

**AACE**  
INTERNATIONAL  
**RECOMMENDED  
PRACTICE**

**58R-10**

**ESCALATION ESTIMATING  
PRINCIPLES AND METHODS USING  
INDICES**

**AACE**  
INTERNATIONAL



AAACE® International Recommended Practice No. 58R-10

## ESCALATION ESTIMATING PRINCIPLES AND METHODS USING INDICES

TCM Framework: 7.3 – Cost Estimating and Budgeting  
7.6 – Risk Management

Rev. May 25, 2011

Note: As AAACE International Recommended Practices evolve over time, please refer to [web.aacei.org](http://web.aacei.org) for the latest revisions.

Any terms found in AAACE Recommended Practice 10S-90, *Cost Engineering Terminology*, supersede terms defined in other AAACE work products, including but not limited to, other recommended practices, the *Total Cost Management Framework*, and *Skills & Knowledge of Cost Engineering*.

### Contributors:

*Disclaimer: The content provided by the contributors to this recommended practice is their own and does not necessarily reflect that of their employers, unless otherwise stated.*

John K. Hollmann, PE CCE CEP  
(Primary Contributor)  
Mohamed H. Abdel-Mageed, CCE  
Michael S. Anderson  
Luis Alejandro Camero Arleo, CCE  
Rene Berghuijs  
Rani Chacko, CCE  
Dr. Ovidiu Cretu, PE  
Dr. Utpal Dutta, PE  
Fabio Leonardo da Silva Fernandes  
Carlton W. Karlik, PE CEP  
Rod Knoll  
Pankaja P. Kumar, CCE  
Rose Mary Lewis, PE  
Michael Shawn Longfellow  
Bruce A. Martin  
Joseph L. N. Martin

John Charles Mulholland  
Rajasekaran Murugesan, CCE  
Chris A. Remme, CCC PSP  
Steven H. Rossi, PE CCE  
Ruben A. Sanchez, CCE  
Amit Sarkar  
Örn Steinar Sigurðsson  
W. James Simons, PSP  
Terence M. Stackpole  
Peter W. van der Schans, CCE  
Mai Tawfeq  
Dr. Ali Touran, PE  
Robert F. Wells, CEP  
Dr. Trefor P. Williams  
David C. Wolfson  
Rashad Z. Zein, PSP

# ESCALATION ESTIMATING PRINCIPLES AND METHODS USING INDICES

TCM Framework: 7.3 – Cost Estimating and Budgeting  
7.6 – Risk Management



May 25, 2011

## TABLE OF CONTENTS

Table of Contents .....	1
Introduction.....	1
Scope .....	1
Background.....	2
General Principles and Methods .....	3
General Principles.....	3
Basic Escalation Cost Estimate Relationship Using Indices.....	4
Price and other Econometric Indices .....	4
Pricing Versus Costs .....	5
Price Index Forecasts .....	6
Addressing Costs Over Time (Cash Flow).....	6
Addressing Cost Account Detail.....	8
Matching Indices to Cost Accounts (Weighting Indices).....	8
Adjusted or Composite Indices .....	9
Using Price Indices to Normalize Historical Project Costs .....	10
Escalation on Contingency.....	11
Escalation Uncertainty and Probabilistic Methods.....	11
“Black Swan” Theory.....	12
Lag and “Sticky Prices” .....	12
Accuracy.....	13
Customer and Business Practice Alignments.....	13
Summary: The Escalation Estimating Process .....	14
References .....	14
Other Industry Practices .....	15
Contributors.....	15

## INTRODUCTION

### Scope

This recommended practice (RP) of AACE International defines basic principles and methodological building blocks for estimating escalation costs using forecasted price or cost indices. There is a range of definitions of escalation

May 25, 2011

and escalation estimating methodologies; this RP will help guide practitioners in developing or selecting appropriate methods for their definitions and situation. Other RPs are expected to cover methods that do not involve indices, that cover specific examples of fully elaborated methodologies for specific project situations, technologies, industries, and probabilistic applications. Also, while the RP discusses the relationships of escalation estimating to other risk cost accounts (namely contingency and currency exchange), dealing with those costs is not this RP's focus.

Escalation estimating is an element of both the cost estimating and risk management processes. Like other risks escalation is amenable to mitigation, control, etc. However, this RP is focused on quantification, not on escalation treatment (i.e., how it is addressed through contracting, bidding, schedule acceleration, hedging, etc.) or control. In terms of cost estimating, this RP covers practices applicable to all classification of estimates<sup>[1]</sup>. The examples in the RP emphasize capital cost estimating, but the principles apply equally to operating, maintenance and other cost.

## BACKGROUND

The current full definition of *escalation* is provided in AACE's recommended practice 10S-90, *Cost Engineering Terminology*<sup>[2]</sup>, but in summary, escalation is a provision in costs or prices for changes in technical, economic and market conditions over time.

As the volatility and uncertainty of the economy and the potential for escalation increases, it demands greater attention from decision makers and cost engineers; i.e., escalation is a major risk. It can have a tremendous impact on estimates, bids, profitability, and so on. In volatile times, it may be the largest cost account in an estimate; in stable times, it may seem insignificant, but could change suddenly. In contracting and procurement, it is a common source of claims and disputes if not addressed explicitly. While in some usages, the term escalation is associated with increase, escalation estimating addresses the impact of change whether that change is an increase or decrease (i.e., in risk terms, it can be either a threat or an opportunity).

Escalation as defined here excludes contingency and currency exchange impacts, but includes inflation. These are all risks, but the principal estimating practices differentiate these. Some of the drivers of escalation, in addition to inflation (inflation is generally defined as the overarching effect on prices of excess money supply), include changes in market conditions, technology, regulation, general industry or regional-wide productivity and other economic factors that generally affect an economic sector or segment. Technology and regulation changes covered by escalation are those that are general in nature such as evolutionary changes in design tools or regulations not immediately impacting the project. Major technology changes or regulations that directly or immediately impact the project would be covered in contingency or reserves. Escalation typically varies between different economic sectors or segments, different regions, and so on. Further, each good and service may be part of a different micro-economy facing its own escalation situation.

Escalation does not include changes in cost or price resulting from potential changes in company or project specific strategies, actions, risk events or other changes. Those pricing risks should be addressed by contingency estimates. Segregating escalation from exchange rate impacts is more challenging because both are driven by economic factors. However, segregation is recommended so that financial and other mitigation strategies can be considered (e.g., hedging of currencies for exchange rate and hedging of commodities for escalation). While this is a general guide, each company must clearly define what is in escalation versus allowance, contingency and currency exchange in its estimating practice. This should be documented in the basis of estimate.

Escalation estimating is typically used to either bring past costs or prices to a current basis (i.e., an element of "normalization"), or to forecast what costs or prices will be in the future. While past escalation can be measured

May 25, 2011

and is therefore less uncertain than the future, the measurements are difficult to make and are rarely of high accuracy.

As an uncertain cost, escalation is always a risk to consider in the risk management process. However, escalation is usually quantified using different methods than used for other risks (i.e., contingency). Being driven by conditions in the economy, which are external to the project, it is less amenable to quantification techniques that use project system empirical data (e.g., parametric contingency estimating), or project team input (e.g., range estimating, expected value, etc.). Given its economic nature, it is recommended that those with the most economics expertise (e.g., economists) be included in the process of developing escalation estimating methods and estimates.

Like other risks, escalation is amenable to mitigation and control. This RP does not cover the treatment and control of escalation (i.e., how it is addressed through contracting, bidding, schedule acceleration, hedging, etc.) or control. However, while this RP deals only with quantification, the unique characteristics of escalation's drivers and impacts mean that it should be controlled and otherwise managed as a unique cost control account (i.e., by AACE's definitions, contingency specifically excludes escalation<sup>[2]</sup>). As such, it is necessary to ensure that all stakeholders agree as to what escalation, contingency and currency exchange are, and estimate and manage them distinctly and appropriately. One reason for this careful attention is that in times of economic volatility, escalation tends to be used as an excuse for cost increases that are really caused by ineffective project practices.

## GENERAL PRINCIPLES AND METHODS

### General Principles

There is no single best way to quantify risks, including escalation. Each method has advantages and disadvantages and its advocates. However, there is general agreement that any recommended practice or method for estimating or forecasting the cost of uncertainty should address the principles identified in the AACE RP 40R-08, *Contingency Estimating: General Principles*<sup>[3]</sup>. The methods discussed in this RP are consistent with those principles.

For escalation, the principles in RP 40R-08 are clarified or expanded as follows in recognition of the differences between contingency and escalation estimating:

- Differentiate between escalation, currency and contingency
- Leverage economist's knowledge (based on macroeconomics)
- Use indices appropriate to each account including addressing differential price trends between accounts
- Use indices that address levels of detail for various estimate classes
- Leverage procurement/contracting specialists knowledge of markets
- Ensure that indices address the specific internal and external market situation
- Facilitate estimation of appropriate spending or cash flow profile
- Calibrate or validate data with historical data
- Use probabilistic methods
- Use the same economic scenarios for both business and capital planning
- Apply in a consistent approach using a tool that facilitates best practice
- Integrate in a total cost management (TCM) process

The escalation estimating methods described below address the above principles.

Estimating escalation at a root level involves measuring or forecasting the performance of macro and micro-economies. Typically, cost engineering skills and knowledge do not include econometric practices. As such, practices that support escalation estimating such as macroeconomic modeling are not included in this RP. This is also in keeping with the principle of leveraging economist's knowledge. As an example of a violation of this

May 25, 2011

principle, it is not uncommon to find estimators taking the shortcut of simply extrapolating past price trends without the benefit of any economic insight. This is not an effective practice and is not recommended.

### Basic Escalation Cost Estimate Relationship Using Indices

The methods covered in this RP require input from economists as appropriate. That input usually takes the form of measured or forecast cost and prices, usually expressed with a relative index (i.e., convert the base year cost to a value of 1.00 or 100 and express the costs in all other years relative to that base).

At an elementary level, using forecast indices to estimate escalation for a future single estimated payment is easy. Escalation cost is the escalated cost minus the base cost as shown below:

$$\text{\$Escalation} = \text{\$Base estimate} \cdot [(\text{Index for target date})/(\text{Index for est. basis date}) - 1]$$

For example, for an item costing \$100 in the base year (index = 1.00) and a forecast index of 1.15 for the year of payment, the escalation cost is as follows:

$$= \$100 \cdot [1.15/1.00 - 1] = \$100 \cdot 0.15 = \$15$$

The target date can be in the past or future depending upon the purpose of the estimate. The time period that you have indices for can vary; however, reliable cost and index data are rarely available for periods more frequent than monthly. Quarterly or annual periods are more commonly used depending on the time duration, availability of cash flow information and so on.

When dealing with economics evaluation, the terms “nominal” versus “real” cost may arise in discussions. These terms can be illustrated by the following relationship. At face value, this indicates that real costs are more or less synonymous with the “base” estimate and nominal cost with escalated costs. However, in communications with business and economists, the use of terms must be clarified.

$$\text{Real Cost} = \text{Nominal Cost} / (1 + \% \text{ Increase in costs since basis date})$$

While the basic equations above are simple, the remainder of this RP discusses many issues that a fully developed methodology or system must address in applying this equation in an effective way.

### Price and other Econometric Indices

Escalation is driven by economic trends. The primary econometric measures of price change over time (i.e., escalation) used by economists are price indices. The index is usually expressed as a relative factor with a value of 1.00 representing the price at a given base time. If the index for a later date was 1.05, this would represent a 5 percent increase since the base time period. The difference between any other two time periods can be simply calculated as the difference between the two indices for those periods.

Economists usually measure price levels using market surveys. They may survey the prices being charged by producers (i.e., producer price indices or PPIs) or the prices paid by (or cost to) consumers (e.g., consumer price indices or CPIs). There are also other econometric indices of various inputs or drivers of price such as wages and compensation (e.g., employment cost indices, average hourly earnings, etc.), capital spending, labor productivity and so on. Each has a use in escalation estimating as will be described. Keep in mind that the consumer being considered is often not representative of your company. Likewise the producers are often not representative of your suppliers.

---

May 25, 2011

The primary sources of historical price and other economic indices are government agencies such as the U.S. Bureau of Labor Statistics (BLS), Eurostat or Statistics Canada to name a few. Most of the indices published in magazines and other sources are derived from these government sources. However, there are unique private sources from individual firms and consultants.

Price indices vary depending upon the stage of processing or the place in the value chain of the item being indexed, the complexity of the item composition, the size and nature of the market (and ability of the economists to get good survey data, particularly in small or micro-economies), and the pricing power of producers in a particular market.

Many companies use the CPI or equivalent as the index basis for their escalation estimates. This is not an effective practice for accurate escalation estimating. The consumer targeted by the CPI reflects a person whose spending patterns and market generally have little relevance to capital project spending or markets. The only time that the CPI works well is when the *only* escalation occurring is inflation and this is not a safe assumption in a changing world (i.e., there is always some change in market conditions, technology, regulation, general productivity and other economic trends relevant to the project).

### **Pricing Versus Costs**

The prices paid by (or cost to) a consumer may differ from the supplier's costs (i.e., the prices suppliers pay for their input goods and services). Supplier prices charged to the consumer include markups for their overhead and profit, contingency and other premiums that they will increase or decrease depending upon their business objectives and their perception of marketplace conditions. Understanding these distinctions is important in escalation estimating because it affects the selection and use of indices, and it affects the reliability of the indices.

As an example of the subtleties of indices, consider the employment cost index (ECI) from the BLS, which is commonly used to track the cost or price of labor. The ECI measures changes in wages and compensation paid to a given type of worker. This may fairly track the costs to an employer for that worker. However, consider the price that a contractor employer will charge a customer for contract services. That price will include not only trends in wages, but trends in markups and premiums that the contractor will add to their bid or invoice. In a volatile market, the markups generally will not follow the same trend as wages. Therefore, the ECI may work for the contractor estimator who is estimating their internal escalation costs, but not for the customer's estimator who is estimating the price they will have to pay for the contracted labor services.

Because of the difficulty in market sampling of the price of contracted services, there are few off-the-shelf indices for these prices. They are difficult to measure because prices are bid and the work deliverables vary greatly in scope for most project services. However, there are exceptions. For example, in 2005, the BLS began developing PPI output indices for non-residential building construction that includes builder overhead and profit and should reflect sell prices reflecting the capital market. They did this by creating complex building cost models and surveying general contractors as to their overhead and profit. Unfortunately, there are no such plans for indices for process plant, infrastructure, etc.

The situation above adds uncertainty to the estimating process. One uncertainty is that the economists tend to only survey major market segments (e.g. a macroeconomic view). They usually will not be surveying labor prices (e.g., bids) or specialized equipment specific to your industry or location. Also, in a volatile market, indices based on surveys often do not track short-term price trends very well. Overbooked contractors and suppliers will tend to submit historically uncompetitive lump-sum bids (if they bid at all), insist on doing work on a time and material basis, insist on escalation clauses, or otherwise act in ways that make final pricing difficult to measure or predict by

---

May 25, 2011

the economists. Situations in which a limited number of suppliers and contractors exist usually cause a major divergence between prices and costs due to the increased leverage realized by these suppliers and contractors.

The method building blocks in this RP will attempt to address the cost/price issues and uncertainties as - described below.

### **Price Index Forecasts**

Many economists study historical trends and build econometric models that forecast future price index values, generally at an aggregate level. The models of price change for specific goods or services are usually tied to macroeconomic models that define the underlying economic conditions that drive all prices to some extent. Some economists rely less on models and more on expert opinion, market surveys and so on. Typically, the economists, in-house or third party, will use a hybrid of methods, overriding or adjusting their base models based on judgment or other inputs as appropriate. Developing forecasts takes effort to produce so forecasts are generally not free. Most government agencies do not prepare long-term forecasts of detailed indices.

Some companies tend to rely more on the forecasts of their procurement and contracting specialists who have some level of insight as to the specific market of their company. Such input should always be obtained and considered, if available. However, there are risks to total reliance on procurement department forecasts. One is that they tend to under-appreciate relevant macroeconomic trends outside of their specific market. They also tend to lack long-term insight. Another is the tendency to be swayed by bias in supplier information. That said, for short-term specific market procurement decisions, the specialist's information tends to be the most reliable.

Estimators must recognize that most economists are not experts in specific capital project costs or sub-markets. Also, third-party sources do not have tailor-made indices for your cost items (particularly concerning labor services and specialized equipment as previously discussed). Many companies are frustrated because economists do not have canned solutions for them. Estimators and economists must work together to find an adjusted combination of indices that can serve as proxies for elements of project or product costs. It is then the estimator's responsibility to apply the indices.

### **Addressing Costs Over Time (Cash Flow)**

The basic escalation cost estimating relationship (CER) presented at the start of the RP assumes spending on one item in one point of time such as for purchasing a discrete item. However, spending is usually spread out over time for many accounts such as labor or bulk materials. For this RP, we will use the phrase cash flow to represent spending distributed over time. In this case, it may represent expended, incurred, or committed amounts as appropriate to the cost account being estimated. In general, the usual cash flow pattern of interest for escalation estimating is when a cost is incurred (i.e., when the resource is obtained or expended whether disbursement of money for that resource was paid or not). For purchases of major items, the estimate must reflect an estimate of when costs will be incurred by the vendor, not one's payment schedule to them (i.e., disregard down-payment, delivery and other payment timing to them, but consider when then will acquire materials and expend shop labor). In general, existing cashflow curves generated for finance or project control are not optimal for escalation estimating.

Figure 1 illustrates three primary methods for addressing costs incurred over time. Using these methods, one can apply the general escalation CER shown previously; i.e., each cost (in total or for a given period) corresponds to a discrete point of time. The methods have increasing granularity as follows:

May 25, 2011

1) *Mid-point spending method*: This method sets the single target date as the mid-point between the start and end of spending on the subject cost account. This is the simplest approach and requires no knowledge of the actual spending pattern. It is most amenable for Class 5 and 4 base cost estimates for which cost and schedule information is limited. It is not very reliable if either cash flow or index trends are inconsistent over time.

2) *Median spending method*: This method sets the single target date as the median date of the cash flow distribution (i.e., half the spending is before and half after this date). This requires some knowledge of the spending pattern even if just to know if it has an early or late bias (i.e., before or after the mid-point). It is most amenable for Class 5 and 4 base estimates for which cost and schedule information is limited. While it addresses asymmetric spending patterns, it is still not very reliable if index trends are inconsistent over time.

3) *Period spending method*: this method breaks the spending into time increments, typically by month, quarter or year depending on the typical duration of the spending (i.e., monthly estimates are usually not justified for projects of many years duration). For each time increment of spending for each account, the simple method in the previous section is applied with the target date for the increment as the mid-point of the incremental period. Alternatively, the percent index change for each period can be applied cumulatively to derive the target year index. For example, if you are estimating costs in year 0 (index=1.00), and the spending will be in year 3, and prices increase 5 percent per year, the price index for year 3 is  $1.05 \times 1.05 \times 1.05 = 1.16$  (i.e., escalation for that item is 16%).

This method requires specific knowledge of the spending pattern. It is amenable for any Class base estimate, but particularly Class 3 or better estimates for which cost and schedule information is fairly detailed.

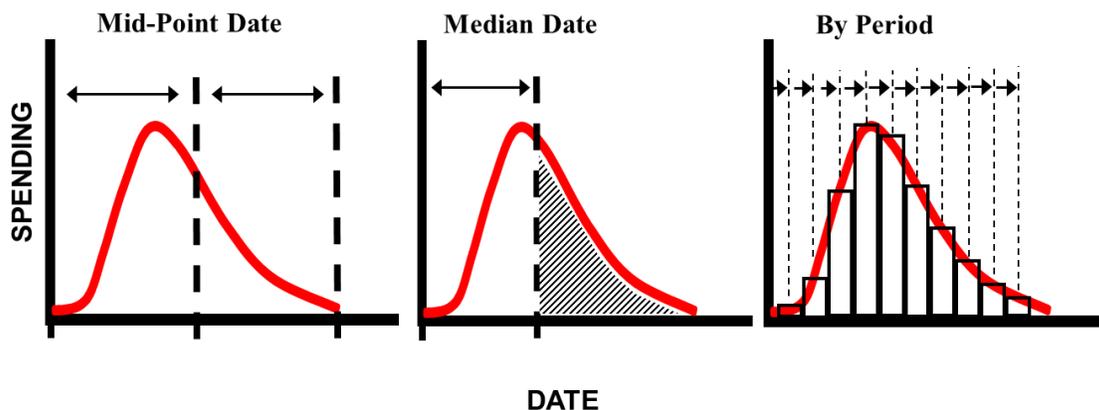


Figure 1—Three Methods of Addressing Cash Flow

Because the By Period method best addresses asymmetric spending patterns as well as variable index trends, it is the recommended method for all classes of estimates. Index forecasts are usually available by period in all cases, and for early estimates, cash flow by period can be reasonably estimated using historical patterns and/or judgment. Cumulative historical spending patterns tend to follow patterns called S-curves in industry. Cash flow and S-curve generation is not covered by this RP, but for those that wish to develop cash flow estimation tools, there are published sources that describe the general form of these cash flow patterns<sup>[3]</sup>.

Regardless of the method used for addressing costs over time, the accuracy of the schedule used is a key driver of the accuracy of the escalation estimate.

May 25, 2011

### Addressing Cost Account Detail

The basic escalation CER and cash flow treatments can be applied to any level of detail of cost breakdown from overall cost, to very detailed cost accounts. However, neither a single account value nor an extremely detailed account breakdown is recommended for a project. The former fails to address differential price changes between cost accounts, and the latter complicates the method without adding value in improved accuracy. Users should establish accounts that meet the following principles:

- Use accounts/indices that address differential price trends between accounts.
- Use accounts/indices that address levels of detail for various estimate classes.

At the highest level, material, office and field labor cost accounts typically have different price trends and need to be segregated. Further breakdowns of material are usually warranted; e.g., equipment (generally by major types), steel, concrete, piping, etc. For process plants, this level of detail roughly corresponds to the AACE RP on project code of accounts<sup>[6]</sup> or the level 2 accounts of the process equipment divisions of the CSI Masterformat<sup>[7]</sup>. For buildings and infrastructure work, this corresponds roughly to the Masterformat division accounts excluding the process equipment subgroup. Where item cost is sensitive to metallurgy or other raw material composition, segregating items by major commodity type is typically advisable (e.g., carbon vs stainless piping). These cost accounts tend to align well with commodity price indices (e.g., the BLS has many steel price indices). Generally, adding accounts beyond a summary level has a diminishing return in estimating accuracy. If a company has a robust estimating process, they will be able to segregate accounts such as steel from concrete even for a Class 5 estimate (i.e., based on typical factors, etc.).

For capital projects, breakdowns by work breakdown (e.g., area/unit/system, CSI Uniformat, etc.) can be used. However, because the cost broken down this way will not align as well with price indices, this will require more index weighting as described in the following section.

Capital project estimates tend to be largely unambiguous in their cost item content. For operating and maintenance or product pricing, cost breakdowns may include more indirect or “allocated” cost items that can be somewhat ambiguous in nature. The principles of this RP still apply to these items; however the task is made more challenging by account content ambiguity.

### Matching Indices to Cost Accounts (Weighting Indices)

It is a challenge to determine the best way to apply disaggregated indices to aggregated or overall project, product or service costs for which no single reliable aggregated forecast index is available. The historical and forecast indices available are usually in a disaggregated format. In other words, there are separate indices for each of the major resources that go into or make up a project’s cost structure. For example, the BLS provides indices for wages of various classes of workers (ECI), producer prices for steel and other commodities (PPIs), and so on

The estimator must create weighted composite indices to apply to an estimate category based on the composition of the estimate category relative to the items represented by the indices. This is not always a straight-forward task. For example, a typical process plant has significant pipe material costs. Most of the piping material cost, as estimated, is for pipe spools from a fabricator. The spool price includes the cost for pipe, fittings and shop labor costs. The available disaggregated indices do not cover spool prices; therefore, the estimator must create an aggregate or “proxy” index for shop-fabricated pipe that includes a weighted mix of pipe costs, fitting costs and shop labor as shown in the following example:

May 25, 2011

Cost Item	% of Piping Account	Item Indices	Weighted Indices
Pipe	40%	1.25	0.5
Fittings	20%	1.20	0.24
Shop Labor	40%	1.15	0.46
Total	100%		1.20

The economists can provide forecasts for hundreds of wage, price and other indices (typically aligned with government historical series). As the estimator builds up weighted indices or otherwise lines up cost categories with indices, there is a risk of going overboard with detail that can greatly complicate the effort without adding much accuracy. For example, there may be wage indices available for many different crafts, but in general, the wages for all crafts follow the same relative trend over time (although absolute costs will differ). Using one of these wage indices as a proxy measure for all crafts may be appropriate. For weighted indices (e.g., fabricated pipe) some costs can be ignored in the weighting if they are less than about 5 or 10 percent of the total costs and are not extremely volatile costs (e.g., primer paint on pipe spools).

Typically, no more than about 15 to 30 wage, commodity, and other detailed price indices (used in different combination of weighted indices) are necessary to effectively estimate process plant capital cost escalation (depending on plant scope and regions covered). The range of indices for operating and maintenance or product costs may be wider depending on their scope. However, the following criteria will help the user select and develop price indices for use in escalation estimating: Indices should:

- Use or be based on industry or government sources that are generally recognized as reliable and are readily available.
- Be generally applicable to the subject industry in the primary regions where a company performs or will perform capital projects, maintenance and operations or manufacturing.
- Be specific to the major cost types found on all the company's projects or products.
- Be easy to update, modify and maintain as an ongoing reference source.

### Adjusted or Composite Indices

A challenge to using indices is dealing with the fact that they do not track micro-economic trends, markups, and so on. For example, the process plant engineering, procurement and construction (EPC) industry is a micro-economy where labor prices often increase much more than the engineering and construction wages that the government agencies and economists track. Again, this is because contractor's prices include markups, premiums, productivity factors, and so on. No commercial source tracks and forecasts EPC *bid* prices explicitly in a way that is amenable to direct use in escalation estimating. While in the long run, underlying cost trends such as wages tend to dominate, market strength or weakness can be the dominant driver of price trends in the time period that covers a typical project life cycle (e.g., 3-5 years or more; for example the 2004-2008 EPC capital project market boom or subsequent decline).

In this situation, estimators and other team members (e.g., procurement lead) must add their knowledge of the EPC industry to the economist's knowledge of macroeconomic trends and adjust the available indices with additional factors that reflect the relative micro-economic market conditions. One method is to start with a base index that is independent of micro-market trends (e.g., an ECI from the BLS), and then use an index of capital spending (a proxy of market conditions) in the micro-market to modify the base index<sup>[8,9]</sup>. This approach is based on two rational hypotheses: 1) a given market's pricing will be correlated to the extent that demand is more or less than the supply in that market, and 2) supply will be more or less inelastic in the short term (period of interest to projects) for items that require significant investment of time and/or resources to create (e.g., skilled labor, major equipment, etc). Fortunately, economists do track and forecast capital spending in many markets.

May 25, 2011

The fact that capital expenditure and price trends are correlated is not a question; the main uncertainty to address is the extent that capital expenditure trends affect price trends for a given item on a given project in a given region and market segment (e.g., small versus large projects). Also, cost- and price-level changes will tend to lag changes in the economy somewhat.

The general form of the index adjustment can be expressed as follows:

$$\text{Adjusted price index} = (\Delta \text{ in price index}) \cdot f(\Delta \text{ in capital expenditure})$$

A simple capital expenditure function or adjustment used successfully by one source based on calibration with empirical data<sup>[8]</sup> is to take the change in capital expenditure indices to an exponential power. Experience has shown that an exponent of 0.5 tends to reflect the escalation cost impact for a market where there is significant supply/demand imbalance (scaling down to 0 where there was no market imbalance).

As a simple conceptual example, consider the prior unadjusted example given of an item costing \$100 in the base year (index = 1.00) and a forecast index of 1.15 for the year of payment. The unadjusted escalation cost is as follows:

$$= \$100 \cdot [1.15/1.00 - 1] = \$100 \cdot 0.15 = \$15$$

If the capital expenditure spending level index was 1.00 in the base year, and 1.25 for the year of the payment, and the exponent was 0.5, the adjusted escalation cost is as follows

$$\begin{aligned} &= \$100 \cdot [1.15/1.00 \cdot (1.25/1.00)^{0.5} - 1] \\ &= \$100 \cdot [1.15 \cdot 1.12 - 1] \\ &= \$100 \cdot [1.29 - 1] \\ &= \$29 \end{aligned}$$

The exponent value was originally determined or calibrated using the same equation substituting known historical cost information and base indices and solving for the exponent. If the base index was inappropriate to start with, the resulting exponent may be inappropriate; one should examine historical data from stable capex periods to determine if the base index is tracking actual cost trends.

Using an objective method that is easily updatable such as this is preferable to more anecdotal manual adjustments because it addresses the following principles previously stated:

- Ensure that indices address the specific market situation
- It can be calibrated or validated with historical data
- Apply in a consistent approach using a tool that facilitates best practice

### Using Price Indices to Normalize Historical Project Costs

Just as forecast price indices can be used to estimate future escalation, historical price indices can be used to normalize past project estimated or actual cost to a current year basis. For example, if the cost for an item is \$A in 1995 (i.e., the estimate base year or the time of commitment), then the cost in 2007 is: \$A x (2007 index/1995 index). As with escalation estimating, normalizing historical costs for time impacts (adjusting costs to a common time basis) has become a critical task because most owners base their feasibility and conceptual estimates to some extent on past project estimates or the costs of completed projects. Without normalization, the value of historical cost databases is greatly diminished. Just as with future escalation, the indices used should be adjusted to address market conditions (i.e., all the complicating factors in this RP apply to both historical normalization and to forecasting the future). Volatile periods such as the capital expenditure boom of 2004-2008 and following decline

May 25, 2011

have made robust, disciplined practices for normalization absolutely mandatory for historical knowledge base management.

### Escalation on Contingency

Contingency, by AACE's definition, is a cost expected to be spent. Therefore, it is logical to apply escalation to contingency like any other estimated cost account. Because it is highly uncertain as to what contingency will be spent on, the weighted index for contingency will typically reflect the weighting of cost accounts for the project as a whole, possibly weighted more for accounts that tend to consume the most contingency (i.e., labor). A forecast of contingency drawdown (i.e., the cash flow for contingency) will be needed to estimate the escalation on it.

### Escalation Uncertainty and Probabilistic Methods

Estimators must keep in mind that escalation costs are uncertain. Each element of the escalation estimate is uncertain including:

- Base cost values
- The timing of spending
- Index and adjustment factor values

As with contingency estimates, it is the estimator's responsibility to quantify the uncertainty of the escalation estimate, usually by providing a distribution or range (e.g., 80% confidence or P10/P90 range), so that management can make effective investment and project decisions and fund the escalation account as they see fit in accordance with their decision and risk management policies.

One method of obtaining a range is to apply Monte-Carlo simulation to the estimate model. In this approach, the uncertain index, factors and timing inputs are substituted with distributions. The base cost uncertainty is addressed by contingency which will be escalated. Schedule uncertainty (timing) has a major impact on escalation. The model is then run to obtain an escalation cost outcome distribution from which management can select a value based on their desired confidence of underrun (usually 50%). Such a Monte-Carlo model can be quite complex for several reasons. One is that the timing of spending needs to be quantified in a model (i.e., a logistic function) that is amenable to Monte-Carlo manipulation and reflects the schedule uncertainty resulting from contingency evaluations (e.g., replace a key form factor in the logistic function with a distribution)<sup>1</sup>. Linking the method to a cost-loaded schedule risk tool to deal with probabilistic timing is not simple because escalation cash flow must reflect the spending by the supplier and not as incurred or expended by the party doing the estimate. Also, escalation cost items may not be aligned with the schedule activities. Another complication is that a price index in one period will have some dependence on the index in the prior period. For example, if costs skyrocket this year, they are less likely to do so the following year (i.e., in the long run price trends do regress to the mean).

Given the complexity of Monte-Carlo modeling, another approach is to perform scenario analysis. In this practice, the economists will provide a range of indices that reflect worst, most likely and best economic scenarios (i.e., they may correspond to a P10/P50/P90 level of confidence or to various market conditions). The estimator can add to these scenarios, the effect of early and late spending timing scenarios to obtain a good idea of the overall escalation cost range.

If the above methods are not practical, simply quoting a range based on the team, estimator's and economist's judgment or empirical experience (e.g., worst is +100% on escalation, best is -50%) will add useful information for

<sup>1</sup> In terms of timing, one risk is that the project completion date will slip which can greatly increase base cost as well as escalation cost; teams need to be clear on whether the cost risk of slip is included in contingency or escalation.

---

May 25, 2011

management consideration so long as the basis of this judgment is well documented in the basis of estimate document.

The discussion above is only intended to introduce general potential approaches of dealing with uncertainty. Specific practices will be covered in other AACE RPs

### **“Black Swan” Theory**

A problem to be aware of with any practice that relies on forecasting the state and direction of the economy is that economists are unable to forecast dramatic turns or events in the economy (e.g., 9/11, the Great Recession, etc.). Unfortunately, these events occur often enough that many large projects are likely to experience one or more during their duration. Taleb calls these events “black swans”<sup>[4]</sup>.

Just as contingency estimating excludes scope change and low probability/high impact events such as hurricanes or earthquakes, the escalation estimating methods in this RP exclude “black swans.” Unfortunately, some will argue that disciplined escalation estimating practices and getting input from economists are not worth the effort because of the inability to forecast (and exclusion of) market turns. Professionals will need to be prepared to counter these arguments. In any case, before sanctioning any project, companies must consider the potential impact and consequences of these “black swans” in their business decision making. Scenario analysis is generally best for this purpose. Economists often do foresee the possibility of market turns and will express this as say 10 percent probability of scenario X. If one’s method only considers the “consensus” view, this risk will be missed.

### **Lag and “Sticky Prices”**

Another uncertainty in escalation estimating, particularly as it regards consideration of market swings, is that suppliers do not immediately change their bidding and pricing levels or strategies in lock-step with underlying trends in commodity, wages and other costs to them. For example, if orders increase, they may hold off on increasing their profit markup for a month or two until they feel they have a solid backlog in place and they see that the trends are real. With increasing costs, suppliers will generally not lag the market too long. However, when costs decrease, suppliers may hold off in passing the savings on for some time as they attempt to capitalize on their improved profits as long as possible (i.e., prices are “sticky on the downside”). An estimating methodology that adjusts indices for market demand will need to consider this lag effect. In the previous example of adjusting indices for capital spending, the lag can be modeled by using a floating average for the future capital spending index [i.e., (index for future time period + index for previous time period)/2]

### *Exchange Rate Interaction*

This RP recommends segregating escalation and exchange rate impacts for projects with resources priced in currencies other than the “base” currency. In part, this is because finance departments are usually responsible for managing exchange rate impacts and they need focused information (and may mitigate this if it is an adverse cost risk). However, perfectly clean segregation is not possible because both escalation and exchange rates are driven by economic conditions. Price trends have an inflation component that is affected by the value of currency and finally, price indices are often not available for each source region.

The optimal approach using segregation is to estimate escalation on an item using a price index that reflects the price trend for that item in the location where it is sourced. For example, if a base estimate was reported for a Canadian project in Canadian dollars at current exchange, but an item was to be bought from the US using US

May 25, 2011

dollars, use a US-based price index for that item. Then, estimate the \$US/\$CAN exchange rate impact separately. A simple illustration of this example is as follows:

Given:

- Price index from US reference source today is 1.10 and 1.32 at planned purchase date
- Exchange rate is 0.85 \$US per \$CAN today and 1.02 at planned purchase date

Then:

- Escalation: (\$100 price in \$CAN)  $\times (1.32/1.10-1) = \$100 \times 0.20 = 20 \$CAN$
- Exchange: (\$100 price in \$CAN)  $\times (0.85/1.02-1) = \$100 \times -0.17 = -\$17CAN$

In this example, the strengthening Canadian dollar relative to the US dollar is advantageous to the project and largely negates the US price escalation.

This would be more difficult if there was no price index readily available for this item in US dollars. For example, a Canadian PPI source may show the indices as 1.10 today and 1.15 at the planned purchase date. However, if Canadian producers buy many of their parts in the US, this more stable Canadian PPI may be reflecting the strengthening Canadian currency. Estimators simply have to use the best knowledge at their disposal of sourcing and markets to attempt a segregation of impacts in this case (adds another uncertainty to probabilistic models). AACE RPs on dealing with exchange rates in estimates and probabilistic approaches will further clarify.

### Accuracy

Estimators are cautioned not to expect too much accuracy from cost indexes and escalation estimates. The indices are approximations intended to represent the average trends for a large group of projects in a broad region. The indices are generic and conceptual in nature and judgment must be applied in using them in any given situation. In and of themselves, escalation estimates should be considered Class 5 estimates per AACE's classifications<sup>[2]</sup> regardless of the class of the base estimate.

### Customer and Business Practice Alignments

Another challenge in escalation estimating is that the customer of the estimate will often have their own economic and/or escalation forecasts or preconceptions. Often these forecasts are little more than rules of thumb (e.g., 3-4 percent increase per year or use of CPI is common). In other cases, the business is basing its revenue and expense projections on certain economic assumptions that they do not share with the estimator. The estimator will need to discover and understand this business case scenario and communicate it to the economists so that their forecasts can be based on this economic assumption; i.e. the capital cost estimate basis must be consistent with the business' rate of return analysis. Differences in assumptions between the business and the economists need to be rationalized.

Similarly, if a life cycle or product cost or price evaluation includes inputs from multiple estimators (e.g., from capital, operating and maintenance groups), these estimators must make sure their methods and economic assumptions are appropriately aligned and follow common principles.

The responsibility for escalation estimate preparation may vary (estimators, economists in the business group, various departments, etc.). There is no clear recommended practice for responsibility other than to assure that responsibilities are assigned, all the best practice principles are covered and all estimates are aligned.

Alignment is also an issue if you are a vendor or contractor and you want (or your customer expects) your prices to be escalated by an indexed method defined in a contract. While this RP does not address contracting methods,

May 25, 2011

price adjustment clauses are generally recommended by FIDIC for major civil and building projects lasting longer than one year based on the assumption that owners are better able to bear the risk<sup>[12]</sup>. There are other examples, but this is a topic for contracting and risk allocation RPs. However, if the customer advocates using a CPI, bare unadjusted indices or some other method not recommended here, caution is advised that the intended risk allocation may not be achieved.

### SUMMARY: THE ESCALATION ESTIMATING PROCESS

The principles of escalation estimating outlined above are fairly straightforward. However, putting them into practice can be a significant effort. Certainly, no one wants to or has the time to build unique indices for each estimate; the only efficient estimating method is to build a tool to automate the process. The steps for an escalation estimating process to build in a tool include the following:

- Review industry literature on escalation estimating<sup>[8,9,10]</sup>
- Get buy-in on the approach from the stakeholders (based on principles)
- Decide on the cost account breakout to use for escalation estimates (preferably based on a standard cost code of accounts—keep it simple)
- Obtain the services of economists that can provide or consult on the historical and forecast indices and scenarios you need
- Obtain the up-to-date indices from the economist and develop weighted indices for each of your tool's input cost accounts
- Make adjustments to the weighted indices as needed, particularly for capital demand trends and diverging price trends
- Determine the estimated project cash flow by cost account
- Apply the indices appropriately to the cash flow for each cost account.
- Decide how to handle escalation on contingency
- Decide on how to apply a probabilistic approach
- The method and key inputs used to estimate escalation should be documented in the basis of estimate documentation.

It is expected that future RPs will cover industry, asset and cost type specific applications of the principles and general process in this RP.

### REFERENCES

1. AACE International, Recommended Practice 17R-97, *Cost Estimate Classification System*, AACE International, Morgantown, WV, (latest revision).
2. AACE International, Recommended Practice 10S-90, *Cost Engineering Terminology*, AACE International, Morgantown, WV, (latest revision).
3. AACE International, Recommended Practice 40R-08, *Contingency Estimating: General Principles*, AACE International, Morgantown, WV, (latest revision).
4. Taleb, Nassim Nicholas, *The Black Swan; The Impact of the Highly Improbable*, Random House, New York NY, 2007.
5. Cioffi, Denis F., *A tool for managing projects: an analytic parameterization of the S-curve*, *International Journal of Project Management*, Volume 23, Issue 3, April 2005.
6. AACE International, Recommended Practice 21R-98, *Project Code of Accounts: As Applied in Engineering, Procurement, and Construction for the Process Industries*, AACE International, Morgantown, WV, (latest revision).
7. Construction Specifications Institute, *Masterformat 2004* (or latest revision at [www.csi.net](http://www.csi.net))

May 25, 2011

8. Hollmann, John K, and Larry Dysert, *Escalation Estimation: Working With Economics Consultants*, AACE International Transactions, 2007
9. Hollmann, John K, and Larry Dysert, *Escalation Estimating: Lessons Learned in Addressing Market Demand*, AACE International Transactions, 2008
10. Stukhart, George, "Estimating the Cost of Escalation" - Chapter 9, *The Engineer's Cost Handbook* (Richard Westney, editor), Marcel Dekker, NY, 1997
11. Bunni, Nael G. "The FIDIC Form of Contract: The Fourth Edition of The Red Book". MPG Books Ltd, UK, 2004

#### Other Industry Practices

- US Department of Energy, G 430.1-1 *Cost Estimating Guide, Chapter 10 "Escalation."*, 03/28/1997. [Note: this revision of the reference is typical of industry references which tend to apply simple mid-point or mean index approaches without objective adjustment for market conditions (i.e., not recommended in this RP but provided here for completeness.)]
- US General Accounting Office, GAO-09-3SP, "GAO Cost Estimating and Assessment Guide, Best Practices for Developing and Managing Capital Program Costs, March 2009 [Note: this reference is typical of industry references which tend to apply simple unadjusted indices without objective adjustment for market conditions. Also uses the terms inflation and escalation interchangeably (i.e., not recommended in this RP but provided here for completeness.)]

#### CONTRIBUTORS

*Disclaimer: The content provided by the contributors to this recommended practice is their own and does not necessarily reflect that of their employers, unless otherwise stated.*

John K. Hollmann, PE CCE CEP (Primary Contributor)

Mohamed H. Abdel-Mageed, CCE

Michael S. Anderson

Luis Alejandro Camero Arleo, CCE

Rene Berghuijs

Rani Chacko, CCE

Dr. Ovidiu Cretu, PE

Dr. Utpal Dutta, PE

Fabio Leonardo da Silva Fernandes

Carlton W. Karlik, PE CEP

Rod Knoll

Pankaja P. Kumar, CCE

Rose Mary Lewis, PE

Michael Shawn Longfellow

Bruce A. Martin

Joseph L. N. Martin

John Charles Mulholland

Rajasekaran Murugesan, CCE

Chris A. Remme, CCC PSP

Steven H. Rossi, PE CCE

Ruben A. Sanchez, CCE

Amit Sarkar

Örn Steinar Sigurðsson

W. James Simons, PSP

Terence M. Stackpole

---

May 25, 2011

Peter W. van der Schans, CCE

Mai Tawfeq

Dr. Ali Touran, PE

Robert F. Wells, CEP

Dr. Trefor P. Williams

David C. Wolfson

Rashad Z. Zein, PSP