Best Practices
for an
Owner Estimating Organization

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Establish an
Estimate Classification System

- Promotes consistency and understanding of the terminology used to classify estimates – both within your organization and to your external partners and contractors

- Develop an Estimate Classification System that correlates with your project development process and that indicates (at least at a summary level) the project and technical deliverables expected for each class of estimate

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Establish an
Estimate Classification System

AACE's 17R-97 – Estimate Classification System

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Establish an Estimate Classification System

OWNER COMPANY ESTIMATE CLASSIFICATION EXAMPLE

Estimate Class	Class 5	Class 4	Class 3
LEVEL OF PROJECT DEFINITION Expressed as % of Complete Definition	<= 5%	~ 3% to 15%	~25% to 40%
END USAGE	Strategic Planning; Capital Budget OOM Estimate; Alternate Schemes Evaluation	Preliminary Project Estimate to Approve Funding to Complete Front-End Engineering; Alternate Schemes Evaluation; Feasibility Study	Project Authorization Estimate; Fair-Price Check Estimate
ESTIMATE METHODOLOGY	Parametric Estimating Models; Capacity Factored; Analogy; Historical Project Comparison; Gross Unit Cost	Parametric Estimating Models; Equipment Factored; Historical Relationship Factors; Broad Unit Cost Data	Semi-Detailed Assemblies and Line-Item Unit Costs by Discipline; Historical Relationship Factors
EXPECTED ACCURACY RANGE	+/~ 30% to 50%	+/- 20% to 30%	+/- 10%
TYPICAL CONTINGENCY To Achieve 50% Probability of Underrun	~ 30%	~ 15% to 20%	~ 5% to 15%

Establish an Estimate Classification System

OWNER COMPANY ESTIMATE CLASSIFICATION EXAMPLE

Estimate Class	Class 5	Class 4	Class 3
ESTIMATE INPUT CHECKLIST			
General Project Information			
Project Scope Description	General	Preliminary	Defined
Plant/Facility Capacity	Assumed	Assumed or Defined	Defined
Plant Location	General	Assumed	Specific
Soils & Hydrology	None	Preliminary	Defined
Integrated Project Plan	None	Preliminary	Defined
Work Breakdown Structure	None	Preliminary	Defined
Project Code of Accounts	None	Major Account	Defined
Project Master Schedule	None	Preliminary	Defined
Escalation Strategy	None	Preliminary	Defined
Contracting Strategy	Assumed	Assumed or Defined	Defined

Establish an
Estimate Classification System

OWNER COMPANY ESTIMATE CLASSIFICATION EXAMPLE

Estimate Class	Class 5	Class 4	Class 3
ESTIMATE INPUT CHECKLIST			
Engineering Deliverables			
Block Flow Diagrams	Started or Preliminary	Preliminary or Approved For Design	Approved for Design
Block Layout Diagrams, Plot Plans	None or Mark-Up	Preliminary	Complete
Process and Utility Flow Diagrams	None or Mark-Up	Preliminary	Complete
Piping and Instrument Diagrams (P&IDs)	None	Preliminary	Approved for Design
Process and Utility Equipment List	None or Mark-Up	Preliminary	Approved for Design
General Equipment Layout Drawings	None	Preliminary	Approved for Design
Equipment Specifications and Data Sheets	None	Preliminary	Approved for Design
Electrical One-Line Diagrams	None	Preliminary	Approved for Design
Electrical Equipment List	None	Preliminary	Approved for Design
Electrical Classification Drawing	None	Preliminary	Approved for Design
Process Control Scope Description	None	Preliminary	Approved for Design
Process Control Equipment List	None	Preliminary	Approved for Design
Instrument List	None	Preliminary	Approved for Design
Civil/Site Discipline Drawings	None	None	Started

Establish an
Estimate Classification System

- The purpose of the Estimate Classification Systems is for all parties within the owner organization to understand both the attributes for each estimate class, and the maturity level of the supporting technical deliverables used to develop each class of estimate

- The Estimate Classification System also facilitates communication with contractors, or others outside of the owner's organization, regarding expectations for each class of estimate

Standard Estimating Guidelines and Procedures

- Department estimating guidelines and procedures should be documented and maintained under controlled distribution; including end-user documentation for software systems, cost database information, and other estimating resource information

- This information should also be available on the organization's intranet site to be accessible throughout the owner organization

Standard Estimating Guidelines and Procedures

- Although not necessarily complete, the following list identifies some of the areas to be covered in an estimating procedures manual:
  - Overview of the Estimating Process
  - Estimate Classification and Technical Requirements
  - Planning the Estimate
  - Structuring the Estimate
  - Developing the Estimate (Internally or using 3rd Parties)
  - Conditioning 3rd Party Prepared Estimates
  - Analyzing Cost Risk and Estimating Contingency
  - Documenting the Basis of Estimate
  - Estimate Reporting
  - Review and Issue Estimate (Including Benchmarking Analysis)
  - Estimate Maintenance (Change Management)
  - Estimate Close-Out (Project Close-Out Support)
  - Estimate Databases and Systems Maintenance

Standard Estimating Guidelines and Procedures

3rd Party Prepared Estimates

- the owner should be prescriptive in identifying estimate requirements and expectations to the 3rd party, including the specification of:
  - Estimate Preparation Plan and Schedule Requirements
  - Identifying Estimate Work Breakdown and Cost Breakdown Structures
  - Estimate Documentation Requirements (including Basis of Estimate)
  - Estimate Benchmarking Requirements
  - Estimate Calculation for Escalation, Contingency, Currency (as required)

Standard Estimating Guidelines and Procedures

3rd Party Prepared Estimates

- If the owner utilizes engineering or construction contractors to prepare estimates, then the owner should pay particular attention to identifying and documenting the steps in "conditioning" a 3rd party estimate (the process of adjusting a 3rd party estimate for specific owner and site conditions, as well as ensuring that all owner's costs are included)

Standard Basis of Estimate

- It is a document that is prepared by the estimator or estimating team that provides the basis for the costs identified within cost estimate

- Facilitates estimate analysis (reconciliation, validation, benchmarking) and review

- Documents significant communications and agreements made regarding the estimated costs (can support litigation)

- Succinctly documents critical aspects of the project to help mitigate cost risk (including risk from misunderstandings)

Standard Basis of Estimate

<u>Content</u>

1 Purpose

2 Scope

3 Design Basis

4 Planning Basis

5 Cost Basis

6 Allowances

7 Assumptions

8 Exclusions

9 Exceptions

10 Risks/Opportunities

11 Contingency

12 Management Reserve

13 Reconciliation

14 Benchmarking

15 Estimate Quality Assurance Plan

16 Attachments

Suite of Estimating
Tools and Techniques

- Owners typically prepare estimates for a wide range of Estimate Classes, and the estimating tools and techniques must match the information available (and completeness of that information) for each estimate class

Suite of Estimating Tools and Techniques

- Class 5 Estimates: Information Requirements

  - Preliminary requirements & scope description

  - Approximate plant/system capacity

  - General project location

  - Block flow diagrams for production units

  - Block layout drawings defining functional areas with relative locations

  - Approximate major equipment capacity & metallurgy (if known)

Suite of Estimating Tools and Techniques

- Class 5 Estimates: Tools and Techniques

  - Capacity factored estimates

  - Investment Curves

  - Specialized parametric estimating software

  - Analogy (past project history adjusted for scope, location, time, etc.)

  - Estimating judgment

Suite of Estimating Tools and Techniques

- Class 4 Estimates: Information Requirements
  - Complete process flow diagrams (PFDs)
  - Preliminary utility load sheets
  - Preliminary process equipment list w/ in-house pricing
  - General equipment layout drawings
  - General plant/site layout drawings
  - Preliminary piping/pipeline specifications
  - Preliminary electrical one-line drawings & equipment/motor list
  - Preliminary process control description
  - Preliminary instrument/major control device list
  - Approximate process control I/O count
  - Preliminary PEP

Suite of Estimating Tools and Techniques

- Class 4 Estimates: Tools and Techniques

  - Equipment factored estimates

  - Specialized parametric estimating software

  - Forced detail line item estimates

  - Factored costs for non-direct construction items

  - Budget quotes for major equipment items

Suite of Estimating Tools and Techniques

- Class 3 Estimates: Information Requirements
  - Complete process & utility P&ID's
  - Final utility load sheets
  - Complete process equipment/spare parts lists w/vendor quotes
  - Final piping/duct specifications
  - Preliminary valve & piping specialty item list w/vendor quotes
  - Final electrical one-line drawings
  - Complete electrical equipment/motor list w/vendor quotes
  - Final process control description
  - Updated instrument/major control device list w/ vendor quotes
  - Final process control I/O count and loop counts
  - Final instrument data sheets
  - Preliminary control panel layouts
  - Definitive PEP

Suite of Estimating Tools and Techniques

- Class 3 Estimates: Tools and Techniques

  - Detailed or semi-detailed line item estimates

  - Detail for project administration, engineering and other non-direct costs

  - Firm quotes for major equipment items

  - Minimal use of factors

Standardized Risk Analysis and Contingency Determination Methodology

- Risk analysis is a process which can be used to provide management with an understanding of the probability of overrunning (underrunning) a specified estimate value

- It provides a realistic view of the probabilities of completing the estimate for a specified value

- Its purpose is to improve the accuracy of project evaluations and funding (not to improve the accuracy of the estimate)
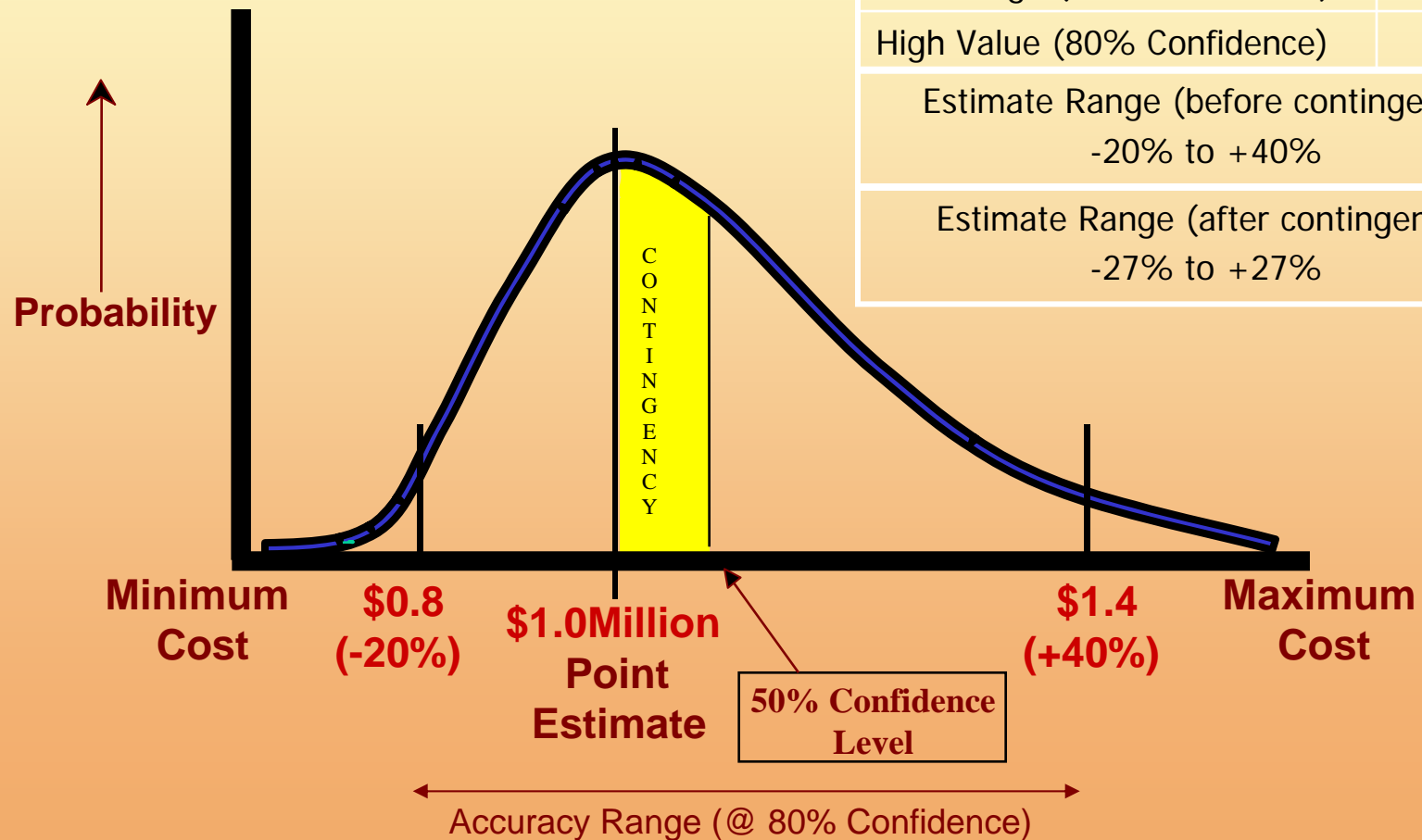
Standardized Risk Analysis and Contingency Determination Methodology

- Risk analysis generally uses a modeling concept to determine a composite probability distribution around the range of possible project cost totals

- The resulting probability distribution of possible final cost outcomes can be used to determine an amount to be used as contingency

- Management selects a proposed final funding value based on the level of risk they are willing to accept

- The difference between the selected funding value and the point estimate is the amount of contingency

Standardized Risk Analysis and Contingency Determination Methodology

Point Estimate	$1.0M
Estimate after Contingency	$1.1M
Low Range (80% Confidence)	$0.8M
High Value (80% Confidence)	$1.4M
Estimate Range (before contingency) -20% to +40%	
Estimate Range (after contingency) -27% to +27%	

Probability

CONTINGENCY

Minimum Cost

$0.8 (-20%)

$1.0Million Point Estimate

50% Confidence Level

$1.4 (+40%)

Maximum Cost

Accuracy Range (@ 80% Confidence)

Standardized Risk Analysis and Contingency Determination Methodology

Contingency Definition

- The funds which are added to the point estimate to achieve a given probability of not overrunning the estimate (given relative stability of the project scope and the assumptions upon which the estimate is based)

Reserves Definition

- Funds allocated to a project to cover additional cost risk outside of the scope and assumptions upon which the estimate is based

    - Management Reserve (typically for potential scope change)
    - Event-Driven Risk Reserve (typically for extraordinary events outside of the assumptions of the estimate)

Standardized Risk Analysis and Contingency Determination Methodology

- Standardized methodology is required for cost risk analysis and contingency/reserve determination
  - Facilitate communication about risk, uncertainty, contingency, reserves throughout organization (and to affected 3rd parties)
  - Drive consistency in approach to risk, contingency, and reserves across all projects
  - Promote improved project control
  - Promote "portfolio" management of risks

Estimate Review
and Validation Process

- Principle purpose of the estimate review process is to present information about the estimate and the project that allows the reviewer to evaluate that the estimate is of sufficient quality to meet its intended purpose

- Formal estimate review process should be a standard practice for all estimating departments to ensure:
  - Quality
  - Accuracy
  - Completeness
  - Consistency
  - Understanding

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Estimate Review
and Validation Process

Typical Estimate Reviews

- **Estimating Group**
  - at various times during the estimate preparation, as required

- **Engineering / Design**
  - formally at the end of estimate preparation, but may be at various times during preparation

- **Project Manager / Project Team**
  - after the estimate has passed all the previous peer and engineering reviews

- **Management**
  - when and at what mgmt level will vary with the strategic importance and/or total project value

Estimate Review
and Validation Process

Estimate Validation

- Estimate should include a "metrics" report

- Summarizes and compares key benchmark ratios versus historical values from similar projects

- Provides sanity check for the estimate

- High level metrics

- Discipline level metrics

- Check estimate using Order-of-Magnitude methods

Estimate Review
and Validation Process

Estimate Validation

- Capability to provide quick check estimates depends on having the correct strategic and conceptual estimating tools and information

- Benchmarking ratios and metrics require having a project history database to collect, analyze and present the required information

Historical Project
Data Collection Process

- Goal

  - Collect actual project cost and schedule data

 - Translate that data into useful information that serves as a knowledge base for your estimating and project controls organization

Historical Project
Data Collection Process

- The Historical Project Data Collection process can yield several useful information tools
  - Tools for Strategic and Conceptual Cost Estimating and Scheduling
  - Measures of Estimating Database Quality
  - Measures of Project, Function, and Organization Quality and Performance
  - Tools for Organizational Forecasting
  - Tools for Project Planning
  - Tools for Risk Assessment
  - Measures for Estimate Validation
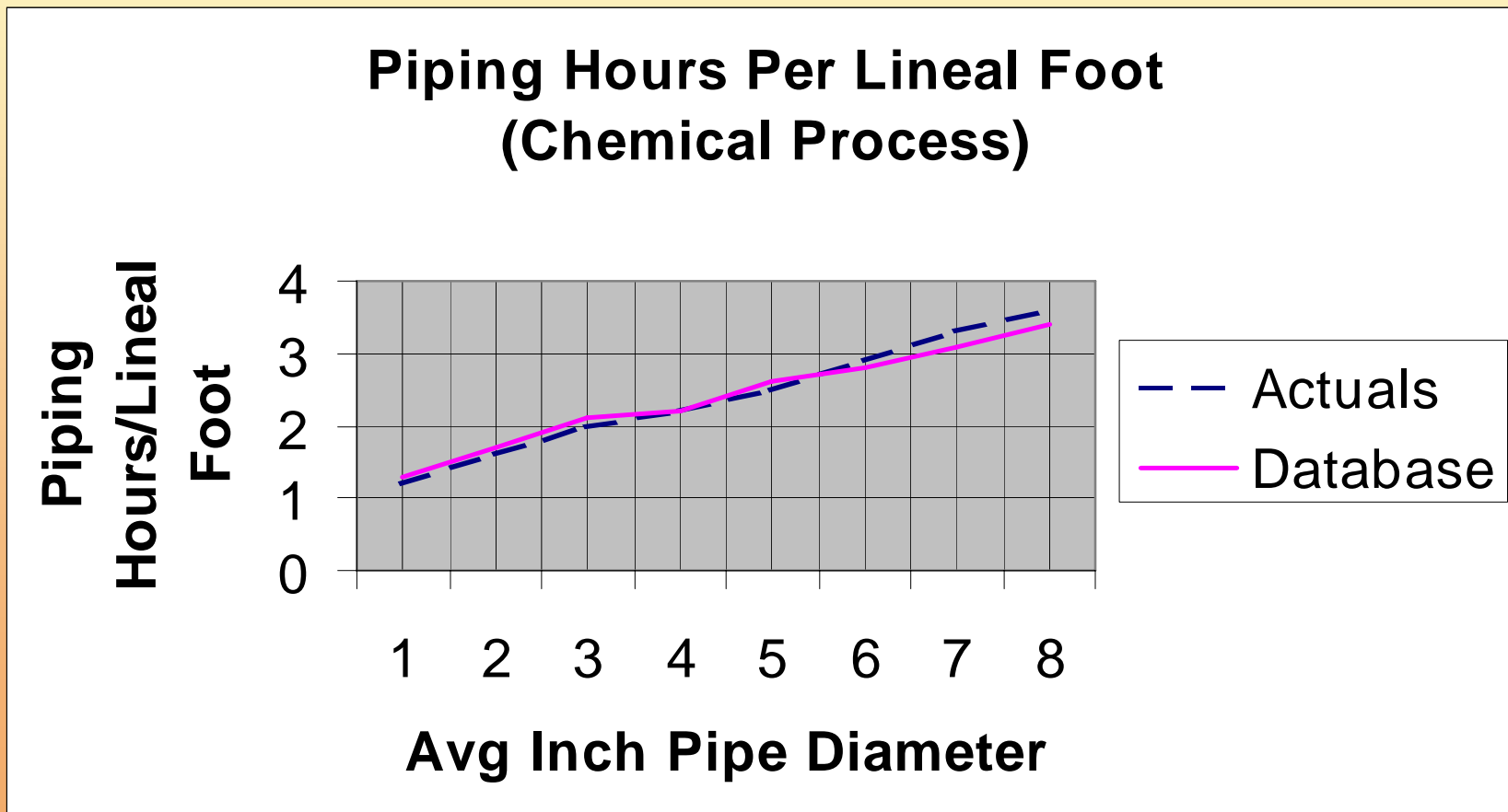 - Tools to establish Project Cost and Schedule Goals

Historical Project
Data Collection Process

- Tools for Conceptual Cost Estimating

Hotel Costs (4-7 Story,Face Brick w/ Concrete Block Back-Up))
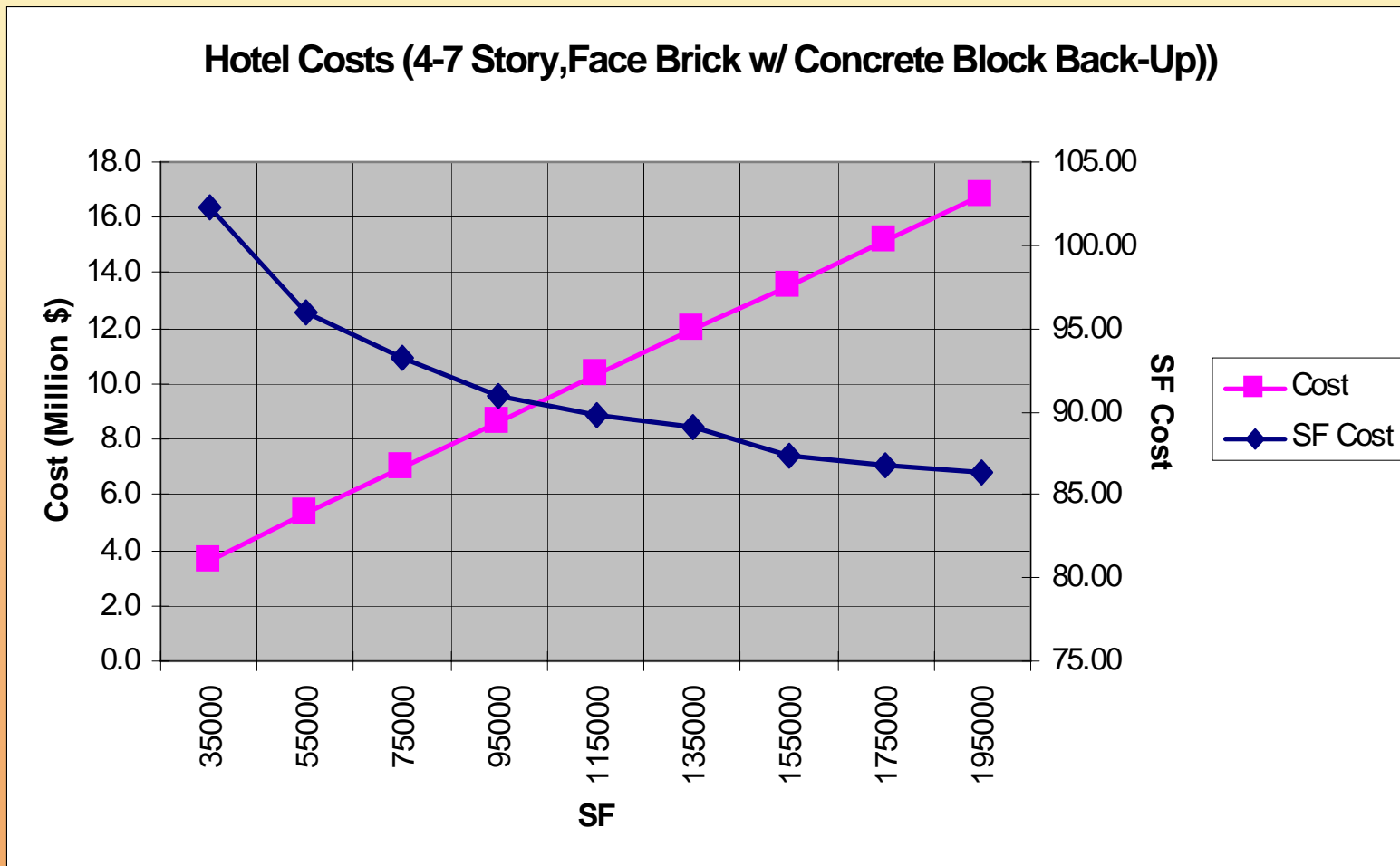
Historical Project
Data Collection Process

- Measures of Estimate Database Quality

Piping Hours Per Lineal Foot
(Chemical Process)

Historical Project
Data Collection Process

- Measures of Project, Function, and Organization Quality and Performance

    - Actual Project Cost to Revised Budget
    - Percentage of Estimates using Required Technical Deliverables
    - Percentage of Projects using Best Practices
    - Comparison to Industry for Cost, Schedule, Safety, Operability Measures

Historical Project
Data Collection Process

- Tools for Risk Assessment

  - Analysis of Contingency Required by Project or Technology Type

  - Comparisons of Contingency Funded versus Contingency Expended

  - Data-Driven or Data-Calibrated Models for Establishing Cost Contingency

Historical Project
Data Collection Process

- **Measures for Estimate Validation**

  - Key Metrics, Ratios, Benchmarks Comparing a Given Estimate to Similar Past Projects
    - Percent Project Administration
    - Percent Engineering/Design
    - Equipment Cost to Total Project Cost
    - Construction Labor Cost to Total Field Cost
    - Total Field Cost to Total Project Cost
    - Project Cost to Specified Unit of Capacity

Historical Project
Data Collection Process

- Tools to Establish Cost and Schedule Goals
  - Key Metrics, Ratios, Benchmarks Comparing a Collection of Project History to Industry Data
    - Percent Project Administration
    - Percent Engineering/Design
    - Equipment Cost to Total Project Cost
    - Construction Labor Cost to Total Field Cost
    - Total Field Cost to Total Project Cost
    - Project Cost to Specified Unit of Capacity

Take "Ownership" of all estimates prepared (internal or external)

The buck stops with you!

– the owner!

Take "Ownership" of all estimates prepared (internal or external)

- Need to understand the technical and project deliverables required for various estimates

- Need a standardized, disciplined estimating process

- Need a standardized Basis of Estimate

- Need variety of tools and techniques

- Need to standardize risk evaluation, contingency, and reserves

- Need standardized review and validation process

- Need historical data to support all of the above

Estimating Best Practices

- Estimates are readily understood, can be readily compared, and inspire confidence
- Estimates are all structured the same (including estimates prepared by 3rd parties)
- Past estimates and project histories are easy to use reliable reference sources
- Estimating knowledge is transferable
- Estimates are highly predictable
- Estimates are sufficiently accurate to support project decision-making

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