Exhibit No.:
Issue: Iatan Prudence
Witness: Daniel F. Meyer
Type of Exhibit: Direct Testimony
Sponsoring Party: Kansas City Power & Light Company
Case No.: ER-2010-____
Date Testimony Prepared: June 4, 2010

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO.: ER-2010-____

DIRECT TESTIMONY

OF

DANIEL F. MEYER

ON BEHALF OF

KANSAS CITY POWER & LIGHT COMPANY

Kansas City, Missouri
June 2010

"[redacted]**" Designates "Highly Confidential" Information Has Been Removed.**
Certain Schedules Attached To This Testimony Designated "(HC)" Have Been Removed Pursuant To 4 CSR 240-2.135.

DIRECT TESTIMONY

OF

DANIEL F. MEYER

Case No. ER-2010-____

Q: Please state your name and address.

A: My name is Daniel F. Meyer. My address is 30 Sequoia, Lake Forest, Illinois.

Q: And by whom are you employed?

A: I am employed by Meyer Construction Consulting, Inc. My services have been retained by Schiff Hardin LLP ("Schiff"), who provides legal, project management and oversight services to Kansas City Power & Light Company ("KCP&L").

Q: How long have you worked with Schiff?

A: Since the early 1990s.

Q: What type of work have you done with Schiff since the early 1990s?

A: Primarily cost analysis work, and project oversight. I have also provided some scheduling work and litigation support. All of my work with Schiff has been in the construction industry, primarily in the power industry.

Q: Can you briefly describe your background in the construction industry?

A: I started working in the industry at the age of 15 as a laborer and a timekeeper. I received a Bachelor of Science in Civil Engineering from Ohio University in 1968. Immediately after college, I started to work for Morrison-Knudsen Company, where I was employed from 1968 through 1983. In 1979, while at Morrison-Knudsen, I attended the Program for Management Development at the Harvard Business School. At Morrison-Knudsen I held various positions, including working as a shift engineer up through and including

Vice President of Operations for the Heavy Construction Group. From 1983 to 1985, I was employed by Perini Corporation and served as Vice President of Operations. Between 1985 and 1990, I worked for Paschen Contractors as General Vice President. Beginning in 1990 through the present, I have had my own consulting business, Meyer Construction Consulting, Inc. Since 1990, I have sat on approximately 75 dispute review boards, where my role is to evaluate contractor claims and to allocate costs between adverse parties primarily on large, complex construction projects. I also provide cost and schedule consulting in the construction and power industries as well as due diligence with respect to mergers and acquisitions in the construction industry. I am also currently on the board of directors of a national real estate developer.

Q: Have you previously testified in a proceeding at the Missouri Public Service Commission or before any other utility regulatory agency?

A: Yes. I have previously filed testimony in KCP&L's last rate case, Case No. ER-2009-0089 ("0089 Docket"). I have also filed testimony before the Kansas Corporation Commission in Docket Nos. 09-KCPE-246-RTS and 10-KCPE-415-RTS.

Q: What is the purpose of your testimony?

A: The purpose of my testimony is to provide commentary on industry best practices applicable to: (1) the development of KCP&L's Control Budget related to the construction of Unit 2 at the Iatan Generating Station ("Iatan Unit 2" or the "Project"); (2) the process used for establishing and characterizing the result of the development of the Control Budget Estimate ("CBE") for Iatan Unit 2 in December 2006 and the subsequent cost reforecasts associated with the CBE by KCP&L during the Project; (3) KCP&L's external reporting and project controls systems and their effect on Project

costs; and (4) the Balance of Plant contracting methodology employed on the Iatan Project. I also discuss Kiewit's original estimate for the Balance of Plant work.

APPLICABLE INDUSTRY BEST PRACTICES

Q: Are there standards in the construction industry regarding accepted classifications for various types of cost estimates for construction projects?

A: There are several ways to classify an estimate. The actual terms themselves can vary from project to project, but there is an accepted progression of the level of accuracy of a cost estimate as a project's scope becomes better defined. The Association for the Advancement of Cost Engineers, also known as AACE International ("AACE"), which is an organization that acts as a clearinghouse for information related to cost issues in the construction industry, has developed a classification system that is widely referenced. This classification system is described in AACE International Recommended Practice No. 10S-90, Cost Engineering Terminology (April 13, 2004) ("AACE Cost Terminology," Schedule DFM2010-1); AACE International Recommended Practice No. 17R-97, Cost Estimate Classification System by Peter Christensen and Larry R. Dysert et al (August 12, 1997) ("AACE Classification System," Schedule DFM2010-2), and AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries by Peter Christensen and Larry R. Dysert et al. (February 2, 2005) d ("AACE EPC Cost Classification," Schedule DFM2010-3).

AACE's Classification System is based upon the level of project definition. As defined by the AACE, "The level 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, lessons learned from past projects, reconnaissance data, and other information that must be developed to (fully) define the project." (AACE Classification System, Schedule DFM2010-2 at p. 3 and AACE Cost Terminology, Schedule DFM2010-1 at p. 17). AACE's Classification System comprises five different "classes" of estimates (Class 1 through Class 5). (AACE Cost Terminology, Schedule DFM2010-1 at pp. 16-18 and generally AACE Classification System, Schedule DFM2010-2). A Class 1 estimate is based upon a fully-developed project definition, while at the other end of the spectrum, a Class 5 estimate is often developed quickly and based on very preliminary and limited information. As a result, an estimate that fits the definition of a Class 5 estimate is not generally regarded within the industry as being very accurate.

Although AACE's Classification System defined above describes the development cycle of a cost estimate for a project from a conceptual stage to a very detailed stage, it is commonplace and acceptable for an estimate to mature based on available information and other project particulars. For an owner, the two most important milestones to consider in the development cycle of a project occur at the conceptual phase and then at the budgetary phase. A cost estimate during the conceptual phase allows corporate management to evaluate the overall feasibility of the project and to begin to evaluate how to strategically allocate resources. Under the AACE's Classification System, this estimate could typically either be a Class 5 or a Class 4 estimate. Conceptual phase estimates are not expected to be highly accurate; rather, they are regarded as merely providing a cost order of magnitude for a project.

The second important milestone to occur in the estimating process is the

achievement of a sufficient level of accuracy to set the budget for the project. This can occur when the available information for the project allows the estimate to meet the definition of Class 3. A Class 3 estimate is typically used to monitor variations to the budget until it is replaced by more detailed estimates, although it is not uncommon for an owner to stop an estimate's developmental progression at a Class 3 estimate level. My interpretation of the accuracy band described in AACE's Classification System around a Class 3 estimate is -15% to +30%.

Q: Did KCP&L follow the AACE Classification System's estimate progression in developing the Iatan Unit 2 Project's estimate?

A: Yes. KCP&L did not formally identify each stage of the estimating process as a certain "class" of estimate based on AACE's definitions, but once the Stipulation was in place for the project to proceed, KCP&L nevertheless followed the typical and expected progression of cost estimate development for the Iatan Unit 2 Project as AACE describes it and as is generally applied throughout the industry.

Q: Are there any other industry standards that you believe KCP&L followed with respect to controlling and monitoring costs during the course of the Project?

A: Yes. KCP&L followed good and accepted industry practice by monitoring costs during the course of the Project and reforecasting the CBE at appropriate points.

Q: What authority supports the practice of reforecasting a project's estimate?

A: In supporting this opinion, I offer an article by John Rowe entitled "Construction Cost Contingency Tracking System." In this article, Mr. Rowe touches on the general subject matter of cost reforecasting and contingency drawdown. (Schedule DFM2010-4) Additionally, based upon my experience, it is a widespread industry practice to

periodically reforecast project cost, and those who do so are generally regarded as prudent. From a cost management perspective, it is good practice to examine and update estimates and reforecast costs. In its simplest sense, a cost reforecast is an exercise that parties in the industry go through at logical points in a project to revisit the budget and the efficacy of the budget amounts.

Q: How does an owner benefit from reforecasting a project's budget?

A: Owners benefit from being able to accurately evaluate whether a project's original assumptions have held true, and whether the assumptions in the original cost estimates continue to hold true. Determining the above can identify whether the project is properly funded, how the project is being managed, whether the contractors are performing, and whether there are any issues that affect cost that require some added focus.

DEVELOPMENT OF THE IATAN UNIT 2 CONTROL BUDGET

Q: What was Schiff's role with respect to the development of the CBE?

A: KCP&L's senior management requested that Schiff provide oversight of the process used to create the CBE and provide our independent view of the quality of the CBE. From the first week in January 2006 through late-April 2006, I, along with others from Schiff, met with Burns & McDonnell's chief estimator and others who were participating in the design at various intervals to review certain aspects of the cost estimate. Schiff was attempting to vet the underlying assumptions and basis for Burns & McDonnell's cost estimate. The purpose of this process was for Burns & McDonnell to present to KCP&L's senior management an estimate that could be used for budgetary purposes.

Q: What was the status of the Iatan Project's estimate at the start of this vetting process?

A: Burns & McDonnell was working to develop what was referred to as an "indicative estimate" for the Iatan Project. At that time, the basis for Burns & McDonnell's indicative estimate was the high-level estimate it prepared as a part of the Project Definition Report ("PDR") in August of 2004. Company witness Brent Davis testifies regarding the nature of the estimate in the PDR. It was evident that the PDR was out of date, meaning that the scope identified in the general outline of the proposed plant had changed since the creation of the PDR. We needed to understand Burns & McDonnell's cost estimating group's assumptions that were embedded in the PDR to so as to relate them to certain changes in the Project scope definition that had arisen during the intervening time.

Q: What is an "indicative estimate"?

A: An "indicative estimate," as this term was used by KCP&L, was intended to be a very rough cost projection used for budget and planning purposes when a project is in the early stages of concept development. In essence, it is an order-of-magnitude estimate that has accuracy in the range of -30% to +50%. Within the industry, developing an indicative estimate is a common and necessary first step in the development of a reliable control estimate.

Q: How would AACE classify such an indicative estimate?

A: This indicative estimate was a Class 4 estimate under AACE's Classification System. As stated by the AACE, "Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges." (AACE Cost

Terminology, Schedule DFM2010-1 at p. 17 and AACE EPC Cost Classification, Schedule DFM2010-3 at p. 4). Acceptable uses for a Class 4 estimate include determining the feasibility of the project, aiding in an evaluation of the project's concept, strategic planning, and in obtaining preliminary budget approval.

Q: Is an indicative estimate an appropriate level of cost estimate for the Iatan Project as of the first half of 2006?

A: Yes. At that time, the Iatan Project was continuing to evolve. Engineering was in its beginning stages, so it was expected that the Project's estimate would have a wide band of accuracy. As I previously stated, I believe the accuracy level of an indicative estimate is somewhere between -30% to +50%.

Q: When did Burns & McDonnell present the indicative estimate for Iatan Unit 2 to KCP&L?

A: The indicative estimate was presented to KCP&L's senior management in phases. On February 15, 2006, Burns & McDonnell made a presentation regarding its progress in developing the estimate for Iatan Unit 2. In this presentation, Burns & McDonnell identified at a high level the changes that it had made to the estimate since the completion of the PDR estimate in September 2004. These changes included: increase of the Iatan Unit 2's size from 800 MW to 850 MW; change in the Project's Provisional Acceptance Date by one year; inflation and escalation; and an increase in steam temperature from 1050°F to 1080°F. **[redacted]

[redacted]**

Q: Did the cost estimate for Iatan Unit 2 change between the PDR and the February 2006 presentation?

A: Yes. The PDR cost estimate was **[redacted]** and in February 2006, the estimate was **[redacted]** Therefore, the estimate had increased by **[redacted]**

Q: Did either Burns & McDonnell or KCP&L change the percentage of contingency as a result of these updates?

A: No. **[redacted]**

Q: How would you characterize the accuracy of the February 2006 estimate?

A: It was, at best, an indicative estimate with an accuracy level of between -30% to +50%, which means this estimate actually represents a possible range of construction costs for the Iatan Unit 2 Project between **[redacted]** under AACE's Classification System.

Q: What was the next evolution of the Iatan cost estimate?

A: In April 2006, Burns & McDonnell again updated the cost estimate to include, among other things, a report it had received from its labor consultant, Schumacher Consulting LLC, regarding the current labor market. (Schedule DFM2010-5).

Q: What is Schumacher Consulting, LLC ("Schumacher")?

A: Schumacher is a consulting firm that specializes in analysis of various aspects of construction labor. It was hired as a sub-consultant to Burns & McDonnell in early 2006.

Q: What were the issues addressed in Schumacher's 2006 report?

A: Schumacher raised a number of issues. We found Schumacher's comments to be most valuable in a section addressing "best practices." In that section, Schumacher discussed the critical factors impacting labor, including: detailed planning, timely delivery of materials and equipment, minimization of engineering changes, timely delivery of engineering drawings, contractor control of site labor, and safety and quality. Schumacher stated that these "best practices" needed to be adhered to or the Iatan Project could develop significant problems with labor.

This report also had a section entitled "man-power" in which Schumacher stated that the ability to attract skilled labor to the Iatan Project would be governed by the number of shifts that were worked because that represents premium money to the trades. Schumacher recommended working "five-tens," or fifty-hour weeks, for the entire Project site, which would entail an appreciable amount of cost. Schumacher also recommended paying various subsidies in order to attract labor to the Iatan Project. Finally, it opined that labor productivity on the Iatan Project vis-à-vis other projects would not be as high and that it could be eight to ten percent below industry averages, which was already trending downward due to a lack of qualified craft.

Q: Did any of Schumacher's conclusions influence any portion of the CBE in late 2006?

A: Yes. As an example, Schumacher's report influenced the estimating of the potential impact of labor productivity issues, as well as subsidy cost, daily per diems, and other craft-related incentives. As I just stated, Schumacher's report identified industry-wide productivity issues during the four-year span of the Iatan Unit 2 Project. Schumacher recommended that the Project's estimate include a productivity handicap of 15% to 30%

for various trades. The CBE included these and other assumptions regarding labor productivity that were consistent with Schumacher's conclusions, as well as related concerns associated with the vetting performed by KCP&L and Schiff.

Q: Were other changes made to the estimate between January 2006 and April 2006?

A: Yes. When ALSTOM received an Interim Notice to Proceed on April 27, 2006, Burns & McDonnell began carrying in the estimate a price for the boiler and AQCS that was reflective of ALSTOM's bid. This actually reduced the estimate by nearly **[redacted]** In addition, Burns & McDonnell increased the estimates for balance of plant mechanical construction and structural/civil work by approximately **[redacted]** not including the aforementioned labor escalation handicap.

Q: Did the Project's overall estimate increase from January 2006 to April 2006?

A: Yes. **[redacted]**

Q: What was the next step in the progression of the Project's cost estimate?

A: During the third and fourth quarters of 2006, Burns & McDonnell continued to refine the Project's estimate. Included in this effort was additional analysis in the form of a "Probabilistic Cost Estimate," which was a statistical analysis performed by Burns & McDonnell to identify the probabilities of certain events. KCP&L engaged Burns & McDonnell to perform this analysis in order to help determine the likely overall Project cost and to develop contingency for the project. The results of this analysis were added to the cost estimate in October 2006. Additionally, the project team continued to work with Burns & McDonnell to vet underlying information that served as the basis of the

estimate.

Q: What happened between October 2006 and December 2006 with respect to the estimate?

A: The Project Team, Schiff and Burns & McDonnell, continued to vet the estimate. Additionally, in October, it was determined that the cost estimate for Unit 2 was missing a significant amount of structural steel quantities for the turbine generator building. In preparing the Iatan Unit 2 estimate, Burns & McDonnell utilized the Iatan Unit 1's as-built quantities for certain commodities and then numerically scaled-up those quantities on a numerical basis for use on Unit 2. Generally speaking, when Burns & McDonnell utilized a scale-up of the existing Unit 1 for Unit 2 on a commodity basis, the measure of that scale-up was 20% to 25% to accommodate the new unit's larger size. Once it was identified that elements of the balance of plant estimate were significantly understated, KCP&L told Burns & McDonnell to re-evaluate the entire Iatan Unit 2 cost estimate before presentation to the KCP&L Board of Directors for budgetary approval. Burns & McDonnell subsequently re-estimated all portions of the Project: (1) that had not been procured; (2) where the scope and cost of any particular work package was influenced by commodities and/or quantities that could be at variance with the current design concept; and (3) where there may have been scope variances between the estimate and the current design.

Q: How did you determine the maturity of the estimate as of December 2006?

A: Schiff looked at several things in the version of the estimate that existed as of December 2006. We looked at the pedigree and the provenance of the original Burns & McDonnell estimate and the various derivative estimates that its team had put together up to that

time. By this time, Burns & McDonnell adjusted certain aspects of the estimate's basis so as to be more reflective of the design work that was underway. We reviewed Burns & McDonnell's PCE analysis and determined which portions of that analysis were useful and relevant for modeling the Iatan Unit 2 Project's contingency. We also reviewed the status of quantities that were available based upon the design status as it existed at that point in time. The design for Iatan Unit 2 was approximately 20 to 25% complete at that time.

Q: Approximately how much of the Iatan Unit 2 Project was procured as of December 2006?

A: Company witness William Downey testifies that as of the fourth quarter of 2006, KCP&L had procured ** [redacted] ** in direct procurements for engineered materials and certain bulk commodities. A significant portion of the work on Iatan Unit 2 was captured in the ALSTOM contract for the boiler and AQCS.

Q: How did Unit 2's cost estimate change from October to December 2006.

A: The estimate increased from ** [redacted] ** The most significant cost increases to the Iatan Unit 2 estimate are described in detail in Burns & McDonnell's Supplement 2 to the PDR dated June 28, 2007. (Schedule BCD2010-8)

Q: What were the primary categories for the increases in the cost estimate from April 2006 to the CBE in December 2006?

A: ** [redacted]

[redacted]**

Q: Why was a portion of the contingency held as management reserve?

A: It is common practice in the industry for a company's senior management to establish a management reserve as part of a project's budget. Typically, the reserve comprises contingency but nevertheless requires senior management approval prior to use at the project level.

Q: Why did KCP&L increase the contingency on the Project?

A: Because it was prudent to do so based upon the known risks at that time. During 2006, KCP&L, with the help of Burns & McDonnell and Schiff, identified several risks that had the potential of increasing the overall cost of the Project. The largest risks included: (1) the management, coordination and execution of a very large and complex construction project, and KCP&L needed to significantly ramp-up its internal and external capabilities in order to manage such an undertaking; (2) the potential escalation of prices for commodities and critical components in an over-heated utility construction market; and (3) potential issues with labor productivity and availability due to the precipitous drop in the number of qualified craft workers since the 1980's. There were certainly other risks, but those were the primary cost drivers to the Iatan Units 1 and 2 Project from the outset, and they have remained primary considerations throughout the entire Project.

Q: When was the estimate presented to the Executive Oversight Committee ("EOC")?

A: The estimate was presented to the EOC in November 2006 as the CBE.

Q: What was the Iatan Unit 2 portion of that estimate?

A: Approximately ** [redacted] ** excluding AFUDC.

Q: How accurate was that estimate?

A: The additional vetting of the estimate that occurred between October and December 2006 allowed Schiff to conclude that the estimate was generally commensurate with an AACE "Class 3" estimate, meaning that the budget for Unit 2 could be established. As a Class 3 estimate, it had an accuracy level within the range of -15% to +30%, which would result in a range of ** [redacted] **

Q: Did KCP&L act within industry standards to set its budget in 2006 based upon an estimate with this level of accuracy?

A: Yes.

Q: What was Schiff's opinion of the process used by Burns & McDonnell to develop the estimate?

A: Based upon its meetings with Burns & McDonnell, Schiff believed that the methodology used in developing the estimate generally conformed to that typically seen in the construction industry. Also, as a part of the vetting process, Burns & McDonnell provided KCP&L the resumes of those personnel contributing to the development of the estimate. Burns & McDonnell's estimators appeared to be reasonably experienced and qualified to prepare the estimate.

THE 2008 COST REFORECAST

Q: Was it expected that the CBE would be revisited in the future?

A: Yes.

Q: In what manner did KCP&L anticipate revisiting the CBE?

A: As stated in The Comprehensive Energy Plan Construction Projects' Cost Control System ("Cost Control System") attached to the direct testimony of Company witness Steven Jones as Schedule SJ2010-1, KCP&L committed to continually monitoring the accumulation of actual costs compared to Control Budget amounts to determine if the initial assumptions in the Project definition were still valid. Based upon this analysis, the KCP&L Project Team would then prepare a new forecasted estimate at completion ("EAC").

Q: How often has KCP&L reforecasted the Iatan Unit 2 Project's Budget?

A: As of this time, KCP&L has completed three separate reforecasts of the CBE in the manner described above. Those cost reforecasts are generally referenced as the May 2008, July 2009 and April 2010 forecasts.

Q: Who performed these various reforecasts?

A: The Iatan Unit 2 Project team performed the work associated with developing the reforecasted EAC. Schiff provided oversight of the process used by the project team and issued its independent view of the EAC on each occasion.

Q: At what point did KCP&L first revisit the CBE?

A: By the second quarter of 2007, it had become clear to the Project Team that the Iatan Unit 2 estimate required reforecasting. The Project brought this issue to the attention of the EOC through some various "Risk and Opportunity" ("R&O") analyses that they had

conducted by that time. The Project Team presented this analysis to the EOC on July 11, 2007. (Schedule DFM2010-6)

Q: What were the Risk and Opportunity analyses that the Project Team generated in 2007 and 2008?

A: During the years of 2007 to 2008 as the Iatan Unit 2 Project was maturing, the Project Team members would identify through R&O analyses areas of risk to the Project that could potentially result in a draw down on the Project's contingency. The Project Team would also look for areas of opportunities that might result in cost under-runs. These risks and opportunities were tracked by the KCP&L Project Controls Group.

Q: Who typically prepared the documents upon which the R&O's were based?

A: The majority of the R&O's were developed by KCP&L's lead engineers, though others on the Project Team also developed R&O's. The documentation that was prepared and maintained was similar for every R&O item on the Project.

Q: At what point did the KCP&L Project Team begin its initial reforecast of the Unit 2 budget?

A: In its most embryonic form, the reforecasting effort began in July of 2007 with initial work on the R&O's. In the analysis presented to the EOC (Schedule DFM2010-6), the Project Team prepared contingency draw-down scenarios based on amounts ("best," "worst" and "most probable") from the CBE based on the R&O's that had been identified as of that time. The "best" case showed that the Project was likely to expend approximately **[redacted]** The "worst" case showed that all but **[redacted]** of the contingency would be allocated for R&O's identified at that time. This analysis led the

Project Team to assemble and track the underlying information on which R&O's were written.

Q: Why did the Project Team launch its cost reforecast effort in the summer of 2007?

A: Shortly after the CBE was adopted in December 2006, Kiewit provided a cost proposal to construct the remaining Balance of Plant work which resulted in a series of vetting activities and presentations by Kiewit that stretched from April 16, 2007 to the end of third quarter of 2007. Because the majority of the work that had not yet been contracted on the Project was addressed in Kiewit's proposal, vetting of Kiewit's estimate was tantamount to the vetting that one would perform as part of a cost reforecast.

Q: As of the summer of 2007, what was the Project Team's expectation regarding the impact to the CBE from the Kiewit contract?

A: In the July 11, 2007 analysis of R&O's provided to the EOC, the Project Team included an assumption of contingency draw-downs related to the Balance of Plant work in light of Kiewit's estimate. The Project Team estimated at that time that the Kiewit contract might require a contingency draw-down of approximately **[redacted]** that was in place in the 2006 CBE for the Iatan Unit 2 Project.

Q: When did the Project Team conclude its vetting of the Kiewit estimate?

A: The Kiewit estimate had been fully vetted by the end of September 2007 and was used as a basis for Kiewit's contract, which was issued in early November 2007. The cost reforecast for the remainder of the Iatan Project work came as a natural outgrowth of the Kiewit estimate vetting and led the Project Team and Schiff to examine a number of other factors in the current cost estimate.

Q: What were some of those factors?

A: With respect to quantity, there was not a full agreement between Kiewit's electrical and mechanical quantities and those that Burns & McDonnell had utilized in its design model. This issue required reconciliation.

Q: Did Kiewit's quantities ultimately change after this vetting process was completed?

A: Yes. Due to the incomplete status of engineering at the time of Kiewit's estimate, KCP&L knew that the quantities would be subject to potential change as additional design packages were completed. Kiewit's contract included quantities that were based on 20 to 25% engineering and Kiewit's estimate included unit prices that would be applied to any change in the final quantities. Accordingly, Kiewit's contract included a process to true-up final design, material and labor quantities resulting from design maturation.

Q: What happened next with respect to the initial cost reforecast?

A: KCP&L initiated a full reforecast of the Unit 1 and 2 cost estimate in November 2007. Members of the KCP&L Project Controls Group and Schiff engaged in a series of meetings with KCP&L's lead engineers to discuss the necessary data to develop a reasonable cost projection and the standards for documentation necessary to adequately vet the reforecast.

Q: Did KCP&L create a process for the cost reforecast?

A: Yes. The process was created by the KCP&L Project Controls Group.

Q: Did KCP&L adhere to this process in preparing the cost reforecast?

A: Yes, it did.

Q: During the process of the Iatan Project's cost reforecast, was there a time that you and other members of the KCP&L staff met with the Staff of the Missouri Public Service Commission ("MPSC Staff") and other parties to the Regulatory Plan?

A: Yes. I met with the MPSC Staff and other parties to KCP&L's Regulatory Plan on March 12, 2008.

Q: Who was present at the meeting from KCP&L?

A: Company witnesses Bill Downey, Brent Davis, Kenneth Roberts, Chris Giles, Bill Riggins, and the project controls director for the Iatan Project, Terry Foster, among others.

Q: What did you present or comment upon at that meeting?

A: I mostly answered questions from the MPSC Staff, though I did help explain the cost reforecasting flow chart as well as describe standard practices in the industry applicable to cost reforecasting efforts.

Q: To your recollection, what was the focus of your presentation to the MPSC Staff and other parties in March 2008?

A: For the most part, the discussion in the meeting centered upon answering the MPSC Staff's questions regarding why KCP&L's reforecasted cost projection had not been completed and announced to the public by that date. I explained at that time that the process was in the "left side" of the flow chart, *i.e.,* the project team was still trying to gather information. I noted that until the information is gathered and the analysis and vetting completed, and the reanalysis that inevitably results from the vetting is also completed, it is not possible to offer up a number that would have any reasonable meaning.

Q: Was KCP&L's cost reforecast completed by March 12, 2008?

A: No, it was not complete at that time.

Q: As of March 12, 2008, what were the major activities that remained to be completed?

A: At that time, based on the process flow chart, the process was in "Prepare Preliminary Cost Reforecast" which had started January 23, 2008 with a projected finish date of April 21, 2008. Therefore, the process was about halfway completed, and no vetting had occurred as yet.

Q: In your opinion, was the Project cost reforecast process utilized for the 2008 reforecast consistent with industry practice?

A: Yes, it was. You might observe some other business entity using a slightly different name, but the process described generally conforms to the typical industry process for cost reforecasting.

Q: When did the Project Team complete its review of the Project's costs?

A: By April 21, 2008, all of the data necessary for review by the Project's leadership team had been assembled. Then, the Project's leadership team vetted the information.

Q: Who was on the Iatan Unit 2 Project's leadership team at that time?

A: Terry Foster, Steve Easley, Brent Davis, Steve Jones, Mike Hermsen and Denise Schumacher comprised the "Leadership Team."

Q: How was the vetting done?

A: Vetting was done in a round-table fashion over a period of approximately one week. The Leadership Team members reviewed each item and the associated backup individually. The various Project Team analyses were prepared, reduced to writing, and the Leadership

Team was given the opportunity to voice either its disagreement or its agreement. The KCP&L cost group, Project controls and Schiff were present to assist the Leadership Team in interpreting the information and facilitating in the vetting process.

Q: What was the Iatan Unit 2 Project's status at the time the 2008 Cost Reforecast was completed?

A: As of May 2008, the Project Team reported that engineering was 70% complete, procurement 96% complete, and construction was approximately 20% complete.

Q: At what point did the Project Team present the results of the cost reforecast to KCP&L's senior management?

A: The results were presented in two phases. On April 25, 2008, the KCP&L Project Team presented its breakdown of the reforecasted budget to the EOC and to KCP&L's Chairman, Mr. Chesser. The following week, on May 5, 2008, Schiff made its presentation to the same members of the EOC.

Q: Describe the process that Schiff used for final vetting of KCP&L's reforecasted budget that was presented on April 25, 2008.

A: **[redacted]

[redacted]**

Q: **[redacted]**

[redacted]**

A: **[redacted]

[redacted]

[redacted]**

Q: **What were the major elements that Schiff looked at in the vetting of the Iatan reforecasted estimate in May 2008?**

A: Our starting point was the CBE from December 2006 and the assumptions that were used for its creation. We then looked at R&O items as a group of line items as well as individual R&O items, and considered the trends that had been established on the Iatan Project thus far for scope changes. We also reviewed: (1) the current procurement status; (2) contractually-based, potential payment incentives for major contractors; and (3) potential future change orders and scope additions.

**[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Q: What was the total reforecasted estimate for Iatan Unit 2 in May 2008?

A: Approximately **[redacted]** excluding AFUDC. This number encompassed the entire construction cost, without regard to KCP&L's ownership percentage or jurisdiction.

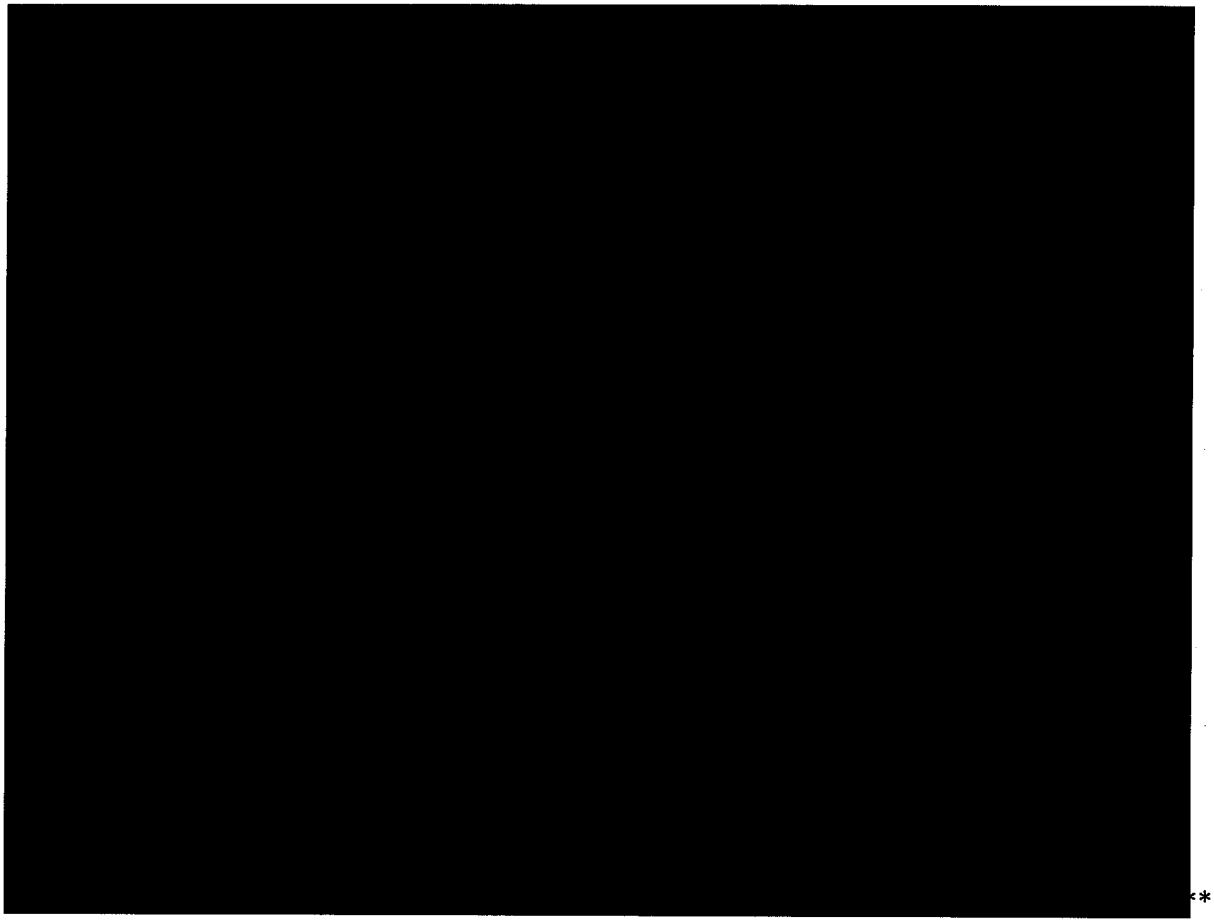
Q: What level of accuracy was the reforecasted Unit 2 estimate as of May 2008?

A: At that time, Iatan Unit 2's design was approximately 70% complete, there were aspects of the work that had not been fully designed that still carried a degree of cost uncertainty, and there were a number of potential risks that had not yet been encountered. As a result, I believe the Iatan Unit 2 portion of the reforecasted Control Budget was generally an AACE Class 2 estimate, which would have a range of accuracy between -15% to +10%, or a range of **[redacted]**.

Q: How did the 2008 reforecasted estimate for Iatan Unit 2 increase from the late 2006 CBE to May 2008?

A: The following chart identifies the differences between the CBE and the 2008 Cost Reforecast.

**



**

Q: What are the categories of difference from the CBE?

A: The main changes between the original CBE and the reforecasted estimate in May 2008 were due to: (1) design maturation increasing the actual amount of quantities installed; (2) design maturation impacting schedule and man-hours as a result of additional work scopes and increased quantities; (3) global pricing changes; (4) permit and compliance

impacts; and (5) operations and construction optimization.

Q: What is design maturation?

A: On day one of the Iatan Project, there was no design. Design of a project has to start somewhere, and it evolves and matures over time. When the Control Budget was established in December 2006, the level of engineering completion for Iatan Unit 2 was in the 20% range. As the Project's design further matured, the configuration with respect to certain aspects of the Project changed resulting in different quantities.

Q: How does design maturation impact the schedule on a project such as Iatan Unit 2?

A: Detailed information from a mature design ultimately results in the determination of final work quantities and related configurations. Final configuration and quantities drive procurement, delivery, and installation and thus the overall construction schedule. After work quantities and configurations are known, procurement can commence. This determines the delivery schedule and in turn may further influence the project's construction schedule.

Q: What portions of the Project were most impacted by design maturation in the time period from the December 2006 CBE to June 2008?

A: For Iatan Unit 2, design maturation most readily impacted areas of the final design that were dependent on the details and workings of the major pieces of plant equipment, functionality of that equipment and operational aspects of that equipment in concert with other systems. Portions of the design that were impacted most by maturation included plant systems such as electrical, water, air, ventilation and mechanical operations. The final design of these plant systems requires significant coordination and a full understanding of the physical size, locations and functionality of adjacent equipment and

structural elements.

Q: Do costs of a project always rise as a result of design maturation?

A: I would not say that "costs rise" due to design maturation but rather one's ability to more accurately forecast the end cost of a project is enhanced as the design is completed and that sometimes results in cost projections increasing. As the design matures and the project's scope becomes more defined, the work quantities and related configurations can more readily be determined. This in turn has an effect on work sequences, overall schedule considerations, work-area sharing arrangements, and time-function expenses. Design evolution enhances an owner's understanding of the nature of a project's various cost streams. As that knowledge and understanding is incrementally accrued, the project's contingency should be re-evaluated in light thereof.

Q: When was the impact of design maturation most apparent on the Iatan Unit 2 Project's costs?

A: During the period between the establishment of the CBE in December 2006 and the May 2008 Cost Reforecast, the design matured from approximately 20% complete to approximately 70% complete. A large percentage of the R&O's that the Project Team had identified during this period reflected the increase of such design maturity.

Q: Based on your analysis of the 2008 reforecasted estimate, did the increase in costs from design maturation that the Iatan Unit 2 Project experienced from December 2006 to May 2008 result from any imprudent acts by KCP&L?

A: No.

Q: What drove the changes to the Project's pricing that were captured in the 2008 reforecast?

A: In the construction industry, material and equipment price escalations are not always predictable. Often the best you can do is make an educated guess, particularly in a heated market where scarcity of resources is a major issue. In addition, some of the Iatan Unit 2 Project's suppliers included price escalation provisions as part of their base contract, so that if raw material and other component costs actually increased, KCP&L was responsible for the difference. This is not uncommon in the industry. An example is the chimney liner, which is made from an alloy material whose cost escalated significantly from the time KCP&L contracted with Pullman until the point in time at which Pullman actually purchased these materials.

Q: Do you have any specific knowledge with respect to the trends in the industry that may have impacted pricing at this time?

A: Yes. In my role as a member of multiple dispute review boards as well as my activities on behalf of other clients, I was very familiar with the economic climate during the all stages of the Iatan Unit 2 Project. Company witness Kenneth Roberts testified to the impact of price escalation on the utility construction industry. As an example, Mr. Roberts' testimony cited the study by Cambridge Energy Research Associates (CERA), a leader in analyzing utility project cost data, stated in February 2008 that prices in the power industry rose by 27% in 2007, and 19% in just the last six-months of 2007. Mr. Roberts' testimony noted that CERA's Power Capital Costs Index shows that costs have risen 130% since 2000 and were poised to rise higher in 2008, (CERA Article, May 27, 2008) which translated would mean that a new power plant that cost $1 billion in

2000 would cost $ 2.3 billion in 2008. The CERA Article is attached to Company witness Ken Roberts' testimony as Schedule KMR2010-8. This analysis is similar to my own experience with projects in the power industry as well other large industrial, governmental and commercial projects that were being planned and built at that time.

Q: Based on your analysis of the 2008 reforecasted estimate, were there imprudent acts by KCP&L which resulted in material or significant increases to the overall projects costs that emanating from increases to pricing from December 2006 to May 2008 to the Iatan Unit 2 Project?

A: I do not believe so, no.

Q: What are changes in the estimate due to Optimization, Operation and Construction?

A: As design matures and the project's scope becomes more focused, owners often take the opportunity to maximize the overall performance of a plant. In the case of Iatan Unit 2, KCP&L defined such changes as those intended to: (1) reduce long-term operations and maintenance costs for the plant; or (2) optimize the construction of Iatan Unit 2. Also included in this category was contingency set aside for reducing potential claims and other risks of construction.

Q: What were examples of R&O's that were associated with this category in the 2008 Cost Reforecast?

A: The largest increase under this category was the cost of the Owner's Construction Management team. The original amount for owner's indirect costs in the 2006 CBE was increased by the new VP of Construction, Mr. David Price, when he was hired in May 2007.

Q: Were the construction management staffing changes generally timely?

A: Yes. The increases to the construction management staff started mid-2007 and the 2008 Cost Reforecast merely recorded the increases in aggregate due to this and all other R&O increases.

Q: What were changes in the cost estimate due to permit and compliance issues?

A: The KCP&L Project Team identified specific cost items related to permitting and compliance issues, the effect of which were not reflected in the 2006 CBE. Included in these costs were additions to the cost of Project oversight and audit from internal KCP&L departments, Schiff, and Ernst & Young. This category also included discrete R&O items related to compliance and permitting items that were derivative of the maturation of the Project's design.

Q: Based on your analysis of the 2008 Cost Reforecast, were the Iatan Unit 2 Project's costs significantly increased from December 2006 to May 2008 as a result of any imprudent acts by KCP&L?

A: Not to my knowledge, no.

Q: What is your overall conclusion regarding the 2008 Cost Reforecast?

A: The 2008 Cost Reforecast was an arduous effort that served to further increase the Project Team's focus on costs. The reforecast well positioned the team to manage the bucketed costs on a going-forward basis. The result was that there were no significant additions to the Iatan Unit 2 Project's cost as measured between the 2008 Cost Reforecast and the 2009 Cost Reforecast.

THE 2009 COST REFORECAST

Q: When was the next time KCP&L reforecasted its Iatan Unit 2 Project Budget?

A: KCP&L engaged in a cost reforecast during the first two quarters of 2009. The result was presented to the KCP&L Board of Directors in July 2009 (the "2009 Cost Reforecast").

Q: Why did KCP&L engage in the 2009 Cost Reforecast?

A: As previously stated, it is good practice to periodically reforecast costs on a complex, multi-year project such as Iatan Unit 2. In addition, design of the Project was essentially complete as of that time. Also, KCP&L was reviewing the potential cost of maintaining the target for Provisional Acceptance date as June 1, 2010 or whether the target date and associated milestones should be revised.

Q: Did the 2009 Cost Reforecast result in any changes to the 2008 cost reforecast?

A: No. After a thorough review of the remaining costs and associated schedule changes, the Project Team recommended to Senior Management that the budget be maintained at the same ** [redacted] ** amount that the Project has carried since June 2008.

Q: At the time of the 2009 Cost Reforecast, had the Project Team accounted for potential changes in Project's costs emanating from changes to the Iatan Unit 2 Project's schedule?

A: Yes. The project team considered all known factors that could have impacted costs as of that time.

Q: Did the Project Team follow the same process for the 2009 Cost Reforecast as it did for the 2008 Cost Reforecast?

A: For the most part, yes. The Project Team embedded some process improvements from the 2008 Cost Reforecast as compared to the 2009 Cost Reforecast that streamlined the analysis. The Project Team also no longer tracked R&O items in the same form and format as used prior to the 2008 Cost Reforecast. Instead, the Project Team aggregated the information into cost projection folders, or "CP's" that were more integrated and encompassing in content than were the R&O's. This enhanced the overall cost analysis and has been utilized again in the subsequent reforecast of the Iatan Unit 2 Project's CBE.

Q: What was Schiff's independent assessment of the 2009 Cost Reforecast?

A: We reviewed the results from the project team and engaged in vetting sessions regarding those results, and performed a similar independent analysis of the CP's. **[redacted]** We presented our results to the Executive Oversight Committee in a similar fashion as with the 2008 Cost Reforecast.

Q: How did KCP&L's Senior Management account for the differences between the project team's view and Schiff's view of the 2009 Cost Reforecast?

A: KCP&L's management chose to continue managing the Iatan Unit 2 Project to the 2008 Cost Reforecast amount of **[redacted]** though stated that the project's costs projected within a range of **[redacted]**

Q: Do you have an opinion as to why the 2009 Cost Reforecast did not result in changes to the 2008 Cost Reforecast at that time?

A: Yes. I believe the 2008 Cost Reforecast was reflective of a significant progression in the overall design maturity of the Iatan Unit 2 Project as measured from the time of the CBE, initially approved in 2006.

APRIL 2010 COST REFORECAST

Q: Has KCP&L reforecasted Iatan Unit 2's budget since the 2009 Cost Reforecast was completed?

A: Yes. KCP&L's project team presented a reforecast of the project's EAC to the EOC on March 26, 2010 which was subsequently provided to the KCP&L Board of Directors for approval on April 6, 2010 (the "April 2010 Cost Reforecast").

Q: What were the circumstances for reforecasting the EAC at this stage of the Iatan Unit 2 Project?

A: Other than good practice, as discussed herein, as Company Witness Robert Bell testifies, the reason for KCP&L to reforecast the project's cost to complete was that KCP&L had recognized that the Iatan Unit 2 Project's in-service dates would be extended into the fall of 2010.

Q: What process did the KCP&L project team utilize for reforecasting as part of the 2010 Cost Reforecast?

A: The process used was essentially the same as used for the 2009 Cost Reforecast, except that the number and nature of several of the CP's had changed to further facilitate the review and analysis of the project's EAC.

Q: What was the result of the 2010 Cost Reforecast?

A: The project's EAC was revised from **[redacted]**

Q: What constituted the primary changes in the 2010 Cost Reforecast?

A: The 2010 Cost Reforecast captured a myriad of changes from the 2009 Cost Reforecast, and the most significant ones were: (1) increases to the project's start-up budget; (2) decreased revenue projections from test power sales during the changed start-up and commissioning period; (3) increases to certain fixed and semi-fixed costs that were more clearly defined; and (4) time-function expenses

Q: Why did the budget for start-up increase since the 2009 Cost Reforecast?

A: At the time the 2009 Cost Reforecast was prepared, the project team had developed only a conceptual estimate for start-up and commissioning. As the project's start-up and commissioning plans matured, the project team's knowledge increased and associated costs became more clear.

Q: Do you believe the increase in the project's start-up and commissioning cost projections from 2009 to 2010 significantly increased the overall cost of the Iatan Unit 2 Project?

A: No. The increase in the start-up budget was due to increased knowledge and understanding of the precise processes and vetting of the same so as to derive a more accurate cost estimate. Had the project team performed the same analysis with the same or similar level of detail in 2009 as it did in the first quarter of 2010, the majority of the projected increases in start-up costs would have been identified at that time and included with specificity in the 2009 Cost Reforecast.

Q: With respect to the changes in test power revenue, why did this projection change?

A: There were two primary reasons: (1) the change to the project's in-service date pushed the power sales from the summer 2010 to fall 2010 when demand is typically significantly lower; and (2) projected changes in the demand and market price for electric power.

Q: What are fixed and semi-fixed costs in the 2010 Cost Reforecast?

A: Fixed and semi-fixed costs are those that are not primarily time function in nature. These costs include changes in the project's scope that became more defined since the 2009 Cost Reforecast.

Q: What are the time function expenses that were projected in the 2010 Cost Reforecast?

A: Time function expenses are those costs that are dependent on the project's schedule. The projected cost increases in the 2010 Cost Reforecast account for the revised in-service date discussed in Company Witness Robert Bell's testimony. These time function expenses generally include personnel cost, overhead expenses and additional consumables and the like required to complete the project based on the project's revised in-service date as well as certain other, similar costs that were always planned to continue past the in-service date.

Q: What in-service date did the project team use for the basis of projecting time function expenses?

A: The project team assumed an in-service date of mid-December 2010. Time function expenses typically shift with schedule performance time, so if the project is completed earlier or later, that would impact the final project cost.

Q: Did the 2010 Cost Reforecast include contingency?

A: Yes. The 2010 Cost Reforecast included ** [redacted] ** in contingency.

Q: Was the contingency included in the 2010 Cost Reforecast appropriate?

A: Yes, I believe it was, based on the risks that KCP&L knew at the time. These risks are discussed in the testimony of Company witnesses Mr. Bell and Mr. Davis and in the Project's Risk Assessment (Schedule RNB2010-1)

Q: What is your opinion regarding the 2010 Cost Reforecast?

A: From a process standpoint, the project team performed a very thorough review and analysis of the remaining costs and risks through the end of the project. The 2010 Cost Reforecast should provide KCP&L's project management team with the template and necessary tools to effectively manage the project's remaining costs.

REPORTING OF PROJECT COSTS

Q: Are you familiar with the cost portfolio that KCP&L was using for tracking the Iatan Project?

A: Yes.

Q: What is your opinion of KCP&L's cost portfolio?

A: The cost portfolio that KCP&L uses is often called a "cost reporting system." The cost portfolio contains cost reporting information that is consistent with that seen in the industry at large. The cost portfolio is a summary level document, and it tracks all of the costs on the Project. The cost portfolio identifies major line items of work being done by the Iatan Project's various contractors and vendors. The information that KCP&L tracks in the cost portfolio is regularly updated to reflect actual costs and awarded costs, approved change orders, and commitments. It also has a section that is allocated to the

current cost reforecast. Viewed against what one would expect to see in the industry at large, the KCP&L cost portfolio contains the type of information that industry management generally uses and considers relevant for projects such as the Iatan Project.

Q: Are you familiar with KCP&L's Cost Control System (Schedule SJ2010-1)?

A: Yes. I assisted with portions of its preparation.

Q: Does KCP&L's Cost Control System conform to controls systems that are generally seen and used in the industry?

A: Yes.

Q: Is the cost portfolio in general conformance with KCP&L's cost control system document that was prepared in July 2006?

A: Yes.

Q: Do you believe that the cost portfolio provides senior management with enough information upon which to make reasonable decisions relative to the Iatan Project?

A: Yes. With the types of decisions that KCP&L's senior management is making, the necessary information is available.

Q: Are you aware of the method that the Project Team has used for informing the MPSC Staff of the cost of the Iatan Unit 2 Project?

A: I have a general understanding that on a quarterly basis, KCP&L provides a written report to the MPSC Staff which it includes an exhibit containing a snapshot of the Project's costs and I have seen such reports. This cost exhibit is consistent with the documentation that I see on a regular basis as I track costs on the Iatan Project. I also believe that the same or similar information is made available to KCP&L's joint owners for their monthly review of the Project's costs, as well as the Kansas Commission Staff.

Q: What other information was provided to the MPSC Staff on a quarterly basis relative to costs?

A: To my knowledge, the MPSC Staff also receives summary-level reports from the cost portfolio, as well as textual descriptions of events that bear on the Iatan Project's costs.

BALANCE OF PLANT CONTRACTING METHOD

Q: How would you define Balance of Plant work in the context of the Iatan Project?

A: On Unit 2, the Balance of Plant work, in essence, would be all work exclusive of the Unit 2 work contained in ALSTOM's contract for the boiler and Air Quality Control Systems ("AQCS").

Q: What is a multi-prime contracting format?

A: A multi-prime contract format involves an owner retaining several separate contractors to perform various portions of the work. The owner either functions as the manager of the entire project or hires another third party to do so. If the owner acts as the construction manager, the owner is responsible for all the coordination and has general management responsibilities associated with the entire site and all of the individual prime contractors.

Q: Are there certain risks that are inherent to multi-prime contracting?

A: Yes. Under such a model, the risk of coordination and construction management fall solely on the owner.

Q: In your opinion, in a multi-prime project where the owner acts as the construction manager, what is the likelihood that productivity issues could affect ultimate project costs and schedule?

A: Based on my industry experience which includes dispute review board assignments of about $15 billion in construction work, it is more likely that productivity issues could

affect the project costs and schedule under a multi-prime contract than where there is a single general contractor for several reasons. On a multi-prime site, there are many competing contractors each using the same local labor pool, and those entities do not have to answer to one another. They are independent, they are not always consistent regarding how each entity addresses compensation, safety and scheduling, and this could result in a potential labor problem on the job. If there is a labor productivity issue on the project, a multi-prime site arrangement increases the risk because the project is subject to the vagaries of multiple parties' individual interests and techniques in regard to labor management and the like. Nevertheless, an owner can control a multi-prime project through effective project management.

Q: Was KCP&L's senior management aware of these risks at the outset of the Iatan Unit 2 Project?

A: Yes. After I began work on the Iatan Unit 2 Project in early 2006, I was involved with Schiff in discussions with KCP&L's Senior Management regarding potential contracting methods for the Balance of Plant work that included the potential risks of a multi-prime model, as well as other options that were available. In addition to the concerns discussed above, Schiff raised as an issue KCP&L's ability to assemble an adequate management staff to execute the Iatan Project in a multi-prime setting. Because KCP&L had been out of the power plant construction business for a long time, it did not have an experienced staff. Schiff discussed how difficult it would be for KCP&L to assemble an adequate management staff.

Q: Was part of the contingency in the original CBE developed to account for the risk of KCP&L managing a multi-prime work site itself?

A: Yes, that risk element was considered and included. Company witness Brent Davis testifies to the process that was used for development of the CBE's contingency.

KIEWIT PROPOSAL FOR BALANCE OF PLANT WORK

Q: At what point did KCP&L become aware of Kiewit Power Constructors Co.'s interest in the Iatan Project?

A: My understanding is that Kiewit unexpectedly contacted KCP&L in December 2006 regarding the Balance of Plant work for the Iatan Project.

Q: In what way was Kiewit's contact unexpected?

A: As Company witness Steven Jones testifies, in the spring of 2006, KCP&L surveyed the Balance of Plant construction market and determined that there was essentially no interest in the Iatan Unit 2 Project. The contractors with the ability to handle the Balance of Plant work had sufficient work backlogs, and those companies who perform such work were very busy in executing that work. Thus, they had little or no interest in bidding the Iatan work. KCP&L's market survey included Kiewit, whose potential interest in the Project was very limited. Accordingly, when Kiewit approached KCP&L in December 2006, for the above reasons it was rather unexpected.

Q: Who were Kiewit's competitors in the utility construction industry?

A: Kiewit's competition includes Bechtel, URS/Washington Group, Shaw Stone and Webster, Fluor, and Black & Veatch. There are other, smaller entities who perform work similar to that of Kiewit though the above mentioned are entities that have the core competence to perform Balance of Plant on projects as large as Iatan Unit 2.

Q: Do you know why KCP&L chose not to bid the Balance of Plant work in early 2007?

A: Company witnesses William Downey and Steven Jones testify that KCP&L tried to find bidders, but the potential contractors declined interest just as they had during the previous market survey. More importantly, because KCP&L's strategy had been to perform the Balance of Plant work on a multi-prime basis, the bid documents necessary for procuring a full bid of the remaining Balance of Plant work had not been prepared. Therefore, additional time would have been required to prepare the drawings, prepare the specifications, issue a Request for Proposal, evaluate the bids, and award the Balance of Plant work. Based on my experience and knowledge of the design effort on the Iatan Unit 2 Project at that time, I believe the additional time required to competitively bid the Balance of Plant work on a Design-Bid-Build basis would have necessitated approximately 10 to 12 months.

Q: Had KCP&L chosen to competitively bid the Balance of Plant work at an earlier time, could significant amounts of time have been saved?

A: No, I don't think so. Engineering work takes time, and there is little that can be done to significantly compress it. Also, KCP&L was in the process of continually gathering market information. In late 2006, as I testified to earlier, the entire construction market was overheated. One of the results of an overheated construction market is that companies build a large backlog of work, and this was certainly the case during the 2005 to 2007 time frame. KCP&L knew that it would be in a very thin market, and had it incurred the expense in an attempt to jump start the engineering for the Balance of Plant, it would have suffered on other fronts including a shortage of bidders and a potentially

decreased quality of the engineering product resulting from design compression.

Q: Prior to its involvement with the Iatan Project, were you familiar with Kiewit and its subsidiaries?

A: Yes. Kiewit is a midwestern-based company that is well known nationally and internationally within the construction industry.

Q: What is your opinion of Kiewit?

A: Kiewit is a very good company with a solid reputation. I have served on dispute review boards on other Kiewit projects and Kiewit is a very competent contractor with considerable organizational depth.

Q: Do you know why Kiewit was suddenly interested in the work on the Iatan Project?

A: It is my understanding from discussions with Company witness Brent Davis that Kiewit told KCP&L it had another powerhouse project that had been placed on hold, and the Iatan Project's timing was such that Kiewit saw it as an opportunity to put that crew to work. Company witness Brent Davis' testimony describes the initial discussions with representatives from Kiewit at this time.

Q: At that time, what work was under contract for Balance of Plant for the Iatan Project?

A: The foundation and substructures and various general site work contracts, as well as much of the engineered materials and other commodities that had been purchased as of that time.

Q: Do you recall what Kiewit proposed for the Iatan Project?

A: On April 13, 2006, Kiewit submitted a price for work on both Iatan Unit 1 and Iatan Unit 2 to KCP&L in the amount of about **[redacted]

[redacted]

[redacted]** for the Balance of Plant construction work for both Iatan units.

Q: What presentations did Kiewit make to KCP&L senior management?

A: Kiewit made a series of presentations. As I recall, the first one was on April 16, 2007 to members of the KCP&L Executive Oversight Committee, the Project management team from the Iatan Unit 2 Project, and Schiff. There were subsequent presentations by Kiewit to smaller groups of individuals after that time.

Q: What was done to validate the estimate that Kiewit provided on April 13, 2007?

A: After Kiewit submitted its initial price in April 2007, KCP&L, with help from Schiff, began a vetting and estimate review process that continued through September 2007. During this time, Kiewit was on the Project site performing walk-downs, and its team developed independent quantity estimates and continually refined its estimate. One beneficial aspect of Kiewit's proposal was that Kiewit performed internal cost estimates using its different internal operating groups. As a result, KCP&L felt it was receiving the benefit of competitive and check estimates provided by those different operating groups.

Q: What risks did Kiewit identify with the Iatan Project in its initial proposal?

A: Kiewit identified labor productivity, labor availability, schedule, and work quantities as major risks. One labor risk, in particular, that Kiewit identified was the potential of what we called a "CB4 effect" on the Iatan Project.

Q: What is "CB4"?

A: CB4 refers to the Council Bluffs Unit 4 project that was built in Council Bluffs, Iowa that

had a significant labor overrun.

Q: How did Kiewit's participation in the Iatan Project offset some of the labor risks that were being considered in early 2007?

A: Kiewit's presence was able to offset or at least compensate for some of the things that Schumacher had pointed out in his report (Schedule DFM2010-5). Some of Schumacher's "best practices" are the very things that Kiewit is known for and for which it has a demonstrated track record in the industry, including: (1) detailed planning and scheduling—in Kiewit's specific proposal for the Iatan Project, discussed at length the process it undertakes using "work packs" and daily work scripts for craft to maximize productivity; (2) minimizing engineering changes—Kiewit's plan for the Iatan Project included measures to ensure that engineering drawings were done timely and correctly; and (3) Kiewit's ability to manage and get along with craft labor. Nationwide, Kiewit probably employs in excess of 60,000 craft people, so Kiewit is a significant labor market player. The unions know Kiewit, and Kiewit knows the unions. So in regard to handling some of the issues looming at Iatan, Kiewit seemed to be a solution for mitigating the labor risks described in Schumacher's labor study.

Q: How did KCP&L vet Kiewit's estimate?

A: One of the goals in vetting the Kiewit estimate was to reconcile Kiewit's price with KCP&L's budget for the Balance of Plant work. As I indicated earlier, one of the reasons for doing this was to confirm KCP&L's budget and the assumptions (i.e., quantities) behind the budget estimate.

There were several meetings with Kiewit regarding all aspects of its estimate. Considerable focus was placed on the issue of work quantities based on the level of

design completion at the time, and KCP&L had a series of meetings with Kiewit to reconcile the quantities that Kiewit had carried in its Iatan estimate with: (1) Kiewit's historical experience on other projects as factored into the quantities that were used at Iatan; and (2) the quantity information that KCP&L had received from Burns & McDonnell. KCP&L expended a great deal of effort over many months to get quantities vetted, reconciled and generally to the point that there was confidence in Kiewit's estimate, based upon the current project status.

Q: What was the result of the vetting of Kiewit's estimate?

A: KCP&L and Kiewit came to a mutual understanding and agreement on most of the quantity issues. As a further result of the vetting process, Kiewit adjusted its original proposal of **[redacted]** and ultimately estimated the cost of the known balance of plant work at about **[redacted]** for both Unit 1 and Unit 2. The Unit 2 portion of Kiewit's base contract was **[redacted]** It is important to note that during this vetting process, for practical evaluation reasons, Kiewit, Burns & McDonnell, the KCP&L Project Team and Schiff decided to freeze the assumptions surrounding Kiewit's original estimate of April 2007 and did not attempt to include any further project definition or design work that was ongoing concurrent to the vetting process.

Q: Why was the estimate frozen?

A: It would have been too difficult to simultaneously vet the original assumptions and incorporate ongoing changes. Instead, the contract was structured to incorporate the effect of any changes as the design work was completed.

Q: What is the compensation structure in the contract between KCP&L and Kiewit?

A: The form of the Kiewit agreement is, in essence, a unit price contract. Kiewit took the

risk except for quantity variations and labor availability. An important issue to KCP&L was that Kiewit took the productivity risk for the scope that was known at that time.

Q: How did Kiewit's price compare the KCP&L's budget for the balance of plant work?

A: Kiewit's price, which was tendered in April 2007, was roughly **[redacted]** for the uncontracted Balance of Plant work. However, by contracting with Kiewit as the general contractor for the Balance of Plant work, KCP&L was able to mitigate other risks that were being carried in the contingency based upon the multi-prime contracting methodology originally planned for the Balance of Plant work.

Q: What was the value of the risks mitigated by Kiewit?

A: Based upon an analysis of the contingency performed during the vetting of the Kiewit estimate, the portion of the contingency in the CBE of December 2006 reserved for certain risks mitigated by Kiewit was valued at **[redacted]** for the Iatan Project (Units 1 and 2). That more than balanced out the difference between Kiewit's price and KCP&L's budgeted amount. There were also other potential savings that could be realized when comparing the CBE to the Kiewit estimate, including: (1) Kiewit had a different methodology of performing the barge facility work than what was embedded in the CBE; (2) KCP&L would be able to reduce its internal management expenses by approximately **[redacted]** from the staffing level necessary to manage a multi-prime; and (3) Kiewit had tendered some value engineering concepts for other scopes that had the potential of saving approximately **[redacted]**

Q: What was Schiff's assessment of the value of the Kiewit proposal for the Iatan Project?

A: ** [redacted] ** Schiff's view was shaped by: (1) Kiewit's demonstrated track record and expertise in the industry; (2) Kiewit had a project management team available who was ready to hit the ground running; (3) Kiewit also had a track record of working with Burns & McDonnell on other projects; (4) Kiewit's plan to co-locate with Burns & McDonnell provided an opportunity to perform constructability reviews as engineering was being prepared; (5) Kiewit is known throughout the industry as having good safety and quality programs, both of which result in lower project cost; (6) Kiewit had management expertise that would likely optimize schedule achievement.

Q: Did KCP&L have any meaningful options to bid the Kiewit portion of the Balance of Plant work?

A: No. As stated, KCP&L did not have the time to stop the work and subject the Balance of Plant scope to competitive bidding. As important, there was no known competition for Kiewit at that time. In my view, the vetting process in which KCP&L and Kiewit engaged was a reasonably suitable substitute for competitively bidding the work given overall project conditions and is often used in the industry.

Q: Did KCP&L's senior management agree to contract with Kiewit based on its final proposal and estimate?

A: Yes.

Q: Was an estimate at completion for Kiewit's work on the Iatan Unit 2 Project part of the 2010 Cost Reforecast?

A: Yes.

Q: When you analyzed that portion of the 2009 Cost Reforecast, what did you find?

A: ** [redacted] ** The overall cost estimated in May 2008 for Kiewit totaled ** [redacted] ** This projection is consistent with the project team's current revised EAC for Kiewit in the 2010 Cost Reforecast.

Q: Based on your analysis of the evolution of the Iatan Unit 2 Project's estimates, do you believe that Kiewit's contract amount on the Iatan Unit 2 Project has grown due to mismanagement by KCP&L?

A: No. I believe that the major sources of growth in the Kiewit contract have resulted from design maturation of the Balance of Plant work and the associated impacts of the same on the schedule for the Iatan Unit 2 Project as well as changes in pricing from an overheated market.

Q: Does that conclude your testimony?

A: Yes.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Kansas City Power & Light Company to Modify Its Tariffs to Continue the Implementation of Its Regulatory Plan	)))	Docket No. ER-2010-____

AFFIDAVIT OF DANIEL F. MEYER

STATE OF ILLINOIS)
) **ss**
COUNTY OF COOK)

Daniel F. Meyer, being first duly sworn on his oath, states:

1. My name is Daniel F. Meyer. I am employed by Meyer Construction Consulting, Inc. My services have been retained by Schiff Hardin LLP, who is a consultant for Kansas City Power & Light Company.

2. Attached hereto and made a part hereof for all purposes is my Direct Testimony on behalf of Kansas City Power & Light Company consisting of forty-eight (48) pages, having been prepared in written form for introduction into evidence in the above-captioned docket.

3. I have knowledge of the matters set forth therein. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded, including any attachments thereto, are true and accurate to the best of my knowledge, information and belief.

Daniel F. Meyer

Subscribed and sworn before me this 20th day of May, 2010.

Notary Public

My commission expires: July 28, 2013

STEPHANIE KAY MCCORKLE
Notary Public - Notary Seal
State of Missouri
Commissioned for Clay County
My Commission Expires: July 28, 2013
Commission Number: 09451858

aace International

AACE International Recommended Practice No. 10S-90

COST ENGINEERING TERMINOLOGY

Recommended Practice No. 10S-90

Cost Engineering Terminology

April 13, 2004

Unless otherwise noted, all terms contained in this document have been developed by various AACE International technical committees, special interest groups, or project teams. All terms have completed a thorough review process, followed by approval by the AACE International Technical Board. Portions of this document have been incorporated into the American National Standards Institute's (ANSI) Standard No. Z94.x.

[A] ASTM Standard No E833. Reprinted, with permission, from the Annual Book of ASTM Standards, copyright American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103. ASTM terminology may not be reproduced in any form whatsoever without the expressed written consent of ASTM.

[B] Based in part upon ASTM Standard No. E833 with modifications

[D] Department of Defense

[P] PMI Representative

(mm/yy) Indicates date adopted

ACCELERATION - conduct by the owner or the engineer (either in a directed or constructive manner) in which a contractor is required to complete performance of the contracted scope of work earlier than scheduled. A Directed Acceleration occurs when the owner formally directs such accelerated completion. A Constructive Acceleration generally occurs when a contractor is entitled to an excusable delay; the contractor requests a time extension from the owner; the owner declines to grant a time extension or grants one in an untimely manner; the owner or the engineer either expressly orders completion within the original performance period or implies in a clear manner that timely completion within the original performance period is expected; and the contractor gives notice to the owner or the engineer that the contractor considers this action an acceleration order. (11/90)

ACCEPTANCE, FINAL (PARTIAL) - the formal action by the owner accepting the work (or a specified part thereof), following written notice from the engineer that the work (or specified part thereof) has been completed and is acceptable subject to the provisions of the contract regarding acceptance. (11/90)

ACCESS TO THE WORK - the right of the contractor to ingress and egress, and to occupy the work site as required to reasonably perform the work described in the contract documents. An example of denial of access to the work would be on the segment of a sewer installation project where no easements or work limits are indicated, but the contractor is ordered, after contract award, to conduct operations within a narrow work corridor necessitating different or unanticipated construction methods (e.g., use of sheeting). (11/90)

ACCOUNTABILITY - answerable, but not necessarily charged personally with doing the work. Accountability cannot be delegated but it can be shared. (11/90)

ACCOUNT CODE STRUCTURE - the system used to assign summary numbers to elements of the work breakdown and account numbers to individual work packages. (11/90)

ACCOUNT NUMBER - a numeric identification of a work package. An account number may be assigned to one or more activities. Syn.: SHOP ORDER NUMBER. (11/90)

ACCOUNTS PAYABLE - the value of goods and services rendered on which payment has not yet been made. See also TAXES PAYABLE. (11/90)

ACCOUNTS RECEIVABLE - the value of goods shipped or services rendered to a customer on which payment has not yet been received. Usually includes an allowance for bad debts. (11/90)

ACTIVITY - An operation or process consuming time and possibly resources. An activity is an element of work that must be performed in order to complete a project. An activity consumes time, and may have resources associated with it. Activities must be measurable and controllable. An activity may include one or more tasks. See also TASK. (3/04)

ACTIVITY CODE - any combination of letters, numbers, or blanks which describes and identifies any activity or task shown on the schedule. Syn.: ACTIVITY IDENTIFIER. (11/90)

ACTIVITY DESCRIPTION - a concise explanation of the nature and scope of the work to be performed, which easily identifies an activity to any recipient of the schedule. (11/90)

ACTIVITY DURATION - the length of time from start to finish of an activity, estimated or actual, in working or calendar time units. (11/90)

ACTIVITY IDENTIFIER - see ACTIVITY CODE. (11/90)

ACTIVITY SPLITTING - dividing (i.e., splitting) an activity of stated scope, description and schedule into two or more activities which are rescoped and rescheduled. The sum of the split activities is normally the total of the original. (11/90)

ACTIVITY TIMES - time information generated through the CPM calculation that identifies the start and finish times for each activity in the network. (11/90)

ACTIVITY TOTAL SLACK - the latest allowable end time minus earliest allowable end time. The activity slack is always greater than or equal to the slack of the activity ending event. (11/90)

ACTS OF GOD - (1) an extraordinary interruption by a natural cause, as a flood or earthquake, or the usual course of events that experience, foresight or care cannot reasonably foresee or prevent; (2) an event in nature over which neither the owner nor the contractor has any control. (11/90)

ACTUAL COMPLETION DATE - the calendar date on which an activity was completed. See ACTUAL FINISH DATE. (11/90)

ACTUAL COSTS - the actual expenditures incurred by a program or project. (11/90)

ACTUAL COST OF WORK PERFORMED (ACWP) - the direct costs actually incurred and the direct costs actually recorded and assigned in accomplishing the work performed. These costs should reconcile with the contractor's incurred cost ledgers when they are audited by the client. (11/90)

ACTUAL FINISH DATE - the calendar date on which the activity was actually completed. It must be prior to or equal to the data date. The remaining duration of this activity is zero. (11/90)

ACTUAL START DATE - the calendar date on which work actually began on an activity. (11/90)

ADDENDA - written or graphic instruments issued prior to the date for opening of bids which may interpret or modify the bidding documents by additions, deletions, clarification, or corrections. (11/90)

ADJUSTED INTERNAL RATE-OF-RETURN (AIRR) - the compound rate of interest that, when used to discount the terminal values of costs and benefits of a project over a given study period, will make the costs equal the benefits when cash flows are reinvested at a specified rate. [A] (11/90)

ADM - see ARROW DIAGRAMMING METHOD. (11/90)

ADMINISTRATIVE EXPENSE - the overhead cost due to the nonprofit-specific operations of a company. Generally includes top management salaries and the costs of legal, central purchasing, traffic, accounting, and other staff functions and their expenses for travel and accommodations. (11/90)

AGENT - a person authorized to represent another (the principal) in some capacity. The agent can only act within this capacity or "scope of authority" to bind the principal. Agency agreements can be oral or in writing. (11/90)

AGGREGATE - a collection of items arbitrarily brought together as associated variables for analytical or comparative purposes. (11/90)

AGREEMENT - the written agreement between the owner and the contractor covering the work to be performed; other contract documents are attached to the agreement and made a part thereof as provided therein. (11/90)

ALLOWANCES - additional resources included in estimates to cover the cost of known but undefined requirements for an individual activity, work item, account or subaccount. (11/90)

AMBIGUITY - an uncertainty in the meaning of provisions of a contract, document or specification. Mere disagreement about the meaning of a provision does not indicate an ambiguity. There must be genuine uncertainty of meaning based on logical interpretation of the language used in the contract. Generally, ambiguities in contracts are construed against the drafter of the agreement. (11/90)

AMENDMENT - a modification of the contract by a subsequent agreement. This does not change the entire existing contract but does alter the terms of the affected provisions or requirements. (11/90)

AMORTIZATION - (1) as applied to a capitalized asset, the distribution of the initial cost by periodic charges to operations as in depreciation. Most properly applies to assets with indefinite life; (2) the reduction of a debt by either periodic or irregular payments; (3) a plan to pay off a financial obligation according to some prearranged schedule. (11/90)

ANALYSIS - the examination of a complex whole and the separation and identification of its constituent parts and their relationships. (11/90)

ANNUAL VALUE - a uniform annual amount equivalent to the project costs or benefits taking into account the time value of money throughout the study period. Syn.: ANNUAL WORTH; EQUIVALENT UNIFORM ANNUAL VALUE. See AVERAGE ANNUAL COST. [A] (11/90)

ANNUAL WORTH - see ANNUAL VALUE. [A] (11/90)

ANNUALLY RECURRING COSTS - those costs that are incurred in a regular pattern each year throughout the study period. [A] (11/90)

ANNUITY - (1) an amount of money payable to a beneficiary at regular intervals for a prescribed period of time out of a fund reserved for that purpose; (2) a series of equal payments occurring at equal periods of time. (11/90)

ANTICIPATORY BREACH - a specific refusal by the contractor to perform within the terms of the contract documents before performance is due; or a clear indication that the contractor is unable or unwilling to perform. (11/90)

APPLICATION FOR PAYMENT - the form furnished by the owner or the engineer which is to be used by the contractor in requesting progress or final payments and which shall contain an affidavit, if required, in the general or supplementary conditions. The application for payment includes all supporting documentation as required by the contract documents. (11/90)

APPROVE - to accept as technically satisfactory by person or persons in authority. The approval may still require confirmation by someone else at a higher level of authority for legal or commercial considerations. (11/90)

ARBITRATION - a method for the resolution of disputes by an informal tribunal in which a neutral person or persons with specialized knowledge in the field in question renders a decision on the dispute. An arbitrator may grant any award which is deemed to be just and equitable after having afforded each party full and equal opportunity for the presentation of the case. Arbitration does not strictly follow the rules of evidence and discovery procedures found in litigation. Arbitration may be conducted under the auspices of an organization (eg, the American Arbitration Association) which is available as a vehicle for conducting an arbitration. (11/90)

ARROW - The graphic representation of an activity in the ADM network. One arrow represents one activity. The tail of the arrow represents the start of the activity. The head of the arrow represents the finish. The arrow is not a vector quantity and is not drawn to scale. It is uniquely defined by two events. (3/04)

ARROW DIAGRAM - a network (logic diagram) on which the activities are represented by arrows between event nodes. (11/90)

ARROW DIAGRAMMING METHOD (ADM) - a method of constructing a logical network of activities using arrows to represent the activities and connecting them head to tail. This diagramming method shows the sequence, predecessor and successor relationships of the activities. (11/90)

AS-BUILT SCHEDULE - the final project timetable, which depicts for each activity actual start and completion date, actual duration, costs, and consumed resources. (11/90)

ASSESSED VALUE - that value entered on the official assessor's records as the value of the property applicable in determining the amount of taxes to be assessed against that property. (11/90)

AUTHORIZED WORK - activity that has been approved to proceed by the client. The scope may or may not be well defined at the time authorized; it is usually defined by contract. (11/90)

AVERAGE ANNUAL COST - the conversion, by an interest rate and present worth technique, of all capital and operating costs to a series of equivalent equal annual costs. As a system for comparing proposal investments, it requires assumption of a specific minimum acceptable interest rate. (11/90)

AVERAGE-INTEREST METHOD - a method of computing required return on investment based on the average book value of the asset during its life or during a specified study period. (11/90)

BACKCHARGE - a cost caused by defective or deficient work by the contractor deducted from or used to offset the amount due to the contractor. (11/90)

BACKUP - supporting documents for an estimate or schedule including detailed calculations, descriptions of data sources, and comments on the quality of the data. (11/90)

BACKWARD PASS - calculation of the latest finish time and latest start time for all uncompleted network activities or late time for events in the ADM and PDM methods. It is determined by working from the final activity and subtracting durations from uncompleted activities. (11/90)

BAR CHART - a graphic presentation of project activities shown by a time-scaled bar line. Syn.: GANTT CHART. (11/90)

BASE DATE - see BASE TIME. [A] (11/90)

BASE PERIOD (OF A GIVEN PRICE INDEX) - period for which prices serve as a reference for current period prices; in other words, the period for which an index is defined as 100 (if expressed in percentage form) or as 1 (if expressed in ratio form). (11/90)

BASE POINT FOR ESCALATION - cost index value for a specific month or an average of several months that is used as a basis for calculating escalation. (11/90)

BASE TIME - the date to which all future and past benefits and costs are converted when a present value method is used (usually the beginning of the study period). Syn.: BASE DATE. [A] (11/90)

BASELINE - In project control, the reference plans in which cost, schedule, scope and other project performance criteria are documented and against which performance measures are assessed and changes noted. (1/03)

BASIS - Documentation that describes how an estimate, schedule, or other plan component was developed and defines the information used in support of development. A basis document commonly includes, but is not limited to, a description of the scope included, methodologies used, references and defining deliverables used, assumptions and exclusions made, clarifications, adjustments, and some indication of the level of uncertainty. (1/03)

BATTERY LIMIT - comprises one or more geographic boundaries, imaginary or real, enclosing a plant or unit being engineered and/or erected, established for the purpose of providing a means of specifically identifying certain portions of the plant, related groups of equipment, or associated facilities. It generally refers to the processing area and includes all the process equipment, and excludes such other facilities as storage, utilities, administration buildings, or auxiliary facilities. The scope included within a battery limit must be well-defined so that all personnel will clearly understand it. See also OFF-SITES. (11/90)

BAYESIAN INFERENCE - a statistical tool for causal analysis and dependency of events. (11/90)

BEGINNING EVENT - an event that signifies the beginning of an activity. Syn.: PREDECESSOR EVENT; PRECEDING EVENT; STARTING EVENT. (11/90)

BEGINNING NETWORK EVENT - the event that signifies the beginning of a network (or subnet). (11/90)

BEGINNING (START) NODE OF NETWORK - (ADM) a node at which no activities end, but one or more activities begin. (11/90)

BENCHMARK INDEXES - for most manufacturing and all mining industries, indexes reflecting changes in output between census years. (11/90)

BENCHMARKING - A measurement and analysis process that compares practices, processes, and relevant measures to those of a selected basis of comparison (i.e., the benchmark) with the goal of improving performance. The comparison basis includes internal or external competitive or best practices, processes or measures. Examples of measures include estimated costs, actual costs, schedule durations, resource quantities and so on. (1/03)

BENEFICIAL OCCUPANCY - use of a building, structure, or facility by the owner for its intended purpose (functionally complete), although other contract work, nonessential to the function of the occupied section, remains to be completed. See also SUBSTANTIAL COMPLETION. (11/90)

BENEFIT COST ANALYSIS - a method of evaluating projects or investments by comparing the present value or annual value of expected benefits to the present value or annual value of expected costs. [A] (11/90)

BENEFIT-TO-COST RATIO (BCR) - benefits divided by costs, where both are discounted to a present value or equivalent uniform annual value. [A] (11/90)

BID - to submit a price for services; a proposition either verbal or written, for doing work and for supplying materials and/or equipment. (11/90)

BID BOND - a bond that guarantees the bidder will enter into a contract on the basis of his/her bond. (11/90)

BIDDER - the individual, partnership, or corporation, or combination thereof, acting directly or through an authorized representative, formally submitting a bid directly to the owner, as distinct from a sub-bidder, who submits a bid to a bidder. (11/90)

BID SECURITY - security is provided in connection with the submittal of a bid to guarantee that the bidder, if awarded or offered the contract, will execute the contract and perform the work. The requirements for the bid security are usually designated in a specific section of the bidding documents. The bid security is payable to the owner (usually around 5% of the total bid price) in the form of either a certified or bank check or a bid bond issued by a surety satisfactory to the owner. The bid security of the successful bidder is usually retained until the bidder has executed the agreement and furnished the required contract security, whereupon the bid security is returned. Bid security of the other bidders is returned after the bid opening. (11/90)

BID SHOPPING - an effort by a prime contractor to reduce the prices quoted by subcontractors and/or suppliers, by providing the bid price to other subcontractors or suppliers in an attempt to get the other subcontractors or suppliers to underbid the original price quoted. The reverse of this situation is when subcontractors try to get a better price out of a prime contractor. This is known as Bid Peddling. (11/90)

BIDDING DOCUMENTS - the advertisement for bids, instructions to bidders, information available to bidders, bid form with all attachments, and proposed contract documents (including all addenda issued prior to receipt of bids). (11/90)

BIDDING REQUIREMENTS - the advertisement for bids, instructions to bidders, supplementary instructions and all attachments therein, information to bidders and all attachments therein, and bid form and all attachments therein. (11/90)

BLACK BOX - describes a system (organism or mechanism) whose structure is unknown either because it cannot be observed or it is proprietary, classified or too complex to be understood. (11/90)

BLANKET BOND - a bond covering a group of persons, articles, or properties. (11/90)

BLOCK DIAGRAM - a diagram made up of vertically placed rectangles situated adjacent to each other on a common base line. Where the characteristic to be depicted is quantitative, the height of the rectangles is usually taken to be proportional to this quantitative variable. When this kind of diagram is used to portray a frequency distribution it takes the name of histogram. (11/90)

B.L.S. -Bureau of Labor Statistics. (11/90)

B.L.S. PERIODICALS–

- **CPI Detailed Report**, issued monthly
- **Current Wage Developments**, issued monthly
- **Employment and Earnings**, issued monthly
- **Monthly Labor Review**, issued monthly
- **Occupational Outlook Quarterly**, issued quarterly
- **Producers' Prices and Price Indexes**, issued monthly (previously **Wholesale Price Index**) (11/90)

BONDS - instruments of security furnished by the contractor and/or surety in accordance with the contract documents. The term contract security refers to the payment bond, performance bond and those other instruments of security required in the contract documents. (11/90)

BOND, BID - a bond that is executed in connection with the submittal of a bid and which guarantees that the bidder, if awarded or offered the contract, will execute the contract and perform the work. The bidding documents sometimes include a specific form for submittal of the bid bond and may be used to satisfy the requirement for bid security as defined in the bidding documents. (11/90)

BOND, PAYMENT - a bond that is executed in connection with a contract and which secures the payment of all persons supplying labor and material in the prosecution of the work provided for in the contract. (11/90)

BOND PERFORMANCE - a bond that is executed in connection with a contract and which secures the performance and fulfillment of all the undertakings, covenants, terms, conditions, and agreements contained in the contract. (11/90)

BONUS-PENALTY - a contractual arrangement between a client and a contractor wherein the contractor is provided a bonus, usually a fixed sum of money, for each day the project is completed ahead of a specified schedule and/or below a specified cost, and agrees to pay a similar penalty for each day of completion after the schedule date or over a specified cost up to a specified maximum either way. The penalty situation is sometimes referred to as liquidated damages. (11/90)

BOOK VALUE (NET) - (1) current investment value on the books calculated as original value less depreciated accruals; (2) new asset value for accounting use; (3) the value of an outstanding share of stock of a corporation at any one time, determined by the number of shares of that class outstanding. (11/90)

BREACH OF CONTRACT - failure, by either the owner or the contractor, without legal excuse, to perform any work or duty owed to the other person. (11/90)

BREAKEVEN CHART - a graphic representation of the relation between total income and total costs for various levels of production and sales indicating areas of profit and loss. (11/90)

BREAKEVEN POINT - (1) in business operations, the rate of operations output, or sales at which income is sufficient to equal operating costs or operating cost plus additional obligations that may be specified; (2) the operating condition, such as output, at which two alternatives are equal in economy; (3) the percentage of capacity operation of a manufacturing plant at which income will just cover expenses. (11/90)

BREAKOUT SCHEDULE - this jobsite schedule, generally in bar chart form is used to communicate the day-to-day activities to all working levels on the project as directed by the construction manager. Detail information with regard to equipment use, bulk material requirements, and craft skills distribution, as well as the work to be accomplished, forms the content of this schedule. The schedule is issued on a weekly basis with a two to three-week look ahead from the issue date. This schedule generally contains from 25 to 100 activities. (11/91)

BUDGET - a planned allocation of resources. The planned cost of needed materials is usually subdivided into quantity required and unit cost. The planned cost of labor is usually subdivided into the workhours required and the wage rate (plus fringe benefits and taxes). (11/90)

BUDGET COST OF WORK PERFORMED (BCWP) - the sum of the budgets for completed portions of in-process work, plus the appropriate portion of the budget for level of effort and apportioned effort for the relevant time period BCWP is commonly referred to as "earned value". (11/90)

BUDGET COST OF WORK SCHEDULED (BCWS) - the sum of the budgets for work scheduled to be accomplished (including work-in- process), plus the appropriate portion of the budgets for level of effort and apportioned effort for the relevant time period. (11/90)

BUDGETING - A process used to allocate the estimated cost of resources into cost accounts (i.e., the cost budget) against which cost performance will be measured and assessed. Budgeting often considers time-phasing in relation to a schedule and/or time-based financial requirements and constraints. (1/03)

BULK MATERIAL - material bought in lots. These items can be purchased from a standard catalog description and are bought in quantity for distribution as required. Examples are pipe (nonspooled), conduit, fittings, and wire. (11/90)

BURDEN - in construction, the cost of maintaining an office with staff other than operating personnel. Includes also federal, state and local taxes, fringe benefits and other union contract obligations. In manufacturing, burden sometimes denotes overhead. (11/90)

BURDEN OF PROOF - The necessity of proving the facts in a dispute on an issue raised between the owner and the contractor. In a claim situation, the burden of proof is always on the person filing the claim. This is true whether the contractor is claiming against the owner, or the owner is making a claim against the contractor. (11/90)

BUSINESS PLANNING - the determination of financial, production and sales goals of a business organization; and the identification of resources, methods, and procedures required to achieve the established objectives within specified budgets and timetables. (11/90)

CALENDAR - time schedule of project activities. The calendar identifies working days, holidays, and the length of the working day in time units and/or shifts. (11/90)

CALENDAR RANGE - the span of the calendar from the calendar start date through the calendar end date. The calendar start date is unit number one. The calendar range is usually expressed in years. (11/90)

CALENDAR UNIT - the smallest time unit of the calendar that is in use to estimate activity duration. This unit is generally in hours, shifts, days, or weeks. Syn.: TIME UNIT. (11/90)

CALENDAR START DATE - the date assigned to the first unit of the defined calendar; the first day of the schedule. (11/90)

CAPACITY FACTOR - (1) the ratio of average load to maximum capacity; (2) the ratio between average load and the rated capacity of the apparatus; (3) the ratio of the average actual use to the rated available capacity. Also called Capacity Utilization Factor. (11/90)

CAPITAL BUDGETING - a systematic procedure for classifying, evaluating, and ranking proposed capital expenditures for the purpose of comparison and selection, combined with the analysis of the financing requirements. (11/90)

CAPITAL, DIRECT - see DIRECT COST (1). (11/90)

CAPITAL, FIXED - the total original value of physical facilities which are not carried as a current expense on the books of account and for which depreciation is allowed by the Federal Government. It includes plant equipment, building, furniture and fixtures, and transportation equipment used directly in the production of a product or service. It includes all costs incident to getting the property in place and in operating condition, including legal costs, purchased patents, and paid-up licenses. Land, which is not depreciable, is often included. Characteristically it cannot be converted readily into cash. (11/90)

CAPITAL, INDIRECT - see INDIRECT COST (1). (11/90)

CAPITAL, OPERATING - capital associated with process facilities inside battery limits. (11/90)

CAPITAL RECOVERY - (1) charging periodically to operations amounts that will ultimately equal the amount of capital expenditure (see AMORTIZATION, DEPLETION, AND DEPRECIATION); (2) the replacement of the original cost of an asset plus interest; (3) the process of regaining the net investment in a project by means of revenue in excess of the costs from the project. (Usually implies amortization of principal plus interest on the diminishing unrecovered balance.) (11/90)

CAPITAL RECOVERY FACTOR - a factor used to calculate the sum of money required at the end of each of a series of periods to regain the net investment of a project plus the compounded interest on the unrecovered balance. (11/90)

CAPITAL, SUSTAINING - the fixed capital requirements to (1) maintain the competitive position of a project throughout its commercial life by improving product quality, related services, safety, or economy, or (2) required to replace facilities which wear out before the end of the project life. (11/90)

CAPITAL, TOTAL - sum of fixed and working capital. (11/90)

CAPITAL, VENTURE - capital invested in technology or markets new at least to the particular organization. (11/90)

CAPITAL, WORKING - the funds in addition to fixed capital and land investment which a company must contribute to the project (excluding startup expense) to get the project started and meet subsequent obligations as they come due. Working capital includes inventories, cash and accounts receivable minus accounts payable. Characteristically, these funds can be converted readily into cash. Working capital is normally assumed recovered at the end of the project. (11/90)

CAPITALIZED COST - (1) the present worth of a uniform series of periodic costs that continue for an indefinitely long time (hypothetically infinite); (2) the value at the purchase date of the asset of all expenditures to be made in reference to this asset over an indefinite period of time. This cost can also be regarded as the sum of capital which, if invested in a fund earning a stipulated interest rate, will be sufficient to provide for all payments required to maintain the asset in perpetual service. (11/90)

CASH COSTS - total cost excluding capital and depreciation spent on a regular basis over a period of time, usually one year. Cash costs consist of manufacturing cost and other expenses such as transportation cost, selling expense, research and development cost or corporate administrative expense. (11/90)

CASH FLOW - the net flow of dollars into or out of a project. The algebraic sum, in any time period, of all cash receipts, expenses, and investments. Also called cash proceeds or cash generated. The stream of monetary (dollar) values -- costs and benefits -- resulting from a project investment. [A] (11/90)

CASH RETURN, PERCENT OF TOTAL CAPITAL - ratio of average depreciation plus average profit, to total fixed and working capital, for a year of capacity sales. Under certain limited conditions, this figure closely approximates that calculated by profitability index techniques where it is defined as the difference, in any time period, between revenues and all cash expenses, including taxes. (11/90)

CAUSATION - an explanation or description of the facts and circumstances that produce a result, the cause and effect for which the contractor claims entitlement to compensation from the owner under the contract. (11/90)

CHAIN INDEX - an index which globally measures the price change of a range of commodities. (11/90)

CHANGE - alteration or variation to a scope of work and/or the schedule for completing the work. (11/90)

CHANGE, CARDINAL - work that is beyond the scope of that specified in the contract and consequently unauthorized. The basic tests for a cardinal change are whether the type of work was within the contemplation of the parties when they entered into the contract and whether the job as modified is still the same basic job. (11/90)

CHANGE, CONSTRUCTIVE - an act or failure to act by the owner or the engineer that is not a directed change, but which has the effect of requiring the contractor to accomplish work different from that required by the existing contract documents. (11/90)

CHANGE IN SCOPE - a change in objectives (either in quality or quantity of the specifications and/or material), work plan, or schedule that results in a material difference from the terms of an approval to proceed previously granted by higher authority. Under certain conditions (normally so stated in the approval instrument), a change in resource applications may constitute a change in scope. (11/90)

CHANGE ORDER - a document requesting a scope change or correction. It must be approved by both the client and the contractor before it becomes a legal change to the contract. (11/90)

CHANGE, UNILATERAL - see MODIFICATION, UNILATERAL. (11/90)

CHANGE IN SEQUENCE - a change in the order of work initially specified or planned by the contractor. If this change is ordered by the owner and results in additional cost to the contractor, the contractor may be entitled to recovery under the changes clause. (11/90)

CHANGED CONDITIONS - see DIFFERING SITE CONDITIONS. (11/90)

CHART OF ACCOUNTS - see CODE OF ACCOUNTS. (11/90)

CHEBYSHEV'S THEOREM - a statistical method of predicting the probability that a value will occur within one or more standard deviations (±) of the mean. (11/90)

CHEMICAL ENGINEERING PLANT COST INDEX - an index tailor-made specifically for chemical plant construction, composed of many subindexes for the various components of a chemical plant. (11/90)

CLAIM - a written statement requesting additional time and/or money for acts or omissions during the performance of the construction contract. The contract must set forth the facts and circumstances for which the owner or the engineer is responsible to be entitled to additional compensation and/or time. (11/90)

CODE OF ACCOUNTS (COA) - A systematic coding structure for organizing and managing asset, cost, resource, and schedule activity information. A COA is essentially an index to facilitate finding, sorting, compiling, summarizing, and otherwise managing information that the code is tied to. A complete code of accounts includes definitions of the content of each account. Syns.: Chart of Accounts, Cost Codes. (1/03)

COMMITMENTS - the sum of all financial obligations made, including incurred costs and expenditures as well as obligations, which will not be performed until later. (11/90)

COMMODITY - in price index nomenclature, a good and sometimes a service. (11/90)

COMPLETED ACTIVITY - an activity with an actual finish date. (11/90)

COMPOSITE PRICE INDEX - an index which globally measures the price change of a range of commodities. (11/90)

COMPOUND AMOUNT - the future worth of a sum invested (or loaned) at compound interest. (11/90)

COMPOUND AMOUNT FACTOR - (1) the function of interest rate and time that determines the compound amount from a stated initial sum; (2) a factor which when multiplied by the single sum or uniform series of payments will give the future worth at compound interest of such single sum or series. (11/90)

COMPOUND INTEREST - (1) the type of interest that is periodically added to the amount of investment (or loan) so that subsequent interest is based on the cumulative amount; (2) the interest charges under the condition that interest is charged on any previous interest earned in any time period, as well as on the principal. (11/90)

COMPOUNDING, CONTINUOUS - (1) a compound interest situation in which the compounding period is zero and the number of periods infinitely great. A mathematical concept that is practical for dealing with frequent compounding and small interest rates; (2) a mathematical procedure for evaluating compound interest factors based on a continuous interest function rather than discrete interest periods. (11/90)

COMPOUNDING PERIOD - the time interval between dates at which interest is paid and added to the amount of an investment or loan. Designates frequency of compounding. (11/90)

CONCEPTUAL SCHEDULE - a conceptual schedule is similar to a proposal schedule except it is usually time-scaled and is developed from the abstract design of the project. This schedule is used primarily to give the client a general idea of the project scope and an overview of activities. Most conceptual schedules contain between 30 and 200 activities. (11/90)

CONFLICT IN PLANS AND SPECIFICATIONS - statements or meanings in the contract documents (including drawings and specifications) that cannot be reconciled by reasonable interpretation on the part of the contractor and which may require the owner to provide an interpretation between alternatives. (11/90)

CONSENT OF SURETY - an acknowledgement by a surety that its bond, given in connection with a contract, continues to apply to the contract as modified; or, at the end of a contract, permission from the surety to release all retainage to the contractor. (11/90)

CONSTANT BASKET - a set of goods and services with quantities fixed in relation to a given time period, used for computing composite price indexes. (11/90)

CONSTANT BASKET PRICE INDEX - a price index which measures price changes by comparing the expenditures necessary to provide the same set of goods and services at different points in time. (11/90)

CONSTANT DOLLARS - dollars of uniform purchasing power exclusive of general inflation or deflation. Constant dollars are tied to a reference year. [A] (11/90)

CONSTANT UTILITY PRICE INDEX - a composite price index which measures price changes by comparing the expenditures necessary to provide substantially equivalent sets of goods and services at different points in time. (11/90)

CONSTRAINT - an externally imposed factor affecting the scheduling of an activity. The external factor may be a resource, such as labor, cost or equipment, or, it can be a physical event that must be completed prior to the activity being restrained. Syn.: RESTRAINT. (11/90)

CONSTRAINT DATE - see PLUG DATE. (11/90)

CONSTRUCTION COST - the sum of all costs, direct and indirect, inherent in converting a design plan for material and equipment into a project ready for start-up, but not necessarily in production operation; the sum of field labor, supervision, administration, tools, field office expense, materials, and equipment. (11/90)

CONSTRUCTION MANAGEMENT - Project management as applied to construction. (11/90)

CONSUMABLES - supplies and materials used up during construction. Includes utilities, fuels and lubricants, welding supplies, worker's supplies, medical supplies, etc. (11/90)

CONSUMERS PRICE INDEX (CPI) - a measure of time-to-time fluctuations in the price of a quantitatively constant market basket of goods and services, selected as representative of a special level of living. (11/90)

CONTINGENCY - An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, and/or effect is uncertain and that experience shows will likely result, in aggregate, in

additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience. Contingency usually excludes; 1) major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project (see management reserve), 2) extraordinary events such as major strikes and natural disasters, 3) management reserves, and 4) escalation and currency effects. Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended. (1/04)

CONTRACTOR - a business entity that enters into contracts to provide goods or services to another party. (11/90)

CONTRACT COMPLETION DATE - the date established in the contract for completion of all or specified portions of the work. This date may be expressed as a calendar date or as a number of days after the date for commencement of the contract time is issued. (11/90)

CONTRACT DATE - any date specified in the contract or imposed on any project activity or event that impacts the activity/project schedule. Syn.: SCHEDULED DATE. (11/90)

CONTRACT DOCUMENTS - the agreement, addenda (which pertain to the contract documents), contractor's bid (including documentation accompanying the bid and any post-bid documentation submitted prior to the notice of award) when attached as an exhibit to the agreement, the bonds, the general conditions, the supplementary conditions, the specifications and the drawings as the same are more specifically identified in the agreement, together with all amendments, modifications and supplements issued pursuant to the general conditions on or after the effective date of the agreement. (11/90)

CONTRACT PRICE - the monies payable by the owner to the contractor under the contract documents as stated in the agreement. (11/90)

CONTRACT "READ AS A WHOLE" - reading an entire contract document, instead of reading each clause in the contract in isolation. If a clause is ambiguous and can be interpreted in more than one way, the meaning that conforms to the rest of the document is usually the accepted meaning. (11/90)

CONTRACT TIME - the number of days within which, or the dates by which, the work, or any specified part thereof, is to be completed. (11/90)

CONTRACT WORK BREAKDOWN STRUCTURE (CWBS) - see WORK BREAKDOWN STRUCTURE. (11/90)

CONTRACTS - legal agreements between two or more parties, which may be of the types enumerated below:

1. In Cost Plus contracts the contractor agrees to furnish to the client services and material at actual cost, plus an agreed upon fee for these services. This type of contract is employed most often when the scope of services to be provided is not well defined.

    a. Cost Plus Percentage Burden and Fee - the client will pay all costs as defined in the terms of the contract, plus "burden and fee" at a specified percent of the labor costs which the client is

paying for directly. This type of contract generally is used for engineering services. In contracts with some governmental agencies, burden items are included in indirect cost.

b. Cost Plus Fixed Fee - the client pays costs as defined in the contract document. Burden on reimbursable technical labor cost is considered in this case as part of cost. In addition to the costs and burden, the client also pays a fixed amount as the contractor's "fee".

c. Cost Plus Fixed Sum - the client will pay costs defined by contract plus a fixed sum which will cover "non-reimbursable" costs and provide for a fee. This type of contract is used in lieu of a cost plus fixed fee contract where the client wishes to have the contractor assume some of the risk for items which would be Reimbursable under a Cost Plus Fixed Fee type of contract.

d. Cost Plus Percentage Fee - the client pays all costs, plus a percentage for the use of the contractor's organization.

2. Fixed Price types of contract are ones wherein a contractor agrees to furnish services and material at a specified price, possibly with a mutually agreed upon escalation clause. This type of contract is most often employed when the scope of services to be provided is well defined.

a. Lump Sum - contractor agrees to perform all services as specified by the contract for a fixed amount. A variation of this type may include a turn-key arrangement where the contractor guarantees quality, quantity and yield on a process plant or other installation.

b. Unit Price - contractor will be paid at an agreed upon unit rate for services performed. For example, technical work-hours will be paid for at the unit price agreed upon. Often field work is assigned to a subcontractor by the prime contractor on a unit price basis.

c. Guaranteed Maximum (Target Price) - a contractor agrees to perform all services as defined in the contract document guaranteeing that the total cost to the client will not exceed a stipulated maximum figure. Quite often, these types of contracts will contain special share-of-the-saving arrangements to provide incentive to the contractor to minimize costs below the stipulated maximum.

d. Bonus-Penalty - a special contractual arrangement usually between a client and a contractor wherein the contractor is guaranteed a bonus, usually a fixed sum of money, for each day the project is completed ahead of a specified schedule and/or below a specified cost, and agrees to pay a similar penalty for each day of completion after the schedule date or over a specified cost up to a specified maximum either way. The penalty situation is sometimes referred to as liquidated damages. (11/90)

CONTROL - management action, either preplanned to achieve the desired result or taken as a corrective measure prompted by the monitoring process. (11/90)

CORRECTION PERIOD - the period of time within which the contractor shall promptly, without cost to the owner and in accordance with the owner's written instructions, either correct defective work, or if it has been rejected by the owner, remove it from the site and replace it with nondefective work, pursuant to the general conditions. (11/90)

COST - in project control and accounting, it is the amount measured in money, cash expended or liability incurred, in consideration of goods and/or services received. From a total cost management perspective,

cost may include any investment of resources in strategic assets including time, monetary, human, and physical resources. (1/02)

COST ACCOUNTING - The historical reporting of actual and/or committed disbursements (costs and expenditures) on a project. Costs are denoted and segregated within cost codes that are defined in a chart of accounts. In project control practice, cost accounting provides the measure of cost commitment and/or expenditure that can be compared to the measure of physical completion (or earned value) of an account. (1/03)

COST ANALYSIS - a historical and/or predictive method of ascertaining for what purpose expenditures on a project were made and utilizing this information to project the cost of a project as well as costs of future projects. The analysis may also include application of escalation, cost differentials between various localities, types of buildings, types of projects, and time of year. (11/90)

COST APPROACH - one of the three approaches in the appraisal process. Underlying the theory of the cost approach is the principle of substitution, which suggests that no rational person will pay more for a property than the amount with which he/she can obtain, by purchase of a site and construction of a building without undue delay, a property of equal desirability and utility. (11/90)

COST AND SCHEDULE CONTROL SYSTEMS CRITERIA (C/SCSC) - established characteristics that a contractor's internal management control system must possess to assure effective planning and control of contract work, costs, and schedules. (11/90)

COST CATEGORY - the name and number, or both, of a function, hardware, or other significant cost category for which costs are to be summarized. (11/90)

COST CONTROL - the application of procedures to monitor expenditures and performance against progress of projects or manufacturing operations; to measure variance from authorized budgets and allow effective action to be taken to achieve minimum costs. (11/90)

COST ENGINEER - an engineer whose judgment and experience are utilized in the application of scientific principles and techniques to problems of estimation; cost control; business planning and management science; profitability analysis; project management; and planning and scheduling. (11/90)

COST ESTIMATE - A prediction of quantities, cost, and/or price of resources required by the scope of an asset investment option, activity, or project. As a prediction, an estimate must address risks and uncertainties. Estimates are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes. Cost estimates are determined using experience and calculating and forecasting the future cost of resources, methods, and management within a scheduled time frame. Included in these costs are assessments and an evaluation of risks. See COST ESTIMATE CLASSIFICATION. (1/04)

COST ESTIMATE CATEGORY. See COST ESTIMATE CLASSIFICATION SYSTEM. (1/04)

COST ESTIMATE CLASS. See COST ESTIMATE CLASSIFICATION SYSTEM. (1/04)

COST ESTIMATE CLASSIFICATION–There are numerous characteristics that can be used to categorize project cost estimate types. Some of these characteristics 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 to define the classification category is the degree of project definition -- the

level of project definition determines the estimate class. The other characteristics are considered secondary.

The level 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, lessons learned from past projects, reconnaissance data, and other information that must be developed to define the project. Each industry will have a typical set of defining 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 level of project definition (e.g., project engineering) progresses.

For projects, the estimate class designations that follow below are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest level of project definition, and a Class 1 estimate is closest to full project definition and maturity. This "countdown" approach considers that estimating is a process whereby successive estimates are prepared until a final estimate closes the process.

CLASS 5 ESTIMATE

(Typical level of project definition required: >0% to 2% of full project definition.)

Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended. Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

CLASS 4 ESTIMATE

(Typical level of project definition required: 1% to 15% of full project definition.)

Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.

CLASS 3 ESTIMATE

(Typical level of project definition required: 10% to 40% of full project definition.)

Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase "control estimate" against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.

CLASS 2 ESTIMATE

(Typical level of project definition required: 30% to 70% of full project definition.)

Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program.

CLASS 1 ESTIMATE

(Typical level of project definition required: 50% to 100% of full project definition.)

Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.

Syn.: COST ESTIMATE TYPE; COST ESTIMATE CLASS; COST ESTIMATE CATEGORY. See also AACE Recommended Practices No. 17R-97 "Cost Estimate Classification System" and No. 18R-97 "Cost Estimate Classification System–As Applied in Engineering, Procurement, and Construction for the Process Industries". (1/04)

COST ESTIMATE TYPE. See COST ESTIMATE CLASSIFICATION SYSTEM. (1/04)

COST ESTIMATING - A predictive process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project. As a predictive process, estimating must address risks and uncertainties. The outputs of estimating are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes.

As applied in the project engineering and construction industry, cost estimating is the determination of quantity and the predicting and forecasting, within a defined scope, of the costs required to construct and equip a facility. Costs are determined utilizing experience and calculating and forecasting the future cost of resources, methods, and management within a scheduled time frame. Included in these costs are assessments and an evaluation of risks. (1/03)

COST ESTIMATING RELATIONSHIP (CER) - In estimating, an algorithm or formula that is used to perform the costing operation. CERs show some resource (e.g., cost, quantity, or time) as a function of one or more parameters that quantify scope, execution strategies, or other defining elements. A CER may be formulated in a manner that in addition to providing the most likely resource value, also provides a probability distribution for the resource value. Cost estimating relationships may be used in either definitive or parametric estimating methods. See DEFINITIVE ESTIMATE and PARAMETRIC ESTIMATE. (1/03)

COST INDEX (PRICE INDEX) - a number which relates the cost of an item at a specific time to the corresponding cost at some arbitrarily specified time in the past. See PRICE INDEX. (11/90)

COST OF CAPITAL - A term, usually used in capital budgeting, to express as an interest rate percentage the overall estimated cost of investment capital at a given point in time, including both equity and borrowed funds. (11/90)

COST OF LOST BUSINESS ADVANTAGE - the cost associated with loss of repeat business and/or the loss of business due to required resources and costs. (11/90)

COST OF OWNERSHIP ¨ the cost of operations, maintenance, follow-on logistical support, and end item and associated support systems. Syn.: OPERATING AND SUPPORT COSTS. [D] (11/90)

COST OF QUALITY - consists of the sum of those costs associated with: (a) cost of quality conformance, (b) cost of quality nonconformance, (c) cost of lost business advantage. (11/90)

COST OF QUALITY CONFORMANCE - the cost associated with the quality management activities of appraisal, training, and prevention. (11/90)

COST OF QUALITY NONCONFORMANCE - the cost associated with deviations involving rework and/or the provision of deliverables that are more than required. (11/90)

COST VALUE - see FUNCTIONAL WORTH. (11/90)

COST-OF-LIVING INDEX - in modern usage, a price index based on a constant utility concept as opposed to a constant basket concept. (11/90)

COSTING - Cost estimating activity that translates quantified technical and programmatic scope information into expressions of the cost and resources required. In costing, this translation is usually done using algorithms or CERs. In the cost estimating process, costing follows scope determination and quantification, and precedes pricing and budgeting. (1/03)

COSTING–ACTIVITY BASED (ABC) - Costing in a way that the costs budgeted to an account truly represent all the resources consumed by the activity or item represented in the account. (1/03)

CRITERIA - a document that provides objectives, guidelines, procedures, and standards to be used to execute the development, design, and/or construction portions of a project. (11/90)

CRITICAL ACTIVITY - any activity on a critical path. (11/90)

CRITICAL PATH - One or more sequences of activities with the least amount of total float activities running from the start event to the finish event in the schedule. It is the longest time path through the schedule. (3/04)

CRITICAL PATH METHOD - a scheduling technique using arrow, precedence, or PERT diagrams to determine the length of a project and to identify the activities and constraints on the critical path. (11/90)

CRITICALITY - a measure of the significance or impact of failure of a product, process, or service to meet established requirements. (11/90)

CRUDE MATERIALS - includes products entering the market for the first time which have not been fabricated or manufactured but will be processed before becoming finished goods (e.g., steel scrap, wheat, raw cotton). Syn: Raw Materials (11/90)

CURRENT COST ACCOUNTING (CCA) - a methodology prescribed by the Financial Accounting Board to compute and report financial activities in constant dollars. (11/90)

CURRENT DOLLARS - dollars of purchasing power in which actual prices are stated, including inflation or deflation. In the absence of inflation or deflation, current dollars equal constant dollars. [A] (11/90)

CURRENT PERIOD (OF A GIVEN PRICE INDEX) - period for which prices are compared to the base period prices. (11/90)

CUSTOM IN THE INDUSTRY - an established practice in a particular industry in the general area. It may be used to show the practice to be followed in a particular circumstance. (11/90)

CYBERNETICS - (1) the field of control and communication theory in general, without specific restriction to any area of application or investigation; (2) the behavior and design of mechanisms, organisms, and/or organizations that receive and generate information and respond to it in order to attain a desired result. (11/90)

DAMAGES, ACTUAL - the increased cost to one party resulting from another party's acts or omissions affecting the contract but not incorporated into a contract modification. (11/90)

DAMAGES, LIQUIDATED - an amount of money stated in the contract as being the liability of a contractor for failure to complete the work by the designated time(s). Liquidated damages ordinarily stop at the point of substantial completion of the project or beneficial occupancy by the owner. (11/90)

DAMAGES, RIPPLE - see IMPACT COST. (11/90)

DATA DATE (DD) - the calendar date that indicates when the project has been updated. (11/90)

DATE FOR THE COMMENCEMENT OF THE CONTRACT TIME - the date when the contract time commences to run and on which the contractor shall start to perform the contractor's obligations under the contract documents. (11/90)

DECELERATION - the opposite of acceleration. A direction, either expressed or implied, to slow down job progress. (11/90)

DECISIONS UNDER CERTAINTY - simple decisions that assume complete information and no uncertainty connected with the analysis of the decisions. (11/90)

DECISIONS UNDER RISK - a decision problem in which the analyst elects to consider several possible futures, the probabilities of which can be estimated. (11/90)

DECISIONS UNDER UNCERTAINTY - a decision for which the analyst elects to consider several possible futures, the probabilities of which cannot be estimated. (11/90)

DECLINING BALANCE DEPRECIATION - method of computing depreciation in which the annual charge is a fixed percentage of the depreciated book value at the beginning of the year to which the depreciation applies. Syn: Percent on Diminishing Value (11/90)

DE-ESCALATE - a method to convert present-day costs or costs of any point in time to costs at some previous date via applicable indexes. (11/90)

DEFECT - a deviation of a severity sufficient to require corrective action. (11/90)

DEFECTIVE - an adjective which, when modifying the work, refers to work that is unsatisfactory, faulty or deficient, or does not conform to the contract documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the contract documents, or has been damaged prior to the engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by the owner at substantial completion in accordance with the contract documents). (11/90)

DEFECTIVE SPECIFICATIONS - specifications and/or drawings which contain errors, omissions, and/or conflicts, which affect or prevent the contractor's performance of the work. (11/90)

DEFECT, LATENT - a defect in the work which cannot be observed by reasonable inspection. (11/90)

DEFECT, PATENT - a defect in the work which can be observed by reasonable inspection. (11/90)

DEFINITIVE ESTIMATE - In estimating practice, describes estimating algorithms or cost estimating relationships that are not highly probabilistic in nature (i.e., the parameters or quantification inputs to the algorithm tend to be conclusive or definitive representations of the scope). Typical definitive estimate algorithms include, but are not limited to, detailed unit and line-item cost techniques (i.e., each specific quantified item is listed and costed separately). (1/03)

DEFLATION - an absolute price decline for a commodity; also, an operation by means of which a current dollar value series is transformed into a constant dollar value series (i.e., is expressed in "real" terms using appropriate price indexes as deflators). (11/90)

DELAY - to cause the work or some portion of the work to start or be completed later than planned or later than scheduled. (4/04)

DELAY, COMPENSABLE - any delay beyond the control and without the fault or negligence of the contractor resulting from the owner-caused changes in the work, differing site conditions, suspensions of the work, or termination for convenience by the owner. (11/90)

DELAY, CONCURRENT - two or more delays in the same time frame or which have an independent effect on the end date. The owner/engineer and the contractor may each be responsible for delay in completing the work. This may bar either party from assessing damage against the other. This may also refer to two or more delays by the same party during a single time period. (11/90)

DELAY, EXCUSABLE - any delay beyond the control and without the fault or negligence of the contractor or the owner, caused by events or circumstances such as, but not limited to, acts of God or of the public enemy, acts of intervenors, acts of government other than the owner, fires, floods, epidemics, quarantine restrictions, freight embargoes, hurricanes, tornadoes, labor disputes, etc. Generally, a delay caused by an excusable delay to another contractor is compensable when the contract documents specifically void recovery of delay costs. (11/90)

DELAY, INEXCUSABLE - any delay caused by events or circumstances within the control of the contractor, such as inadequate crewing, slow submittals, etc, which might have been avoided by the exercise of care, prudence, foresight, or diligence on the part of the contractor. (11/90)

DELAY, NONPREJUDICIAL - any delay impacting a portion of the work within the available total float or slack time, and not necessarily preventing completion of the work within the contract time. (11/90)

DELAY, PREJUDICIAL - any excusable or compensable delay impacting the work and exceeding the total float available in the progress schedule, thus preventing completion of the work within the contract time unless the work is accelerated. (11/90)

DELIVERABLE - a report or product of one or more tasks that satisfy one or more objectives and must be delivered to satisfy contractual requirements. (11/90)

DEMAND FACTOR - (1) the ratio of the maximum instantaneous production rate to the production rate for which the equipment was designed; (2) the ratio between the maximum power demand and the total connected load of the system. (11/90)

DEMOGRAPHIC INDEX - cost indexes developed to deal with geographic cost differences. (11/90)

DEMURRAGE - a charge made on cars, vehicles, or vessels held by or for consignor or consignee for loading or unloading, for forwarding directions or for any other purpose. (11/90)

DEPLETION - (1) a form of capital recovery applicable to extractive property (eg, mines). Depletion can be on a unit-of-output basis related to original or current appraisal of extent and value of the deposit. (Known as percentage depletion.) (2) lessening of the value of an asset due to a decrease in the quantity available. Depletion is similar to depreciation except that it refers to such natural resources as coal, oil, and timber in forests. (11/90)

DEPRECIATED BOOK VALUE - the first cost of the capitalized asset minus the accumulation of annual depreciation cost charges. (11/90)

DEPRECIATION - (1) decline in value of a capitalized asset; (2) a form of capital recovery applicable to a property with a life span of more than one year, in which an appropriate portion of the asset's value is periodically charged to current operations. (11/90)

DETAILED ENGINEERING - the detailed design, drafting, engineering, and other related services necessary to purchase equipment and materials and construct a facility. (11/90)

DETAILED SCHEDULE - a schedule which displays the lowest level of detail necessary to control the project through job completion. The intent of this schedule is to finalize remaining requirements for the total project. (11/90)

DETERMINISTIC MODEL - a deterministic model, as opposed to a Stochastic model, is one which contains no random elements and for which, therefore, the future course of the system is determined by its state at present (and/or in the past). (11/90)

DEVELOPMENT COSTS - those costs specific to a project, either capital or expense items, which occur prior to commercial sales and which are necessary in determining the potential of that project for consideration and eventual promotion. Major cost areas include process, product, and market research and development. (11/90)

DEVIATION - a departure from established requirements. A deviation in the work product may be classified as an imperfection, nonconformance, or defect, based on its severity in failing to meet or unnecessarily exceed the requirements. (11/90)

DEVIATION COSTS - the sum of those costs, including consequential costs such as schedule impact, associated with the rejection or rework of a product, process, or service due to a departure from established requirements. Also may include the cost associated with the provision of deliverables that are more than required. (11/90)

DIFFERENTIAL PRICE ESCALATION RATE - the expected percent difference between the rate of increase assumed for a given item of cost (such as energy), and the general rate of inflation. [A] (11/90)

DIFFERING SITE CONDITIONS - subsurface or latent physical conditions at the site differing materially from those conditions indicated in the contract documents or unknown physical conditions at the site, of an unusual nature, differing materially from conditions normally encountered and generally recognized as inherent in work of the nature provided for in the contract. (11/90)

DIRECT COST - (1) in construction, cost of installed equipment, material and labor directly involved in the physical construction of the permanent facility. (2) in manufacturing, service and other non-construction industries, the portion of operating costs that is generally assignable to a specific product or process area. Usually included are:

a. Input Materials
b. Operating, Supervision, and Clerical Payroll
c. Fringe Benefits
d. Maintenance
e. Utilities
f. Catalysts, Chemicals and Operating Supplies
g. Miscellaneous (Royalties, Services, Packaging, etc.)

Definitions of the above classifications are:

a. Input Material - raw materials which appear in some form as a product. For example, water added to resin formulation is an input material, but sulfuric acid catalyst, consumed in manufacturing high octane alkylate, is not.

b. Operating, Supervision, and Clerical Payroll - wages and salaries paid to personnel who operate the production facilities.

c. Fringe Benefits - payroll costs other than wages not paid directly to the employee. They include costs for:

1) Holidays, vacations, sick leave
2) Federal old age insurance
3) Pensions, life insurance, savings plans, etc.

In contracts with some governmental agencies these items are included in indirect cost.

d. Maintenance Cost - expense incurred to keep manufacturing facilities operational. It consists of:

1) Maintenance Payroll Cost
2) Maintenance Materials and Supplies Cost

Maintenance materials which have a life of more than one year are usually considered capital investment in detailed cash flow accounting.

e. Utilities - the fuel, steam, air, power and water which must be purchased or generated to support the plant operation.

f. Catalysts, Chemicals and Operating Supplies - materials consumed in the manufacturing operation, but not appearing as a product. Operating supplies are a minor cost in process industries and are

sometimes assumed to be in the maintenance materials estimate; but in many industries, mining for example, they are a significant proportion of direct cost.

g. Miscellaneous

1) Royalties - costs paid to others for the use of a proprietary process. Both paid-up and "running" royalties are used. Cost of paid-up royalties are usually on the basis of production rate. Royalties vary widely, however, and are specific for the situation under consideration.

2) Packaging Cost - material and labor necessary to place the product in a suitable container for shipment. Also called Packaging and Container Cost or Packing Cost. Sometimes considered an indirect cost together with distribution costs such as for warehousing, loading and transportation.

Although the direct costs described above are typical and in general use, each industry has unique costs which fall into the "direct cost" category. A few examples are equipment rental, waste disposal, contracts, etc. (11/90)

DISCOUNTED CASH FLOW - (1) the present worth of a sequence in time of sums of money when the sequence is considered as a flow of cash into and/or out of an economic unit; (2) an investment analysis which compares the present worth of projected receipts and disbursements occurring at designated future times in order to estimate the rate of return from the investment or project. Also called Discounted Cash Flow Rate of Return, Interest Rate of Return, Internal Rate of Return, Investor's Method or Profitability Index. (11/90)

DISCOUNTED PAYBACK PERIOD (DPB) - the time required for the cumulative benefits from an investment to pay back the investment cost and other accrued costs considering the time value of money. [A] (11/90)

DISCOUNT FACTOR - a multiplicative number (calculated from a discount formula for a given discount rate and interest period) that is used to convert costs and benefits occurring at different times to a common time. [A] (11/90)

DISCOUNTING - a technique for converting cash flows that occur over time to equivalent amounts at a common time. [A] (11/90)

DISCOUNT RATE - the rate of interest reflecting the investor's time value of money, used to determine discount factors for converting benefits and costs occurring at different times to a base time. The discount rate may be expressed as nominal or real. [A] (11/90)

DISINFLATION - a downward trend in inflation rates, effected by weak or declining demand. It may well portend deflation. (11/90)

DISPATCHING - the selecting and sequence of jobs to be run at individual work stations and the assignment of these jobs to workers. In many companies, dispatching is done by the actual shop line supervisor, set-up worker or lead worker. A dispatcher is usually a representative of the Production Control Department which handles this job assignment task. (11/90)

DISPERSION - the scattering of values from the mean. (11/90)

DISPUTE - a disagreement between the owner and the contractor as to a question of fact or contract interpretation which cannot be resolved to the mutual satisfaction of the parties. (11/90)

DISRUPTION - an action or event which hinders a party from proceeding with the work or some portion of the work as planned or as scheduled. (4/04)

DISTRIBUTABLES - the field portion of a construction project that can be associated with any specific account. Includes the field nonmanual staff, field office, office supplies, temporary construction, utilities, small tools, construction equipment, weather protection, snow removal, lost time, labor burden, etc. When completion cost reports are prepared, the distributable costs may be distributed across the direct accounts. (11/90)

DISTRIBUTION - the broad range of activities concerned with efficient movement of finished products from the end of the production line to the consumer; in some cases it may include the movement of raw materials from the source of supply to the beginning of the production line. These activities include freight transportation, warehousing, material handling, protective packaging, inventory control, plant and warehouse site selection, order processing, market and sales forecasting, customer service, attendant management information systems; and in some cases, buying activities. (11/90)

DISTRIBUTION CURVE - the graph of cumulated frequency as ordinate against the variate value as abscissa, namely the graph of the distribution function. The curve is sometimes known as an "ogive", a name introduced by Galton, because the distribution curve of a normal function is of the ogive shape; but not all distribution curves have this form and the term "ogive" is better avoided or confined to the normal or nearly normal case. (11/90)

DRAWINGS, PLANS - the drawings, plans or reproductions thereof, which show location, character, dimensions, and details of the work to be performed and which are referred to in the contract documents. (11/90)

DUMMY ACTIVITY - an activity, always of zero duration, used to show logical dependency when an activity cannot start before another is complete, but which does not lie on the same path through the network. Normally, these dummy activities are graphically represented as a dashed line headed by an arrow and inserted between two nodes to indicate a precedence relationship or to maintain a unique numbering of concurrent activities. (11/90)

DUMMY START ACTIVITY - an activity entered into the network for the sole purpose of creating a single start for the network. (11/90)

DURABLE GOODS - generally, any producer or consumer goods whose continuous serviceability is likely to exceed three years (e.g., trucks, furniture). (11/90)

DURATION - the time required to accomplish an activity. See ACTIVITY DURATION. (11/90)

DYNAMIC PROGRAMMING - a method for optimizing a set of decisions which may be made sequentially. Characteristically, each decision may be made in the light of the information embodied in a small number of observables called state variables. The incurred cost for each period is a mathematical function of the current state and decision variables, while future states are functions of these variables. The aim of the decision policy is to minimize the total incurred cost, or equivalently the average cost per period. The mathematical treatment of such decision problems involves the theory of functional equations, and usually requires a digital computer for implementation. (11/90)

EARLIEST EXPECTED COMPLETION DATE - the earliest calendar date on which the completion of an activity work package or summary item occurs. [P] (11/90)

EARLY EVENT TIME (EV) - the earliest time at which an event may occur. (11/90)

EARLY FINISH TIME (EF) - the earliest time at which an activity can be completed; equal to the early start of the activity plus its remaining duration. (11/90)

EARLY START TIME (ES) - the earliest time any activity may begin as logically constrained by the network for a specific work schedule. (11/90)

EARLY WORK SCHEDULE - predicated on the parameters established by the proposal schedule and any negotiated changes, the early work schedule defines reportable pieces of work within major areas. The format is developed into a logic network including engineering drawings, bid inquiries, purchase orders, and equipment deliveries, and can be displayed as a time-phased network. The detail of this schedule concentrates on projected engineering construction issue drawings released and equipment deliveries. The activities of the early part of construction are more defined than in the proposal or milestone schedule. (11/90)

EARNED VALUE - the periodic, consistent measurement of work performed in terms of the budget planned for that work. In criteria terminology, earned value is the budgeted cost of work performed. It is compared to the budgeted cost of work scheduled (planned) to obtain schedule performance and it is compared to the actual cost of work performed to obtain cost performance. (11/90)

EARNED VALUE CONCEPT - the measurement at any time of work accomplished (performed) in terms of budgets planned for that work, and the use of these data to indicate contract cost and schedule performance. The earned value of work done is quantified as the budgeted cost for work performed (BCWP) compared to the budgeted cost for work scheduled (BCWS) to show schedule performance and compared to the actual cost of work performed (ACWP) to indicate cost performance. (11/90)

EARNED VALUE REPORTS - cost and schedule performance reports that are part of the performance measurement system. These reports make use of the earned value concept of measuring work accomplishment. (11/90)

EARNINGS VALUE - the present worth of an income producer's probable future net earnings, as prognosticated on the basis of recent and present expense and earnings and the business outlook. (11/90)

ECONOMIC EVALUATION METHODS - a set of economic analysis techniques that considers all relevant costs associated with a project investment during its study period, comprising such techniques as life-cycle cost, benefit-to-cost ratio, savings-to-investment ratio, internal rate of return, and net savings. [A] (11/90)

ECONOMIC LIFE - that period of time over which an investment is considered to be the least-cost alternative for meeting a particular objective. Syn.: PROJECT LIFE. [A] (11/90)

ECONOMIC RETURN - the profit derived from a project or business enterprise without consideration of obligations to financial contributors and claims of others based on profit. (11/90)

ECONOMIC VALUE - the value of property in view of all its expected economic uses, as distinct from its value in view of any particular use. Also, economic value reflects the importance of a property as an economic means to an end, rather than as an end in itself. (11/90)

ECONOMY - the cost or profit situation regarding a practical enterprise or project as in economy study, engineering economy, and project economy. (11/90)

EFFECTIVE DATE OF THE AGREEMENT - the date indicated in the agreement on which it becomes effective, but if no such date is indicated, the date on which the agreement is signed and delivered by the last of the two parties to sign and deliver. (11/90)

EFFECTIVE INTEREST - the true value of interest rate computed by equations for compound interest rate for a l-year period. (11/90)

EFFICIENCY - the ratio of the effective or useful output to the total input in a project. (4/04)

ELEMENTARY COMMODITY GROUPS (ELEMENTARY GROUPS) - the lowest level of goods and services for which a consistent set of value weights is available (11/90)

ENDING EVENT - the event that signifies the completion of all activities leading to that event. (11/90)

ENDING NODE OF NETWORK (ADM) - a node where no activities begin, but one or more activities end. (11/90)

END NETWORK EVENT - the event that signifies the end of a network. (11/90)

ENDOWMENT - a fund established for the support of some project or succession of donations or financial obligations. (11/90)

ENGINEER (IN CONTRACTS) - the individual, partnership, corporation, joint venture, or any combiantion thereof, named as the engineer in the agreement who will have the rights and authority assigned to the engineer in the contract documents. The term "the engineer" means the engineer or the engineer's authorized representative. (11/90)

ENTERPRISE - in total cost management, any endeavor, business, government, group, individual or other entity that owns, controls, or operates strategic assets. (1/02)

EQUITABLE ADJUSTMENT - a change in the contract price and/or time to compensate the contractor for expense or delay incurred due to the actions or lack of action of the owner or the owner's representatives or other occurrences, or to compensate the owner for contract reductions. The objective of an equitable adjustment is to put the contractor on the same relative financial position after the change as before the change. (11/90)

EQUIVALENT SETS OF COMMODITIES - sets of commodities which provide the same total satisfaction to a given group of consumers (without necessarily being identical). (11/90)

EQUIVALENT UNIFORM ANNUAL VALUE - See ANNUAL VALUE. [A] (11/90)

ERROR - any item or activity in a system that is performed incorrectly, resulting in a deviation, e.g., design error, fabrication error, construction error, etc. An error requires an evaluation to determine what corrective action is necessary. (11/90)

ERRORS AND OMISSIONS - deficiencies, usually in design or drafting, in the plans and specifications that must be corrected in order for the facility to operate properly. Errors in plans and specifications are normally items that are shown incorrectly, while omissions are normally items that are not shown at all. (11/90)

ESCALATION - the provision in actual or estimated costs for an increase in the cost of equipment, material, labor, etc, over that specified in the purchase order or contract due to continuing price level changes over time. (11/90)

ESCALATOR CLAUSE - clause contained in collective agreements, providing for an automatic price adjustment based on changes in specified indices. (11/90)

ESTEEM VALUE - see FUNCTIONAL WORTH. (11/90)

ESTIMATE, COST - see COST ESTIMATE, COST ESTIMATE CLASSIFICATION. (1/04)

ESTIMATE, COST–BUDGET ESTIMATE - see COST ESTIMATE CLASSIFICATION–CLASS 4 ESTIMATE, COST ESTIMATE CLASSIFICATION–CLASS 3 ESTIMATE. (1/04)

ESTIMATE, COST–DEFINITIVE ESTIMATE - see COST ESTIMATE CLASSIFICATION–CLASS 2 ESTIMATE, COST ESTIMATE CLASSIFICATION–CLASS 1 ESTIMATE. (1/04)

ESTIMATE, COST - ORDER OF MAGNITUDE ESTIMATE - see COST ESTIMATE CLASSIFICATION–CLASS 5 ESTIMATE. (1/04)

ESTIMATE-TO-COMPLETE - the estimated workhours, costs, and time and/or materials required to complete a work package or summary item (includes applicable overhead unless only direct costs are specified). (11/90)

EVENT - an identifiable single point in time on a project. Graphically, it is represented by a node. An event occurs only when all work preceding it has been completed. It has zero duration. [P] (11/90)

EVENT NAME - an alphanumeric description of an event. [P] (11/90)

EVENT NUMBER - a numerical description of an event for computation and identification. (11/90)

EVENT SLACK - the difference between the latest allowable date and the earliest date for an event. (11/90)

EVENT TIMES - time information generated through the network analysis calculation, which identifies the start and finish times for each event in the network. (11/90)

EXCHANGE VALUE - see FUNCTIONAL WORTH. (11/90)

EXEMPT EMPLOYEES - employees exempt from federal wage and hours guidelines. (11/90)

EXPANSION - any increase in the capacity of a plant facility or unit, usually by added investment. The scope of its possible application extends from the elimination of problem areas to the complete replacement of an existing facility with a larger one. (11/90)

EXPECTATION - the expected value of a function of variate values is its mean value in repeated sampling. Thus, if $t(x_1,x_2,...,x_n)$ is some statistic dependent on variates $x_1,x_2,...,x_n$ with a joint distribution $dF(x_1,x_2,...x_n)$ the expected value of t, if it exists, is

$$\int t(x_1,x_2,...,x_n)dF(x_1,x_2,...,x_n)$$

The "expected" value is not necessarily the most frequently occurring value or even a possible value; eg, if a variate can take each of the values 0 and 1 with a probability 1/2 and no other value is possible, the expected value is 1/2. (11/90)

EXPECTED BEGIN DATE - begin date assigned to a specific activity. Syn.: TARGET START DATE. (11/90)

EXPENSE - expenditures of short-term value, including depreciation, as opposed to land and other fixed capital. For factory expense, see PLANT OVERHEAD. (11/90)

EXTRAPOLATION - to infer from values within an observed interval, or to project or extend beyond observed data. (11/90)

EXPECTED DURATION - the length of time anticipated for a particular activity in the PERT method or in arrow or precedence diagramming methods (ADM, PDM). (11/90)

EXPECTED ELAPSED TIME - statistically weighted time estimates or a single knowledgeable estimate for activity duration. If a weighted or mean time estimate, it incorporates an optimistic (a) most likely (m) and pessimistic (b) estimate for the work to be accomplished. (11/90)

FACTOR ANALYSIS - a branch of multivariate analysis in which the observed variates $x_i (i=1,2...,p)$ are supposed to be expressible in terms of a number $m<p$ factors f_j. together with residual elements. (11/90)

FACTORY EXPENSE - see PLANT OVERHEAD. (11/90)

FAIR VALUE - that estimate of the value of a property that is reasonable and fair to all concerned, after every proper consideration has been given due weight. (11/90)

FEE - the charge for the use of one's services to the extent specified in the contract. (11/90)

FEEDBACK - information (data) extracted from a process or situation and used in controlling (directly) or in planning or modifying immediate or future inputs (actions or decisions) into the process or situation. (11/90)

FEEDBACK LOOP - the part of a closed-loop system which allows the comparison of a response to a command. (11/90)

FIELD COST - engineering and construction costs associated with the construction site rather than with the home office. (11/90)

FIELD LABOR OVERHEAD - the sum of the cost of payroll burden, temporary construction facilities, consumables, field supervision, and construction tools and equipment. (11/90)

FIELD ORDER - a written order issued by the engineer to the contractor which orders minor changes in the work but which does not involve an adjustment in the contract price or the contract time. (11/90)

FIELD SUPERVISION - the cost of salaries and wages of all field supervisory and field support staff personnel (excluding general foreman), plus associated payroll burdens, home office overhead, living and travel allowances, and field office operating costs. (11/90)

FIFO (First In, First Out) - a method of determining the cost of inventory used in a product. In this method, the costs of materials are transferred to the product in chronological order. Also used to describe the movement of materials. see LIFO. (11/90)

FINANCIAL LIFE - see VENTURE LIFE. (11/90)

FINISHED GOODS - commodities that will not undergo any further processing and are ready for sale to the user (e.g., apparel, automobiles, bread). (11/90)

FIRST COST - costs incurred in placing a facility into service, including but not limited to costs of planning, design, engineering, site acquisition and preparation, construction, purchase, installation, property taxes paid and interest during the construction period, and construction-related fees. Syn.: INITIAL INVESTMENT COST; INITIAL COST. [A] (11/90)

FIRST EVENT NUMBER - the number of the first event in time for a work package or summary item. This event number defines the beginning of the work package or summary item in relation to the network. (11/90)

FIXED COST - those costs independent of short term variations in output of the system under consideration. Includes such costs as maintenance; plant overhead; and administrative, selling and research expense. For the purpose of cash flow calculation, depreciation is excluded (except in income tax calculations). (11/90)

FIXED-PRICE CONTRACT - a contract where the contractor agrees to furnish services and material at a specified price, possibly with a mutually agreed-upon escalation clause. This type of contract is most often employed when the scope of services to be provided is well defined. (11/90)

FLOAT - (1) in manufacturing, the amount of material in a system or process, at a given point in time, that is not being directly employed or worked upon. (2) in construction, the cushion or slack in any noncritical path in a network planning system. Syn.: SLACK; PATH FLOAT. [P] (11/90)

FORECAST - an estimate and prediction of future conditions and events based on information and knowledge available at the time of the forecast. (11/90)

FORWARD PASS - (1) in construction, network calculations which determine the earliest start/earliest finish time (date) of each activity. (2) in manufacturing, often referred to as forward scheduling, a scheduling technique where the scheduler proceeds from a known start date and computes the completion date for an order usually proceeding from the first operation to the last. (11/90)

FRACTILE - a selected portion of a distribution of values (e.g., quartile). (11/90)

FRAGNET - a portion or fragment of a CPM network usually used to illustrate changes to the whole network. (11/90)

FREE FLOAT (FF) - the amount of time that the completion of an activity may exceed its scheduled finish time without increasing the start time of any succeeding activity. (11/90)

FREE HAUL - the distance every cubic yard of excavated material is entitled to be moved without an additional charge for haul. (11/90)

FREQUENCY DISTRIBUTION - a specification of the way in which the frequencies of members of a population are distributed according to the values of the variates which they exhibit. For observed data the distribution is usually specified in tabular form, with some grouping for continuous variates. A conceptual distribution is usually specified by a frequency function or a distribution function. (11/90)

FREQUENCY FUNCTION - an expression giving the frequency of a variate value x as a function of x; or, for continuous variates, the frequency in an elemental range dx. Unless the contrary is specified, the total frequency is taken to be unity, so that the frequency function represents the proportion of variate values x. From a more sophisticated standpoint the frequency function is most conveniently regarded as the derivative of the Distribution Function. The derivative is also commonly called the probability density function. The generalization to more than one variate is immediate. (11/90)

FREQUENCY THEORY OF PROBABILITY - the frequency theory of probability regards the probability of an event as the limit of the frequency of occurrence of that event in a series of n trials as n tends to infinity. The existence of this limit is an axiom of the theory as proposed by von Mises (1919), but later axiomatizations, eg, by Kolmogoroff (1933) avoid the difficulties associated with it by taking the probability as a measure associated with a set of points (events) and proceeding on the basis of measure theory. This avoids the difficulty only for a mathematician. For the statistician the problem of relating probability to frequency of occurrence remains. (11/90)

FRINGE BENEFITS - employee welfare benefits, ie, expenses of employment such as holidays, sick leave, health and welfare benefits, retirement fund, training, supplemental union benefits, etc. (11/90)

FUNCTION - an expression of conceptual relationships useful in model formulations (e.g., productivity is a function of hours worked). (11/90)

FUNCTIONAL REPLACEMENT COST - the current cost of acquiring the same service potential as embodied by the asset under consideration. (11/90)

FUNCTIONAL USE AREA - the net usable area of a building or project -- exclusive of storage, circulation, mechanical, and similar types of space. (11/90)

FUNCTIONAL SYSTEM - an assembly of parts or components and/or subsystems having one primary end use in the project. It should be noted that secondary and tertiary uses for functional systems are common. (11/90)

FUTURE VALUE - the value of a benefit or a cost at some point in the future, considering the time value of money. Syn.: FUTURE WORTH. [A] (11/90)

FUNCTIONAL WORTH - the lowest overall cost for performing a function. Four types are as follows:

Cost Value - the monetary sum of labor, material, burden, and all other elements of cost required to produce an item or provide a service.

Esteem Value - the monetary measure of the properties of a product or service, which contribute to desirability or salability but not to required functional performance.

Exchange Value - the monetary sum at which a product or service can be traded.

Use Value - the monetary measure of the necessary functional properties of a product or service that contribute to performance. (11/90)

FUTURE WORTH - see FUTURE VALUE. [A] (11/90)

GANTT CHART - see BAR CHART. (11/90)

GENERAL PURPOSE INDEX - a broad-based index designed to reflect general changes in the economy (eg, Gross National Expenditures Implicit Price Index). (11/90)

GENERAL TERMS AND CONDITIONS - that part of a contract, purchase order, or specification that is not specific to the particular transaction but applies to all transactions. (11/90)

GENERAL OVERHEAD - the fixed cost in operation of a business. General overhead is also associated with office, plant, equipment, staffing, and expenses thereof, maintained by a contractor for general business operations. The costs of general overhead are not specifically applicable to any given job or project. See OVERHEAD. (11/90)

GENERAL REQUIREMENTS - distributables and field costs. (11/90)

GIVEN YEAR - the year or period selected for comparison, relative to the base year or base period. (11/90)

GROSS AREA - Generally, the sum of all the floor or slab areas of a project that are enclosed by the exterior skin of the building. (11/90)

GROSS NATIONAL PRODUCT (GNP) - the total national output of goods and services at the market prices for the stated year. (11/90)

GUIDELINE - a document that recommends methods to be used to accomplish an objective. (11/90)

HAMMOCK - an aggregate or summary activity spanning the nodes of two or more activities and reported at a summary management level. (11/90)

HANGER - a beginning or ending node not intended in the network (a break in a network path). (11/90)

HAUL DISTANCE - the distance measured along the center line or most direct practical route between the center of mass of excavation and the center of mass finally placed. It is the average distance material is moved by a vehicle. (11/90)

HEDGE - in master production scheduling, a quantity of stock used to protect against uncertainty in demand. The hedge is similar to safety stock, except that a hedge has the dimension of timing as well as amount. (11/90)

HIGHEST AND BEST USE - the valuation concept that requires consideration of all appropriate purposes or uses of the subject property in order to determine the most profitable likely utilization. (11/90)

HISTOGRAM - see BLOCK DIAGRAM. (11/90)

HOLDING TIME - time that an item is not operational so that it may be serviced. (11/90)

HOME OFFICE COST - those necessary costs involved in the conduct of everyday business, which can be directly assigned to specific projects, processes, or end products, such as engineering, procurement, expediting, legal fees, auditor fees inspection, estimating, cost control, taxes, travel, reproduction, communications, etc. (11/90)

IDEAL INDEX - the geometric mean of the Laspeyres index and the Paasche index. (11/90)

IDLE EQUIPMENT COST - the cost of equipment that remains on site ready for use but is placed in a standby basis. Ownership or rental costs are still incurred while the equipment is idle. (11/90)

IMPACT COST - added expenses due to the indirect results of a changed condition, delay, or changes that are a consequence of the initial event. Examples of these costs are premium time, lost efficiency, and extended field and home office overhead. (4/04)

IMPERFECTION - a deviation that does not affect the use or performance of the product, process, or service. In practice, imperfections are deviations that are accepted as-is. (11/90)

IMPOSED DATE - a date externally assigned to an activity that establishes the earliest or latest date in which the activity is allowed to start or finish. (11/90)

IMPOSED FINISH DATE - a predetermined calendar date set without regard to logical considerations of the network, fixing the end of an activity and all other activities preceding that ending node. (11/90)

IMPOSSIBILITY - An inability to meet contract requirements because it was in fact physically impossible to do so (Actual Impossibility). (11/90)

IMPRACTICABILITY - inability to perform because of extreme and unreasonable difficulty, expense, injury, or loss involved. This is sometimes considered Practical Impossibility. (11/90)

IMPUTATION (OF PRICE MOVEMENT) - the assignment of known price changes to a certain commodity on the basis of the assumed similarity of price movement. (11/90)

INCOME - used interchangeably with profit. Avoid using Income instead of Sales Revenue. See PROFIT. (11/90)

INCREMENTAL COSTS (BENEFITS) - The additional cost (benefit) resulting from an increase in the investment in a project. Syn.: MARGINAL COST (BENEFIT). [A] (11/90)

INDEPENDENT EVENT - an event which in no way affects the probability of the occurrence of another event. (11/90)

INDIRECT COSTS - (1) in construction, all costs which do not become a final part of the installation, but which are required for the orderly completion of the installation and may include, but are not limited to, field administration, direct supervision, capital tools, startup costs, contractor's fees, insurance, taxes, etc; (2) In manufacturing, costs not directly assignable to the end product or process, such as overhead and general purpose labor, or costs of outside operations, such as transportation and distribution. Indirect manufacturing cost sometimes includes insurance, property taxes, maintenance, depreciation, packaging, warehousing and loading. In government contracts, indirect cost is often calculated as a fixed percent of direct payroll cost. (11/90)

INDIVIDUAL PRICE INDEX - an index which measures the price change for a particular commodity and which may be computed as the ratio of its prices at two points in time. (11/90)

INEFFICIENCY - level of production or performance that is less than that which could have been achieved under as-planned normal working conditions. Some of the causes that may lead to inefficient performance are changes, delays, and differing site conditions. (4/04)

INFLATION - a rise in the general price level, usually expressed as a percentage rate. [A] (11/90)

INITIAL COST - see FIRST COST. [A] (11/90)

INITIAL INVESTMENT COST - see FIRST COST. [A] (11/90)

IN-PLACE VALUE - value of a physical property, i.e., market value plus costs of transportation to site and installation. (11/90)

IN-PROGRESS INVENTORY - see WORK-IN-PROCESS. (11/90)

IN-PROGRESS ACTIVITY - an activity that has been started but is not completed on the reporting date. (11/90)

INPUT-OUTPUT ANALYSIS - a matrix which provides a quantitative framework for the description of an economic unit. Basic to input-output analysis is a unique set of input-output ratios for each production and distribution process. If the ratios of input per unit of output are known for all production processes, and if the total production of each end product of the economy, or of the section being studied is known, it is possible to compute precisely the production levels required at every intermediate stage to supply the total sum of end products. Further, it is possible to determine the effect at every point in the production process of a specified change in the volume and mix of end products. (11/90)

INTANGIBLES - (1) in economy studies, conditions or economy factors that cannot be readily evaluated in quantitative terms as in money; (2) in accounting, the assets that cannot be reliably evaluated (e.g., goodwill). (11/90)

INTEREST - (1) financial share in a project or enterprise; (2) periodic compensation for the lending of money; (3) in economy study, synonymous with required return, expected profit, or charge for use of capital; (4) the cost for the use of capital. Sometimes referred to as the Time Value of Money. (11/90)

INTEREST RATE - the ratio of the interest payment to the principal for a given unit of time and is usually expressed as a percentage of the principal. (11/90)

INTEREST RATE, COMPOUND - the rate earned by money expressed as a constant percentage of the unpaid balance at the end of the previous accounting period. Typical time periods are yearly, semiannually, monthly, and instantaneous. (11/90)

INTEREST RATE, EFFECTIVE - an interest rate for a stated period (per year unless otherwise specified) that is the equivalent of a smaller rate of interest that is more frequently compounded. (11/90)

INTEREST RATE, NOMINAL - the customary type of interest rate designation on an annual basis without consideration of compounding periods. A frequent basis for computing periodic interest payments. (11/90)

INTEREST RATE OF RETURN - see PROFITABILITY INDEX. (11/90)

INTERFACE ACTIVITY - an activity connecting an event in one subnetwork with an event in another subnetwork, and representing a logical or imposed interdependence between them. (11/90)

INTERFACE NODE - a common node for two or more subnets representing logical interdependence. (11/90)

INTERFERENCE - conduct that interrupts the normal flow of operations and impedes performance. A condition implied in every construction contract is that neither party will do anything to hinder the performance of the other party. (11/90)

INTERIM DATES - dates established in the contract designating the start or the completion of designated facilities or features of a facility. Interim dates are also referred to as Intermediate Access or Intermediate Completion Dates. (11/90)

INTERMEDIATE EVENTS - detailed events and activities, the completion of which are necessary for and lead to the completion of a major milestone. (11/90)

INTERMEDIATE MATERIALS - commodities that have been processed but require further processing before they become finished goods (e.g., fabric, flour, sheet metal). (11/90)

INTERMEDIATE NODE - a node where at least one activity begins and one activity ends. (11/90)

INTERNAL RATE OF RETURN (IRR) - the compound rate of interest that, when used to discount study period costs and benefits of a project, will make the two equal. See PROFITABILITY INDEX. [A] (11/90)

INVENTORY - raw materials, products in process, and finished products required for plant operation or the value of such material and other supplies, e.g., catalysts, chemicals, spare parts. (11/90)

INVESTMENT - the sum of the original costs or values of the items that constitute the enterprise; used interchangeably with capital; may include expenses associated with capital outlays such as mine development. (11/90)

INVESTMENT COST - includes first cost and later expenditures that have substantial and enduring value (generally more than one year) for upgrading, expanding, or changing the functional use of a facility, product, or process. [A] (11/90)

INVESTOR'S METHOD - see DISCOUNTED CASH FLOW. (11/90)

ITEM - a commodity designated and defined specifically for direct price observation. (11/90)

JOB OVERHEAD - the expense of such items as trailer, toilets, telephone, superintendent, transportation, temporary heat, testing, power, water, cleanup, and similar items possibly including bond and insurance associated with the particular project. (11/90)

JUDGMENTAL SAMPLING - a procedure of selecting the sample which is based on specific criteria established by sample designers. The selection of priced items and outlets is not a probability sample; that is, it is not based on random chance. (11/90)

KEY ACTIVITY - an activity that is considered of major significance. A key activity is sometimes referred to as a milestone activity. (11/90)

LABOR BURDEN - taxes and insurances the employer is required to pay by law based on labor payroll, on behalf of or for the benefit of labor. (In the US these are federal old age benefits, federal unemployment insurance tax, state unemployment tax, and worker's compensation). (11/90)

LABOR COST, MANUAL - the salary plus all fringe benefits of construction workers and general labor on construction projects and labor crews in manufacturing or processing areas which can be definitely assigned to one product or process area or cost center. (11/90)

LABOR COST, NON-MANUAL - in construction, normally refers to field personnel other than crafts and includes field administration and field engineering. (11/90)

LABOR FACTOR - the ratio between the workhours actually required to perform a task under project conditions and the workhours required to perform an identical task under standard conditions. (11/90)

LADDERING - a method of showing the logic relationship of a set of several parallel activities with the arrow technique. (11/90)

LAG - specified time increment or delay between the start or completion of an activity and the start or completion of a successor activity. [P] (11/90)

LAG RELATIONSHIP - the four basic types of lag relationships between the start and/or finish of a work item and the start and/or finish of another work item are:

1. Finish to Start
2. Start to Finish
3. Finish to Finish
4. Start to Start (11/90)

LASPEYRES-TYPE PRICE INDEX (STRICT APPELLATION) - a composite index founded on a Constant Basket which is taken from the base period of this index. (11/90)

LATE FINISH (LF) - the latest time an activity may be completed without delaying the project finish date. (11/90)

LATENT CONDITION - a concealed, hidden, or dormant condition that cannot be observed by a reasonable inspection. (11/90)

LATEST EVENT TIME (LET) - the latest time an event may occur without increasing the project's scheduled completion date. (11/90)

LATE START - the latest time at which an activity can start without lengthening the project. (11/90)

LATEST REVISED ESTIMATE - the sum of the actual incurred costs plus the latest estimate-to-complete for a work package or summary item as currently reviewed and revised, or both (including applicable overhead where direct costs are specified). (11/90)

LAWS AND REGULATIONS - laws, rules, regulations, ordinances, codes and/or orders. (11/90)

LEAD - a PDM constraint introduced before a series of activities to schedule them at a later time. (11/90)

LEARNING CURVE - a graphic representation of the progress in production effectiveness as time passes. Learning curves are useful planning tools, particularly in the project oriented industries where new products are phased in rather frequently. The basis for the learning curve calculation is the fact that workers will be able to produce the product more quickly after they get used to making it. (11/90)

LETTER OF CREDIT - a vehicle that is used in lieu of retention and is purchased by the contractor from a bank for a predetermined amount of credit that the owner may draw against in the event of default in acceptance criteria by the contractor. Also applies when an owner establishes a line of credit in a foreign country to provide for payment to suppliers of contractors for goods and services supplied. (11/90)

LEVEL FINISH/SCHEDULE/ (SF) - the date when the activity is scheduled to be completed using the resource allocation process. Level finish is equal to the level start plus duration except when split. (11/90)

LEVEL FLOAT - the difference between the level finish and the imposed finish date. (11/90)

LEVELIZED FIXED-CHARGE RATE - the ratio of uniform annual revenue requirements to the initial investment, expressed as a percent. (11/90)

LEVEL OF EFFORT (LOE) - support effort (e.g., vendor liaison) that does not readily lend itself to measurement of discrete accomplishment. It is generally characterized by a uniform rate of activity over a specific period of time. (11/90)

LEVEL START/SCHEDULE/ (SS) - the date the activity is scheduled to begin using the resource allocation process. This date is equal to or later in time than early start. (11/90)

LEVERAGE (TRADING ON EQUITY) - the use of borrowed funds or preferred stock in the intent of employing these "senior" funds at a rate of return higher than their cost in order to increase the return upon the investment of the residual owners. (11/90)

LIFE - (1) physical: that period of time after which a machine or facility can no longer be repaired in order to perform its design function properly. (2) service: the period of time that a machine or facility will satisfactorily perform its function without a major overhaul. See also VENTURE LIFE; STUDY PERIOD; ECONOMIC LIFE. (11/90)

LIFE CYCLE - the stages, or phases that occur during the lifetime of an object or endeavor. A life cycle presumes a beginning and an end with each end implying a new beginning. In life cycle cost or investment analysis, the life cycle is the length of time over which an investment is analyzed (i.e., study period). See also STUDY PERIOD; LIFE. [A] (1/02)

LIFE CYCLE; ASSET - the stages, or phases of asset existence during the life of an asset. Asset life cycle stages typically include ideation, creation, operation, modification, and termination. (1/02)

LIFE CYCLE; PROJECT - the stages or phases of project progress during the life of a project. Project life cycle stages typically include ideation, planning, execution, and closure. (1/02)

LIFE-CYCLE COST (LCC) METHOD - a technique of economic evaluation that sums over a given study period the costs of initial investment (less resale value), replacements, operations (including energy use), and maintenance and repair of an investment decision (expressed in present or annual value terms). [A] (11/90)

LIFO (Last In, First Out) - a method of determining the cost of inventory used in a product. In this method, the costs of material are transferred to the product in reverse chronological order. LIFO is used to describe the movement of goods. See FIFO. (11/90)

LIMIT (Lot size Inventory Management Interpolation Technique) - a technique for looking at the lot sizes for groups of products to determine what effect economic lot sizes will have on the total inventory and total setup costs. (11/90)

LINEAR PROGRAMMING - mathematical techniques for solving a general class of optimization problems through minimization (or maximization) of a linear function subject to linear constraints. For example, in blending aviation fuel, many grades of commercial gasoline may be available. Prices and octane ratings, as well as upper limits on capacities of input materials which can be used to produce various grades of fuel are given. The problem is to blend the various commercial gasolines in such a way that (1) cost will be minimized (profit will be maximized), (2) a specified optimum octane rating will be met, and (3) the need for additional storage capacity will be avoided. (11/90)

LINE OF CREDIT - generally an informal understanding between the borrower and the bank as to the maximum amount of credit that the bank will provide the borrower at any one time. (11/90)

LINKING PROCEDURE - a procedure by which a "new" series of indexes is connected to an "old" series in a given link period, generally because of a change in baskets. Actually, indexes of the new series with link period as time base are multiplied by the old index for the link period as the given period. See SPLICING TECHNIQUE. (11/90)

LOAD FACTOR - (1) a ratio that applies to physical plant or equipment average load/maximum demand, usually expressed as a percentage. It is equivalent to percent of capacity operation if facilities just accommodate the maximum demand; (2) the ratio of average load to maximum load. (11/90)

LOAD LEVELING - the technique of averaging, to a workable number, the amount or number of people working on a given project or in a given area of a project at a particular point in time. Load leveling is a benefit of most scheduling techniques and is necessary to insure a stable use of resources. Syn.: WORK POWER LEVELING. (11/90)

LOCAL COST - in foreign work, the cost of local labor, equipment taxes, insurance, equipment, and construction materials incorporated in a construction project, with local currencies. This includes the

finishing of imported goods using local labor and materials, the cost of transforming imported raw or semi-finished products using local labor and plant facilities and the marketing of locally produced products. (11/90)

LOCATION FACTOR - an estimating factor used to convert the cost of an identical plant from one location to another. This factor takes into consideration the impact of climatic conditions, local infrastructure, local soil conditions, safety and environmental regulations, taxation and insurance regulations, labor availability and productivity, etc. (11/90)

LOGIC - Relationship describing the interdependency of starts and finishes between activities or events. Every activity should have a predecessor (except for the initial activity or event), and every activity should have a successor (except for the ending activity or event). (3/04)

LOGIC NETWORK DIAGRAM - Visual representation of relationship between activities. See also NETWORK. (3/04)

LOGICAL RESTRAINT - a dummy arrow or constraint connection that is used as a logical connector but that does not represent actual work items. It is usually represented by a dotted line, and is sometimes called a dummy because it does not represent work. It is an indispensable part of the network concept when using the arrow diagramming method of CPM scheduling. (11/90)

LOOP - a path in a network closed on itself passing through any node or activity more than once, or, a sequence of activities in the network with no start or end. (11/90)

LOSS OF PRODUCTIVITY/EFFICIENCY - see INEFFICIENCY. (11/90)

LOST PRODUCTIVITY - see INEFFICIENCY. (4/04)

LOT BATCH - a definite quantity of some product manufactured under conditions of production that are considered uniform. (11/90)

LOT SIZE - the number of units in the lot. (11/90)

LUMP-SUM - the complete in-place cost of a system, a subsystem, a particular item, or an entire project. Lump-sum contracts imply that no additional charges or costs will be assessed against the owner. See FIXED-PRICE CONTRACT. (11/90)

MAINTENANCE AND REPAIR COST - the total of labor, material, and other related costs incurred in conducting corrective and preventative maintenance and repair on a facility, on its systems and components, or on both. Maintenance does not usually include those items that cannot be expended within the year purchased. Such items must be considered as fixed capital. [B] (11/90)

MAJOR COMPONENTS - part of the aggregation structure of a price index (eg, a CPI can be subdivided into major components of food, housing, clothing, transportation, health and personal care, recreation, reading and education, tobacco and alcohol). (11/90)

MAJOR MILESTONE - the most significant milestones in the project's life or duration, representing major accomplishments or decision points; usually associated with the first breakdown level in the work breakdown structure. [P] (11/90)

MAJOR SYSTEM ACQUISITION PROJECTS - those projects that are directed at and are critical to fulfilling a mission, entail the allocation of relatively large resources, and warrant special management attention. (11/90)

MANAGEMENT CONTROL SYSTEMS - the systems (e.g., planning, scheduling, budgeting, estimating, work authorization, cost accumulation, performance measurement, etc) used by owners, engineers, architects, and contractors to plan and control the cost and scheduling of work. [P] (11/90)

MANAGEMENT RESERVE - An amount added to an estimate to allow for discretionary management purposes outside of the defined scope of the project as otherwise estimated. Unlike contingency, the estimated reserve is not expected to be spent unless management so directs, and a reserve is generally not included in all estimates. An example of when a reserve might be included in a project estimate is when a project's schedule, safety, or operability are so critical to business objectives that business management authorizes reserve funds for project management to use at their discretion for any scope changes they feel are needed to meet the business objectives. Syns.: Reserve or Reserve Allowance. (1/03)

MANAGEMENT SCIENCE - the application of methods and procedures including sophisticated mathematical techniques to facilitate decision making in the handling, direction, and control of projects and manufacturing operations. (11/90)

MANUFACTURING COST - the total of variable and fixed or direct and indirect costs chargeable to the production of a given product, usually expressed in cents or dollars per unit of production, or dollars per year. Transportation and distribution costs, and research, development, selling and corporate administrative expenses are usually excluded. See also OPERATING COST. (11/90)

MANUFACTURING RESOURCE PLANNING (MRP II) - a method for the effective planning of all the resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer "what if" questions. It is made up of a variety of functions, each linked together: business planning, production planning, master production scheduling, material requirements planning, capacity requirements planning, and the execution systems for capacity and priority. Outputs from these systems would be integrated with financial reports such as the business plan, purchase commitment report, shipping budget, inventory projections in dollars, etc. Manufacturing resource planning is a direct outgrowth and extension of material requirement planning. (11/90)

MAPI METHOD - (1) a procedure for replacement analysis sponsored by the Machinery and Allied Products Institute; (2) a method of capital investment analysis which has been formulated by the Machinery and Allied Products Institute. This method uses a fixed format and provides charts and graphs to facilitate calculations. A prominent feature of this method is that it explicitly includes obsolescence. (11/90)

MARGINAL ANALYSIS - an economic concept concerned with those incremental elements of costs and revenue which are associated directly with a specific course of action, normally using available current costs and revenue as a base and usually independent of traditional accounting allocation procedures. (11/90)

MARGINAL COST (BENEFIT) - see INCREMENTAL COST (BENEFIT). [A] (11/90)

MARKETING - the broad range of activities concerned primarily with the determination of consumer or user demands or desires, both existing and potential; the satisfaction of these demands or desires

through innovation or modification; and the building of buyer awareness of product or service availability through sales and advertising efforts. (11/90)

MARKETING COST ANALYSIS - the study and evaluation of the relative profitability or costs of different marketing operations in terms of customer, marketing units, commodities, territories, or marketing activities. Typical tools include cost accounting. (11/90)

MARKETING RESEARCH - the systematic gathering, recording, and analyzing of data about problems relating to the marketing of goods and services. Such research may be undertaken by impartial agencies or by business firms, or their agents. Marketing research is an inclusive term which includes various subsidiary types:

1. Market Analysis, of which product potential is a type, which is the study of size, location, nature, and characteristics of markets.

2. Sales Analysis (or Research), which is the systematic study and comparison of sales (or consumption) data.

3. Consumer Research, of which motivation research is a type which is concerned chiefly with the discovery and analysis of consumer attitudes, reactions, and preferences. (11/90)

MARKET VALUE - the monetary price upon which a willing buyer and a willing seller in a free market will agree to exchange ownership, both parties knowing all the material facts but neither being compelled to act. The market value fluctuates with the degree of willingness of the buyer and seller and with the conditions of the sale. The use of the term market suggests the idea of barter. When numerous sales occur on the market, the result is to establish fairly definite market prices as the basis of exchanges. (11/90)

MARK-UP - as variously used in construction estimating, includes such percentage applications as general overhead, profit, and other indirect costs. When mark-up is applied to the bottom of a bid sheet for a particular item, system, or other construction price, any or all of the above items (or more) may be included, depending on local practice. (11/90)

MASTER PRODUCTION SCHEDULE (MPS) - for selected items, a statement of what the company expects to manufacture. It is the anticipated build schedule for those selected items assigned to the master scheduler. The master scheduler maintains this schedule and, in turn, it becomes a set of planning numbers which "drives" MRP. It represents what the company plans to produce expressed in specific configurations, quantities, and dates. The MPS should not be confused with a sales forecast which represents a statement of demand. The master production schedule must take forecast plus other important considerations (backlog, availability of material, availability of capacity, management policy and goals, etc.) into account prior to determining the best manufacturing strategy. (11/90)

MASTER SCHEDULE - see MASTER PRODUCTION SCHEDULE. (11/90)

MASTER SCHEDULE ITEM - a part number selected to be planned by the master scheduler. The item would be deemed critical in terms of its impact on lower level components and/or resources such as skilled labor, key machines, dollars, etc. A master schedule item may be an end item, a component, a pseudo number, or a planning bill of material. (11/90)

MASTER SCHEDULER - the job title of the person who manages the master construction or production schedule. This person should be the best scheduler available as the consequences of the planning here have a great impact on material and capacity planning. Ideally, the person would have substantial product, shop, or field knowledge. (11/90)

MATERIAL COST - the cost of everything of a substantial nature that is essential to the construction or operation of a facility, both of a direct or indirect nature. Generally includes all manufactured equipment as a basic part. (11/90)

MATERIAL DIFFERENCE - a change that is important to the performance of the work or that will have a measurable influence or effect on the time, cost of, or procedures for the work under the contract. (11/90)

MATERIAL REQUIREMENTS PLANNING (MRP) - a system which uses bills of material, inventory and open order data, and master production schedule information to calculate requirements for materials. It makes recommendations to release replenishment orders for material. Further, since it is time-phased, it makes recommendations to reschedule open orders when due dates and need dates are not in phase. See MANUFACTURING RESOURCE PLANNING. (11/90)

MATHEMATICAL PROGRAMMING - the operation of reducing a relationship of several variables, which may be subject to constraints, to a mathematical form and, possibly, to a computer program. Specifically, the term used to denote the general problem of optimizing a mathematical function. If the function and constraints are linear in the variables and a subset of the constraints restrict the variables to be non-negative, we have a linear programming problem. (11/90)

MAXIMUM OUT-OF-POCKET CASH - the highest year-end negative cash balance during project life. (11/90)

MECHANICAL COMPLETION - placing a fixed asset in service. Mechanical completion is an event. (11/90)

MERIT SHOP - see OPEN SHOP. (11/90)

METHOD OF PERFORMANCE - the manner in which the specified product or objective is accomplished, which is left to the discretion of the contractor unless otherwise provided in the contract. If the owner or the engineer orders the contractor to modify the construction procedure, this constitutes a change in method. If the imposition of this modification results in additional cost to the contractor, the contractor may be entitled to recovery under the changes clause. (11/90)

MILESTONE - an important or critical event and/or activity that must occur when scheduled in the project cycle in order to achieve the project objective(s). [P] (11/90)

MILESTONE FLAG - a numeric code that may be entered on an event to flag the event as a milestone. (11/90)

MILESTONE LEVEL - the level of management at which a particular event is considered to be a key event or milestone. (11/90)

MILESTONE REPORT - an output report at a specified level showing the latest allowable date, expected date, schedule completion date, and the slack for the successor event contained on each activity or event name flagged as a milestone at the level specified. (11/90)

MILESTONE SCHEDULE - a schedule comprised of key events or milestones selected as a result of coordination between the client's and the contractor's project management. These events are generally critical accomplishments planned at time intervals throughout the project and used as a basis to monitor overall project performance. The format may be either network or bar chart and may contain minimal detail at a highly summarized level. (11/90)

MISREPRESENTATION - inaccurate factual information furnished by either party to a contract, even if done unintentionally. (11/90)

MITIGATION OF DAMAGES - to take all possible measures to avoid damage and delay and, if not avoidable, to reduce or lessen the extra costs incurred due to occurrence of the event. (11/90)

MODEL PRICING - the techniques of using verbal, symbolic, or analog models to depict cost relationships, and the form which they take. Mathematics and digital computers are basic analytical tools for model pricing. (11/90)

MODIFICATION, BILATERAL - an agreement negotiated by and entered into by both parties for a modification of the existing contract terms of a mutually agreed time or price adjustment. (11/90)

MODIFICATION, UNILATERAL - a modification to the contract issued by the owner without the agreement of the contractor as to the time or price adjustment. (11/90)

MONITORING - periodic gathering, validating and analyzing various data on contract status to determine any existing or potential problems. Usually one accomplishes this through use of the data provided in contractor reports on schedule, labor, cost and technical status to measure progress against the established baselines for each of these report areas. However, when deemed necessary, on-site inspection and validation and other methods can be employed. (11/90)

MONTE CARLO METHOD - a simulation technique by which approximate evaluations are obtained in the solution of mathematical expressions so as to determine the range or optimum value. The technique consists of simulating an experiment to determine some probabilistic property of a system or population of objects or events by use of random sampling applied to the components of the system, objects, or events. (11/90)

MONTHLY GUIDE SCHEDULE - a detailed two-month schedule used to detail the sequence of activities in an area for analysis or to plan work assignments. This schedule is usually prepared on an "as needed" basis or within a critical area. Syn.: SHORT-TERM ACTIVITIES (11/90)

MONTH-TO-MONTH PRICE INDEX - a price index for a given month with the preceding month as the base period. (11/90)

MOST LIKELY TIME ESTIMATE - the most realistic estimate of the time an activity might consume. (11/90)

MOVING AVERAGE - smoothing a time series by replacing a value with the mean of itself and adjacent values. (11/90)

MRP - see MATERIAL REQUIREMENTS PLANNING. (11/90)

MULTIPLE FINISH NETWORK - a network that has more than one finish activity or finish event. (11/90)

MULTIPLE START NETWORK - a network that has more than one start activity or event. (11/90)

MULTIPLE STRAIGHT-LINE DEPRECIATION METHOD - a method of depreciation accounting in which two or more straight line rates are used. This method permits a predetermined portion of the asset to be written off in a fixed number of years. One common practice is to employ a straight line rate which will write off 3/4 of the cost in the first half of the anticipated service life; with a second straight line rate to write off the remaining 1/4 in the remaining half life. (11/90)

NEAR-CRITICAL ACTIVITY - an activity that has low total float. (11/90)

NEGLIGENCE - failure to exercise that degree of care in the conduct of professional duties that should be exercised by the average, prudent professional, practicing in the same community under similar circumstances. Under this concept, an architect/engineer is not liable for errors of judgment, but only for a breach of duty to exercise care and skill. (11/90)

NET AREA - when used in building construction, it is the area, exclusive of encroachments by partitions, mechanical space, etc, which is available for circulation or for any other functional use within a project. (11/90)

NET BENEFITS (SAVINGS) - the difference between the benefits and the costs -- where both are discounted to present or annual value dollars. [A] (11/90)

NET PRESENT VALUE - see PRESENT VALUE. (11/90)

NET PROFIT - earnings after all operating expenses (cash or accrued non-cash) have been deducted from net operating revenues for a given period. (11/90)

NET PROFIT, PERCENT OF SALES - the ratio of annual profits to total sales for a representative year of capacity operations. An incomplete measure of profitability, but a useful guidepost for comparing similar products and companies. Syn.: PROFIT MARGIN (11/90)

NET PURCHASES (CONCEPT OF) - according to this concept, any proceeds from the sale in the reference year of a used commodity belongs to a given elementary group and are subtracted from the expenditure reported on commodities in that elementary group. (11/90)

NETWORK - a logic diagram of a project consisting of the activities and events that must be accomplished to reach the objectives, showing their required sequence of accomplishments and interdependencies. (11/90)

NETWORK ANALYSIS - technique used in planning a project consisting of a sequence of activities and their interrelationship within a network of activities making up a project. See CRITICAL PATH. (11/90)

NETWORK PLANNING - a broad generic term for techniques used to plan complex projects using logic diagrams (networks). Two of the most popular techniques are ADM and PDM. (11/90)

NODE - the symbol on a logic diagram at the intersection of arrows (activities). Nodes identify completion and/or start of activities. See EVENT. (11/90)

NOMINAL DISCOUNT RATE - the rate of interest reflecting the time value of money stemming both from inflation and the real earning power of money over time. This is the discount rate used in discount formulas or in selecting discount factors when future benefits and costs are expressed in current dollars. [A] (11/90)

NONCASH - a term frequently used for tangible commodities to be used from inventory and not replaced. (11/90)

NONDURABLE GOODS - goods whose serviceability is generally limited to a period of less than three years (such as perishable goods and semidurable goods). (11/90)

NONEXEMPT EMPLOYEES - employees not exempt from federal wage and hours guidelines. (11/90)

NONWORK UNIT - a calendar-specified time unit during which work will not be scheduled. (11/90)

NOTICE OF AWARD - the written notice of acceptance of the bid by the owner to a bidder stating that upon compliance by the bidder with the conditions precedent enumerated therein, within the time specified, the owner will sign and deliver the agreement. (11/90)

NOTICE TO PROCEED - a written notice issued by the owner to the contractor authorizing the contractor to proceed with the work and establishing the date for commencement of the contract time. (11/90)

OBJECTIVE EVENT - an event that signifies the completion of a path through the network. A network may have more than one objective event. (11/90)

OBSOLESCENCE - (1) the condition of being out of date. A loss of value occasioned by new developments which place the older property at a competitive disadvantage. A factor in depreciation; (2) a decrease in the value of an asset brought about by the development of new and more economical methods, processes, and/or machinery; (3) the loss of usefulness or worth of a product or facility as a result of the appearance of better and/or more economical products, methods or facilities. (11/90)

OFFSITES -- general facilities outside the battery limits of process units, such as field storage, service facilities, utilities, and administrative buildings. (11/90)

OMISSION - any part of a system, including design, construction and fabrication, that has been left out, resulting in a deviation. An omission requires an evaluation to determine what corrective action is necessary. (11/90)

ON-STREAM FACTOR - the ratio of actual operating days to calendar days per year. (11/90)

OPEN SHOP - an employment or project condition where either union or non-union contractors or individuals may be working. Open shop implies that the owner or prime contractor has no union agreement with workers. Also referred to as merit shop. (11/90)

OPERATING COST - the expenses incurred during the normal operation of a facility, or component, including labor, materials, utilities, and other related costs. Includes all fuel, lubricants, and normally scheduled part changes in order to keep a subsystem, system, particular item, or entire project functioning. Operating costs may also include general building maintenance, cleaning services, taxes, and similar items. See MANUFACTURING COST. (11/90)

OPERATION - ongoing endeavor, or activities that utilize strategic assets for a defined function or purpose. (1/02)

OPERATIONS RESEARCH (OR) - quantitative analysis of industrial and administrative operations with intent to derive an integrated understanding of the factors controlling operational systems and in view of supplying management with an objective basis to make decisions. OR frequently involves representing the operation or the system with a mathematical model. (11/90)

OPPORTUNITY COST OF CAPITAL - the rate of return available on the next best available investment of comparable risk. [A] (11/90)

OPTIMISTIC TIME ESTIMATE - the minimum time in which the activity can be completed if everything goes exceptionally well. It is generally held that an activity would have no more than one chance in a hundred of being completed within this time. (11/90)

OPTIMUM PLANT SIZE - the plant capacity which represents the best balance between the economics of size and the cost of carrying excess capacity during the initial years of sales. (11/90)

OPTIMIZATION - Techniques that analyze a system with the goal of finding an optimum result. Finding an optimum result usually requires evaluating design elements, execution strategies and methods, and other system inputs for their effects on cost, schedule, safety, or some other set of outcomes or objectives. Commonly employs computer simulation and mathematical modeling. (1/03)

ORGANIZATIONAL CODES - numerical or alphabetized characters that the user specifies for the system to associate with a particular activity for sorting purposes. (11/90)

ORIGINAL DURATION - the initial accepted estimate of an activity duration used in the original baseline schedule. (11/90)

OVER-HAUL - the distance in excess of that given as the stated haul distance to transport excavated material. (11/90)

OVERHEAD - a cost or expense inherent in the performing of an operation, ie, engineering, construction, operating or manufacturing, which cannot be charged to or identified with a part of the work, product or asset and, therefore, must be allocated on some arbitrary base believed to be equitable, or handled as a business expense independent of the volume of production. Plant overhead is also called factory expense. (11/90)

OVER (UNDER) PLAN - the planned cost to date minus the latest revised estimate of cost to date. When planned cost exceeds latest revised estimate, a projected underplan condition exists. When latest revised estimate exceeds planned cost, a projected overplan condition exists. (11/90)

OVERRUN (UNDERRUN) - the value for the work performed to date minus the actual cost for that same work. When value exceeds actual cost, an underrun condition exists. When actual cost exceeds value, an overrun condition exists. (11/90)

OWNER - the public body or authority, corporation, association, firm or person with whom the contractor has entered into the agreement and for whom the work is to be provided. (11/90)

PAASCHE-TYPE PRICE INDEX - a composite index founded on a fixed basket which is taken from the current period of this index. (11/90)

PARAMETRIC ESTIMATE - In estimating practice, describes estimating algorithms or cost estimating relationships that are highly probabilistic in nature (i.e., the parameters or quantification inputs to the algorithm tend to be abstractions of the scope). Typical parametric algorithms include, but are not limited to, factoring techniques, gross unit costs, and cost models (i.e., algorithms intended to replicate the cost performance of a process of system). Parametric estimates can be as accurate as definitive estimates. (1/03)

PARTIAL UTILIZATION - placing a portion of the work in service for the purpose for which it is intended (or a related purpose) before reaching substantial completion for all the work. (11/90)

~~PATH - the logically continuous series of connected activities through a network. [P]~~ (11/90)

PATH FLOAT - see FLOAT. (11/90)

PAYBACK METHOD - a technique of economic evaluation that determines the time required for the cumulative benefits from an investment to recover the investment cost and other accrued costs. See DISCOUNTED PAYBACK PERIOD; SIMPLE PAYBACK PERIOD. [A] (11/90)

PAYOFF (PAYBACK) PERIOD - see PAYOUT TIME. [A] (11/90)

PAYOUT TIME - the time required to recover the original fixed investment from profit and depreciation. Most recent practice is to base payout time on an actual sales projection. Syn.: PAYOFF PERIOD. See also SIMPLE PAYBACK PERIOD. (11/90)

PAYROLL BURDEN - includes all payroll taxes, payroll insurances, fringe benefits, and living and transportation allowances. (11/90)

PDM - see PRECEDENCE DIAGRAM METHOD. (11/90)

PDM ARROW - a graphical symbol in PDM networks used to represent the lag describing the relationship between work items. (11/90)

PDM FINISH TO FINISH RELATIONSHIP - this relationship restricts the finish of the work item until some specified duration following the finish of another work item. (11/90)

PDM FINISH TO START RELATIONSHIP - the standard node type of relationship as used in ADM where the activity of work item may start just as soon as another work item is finished. (11/90)

PDM START TO FINISH RELATIONSHIP - the relationship restricts the finish of the work item until some duration following the start of another work item. (11/90)

PDM START TO START RELATIONSHIP - this relationship restricts the start of the work item until some specified duration following the start of the preceding work item. (11/90)

PERCENT COMPLETE - a comparison of the work completed to the current projection of total work. The percent complete of an activity in a program can be determined by inspection of quantities placed as workhours expended and compared with quantities planned or workhours planned. Other methods can also be used. (11/90)

PERCENT ON DIMINISHING VALUE - see DECLINING BALANCE DEPRECIATION. (11/90)

PERFORMANCE BOND - a bond that guarantees the work will be completed in accordance with the contract documents. The bond also assures the owner that the contractor will fulfill all contractual and financial obligations. (11/90)

PERFORMANCE MEASUREMENT BASELINE - the time-phased budget plan against which contract performance is measured. It is formed by the budgets assigned to scheduled work elements and the applicable indirect budgets. For future effort not planned in detail, the performance measurement baseline also includes budgets assigned to higher level CWBS elements and undistributed budget. It will reconcile to the contract budget base. It equals the total allocated budget less management reserve. (11/90)

PERT - an acronym for Project Evaluation Review Technique which is a probabilistic technique, used mostly by government agencies, for calculating the "most likely" durations for network activities. Most recently, however, the term PERT has been used as a synonym for CPM. (11/90)

PESSIMISTIC TIME ESTIMATE - the maximum time required for an activity under adverse conditions. It is generally held that an activity would have no more than one chance in a hundred of exceeding this amount of time. (11/90)

PHASED CONSTRUCTION - as most commonly used today, implies that construction of a facility or system or subsystem commences before final design is complete. Phased construction is used in order to achieve beneficial use at an advanced date. (11/90)

PHYSICAL PROGRESS - the status of a task, activity, or discipline based on preestablished guidelines related to the amount or extent of work completed. (11/90)

PLAN - a predetermined course of action over a specified period of time which represents a projected response to an anticipated environment in order to accomplish a specific set of adaptive objectives. (11/90)

PLANNED COST - the approved estimated cost for a work package or summary item. This cost when totaled with the estimated costs for all other work packages results in the total cost estimate committed under the contract for the program or project. (11/90)

PLANNING - the determination of a project's objectives with identification of the activities to be performed, methods and resources to be used for accomplishing the tasks, assignment of responsibility and accountability, and establishment of an integrated plan to achieve completion as required. (11/90)

PLANNING BILL (of Material) - an artificial grouping of items, in bill of material format, used to facilitate master scheduling and/or material planning. (11/90)

PLANNING HORIZON - in an MRP system, the span of time from the current to some future date for which material plans are generated. This must cover at least the cumulative purchasing and manufacturing lead time and is usually substantially longer to facilitate MRP II. (11/90)

PLANNING PACKAGE - a logical aggregation of work within a cost account, normally the far term effort that can be identified and budgeted in early baseline planning, but which will be further defined into work packages, LOE, or apportioned effort. (11/90)

PLANT OVERHEAD - those costs in a plant that are not directly attributable to any one production or processing unit and are allocated on some arbitrary basis believed to be equitable. Includes plant management salaries, payroll department, local purchasing and accounting, etc. Syn.: FACTORY EXPENSE. (11/90)

PLUG DATE - a date assigned externally to an activity that establishes the earliest or latest date when the activity is scheduled to start or finish. Syn.: CONSTRAINT DATE. (11/90)

POPULATION - all conceivable or hypothetically possible instances or observations of the selected phenomenon. (11/90)

PRECEDENCE DIAGRAM METHOD (PDM) - a method of constructing a logic network using nodes to represent the activities and connecting them by lines that show logic relationships. (11/90)

PRECEDING EVENT - see BEGINNING EVENT. (11/90)

PRECONSTRUCTION CPM - a plan and schedule of the construction work developed during the design phase preceding the award of contract. (11/90)

PREDECESSOR - An activity that immediately precedes another activity. (3/04)

PREDECESSOR ACTIVITY - any activity that exists on a common path with the activity in question and occurs before the activity in question. (11/90)

PREDECESSOR EVENT - see BEGINNING EVENT. (11/90)

PREFERENTIAL LOGIC - the contractor's approach to sequencing of the work over and above those sequences indicated in or required by the contract documents. Examples include equipment restraints, crew movements, form reuse, special logic (lead/lag) restraints, etc factored into the progress schedule instead of disclosing the associated float times. (11/90)

PRELIMINARY CPM PLAN - CPM analysis of the construction phase made before the award of contracts to determine a reasonable construction period. See PRECONSTRUCTION CPM. (11/90)

PRELIMINARY ENGINEERING - includes all design-related services during the evaluation and definition phases of a project. (11/90)

PRESENT VALUE - the value of a benefit or cost found by discounting future cash flows to the base time. Also, the system of comparing proposed investments, which involves discounting at a known interest rate (representing a cost of capital or a minimum acceptable rate of return) in order to choose the alternative having the highest present value per unit of investment. This technique eliminates the occasional difficulty with profitability index of multiple solutions, but has the troublesome problem of choosing or calculating a "cost of capital" or minimum rate of return. Also called Net Present Value. Syn.: PRESENT WORTH. [B] (11/90)

PRESENT VALUE FACTOR - (1) the discount factor used to convert future values (benefits and costs) to present values; (2) a mathematical expression also known as the present value of an annuity of one; (3) one of a set of mathematical formulas used to facilitate calculation of present worth in economic analysis involving compound interest. Syn.: PRESENT WORTH FACTOR. [B] (11/90)

PRESENT WORTH - see PRESENT VALUE. [A] (11/90)

PRESENT WORTH FACTOR - see PRESENT VALUE FACTOR. [A] (11/90)

PREVENTION - quality activities employed to avoid deviations; includes such activities as quality systems development, quality program development, feasibility studies, quality system audits, contractor/subcontractor evaluation, vendors/suppliers of information/materials evaluation, quality orientation activities, and certification/qualification. (11/90)

PRICE - the amount of money asked or given for a product (eg, exchange value). The chief function of price is rationing the existing supply among prospective buyers. (11/90)

PRICE INDEX - the representation of price changes, which is usually derived by dividing the current price for a specific good by some base period price. See COST INDEX. (11/90)

PRICE RELATIVES - the ratio of the commodity price in a given period to its price in the base period. (11/90)

PRICING - In estimating practice, after costing an item or activity, the determination of the amount of money asked in exchange for the item, activity, or project. Pricing determination considers business and other interests (e.g., profit, marketing, etc.) in addition to inherent costs. The price may be greater or less than the cost depending on the business or other objectives. In the cost estimating process, pricing follows costing and precedes budgeting. In accounting practice, the observation and recording (collecting) of prices. (1/03)

PRICING, FORWARD - an estimation of the cost of work prior to actual performance. It is also known as Prospective Pricing. Pricing forward is generally used relative to the pricing of proposed change orders. (11/90)

PRICING, RETROSPECTIVE - the pricing of work after it has been accomplished. (11/90)

PRIMARY CLASSIFICATION - the classification of commodities by "commodity type." (11/90)

PROBABILITY - a value depicting the likelihood of an expected or occurred event. (11/90)

PROBABILITY DISTRIBUTION - a distribution giving the probability of a value x as a function of x; or more generally, the probability of joint occurrence of a set of variates $x_1...x_p$ as a function of those quantities.

It is customary, but not the universal practice, to use "probability distribution" to denote the probability of values up to and including the argument x. From a frequency viewpoint the distinction is the same as between Frequency Function and "distribution function". (11/90)

PROCUREMENT - the acquisition (and directly related matters) of equipment, material, and nonpersonal services (including construction) by such means as purchasing, renting, leasing (including real property), contracting, or bartering, but not by seizure, condemnation, or donation. Includes preparation of inquiry packages, requisitions, and bid evaluations; purchase order award and documentation; plus expediting, in-plant inspection, reporting, and evaluation of vendor performance. (11/90)

PRODUCTION PLAN - the agreed upon strategy that comes from the production planning function. (See PRODUCTION PLANNING.) (11/90)

PRODUCTION PLANNING - the function of setting the overall level of manufacturing or construction output. Its prime purpose is to establish production rates that will achieve management's objective, while usually attempting to keep the production force relatively stable. (11/90)

PRODUCTION RATE - the amount of work, which may be accomplished in a given unit of time. (4/04)

PRODUCTION SCHEDULE - a plan which authorizes the factory to manufacture a certain quantity of a specific item. Usually initiated by the production planning department. (11/90)

PRODUCTIVITY - In general terms, labor productivity can be defined as the ratio of the value that labor produces to the value invested in labor. It is an absolute measure of work process efficiency, i.e., a measure of the extent to which labor resources are minimized and wasted effort is eliminated from the work process.

In earned value project control practice, productivity is a relative measure of labor efficiency, either good or bad, when compared to an established base or norm as determined from an area of great experience. Alternatively, productivity is defined as the reciprocal of the labor factor. (1/04)

PROFIT–

(1) Gross Profit - earnings from an on-going business after direct costs of goods sold have been deducted from sales revenue for a given period.

(2) Net Profit - earnings or income after subtracting miscellaneous income and expenses (patent royalties, interest, capital gains) and federal income tax from operating profit.

(3) Operating Profit - earnings or income after all expenses (selling, administrative, depreciation) have been deducted from gross profit. (11/90)

PROFIT MARGIN - see NET PROFIT, PERCENT OF SALES. (11/90)

PROFITABILITY - a measure of the excess income over expenditure during a given period of time. (11/90)

PROFITABILITY ANALYSIS - the evaluation of the economics of a project, manufactured product, or service within a specific time frame. (11/90)

PROFITABILITY INDEX (PI) - the rate of compound interest at which the company's outstanding investment is repaid by proceeds for the project. All proceeds from the project, beyond that required for interest, are credited, by the method of solution, toward repayment of investment by this calculation. Also called discounted cash flow, interest rate of return, investor's method, internal rate of return. Although frequently requiring more time to calculate than other valid yardsticks, PI reflects in a single number both the dollar and the time values of all money involved in a project. In some very special cases, such as multiple changes of sign in cumulative cash position, false and multiple solutions can be obtained by this technique. (11/90)

PROGRAM - an endeavor of considerable scope and enduring in nature as opposed to a project; usually representing some definable portion of the basic agency mission and defined as a line item in the agency budget. (11/90)

PROGRAM MANAGER - an official in the program division who has been assigned responsibility for accomplishing a specific set of program objectives. This involves planning, directing and controlling one or more projects of a new or continuing nature, initiation of any acquisition processes necessary to get project work under way, monitoring of contractor performance and the like. (11/90)

PROGRESS - development to a more advanced stage. Progress relates to a progression of development and, therefore, shows relationships between current conditions and past conditions. In networking, progress indicates activities have started or completed, or are in progress. See STATUS. (11/90)

PROGRESS TREND - an indication of whether the progress rate of an activity or of a project is increasing, decreasing, or remaining the same (steady) over a period of time. (11/90)

PROJECT - an endeavor with a specific objective to be met within the prescribed time and dollar limitations and which has been assigned for definition or execution. (11/90)

PROJECT CONTROL - project control is a process for controlling the investment of resources in an asset where investments are made through the execution of a project. Project control includes the general steps of; 1) project planning including establishing project cost and schedule control baselines; 2) measuring project performance; 3) comparing measurements against the project plans, and; 4) taking corrective, mitigating, or improvement action as may be determined through forecasting and further planning activity. (1/02)

PROJECT DURATION - the elapsed duration from project start date through project finish date. (11/90)

PROJECTED FINISH DATE - the current estimate of the calendar date when an activity will be completed. (11/90)

PROJECTED START DATE - the current estimate of the calendar date when an activity will begin. (11/90)

PROJECTED UNDERRUN (OVERRUN) - the planned costs minus the latest revised estimate for a work package or summary item. When planned cost exceeds the latest revised estimate, a projected underrun condition exists. When the latest revised estimate exceeds the planned cost, a projected overrun condition exists. (11/90)

PROJECT FINISH DATE (SCHEDULE) - the latest scheduled calendar finish date of all activities on the project. (11/90)

PROJECTION - an extension of a series, or any set of values, beyond the range of the observed data. (11/90)

PROJECT LIFE - see ECONOMIC LIFE. [A] (11/90)

PROJECT MANAGEMENT - the utilization of skills and knowledge in coordinating the organizing, planning, scheduling, directing, controlling, monitoring and evaluating of prescribed activities to ensure that the stated objectives of a project, manufactured product, or service, are achieved. (11/90)

PROJECT MANAGER - an individual who has been assigned responsibility and authority for accomplishing a specifically designated unit of work effort or group of closely related efforts established to achieve stated or anticipated objectives, defined tasks, or other units of related effort on a schedule for

performing the stated work funded as a part of the project. The project manager is responsible for the planning, controlling, and reporting of the project. [P] (11/90)

PROJECT NETWORK ANALYSIS (PNA) - a group of techniques based on the network project representation to assist managers in planning, scheduling, and controlling a project. (11/90)

PROJECT OFFICE - the organization responsible for administration of the project management system, maintenance of project files and documents, and staff support for officials throughout the project life cycle. (11/90)

PROJECT PHASES - the major phases of a project, which include preplanning, design, procurement, construction, start-up, operation, and final disposition. (11/90)

PROJECT PLAN - the primary document for project activities. It covers the project from initiation through completion. (11/90)

PROJECT START DATE (SCHEDULE) - the earliest calendar start date among all activities in the network. (11/90)

PROJECT SUMMARY WORK BREAKDOWN STRUCTURE (PSWBS) - a summary WBS tailored by project management to the specific project, and identifying the elements unique to the project. (11/90)

PROJECT TIME - the time dimension in which the project is being planned. (11/90)

PROPOSAL SCHEDULE - the first schedule issued on a project; accompanies either the client's request or the contractor's proposal. (11/90)

PROPOSED BASE CONTRACT PRICE - the sum total of the individual total price amounts for items of work designated as base bid items listed on the schedule of prices on the bid form (excluding alternates, if any). (11/90)

PROPOSED COMBINED CONTRACT PRICE - the sum total of bidder's proposed base contract price and all of the individual total price amounts for items of work designated as alternate bid items listed on the schedule of prices for alternate bid items on the bid form (excluding all additional alternates, if any). (11/90)

PROPOSED CHANGE ORDER - the form furnished by the owner or the engineer which is to be used (1) by the owner, when signed by the owner, as a directive authorizing addition to, deletion from, or revision in the work, or an adjustment in contract price or contract time, or any combination thereof; (2) by the owner, when unsigned, to require that the contractor figure the potential effect on contract price or contract time of a proposed change, if the proposed change is ordered upon signing by the owner; (3) by the contractor, to notify the owner that in the opinion of the contractor, a change is required as provided in the applicable provisions of the contract documents. When signed by the owner, a proposed change order may or may not fully adjust contract price or contract time, but is evidence that the change directed by the proposed change order will be incorporated in a subsequently issued change order following negotiations as to its effect, if any, on contract price or contract time. When countersigned by the contractor, a proposed change order is evidence of the contractor's acceptance of the basis for contract adjustments provided, except as otherwise specifically noted. (11/90)

PRUDENT INVESTMENT - that amount invested in the acquisition of the property of an enterprise when all expenditures were made in a careful, businesslike, and competent manner. (11/90)

PUNCHLIST - a list generated by the owner, architect, engineer, or contractor of items yet to be completed by the contractor. Sometimes called a "but" list ("but" for these items the work is complete). (11/90)

PURE PRICE CHANGE - change in the price of a particular commodity which is not attributable to change in its quality or quantity. (11/90)

QUALIFICATION SUBMITTALS - data pertaining to a bidder's qualifications which shall be submitted as set forth in the instructions to bidders. (11/90)

QUALITY - conformance to established requirements (not a degree of goodness). (11/90)

QUALITY ACCEPTANCE CRITERIA - specified limits placed on characteristics of a product, process, or service defined by codes, standards, or other requirement documents. (11/90)

QUALITY ACTIVITIES - those activities directly associated with appraisal, training, and prevention. (11/90)

QUALITY APPRAISAL - quality activities employed to determine whether a product, process, or service conforms to established requirements, including: design review, specification review, other documentation review, constructability review, materials inspection/tests, personnel testing, quality status documentation, and post project reviews. (11/90)

QUALITY ASSURANCE - all those planned or systematic actions necessary to provide adequate confidence that a product, process, or service will conform to established requirements. (11/90)

QUALITY AUDIT - a formal, independent examination with intent to verify conformance with the acceptance criteria. An audit does not include surveillance or inspection for the purpose of process control or product acceptance. (11/90)

QUALITY CONFORMANCE - quality management activities associated with appraisal, training, and prevention adapted to achieve zero deviations from the established requirements. (11/90)

QUALITY CONTROL - inspection, test, evaluation or other necessary action to verify that a product, process, or service conforms to established requirements and specifications. (11/90)

QUALITY CORRECTIVE ACTION - measures taken to rectify conditions adverse to quality and, where necessary, to preclude repetition. Corrective action includes rework and remedial action for nonconformance deviations. (11/90)

QUALITY MANAGEMENT - concerns the optimization of the quality activities involved in producing a quality product, process or service. As such, it includes appraisal, training, and prevention activities. (11/90)

QUALITY MANAGEMENT COSTS - the sum of those costs associated with appraisal, training, and prevention activities. (11/90)

QUALITY NONCONFORMANCE - a deviation that occurs with a severity sufficient to consider rejection of the product, process, or service. In some situations the product, process, or service may be accepted as is; in other situations, it will require corrective action. It also may involve the provision of deliverables that are more than required. (11/90)

QUALITY PERFORMANCE TRACKING SYSTEM - a management tool providing data for the quantitative analysis of certain quality-related aspects of projects by systematically collecting and classifying costs of quality. (11/90)

QUANTIFICATION - In estimating practice, an activity to translate project scope information into resource quantities suitable for costing. In the engineering and construction industry, a take-off is a specific type of quantification that is a measurement and listing of quantities of materials from drawings. Syn.: TAKE-OFF. (1/03)

QUANTITY RATIO - a ratio which measures, for a given commodity, its quantitative shift between alternative baskets. (11/90)

QUANTITY SURVEY - using standard methods measuring all labor and material required for a specific building or structure and itemizing these detailed quantities in a book or bill of quantities. (11/90)

QUANTITY SURVEYOR - In the United Kingdom, contractors bidding a job receive a document called a bill of quantities, in addition to plans and specifications, which is prepared by a quantity surveyor, according to well-established rules. To learn these rules the quantity surveyor has to undergo five years of technical training and must pass a series of professional examinations. In the United Kingdom a quantity surveyor establishes the quantities for all bidders, and is professionally licensed to do so. (11/90)

QUEUING THEORY - the theory involving the use of mathematical models, theorems and algorithms in the analysis of systems in which some service is to be performed under conditions of randomly varying demand, and where waiting lines or queues may form due to lack of control over either the demand for service or the amount of service required, or both. Utilization of the theory extends to process, operation and work studies. (11/90)

RANDOM PROCESS - in a general sense the term is synonymous with the more usual and preferable "stochastic" process. It is sometimes employed to denote a process in which the movement from one state to the next is determined by a variate which is independent of the initial and final state. (11/90)

RANDOM WALK - the path traversed by a particle which moves in steps, each step being determined by chance either in regard to direction or in regard to magnitude or both. Cases most frequently considered are those in which the particle moves on a lattice of points in one or more dimensions, and at each step is equally likely to move to any of the nearest neighboring points. The theory of random walks has many applications, eg, to the migration of insects, sequential sampling and, in the limit, to diffusion processes. (11/90)

RATE OF RETURN - the interest rate earned by an investment. See RETURN ON AVERAGE INVESTMENT, RETURN ON ORIGINAL INVESTMENT, PROFITABILITY INDEX, INTERNAL RATE OF RETURN, DISCOUNTED CASH FLOW. (11/91)

REAL DISCOUNT RATE - the rate of interest reflecting that portion of the time value of money related to the real earning power of money over time. This is the discount rate used in discount formulas or in selecting discount factors when future benefits and costs are expressed in constant dollars. [A] (11/90)

REAL DOLLARS - see CONSTANT DOLLARS. [A] (11/90)

REAL ESTATE - this refers to the physical land and appurtenances, including structures affixed thereto. In some states, by statute, this term is synonymous with real property. (11/90)

REAL PROPERTY - refers to the interests, benefits, and rights inherent in the ownership of physical real estate. It is the bundle of rights with which the ownership of real estate is endowed. (11/90)

REASONABLENESS STANDARD - costs that do not exceed the amount incurred by a prudent contractor or those costs which are generally accepted. Some factors on which reasonableness is based are recognition of the costs as ordinary and necessary and restraints imposed by law, contract terms, or sound business practices. (11/90)

REBASING - conversion of a price index from one time base to another. (11/90)

REGRESSION - a functional relationship between two or more correlated variables often empirically determined from data and used to predict values of one variable when given values of the others. (11/90)

REMAINING AVAILABLE RESOURCES - the difference between the resource availability pool and the level schedule resource requirements. Its computed from the resource allocation process. (11/90)

REMAINING DURATION - the estimated work units needed to complete an activity as of the data date. (11/90)

REMAINING FLOAT (RF) - the difference between the early finish and the late finish. (11/90)

RENTAL (LEASED) EQUIPMENT COST - the amount which the owner of the equipment (lessor) charges to a lessee for use of the equipment. The best evidence of such costs are rental invoices that indicate the amount paid for leasing such equipment. (11/90)

REPLACEMENT - a facility proposed to take the place of an existing facility, without increasing its capacity, caused either by obsolescence or physical deterioration. (11/90)

REPLACEMENT COST - (1) the cost of replacing the productive capacity of existing property by another property of any type, to achieve the most economical service, at prices as of the date specified; (2) facility component replacement and related costs, included in the capital budget, that are expected to be incurred during the study period. [B] (11/90)

REPLACEMENT VALUE - that value of an item determined by repricing the item on the basis of replacing it, in new condition, with another item that gives the same ability to serve, or the same productive capacity, but which applies current economic design, adjusted for the existing property's physical deterioration. (11/90)

REPRODUCTION COST - the cost of reproducing substantially the identical item or facility at a price level as of the date specified. (11/90)

REPROGRAMMING - a comprehensive replanning of the efforts remaining in the contract resulting in a revised total allocated budget which exceeds the contract budget base. (11/90)

REPUDIATION - see ANTICIPATORY BREACH. (11/90)

REQUIRED COMPLETION DATE - the required date of completion assigned to a specific activity or project. (11/90)

REQUIRED RETURN - the minimum return or profit necessary to justify an investment. It is often termed interest, expected return or profit, or charge for the use of capital. (11/90)

REQUIREMENT - an established requisite characteristic of a product, process, or service. A characteristic is a physical or chemical property, a dimension, a temperature, a pressure, or any other specification used to define the nature of a product, process, or service. (11/90)

RESALE VALUE - the monetary sum expected from the disposal of an asset at the end of its economic life, its useful life, or at the end of the study period. [A] (11/90)

RESCHEDULE -(1) in construction, the process of changing the duration and/or dates of an existing schedule in response to externally imposed conditions or progress. (2) in manufacturing, the process of changing order or operation due dates, usually as a result of their being out of phase with when they are needed. (11/90)

RESEARCH EXPENSE - those continuing expenses required to provide and maintain the facilities to develop new products and improve present products. (11/90)

RESERVE STOCK - see SAFETY STOCK. (11/90)

RESIDENT ENGINEER - the authorized representative of the engineer who is assigned to the site or any part thereof whose duties are ordinarily set forth in the contract documents and/or the engineer's agreement with the owner. (11/90)

RESOURCE - in planning and scheduling, a resource is any consumable, except time, required to accomplish an activity. From a total cost and asset management perspective, resources may include any real or potential investment in strategic assets including time, monetary, human, and physical. A resource becomes a cost when it is invested or consumed in an activity or project. (1/02)

RESOURCE ALLOCATION PROCESS (RAP) - the scheduling of activities in a network with the knowledge of certain resource constraints and requirements. This process adjusts activity level start and finish dates to conform to resource availability and use. (11/90)

RESOURCE AVAILABILITY DATE - the calendar date when a resource level becomes available to be allocated to project activity. (11/90)

RESOURCE AVAILABILITY POOL - the amount of resource availability for any given allocation period. (11/90)

RESOURCE CODE - the code for a particular labor skill, material, equipment type; the code used to identify a given resource. (11/90)

RESOURCE DESCRIPTION - the actual name or identification associated with a resource code. (11/90)

RESOURCE HISTOGRAM - a graphic display of the amount of resource required as a function of time on a graph. Individual, summary, incremental, and cumulative resource curve levels can be shown. Syn.: RESOURCE PLOT. (11/90)

RESOURCE LIMITED SCHEDULING - a schedule of activities so that a preimposed resource availability level (constant or variable) is not exceeded in any given project time unit. (11/90)

RESOURCE PLOT - see RESOURCE HISTOGRAM. (11/90)

RESOURCE REQUIREMENTS PLANNING - the process of converting the production plan and/or the master production schedule into the impact on key resources, such as labor, machine hours, storage, standard cost dollars, shipping dollars, inventory levels, etc. (11/90)

RESPONSIBLE ORGANIZATION - the organization responsible for management of a work package. (11/90)

RESPONSIBILITY - originates when one accepts the assignment to perform assigned duties and activities. The acceptance creates a liability for which the assignee is held answerable for and to the assignor. It constitutes an obligation or accountability for performance. (11/90)

RESTRAINT - see CONSTRAINT. (11/90)

RETENTION - usually refers to a percent of contract value (usually 5 or 10 percent) retained by the purchaser until work is finished and testing of equipment is satisfactorily completed. (11/90)

RETIREMENT OF DEBT - the termination of a debt obligation by appropriate settlement with the lender. It is understood to be in full amount unless partial settlement is specified. (11/90)

RETURN ON AVERAGE INVESTMENT - the ratio of annual profits to the average book value of fixed capital, with or without working capital. This method has some advantages over the return-on-original-investment method. Depreciation is always considered; terminal recoveries are accounted for. However, the method does not account for the timing of cash flow and yields answers that are considerably higher than those obtained by the return-on-original-investment and profitability index methods. Results may be deceiving when compared, say, against the company's cost of capital. (11/90)

RETURN ON ORIGINAL INVESTMENT - the ratio of expected average annual after tax profit (during the earning life) to total investment (working capital included). It is similar in usefulness and limitations to payoff period. (11/90)

RETURN ON RATE BASE - for a public utility, that monetary sum established by the proper regulatory authority as a basis for determining the charges to customers and the "fair return" to the owners of the utility. (11/90)

REVISION - in the context of scheduling, a change in the network logic, activity duration, resources availability or resources demand which requires network recalculation and drawing correction(s). (11/90)

RIPPLE EFFECT - the multiplying effect of change(s) and/or productivity impacts to upstream work that may have an adverse impact on the subsequent work to be performed. (4/04)

RISK - the degree of dispersion or variability around the expected or "best" value which is estimated to exist for the economic variable in question, eg, a quantitative measure of the upper and lower limits which are considered reasonable for the factor being estimated. (11/90)

ROLLING WAVE PLANNING - Concept of planning where near-term work is planned in more detail than work in the future that is usually planned in summary. As the project progresses, summary activities are broken into more detail for near term execution. (3/04)

ROYALTIES - payments a company receives to allow others to use a design or concept the company has researched and developed to commercialization. Generally, one of two types: (1) paid-up royalties where a lump sum payment is made, and (2) running royalties where continuous payments are made, usually based on actual production or revenues. (11/90)

SAFETY STOCK - the average amount of stock on hand when a replenishment quantity is received. Its purpose is to protect against the uncertainty in demand and in the length of the replenishment lead time. Safety stock and cycle stock are the two main components of any inventory. Syn.: RESERVE STOCK. (11/90)

SAFETY TIME - in a time series planning system, material is frequently ordered to arrive ahead of the forecast requirement date to protect against forecast error. The difference between the forecast requirement date and the planned in-stock date is safety time. (11/90)

SALES - orders booked by customers. (11/90)

SALES ANALYSIS (or RESEARCH) - a systematic study and comparison of sales for consumption data along the lines of market areas, organizational units, products or product groups, customers or customer groups, or such other units as may be useful. See MARKET RESEARCH. Typical analyses would include:

1. Promotion Evaluation

2. Quota Assignment

3. Territory Assignment (11/90)

SALES FORECAST - a prediction or estimate of sales, in dollars or physical units, for a specified future period under a proposed marketing plan or program and under an assumed set of economic and other forces outside the unit for which the forecast is made. The forecast may be for a specified item of merchandise or for an entire line. (11/90)

SALES PROFILE - the growth or decline of historical or forecast sales volume, by years. (11/90)

SALES PRICE - the revenue received for a unit of a product. Gross sales price is the total amount paid. Net sales are gross sales less returns, discounts, freight and allowances. Plant netbacks are net sales less selling, administrative and research expenses. Syn.: SELLING PRICE. (11/90)

SALES REVENUE - revenue received as a result of sales, but not necessarily during the same time period. (11/90)

SALVAGE VALUE - (1) the cost recovered or which could be recovered from a used property when removed, sold, or scrapped; (2) the market value of a machine or facility at any point in time (normally an estimate of an asset's net market value at the end of its estimated life); (3) the value of an asset, assigned for tax computation purposes, that is expected to remain at the end of the depreciation period. (11/90)

SAMPLE - a part, or subset, of a population. (11/90)

SAVINGS-TO-INVESTMENT RATIO (SIR) - either the ratio of present value savings to present value investment costs, or the ratio of annual value savings to annual value investment costs. [A] (11/90)

SCHEDULE - the plan for completion of a project based on a logical arrangement of activities, resources available, imposed dates or funding budgets. (11/90)

SCHEDULED COMPLETION DATE - a date assigned for completion of activity or accomplishment of an event for purposes of meeting specified schedule requirements. (11/90)

SCHEDULED DATE - see CONTRACT DATE. (11/90)

SCHEDULED EVENT TIME - in PERT, an arbitrary schedule time that can be introduced at any event but is usually only used at a certain milestone or the last event. (11/90)

SCHEDULE VARIANCE - the difference between BCWP and BCWS. At any point in time it represents the difference between the dollar value of work actually performed (accomplished) and that scheduled to be accomplished. (11/90)

SCHEDULING - the assignment of desired start and finish times to each activity in the project within the overall time cycle required for completion according to plan. (11/90)

SCHEDULING RULES - basic rules that are spelled out ahead of time so that they can be used consistently in a scheduling system. (11/90)

SCHEDULING VARIANCE - the difference between projected start and finish dates and actual or revised start and finish dates. (11/90)

SCOPE - The sum of all that is to be or has been invested in and delivered by the performance of an activity or project. In project planning, the scope is usually documented (i.e, the scope document), but it may be verbally or otherwise communicated and relied upon. Generally limited to that which is agreed to by the stakeholders in an activity or project (i.e., if not agreed to, it is "out of scope"). In contracting and procurement practice, includes all that an enterprise is contractually committed to perform or deliver. Syn.: PROJECT SCOPE. (1/03)

SCOPE CHANGE - a deviation from the project scope originally agreed to in the contract. A scope change can consist of an activity either added to or deleted from the original scope. A contract change order is needed to alter the project scope. (11/90)

SEASONAL COMMODITIES - commodities which are normally available in the market-place only in a given season of the year. (11/90)

SEASONAL VARIATION - that movement in many economics series which tends to repeat itself within periods of a year. (11/90)

SECONDARY FLOAT (SF) - is the same as the Total Float, except that it is calculated from a schedule date set upon an intermediate event. (11/90)

SECULAR TREND - the smooth or regular movement of a long-term time series trend over a fairly long period of time. (11/90)

SELLING EXPENSE - the total expense involved in marketing the products in question. This normally includes direct selling costs, advertising, and customer service. (11/90)

SELLING PRICE - see SALES PRICE. (11/90)

SENSITIVITY - the relative magnitude of the change in one or more elements of an engineering economy problem that will reverse a decision among alternatives. (11/90)

SENSITIVITY ANALYSIS - a test of the outcome of an analysis by altering one or more parameters from an initially assumed value(s). [A] (11/90)

SENTIMENTAL VALUE - a value associated with an individual's personal desire, usually related to a prior personal relationship. (11/90)

SEQUENTIAL ANALYSIS - a process by which statistical data are analyzed continuously as the sample accumulates. After each additional item is obtained, and on the basis of a certain calculation, a decision is made whether to accept the hypothesis H_1, under test, or to accept an alternative hypothesis H_2 or to suspend judgement until more data are examined. The decision is based on the probability ratio of the sample under alternative hypotheses where the probabilities of the two types of erroneous conclusions are assigned in advance. Frequently fewer observations are required than under any other known method for the same degree of reliability and discrimination. It is very simple to apply and it requires the analyst to state his problem precisely and determine the alternative answers in advance with the attendant probabilities of erroneous conclusion. The calculations involved are the computations of the ratio of the probability of the observations if H_1 is true to the probability of the observations under the hypothesis H_2. If this ratio exceeds (I-B)/A, the hypothesis H_1 is accepted, whereas if it is less than B/(I-A), the hypothesis H_2 is accepted; if it is between these two ratios, judgement is suspended. A is the maximum acceptable probability of erroneously rejecting the hypothesis H_2, and B is the maximum acceptable probability of erroneously accepting the hypothesis H_2. (11/90)

SERVICEABILITY - a measure of the degree to which servicing of an item will be accomplished within a given time under specified conditions. (11/90)

SERVICING - the replenishment of consumables needed to keep an item in operating condition, but not including any other preventive maintenance or any corrective maintenance. (11/90)

SERVICE WORTH VALUE - earning value, assuming the rates and/or prices charged are just equal to the reasonable worth to customers of the services and/or commodities sold. (11/90)

SHIFTING BASE - changing the point of reference of an index number series from one time reference period to another. (11/90)

SHOP DRAWINGS - all drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the contractor to illustrate some portion of the work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a

supplier and submitted by the contractor to illustrate material or equipment for some portion of the work. (11/90)

SHOP ORDER NUMBER - see ACCOUNT NUMBER. (11/90)

SHOP PLANNING - the coordination of material handling, material availability, the setup and tooling availability so that a job can be done on a particular machine. (11/90)

SHORT-TERM ACTIVITIES - see MONTHLY GUIDE SCHEDULE. (11/90)

SHUTDOWN POINT - the production level at which it becomes less expensive to close the plant and pay remaining fixed expenses out-of-pocket rather than continue operations; that is, the plant cannot meet its variable expense. See BREAKDOWN POINT. (11/90)

SIC CODE - the Standard Industrial Classification of the Office of Management and Budget, which provides the framework for the industry-sector index classification scheme. Product indexes are aggregated to five-digit product classes and four-digit industries. Industry indexes can be aggregated to three- and two-digit levels as well. (11/90)

SIGNIFICANT VARIANCES - those differences between planned and actual performance which exceed established thresholds and which require further review, analysis and action. (11/90)

SIMPLE INTEREST - (1) interest that is not compounded -- is not added to the income-producing investment or loan; (2) the interest charges under the condition that interest in any time period is only charged on the principal. (11/90)

SIMPLE PAYBACK PERIOD (SPB) - the time required for the cumulative benefits from an investment to pay back the investment cost and other accrued costs, not considering the time value of money. [A] (11/90)

SIMULATION - (1) the technique of utilizing representative or artificial operating and demand data to reproduce, under test, various conditions that are likely to occur in the actual performance of a system. Simulation is frequently used to test the accuracy of a theoretical model or to examine the behavior of a system under different operating policies; (2) the design and operation of a model of a system. (11/90)

SINKING FUND - (1) a fund accumulated by periodic deposits and reserved exclusively for a specific purpose, such as retirement of a debt or replacement of a property; (2) a fund created by making periodic deposits (usually equal) at compound interest in order to accumulate a given sum at a given future time for some specific purpose. (11/90)

SITE PREPARATION - an act involving grading, landscaping, installation of roads and siding, of an area of ground upon which anything previously located had been cleared so as to make the area free of obstructions, entanglements or possible collisions with the positioning or placing of anything new or planned. (11/90)

SKEWNESS - an expression for nonsymmetrical "tailing" of a distribution. (11/90)

SLACK - see FLOAT. (11/90)

SLACK PATHS - the sequences of activities and events that do not lie on the critical path or paths. (11/90)

SLACK TIME - the difference in calendar time between the scheduled due date for a job and the estimated completion date. If a job is to be completed ahead of schedule, it is said to have slack time; if it is likely to be completed behind schedule, it is said to have negative slack time. Slack time can be used to calculate job priorities using methods such as the critical ratio. In the critical path method, total slack is the amount of time a job may be delayed in starting without necessarily delaying the project completion time. Free slack is the amount of time a job may be delayed in starting without delaying the start of any other job in the project. (11/90)

SPECIFICATION, DESIGN (PRESCRIPTIVE) - a design specification providing a detailed written and/or graphic presentation of the required properties of a product, material, or piece of equipment, and prescribing the procedure for its fabrication, erection, and installation. (11/90)

SPECIFICATION, PERFORMANCE - a statement of required results, verifiable as meeting stipulated criteria, and generally free of instruction as to the method of accomplishment. (11/90)

SPECIFICATIONS - written directions regarding the quality of materials and the nature of the workmanship for a job. Specifications may be written directly on the drawings, or presented in a separate document. (11/90)

SPLICING TECHNIQUE - one of the procedures used for maintaining the continuity of a price index series in the case of substituted items (and/or replaced outlets). The basic assumption underlying the technique is that, at a given point in time, the relative difference in prices between the replaced and replacing items (and/or outlets) reflects the difference in respective qualities. In effect, the splicing technique is analogous to, and may be considered a particular case of, the linking procedure. (11/90)

SPOT MARKET PRICE INDEX - daily index used as a measure of price movements of 22 sensitive basic commodities whose markets are to be presumed to be among the first to be influenced by changes in economic conditions. It serves as one early indicator of impending changes in business activity. (11/90)

STAGE OF PROCESSING - a commodity's intermediate position in the value-added channel of production. (11/90)

STANDARD DEVIATION - the most widely used measure of dispersion of a frequency distribution. It is calculated by summing squared deviations from the mean, dividing by the number of items in the group and taking the square root of the quotient. (11/90)

STANDARD ERROR OF THE MEAN - the standard deviation of the distribution, divided by the square root of the number of cases. (11/90)

STANDARD ERROR OF ESTIMATE - an expression for the standard deviation of the observed values about a regression line, i.e., an estimate of the variance likely to be encountered in making predictions from the regression equation. (11/90)

STANDARD INDUSTRIAL CLASSIFICATION (SIC CODE) - a classification system of the Office of Management and Budget which provides the framework for the industry-sector index classification scheme. Product indexes are aggregated to five-digit product classes and four-digit industries. Industry indexes can be aggregated to three- and two-digit levels as well.

Example: industry code - 3443 - fabricated platework
product code - 80201 carbon steel tanks and vessels (11/90)

STANDARD NETWORK DIAGRAM - a predefined network intended to be used more than one time in any given project. (11/90)

STARTING EVENT - see BEGINNING EVENT. (11/90)

STARTUP - that period after the date of initial operation, during which the unit is brought up to acceptable production capacity and quality within estimated production costs. Startup is the activity that commences on the date of initial activity that has significant duration on most projects, but is often confused (used interchangeably) with date of initial operation. (11/90)

STARTUP COSTS - extra operating costs to bring the plant on stream incurred between the completion of construction and beginning of normal operations. In addition to the difference between actual operating costs during that period and normal costs, it also includes employee training, equipment tests, process adjustments, salaries and travel expense of temporary labor, staff and consultants, report writing, post-startup monitoring and associated overhead. Additional capital required to correct plant problems may be included. Startup costs are sometimes capitalized. (11/90)

STATUS - the condition of the project at a specified point in time relative to its plan. An instantaneous snapshot of the then current conditions. See PROGRESS. [P] (11/90)

STATUS LINE - a vertical line on a time-scaled schedule indicating the point in time (date) on which the status of the project is reported. Often referred to as the time now line. See DATA DATE. (11/90)

STATUSING - indicating on the schedule the most current project status. See UPDATE. (11/90)

STOCHASTIC - the adjective "stochastic" implies the presence of a random variable. (11/90)

STOCK AND BOND VALUE - a special form of market value for enterprises, which can be owned through possession of their securities. Stock and bond value is the sum of (1) the par values in dollars of the different issues of bonds multiplied by the corresponding ratios of the market price to the par value, and (2) the number of shares of each issue of stock multiplied by the corresponding market price in dollars per share. (11/90)

STOP WORK ORDER - see SUSPENSION OF WORK, DIRECTED. (11/90)

STRAIGHT-LINE DEPRECIATION - method of depreciation whereby the amount to be recovered (written off) is spread uniformly over the estimated life of the asset in terms of time periods or units of output. (11/90)

STRATEGIC ASSET - any unique physical or intellectual property that is of long term or ongoing value to the enterprise. As used in total cost management, it most commonly includes capital or fixed assets, but may include intangible assets. Excludes cash and purely financial assets. Strategic assets are created by the investment of resources through projects. (1/02)

STUDY PERIOD - the length of time over which an investment is analyzed. Syn.: LIFE CYCLE; TIME HORIZON. [A] (11/90)

SUBCONTRACT - any agreement or arrangement between a contractor and any person (in which the parties do not stand in the relationship of an employer and an employee) and where neither party is the owner. (11/90)

SUBCONTRACTOR - an individual, partnership, corporation, joint venture or other combination thereof having a direct contract with the contractor or with any other subcontractor for the performance of a part of the work at the site. (11/90)

SUBINDEX - a price index for a subaggregate of a given basket of commodities. (11/90)

SUBNET - the subdivision of a network into segments usually representing some form of subproject; a portion of a larger network generally for a unique area of a project. See also FRAG NET. [P] (11/90)

SUBSTANTIAL COMPLETION - work (or a specified part thereof) which has progressed to the point where in the opinion of the engineer, as evidenced by the engineer's definitive certificate of substantial completion, it is sufficiently complete, in accordance with the contract documents, so that the work (or specified part) can be utilized for the purposes for which it is intended; or if there be no such certificate issued, when final payment is due in accordance with the general conditions. Substantial completion of the work, or specified part thereof, may be achieved either upon completion of pre-operational testing or startup testing, depending upon the requirements of the contract documents. The terms Substantially Complete and Substantially Completed as applied to any work refer to substantial completion thereof. (11/90)

SUBSYSTEM - an aggregation of component items (hardware and software) performing some distinguishable portion of the function of the total system of which it is a part. Normally, a subsystem could be considered a system in itself if it were not an integral part of the larger system. (11/90)

SUCCESSOR - An activity that immediately succeeds another activity. (3/04)

SUCCESSOR ACTIVITY - any activity that exists on a common path with the activity in question and occurs after the activity in question. (11/90)

SUCCESSOR EVENT - the event that signifies the completion of an activity. (11/90)

SUMMARY ITEM - an item appearing in the work breakdown structure. (11/90)

SUMMARY NETWORK - a summarization of the CPM network for presentation purposes. This network is not computed. (11/90)

SUMMARY NUMBER - a number that identifies an item in the work breakdown structure. (11/90)

SUMMARY SCHEDULE - see MASTER PROJECT SCHEDULE. (11/90)

SUM-OF-DIGITS METHOD - A method of computing depreciation in which the amount for any year is based on the ratio: (years of remaining life)/(1+2+3+...+n), n being the total anticipated life. Also known as sum-of-the-years-digits method. (11/90)

SUNK COST - a cost that has already been incurred and which should not be considered in making a new investment decision. [B] (11/90)

SUPERIOR KNOWLEDGE - see MISREPRESENTATION. (11/90)

SUPPLEMENTARY CONDITIONS - the part of the contract documents which amends or supplements the general conditions. (11/90)

SUPPLIER - a manufacturer, fabricator, distributor or vendor. (11/90)

SURETY - a bonding company licensed to conduct business which guarantees the owner that the contract will be completed (Performance Bond) and that subcontractors and suppliers will be paid (Payment Bond). (11/90)

SUSPENSION OF WORK, CONSTRUCTIVE - an act or failure to act by the owner, or the owner's representative, which is not a directed suspension of work or work stoppage, but which has the effect of delaying, interrupting, or suspending all or a portion of the work. (11/90)

SUSPENSION OF WORK, DIRECTED - actions resulting from an order of the owner to delay, interrupt, or suspend any or all portions of the work for a given period of time, for the convenience of the owner. (11/90)

SYSTEM - a collection of hardware (equipment and facilities) and related software (procedures, etc) designated to perform a unique and useful function. A system contains everything necessary (except personnel and materials or supplies) to perform its defined function. (11/90)

SYSTEMS STUDIES - the development and application of methods and techniques for analyzing and assessing programs, activities and projects to review and assess efforts to date and to determine future courses and directions. These studies include cost/ benefit analysis, environmental impact analysis, assessment of the likelihood of technical success, forecasts of possible futures resulting from specific actions, and guidance for energy program planning and implementation. (11/90)

TAKE-OFF - a take-off is a specific type of quantification that is a measurement and listing of quantities of materials from drawings in order to support the estimate costing process and/or to support the material procurement process. Syn.: QUANTIFICATION. (1/03)

TANGIBLES - things that can be quantitatively measured or valued, such as items of cost and physical assets. (11/90)

TARGET DATE - the date an activity is desired to be started or completed; either externally imposed on the system by project management or client, or accepted as the date generated by the initial CPM schedule operation. (11/90)

TARGET REPORTING - a method of reporting the current schedule against some established base line schedule and the computations of variances between them. (11/90)

TARGET START DATE - see EXPECTED BEGIN DATE. (11/90)

TASK - Smallest unit of work planned. It must have an identifiable start and finish, and usually produces some recognizable results. (3/04)

TASK MONITOR - the individual assigned the monitoring responsibility for a major effort within the program. (11/90)

TAXES PAYABLE - tax accruals due within a year. (11/90)

TEMPORARY CONSTRUCTION COST - includes costs of erecting, operating, and dismantling impermanent facilities, such as offices, workshops, etc, and providing associated services such as utilities. (11/90)

TERMINATION - actions by the owner, in accordance with contract clauses, to end, in whole or in part, the services of the contractor. Termination may be for the convenience of the owner or for default by the contractor. (11/90)

TERMS OF PAYMENT - defines a specific time schedule for payment of goods and services and usually forms the basis for any contract price adjustments on those contracts that are subject to escalation. (11/90)

THIRD PARTY CLAIM - a claim against either or both the owner or the contractor by members of the public, or other parties, usually for property damage or personal injury. (11/90)

TIED ACTIVITY - an activity that must start within a specified time or immediately after its predecessor's completion or start. (11/90)

TIME EXTENSION - an increase in the contract time by modification to complete an item of work. Time extension may be granted under the corresponding provisions in the general conditions. An excusable delay generally entitles a contractor to a time extension. (11/90)

TIME HORIZON - see STUDY PERIOD. [A] (11/90)

TIME-LIMITED SCHEDULING - the scheduling of activities so predetermined resource availability pools are not exceeded unless the further delay will cause the project finish to be delayed. Activities can be delayed only until their late start date. However, activities will begin when the late start date is reached, even if resource limits are exceeded. Networks with negative total float time cannot be processed by time-limited scheduling. (11/90)

TIME NOW LINE - the point in time that the network analysis is based upon. May or may not be the data date. See STATUS LINE. (11/90)

TIME OF THE ESSENCE - a contract requirement that completion of the work within the time limits in the contract is essential. Failure to do so is a breach for which the injured party is entitled to damages. (11/90)

TIME-SCALED CPM - a plotted or drawn representation of a CPM network where the length of the activities indicates the duration of the activity as drawn to a calendar scale. Float is usually shown with a dashed line as are dummy activities. (11/90)

TIME UNIT - see CALENDAR UNIT. (11/90)

TIME VALUE OF MONEY - (1) the time-dependent value of money stemming both from changes in the purchasing power of money (that is, inflation or deflation), and from the real earning potential of

alternative investments over time. (2) the cumulative effect of elapsed time on the money value of an event, based on the earning power of equivalent invested funds. See FUTURE WORTH and PRESENT WORTH; (3) the expected interest rate that capital should or will earn. [B] (11/90)

TOTAL COST BIDDING - a method of establishing the purchase price of movable equipment; the buyer is guaranteed that maintenance will not exceed a set maximum amount during a fixed period and that the equipment will be repurchased at a set minimum price when the period ends. (11/90)

TOTAL COST MANAGEMENT - the effective application of professional and technical expertise to plan and control resources, costs, profitability and risks. Simply stated, it is a systematic approach to managing cost throughout the life cycle of any enterprise, program, facility, project, product, or service. This is accomplished through the application of cost engineering and cost management principles, proven methodologies and the latest technology in support of the management process. Can also be considered the sum of the practices and processes that an enterprise uses to manage the total life cycle cost investment in its portfolio of strategic assets. (1/02)

TOTAL FLOAT (TF) - the amount of time (in work units) that an activity may be delayed from its early start without delaying the project finish date. Total float is equal to the late finish minus the early finish or the late start minus the early start of the activity. (11/90)

TOTAL QUALITY MANAGEMENT - the consistent integrated orchestration of the total complex of an organization's work processes and activities to achieve continuous improvement in the organization's processes and products. (11/90)

TRACKING - a form of monitoring applied to projects. The measurements are expected to change according to the planned progress. [P] (11/90)

TRANSFER PRICE - a term used in economic analysis in the mineral processing industries; used to assign a value to raw materials when the same company does the mining and processing; usually equal to the fair market value. (11/90)

TRANSPORTATION PROBLEM - a homogeneous product is to be shipped in the amounts $a_1, a_2,...,a_m$ respectively from each of m shipping origins and received in amounts $b_1, b_2,...,b_n$ respectively by each of n shipping destinations. The cost of shipping a unit amount from the i^{th} origin to the j^{th} destination is c_{ij} and is known for all combinations (i,j). The problem is to determine the amounts x_{ij} to be shipped over all routes (i,j) so as to minimize the total cost of transportation. (11/90)

TRANSSHIPMENT PROBLEM - a generalized transportation problem in which transshipment through intermediate nodes between source and destination is allowed. (11/90)

TURNOVER RATIO - the ratio of annual sales to investment. Inclusion of working capital is preferable, but not always done. Turnover ratio is considered by some to be reasonable basis for a guesstimate of facilities cost, for new products similar to existing products. It ranges around 1.0 for many chemical plants. The product of turnover ratio and profit margin on sales gives a return-on-investment measure. (11/90)

UNBALANCING - A technique used in the pricing process to allocate estimated costs to accounts whose definitions do not fully reflect the nature of the cost being allocated. The purpose of unbalancing is to achieve a desired business result such as improved cash flow. For example, a disproportionate amount of overhead costs may be allocated in a contract bid to early project activities so that early income is maximized. (1/03)

UNCERTAINTY - unknown future events which cannot be predicted quantitatively within useful limits, eg, accidents which destroy invested facilities, a major strike, a competitor's innovation which makes the new product obsolete. (11/90)

UNDERGROUND FACILITIES - all pipelines, conduits, ducts, cables, wires, utility accessways, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water. (11/90)

UNIT COST - dollar per unit of production. It is usually total cost divided by units of production, but a major cost divided by units of production is frequently referred to as a unit cost; for example, the total unit cost is frequently subdivided into the unit costs for labor, chemicals, etc. (11/90)

UNJUST ENRICHMENT DOCTRINE - the belief in law that one person should not be allowed to profit or enrich himself or herself unfairly at the expense of another person. (11/90)

UNUSUALLY SEVERE WEATHER - adverse weather which, at the time of year in which it occurred, is unusual for the place of contract performance. No matter how severe or destructive, if the weather is not unusual for the particular time and place, the contractor is not entitled to relief. Unusual or normal weather does not mean ideal weather or the best weather that can be expected; rather it means the normal weather pattern, both good and bad, that could be reasonably anticipated in a particular area. The normal weather pattern is generally that based on the record of the prior ten years unless the contract documents provide for a different period. (11/90)

UPDATING - the regular review, analysis, evaluation, and reporting of progress of the project, including recomputation of an estimate or schedule. See STATUSING. (11/90)

UNION - a group of workers who organize together for the purpose of negotiating wage rates, working conditions and fringe benefits. (11/90)

USEFUL LIFE - the period of time over which an investment is considered to meet its original objective. [A] (11/90)

USE VALUE - see FUNCTIONAL WORTH. (11/90)

VALUATION OR APPRAISAL - the art of estimating the fair-exchange value of specific properties. (11/90)

VALUE, ACTIVITY - that portion of the contract price which represents a fair value for the part of the work identified by that activity. (11/90)

VALUE ADDED BY DISTRIBUTION - the portion of the value of a product or service to the consumer or user which results from distribution activities. This value includes such components as time utility and place utility. (11/90)

VALUE ADDED BY MARKETING - that portion of the value of a product or service to the consumer or user which results from marketing activities. This value includes such components as price reduction through economies of scale and buyer awareness of more desirable innovations in products or services. (11/90)

VALUE OF WORK PERFORMED TO DATE - the planned cost for completed work. (11/90)

VALUE EFFECTIVE - generally used to describe decisions which have a cost impact; value-effective decisions tend to optimize the value received for the decision made and to maximize return on investments. (11/90)

VALUE ENGINEERING - a practice function targeted at the design itself, which has as its objective the development of design of a facility or item that will yield least life-cycle costs or provide greatest value while satisfying all performance and other criteria established for it. (11/90)

VALUE ENGINEERING COST AVOIDANCE - a decrease in the estimated overall cost for accomplishing a function. (11/90)

VALUE ENGINEERING COST REDUCTION - a decrease in the committed and/or established overall cost for accomplishing a function. (11/90)

VALUE ENGINEERING JOB PLAN - an aid to problem recognition, definition, and solution. It is a formal, step-by-step procedure followed in carrying out a value engineering study. (11/90)

VARIABLE COSTS - those costs that are a function of production, eg, raw materials costs, by-product credits, and those processing costs that vary with plant output (such as utilities, catalysts and chemical, packaging, and labor for batch operations). (11/90)

VARIANCE - in cost control, the difference between actual cost or forecast budget cost. (11/90)

VARIATION IN ESTIMATED QUANTITY - the difference between the quantity estimated in the bid schedule and the quantity actually required to complete the bid item. Negotiation or adjustment for variations are generally called for when an increase or decrease exceeds 15 percent. (11/90)

VENTURE LIFE - the total time span during which expenditures and/or reimbursements related to the venture occur. Venture life may include the research and development, construction, production and liquidation periods. See FINANCIAL LIFE. (11/90)

VENTURE WORTH - present worth of cash flows above an acceptable minimum rate, discounted at the average rate of earnings. (11/90)

VERTICAL EVENT NUMBERING - assigning event numbers in vertical order. (11/90)

WAGE RATE - the hourly, daily or weekly cost of a person who works for wages, e.g., mechanics, laborers, steamfitters. (11/90)

WEIGHTS - numerical modifiers used to infer importance of commodities in an aggregative index. (11/90)

WORK - any and all obligations, duties, responsibilities, labor, materials, equipment, temporary facilities, and incidentals, and the furnishing thereof necessary to complete the construction which are assigned to, or undertaken by the contractor, pursuant to the contract documents. Also, the entire completed construction or the various separately identifiable parts thereof required to be furnished under the contract documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the contract documents. (11/90)

WORK BREAKDOWN STRUCTURE (WBS) - a product-oriented family tree division of hardware, software, facilities and other items which organizes, defines and displays all of the work to be performed in accomplishing the project objectives.

1. Contract Work Breakdown Structure (CWBS) - the complete WBS for a contract developed and used by a contractor in accordance with the contract work statement. It extends the PSWBS to the lowest level appropriate to the definition of the contract work.

2. Project Summary Work Breakdown Structure (PSWBS) - a summary WBS tailored by project management to the specific project with the addition of the elements unique to the project. (11/90)

WORK BREAKDOWN STRUCTURE ELEMENT - any one of the individual items or entries in the WBS hierarchy, regardless of level. (11/90)

WORK DIRECTIVE CHANGE - a written directive to the contractor, issued on or after the effective date of the agreement and signed by the owner and recommended by the engineer ordering an addition, deletion or revision in the work, or responding to differing or unforeseen physical conditions or emergencies under which the work is to be performed as provided in the general conditions. A work directive change may not change the contract price or the contract time, but is evidence that the parties expect that the change directed or documented by a work directive change will be incorporated in a subsequently issued change order following negotiations by the parties as to its effect, if any, on the contract price or contract time. (11/90)

WORKHOUR - an analysis of planned versus actual staffing of the project used to determine work progress, productivity rates, staffing of the project, etc. (11/90)

WORK-IN-PROCESS - product in various stages of completion throughout the factory, including raw material that has been released for initial processing and completely processed material awaiting final inspection and acceptance as finished product or shipment to a customer. Many accounting systems also include semifinished stock and components in this category. Syn: IN-PROCESS INVENTORY. (11/90)

WORK ITEM - the precedence notation equivalent of an activity. See ACTIVITY. (11/90)

WORK PACKAGE - a segment of effort required to complete a specific job such as a research or technological study or report, experiment or test, design specification, piece of hardware, element of software, process, construction drawing, site survey, construction phase element, procurement phase element, or service, which is within the responsibility of a single unit within the performing organization. The work package is usually a functional division of an element of the lowest level of the WBS. (11/90)

WORK POWER LEVELING - see LOAD LEVELING. (11/90)

WORK SAMPLING - A direct method of measuring and monitoring labor productivity so that labor resources can be minimized and wasted effort eliminated from work processes. Work sampling provides information about the work process (i.e., how work is done) in a way that supports statistical assessment of such processes in order to optimize productivity. (1/04)

WORK SITE - The area designated in the contract where the facility is to be constructed. (11/90)

WORK UNIT - a unit of time used to estimate the duration of activities. (11/90)

WORTH - the worth of an item or groups of items, as in a complete facility, is determined by the return on investment compared to the amount invested. The worth of an item is dependent upon the analysis of feasibility of the entire item or group or items under discussion (or examination). (11/90)

WRITTEN AMENDMENT - A written amendment of the contract documents, signed by the owner and the contractor on or after the effective date of the agreement and normally dealing with the non-engineering or non-technical rather than strictly work-related aspects of the contract documents. (11/90)

YEAR-TO-YEAR PRICE INDEX - a price index for a given year with the preceding year as the base period. (11/90)

YIELD - the ratio of return or profit over the associated investment, expressed as a percentage or decimal usually on an annual basis. See RATE OF RETURN. (11/90)

aace International

AACE International Recommended Practice No. 17R-97

COST ESTIMATE CLASSIFICATION SYSTEM

Acknowledgment:
Peter Christensen CCE, Primary Author
Larry R. Dysert CCC, Primary Author
Jennifer Bates CCE
Dorothy J. Burton
Robert C. Creese PE CCE
John K. Hollmann PE CCE
Kenneth K. Humphreys PE CCE
Donald F. McDonald JR. PE CCE
C. Arthur Miller
Bernard A. Pietlock CCC
Wesley R. Querns CCE
Don L. Short II

Recommended Practice No. 17R-97

Cost Estimate Classification System

August 12, 1997

PURPOSE

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to asset project cost estimates. Asset project cost estimates typically involve estimates for capital investment, and exclude operating and life-cycle evaluations. The Cost Estimate Classification System maps the phases and stages of asset cost estimating together with a generic maturity and quality matrix that can be applied across a wide variety of industries.

This guideline and its addenda have been developed in a way that:

- provides common understanding of the concepts involved with classifying project cost estimates, regardless of the type of enterprise or industry the estimates relate to;
- fully defines and correlates the major characteristics used in classifying cost estimates so that enterprises may unambiguously determine how their practices compare to the guidelines;
- uses degree of project definition as the primary characteristic to categorize estimate classes; and
- reflects generally-accepted practices in the cost engineering profession.

An intent of the guidelines is to improve communication among all of the stakeholders involved with preparing, evaluating, and using project cost estimates. The various parties that use project 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.

This classification guideline is intended to 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.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally-acceptable classification system that can be used as a basis to compare against. If an enterprise or organization has not yet formally documented its own estimate classification scheme, then this guideline may provide an acceptable starting point.

INTRODUCTION

An AACE International guideline for cost estimate classification for the process industries was developed in the late 1960s or early 1970s, and a simplified version was adopted as an ANSI Standard Z94.0 in 1972. Those guidelines and standards enjoy reasonably broad acceptance within the engineering and construction communities and within the process industries. This recommended practice guide and its addenda improves upon these standards by:

1. providing a classification method applicable across all industries; and
2. unambiguously identifying, cross-referencing, benchmarking, and empirically evaluating the multiple characteristics related to the class of cost estimate.

This guideline is intended to provide a generic methodology for the classification of project cost estimates in any industry, and will be supplemented with addenda that will provide extensions and additional detail for specific industries.

CLASSIFICATION METHODOLOGY

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."

Categorizing cost estimates by degree of project definition is in keeping with the AACE International philosophy of Total Cost Management, which is a quality-driven process applied during the entire project life cycle. The discrete levels 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.

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

The estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest level of project definition, and a Class 1 estimate is closest to full project definition and maturity. This arbitrary "countdown" approach considers that estimating is a process whereby successive estimates are prepared until a final estimate closes the process.

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

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

Figure 1 – Generic Cost Estimate Classification Matrix

DEFINITIONS OF COST ESTIMATE CHARACTERISTICS

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

Level of Project Definition (Primary Characteristic)

This characteristic is based upon percent complete of project definition (roughly corresponding to percent complete of engineering). The level 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, learnings from past projects, reconnaissance data, and other information that must be 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 level of project definition (i.e., project engineering) progresses.

End Usage (Secondary Characteristic)

The various classes (or phases) of cost estimates prepared for a project typically have different end uses or purposes. As the level of project definition increases, the end usage of an estimate typically progresses from strategic evaluation and feasibility studies to funding authorization and budgets to project control purposes.

Estimating Methodology (Secondary Characteristic)

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 often are somewhat subject to conjecture. With deterministic methods, the independent variable(s) are more or less a definitive measure of the item being estimated. A deterministic methodology is not subject to significant conjecture. As the level of project definition increases, the estimating methodology tends to progress from stochastic to deterministic methods.

Expected Accuracy Range (Secondary Characteristic)

Estimate accuracy range is in indication of the degree to which the final cost outcome for a given project will 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 level of project definition increases, the expected accuracy of the estimate tends to improve, as indicated by a tighter +/- range.

Note that in figure 1, the values in the accuracy range column do not represent + or - 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.

Effort to Prepare Estimate (Secondary Characteristic)

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 level 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 the effort metrics; they only cover the cost to prepare the cost estimate itself.

RELATIONSHIPS AND VARIATIONS OF CHARACTERISTICS

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 level 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.

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 "accuracy" and "methodology" can vary markedly from one industry to another, and even from estimator to estimator within a given industry.

Level of Project Definition

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"—i.e., 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 on. Understanding these drivers puts the differences that may appear in the more detailed industry addenda into perspective.

End Usage

While there are common end usages of an estimate among different stakeholders, usage is often relative to the stakeholder's 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 stakeholder's 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 level of project definition achieved).

Estimating Methodology

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 and/or technical parameters. 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 level 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.

Expected Accuracy Range

The accuracy range of an estimate is dependent upon a number of characteristics of the estimate input information and the estimating process. The extent and the maturity of the input information as measured by percentage completion (and related to level 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.

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 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.

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.

In summary, estimate accuracy will generally be correlated with estimate classification (and therefore the level 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 technology, 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.

Effort to Prepare Estimate

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.

It also should be noted that the 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.

ESTIMATE CLASSIFICATION MATRIX

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed above.

This generic matrix and guideline provide a high-level estimate classification system that is nonindustry specific. Refer to subsequent addenda for further guidelines that will provide more detailed information for application in specific industries. These will provide additional information, such as input deliverable checklists, to allow meaningful categorization in that industry.

REFERENCES

ANSI Standard Z94.2-1989. **Industrial Engineering Terminology: Cost Engineering**.

aace International

AACE International Recommended Practice No. 18R-97

COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

Acknowledgments:

Peter Christensen, CCE (Author)
Larry R. Dysert, CCC (Author)
Jennifer Bates, CCE
Dorothy J. Burton
Robert C. Creese, PE CCE
John K. Hollmann, PE CCE
Kenneth K. Humphreys, PE CCE
Donald F. McDonald, Jr. PE CCE
C. Arthur Miller
Bernard A. Pietlock, CCC
Wesley R. Querns, CCE
Don L. Short, II

AACE International Recommended Practice No. 18R-97

COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

February 2, 2005

PURPOSE

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The Cost Estimate Classification System maps the phases and stages of project cost estimating together with a generic maturity and quality matrix, which can be applied across a wide variety of industries.

This addendum to the generic recommended practice provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. This addendum supplements the generic recommended practice (17R-97) by providing:

- a section that further defines classification concepts as they apply to the process industries;
- charts that compare existing estimate classification practices in the process industry; and
- a chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic standard, an intent of this addendum is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally acceptable classification system for process industries that can be used as a basis to compare against. It is hoped that this addendum will allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

INTRODUCTION

For the purposes of this addendum, the term process industries is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents. These documents are key deliverables in determining the level of project definition, and thus the extent and maturity of estimate input information.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries, such as pharmaceutical, utility, metallurgical, converting, and similar industries. Specific addendums addressing these industries may be developed over time.

This addendum specifically does not address cost estimate classification in nonprocess industries such as commercial building construction, environmental remediation, transportation infrastructure, "dry" processes such as assembly and manufacturing, "soft asset" production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps in these systems.

The cost estimates covered by this addendum are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the

significant building construction that may be a part of process plants. Building construction will be covered in a separate addendum.

This guideline reflects generally-accepted cost engineering practices. This addendum was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed by the AACE International Cost Estimating Committee. The practices were found to have significant commonalities that are conveyed in this addendum.

COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed in the generic standard. The characteristics are typical for the process industries but may vary from application to application.

This matrix and guideline provide an estimate classification system that is specific to the process industries. Refer to the generic standard for a general matrix that is non-industry specific, or to other addendums for guidelines that will provide more detailed information for application in other specific industries. These will typically provide additional information, such as input deliverable checklists to allow meaningful categorization in those particular industries.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [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 given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Schedule DFM2010-3

Figure 1. – Cost Estimate Classification Matrix for Process Industries
CHARACTERISTICS OF THE ESTIMATE CLASSES

The following charts (figures 2a through 2e) provide detailed descriptions of the five estimate classifications as applied in the process industries. They are presented in the order of least-defined estimates to the most-defined estimates. These descriptions include brief discussions of each of the estimate characteristics that define an estimate class.

For each chart, the following information is provided:

- **Description:** a short description of the class of estimate, including a brief listing of the expected estimate inputs based on the level of project definition.
- **Level of Project Definition Required:** expressed as a percent of full definition. For the process industries, this correlates with the percent of engineering and design complete.
- **End Usage:** a short discussion of the possible end usage of this class of estimate.
- **Estimating Methods Used:** a listing of the possible estimating methods that may be employed to develop an estimate of this class.
- **Expected Accuracy Range:** typical variation in low and high ranges after the application of contingency (determined at a 50% level of confidence). Typically, this results in a 90% confidence that the actual cost will fall within the bounds of the low and high ranges.
- **Effort to Prepare:** this section provides a typical level of effort (in hours) to produce a complete estimate for a US$20,000,000 plant. Estimate preparation effort is highly dependent on project size, project complexity, estimator skills and knowledge, and on the availability of appropriate estimating cost data and tools.
- **ANSI Standard Reference (1989) Name:** this is a reference to the equivalent estimate class in the existing ANSI standards.
- **Alternate Estimate Names, Terms, Expressions, Synonyms:** this section provides other commonly used names that an estimate of this class might be known by. These alternate names are not endorsed by this Recommended Practice. The user is cautioned that an alternative name may not always be correlated with the class of estimate as identified in the chart.

CLASS 5 ESTIMATE	
Description: Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended—sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation. **Level of Project Definition Required:** 0% to 2% of full project definition. **End Usage:** Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.	**Estimating Methods Used:** Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques. **Expected Accuracy Range:** Typical accuracy ranges for Class 5 estimates are - 20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. **Effort to Prepare (for US$20MM project):** As little as 1 hour or less to perhaps more than 200 hours, depending on the project and the estimating methodology used. **ANSI Standard Reference Z94.2-1989 Name:** Order of magnitude estimate (typically -30% to +50%). **Alternate Estimate Names, Terms, Expressions, Synonyms:** Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

Figure 2a. – Class 5 Estimate

CLASS 4 ESTIMATE	
Description: Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists. **Level of Project Definition Required:** 1% to 15% of full project definition. **End Usage:** Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.	**Estimating Methods Used:** Class 4 estimates virtually always use stochastic estimating methods such as equipment factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques. **Expected Accuracy Range:** Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. **Effort to Prepare (for US$20MM project):** Typically, as little as 20 hours or less to perhaps more than 300 hours, depending on the project and the estimating methodology used. **ANSI Standard Reference Z94.2-1989 Name:** Budget estimate (typically -15% to + 30%). **Alternate Estimate Names, Terms, Expressions, Synonyms:** Screening, top-down, feasibility, authorization, factored, pre-design, pre-study.

Figure 2b. – Class 4 Estimate

CLASS 3 ESTIMATE	
Description: Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists. **Level of Project Definition Required:** 10% to 40% of full project definition. **End Usage:** Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase "control estimates" against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.	**Estimating Methods Used:** Class 3 estimates usually involve more deterministic estimating methods than stochastic methods. They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project. **Expected Accuracy Range:** Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. **Effort to Prepare (for US$20MM project):** Typically, as little as 150 hours or less to perhaps more than 1,500 hours, depending on the project and the estimating methodology used. **ANSI Standard Reference Z94.2-1989 Name:** Budget estimate (typically -15% to + 30%). **Alternate Estimate Names, Terms, Expressions, Synonyms:** Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering phase estimate, target estimate.

Figure 2c. – Class 3 Estimate

CLASS 2 ESTIMATE	
Description: Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, piping and instrument diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc. **Level of Project Definition Required:** 30% to 70% of full project definition. **End Usage:** Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program.	**Estimating Methods Used:** Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detail takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods. **Expected Accuracy Range:** Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. **Effort to Prepare (for US$20MM project):** Typically, as little as 300 hours or less to perhaps more than 3,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes. **ANSI Standard Reference Z94.2-1989 Name:** Definitive estimate (typically -5% to + 15%). **Alternate Estimate Names, Terms, Expressions, Synonyms:** Detailed control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.

Figure 2d. – Class 2 Estimate

CLASS 1 ESTIMATE	
Description: Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. **Level of Project Definition Required:** 50% to 100% of full project definition. **End Usage:** Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.	**Estimating Methods Used:** Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities. **Expected Accuracy Range:** Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. **Effort to Prepare (for US$20MM project):** Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 6,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes. **ANSI Standard Reference Z94.2 Name:** Definitive estimate (typically -5% to + 15%). **Alternate Estimate Names, Terms, Expressions, Synonyms:** Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

Figure 2e. – Class 1 Estimate

Schedule DFM2010-3

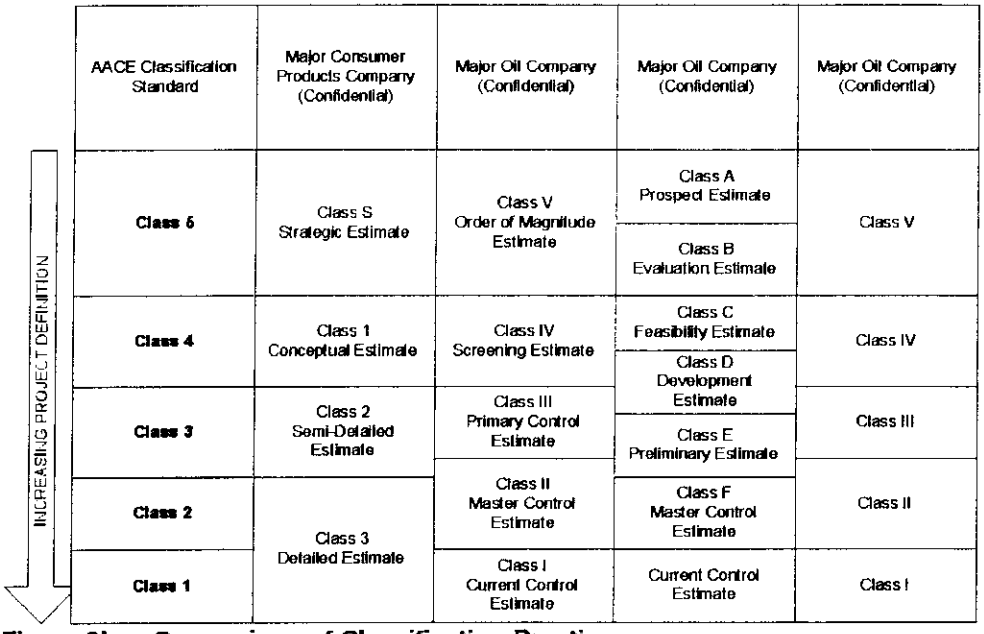
COMPARISON OF CLASSIFICATION PRACTICES

Figures 3a through 3c provide a comparison of the estimate classification practices of various firms, organizations, and published sources against one another and against the guideline classifications. These tables permits users to benchmark their own classification practices.

INCREASING PROJECT DEFINITION

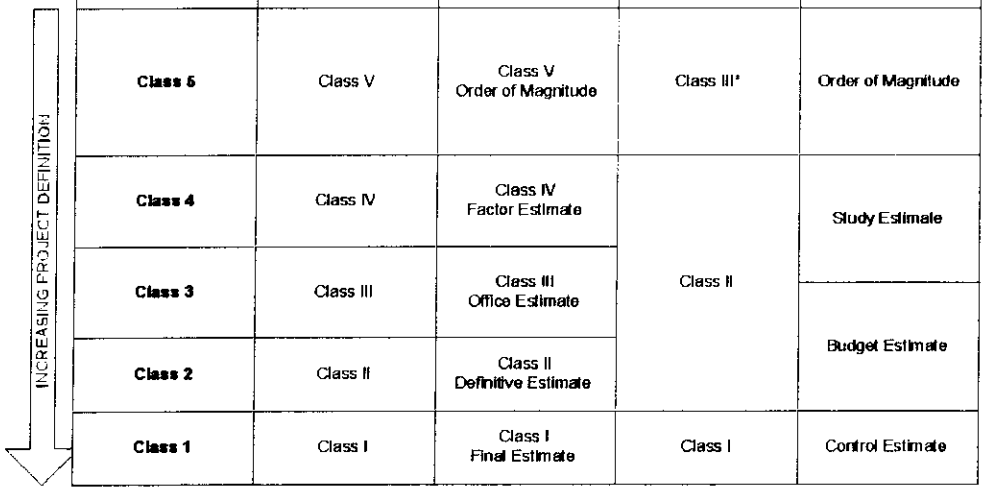
AACE Classification Standard	ANSI Standard Z94.0	AACE Pre-1972	Association of Cost Engineers (UK) ACostE	Norwegian Project Management Association (NFP)	American Society of Professional Estimators (ASPE)
Class 5	Order of Magnitude Estimate -30/+50	Order of Magnitude Estimate	Order of Magnitude Estimate Class IV -30/+30	Concession Estimate	Level 1
				Exploration Estimate	
				Feasibility Estimate	
Class 4	Budget Estimate -15/+30	Study Estimate	Study Estimate Class III -20/+20	Authorization Estimate	Level 2
Class 3		Preliminary Estimate	Budget Estimate Class II -10/+10	Master Control Estimate	Level 3
Class 2	Definitive Estimate -5/+15	Definitive Estimate	Definitive Estimate Class I -5/+5	Current Control Estimate	Level 4
Class 1		Detailed Estimate			Level 5
					Level 6

Figure 3a. – Comparison of Classification Practices



AACE Classification Standard	Major Consumer Products Company (Confidential)	Major Oil Company (Confidential)	Major Oil Company (Confidential)	Major Oil Company (Confidential)
Class 5	Class S Strategic Estimate	Class V Order of Magnitude Estimate	Class A Prospect Estimate	Class V
			Class B Evaluation Estimate	
Class 4	Class 1 Conceptual Estimate	Class IV Screening Estimate	Class C Feasibility Estimate	Class IV
			Class D Development Estimate	
Class 3	Class 2 Semi-Detailed Estimate	Class III Primary Control Estimate		Class III
			Class E Preliminary Estimate	
Class 2	Class 3 Detailed Estimate	Class II Master Control Estimate	Class F Master Control Estimate	Class II
Class 1		Class I Current Control Estimate	Current Control Estimate	Class I

Figure 3b. – Comparison of Classification Practices



AACE Classification Standard	J.R. Heizelman, 1988 AACE Transactions [1]	K.T. Yeo, The Cost Engineer, 1989 [2]	Stevens & Davis, 1988 AACE Transactions [3]	P. Behrenbruck, Journal of Petroleum Technology, 1993 [4]
Class 5	Class V	Class V Order of Magnitude	Class III*	Order of Magnitude
Class 4	Class IV	Class IV Factor Estimate	Class II	Study Estimate
Class 3	Class III	Class III Office Estimate		Budget Estimate
Class 2	Class II	Class II Definitive Estimate		
Class 1	Class I	Class I Final Estimate	Class I	Control Estimate

[1] John R. Heizelman, ARCO Oil & Gas Co., 1988 AACE Transactions, Paper V3.7
[2] K.T. Yeo, The Cost Engineer, Vol. 27, No. 6, 1989
[3] Stevens & Davis, BP International Ltd., 1988 AACE Transactions, Paper B4.1 (* Class III is inferred)
[4] Peter Behrenbruck, BHP Petroleum Pty., Ltd., article in Petroleum Technology, August 1993

Figure 3c. – Comparison of Classification Practices

ESTIMATE INPUT CHECKLIST AND MATURITY MATRIX

Figure 4 maps the extent and maturity of estimate input information (deliverables) against the five estimate classification levels. This is a checklist of basic deliverables found in common practice in the process industries. The maturity level is an approximation of the degree of completion of the deliverable. The degree of completion is indicated by the following letters.

- None (blank): development of the deliverable has not begun.
- Started (S): work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
- Preliminary (P): work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
- Complete (C): the deliverable has been reviewed and approved as appropriate.

	ESTIMATE CLASSIFICATION				
General Project Data:	**CLASS 5**	**CLASS 4**	**CLASS 3**	**CLASS 2**	**CLASS 1**
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:					
Block Flow Diagrams	S/P	P/C	C	C	C
Plot Plans		S	P/C	C	C
Process Flow Diagrams (PFDs)		S/P	P/C	C	C
Utility Flow Diagrams (UFDs)		S/P	P/C	C	C
Piping & Instrument Diagrams (P&IDs)		S	P/C	C	C
Heat & Material Balances		S	P/C	C	C
Process Equipment List		S/P	P/C	C	C
Utility Equipment List		S/P	P/C	C	C
Electrical One-Line Drawings		S/P	P/C	C	C
Specifications & Datasheets		S	P/C	C	C
General Equipment Arrangement Drawings		S	P/C	C	C
Spare Parts Listings			S/P	P	C
Mechanical Discipline Drawings			S	P	P/C
Electrical Discipline Drawings			S	P	P/C
Instrumentation/Control System Discipline Drawings			S	P	P/C
Civil/Structural/Site Discipline Drawings			S	P	P/C

Figure 4. – Estimate Input Checklist and Maturity Matrix

REFERENCES

ANSI Standard Z94.2-1989. **Industrial Engineering Terminology: Cost Engineering**.
AACE International Recommended Practice No.17R-97, **Cost Estimate Classification System**.

CONTRIBUTORS

Peter Christensen, CCE (Author)
Larry R. Dysert, CCC (Author)
Jennifer Bates, CCE

Dorothy J. Burton
Robert C. Creese, PE CCE
John K. Hollmann, PE CCE
Kenneth K. Humphreys, PE CCE
Donald F. McDonald, Jr. PE CCE
C. Arthur Miller
Bernard A. Pietlock, CCC
Wesley R. Querns, CCE
Don L. Short, II

2005 AACE International Transactions

CSC.14

Construction Cost Contingency Tracking System

Mr. John F. Rowe, PE

The author will present an objective, forward-looking cost contingency tracking system (CTS) that uses readily available cost information and a simple spreadsheet format. Using the CTS, project managers can assign contingency to construction contracts, track its consumption and manage a reserve for upcoming work. The paper will discuss the development of rules, using the perceived risk of each construction contract, to assign an initial contingency value to each construction contract. The author will then describe setting up the CTS using this initially assigned contingency value, basic cost information and cost trends from field staff. Once in place, project managers can use the CTS to assess a project's overall budget health and focus on contracts that require special attention. The CTS can also be used to calculate the estimated cost at completion for each contract to provide early warning of overruns. It has been successfully tested on a $1.4 billion rail and highway improvement program.

CONTINGENCY

The Association for Advancement of Cost Engineering defines contingency as, "An amount added to the estimate to allow for changes that experience shows will likely be required"[5]. The value of possible changes, and thus contingency, is proportional to the risk present in a project and this risk drops as the design advances, construction contracts are awarded, and construction is completed. Figure 1 shows a downward sloping channel that represents total project contingency over the life cycle of a project. Typically, the baseline project budget is set at some point in the project life cycle and project managers must live within that contingency budget. Ideally, the baseline budget should not be set until the project manager has a good handle on the remaining project risk and can determine a sufficient value of contingency to include in the budget to cover that risk [1,2]. Although beyond the scope of this paper, much has been written about techniques to initially set the contingency budget including expert opinion, Monte Carlo analysis, and other statistical methods [3,4]. This paper will focus on managing that contingency budget once it has been set, specifically during the construction phase of a capital project. This is accomplished by solving the twin problems of how to assign cost contingency to each construction contract and how to accurately forecast the final cost of these contracts at any given time.

The construction phase is where the rubber meets the road in managing capital projects. The pace quickens, spending accelerates, and an unprepared project team can be left in the dust. During the construction phase, the estimate at completion (EAC) of the contract packages changes more quickly than at any other phase of the project. A project manager must be able to detect potential project contingency shortfalls in order to down-scope or otherwise rebuild contingency. Conversely, if it becomes apparent that excess contingency will remain at the end of the project, project managers should re-deploy that capital to a more productive use as soon as possible.

ASSIGNING CONTINGENCY TO CONSTRUCTION CONTRACTS

By the start of the construction phase, final design should be complete and most, if not all, risk associated with each contract should result from change order growth occurring after contract award. Since the engineer's estimate for a construction contract is only intended to predict the bid price of the contract, contingency must be included in the contract budget to account for change order growth.

Project managers should establish guidelines governing the amount of change order contingency to be assigned to each contract. A survey of past experience with change order growth on completed contracts can provide a good basis for setting these guidelines. Typically, since different types of contracts contain different levels of change order risk, initial contingency guidelines should take the contract type into account. Table 1 shows an example set of guidelines by contract type—the details will vary by project. Using established guidelines, the project team can quickly determine the desired contingency value to assign to each contract as its design is completed. The same guidelines will be used to reset the contingency based on the original contract value once bids are received on each contract. This initial contingency value (C_I) is a key numerical input to the CTS.

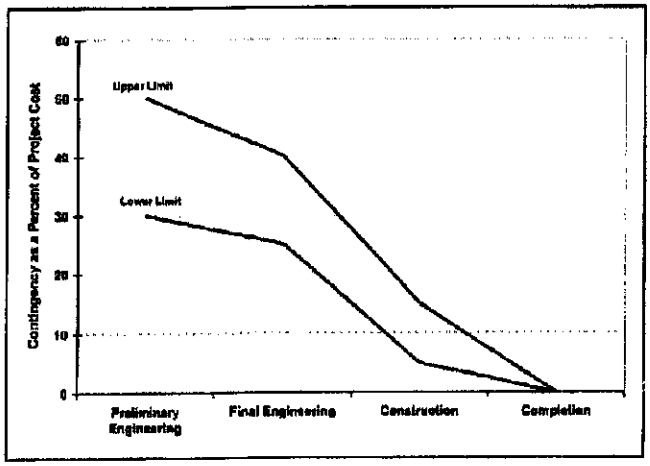


Figure 1—Project Contingency Should Decrease Over the Life of a Project.

Table 1—Example Guidelines for Initial Contingency Assignment.

Contract Type	Initial Change Order Contingency *(as a % of Contract Cost)*
Procurement Only	5%
Typical Construction	10%
Special Construction :	
Tunnels	15%
Very Small Contracts	20%

ACCURATE CONSTRUCTION CONTRACT FORECASTING

Once construction contracts have been awarded, accurate forecasts are needed to track contingency consumption. The people most able to provide accurate forecast information for each construction contract are those closest to the action. These are typically the resident engineers, project controls engineers, or contract administrators with direct responsibility for day-to-day construction management. Using either spreadsheets or specialized construction management software, the field team should maintain the most thorough contract forecast possible, given the other demands on their time. This forecast should include the original contract amount, approved change orders, pending change orders, and all identified cost issues. A well maintained forecast will change from day to day as issues are identified, negotiations are completed, and costs are agreed upon. This field-generated contract forecast (F) is another important numerical input to the CTS.

From experience we know that even the best field team will not be able to forecast all the change issues and associated costs until very close to the end of construction. For this reason, to develop an accurate value for the estimate at completion (EAC), we must keep some retained contingency (C_R) in addition to the field-generated Contract Forecast (F). This can be expressed as follows:

$$EAC = F + C_R$$

(equation 1)

Intuitively, the value of retained contingency (C_R) should be based on the initial contingency (C_I) value assigned at contract award and should drop as the contract is completed and risk drops.

AN EMPIRICAL FORMULA FOR RETAINED CONTINGENCY

For simplicity, one could assign retained contingency (C_R) based on the assumption that risk drops linearly as a contract is completed and is inversely related to the percent complete. As an example, at 80 percent complete 20 percent of initial contingency (C_I) would be retained to account for changes that have not yet been identified. Intuitively, this linear assumption seems conservative, as we would expect that more than half of the change issues should have been identified at the 50 percent completion point. In order to test the straight-line assumption and modify it if necessary, the author collected some real world data. Actual cost (A) and contract forecast (F) data were collected over four years, on a monthly basis, for 15 of the largest construction contracts on a light rail expansion program managed by the Valley Transportation Authority in San Jose, California. The contracts studied had a combined value of $257 million and covered a wide array of work including heavy civil and track, tunnel, elevated structure, station finish and overhead contact system construction contracts.

For each monthly Contract Forecast (F) reading, the Value of Changes Forecast (Δ_t) at that time was calculated by subtracting the Original Contract Amount (C_0).

$$\Delta_t = F - C_0$$

(equation 2)

Once each contract is complete, the final contract amount (CF) is known and the final value of changes (Δ_F) can be calculated as follows:

$$\Delta_F = C_F - C_0$$

(equation 3)

The proportion of final changes forecast ($\Delta_{t/F}$) at each point in time can be readily calculated using the final value of changes (DF) as follows:

$$\Delta_{t/F} = \Delta_t / \Delta_F$$

(equation 4)

Figure 2 shows a scatter diagram with a total of 282 monthly coordinates for the proportion of final changes forecast ($\Delta_{t/F}$) on the y-axis (expressed as a percent) and percent complete (P) on the x-

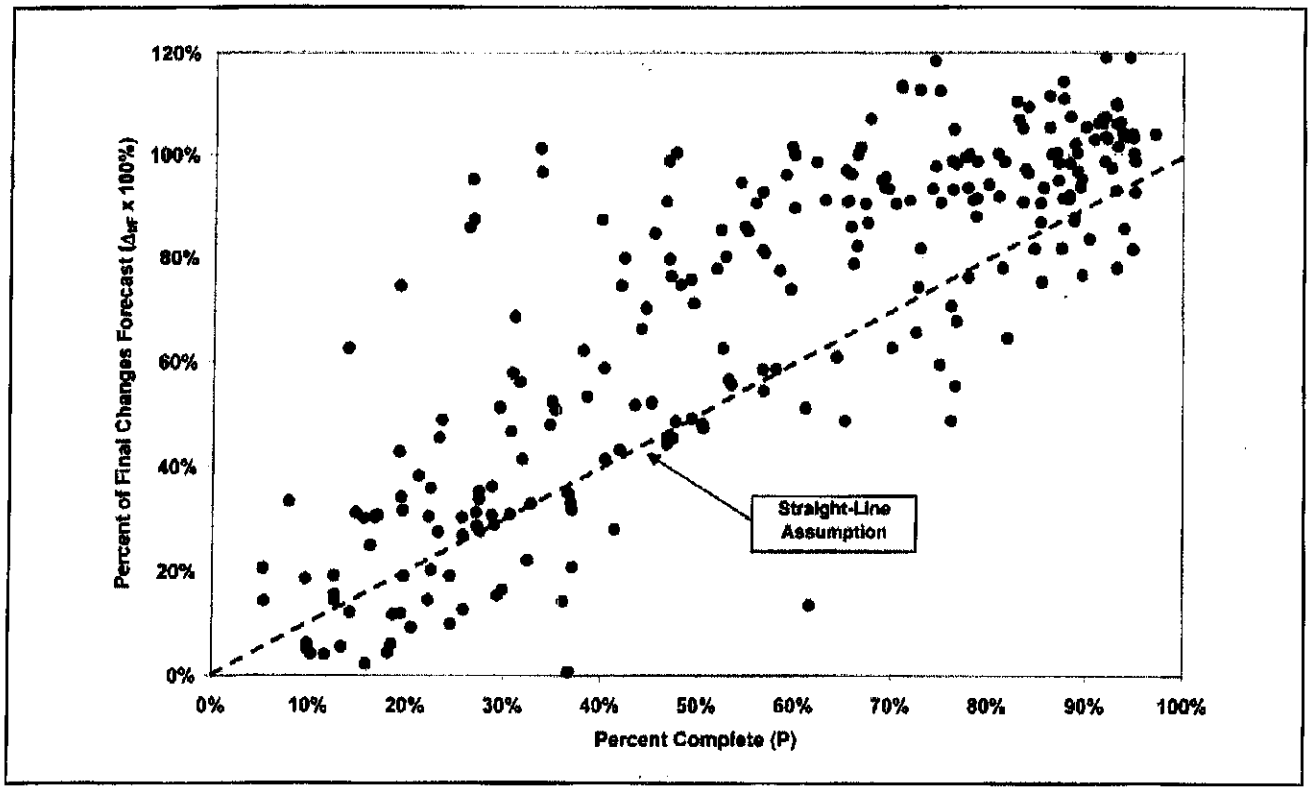


Figure 2—Scatter Diagram of Data with Straight-Line Assumption Superimposed.

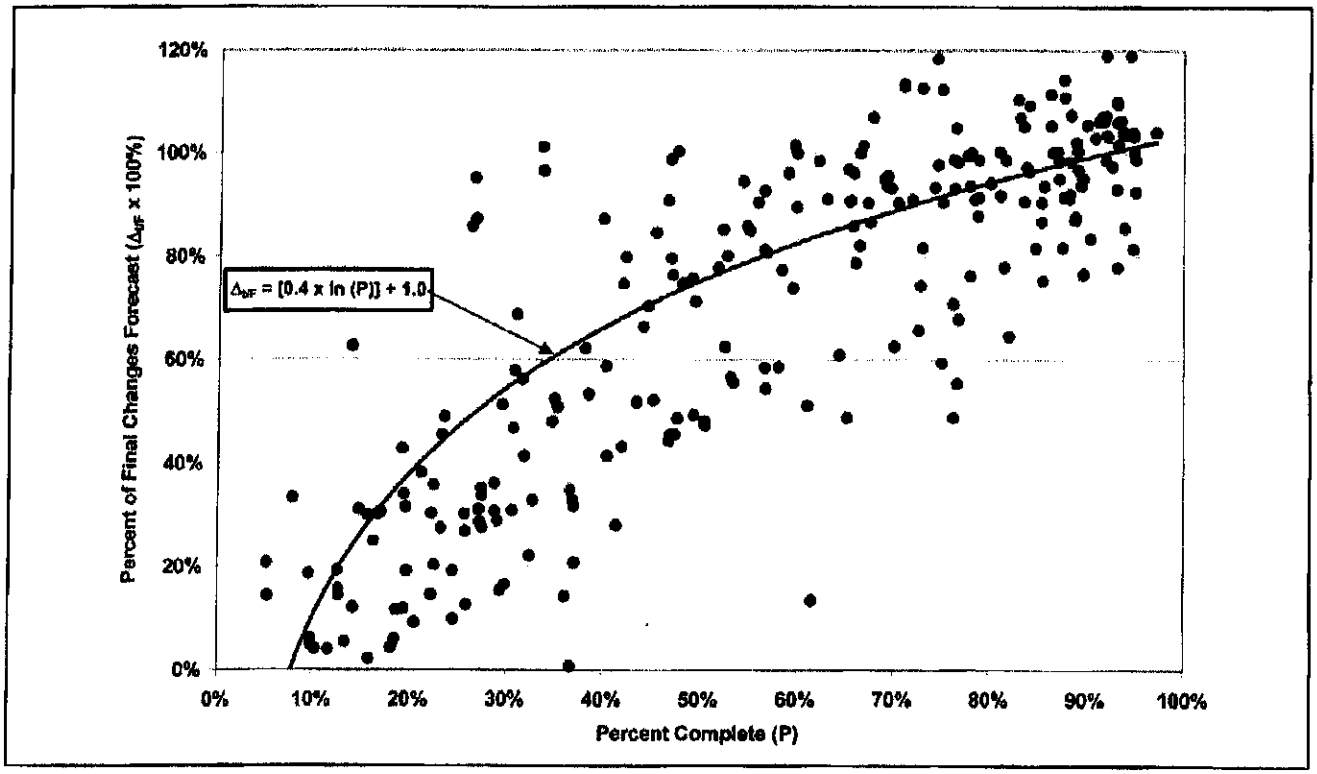


Figure 3—Scatter Diagram from Figure 2 With the Best-Fit Curve and Equation.

axis. (Values for P<5% and P>95% were excluded for clarity.) The dashed line on the graph shows the straight-line assumption we are testing.

Although the data points in our sample don't trace out a perfect curve, it is clear that the straight-line assumption is not accurate and is probably too conservative. In order to find a better solution, the author employed the spreadsheet program's curve-fitting feature. The best-fit curve (R^2=0.46), shown in figure 3, is a natural logarithmic function (ln = $\log_e$) described as follows:

$$\Delta_{t/F} = 0.4 \ln(P) + 1.0$$

(equation 5)

This equation provides a value for the proportion of final changes Forecast ($\Delta_{t/F}$) expected to be included in the contract forecast (F) as a function of percent complete (P). It should be noted that, for values of percent complete (P) less than approximately 25percent, the best-fit curve does not fit the data very well. For this reason, and due to the fact that forecast data can be highly variable in the early stages of contract execution, estimate at complete (EAC) values derived from this equation and the contingency Tracking system (CTS), to be described shortly, should be considered to be unreliable until at least 25 percent completion is reached.

Natural log functions are readily calculated by spreadsheet programs, and table 2 shows the results of this equation for a range of percent complete (P) values. The numerical results generated by this empirical equation seem to be intuitively more accurate than the straight-line assumption, as the proportion of final changes forecast ($\Delta_{t/F}$) rises quickly in the first half of contract completion as cost issues are identified and negotiated, then levels out as completion is reached.

As an example, for a contract that is 50 percent complete, table 2 shows that we can expect that a good contract forecast (F) figure has captured 72 percent of the final changes that will occur on the contract. To account for the 28 percent of changes that have not yet been forecast, we would simply retain 28 percent of the initial contingency (C_I) value in addition to the contract forecast (F) value. Since the value of $\Delta_{t/F}$ derived in our empirical equation is expressed as a decimal, we would subtract it from one to arrive at a value for retained contingency (C_R). Mathematically, retained contingency (C_R) is derived as follows:

$$C_R = (1 - \Delta_{t/F}) \times C_I$$

(equation 6)

Substituting in our empirical equation for $\Delta_{t/F}$:

$$C_R = [1 - (0.4 \ln(P) + 1.0] \times C_I$$

(equation 7)

Simplifying the equation results in the following:

$$C_R = -0.4 \ln(P) \times C_I$$

(equation 8)

Table 2—Values of $\Delta_{t/F}$ Resulting from the Empirical Equation.

Percent Complete (P)	Percent of Final Changes Included in Contract Forecast ($\Delta_{t/F}$ x 100%)
10%	8%
20%	36%
30%	52%
40%	63%
50%	72%
60%	80%
70%	86%
80%	91%
90%	96%
100%	100%

Table 3—An Example CTS for a Simplified Light Rail Project.

		Numerical Inputs				*Calculated Values*			
		B	F	A	C_I	P = (A/F) as %	C_R = -0.4 ln(P) x C_I	EAC = F + C_{RET}	C_{SD} = B - EAC
Contract No.	Contract Description	Current Budget	Current Forecast	Actual Costs	Initial Contingency	Percent Complete	Retained Contingency	Estimate at Completion	Contingency Surplus/(Deficit)
A100	Procure Rail, Ties and Special Trackwo	525,000	525,000	525,000	25,000	100.0%	0	525,000	0
A999	Procurement Allocated Contingency	0	0	0	0	0.0%	0	0	0
	Subtotal Procurement	525,000	525,000	525,000	25,000	100.0%	0	525,000	0
C100	Civil, Track & Landscaping	11,000,000	11,325,000	7,630,000	1,000,000	67.4%	157,970	11,482,970	(482,970)
C200	Stations & Park and Ride Facilities	3,300,000	3,125,000	1,000,000	300,000	32.0%	136,732	3,261,732	38,268
C999	Civil Allocated Contingency	25,000	0	0	0	0.0%	0	0	25,000
	Subtotal Construction	14,325,000	14,450,000	8,630,000	1,300,000	59.7%	294,702	14,744,702	(419,702)
S100	Overhead Contact System	1,650,000	1,550,000	50,000	150,000	3.2%	206,039	1,756,039	(106,039)
S200	Combined Communications & Signals	2,300,000	2,000,000	0	300,000	0.0%	300,000	2,300,000	0
S999	Systems Allocated Contingency	25,000	0	0	0	0.0%	0	0	25,000
	Subtotal Systems	3,975,000	3,550,000	50,000	450,000	1.4%	506,039	4,056,039	(81,039)
Z999	Project (Unallocated) Contingency	1,500,000	0			0.0%	0	0	1,500,000
	Subtotal Project Contingency	1,500,000	0	0	0	0.0%	0	0	1,500,000
	TOTAL PROJECT	$20,325,000	$18,525,000	$9,206,000	$1,775,000	49.7%	$800,741	$19,325,741	$999,259

Table 4—Numerical Inputs to the CTS

Numerical Input	Designation	Contract Status / Type	Value to Use
Current Budget	B	Pre-Bid	Current Budget, which should include change order contingency that was developed using the contingency guidelines.
		Active	Current Budget, which was reset at award to equal the Original Contract Value + Initial Contingency (C_I).
		Contingency Line	Current Budget for the contingency line.
Current Forecast	F	Pre-Bid	Set equal to the Current Budget (B) less any change order contingency included in that number.
		Active	Original Contract Amount + Approved/Pending Change Orders + Identified Potential Changes. *(Note: This value should not include any allowance for changes that have not yet been identified.)*
		Contingency Line	Always zero.
Actual/Incurred Costs to Date	A	Pre-Bid	Always zero.
		Active	Use either Actual or Incurred Costs for the contract, depending on what's available from the cost system.
		Contingency Line	Always zero.
Initial Contingency	C_I	Pre-Bid	Change order contingency included in the Current Budget
		Active	Use the contingency guidelines, based on the contract risk type, to develop a percentage factor to apply to the Original Contract Amount.
		Contingency Line	Always zero.

Table 5—Calculated Values Used in the CTS

Calculated Value	Designation	Calculation	Description
Contract Percent Complete	P	A / F	Measure of progress toward contract completion expressed as a percentage.
Retained Contingency	C_R	$-0.4\ ln(P) \times C_I$	This equation was derived empirically. C_R is an allowance for future changes that have not yet been identified. *(For P=0, $C_R = C_I$)*
Estimate at Completion	EAC	$F + C_R$	Contract estimated cost at completion that takes into account all approved/identified changes plus an allowance for future changes.
Contingency Surplus/Deficit	$C_{S/D}$	B - E	A contract's projected impact on project contingency. Negative values (deficit) represent consumption of project contingency while positive values (surplus) indicate contracts that will return contingency back to the project upon completion.

We now have all the prerequisites in place for a construction phase contingency tracking system (CTS).

THE CONTINGENCY TRACKING SYSTEM (CTS)

The contingency tracking system (CTS) was developed to provide an up-to-date snapshot of remaining cost contingency on a large rail and highway expansion program. The goal was to provide an objective measure of remaining contingency that takes into account the latest forecast cost for each component construction contract as well as an allowance for changes that will likely occur but have not yet been identified. The CTS had to be simple to understand so that it would be accepted by a number of project stakeholders, and easily maintained so as not to present a recurring burden to the project controls staff. The CTS focuses on the construction category of project costs since, during the construction phase, this is where the vast majority of risk remains. Table 3 shows the CTS as applied to a simplified project, in this example a small light rail project. At first glance, it looks somewhat complex but as will be shown, it consists of readily available numerical inputs and values derived from these inputs with simple calculations.

The rows of the CTS represent construction contracts and contingency line items that are organized by contract type. In this example, an allocated contingency line is included in each construction category as well as a project contingency line at the bottom. The specifics of how contingency is deployed across the project categories are a matter of preference, but the CTS can be adapted to any scenario.

The contracts in table 3 range in progress from pre-bid (S200), to active (C100, C200, and S100), to completed (A100) in order to demonstrate how the CTS treats each type. Totals for each column are shown by category and at the bottom line. The columns are organized into two groups: numerical inputs and calculated values.

NUMERICAL INPUTS TO THE CTS

The numerical inputs to the CTS should all be readily available information from either the project cost report or forecast reports maintained by field construction management staff. These numerical inputs are as follows and are summarized in table 4 for handy reference:

Current Budget (B)

Taken from the project cost report, it should include all budget transfers/changes that resulted from the evolution of contract scope up until contract award and, as discussed, should also include an amount to cover change orders. When bids are received and the contract is awarded, the budget should be re-set to equal the original contract amount plus an initial contingency (C_I) by transferring budget to/from allocated and/or project contingency. Ideally, this budget will not be changed again until the contract is completed and excess budget is returned to contingency.

Current Forecast (F)

Before a contract is bid, this will equal the current budget, less the amount included to cover change orders. After contract award, field construction management personnel typically maintain the current forecast as previously discussed. Note that the current forecast should not include any factors to predict the value of unidentified changes, as the CTS will account for these.

Actual Costs (A)

Taken from the project cost report. The value of all payments made on a given contract as of the date the CTS is being updated.

Initial Contingency (C_I)

Before a contract is bid, the initial contingency guidelines discussed earlier are typically employed to develop the Initial Contingency (C_I) value based on the engineer's estimate. When bids are received and the contract is awarded, C_I is recalculated using the same guidelines applied to the bid amount. Note that, while the other numerical inputs are updated on a regular basis, initial contingency is a static number that will not change once contract award is made.

CALCULATED VALUES USED IN THE CTS

The CTS takes the numerical inputs described above to derive calculated values that are ultimately used to arrive at the total contingency available after taking construction cost trends into account. These calculated values are as follows and are summarized in table 5 for handy reference:

Contract Percent Complete (P)

There are many ways to ascertain progress toward completion of construction contracts. For simplicity, the CTS relies on Actual Costs (A) and the Current Forecast (F) to generate this number as follows:

$$P = A / F \qquad \text{(equation 9)}$$

Retained Contingency (C_R)

This calculation is at the heart of the CTS. It represents a forecast value of change orders that have not yet been identified by the construction management team but that we anticipate from experience will sooner or later be encountered. As derived earlier, this number is a natural log function, calculated as follows:

$$C_R = -0.4 \ln(P) \times C_I \qquad \text{(equation 8)}$$

This formula provides invalid results for a zero value of percent complete (P). In this case, the value of initial contingency (C_I) should be used.

Estimate at Completion (EAC)

This number is simply the sum of the current forecast (F) provided by our field construction management staff and Retained Contingency (C_R). The estimate at completion (EAC) is calculated as equation 1 demonstrates.

The author has used this EAC value as an early warning of contracts that are trending toward exceeding agency contract authorization limits. It often provides a warning several months before an overrun becomes readily apparent, but tends to be unreliable until a contract is at least 25 percent complete, as discussed earlier.

Contingency Surplus/Deficit (CS/D)

By comparing the estimate at completion (EAC) to the current budget (B) we can determine whether a given contract is trending towards adding to or depleting project contingency. The contingency surplus/deficit ($C_{S/D}$) is calculated as follows:

$$C_{S/D} = B - F \qquad \text{(equation 10)}$$

When the contingency surplus/deficit ($C_{S/D}$) is totaled across all construction contracts, allocated contingency lines and the project contingency line, the resulting value represents a good estimate of contingency available for non-construction project categories (e.g. right-of-way, design, and management).

The "punch line" of our CTS example is shown in the bottom right corner of table 3. This number represents the contingency available for other project risks after construction risks are

covered. In the example, although the budgeted project contingency is $1.5 million, the CTS shows that only about $1.0 million in contingency is actually available for non-construction project risks. The CTS is forecasting that the construction contracts will consume $0.5 million of project contingency to complete.

Note that, in the example project depicted in table 3, the total bottom-line value for retained contingency (C_R) is approximately $0.8 million. Recall, that this is the amount the CTS is adding to the field-generated contract forecasts to account for unidentified changes. Therefore, a project manager who relied solely on the field-generated forecasts to calculate EAC's would think that $1.8 million in contingency was available. If a scope addition valued at $1.25 million was approved, it might lead to a nasty surprise, as construction contracts progressed and additional changes were identified, resulting in an overrun of the project budget.

ADVANTAGES AND LIMITATIONS OF THE CTS

The main advantage of the CTS is its simplicity. It does not require advanced mathematics, statistics, or computer programming abilities to set up and maintain. This simplicity makes it easier to explain to and achieve buy-in from project stakeholders for the results that it generates. The basis for the Retained Contingency (C_R) calculation at the heart of the CTS is a set of real-world data, and the results pass the reasonableness test. The simple spreadsheet format and readily available numerical inputs make maintenance quite easy, which is important because the CTS should be updated on a regular basis in order to spot trends early. Another advantage is that the CTS provides an objective reading of remaining contingency, generated in a consistent manner from month to month. The only subjective input to the CTS is the initial contingency (C_I) value for each contract, and even that results from the application of a pre-determined set of guidelines and is set just one time for the life of the contract. Individual judgment can be applied to the values that result from the CTS, but the objectivity and consistency of the calculation method is important given the high stakes involved in managing project contingency.

As discussed, the retained contingency (C_R) calculation at the heart of the CTS was derived empirically from real world data on a light rail project. That data did not conform perfectly to a smooth curve; hence there is bound to be some inaccuracy in the empirical equation that resulted from it. However, the results shown in table 2 seem to be intuitively more representative of reality than the simplified straight-line alternate assumption. The fact that the data used to derive the calculation came from light rail projects may limit its usefulness in other sectors, e.g. building construction. More study is needed here, with forecast data collection and analysis in other sectors of construction necessary to verify or modify the retained contingency (C_R) calculation as appropriate. Also, as mentioned earlier, the estimate at completion (EAC) calculation can produce inaccurate results on an individual contract basis prior to approximately 25 percent completion due to inconsistent forecast information and poor correlation of the model in the early stages of contract execution.

As with any mathematical system, the CTS is only as good as the data that goes into it. The most important and hardest numerical input to come by is an accurate current forecast (F) for each contract. If reliable current forecast numbers are not available, the CTS will be of limited value. Finally, although simple, the CTS does require that consumers of its output be educated on the assumptions and calculations that underpin it to the point that they can understand and trust its results. There is no purpose in setting up and maintaining the CTS if project stakeholders have no understanding of or faith in it and are unwilling to act on its results.

As stated at the beginning of this paper, contingency is defined as an amount added to the budget to account for changes that inevitably occur. Using pre-established guidelines, we can establish a percentage of the original bid to initially include in our contract budget to account for change order growth. We have seen that, to derive an accurate estimate at completion (EAC) for each construction contract, we must start with a thorough contract forecast and add a retained portion of the initially established change order contingency to account for changes that have not yet been identified. A formula for calculating the retained contingency value was then derived based on a sample of real-world data. By comparing EAC's calculated in this way with the current budget for each contract, we can determine the amount each contract will add to or subtract from project contingency. Finally, by summing these impacts over all contracts and contingency lines, a bottom-line value of project contingency available for non-construction uses can be obtained.

The contingency tracking system (CTS) combines all of these steps into a compact and easily maintainable spreadsheet table. Using the CTS, project managers have a guide to the expected final cost of each contract and the approximate value of project contingency left after accounting for construction risks. This ability to see into the future will serve project managers well as they navigate the many obstacles standing in the way of successful project delivery.

REFERENCES

1. Collins, Jack J. and Rowe, John F. *"Management Challenges Unique to Transit Projects."* 2005 **AACE International Transactions**. (Morgantown, WV, 2005): PM.15.
2. Collins, Jack J. *"Steps to Better Cost Control of Transit Projects."* **American Public Transportation Association 1998 Rapid Transit Conference**, (June 1998).
3. Nassar, Khaled. *"Cost Contingency Analysis for Construction Projects Using Spreadsheet Techniques."* **Cost Engineering**, (September 2002): 26-31.
4. Oswald, Phillip F. **Construction Cost Analysis and Scheduling**. (New Jersey: Prentice Hall, 2001.
5. Woodward, Charles P. and Chen, Mark T. *"Chapter 1 - Cost Estimating Basics"* **Skills and Knowledge of Cost Engineering**. (Morgantown, WV: AACE International, 1999): 1-2.

Mr. John Rowe, PE
Rowe & Associates
908 Forest Ridge Drive
San Jose, CA 9529

E-mail: jfrowe@pacbell.net

SCHUMACHER

CONSULTING LLC

INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

Prepared for:

Burns & McDonnell Engineering

Area Labor Study
for
KCPL Iatan Unit 2 Project

February 13th, 2006

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

KCPL Iatan Unit 2 Project
Area Labor Study

Table of Contents

1.0	**Overview**
Attachment #1	**5-10's Cost Summary**
Attachment #2	**Labor Rate Summary**
2.0	**Iatan Project Preliminary Schedule**
3.0	**Current and Future Area Workload**
4.0	**Other Workload**
5.0	**Critical Craft Manpower Requirements**

1.0 Overview

The period of 2006 through 2012 will see unprecedented amounts of new industrial construction and retrofits in the Midwest and gulf coast states. In addition, the rebuilding from hurricane damage will add to the strain on skilled manpower supply. It is reported that it will take 43,000 crafts to rebuild housing alone in the New Orleans area and predictions are for a 35% shortage of skilled workers overall in the gulf coast region.

The result of this high demand for skilled workers will be higher wages and incentive pay. The non union sector has not been successful in attracting and maintaining a skilled workforce in recent years. Existing skilled manpower is estimated to be 25,000 people in the gulf coast region.

Wages have been flat for 20 years, benefits are lagging other occupations, all resulting in a 75% drop in enrollment at NCCER, the ABC training center for construction crafts. The gulf coast private sector is very concerned about stability in the non union construction area regarding costs, schedules, and supply of workers.

Only recently, a non union welder on the gulf coast is paid $29 per hour in wages plus $3.50 per hour in fringes, $70 per day Per Diem, and up to $2.00 per hour in incentives. The standard work week is 5-10's.

The oil refining work load requirements add pressure to the Pipefitter, Boilermaker, and Electrician manpower problems. In addition, the $100 Billion dollar Tar Sands Project in Canada will preclude the use of Canadian workers on US work.

The Iatan Project will have reasonable success in attracting tradesmen due to the union's high wage and fringe packages (see attachment 2). For example, the Pipefitter wage in Kansas City is $34.83 per hour plus $15.00 per hour in fringes, compared to the Pipefitter union wage in Houston and Tulsa of $23 per hour and $10 per hour in fringes. It is significant to note that now the union fringe benefits are accrued to the workers home local. In the past the fringes stayed in the local where the work was performed.

The Kansas City Building trades enjoy a good reputation with the contractors for productive work and jobsite harmony when compared to many other parts of the country.

The International unions are interested in keeping their existing clients such as KCPL and expanding market share. Progressive activities are ongoing with the national building trades, such as the establishment of the Mechanical Trades Alliance, headed up by UA General President Bill Hite. This alliance is focusing on shared resources for the training of workers, productivity enhancements, and seamless jurisdiction between the trades. Other initiatives involve competitive agreements for use in low density union areas.

I recommend the NMAPC (National Maintenance Agreement) for this project (See paragraph 1.4). This agreement is administered by equal numbers of international union representatives, contractors, and a very competent staff. The application of the agreement is consistent among all crafts. All trades are bound to the agreement including the carpenters and teamsters even though those particular crafts have disaffiliated themselves with the AFL/CIO.

My review for information herein included inquiries of the following;

- Kansas City Building Trades

- UA, BM, IW International Representatives
- Four National Contractors
- NACBE
- NMAPC
- UA, BM, & IW Kansas City Locals
- BM Locals in surrounding areas
- Director of Pride Inc. of St. Louis
- Burns & McDonnell Sales and Marketing information

1.1 BEST PRACTICES

Approximately 30% of this projects costs will be construction labor therefore productivity enhancement is a must.

The ability to attain good productivity results requires the following practices at a minimum;

1). The contractor must be committed to the zero injury culture and techniques.

2). Detailed planning and scheduling by the contractor. This must be a serious effort. The plan must run the job. The contractor must have these resources.

3). Timely delivery of materials and equipment.

4). Minimize engineering and fabrication changes.

5). Substance abuse testing, including random.

6). Timely delivery of engineering and technical information.

7). The contractors must provide ample tools and equipment.

8). The contractor must have experienced and competent staff and supervision.

9). The contractor must control the labor on site. Utilize and understand the labor agreement management article to its fullest extent.

10). Control work jurisdiction between the crafts.

11). Negotiate a crew mix within the crafts using apprentices.

12). Avoid saturated manning and high work density.

13). Avoid shift work and overtime.

14). Promote craft ownership in the project. This begins with the safety initiative.

15). Minimize worker turnover. A 10% increase in turnover results in a 2.5% increase in labor costs plus productivity and safety impacts.

1.2 SAFETY/WORKER COMPENSATION

Training and orientation should be centered around the Zero Injury Techniques. (RE: Zero Employee Injury, Nelson Consulting).

The top high impact techniques are:

- Pre project / Pre task planning.
- Safety orientation and training. The quality of the training is much more effective than the quantity of training.
- Safety incentive, recognition and rewards program.
- Substance abuse program.
- Staffing for safety.
- Accident investigation.
- Worker participation and empowerment.
- A demonstrated management commitment.

Safety excellence is top driven; the owner, construction manger, and contractor executives and staff must actively support its commitment to having a zero injury work site. I also believe that the union business manager must become an active participant. I have a concern that they are not totally involved today.

Substance abuse testing on union projects has been somewhat more difficult to accomplish because the NLRB has ruled random testing of an employee must be negotiated or included in the collective bargaining agreement. I believe this could be negotiated through the NMAPC and the International Unions. Another method for accomplishing random testing would be to have an owner's drug policy for all contractors on their site.

1.3 QUALITY

Welder quality is excellent for pipefitters and boilermakers, however it is recommended to test each welder prior to start of work.

The NMA agreement allows 4 hours of pay if the welder passes the test.

The contractor on the Council Bluffs Project expressed that he has never had to perform as much on site training for any one project in the company's history. In particular the skill level of the Ironworkers, Carpenters, and Certified Operators was a serious problem. Most had very little industrial experience.

1.4 LABOR AGREEMENT

Attached is a copy of the NMAPC agreement and a summary of the agreement.

It is recommended that this project be done under the NMAPC agreement.

All crafts will be under the same agreement, therefore application of the articles are consistent among all.

The management clause is strong but it requires the contractor to use it effectively.

All trades are signatory including the Carpenters and Teamsters.

Consistent application of the agreement will minimize grievances and other HR issues which tend to take management time away from execution of the work.

Likewise, it is important the contractors enforce the work rules and agreement from day one on the project.

On reimbursable work I would consider placing a portion of the contractors fee at risk and use the management of the agreement as an incentive.

There is a "book of decisions" covering interpretation resulting from past issues and grievances which were ruled upon by the policy committee.

Even though the agreement is defined as maintenance, there have been broad interpretations of the agreement to include new construction.

The agreement is a stand alone national program without local administration. The only part of a local agreement is wages, fringe benefit trusts, and referral rules.

One may conclude that voting on issues and grievances, with the makeup of the policy committee being 14 management and 14 international union representatives to be along party lines, but as a member of the committee for many years, I have never seen a close vote, which says a great deal about the NMA

The vehicle is the NMAPC program, a labor- management organization that can reduce labor costs by at least 16% over local agreements. Some of these advantages include:

*No strikes clause- including substantial penalties

*Mandated pre-job conferences

*Alternate dispute resolution to reduce workmen's compensation insurance costs

*All overtime @ 1 1/2x except for Sundays and holidays

*All crafts observe the same 7 unpaid holidays

*Flexibility in scheduling

*Commitment to drug free workplace

*Contractor determines crew size needed

*Welder certification cost control

*Only 1 foreman per craft on any shift is guaranteed 40 hours pay

*Provision to enable participants to respond to changing needs

The Facts: *Over 1.6 billion man-hours worked since 1971

The Committee: The NMAPC is the construction industry's first incorporated labor management committee. It's members are 14 national maintenance contractors and 14 representatives from the participating International Unions of Building and Construction Trades Department, AFL-CIO. The office of the Impartial Secretary administers the NMAPC Program with a full time staff located in Arlington, Virginia. The Committee is a proactive entity which

meets regularly to administer the NMAPC Program and provide a national forum to promote labor management cooperative efforts in construction.

1.4 LABOR AGREEMENT (Cont.)

NMAPC, Inc.
1501 Lee Highway, Suite 202
Arlington, Virginia 22209-1109
Web: www.nmapc.org
Email: info@nea-nmapc.org
Phone: 703-841-9707
Fax: 703-524-3364
Founded: 1971

1.5 MANPOWER

The compiling of manpower only focuses on the critical crafts of Boilermakers, Pipefitters, Ironworkers, and Electricians.

Membership rosters are as follows:

Pipefitters – 600 members
Boilermakers – 500 Members (200 live in the Kansas City Metro area)
Electricians – 1200 Members
Ironworkers – 1200 Members (covers western Missouri and eastern Kansas)

Boilermakers:
It is quite evident that the Boilermaker union feels an overwhelming responsibility to service KCPL work.

Local 83 covers Kansas, Iowa, Nebraska, and Western Missouri. The Boilermaker work through 2007, 2008, and 2009 in the four state area will average 1100 men with estimated peaks at 1600 men. The St. Louis and Southern Illinois locals have approximately 200 men working in local 83 presently but due to their upcoming workload these locals will not be a source of workers.

Local 83, with its wage and fringe structure plus a 5-10's work week will be in a position to man the Iatan project. They have had up to 900 boilermaker travelers in the past on work around the Kansas City metro area.

In the event the manpower during the project becomes a critical issue, even more so than we know now, consideration should be made for paying subsistence rather than increasing overtime hours of work due to the inefficiency encountered with overtime.

Additional workload on power projects in Wisconsin, Minnesota, and Michigan are going to exceed manpower availability in those respective locals by 1000 to 1200 Boilermakers in the 2007 through 2009 period. (1400 members, 2600 required). Currently there are 500 Boilermakers working 6-10's on the Council Bluffs project.

Nationally the Boilermaker Union has 26,000 active construction members which in my view will likely be exceeded by 5000 during the 2008/2009 period.

We must keep in mind the labor contract expires 12/31/07 and could see wage increases at $2.00 to $3.00 per hour.

Pipefitters:
The Kansas City Local has Jurisdiction over the Iatan and Norborne projects. The peak loading will occur during 2009 at 800 men for the two projects when the schedules overlap. A fairly steady requirement of 200 to 250 Pipefitters will be required on other work during the same time period.

This totals approximately 1000 men required where the local availability is 600. Presently they have 150 men out of work.

Again with the high wage and fringe in local 533, plus 5-10's work schedules, additional manpower will be available from Texas, Oklahoma, Louisiana, and Arkansas. Presently the Council Bluffs project has 600 Pipefitter travelers.

The Pipefitter contract expires 5/31/08.

Ironworkers:
Local 10 covers western Missouri and eastern Kansas and has 1200 active members with about 600 available in the Kansas City Metro area. Presently they have full employment; however, the commercial workload will decline somewhat by mid 2007.

The Ironworkers fringe package is the highest of all the trades which includes a $5.35 per hour annuity. This is an attraction for out of town workers.

The ironworker's skill level is reasonably good for setting heavy and high steel.

Manning of Iatan does not appear to be a problem with a 5-10's schedule.

Electricians:
This local has approximately 1200 members and presently does not have full employment. Most members are employed on commercial work.

The IBEW has a major effort ongoing nationally in training and innovative labor contracts in the low density union areas. Ed Hill, IBEW General President, is one of the building trades most progressive leaders on issues such as hours worked for hours paid, quality, safety, and training.

Their labor contract expires on 9/2/07 and I would expect to see $2.00 to $3.00 per hour settlements.

1.6 Summary

Solely for skilled labor attraction it is recommended the Iatan project work 5-10's when the critical crafts of Boilermakers and Pipefitters are required. This is approximately mid 2007. Obviously the entire project must work the 5-10's, not just the critical crafts, to keep labor harmony.

The total cost calculation for the project to work 5-10's from the start of civil / site work to completion is $35,524,000. If started only when critical crafts are required in mid 2007 that cost would be reduced by $5,000,000. When considering overtime work I would never consider

hours greater than 10 hours per day or 6 days per week. For Example, the inefficiency for 7-12's is in excess of 30% and the premium pay adds 40% to labor costs.

I would consider a worker subsistence / Per Diem before increasing overtime beyond the 5-10's schedule. 6-10's, for example, only yields 8.2 hours of work per day after applying an inefficiency factor.

Labor escalation is expected to be 8-10% per year. See Attachment 2 for contract expiration dates and existing wage and fringe packages.

The average cost rate (Wage, fringe, Insurance, and taxes) is $53.45 per hour. A crew mix with apprentices will lower the overall rate. The contractor must request apprentices and give them meaningful work on the site. It is reasonable to expect 25% of the crew on work of this type could be apprentices.

Employees should be expected to be "work ready" when they arrive at the site. This would include safety training, site orientation, substance abuse testing, and all certification to be completed prior to signing up for employment.

A serious "Zero Injury" safety program must be in place prior to the start of work. I recommend Emmitt Nelson of Nelson Consulting in Houston, Texas for this endeavor.

A substance abuse policy with pre-employment, for cause, and random testing is a must. The pre-employment failure rate at Council Bluffs was an average of 10%. A recent power project in Northern Iowa had a 35% failure rate.

The NMAPC labor agreement is an agreement the Kansas City Building trades are familiar with and is very cost effective. It does require the contractor to manage the agreement for good results. The expectations for the project must be made clear to the labor organizations early on. This will also minimize turnover. In addition to the direct costs of turnover there is a high correlation between productivity and turnover. A turnover rate of 30% could result in a productivity factor of 1.5.

Attachment 1
Cost to Work 5-10's

- **Basis is Burns & McDonnell Manhour Summary** 3,864,327 Mhs
- **Factors:**
  - **Premium Time** 20% of manhours at half time
  - **Inefficiency** 8% of manhours at full rate
- **Cost Calculations:**

Premium time	3,864,327	Mhs
	X 20%	
	772,865	Mhs
	X $22.00	
	$17,000,000	

Inefficiency	3,864,327	Mhs
	X 8%	
	309,146	Mhs
	X $53.45	
	$16,524,000	

- **Total cost for 5-10's:**

Premium time	$17,000,000
Inefficiency	$16,524,000
Total	**$33,524,000**

SCHUMACHER

CONSULTING LLC

INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

Attachment 2
Craft Labor Rates

Craft	% of Job	JM Wage	Through	JM Wage	Through	JM Wage	Through	Fringes**	Contract Expiration
Insulator	1.2	29.64	9/30/07	31.64	9/30/08			18.80	9/30/08
Boilermaker	20.2	29.85	9/1/07	30.55	12/31/07			17.26	12/31/07
Carpenter / MW	10.2	31.85	4/1/07	33.70	4/1/08	35.55	3/31/09	9.66	3/31/09
Cement Finisher	.7	26.23	4/1/07	28.23	4/1/08	29.83	3/31/09	10.87	3/31/09
Electrician	11.2	31.53	9/2/07					14.31	9/2/07
Operators	10.7	32.31	3/31/07					9.98	3/31/07
Ironworkers	8.7	26.95	4/1/07	28.80	4/1/08	30.65	3/31/09	16.65	3/31/09
Laborer	10.4	23.05	3/31/07					9.76	3/31/07
Pipefitter	24.3	34.83	6/1/07	36.93	5/31/08			15.00	5/31/08
Sheetmetal	.9	35.87	6/30/07					13.41	6/30/07
Teamster	1.5	26.55	3/31/07					8.86	3/31/07
Avg.	100	30.73						13.81	

**** Some Fringes calculated on paid hours**

Payroll taxes and Insurance:

- W/C 6.8 % @ EMR of 1
- General Liability 5.0 %
- FICA 7.65 %
- FUI .8 %
- SUI 8.8 %

29.05 % x Wages

Overtime:

- Time & ½ after 8 hours / day & Saturday
- Double Time Sunday & Holidays

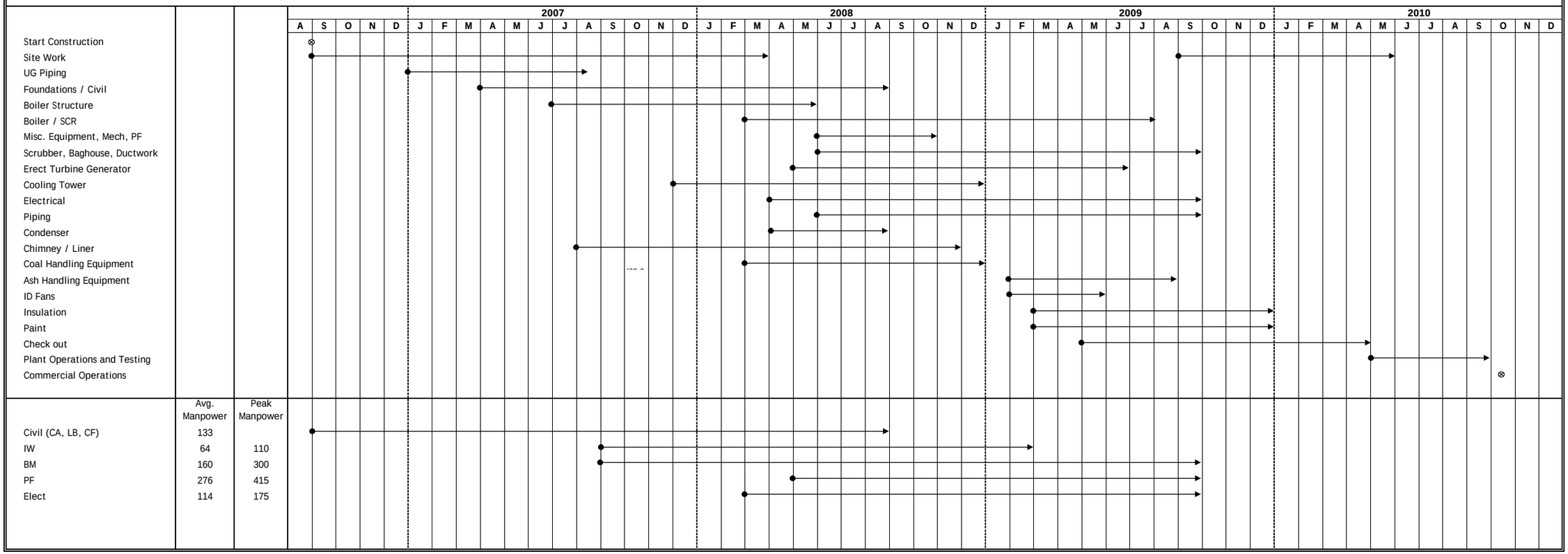
Example:

Boilermaker Wage	$29.85
Fringes	$17.26
T & I (29.05%)	$ 8.67
Total Cost	$55.78 Per Hour

Average Cost Rate:	**ST**	**T-1/2 Add**	**2T Add**
Wage	$30.73	15.37	
Fringes	$13.81	4.00	
T & I	$ 8.91	2.65	
Total Cost	$53.45	$22.00	$44.00

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

2.0
IATAN UNIT 2 PROJECT
PROJECT SCHEDULE AND MANPOWER

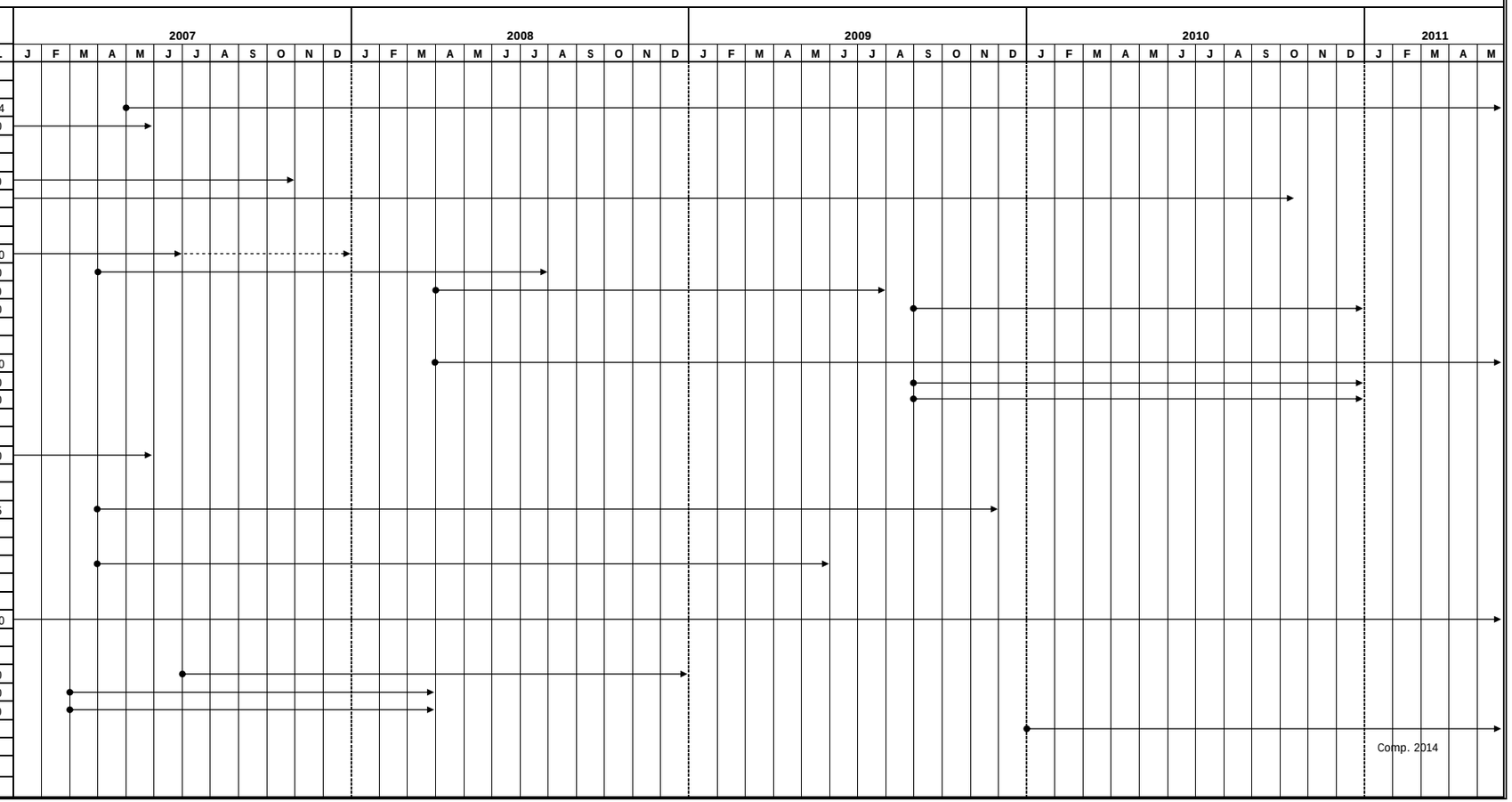


	Avg. Manpower	Peak Manpower
Civil (CA, LB, CF)	133	
IW	64	110
BM	160	300
PF	276	415
Elect	114	175

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

3.0
IATAN UNIT 2 PROJECT
CURRENT AND FUTURE AREA WORKLOAD

Project	Location	Critical Crafts Avg. Manpower BM	PF	IW	EL
Associated Electric					
Norborne Station - New 600 MW CFB	Norborne, MO	160	270	64	114
Thomas Hill - New SCR		120	40		20
KCPL					
LaCygne Station - New SCR	LaCygne, KS	120	40		20
Iatan Unit 2 - New CFB	Iatan, MO				
MidAmerica Energy					
Council Bluffs - New 790 MW CFB	Council Bluffs, IA	600	600		200
Council Bluffs - Unit 3 SCR	Council Bluffs, IA	120	40		20
Muscatine - New SCR / Scrubber	Muscatine, IA	120	40		20
Neal - New SCR / Scrubber		120	40		20
Alliant Energy					
Southerland - New 300-500 MW CFB		160	250	60	100
Ottumwa - New SCR / Scrubber - (1) 800 MW	Ottumwa, IA	120	40		20
Burlington - New SCR / Scrubber - (2) 300 M	Burlington, IA	120	40		20
Empire Electric					
Asbury Station - New SCR	Asbury, MO	100	30		20
City of Springfield, MO Utilties					
New 350 MW CFB	Springfield, MO	120	180	45	75
City of Hastings, NE Utilities					
New 225 MW CFB	Hastings, NE	Non-Union			
TriState / Sunflower Energy					
(2) New 700 MW CFB	Holcomb, KS	400	500	120	200
Westar Energy					
Simple Cycle	Kansas	40	40		40
Jeffrey Station - (3) 800 MW FGD	Kansas	120	40		20
Lawrence Station - Scrubber & Baghouse	Lawrence, KS	120	40		20
New CFB	Kansas				

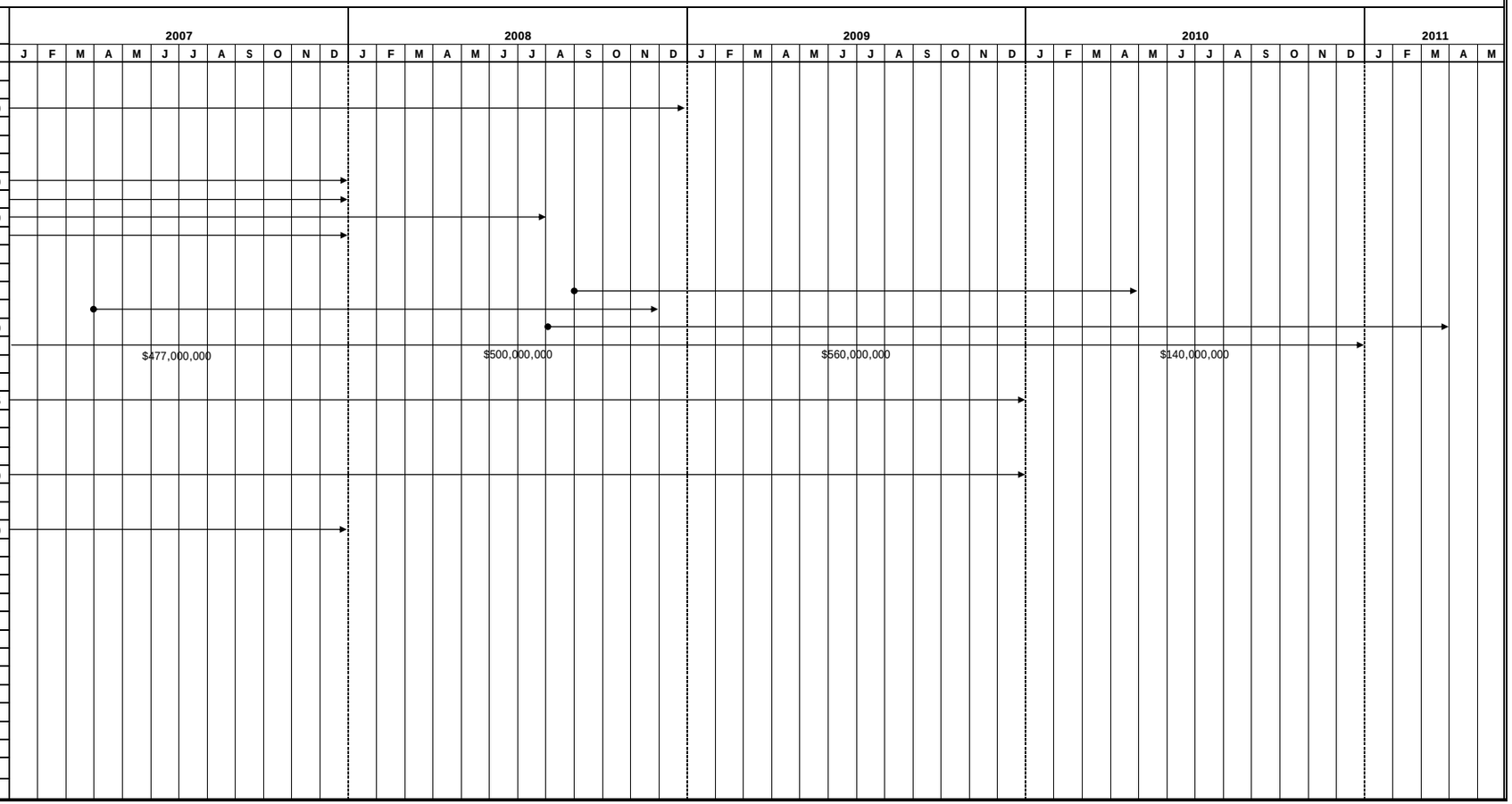


Schedule DFM2010-5

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

4.0
IATAN UNIT 2 PROJECT
OTHER WORKLOAD

Project	Location	Critical Crafts Avg. Manpower BM	PF	IW	EL
KC Commercial Work					
Auto, Hospital, Light Industrial	Kansas City, MO	0	200	300	400
$3.3 Billion Construction					
Petrochemical					
Coffeyville Refinery - Maint & T/A	Coffeyville, KS	55	165		100
McPherson Refinery - Maint. & T/A	McPherson, KS	50	150		80
ConocoPhillips - New Coker	Wood River, IL	120	400		250
Kansas, TX, OK, LA Turnarounds		2,650,000 Manhours			
Ameren					
Sioux Unit 1 & 2 SCR	Eastern MO	260	80		40
Sioux Unit 1 & 2 Scrubber	Eastern MO	240	100		40
Rush Island - New 750 MW CFB	Eastern MO	180	300		120
Upgrades & Outages	Eastern MO				
Peabody Energy					
Prairie States Energy	Marissa, IL	400	550	130	225
Greenfield 1500 MW plant					
Southern Illinois					
Misc Scrubbers, SCR's, and Baghouses		600	200		200
Holcim					
New Cement Plant	St. Genevieve, MO	400	150		150

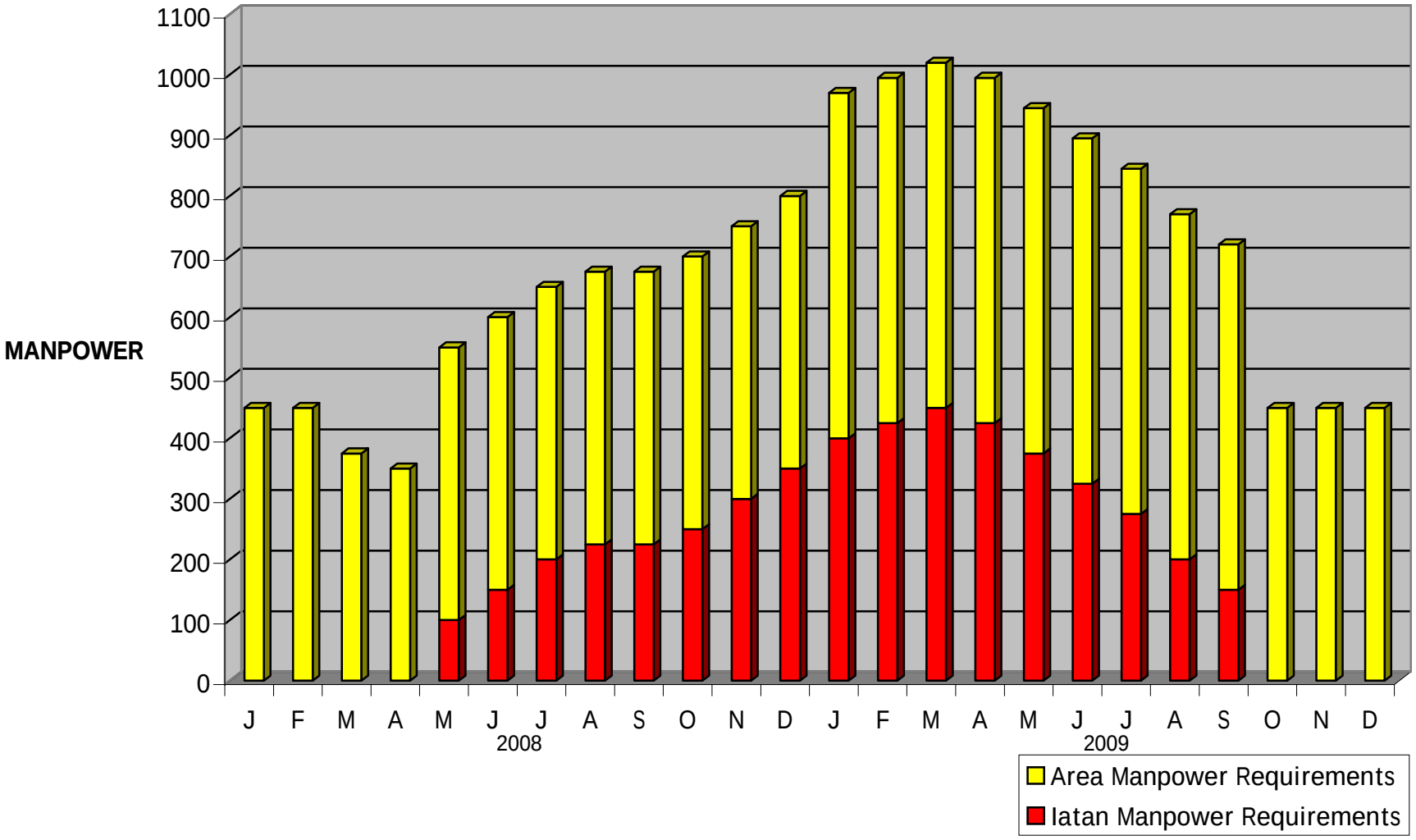


Schedule DFM2010-5

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

PIPEFITTERS L533

600 Active members available w/o travelers

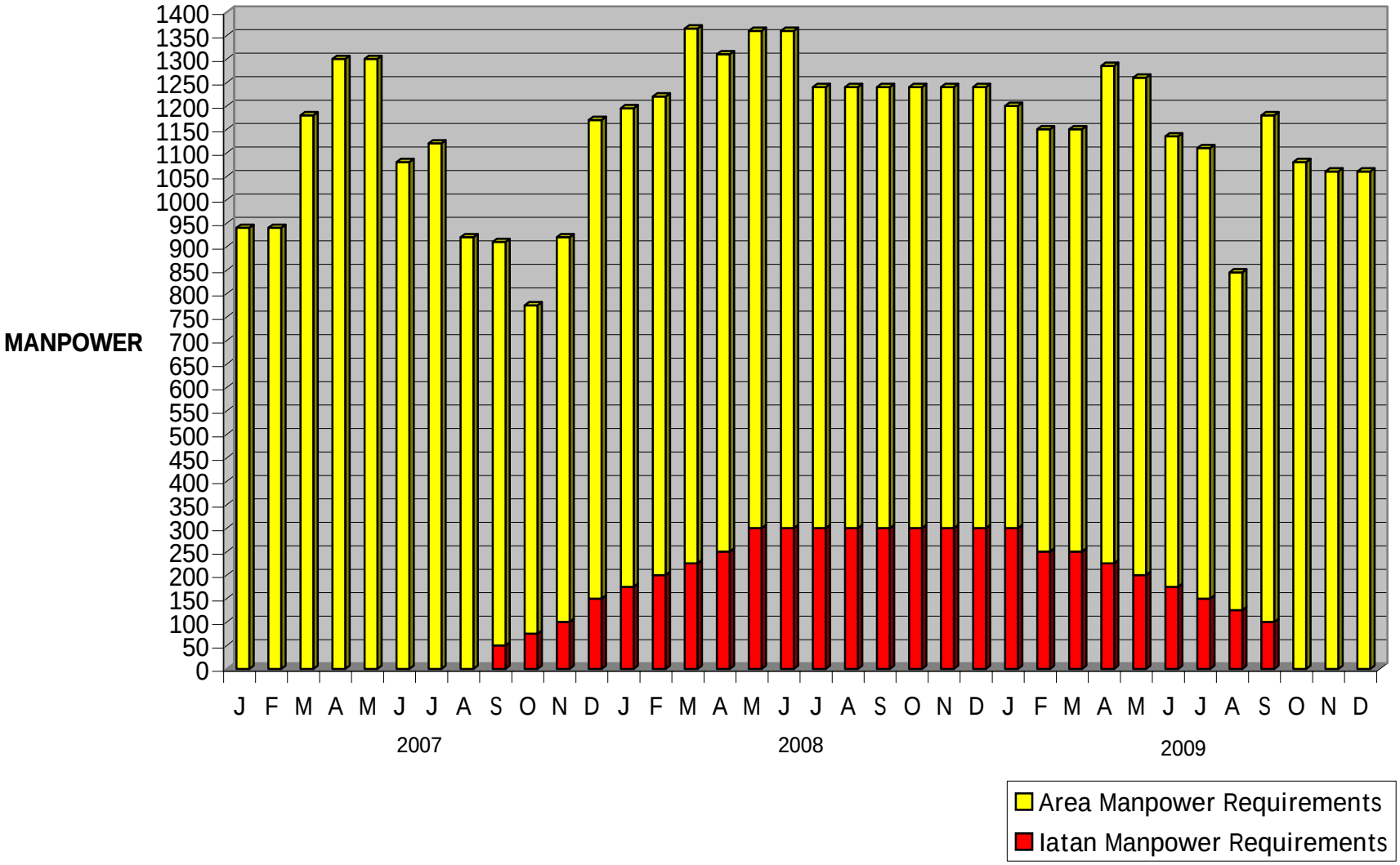


Schedule DFM2010-5

SCHUMACHER
CONSULTING LLC
INDUSTRIAL CONSTRUCTION & TURNAROUND CONSULTANT

BOILERMAKERS L83

500 Active members available w/o travelers



Schedule DFM2010-5

PIPEFITTERS	2008												2009											
Date	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Area Manpower	450	450	375	350	450	450	450	450	450	450	450	450	570	570	570	570	570	570	570	570	570	450	450	450
Iatan Manpower	0	0	0	0	100	150	200	225	225	250	300	350	400	425	450	425	375	325	275	200	150	0	0	0

BOILERMAKERS	2007												2008												2009										
Date	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Area Manpower	940	940	1180	1300	1300	1080	1120	920	860	700	820	1020	1020	1020	1140	1060	1060	1060	940	940	940	940	940	940	900	900	900	1060	1060	960	960	720	1080	1080	1060	1060
Iatan Manpower	0	0	0	0	0	0	0	0	50	75	100	150	175	200	225	250	300	300	300	300	300	300	300	300	300	250	250	225	200	175	150	125	100	0	0	0

SCHEDULE DFM2010-6

THIS DOCUMENT CONTAINS HIGHLY CONFIDENTIAL INFORMATION NOT AVAILABLE TO THE PUBLIC