City of Fort Saskatchewan

Project Management Process Review

CITY OF
FORT SASKATCHEWAN

Grant Schaffer
5-26-2017

Project Management Process Review

i) Recommendation

As a result of the Project Management Review, a new Major Capital Project Budget Policy is recommended. This Policy would create a two stage budgeting process for major capital projects. The scope and priorities of projects are identified with an order of magnitude cost estimate within a Master Planning document. As the project becomes a priority, a design budget is set to further enhance the design and provide a more accurate Class 2 Estimate (Planning Phase). This estimate is used to set the construction budget for the project (Construction Phase), if Council wishes to proceed. Council will have two approval points for the projects. The first is the approval of design, the second is the approval of construction.

ii) Summary

A review of Project Management policies, procedures and processes was conducted to ensure that our processes align with best practices of the industry. Project estimating and budgeting processes were also reviewed in order to make recommendations to improve the process.

Through the review, it was determined that current Project Management practices follow industry Best Practices. Project Charters are developed and followed, thus ensuring outcomes, scope and affected departments are identified and consulted throughout the project cycle. Project Delivery models are constantly being evaluated and implemented, when it is appropriate, for a given project.

Contingencies are set at values in line with Industry Best Practices. The contingencies will vary based on the type of project and stage it is in when it set, but they generally fall within 5 – 15% of the estimated construction value. Contingencies should not be used to account for estimate accuracy, they are intended to cover the costs of issues that arise during construction.

Risk management is identified within the Project Charters. Potential risks are identified as well as actions required. The earlier in a project that budgets are set, the higher the risk and more impact it could have on the project outcome / budget.

Adding time constraints to projects (bonus / penalty) adds risk to the contract and should only be used in exceptional circumstances. If a project needs to be complete for an event or other commitment it could be prudent to include constraints in the contract.

The City of Fort Saskatchewan is currently setting project budgets very early in the project development, and we are not unique. The municipalities who responded to our survey all set their budgets early, and experience budget adjustments as the project moves forward into tender and construction.

ASTM E2516-11, Standard Classification for Cost Estimate Classification System, identifies the risk associated with setting a budget very early in a project's life. With little to no project definition these estimates can be expected to have an accuracy range of -30% to +50%.

The result of the review is a recommendation to change the budget process to help ensure that the approved construction budget is a more accurate estimate of the anticipated construction costs. This process will also allow for a more formal confirmation of priorities and scope as the project moves from design approval into construction approval.

Contents

1. Current Policy

There is currently one Administrative Project Management Policy in place, GOV-008-A. This policy outlines the need to ensure that all stakeholders and affected departments are consulted prior to and during the project process. Administrative Procedure GOV-008-A outlines the process for ensuring that consultation takes place through the development of a Project Charter. The Charter outlines the project process, responsibilities, timelines and communication needs of the project.

Project Charters have been used on all major Capital projects since the inception of the Policy and Procedure in 2014.

2. Cost Estimates

ASTM has developed standard ASTM E2516-11, Standard Classification for Cost Estimate Classification System.

This standard outlines 5 classes of cost estimate, the work that is put into them, their potential accuracy and what they mean.

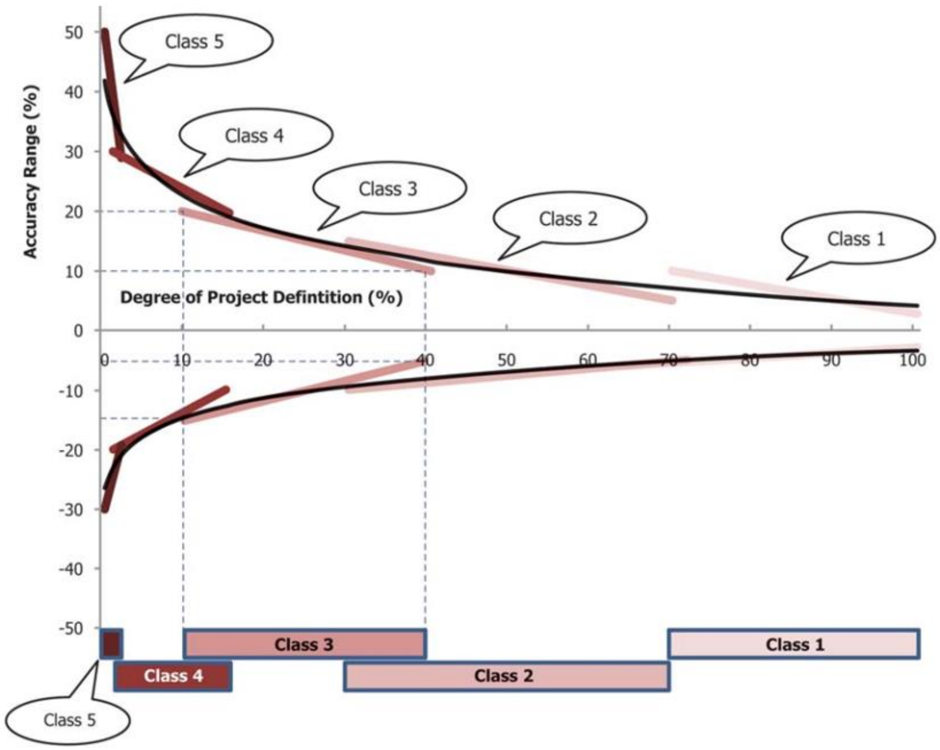
The accuracy of an estimate is related to the Degree of Project Definition. A project is not 100% defined until the design is 100% complete. At this point, everything that can be known about the project before construction has been determined. With a 70-100% complete design, a Class 1 Estimate can be produced with a degree of accuracy of -5% to +10%.

The percent of Design Definition can also be expressed in terms of the percent of effort (% of Design Money) spent to date. A $10,000,000 project budget would have an approximately $1,000,000 design budget. The percent of project definition could be calculated by dividing the amount of design money spent by the total design budget.

Classes of estimates have been developed based on the Degree of Project Definition.

Estimate Class	**Degree of Project Definition**	**Expected Accuracy Range**
Class 5	0% to 2%	-30% to +50%
Class 4	1% to 15%	-20% to +30%
Class 3	10% to 40%	-15% to +20%
Class 2	30% to 70%	-10% to +15%
Class 1	70% to 100%	-5% to +10%

ASTM Standard E2516-11 – Defines Class 1 to Class 5 Estimates



3. Current Budgeting Practice

Major capital projects are identified in Council Plans and Master Plans. Within these plans a rough concept and estimate are usually included. The plans typically outline the need and priorities for the project, but do not provide detail on the project itself. While a site is usually selected, there are no site investigations to determine potential site constraints, nor is there any investigation into potential technologies to be used in construction or operations. The estimates within these reports are put into the 10-year Capital Plan and are carried forward as the budget for the project.

As projects are brought forward for budget approval, the estimates are reviewed to determine if they are still reasonable, however no additional work is done to define the project.

Once the estimate is approved as part of the current budget, the project budget is set. Setting the budget this early in the design process results in projects that are designed to meet a budget. This could result in not all user needs and expected outcomes being met because the scope of the project is adjusted to meet budget. Alternatively, the projects are brought back to Council for additional funding to ensure the entire scope is met, however this is now over budget.

The City is currently setting major project budgets based on Class 5 Estimates as outlined within Master Plan documents. As an example the Recreation Master Plan identifies approximately $90,000,000 in projects with only about $100,000 being spent on concept development. (1.1% of Design Budget)

4. Contingency

Contingencies are built into budgets to address unanticipated issues that arise during the course of construction. They should not be used as a buffer for estimate accuracy. Contingencies will vary on a project-by-project basis between 5% and 15% depending on the complexity, stage and type of project.

A linear project (Water / Sewer / Road) will generally carry less contingency than a new building which will carry less than a renovation project.

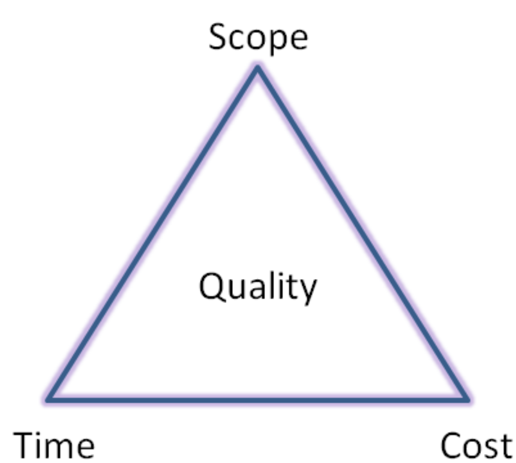
5. Risk Management

As part of the Project Charter development, project risks are identified. These risks are listed with an assessment of the probability, the severity and a high level plan to deal with them should they arise. Risks that pertain to budget have only two options, adjust the scope or increase the budget. In either case, the decision would have to come back to Council to either ensure that the scope change will still meet Council Priorities or to authorize an adjustment to the budget.

The earlier in a project cycle that the budget is set, the higher the risk that budget and scope will be at risk.

6. Schedule

In project management, the Project Management Triangle identifies the three pillars of a project. Quality is never something we want to sacrifice, so it stays constant in the middle of the Triangle. The pillars of Time, Scope, and Cost are balanced to ensure that a quality project is delivered on time, on budget and with the desired outcome (Scope).



What the figure identifies is that if a project is required to deliver a specific scope and a specific cost, then it will take the time it requires to complete the project to the specified quality.

If a time constraint is added to a project, then something needs to change with it. Keeping quality constant, either the cost will increase or the scope will need to be reduced in order to meet a time constraint.

Figure 2: Project Management Triangle
(With a Time Constraint)

Other versions of the Project Management Triangle put quality at the top of the triangle and leave scope as the constant. In this case, Quality and / or cost would be sacrificed with time constraints.

When contractors are bidding on a project, their bid is made up of hard costs (material, equipment, and labour), overhead, profit and risk. The more risk that is put into a contract for the contractor, the higher the risk factor ($$) he will apply to his bid. Introducing a bonus and penalty clause into a contract introduces risk. The owner is now setting the schedule with a penalty to the contractor if the schedule is not met and a bonus if they do meet it. Because the contractor has not set the schedule, if the schedule is tight the contractor will bid with more risk, in essence bidding with some included penalty. However, during the course of the contract, the contractor will do what they can to earn the bonus as well. This means that quality of work is put in jeopardy as the time and cost are set.

In some projects, it may be prudent to include penalty and bonus clauses. If something needs to open at a certain time to meet other commitments etc, a bonus and penalty structure may be prudent. However, on most projects, letting the schedule run its course (within reason) is the best way to achieve the quality and cost expected on a project.

7. Regional Comparison

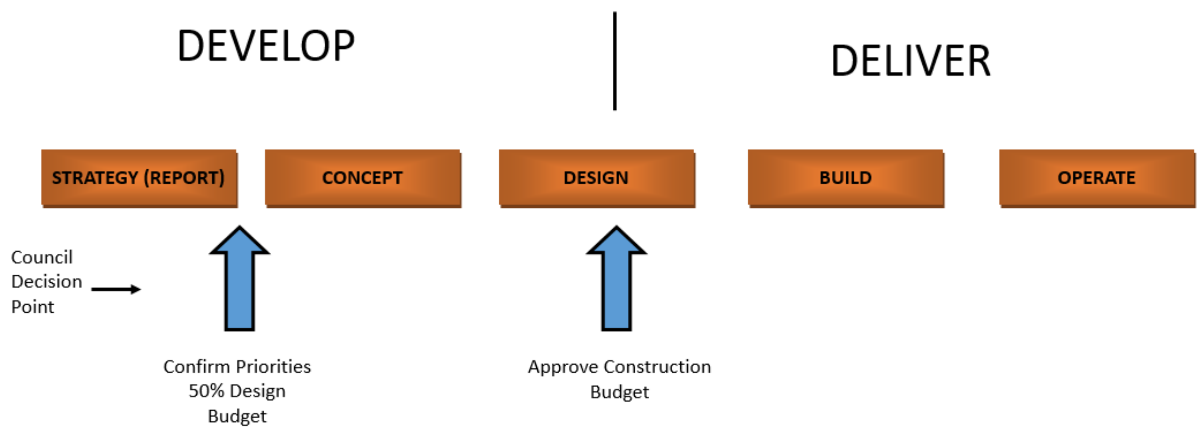
A survey was sent to comparable municipalities in the Capital Region. Three were returned with information on processes provided by an additional two (City of St. Albert and City of Edmonton).

Municipalities in the region generally follow the same process. Budgets are set early and are adjusted once tender approaches or closes. Edmonton and St. Albert have recently adopted new policies and procedures to refine and formalize this process.

Over the past six months, both the City of Edmonton and City of St. Albert have adopted new budgeting policies for Capital Projects. These changes were a result of early cost estimates being carried forward into construction budgets. This resulted in projects being completed over budget or having scope reduced to a point where the desired outcomes were not met.

8. City of Edmonton Model

The City of Edmonton Model is a simple process that breaks the budgeting process into two phases. It ensures that the scope and project priorities are clearly understood before design work begins. It allows the project concept and design to proceed based on scope and project outcomes rather than designing the project to meet a budget.



In the Develop phase, the Master Plan, Needs Assessment or Strategy Report outlines the future projects and timelines with order of magnitude estimates (-30% to +50%, Class 5). As the projects move into the current Capital Plan, Council confirms the priorities and outcomes of the project and kicks off the design phase with 50% of the design money. This allows development of the detailed concepts and brings the detailed design to 60% completion with a Class 2, or better, Estimate (-20% to +15%). At this point, Council approves the final project budget prior to moving into the Deliver phase of the project.

While each major project would have two Council decision points, Council would see the projects and receive updates at the end of concept development prior to detailed design (Class 4 estimate) and again would receive updates during the tender / construction phases.

This model allows Council to approve a scope of work, with an approval of design money, to refine the scope and bring the project to a 60% Design Phase. At 60%, the design is refined with enough detail to show the site constraints, technologies and features that are proposed for the project. The 60% design phase will allow a Class 2 Estimate to be prepared. As well, at the 60% design phase adjustments can still be made to the scope and priorities without significant rework if Council feels this is required.

Project Management Process Review

The City of Edmonton model for Capital Program Budgeting, as described above, is the recommended model for the City of Fort Saskatchewan to implement within a Capital Budgeting Policy. Projects within on-going programs (Neighbourhood and Road Rehab etc.) would be exempt from this process as the unknowns on these types of projects are limited.

Appendix A – Council Decision – December 13, 2016

Council Decision – December 13th, 2016

CITY OF FORT SASKATCHEWAN ALBERTA

DATE: **December 14th, 2016** **FILE:** 1500/CC/CFU

TO: **Troy Fleming, General Manager, Infrastructure & Planning**

FROM: **Brenda Molter, Director, Legislative Services**

SUBJECT: **Review of Policies and Practices for Project Management**

Reference:
The following was discussed at the Tuesday, December 13th, 2016 regular City of Fort Saskatchewan Council meeting:

- Following a notice of motion presented at the November 22nd meeting, Council was requested to provide direction whether to support a review of Project Management policies and procedures.

Motion:
The following motion was approved:

Due to the Multi-million dollar budget overages seen for the High Performance Sports Field and Curling Rink Revitalization projects, that Council direct Administration to prepare a report for Council:

1. To review policies and processes related to project management, including cost estimation, budgeting, risk mitigation plans, including contingency policies, and construction management best practices;
2. Which includes information regarding project deadline policies and best practices from comparable municipalities; and
3. To be presented to Council in the 2nd Quarter of 2017.

Follow-Up:
- Conduct required research as per the approved motion
- Preparation of a Council report and presentation prior to June 30th, 2017

Brenda Molter,
Director, Legislative Services

cc: Kelly Kloss, City Manager
Grant Schaffer, Director, Project Management
Sheryl Exley, Legislative Officer

Appendix B – Administrative Policy – Project Management GOV-008-A
Administrative Procedure – Project Management – GOV-008-A

ADMINISTRATIVE POLICY

GOV-008-A

PROJECT MANAGEMENT

Date Issued: 17.July.14

Current Revision: 17.July.14

Next Review Diarized: 01.Jan.16

Mandated by: City Manager

Cross Reference:

Responsibility: All Directors

PURPOSE

This policy and its supporting procedures regulate how the City manages projects, to increase our level of accountability and responsibility for projects and to ensure projects are managed and completed on time and on budget.

POLICY

The City takes a disciplined approach to managing projects. Sound project management is the direct responsibility of all managers, directors, and supervisors of the City of Fort Saskatchewan.

EXECUTIVE LIMITATIONS

1. At the outset of every project involving two or more areas of responsibility, each Director is required to ensure a Project Charter is established in accordance with the template included as part of Project Management Administrative Procedure GOV-008-A.
2. Changes in project scope shall be reviewed and approved in accordance with the roles and responsibilities outlined in the Project Charter.

AUTHORITY / RESPONSIBILITY TO IMPLEMENT

1. All Directors, in consultation with General Managers, are responsible for the implementation and compliance monitoring of this policy.
2. The Corporate Strategy Director is authorized to establish procedures to provide for the application of this policy.

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City Manager

ADMINISTRATIVE PROCEDURE

FORT SASKATCHEWAN

GOV-008-A

PROJECT MANAGEMENT

Date Issued: 17.July.14

Current Revision: 17.July.14

Next Review Diarized:01.Jan.16

Mandated by: City Manager

Cross Reference:

Responsibility: Corporate Strategy Director

PURPOSE

The purpose of having a Project Charter Template is 1) to increase our level of accountability and responsibility for projects; and 2) to ensure projects are managed and completed on time and on budget, all people who need to be part of a project are involved appropriately, and that a process is articulated for dealing effectively with changes in project scope.

PROCEDURE

1. At the outset of each project, a Project Charter shall be created in the format included under Attachment 1 to this document.
2. Project Charters shall be signed off by all affected parties as described in the key responsibilities included below.
3. Should a change in scope be required, revised project terms shall be approved by all affected parties. Examples of changes in scope include changes to the nature or timing of milestones or key deliverables; roles and responsibilities; processes to be undertaken to achieve deliverables; or budget.

KEY RESPONSIBILITIES

Following are definitions of the key roles referred to in the Project Charter:

Project Sponsor

The Project Sponsor has responsibility to provide the funding, direction, commitment, resources and approval at specific milestones. The Sponsor may be called upon to work with the Project Team to resolve high ranked project issues and risks.

Project Manager

The Project Manager develops the project work plans and monitors project activities and outcomes to ensure successful delivery of the project deliverables with defined scope, schedule and budget. The Project Manager will facilitate the review sessions and meetings, document outcomes and be accountable to the Project Team for project status information.

Project Team

Project Team members are those individuals identified in the RACI Chart, which sets out project deliverables or activities and assigns individuals as being either **R**esponsible, **A**ccountable, **C**onsulted or **I**nformed, as defined below.

Responsible

- Does the step ("the doer")
- Those who do the work to achieve the task. There is at least one role with a participation type of *responsible*; this may also include support resources allocated to the *responsible* and delegated to assist in the work required. Unlike consulted, who may provide input to the task, support resources help to complete the task.

Accountable (also *approver* or final *approving authority*)

- Accountable for the step ("the buck stops here")
- The one ultimately answerable for the correct and thorough completion of the deliverable or task, and the one who delegates the work to those *responsible*. In other words, an *accountable* must sign off (approve) on work that *responsible* provides. There **must** be only one *accountable* specified for each task or deliverable.

Consulted

- Consulted with before the step ("in the loop")
- Those whose opinions are sought, typically subject matter experts; and with whom there is two-way communication

Informed

- Informed when the step is completed ("kept in the picture")
- Those who are kept up-to-date on progress, often only on completion of the task or deliverable; and with whom there is just one-way communication.

Very often the role that is *accountable* for a task or deliverable may also be *responsible* for completing it (indicated on the matrix by the task or deliverable having a role *accountable* for it, but no role *responsible* for its completion, i.e. it is implied). Outside of this exception, it is generally recommended that each role in the project or process for each task receive, at most, just one of the participation types. Where more than one participation type is shown, this generally implies that participation has not yet been fully resolved, which can impede the value of this technique in clarifying the participation of each role on each task.

ROLES AND RESPONSIBILITIES MATRIX (RACI CHART)

A summary of key activities to be undertaken along with an indication of individual roles and responsibilities relative to each activity shall be included as part of the Project Charter – this is referred to as the RACI Chart for the project.

A sample RACI Chart is included on the following page.

Sample RACI Chart (Roles and Responsibilities Matrix)

	Facilities Mgr	Plant Mgr	HR	Security	Project Mgr
Identify a minimum of three asphalt contractors from Angie's List	C	-	-	-	R
Arrange for contractor visits and quotes	I	-	-	-	R
Review quotes and references, make contractor selection	A	I	I	-	R
Review and finalize contract, lock in plant shutdown week	I	I	-	-	R
Communicate project to shutdown maintenance crew, make sure all vehicles are removed from the lot	I	I	R	I	I
Provide security gate access codes for asphalt crew by June 15	I	-	A	R	I
Oversee the project during the plant shutdown week, ensure it is completed on time	A	I	I	-	R

R = Responsible, A = Accountable, C = Consulted, I = Informed

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ATTACHMENT 1

City of Fort Saskatchewan
Project Charter Template

PROJECT NAME:	
PROJECT START DATE:	TARGET PROJECT COMPLETION DATE:
PROJECT SPONSOR:	PROJECT MANAGER:

A. Project Background
Context for the project including: ▪ Why the project was started ▪ Key issues and factors driving the project ▪ Relevant history

B. Project Purpose
Provides the high level overview of why the project is being undertaken ▪ What need or opportunity is the project addressing? ▪ What is the social, economic or environmental impact of the project? ▪ What are the broad outcomes or deliverables to be achieved?

C. Project Scope
▪ What must be done to complete this project? ▪ What must be done now? ▪ What may be done later? ▪ Are there any factors that will influence the scope including regulatory timelines? ▪ What is the project budget?

D. Results to be achieved	
▪ Provide the details of what this project aims to accomplish by identifying specific measurable outcomes and then identifying how you will measure whether the results have been achieved	
Outcomes	**Indicators of Success**
1.	
2.	
3.	
4.	
5.	

E. Project Team	
▪ List all individuals to be involved in the project and their respective roles. As a minimum, one individual must be named as Project Sponsor and one named as Project Manager. ▪ Each individual named below is required to approve and sign off the Project Charter.	
Name	**Role**
1.	Project Sponsor
2.	Project Manager
3.	Project Team Member
4.	Project Team Member
5.	Project Team Member

F. Assumptions
▪ List any assumptions being made at the beginning of the project that could affect the outcome in terms of schedule, budget, etc. ▪ For example: ▪ Project Budget will be approved by January 15, 2015 ▪ Ground conditions will be suitable for a simple foundation ▪ Successful Contractor will begin within two weeks of award ▪ Staff will be available as required

G. Major Project Risks			
Risks ▪ High level threats to the project	**Likelihood** Low Moderate High	**Impact** Low Moderate High	**Risk Response** ▪ What will be done to avoid, mitigate or transfer the risk?
Risks	**Likelihood**	**Impact**	**Risk Response**
1.			
2.			
3.			
4.			
5.			

H. Detailed Project Plan *(attach spreadsheet)*
1. Create Work Breakdown Structures (WBS) ▪ Break down the detailed work that needs to be done into Major Phases, Milestones, Activities and Tasks and Deliverables ▪ **Phases** represent the major phases of the project such as research, consultation, analysis of findings, drafting of legislation etc. ▪ **Milestones** represent interim events or points in time during the project which identify the completion of a significant segment ▪ **Activities and tasks** are a further breakdown of the work to be done. Ideally the lowest level tasks should be able to be assigned to one person ▪ **Deliverables** should be identified at an appropriate level for the magnitude of the project to provide clarity as to what is required to ensure that a phase, milestone, activity or task is complete ▪ Indicate timelines or projected completion date 2. Identify the individuals involved in completing each activity and task via a RACI Chart. This is your project team; each person named will be required to sign off the Project Terms of Reference. 3. Identify any costs associated with completion of the project such as contractors, materials, training etc.

I. Change Order Process
▪ List of activities that would constitute a change in project scope and a description of the process to be followed for review and approval of such changes. ▪ Includes who would be responsible, accountable, consulted or informed in the event of such changes in scope.

J. Project Communications Strategy				
▪ Identify all communication that must be conducted prior to project start, during the project and upon completion of the project ▪ Identify all communication required with stakeholders and partners				
Communications Needs	**Audience**	**Actions**	**Timing**	**Responsibility**
1.				
2.				
3.				
4.				
5.				

K. Additional Information
▪ List other related documentation such as public engagement plan or Gantt chart ▪ Include documents as attachments to the Project Charter

APPROVALS

Project Sponsor	**Date**
Project Manager	**Date**
Project Team Member	**Date**
Project Team Member	**Date**
Project Team Member	**Date**
Project Team Member	**Date**

Appendix C – Regional Survey Summary

Project Management Review

Comparisons to other Municipalities

Question Asked	Leduc County	City of Leduc	Town of Devon
1. Does your Municipality have any Policy or procedure defining appropriate contingency by type or stage of project? If yes, please include or summarize.	No	Currently no policy or procedure used to determine appropriate contingency amount. (normally 10% to 15% of project value)	We do not have a policy to define contingency. 10% is typical, however for planning higher contingencies can be used.
2. Are Contingencies carried on a project by project basis or is there a contingency pool?	For the last few years we have been adding contingencies on each project, however Council is considering using a pool system for most projects going forward.	Contingencies are based on project by project	Project basis.
3. At what point in the project life are project construction budgets set? (Concept Design, Pre-Design, % of Detailed Design, etc) If construction budgets are set very early in the project life, do you have opportunity to adjust them with Council at a later date?	We set budgets very early, usually at the concept stage. Yes, budgets are updated if required at final budget or at tender award.	Budget are set at the pre-Design stage and any adjustment to the budget are done during the spring budget adjustment.	Varies, for larger more complex projects the budgets are adjusted prior to final approval by council as the project moves through design phases into tender. Smaller projects the project can be adjusted according to budget.
4. Do your contracts include Bonus, Penalty, or Liquidated Damages for project schedule? What determines the method used?	No	Bonus and penalty are set based on the project needs and sensitivity of the project location	For larger projects standard CCDC 2 contract is utilized, the contract specifics vary based on consulting firm used for larger contracts. The town has smaller contracts for smaller jobs, the smaller contracts do not include bonus, penalties or liquidated damages.
5. In your experience do Bonus / Penalty clauses provide value? How?	No, typically I have found that the additional conflict that this process adds into the relationship between the owner and the contractor ultimately leads a lower quality of product from the contractor.	In most cases no extra value, just to ensure sensitive projects are done on schedule.	Have not found they worked well in my personal experience. I do think they can if developed properly. Perhaps more affective if a best value procurement method is utilized.
6. Which types of project delivery do you run? (Design/Bid/Build, Design/Construction, Construction Management, Integrated Project Delivery, etc)	Typically we use Design/Bid/Build. However we have recently had good success using a Best Value Procurement model.	Only Design / Bid / Build	Design/bid/build typically

7. If more than one type of project delivery method is used, what criteria are used to determine the best model for the project?	We use Design / Bid / Build for lower complexity projects and Best Value for larger more complex projects.	N/A

Appendix D – ASTM E2516-11 Standard Classification for Cost Estimate Classification System

Designation: E2516 – 11

Standard Classification for Cost Estimate Classification System[1, 2]

This standard is issued under the fixed designation E2516; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This classification provides a generic classification system for cost estimates and provides guidelines for applying the classification to cost estimates.

1.2 This classification maps the phases and stages of cost estimating to a generic maturity and quality matrix, keyed to a degree of project definition, that can be applied across a wide variety of industries.

1.3 The Cost Estimate Classification System has been developed in a way that:

1.3.1 provides a common understanding of the concepts involved with classifying cost estimates;

1.3.2 defines and correlates the major characteristics used in classifying cost estimates, and;

1.3.3 uses the degree of project definition as the primary characteristic used to categorize estimate classes.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E631 Terminology of Building Constructions

E833 Terminology of Building Economics

E1804 Practice for Performing and Reporting Cost Analysis During the Design Phase of a Project

2.2 *Other Standards:*

ANSI Z94.2-1989 Industrial Engineering Terminology: Cost Engineering[4]

AACE International Recommended Practice No 17R-97: Cost Estimate Classification System[5]

AACE International Recommended Practice No 18R-97: Cost Estimate Classification System: As Applied in Engineering, Procurement, and Construction for the Process Industries[5]

AACE International Recommended Practice No 56R-08: Cost Estimate Classification System – As Applied in Building and General Construction Industries[5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology E833 and Terminology E631.

4. Significance and Use

4.1 Use of this classification will improve communication among all the stakeholders involved with preparing, evaluating, and using cost estimates.

4.2 The various parties that use cost estimates often misinterpret the quality and value of the information available to prepare cost estimates, the various methods employed during the estimating process, the accuracy level expected from estimates, and the level of risk associated with estimates.

4.3 This classification applies the degree of project definition as the primary characteristic for determining an estimate's classification.

4.4 Using this classification will help those involved with project estimates to avoid misinterpretation of the various classes of cost estimates and to avoid their misapplication and misrepresentation. Improving communications about estimate classifications reduces business costs and project cycle times by avoiding inappropriate business and financial decisions, actions, delays, or disputes caused by misunderstandings of cost estimates and what they are expected to represent.

4.5 This classification is intended to be generic and so provide a system for the classification of cost estimates in any industry. There are also references to specific industries, for cost estimate classification as applied in: AACE International, Process Industry 18R-97, and AACE International, Building/General Construction Industry 56R-08.

4.6 Estimate classifications provide valuable additional reporting information when used as an adjunct to Practice E1804.

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[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

Current edition approved April 1, 2011. Published May 2011. Originally approved in 2006. Last previous edition approved in 2006 as E2516 – 06. DOI: 10.1520/E2516-11.

[2] This classification is based on the AACE International Recommended Practices 17R–97, 18R-97, and 56R-09 pertaining to Cost Estimate Classification System.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from the Association of the Advancement of Cost Engineering International (AACE International), 209 Prairie Avenue, Suite 100, Morgantown, WV 26501, http://www.aacei.org.

5. Basis of Classification

5.1 There are numerous characteristics that can be used to categorize cost estimate types. The most significant of these are degree of project definition, end usage of the estimate, estimating methodology, and the effort and time needed to prepare the estimate. The primary characteristic used in this guideline to define the classification category is the degree of project definition. The other characteristics are secondary.

5.2 The discrete degrees of project definition used for classifying estimates correspond to the typical phases and gates of evaluation, authorization, and execution often used by project stakeholders during a project life cycle.

5.3 Five cost estimate classes have been established. While the degree of project definition is a continuous spectrum, it has been determined from benchmarking industry practices that three to five discrete categories are commonly used. Five categories are established in this standard classification as it is easier to simplify by combining categories than it is to arbitrarily split a standard.

5.4 In Table 1 these estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest degree of project definition, and a Class 1 estimate is closest to full project definition and maturity. This countdown approach considers that estimating is an iterative process whereby successive estimates are prepared until a final estimate closes the process.

5.5 The five estimate classes are presented in Table 1 in relationship to the identified characteristics. It is important to understand that it is only the degree of project definition that determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the degree of project definition.

5.6 This generic matrix and guideline provides a high-level estimate classification system that is non-industry specific. The accuracy ranges identified in Table 1 are indicated as index values so that they may be applied generically to just about any particular industry. A more detailed explanation of these index values, including two examples of their possible ranges, can be found in Appendix X1.

6. Determination of the Cost Estimate Class

6.1 The cost estimator makes the determination of the estimate class based upon the degree of project definition (design % complete). While the determination of the estimate class is somewhat subjective, the design input data, completeness and quality of the design deliverables serve to make the determination more objective.

7. Estimate Characteristics

7.1 The following are brief discussions of the various estimate characteristics used in the estimate classification matrix, Table 1. For the secondary characteristics, the overall trend of how each characteristic varies with the degree of project definition (the primary characteristic) is provided.

7.2 *Degree of Project Definition (Primary Characteristic):*

7.2.1 This characteristic is based upon the level of completion of project definition (roughly corresponding to the percentage completion of architectural/engineering detail and design). The degree of project definition defines maturity, or the extent and types, of input information available to the estimating process. Such inputs include project scope definition, requirements documents, specifications, project plans, drawings, calculations, knowledge and experience gained from past projects, reconnaissance data, and other information that must be used, and developed, to define the project. Each industry will have a typical set of deliverables that are used to support the type of estimates used in that industry. The set of deliverables becomes more definitive and complete as the degree of project definition (such as architecture and engineering) progresses.

7.3 *End Usage (Secondary Characteristic):*

7.3.1 The various classes (or phases) of cost estimates prepared for a project typically have different end uses or purposes. As the degree of project definition increases, the end

TABLE 1 Generic Cost Estimate Classification Matrix

	Primary Characteristic	Secondary Characteristic			
ESTIMATED CLASS	DEGREE OF PROJECTION DEFINITION	END USAGE	METHODOLOGY	EXPECTED ACCURACY RANGE	PREPARATION EFFORT
	Expressed as % of complete definition	Typical purpose of estimate	Typical estimating method	Typical ± range relative to index of 1 (that is, Class 1 estimate)[A]	Typical degree of effort relative to least cost index of 1[B]
Class 5	0 % to 2 %	Screening or feasibility	Stochastic (factors or models, or both) 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	70 % to 100 %	Check estimate or bid/tender	Deterministic	1	10 to 100

[A] If the expected accuracy range index value of “1” represents +10/-5 %, then an index value of “10” represents +100/-50 %.
[B] If the preparation effort index value of “1” represents 0.005 % of project costs, then an index value of “100” represents 0.5 %.

usage of an estimate typically progresses from strategic evaluation and feasibility studies to funding authorization and budgeting, to project control.

7.4 *Estimating Methodology (Secondary Characteristic)*

7.4.1 Estimating methodologies fall into two broad categories: stochastic and deterministic. In stochastic methods, the independent variable(s) used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. The cost estimating relationships used in stochastic methods are often based on factors, metrics, models, etc. With deterministic methods, the independent variable(s) are more or less a definitive measure of the item being estimated (can include, detailed takeoff, quotes, bids, etc.). A deterministic methodology reduces the level of conjecture inherent in an estimate. As the degree of project definition increases, the estimating methodology tends to progress from stochastic to deterministic methods.

7.5 *Expected Accuracy Range (Secondary Characteristic):*

7.5.1 Estimate accuracy range is an indication of the degree to which the final cost outcome for a given project could vary from the estimated cost. Accuracy is traditionally expressed as a ± percentage range around the point estimate, after application of contingency, with a stated level of confidence that the actual cost outcome would fall within this range (± measures are a useful simplification, given that actual cost outcomes have different frequency distributions for different types of projects). As the degree of project definition increases, the expected accuracy of the estimate tends to improve, as indicated by a narrower ± range. Additionally, industry experience shows that a percentage range should also vary with the cost magnitude of the project. In addition to the degree of project definition, estimate accuracy is also subject to:

7.5.1.1 Level of non-familiar technology in the project.

7.5.1.2 Complexity of the project.

7.5.1.3 Quality of reference cost estimating data.

7.5.1.4 Quality of assumptions used in preparing the estimate.

7.5.1.5 Experience and skill level of the estimator.

7.5.1.6 Estimating techniques employed.

7.5.1.7 Time and level of effort budgeted to prepare the estimate.

NOTE 1—In Table 1, the values in the accuracy range column do not represent plus or minus percentages, but instead represent an index value relative to a best range index value of 1. If, for a particular industry, a Class 1 estimate has an accuracy range of +10/-5 percent, then a Class 5 estimate in that same industry may have an accuracy range of +100/-50 percent.

NOTE 2—Appendix A provides an illustrative example of estimate accuracy ranges for two particular industries.

7.6 *Effort to Prepare Estimate (Secondary Characteristic):*

7.6.1 The level of effort needed to prepare a given estimate is an indication of the cost, time, and resources required. The cost measure of that effort is typically expressed as a percentage of the total project costs for a given project size. As the degree of project definition increases, the amount of effort to prepare an estimate increases, as does its cost relative to the total project cost. The effort to develop the project deliverables is not included in these effort metrics; they only cover the cost to prepare the cost estimate itself.

8. Relationships and Variations of Estimate Characteristics: Discussion

8.1 There are a myriad of complex relationships that may be exhibited among the estimate characteristics within the estimate classifications. The overall trend of how the secondary characteristics vary with the degree of project definition was provided above. This section explores those trends in more detail. Typically, there are commonalties in the secondary characteristics between one estimate and the next, but in any given situation there may be wide variations in usage, methodology, accuracy, and effort.

8.1.1 The level of project definition is the driver of the other characteristics. Typically, all of the secondary characteristics have the level of project definition as a primary determinant. While the other characteristics are important to categorization, they lack complete consensus. For example, one estimator's bid might be another's budget. Characteristics such as methodology and accuracy can vary markedly from one industry to another and even from estimator to estimator within a given industry.

8.2 *Degree of Project Definition:*

8.2.1 Each project (or industry grouping) will have a typical set of deliverables that are used to support a given class of estimate. The availability of these deliverables is directly related to the level of project definition achieved. The variations in the deliverables required for an estimate are too broad to cover in detail here; however, it is important to understand what drives the variations. Each industry group tends to focus on a defining project element that drives the estimate maturity level. For instance, chemical industry projects are process equipment-centric; such as, the level of project definition and subsequent estimate maturity level is significantly determined by how well the equipment is defined. Architectural projects tend to be structure-centric, software projects tend to be function-centric, and so forth. Understanding these drivers puts the differences that may appear in the more detailed industry addenda into perspective.

8.3 *End Usage:*

8.3.1 While there are common end usages of an estimate among different stakeholders, usage is often relative to the stakeholders identity. For instance, an owner company may use a given class of estimate to support project funding, while a contractor may use the same class of estimate to support a contract bid or tender. It is not at all uncommon to find stakeholders categorizing their estimates by usage-related headings such as budget, study, or bid. Depending on the stakeholders perspective and needs, it is important to understand that these may actually be all the same class of estimate (based on the primary characteristic of degree of project definition achieved).

8.4 *Estimating Methodology:*

8.4.1 As stated previously, estimating methodologies fall into two broad categories: stochastic and deterministic. These broad categories encompass scores of individual methodologies. Stochastic methods often involve simple or complex modeling based on inferred or statistical relationships between costs and programmatic or technical parameters, or both.

Deterministic methods tend to be straightforward counts or measures of units of items multiplied by known unit costs or factors. It is important to realize that any combination of methods may be found in any given class of estimate. For example, if a stochastic method is known to be suitably accurate, it may be used in place of a deterministic method even when there is sufficient input information based on the degree of project definition to support a deterministic method. This may be due to the lower level of effort required to prepare an estimate using stochastic methods.

8.5 *Expected Accuracy Range:*

8.5.1 The accuracy range of an estimate is dependent upon a number of characteristics of the estimate input information and the estimating process. The extent of the input information as measured by percentage completion (and related to degree of project definition) is a highly important determinant of accuracy. However, there are factors besides the available input information that also greatly affect estimate accuracy measures. Primary among these are the state of technology in the project and the quality of reference cost estimating data.

8.5.2 *State of Technology*—Technology varies considerably between industries, and thus affects estimate accuracy. The state of technology used here refers primarily to the programmatic or technical uniqueness and complexity of the project. Procedurally, having full extent and maturity in the estimate basis deliverables is deceptive if the deliverables are based upon assumptions regarding uncertain technology. For a first-of-a-kind project there is a lower level of confidence that the execution of the project will be successful (all else being equal). There is generally a higher confidence level for projects that repeat past practices. Projects for which research and development are still under way at the time that the estimate is prepared are particularly subject to low accuracy expectations. The state of technology may have an order of magnitude (10 to 1) effect on the accuracy range.

8.5.3 *Quality of Reference Cost Estimating Data*—Accuracy is also dependent on the quality of reference cost data and history. It is possible to have a project with common practice in technology, but with little cost history available concerning projects using that technology. In addition, the estimating process typically employs a number of factors to adjust for market conditions, project location, environmental considerations, and other estimate-specific conditions that are often uncertain and difficult to assess. The accuracy of the estimate will be better when verified empirical data and statistics are employed as a basis for the estimating process, rather than assumptions.

8.5.4 In summary, estimate accuracy will generally be correlated with estimate classification (and therefore the degree of project definition), all else being equal. However, specific accuracy ranges will typically vary by industry. Also, the accuracy of any given estimate is not fixed or determined by its classification category. Significant variations in accuracy from estimate to estimate are possible if any of the determinants of accuracy, such as differing technological maturity, quality of reference cost data, quality of the estimating process, and skill and knowledge of the estimator vary. Accuracy is also not necessarily determined by the methodology used or the effort expended. Estimate accuracy must be evaluated on an estimate-by-estimate basis, usually in conjunction with some form of risk analysis process.

8.6 *Effort to Prepare Estimate:*

8.6.1 The effort to prepare an estimate is usually determined by the extent of the input information available. The effort will normally increase as the number and complexity of the project definition deliverables that are produced and assessed increase. However, with an efficient estimating methodology on repetitive projects, this relationship may be less defined. For instance, there are combination design/estimating tools in the process industries that can often automate much of the design and estimating process. These tools can often generate Class 3 deliverables and estimates from the most basic input parameters for repetitive-type projects. There may be similar tools in other industry groupings.

NOTE 3—Estimate preparation costs as a percentage of total project costs will vary inversely with project size in a nonlinear fashion. For a given class of estimate, the preparation cost percentage will decrease as the total project costs increase. Also, at each class of estimate, the preparation costs in different industries will vary markedly. Metrics of estimate preparation costs normally exclude the effort to prepare the defining project deliverables.

9. Keywords

9.1 Bid/tender; Class 1 estimate; Class 2 estimate; Class 3 estimate; Class 4 estimate; Class 5 estimate; Class of estimate; Cost estimate; Cost estimate classification methodology; Degree of project definition; Deterministic; Effort to prepare estimates; End usage; Estimate classification; Estimate classification matrix; Estimating methodology; Expected accuracy range; Life cycle; Maturity and quality matrix; Project; Stochastic

APPENDIX

(Nonmandatory Information)

X1. GUIDANCE NOTES

X1.1 The accuracy ranges identified in Table 1, above, are indicated as index values so that they may be applied generically to just about any particular industry. Any particular industry may have typical norms associated with the accuracy level expected for each class of estimate. The accuracy ranges typically associated with the building and general construction industry will generally be tighter than the accuracy ranges associated with the process industry (see Table X1.1). Both will have tighter accuracy ranges than those associated with the software development industry.

X1.2 Table X1.1, that follows, illustrates typical accuracy ranges that may be associated with the process and general building and construction industries. Depending on the technical and project deliverables associated with each estimate, the accuracy range for any particular estimate is expected to fall into the ranges identified.

X1.3 As noted above in Section 8, there are a myriad of complex relationships that come into play when drafting any statement of accuracy levels for each estimate class. The many sectors of the construction industry do vary significantly in their design, procurement and implementation methodologies, as well as the technologies they employ, the range in their scope, and the magnitude of their funding needs.

X1.4 Another way to look at the variability associated with estimate accuracy ranges is shown in Fig. X1.1 and Fig. X1.2, that follow. Depending upon the technical complexity of the project, the availability of appropriate cost reference information, the degree of project definition, and the inclusion of appropriate contingency determination, a typical Class 5 estimate for a process industry project may have an accuracy range as broad as –50 % to +100 %, or as narrow as –20 % to +30 %.

X1.5 In these figures, you can also see that the estimating accuracy ranges overlap the estimate classes. There are cases where a Class 5 estimate for a particular project may be as accurate as a Class 3 estimate for a different project. This may be the case if the Class 5 estimate was based on a repeat project with good cost history and data, whereas the Class 3 estimate was for a project involving new technology. It is for this reason that Table 1 provides a range in index values. This permits application of the specific circumstances inherent in a project, and an industry sector, to the indication of realistic estimate class accuracy range percentages.

TABLE X1.1 Illustrative Example of Typical Accuracy Ranges for the Process and General Building Construction Industries

	Primary Characteristic	Secondary Characteristic	
	DEGREE OF PROJECTION DEFINITION	EXPECTED ACCURACY RANGE Typical variation in low and high ranges[A]	
Estimated Class	Expressed as % of complete definition	Process Industry	Building Construction and General Construction Industry
Class 5	0 % to 2 %	L: –20 % to –50 % H: +30 % to +100 %	L: –20 % to –30 % H: +30 % to + 50 %
Class 4	1 % to 15 %	L: –15 % to –30 % H: +20 % to +100 %	L: –10 % to –20 % H: +20 % to +30 %
Class 3	10 % to 40 %	L: –10 % to –20 % H: _10 to +50	L: –5 % to –15 % H: +10 % to +20 %
Class 2	30 % to 70 %	L: –5 % to –15 % H: +5 % to +20 %	L: –5 % to –10 % H: +5 % to +15 %
Class 1	70 % to 100 %	L: –3 % to –10 % H: +3 % to +15 %	L: –3 % to –5 % H: +3 % to +10 %

[A] The state of process technology and availability of applicable reference cost data affect the range markedly. The ± value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50 % level of confidence) for a given scope.

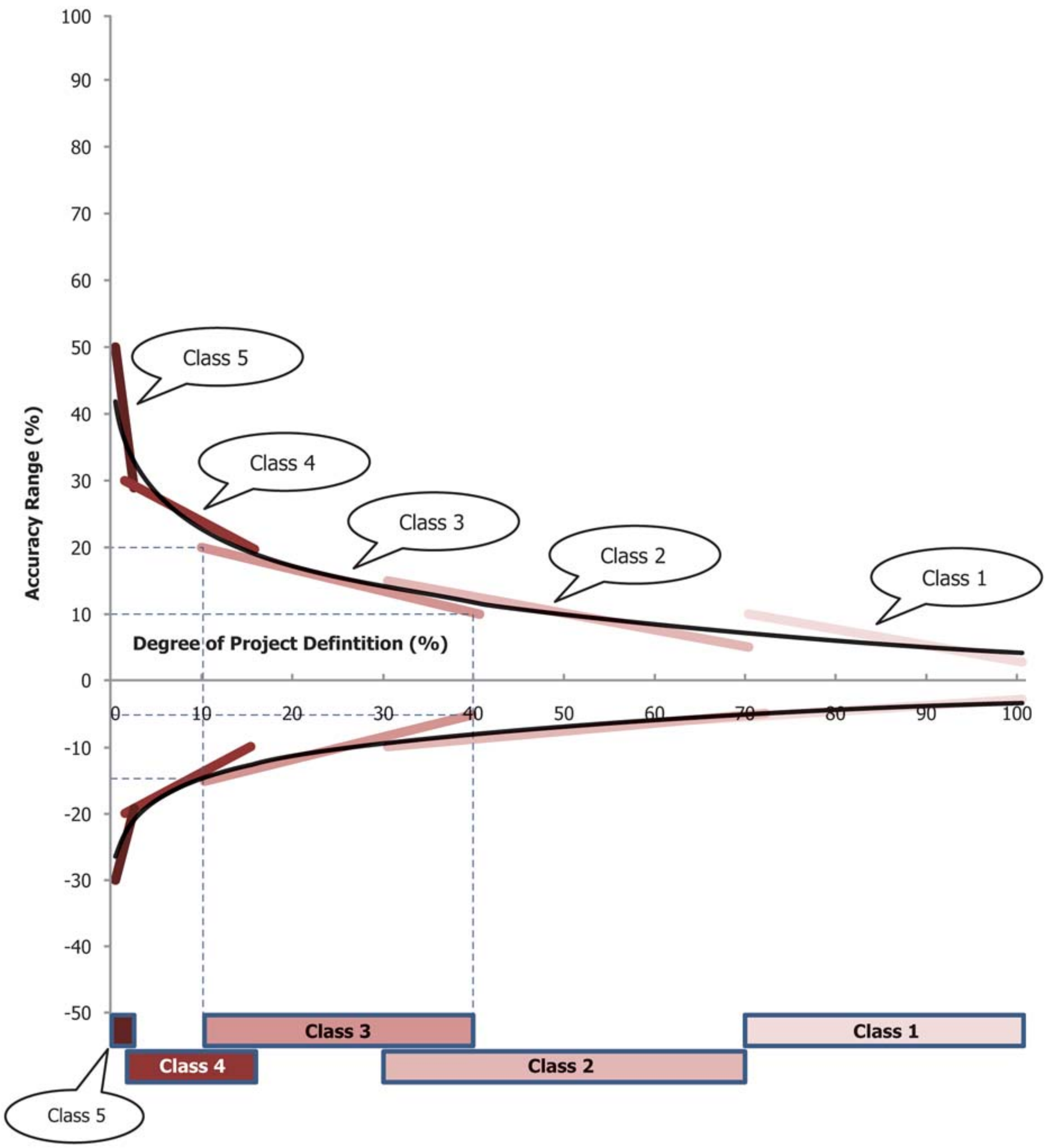

FIG. X1.1 Example of the Variability in Accuracy Ranges for a Building and General Construction Industry Estimate

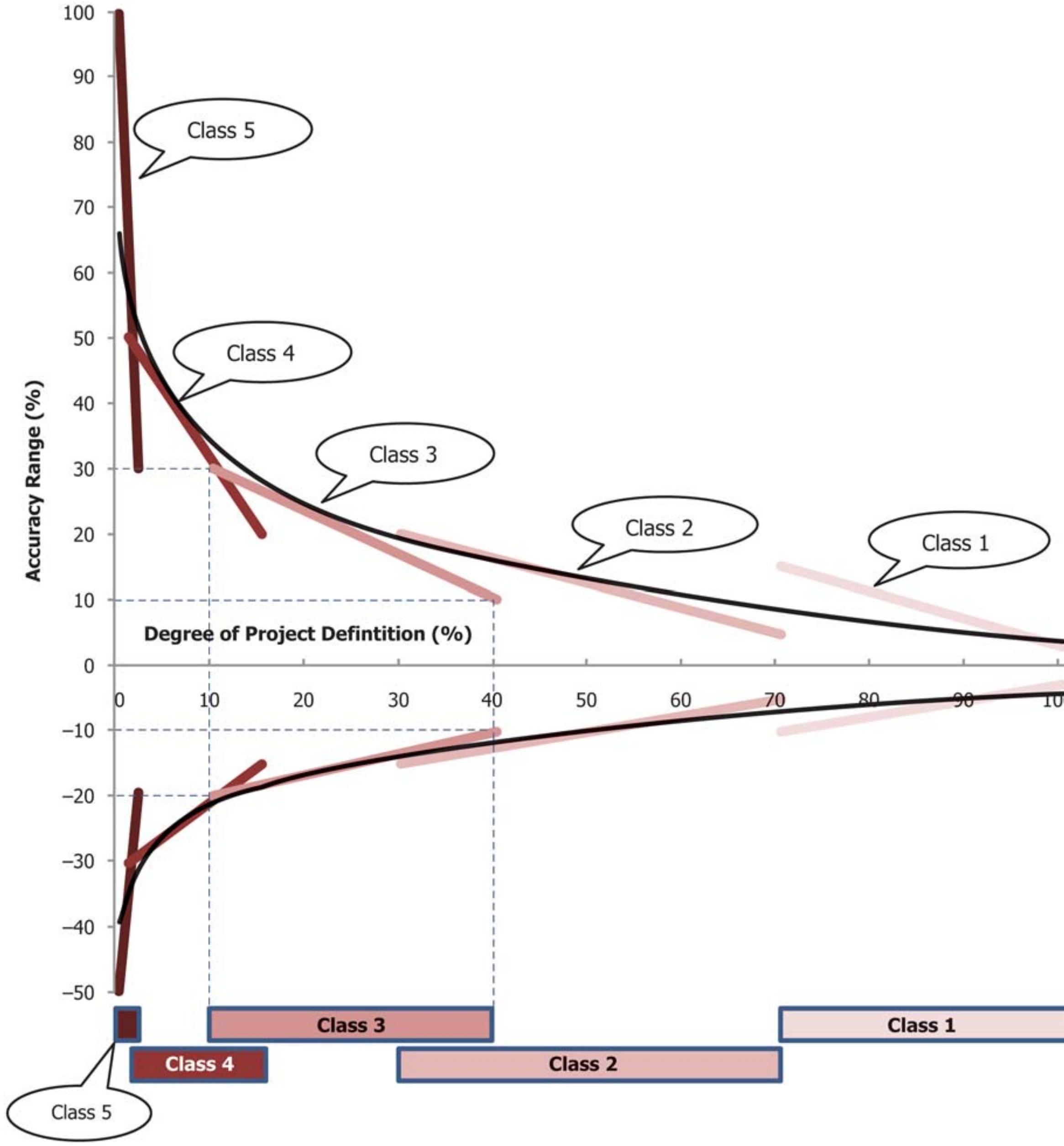

FIG. X1.2 Example of the Variability in Accuracy Ranges for a Process Industry Estimate