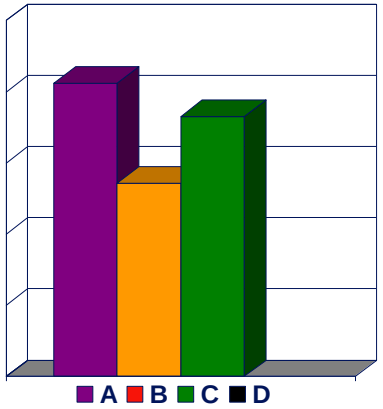
- Process Buildings & Struct: [0.30]
- Ancillary buildings: [0.15]
- Tech space: [0.15]
- Warehouse: [0.15]
- Environmental: [0.1 to 0.30]

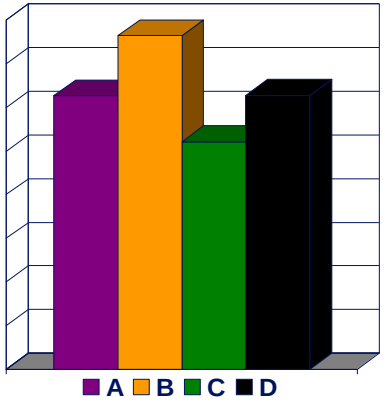
Floor Area Costs

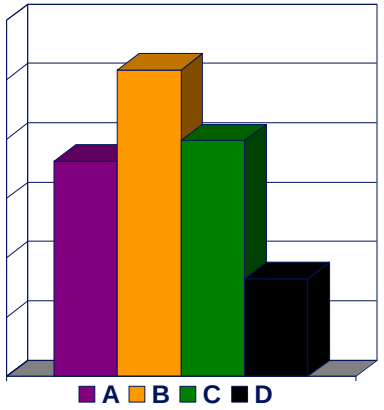
Biofacility Cost Comparison					
			AK pharma PROJECT		
client	1	2	3	4	5
£/m2 of Production Area	18,129	8,246	25,816	19,876	32,483
£/m2 of FA	6,258	6,264	7,633	5,206	5,988
Prod. Area over FA	35%	76%	30%	26%	18%
(FA - Floor Area)					

Floor Area Costs

	A Grade A/B	B Grade C	C Grade D	D Tech/office.
Cost/m² Footprint	33000	22000	30000	n/a
Cost/m² GIFA	10000	12500	8500	10000
Cost/m² Area	29500	42000	32500	13500





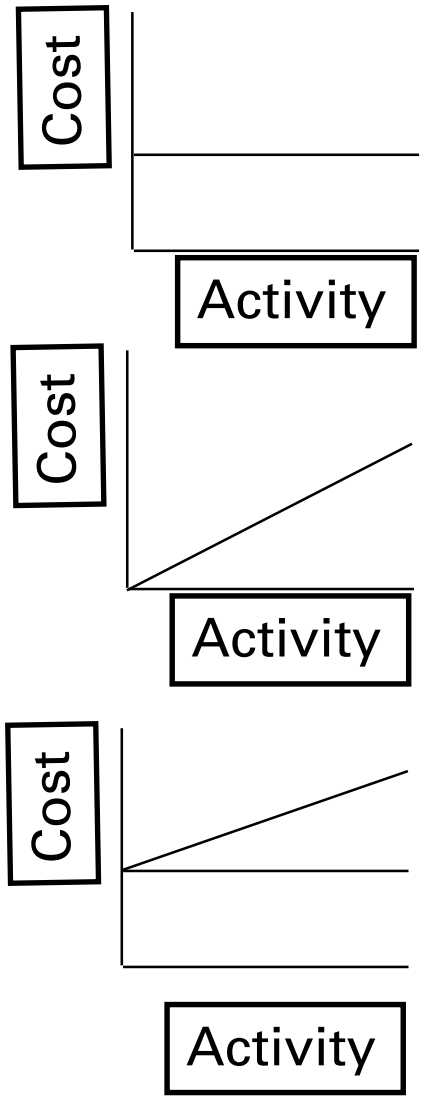


GIFA: Gross Internal Floor Area

All figures in £

Operational Costs

- Fixed Costs
  - Salaries of permanent staff
  - Maintenance
- Variable Costs
  - Raw materials
  - Direct labour
  - Plant upgrades
- Semi-Fixed Costs
  - Utilities
  - Contract Production



SUMMARY

- Estimates can be very complex & expensive task
- Cost estimation methods are approximate and the more distant the data on which the estimate is based the less accurate it will be.
- Sometimes it is better/faster/cheaper to ask a supplier for a quotation + add a margin.
- As you move into detailed design phase. Specify plant & generate material take off prices for equipment plant and materials-Fixed pricing from all suppliers to increase the accuracy of the estimate.

Group /Individual Exercise

Prepare and OOM estimate for your proposed project flowsheet and layout developed in last exercise.

This process is currently in R&D and operated at 20 Litre scale with a bioreactor yield of 7 g/l.

The equipment costs for the current process are supplied.

The forecast capacity for the full scale commercial process is 1,000,000 vials containing 1 mg of protein product.

Establish scale up factor. Think about yield losses across the process stages ?

GROUP / INDIVIDUAL EXERCISE

COST DATA FOR DESIGN

Equipment	Supplier	Year of Purchase	Cost when Purchased £
Cell Bank Freezer	ICS		40,000
450 L Fermenter	Pierre Guerin		350,000
75 L Fermenter	Pierre Guerin		90,000
20 L Fermenter	Pierre Guerin		50,000
7 L Fermenter	Pierre Guerin		35,000
CSA Centrifuge	GEA Centrifuge		150,000
Cell Disruptor	GEA Soavi		120,000
25 cm Column	GE Health care		90,000
Column Liquid Handling 1/2"	GE Health care		250,000
200 Litre Stainless steel vessel	Suncombe		30,000
Virus Filtration Skid	Pall		150,000
UF TFF Skid	Pall		70,000
Kill Tanks	Suncombe		50,000
Autocalves	Steritech		120,000
Glycol Plant	Johnson Controls		50,000
HVAC Plant	Woods		20,000
WFI Still	Steritech		300,000
Vial Filling Line	IMA		1,000,000
Clean Steam Generator	Steritech		170,000
Compressed Air Generation	Motivair		35,000
Plant Steam	Clayton		500,000
CIP Skid	Suncombe		150,000