



Glossary of Terminology

Scheduling, Estimating, Project/Construction Management, Contract Administration, and Construction Claims Terminology for Engineering and Construction Projects

Richard J. Long, P.E.

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(A quick reference guide of the most commonly used terms with short definitions)

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Scheduling, Estimating, Project/Construction Management, Contract Administration, and Construction Claims Terminology for Engineering and Construction Projects

(A quick reference guide of the most commonly used terms with short definitions)

The following definitions are provided for commonly used terms used by scheduling, estimating, project/construction management, and contract administration professionals, and construction claims experts involved with engineering and construction projects.

A/B Estimates of Damages – The A/B estimate method is generally utilized in cases where the changed work or the cause of the delay or disruption related to the changed work is fairly straightforward. For example, a lump sum contractor bids on a chemical plant expansion assuming that a large pressure vessel is to be located at grade with its own foundation. After the job begins, the contractor discovers that the engineer has relocated the vessel in the structure above grade because of other process changes made by the owner. The contractor in such a case can prove his damages by subtracting an independent estimate of the work as planned (the “A Estimate”) from the new estimate of the work with the vessel relocated (the “B Estimate”). The “B Estimate” is a fair and reasonable estimate of the value of the work, at the time of the bid, if the contract documents had contained an adequate description of the problems and changes that actually occurred during the course of the work. The contractor’s damages under this method would be the difference between the two estimates.

Absenteeism – Absence of crew members may lower the overall crew productivity rate because of fewer resources or different skill levels of the remaining crew. The contractor is usually responsible for the consequences (delay and loss of productivity) for this problem.

Acceleration – Acceleration of a construction project occurs when the construction schedule for the project, or a portion of the project, is shorter than what would be required using normal sequences of construction on a normal working schedule. If the contractor agreed to a short schedule, it may be responsible for the acceleration costs unless the owner caused critical path delay to the contractor’s work and did not provide a time extension. Also, compensable acceleration may occur when the contractor is directed to perform the work in a shorter time period than it believes is allowed under the contract. Compensable acceleration can also occur when additional work is added through contract changes or constructive changes but additional time for performance is not granted. If both parties are responsible for delays to the work that requires acceleration, then it may be necessary to allocate the acceleration costs based on an allocation of delay responsibility and other contractual issues, such as but not limited to the owner’s responses to time extension requests by the contractor.

Activity – Component of the Scope of Work that is expressed in the schedule. Also may be referred to as a “task.”



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Activity-Based Costing (ABC) – Activity-Based Costing identifies activities in an organization and assigns the cost of each activity resource to all products and services according to the actual consumption by each: it assigns more indirect costs (overhead) into direct costs. In this way an organization can establish the true cost of its individual products and services for the purposes of identifying and eliminating those which are unprofitable and lowering the prices of those which are overpriced. The methodology assigns an organization's resource costs through activities to the products and services provided to its customers. It is generally used as a tool for understanding product and customer cost and profitability. As such, ABC has predominantly been used to support strategic decisions such as pricing, outsourcing and identification and measurement of process improvement initiatives.

Acts of God – Natural disasters, including but not limited to floods, fire, earthquakes, tornadoes, hurricanes, lightning, drought, high tides, and other unusual and severe conditions. Contracts often contain provisions by which acts of God are defined in a “*Force Majeure*” clause by which the owner and contractor agree that the contractor cannot claim additional compensation for increased costs or delays resulting from such acts of God, and the only relief for such events is that the contractor is entitled to an extension of time. However, the contractor must still demonstrate that the activities in its schedule that were affected by such acts of God were on the critical path of the project schedule at the time that the acts of God occurred and the contractor was not responsible for other concurrent delays at that time.

Acts of Government (Sovereign Acts) – Actions or inaction by federal, state, county, city, municipal or other government agencies or officials that stop, delay, disrupt, hinder or otherwise affect on-going or planned work. These actions or inactions may be covered by a *Force Majeure* clause and entitle a contractor to an extension of time if they affect critical path work and delay the project. Unless recovery of costs resulting from such actions or inactions are precluded by the contract, a contractor may also attempt to claim for its increased direct and time-related costs that result from Acts of Government. However, the contractor must still demonstrate that the activities in its schedule that were affected by such acts of Government were on the critical path of the project schedule at the time that the acts of Government occurred and the contractor was not responsible for other concurrent delays at that time.

Actual Cost – Cost sustained in fact, on the basis of costs incurred, as opposed to a standard, predetermined, forecasted, or estimated Cost. Actual Costs to date include costs of Direct Labor, Direct Material, and other direct charges, specifically identified to appropriate Cost Accounts as incurred, and overhead costs and general administrative expenses reasonably allocated to cost accounts.

Actual Cost of Work Performed (ACWP) – The cost incurred and recorded in the accounting system for performing the work within a specific time period.



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Authorized Work – Work that has been defined and is included in the contract value. Also may include work that has been authorized in writing, but for which contract value has not been determined and agreed.

Bar Chart – A scheduling tool (also called a Gantt chart) that shows the time span of each activity as a horizontal line, the ends of which correspond to the start and finish dates of the activity.

Baseline – A quantitative definition of cost, schedule, and scope performance that serves as a base or standard for measurement and control during the performance of an effort. The established plan against which the status of resources and the work effort are measured, assessed, and controlled. Once established, baselines are subject to change control procedures.

Bid Error – An error made by the contractor in preparing its bid proposal/cost for performing contract work. Bid errors may include, but are not limited to, incorrect labor rates, labor productivity factors, overhead rates, schedule duration assumptions, estimated quantities, and technical assumptions for which the contractor is responsible.

Budget – The estimated costs, obligations, and expenditures for performing the project; also called the performance measurement baseline budget.

Budgeted Cost of Work Performed (BCWP) – The BCWP is the earned dollar value of work accomplished during the measurement period. The method used to calculate earned value can be either objective or subjective.

Budgeted Cost of Work Scheduled (BCWS) – The sum of budgets for the work scheduled to be accomplished within a given time period.

Cardinal Change – The U.S. Court of Claims has defined “Cardinal Change” as a change or series of changes that are beyond the scope of the contract and are a breach of contract. The U.S. Supreme Court defined work within the general scope as work that “should be regarded as fairly and reasonably within the contemplation of the parties when the contract was entered into”.¹ Key words that provide an indication that a cardinal change has occurred include outside contract scope, excessive changes, beyond contract obligations, extent of changes, and breach of contract. There are two basic tests to determine if a cardinal change exists. Test one asks, “was the type of work within the contemplation of the parties when they entered into the contract?” Test two asks, “was the finished product basically the same in form or function as the originally contemplated product?”

Faced with a cardinal change, a contractor has two options. First, it may perform the change and seek breach of contract damages after completing the work. As a second option, the contractor may refuse to perform and claim breach of contract.² If the contractor performs the change, it can suffer severe financial hardship until it proves and recovers breach of contract damages. If the contractor

¹ *Freund v. United States*, 260 U.S. 60, 63 (1922).

² See *Boston Shipyard Corp.*, 886 F2d 451,456 (1st Cir. 1989).



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opts not to perform but the change ultimately is found not to be cardinal, the contractor will have committed a breach of contract because it was obligated by the disputes clause to perform all of the original scope of work and all non-cardinal changes.³

Change Control – A documented process applying technical and management review and approval of changes to scope, schedule, and cost baselines.

Change Order Proposal – The document prepared to provide a complete description of a proposed change and its resulting impacts on project baselines.

Change Order (also see Directed Change) – A formal change to the contract pursuant to the changes clause contained in the contract, wherein the scope of work is either increased or decreased, or the required means or method of performance is changed. The change order will also identify the increase or decrease in the contractor's compensation and may also identify any change to the contractual completion date.

Claim – An assertion or request for a contract price and/or time for completion adjustment by one of the contracting parties seeking adjustment or interpretation of an existing contract subject to the dispute clause on the contract.

Code of Accounts – A logical, hierarchical breakdown of project into controllable elements for purposes of cost control and reporting.

Commercial Impracticability: Performance (Impractical Performance) – Contract performance becomes extremely expensive (*e.g.*, costs double), dangerous or difficult, and where such expenses, dangers or difficulties were unexpected. Unprofitable work, hardship or high costs alone are usually not enough. Depending on the existence of contractual provisions stating otherwise, such impracticability may entitle the contractor to a compensable delay if the work affected by such problems was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Commercial Impracticability: Supply (Unavailable Material) – Unreasonable difficulty in locating or obtaining necessary materials, supplies, tools or equipment; unavailability of materials despite exhaustive search for alternative sources; cost of obtaining items is commercially senseless or unreasonably high (*e.g.*, costs approximately double what was planned); procurement or delivery is not possible at the time or place needed. Depending on the existence of contractual provisions stating otherwise, such impracticability may entitle the contractor to a compensable delay if the work affected by such problems was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

³ See Simon, Construction Law Claims and Liability, Cardinal Changes, § 11.2 (1983).



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Concurrent Delay – Concurrent delays are two or more delays that occur, at least to some degree, concurrently; that is, during the same period of time. The term is used in the construction law as a term of art that refers to the situation when a compensable delay and a noncompensable, unexcusable delay occur at the same time or in overlapping time periods. For example, the term would apply when a contractor cannot commence work on the second phase of a project because the owner has failed to obtain a necessary right-of-way, and, simultaneously the contractor is also prevented from commencing the second phase by its failure to timely complete precedent work in the first phase.

This phenomenon of “concurrent delay” creates interesting legal issues with regard to assessing responsibility for the overall project delay. This issue may be further complicated because: the delay periods may be of different lengths; the delay periods may be of the same or different lengths but not totally concurrent; the delays may be of identical lengths and totally concurrent, but have a different impact in terms of the number and types of work activities affected thereby and the severity of that impact.

Configuration Management – Technical and administrative direction and surveillance actions taken to: (a) identify and document the functional and physical characteristics of a configuration item; (b) control changes to those characteristics; and, (c) record and report configuration change processing and implementation status.

Constructive Acceleration – Constructive acceleration occurs when a construction contractor encounters excusable delay during its performance of the contract work, such as design changes, added scope, unusually severe weather, differing site conditions, acts of God, or owner-caused delays. The contractor is then entitled to a time extension equivalent to the time of excusable delay. The contractor is constructively accelerated when it is not granted the time extension. The contractor must then decide whether to accelerate its performance to meet the mandated completion date. If the contractor is compelled by such circumstances to accelerate its performance, it may be entitled to recover damages based on a theory of constructive acceleration.

Constructive Change – A change in contract work without issuance of a formal change order; insistence on performance in a manner different from that allowed by the contract or refusal to accept performance in a manner allowed by the contract. A constructive change can also occur if the owner requires performance of work not called for in the contract, but refuses to issue a change order. Such constructive changes may entitle the contractor to a compensable delay if the work affected by such changes was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Often, notice is not given in a formal written context or in written form at all. For example, the contracting parties who interact daily on a project may perceive and argue that notice has been given of an impact event because the issue is common knowledge by all involved. An example would be where the owner has a designated site agent based full time on site to monitor the progress of the works. The agent would have direct and daily knowledge of project events as and when they occur.



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The owner's agent would usually attend daily site meetings, keep a daily diary or log of core issues as observed, and often receive daily or weekly site documents from the contractor. The contractor would argue that the agent, as the owner's representative, has first-hand knowledge of all claim and change events as and when they occur, or constructive notice, notwithstanding that a formal contract letter has not been issued by the contractor, and that under such circumstances, the contract notice requirements have been met.

Constructive Notice – Most construction contracts, whether they are standard or customized forms, usually contain specific provisions related expressly to the process of giving 'notice.' The notice generally refers to an obligation on the part of the Contractor to notify the relevant party administering the contract, normally the architect, resident engineer, or owner's representative, of a claim or change event that gives rise to possible additional entitlement for time and/or cost. The duty imposed upon the issuing party when giving notice in terms of information to be supplied and the time for performance of any specific and designated obligations varies with the form of contract employed.

Contingency – The amount budgeted to cover costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties. The amount of the contingency depends on the status of design, procurement, and construction and the complexity and uncertainty of the component parts of the project.

Control Budget – The control budget is a restatement of the original bid estimate in a form that facilitates comparisons between budget and actual costs. The control budget is normally prepared after bid opening and before construction starts.

The control budget is not the contractor's bid. The bid proposal is the price sheet used in the contract as the basis of payment for work performed. The contractor prepares an estimate of costs, overheads, and anticipated profit (the total of which becomes the bottom line of its bid), but the makeup of individual cost elements becomes hidden when assigning values (prices) to each bid item. Bid unbalancing is common. In addition, payment is usually based on units of work completed and not for interim steps along the way. An example of the latter is payment for concrete – paid for by the cubic yard, in place. No separate payment is usually made for forming, pouring, finishing, etc. For this reason, the control budget (which shows separate estimated costs of forming, finishing, and placement of concrete), and not the bid schedule, is to be used as the basis for comparison for calculations of damages using the using the discrete damages/cost variance analysis approach.

Thus, the control budget is a restatement of the original bid estimate and commercial proposal in a form that facilitates detailed cost account comparisons and reporting between budget and actual costs, quantities, man-hours, and unit productivity rates. The control budget is normally prepared after the contractor's commercial tender is accepted by the owner, and before project specific engineering and construction begins on a turnkey engineering, procurement, and construction (EPC) project. The control budget delineates the contractor's total estimated costs (by cost elements such



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as labor and material), quantities, and man-hours into cost accounts comprising the project scope of work defined by the project work breakdown structure (WBS).

Control/Cost Account – The terms “cost account” and “control account” are often used interchangeably. The management control point at which actual costs are accumulated and performance is determined. It represents the defined work assigned to one responsible organizational element according to the work breakdown structure and must contain the specific Scope of Work, definite schedule, assigned budget, unique identification, and method of measuring performance. The control account concept is applicable to all projects. Large projects may have a series of control accounts that may be divided into work packages and planning packages. Small projects may have only one control account consisting of a single charge number.

Cost Account – The management control point in the WBS where an individual becomes responsible for execution of work for agreed upon scope, schedule, and budget. Cost accounts are made up of work packages for near-term effort and planning packages for far-term effort where detail planning is impractical.

Cost Baseline – A budget that has been developed from the base cost estimate for the scope baseline and has been time-phased in accordance with the project schedule. The cost baseline is referred to as a baseline since it is integrated with the scope and schedule baselines and subject to formal change control. Normally it also contains direct and indirect budget, management reserve budget, undistributed budget and higher level budgets, and a contingency amount.

Cost Benefit Analysis (CBA) – Process of quantifying costs and benefits of a decision, program, or project (over a certain period), and those of its alternatives (within the same period), in order to have a single scale of comparison for unbiased evaluation. Unlike the present value (PV) method of investment appraisal, CBA estimates the net present value (NPV) of the decision by discounting the investment and returns.

Cost Contingency – The amount appropriated to cover costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties. The amount of the contingency will depend on the status of design, procurement, and construction and the complexity and uncertainty (risk) of the component parts of the project. Cost contingency is not a substitute to making an accurate assessment of expected cost.

Cost Estimate – A result or product of an estimating procedure which specifies the expected dollar cost required to perform a defined Scope of Work, activity, or project. A cost estimate may constitute a single value or a range of values.

Cost Estimate Types – Cost estimates are grouped into four general categories: (a) Planning Estimates, often referred to as Rough Order of Magnitude or Ball Park Estimates, are intended to grossly approximate the value of a given task or program. Planning cost estimates are of a low confidence level, since they are based upon loosely defined project parameters, drawings, plans,



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definition, and data with respect to scoping the overall schedules, statement of work, equipment lists, and delivery requirements. Because of this, a significant risk allowance/contingency is usually added to planning estimates for undefined work and other unknowns. Planning estimates are generally required early in the program definition cycle for the purpose of go-no go decisions. The amount of estimating detail is minimal, and normally only a top dollar value is provided. Planning estimates are submitted for information purposes only and do not represent a formal commitment. (b) Budget Estimates are normally required for funding, fiscal planning, or procurement decisions. Budget estimates are often derived through the use of preliminary functional organization estimates and gross parameters, and are based upon substantially well-defined data and ground rules, but require additional definition before a firm price can be quoted. An allowance for undefined work and unknowns is generally added to budget estimates. Budget estimates denote pricing accuracies that are superior to Planning Estimates, but still do not represent a firm commitment. (c) Firm Cost Estimates are based on well-defined plans and data, and are usually in response to a customer firm request for proposal that has a near term go-ahead. Firm estimates require the submission of the greatest amount of substantiating detail, and the preparation of an extensive backup package, to support contractual negotiations. (d) Not To Exceed (NTE), or Not Less Than (NLT), Estimates are commitments from a contractor as to the maximum amount (or minimum credit) required to accomplish (or delete) a specific task, item, or procurement. NTE/NLT estimates are prepared from Planning, Budget, or Firm Estimate information. The amount of Contingency or NTE/NLT allowance added is strictly an estimator or management judgment factor.

Cost Reimbursement Contract – A contract type which provides for payment to the contractor of allowable costs incurred in the performance of the contract, to the extent prescribed in the contract. A variation is a Cost Plus Fee or Fixed Fee Contract, where a fee based on a percent of the costs incurred or a fixed fee is added to the actual costs incurred to derive the contract price.

Craft Turnover – Learning curve productivity loss results from the continual turnover of labor. Unless it can be demonstrated that the owner is responsible for this problem, the contractor is usually responsible for the consequences (delay and loss of productivity) for this problem.

Critical Activities – Those activities in the schedule network for which float values are less than or equal to zero days. Zero float day activities must be completed at the calculated schedule time to prevent an expansion of the total project duration and a delay in the project completion date. Activities with negative float indicate that the completion of the project is already delayed from the scheduled completion date, and the activity path with the most negative float is now the critical path to completion of the project and any delay to that path will delay the completion date even further.

Critical Path – The portion of the schedule that is comprised of scheduled activities for which any schedule delay may be expected to cause a corresponding delay in the overall project completion or end product.

Critical Path Method (CPM) – The methodology/management technique that makes analytical use of information regarding the critical path and other sequential paths through the network. A logical,



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analytical, network-based scheduling tool that demonstrates the schedule paths and constraints toward accomplishment of specified objectives and evaluates the allowable and expected time spans for the activities contained therein. Activities, which, when delayed, have an impact on the total project schedule, are critical and said to be on the critical path.

Cumulative Impact – Cumulative impact is the unforeseeable disruption of productivity resulting from the “synergistic” effect of an undifferentiated group of changes. Cumulative impact is referred to as the “ripple effect” of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships. This phenomenon arises at the point the ripples caused by an indivisible body on two or more changes on the pond of a construction project sufficiently overlap and disturb the surface such that entitlement to recover additional costs resulting from the turbulence spontaneously erupts. This overlapping of the ripples is also described as the “synergistic effect” of accumulated changes. This effect is unforeseeable and indirect. Cumulative impact has also been described in terms of the fundamental alteration of the parties’ bargain resulting from changes.⁴

Defective and Deficient Contract Documents – Errors or omissions in the contract drawings or specifications; impossibility or extreme difficulty in performing contract requirements; incorrect dimensions; unattainable performance requirements. Unless the contractor is also responsible for the design, such errors or omissions may entitle the contractor to a compensable delay if the work affected by such errors or omissions was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Delay – The time during which some part of the project has been extended due to an unanticipated circumstance. Delays can be either (1) excusable and compensable, (2) excusable and noncompensable, or (3) nonexcusable and noncompensable.

Delay of Approvals (Slow Turn-around) – Unreasonable delay by the owner in approving shop drawings, schedules, samples, or other items that the contractor timely, accurately, and completely submitted. Depending on the existence of contractual provisions stating otherwise, such as a deemed approved clause after so many days without a response by the owner after the contractor’s submittal, such delays may entitle the contractor to a compensable delay if the work affected by such approvals was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Delayed Notice to Proceed – The owner fails to issue a Notice to Proceed (for the contract as a whole, or any divisible part of the contract) on the date set forth in the contract, or unreasonably delays issuance of the Notice to Proceed where the contract does not set a specific time for issuance of the Notice to Proceed. The contractor may be entitled to delay costs if the contractor reasonably relied upon the owner’s representations and if the contractor was not responsible for other concurrent delays at that time.

⁴ *Centex Bateson Constr. Co., Inc.*, VABCA No. 4613, 5162, 5165, 99-1 BCA ¶ 30,153 @149,258.



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Deliverables – Those items, contractual or otherwise, requiring delivery to another area of responsibility. Deliverables can be project documents, such as drawings, schedules, procedures, purchase orders, etc.; physical items to be installed in a facility, such as equipment or materials; or components of or the entire completed facility or project.

Delta Estimates Damages Method – The delta estimate method is no different than adding up a number of individual change order requests to derive the total claim amount. The delta estimate becomes difficult to apply if several problems and their effects are interrelated. Also, the delta estimate method is often criticized because the sum of the parts may exceed the whole (cost overrun). For example, contractors often calculate overall increases in labor costs by using multiple causes of lost productivity, such as:

- Excessive and sustained overtime
- Stacking of trades;
- Overcrowding;
- Effect of multiple changes;
- Temperature; and
- Others.

Each of these causes of productivity loss is evaluated and the calculated loss from each cause is summed to yield the overall productivity loss claim. However, without comparing the resulting total labor increase to the actual labor man-hour variance between the contractor's control budget and the total actual labor man-hours expended, including consideration for approved and pending changes, the calculation of the sum of the parts may yield a result that is greater than the whole variance. An owner should insist on a review of the contractor's job cost report to evaluate the actual variance between the control budget man-hours and actual labor man-hours for individual work activities.

Design Development – Transitional phase of an architect/engineer (A/E) services in which the design moves from the schematic phase to the detailed design phase. In the design development phase, the A/E prepares drawings and other presentation documents to crystallize the design concept and describe it in terms of architectural, electrical, mechanical, and structural systems. The design development phase is a refinement of the Scope of Work identified during conceptual design. As required, large-scale drawings, mock-ups, and detailed plans are developed to present a coordinated, clear view of the project's major elements with respect to architectural, structural, mechanical, electrical, plumbing, equipment, civil, landscape, and utility infrastructure. In an EPC contract, if a contractor contracts to perform a detailed design from a FEED design (Front End Engineering Design), certain design development must be performed. Certain changes to the FEED design documents would not be considered scope changes and instead design development. For example, detailing out the small bore pipe with valves, drains, etc. in a piping system from the FEED piping design would be considered design development.



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Destruction or Damage to Completed Work – Destruction or damage to completed or partially completed work that stops, delays, disrupts or hinders the contractor’s on-going or planned work or requires the contractor to perform extra or additional work. If such damage occurs as a result of weather problems, the contractor may have to recover its costs through its insurance policy. Depending on which party is contractually responsible for site security, the contractor may be entitled to a compensable delay if such damage occurs through vandalism or other similar acts after normal working hours and if the contractor was not responsible for other concurrent delays at that time.

Destruction or Damage to Tools, Equipment, Materials or Supplies – Destruction or damage to the contractor’s tools, equipment, materials, or supplies that stops, delays, disrupts or hinders its on-going or planned work, or requires the contractor to purchase, repair or replace damaged items. If such damage occurs as a result of weather problems, the contractor may have to recover its costs through its insurance policy. Depending on which party is contractually responsible for site security, the contractor may be entitled to a compensable delay if such damage occurs through vandalism or other similar acts after normal working hours and if the contractor was not responsible for other concurrent delays at that time.

Differing Site Conditions (DSC) – Physical site conditions that either differ from those described in the contract, or that are unusual or extraordinary. The prospects for a contractor to recover after encountering a DSC are dependent on: 1) the extent of the positive representations as to anticipated subsurface conditions made by the owner; 2) the extent to which conditions encountered differed materially from those represented; 3) the extent to which the contractor could have anticipated or observed the different conditions, by a site visit, previous experience in the geographic area, etc.; 4) The owner’s knowledge of the conditions actually encountered; and 5) the extent to which the contractor provided notice to the owner when the DSC was encountered.

Dilution of Supervision – Splitting up crews to perform base work and changed work, or continual replanning and resequencing of work, can result in less than effective supervision and lower productivity. If the owner is responsible for changes to the work which require dilution of supervision, the contractor may be entitled to recover its loss of productivity costs that result from this problem.

Direct Cost – Any cost that is specifically identified with a particular project or activity, including labor, equipment, materials, supplies, or other costs directly benefiting the project or activity.

Direct Impact – Direct impact is generally characterized as the immediate and direct disruption resulting from a change that lowers productivity in the performance of the changed or unchanged work. Direct impact is considered foreseeable and the disrupting relationship to unchanged work can be related in time and space to a specific change.⁵

⁵ “Change Orders Productivity Overtime,” MCAA, 2011, pp. 82-83, citing *Centex Bateson Constr. Co.*, VABCA Nos. 4613, 5162, 5165, 99-1 BCA ¶ 30,153.



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Directed Change (also see Change Order) – In any construction project, various changes in circumstances or conditions can arise which have not been covered in the original contract documents; changes such as: (1) errors and omissions in plans and specifications; (2) changes instituted by regulatory agencies; (3) minor design changes; (4) overruns or underruns in quantities; and (5) factors affecting time of completion or the method or manner of performance of the work.

A “change” is an alteration to the contract work involving work already required to be done. In contracts, an “extra” involves additional items of work that are not included in the original contract. Both changes and extras give rise to modifications to the contract.

The pervasiveness of changes in the construction process has not been lost on drafters of construction contracts. Virtually every such contract executed today contemplates the occurrence of changes and sets forth a procedure to implement them by including some form of changes clause. Typically the changes clause of a contract establishes a formal procedure resulting in a written amendment to the contract, which describes the precise nature of the new and different work that will be performed and the compensation to be made therefor. The process is often triggered by a communication from the owner notifying the contractor of the requirement for a change to the design; defining, detailing and explaining the new and different work to be performed; and requesting a cost proposal for performing that work. The contractor is expected to promptly respond with his lump sum proposal, covering his work and the work of his subcontractors (including appropriate and applicable mark-ups for profit and overhead), and a request for any required time extension. The change order clause in question will probably provide for compensation on the basis of agreed upon unit prices, if applicable to the work, or “time and material”, if desired by the owner, in which case no estimate or proposal is required from the contractor.

The benefits of having a changes clause in the contract are that it allows for greater flexibility by permitting changes without necessitating a new contract for each addition, deletion, or revision on a project; and allows for adjustment of plans and specifications to make clear the work the design professional and owner intended to be performed by the contractor without breaking contractual requirements. The change order mechanism also encourages the contractor to suggest beneficial changes knowing that it may receive a price adjustment for the additional work performed.

By effectively using this clause, owners (and contractors) are able to meet unforeseen contingencies without risking a breach of contract or being required to renegotiate a new contract. However, the owner’s right to modify the contract is subject to two significant limitations: (1) the modification should not fundamentally change the contract; and (2) the contractor must be compensated if the modification affects its costs or schedule or both. “Changes” clauses also have the effect of reducing contingencies in competitive bidding and thus decreasing the overall cost to the owner.

Generally, contracts may not be modified without the consent of all parties. However, “Changes” clauses in the contract may authorize one party, the owner, to modify the contract as needed to meet changing circumstances during the performance of the contract. The owner’s right to make changes



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or order extras will be governed by the wording of the particular clause and the law of the state or country where the contract is executed.

While all “Changes” clauses allow the owner or its representative to initiate the change without the consent of the contractor, the change order generally must be in writing, and must be within the general scope of the contract to prevent being designated a “Cardinal Change.”

Directing performance of extra work on a construction project was once little more than a rudimentary task for the owner. Unfortunately, such simplicity is no longer the order of the day. Contractors and subcontractors alike are becoming increasingly reluctant to proceed with extra work without complete assurance that all direct and impact costs will be paid. Absent such assurance, they are insisting that the extra work proceed with the right to reimbursement for additional time and costs if warranted. Conversely, owners are equally reluctant to direct additional work if the time and financial aspects are not firmly established. With such an atmosphere, the extra work/change order process in construction has become ripe for controversy.

Discrete Damages/Cost Variance Analysis Damages Method – By applying a variation of the delta estimate and modified total cost methods, the claimant can go one step further to provide convincing proof of the damages incurred using an approach known as the “discrete damages/cost variance analysis method.” This analysis method, in addition to evaluating cost growth for each cost account, considers quantity, man-hour, cost, unit price and unit productivity variance information for each account based upon a comparison of the current budget and actual values for these incises. For example, an account impacted by the direct consequences of significant man-hour growth for scope changes, and bid errors for quantity and productivity variations, may explain the vast majority of the cost variance (cost overrun) in the account. Residual labor costs, if any, may be attributable to rework, acceleration inefficiencies, and indirect cumulative impact or disruption which are evaluated separately. Because of the comprehensive nature of this type of analysis, it relies heavily upon the contractor’s contemporaneous detailed cost records and reports, and the current budget versus actual quantity, man-hour, and cost variance data derived for each account from this information.

The method involves the specific distribution of all costs incurred on the project rather than quantifying only certain parts of the cost or damage analysis as may be used in the other methods. The credibility of this method is established by separating the cost growth that results from bid error, non-compensable problems, and compensable problems, and then identifying individual compensable problems with specific costs tied to each problem. In addition, the cost growth for each claim problem is applied to each relevant cost account to demonstrate that the “sum of the parts” of each claim does not exceed the whole cost overrun for each cost account.

Disruption – Disruption can be defined as any change in the method of performance or planned work sequence contemplated by the contractor at the time the job was bid that prevents the contractor from actually performing in that manner. In other words, disruption is a material alteration in the orderly performance conditions that were expected at the time of bid from those



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actually encountered, resulting in increased difficulty and cost of performance. Disruption claims can be asserted by contractors against owners, subcontractors against contractors, contractors against subcontractors, and, when permitted by law, contractors against design professionals.

With respect to contract performance, disruption encompasses three general principles. First, when a contractor bids on a contract, it is entitled to schedule its performance in a series of economical operations, with each stage of performance dependent on a previous stage. Therefore, any disruption to one stage may have a potentially disruptive impact on the subsequent stages. Second, parties to a contract are expected to cooperate with one another and not hinder each other's performance. A contractor plans to perform its work in a certain manner and sequence, and the owner has an implied duty not to hinder, interfere, or disrupt the contractor's planned performance. Third, when a contractor plans its contract performance, it must do so reasonably. A contractor may not make unrealistic assumptions about contract performance. For example, a contractor cannot make a valid disruption claim if it has assumed that it would have sole access to the site when the contract documents indicated that other contractors would be simultaneously onsite.

Dummy – in ADM format only, a zero-duration activity used to connect two or more related activities

Duration – The period of time that is required to complete an activity.

Early Completion Prevented – Actions or inactions of the owner that prevent the contractor from completing the project, or any part of the project, on the date that the contractor planned, when and if that date is before the established contract completion date. To make a claim for delay to early completion, the contractor may need to establish that it notified the owner of its intent to complete the project early, and that its plan was reasonable.

Early Finish (EF) – In a network diagram schedule, the earliest time an activity can be completed.

Early Start (ES) – In a network diagram schedule, the earliest time an activity can be started.

Earned Hours – The time in hours credited to a workman or group of workmen as a result of their completion of a given task or group of tasks. Typically, earned hours are based on the unit productivity rate or budgeted rate for a given task. Actual hour could be less than, equal to, or greater than the earned hours, depending on the worker's actual productivity.

Earned Value – The value of completed work expressed in terms of the budget assigned to such work. Also referred to as the Budgeted Cost of Work Performed (BCWP).

Engineering, Procurement, and Construction Contract (EPC Contract) – Under an EPC contract, the contractor has responsibility for the design, procurement, and construction of the project.

Engineering, Procurement, and Construction Management Contract (EPCM Contract) – The primary difference between an EPC and an EPCM contract is that the contractor under an EPCM



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contract has responsibility for supervision/management of construction but does not assume responsibility for the construction itself.

Equipment-Factored Estimate – An estimating method by which the costs of the major items of installed equipment are estimated and totaled. Estimating factors are then applied to the total of the equipment costs estimate for other costs, such as the costs of civil work, piping, electrical, instrumentation, and indirect costs to derive the total estimated costs for a project. This type of estimate is most often used at the early, planning stages of a process plant or power plant project.

Escalation – Use of a price index to convert past to present prices or of converting present to future prices. Cost increases as a result of inflation.

Estimate at Completion (EAC) – Direct and indirect costs (ACWP) actually charged to the WBS element to-date, plus the estimate of costs (direct and indirect) for authorized work remaining. The term, Latest Revised Estimate (LRE), is synonymous.

Estimate-to-Complete (ETC) – The cost and schedule estimates for completion of all remaining scope.

Fatigue – Productivity declines as workers are tired, and more than normal mistakes, injuries, and accidents may occur. If the contractor can demonstrate that the owner is responsible for such problems, the contractor may be entitled to recover its loss of productivity costs for such problems.

Fee – Fee represents an agreed-to amount beyond the Costs for work performed, and is commonly also referred to as profit. In most instances, fee reflects a variety of factors, including risk. Fee may be fixed at the outset of performance, as in a Cost Plus Fixed Fee (CPFF) arrangement, or may vary (within a contractually specified minimum-maximum range) during performance, as in a Cost Plus Incentive Fee arrangement.

Firm-Fixed-Price Contract (FFPC) – A contract which provides for a price which normally is not subject to any adjustment. FFP contracts are generally used for contracts awarded after formal advertising, or for negotiated contracts when reasonably definite specifications are available and costs can be estimated with reasonable accuracy to enable the negotiation of a fair price. An FFP contract price may be altered under the provisions of a Contract change clause.

Fixed-Price Contract – A type of Contract which generally provides for a firm price, but which, under certain appropriate contract clauses (change clauses, etc.) may provide for an adjustable price, for the supplies or services which are being procured.

Float – The amount of time that an activity may be delayed from its early start without delaying the project finish date. Float is a mathematical calculation, and can change as the project progresses and changes are made to the project plan. Also called slack, total float, and path float. See also free float.



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Free Float (FF) – The amount of time an activity can be delayed from its earliest start time to the point where it interferes with the earliest start time of its succeeding activity.

Front End Engineering Design (FEED) – A contract to perform sufficient engineering and preparation of the technical specifications and drawings that describe the project in sufficient detail that a contractor can prepare a bid to perform the detailed design, procurement, and construction of the project. The scope of the FEED typically comprises the following:

- Develop the functional requirements of a facility, typically a process plant or power plant;
- Complete the design basis;
- Develop the detailed scope of work for the bidding contractors for the EPC phase;
- Define the configuration of the facility and its major systems;
- Develop a design specification for detailed engineering;
- Conduct safety studies and assess risks;
- Define major interfaces; and
- Produce drawings (process flow diagrams, P&IDs, preliminary plot plans, preliminary general arrangement drawings and piping layout drawings, and specifications).

General and Administrative (G&A) Costs – Indirect Expenses, including a company's general and executive offices, the Cost of staff services such as legal, accounting, public relations, financial, and similar expenses, and other general expenses related to the overall business.

Global Claim – Global claims may be defined as those where a global or composite sum, however computed, is put forward as the measure of damage or contractual compensation where there are two or more specific matters of claim or complaints, and where it is said to be impractical or impossible to provide a breakdown or sub-division of the sum claimed between those matters. ‘Total actual cost’ or ‘total cost’ are American expressions used...to describe those claims, whether in respect of one only or more than one matter of complaint, where the alleged total costs of [the contractor] ... is compared with the contract value or price, and the difference then put forward as representing the measure of damage or additional cost caused by one or more matters complained of. Where more than one separate matter is relied on, as is very often the case, a total cost claim will also, therefore, constitute a global claim as above defined.⁶

Impact – The term “impact” refers to the indirect delay or interference that a change on one phase of work may create on another phase. The costs of such delay or interference should be recognized as a consequential cost to be considered as part of direct cost.

⁶ Pickavance, Keith, *Delay and Disruption in Construction Contracts*, 3rd ed., T&F Informa (UK) Ltd, London, 2005, p. 764, paragraph 19.5, citing Duncan Wallace, Ian, QC (ed.), *Hudson’s Building and Engineering Contracts*, 11th edn, 1995, Sweet & Maxwell) at p. 1086.



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Implied Warranty – The owner carries an implied warranty that the drawings, specifications and other contract documents that it furnishes to a contractor are accurate and that an acceptable product will result if such specifications are met. Examples of the breach of implied warranty of the accuracy of the specifications include misrepresentations of soils conditions, misrepresentation of the availability of construction water, or structural design flaws such as bolts too small to meet loads. Examples of the breach of suitability of specifications include the design of a heating system insufficient for a building’s needs, specification of roof insulation that violates the local building codes, or the specification of foundation piles or pile driving methods that provide an inadequate foundation for a building. In addition, there is an implied warranty that neither party to a contract will do anything to prevent performance thereof by the other party, or that will hinder or delay him in its performance. On multi-prime projects, there is an implied warranty that the owner or construction manager will coordinate the activities of the respective contractors so as to avoid disruptions.

Impossibility of Performance – Work cannot be performed according to contract terms by the contractor (or any other contractor) due to specification errors or unattainable performance requirements; specified equipment does not satisfy specified performance requirements; performance requirements are beyond state-of-the-art; damage or destruction to the structure upon which contract performance is dependent.

Improper Inspections – Unreasonably burdensome, improper, or overzealous inspection of the contractor’s work by the owner or its construction manager which stops, delays, disrupts, or hinders the contractor’s on-going or planned work. Improper Inspections may also include incorrect or erroneous standard applied or test performed during the inspection of the contractor’s work. The contractor may be entitled to recover its delays costs for improper inspections if the activities in its schedule that were affected by improper inspections were on the critical path of the project schedule at the time that the problems occurred and if the contractor was not responsible for other concurrent delays at that time.

Inadequate Supervision – Failure of the owner to oversee or supervise the contractor’s work in progress on site if the contract requires such supervision to allow the contractor to proceed with the ongoing work. Inadequate Supervision may also occur when representatives of the owner are inaccessible on a day-to-day basis to address the contractor’s problems and concerns during construction. Such problems may cause delays to the contractor’s work for which the contractor may be entitled to compensable delay damages if the affected work is on the critical path to project completion and if the contractor was not responsible for other concurrent delays at that time. Inadequate supervision is not limited to a problem for which the owner is responsible. The contractor may also be responsible for inadequate supervision of its subcontractor’ work and the delays and costs that result therefrom.

Inadequate Utilities – The contractor may be entitled to compensable direct costs and delay costs if the owner fails to deliver, or delays in delivering utilities (*e.g.*, electrical power, water, etc.) in violation of the contract, or that were reasonably expected. Also, the contractor may be entitled to



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compensable direct costs and delay costs if the owner-provided utilities are inadequate to properly support contract performance.

Incentive Type Contract – The incentive type contract may be of either a fixed price or cost reimbursement nature, with a special provision for adjustment of the fixed price or Fee. It provides for a target price, target profit or fee, and target cost as a point of departure for various Incentives. It also has a maximum price or maximum fee, with price or fee adjustment after completion of the contract for the purpose of establishing a final price or fee. The final adjustment is based on the contractor's actual costs, plus a sliding scale of profit or fee which varies inversely with the cost, but which, in no event, shall permit the final price or fee to exceed the maximum price or fee stated in the contract. Incentive type contracts may include specific incentive goals for schedule, technical performance, etc.

Indirect Cost – The cost incurred by an organization for common or joint objectives that cannot be identified specifically with a particular part of a project or activity.

Interference – Owner actions, inactions, or instructions that interfere with, stop, delay, disrupt or hinder the contractor's on-going or planned work. The contractor may be entitled to recover its disruption costs for such interference as well as its delay costs if the activities in its schedule that were affected by such interference were on the critical path of the project schedule at the time that the interference occurred and if the contractor was not responsible for other concurrent delays at that time.

Jury Verdict Damages – The jury verdict method provides the courts another way to calculate damages when discrete damages are not presented by the contractor or owner. The term "jury verdict" is misleading in that most cases that have received damages awards on a jury verdict basis involve decisions by courts or Boards of Contract Appeals, not juries. In these cases, judges and board panel members serve the role of a jury and as triers of fact, hearing testimony and weighing evidence, and awarding damages based on an approximation of damages suffered.

Labor Relations and Labor Management Factors – Productivity loss may result from union jurisdictional and industrial relations issues, safety issues, evacuation alarms, and late permit and access issues. The party responsible for such labor problems bears the responsibility for the increased costs that result therefrom.

Labor Shortage – Shortage in available labor resulting from injury, widespread illness (epidemics), competition from other projects, or other unusual and unforeseeable circumstances. The lack of skilled labor can also cause a labor shortage even though there is non-skilled labor in plentiful supply. These problems are usually the responsibility of the contractor.

Lack of Access – Access problems can result from impaired access to work areas, small or cramped work space, and access restricted by other work, strikes, unsafe conditions, etc. Depending on the existence of contractual provisions stating otherwise, such lack of access problems may entitle the



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contractor to a compensable delay if the work affected by such problems was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Lack of Information or Decision – Time spent awaiting instructions, decisions or clarifications from the owner; work force or activities shifted while waiting, or efforts wasted because information comes late. Depending on the existence of contractual provisions stating otherwise, such lack of information or decision problems may entitle the contractor to a compensable delay if the work affected by such problems was on the critical path at the time that the delay occurred and if the contractor was not responsible for other concurrent delays at that time.

Lack of Permits – Failure of the owner to secure permits or licenses necessary for the performance of the work; delay in securing permits. If the owner was responsible for securing such permits by a contractual date, the contractor may be entitled to recover its delay costs if the activities in its schedule that were affected by not having the necessary permit(s) were on the critical path of the project schedule at the time that the permits were needed and if the contractor was not responsible for other concurrent delays at that time.

Lack of Right-of-Way – Roadways or routes to or from the project are blocked, unavailable, or otherwise impaired. If the owner was responsible for securing such right-of-ways to access the project, the contractor may be entitled to recover its delay costs if the activities in its schedule that were affected by not having the necessary right-of-ways were on the critical path of the project schedule at the time that the right-of-ways were needed and if the contractor was not responsible for other concurrent delays at that time.

Late Drawings – Drawings or sketches required by contract to be furnished to the contractor, or that the contractor can reasonably expect to receive, are furnished to the contractor late or not at all, thereby affecting the orderly performance of the contractor's work. If the owner was responsible for delivering such drawings, the contractor may be entitled to recover its delay costs if the activities in its schedule that were affected by not having the necessary drawings were on the critical path of the project schedule at the time that the drawings were needed and if the contractor was not responsible for other concurrent delays at that time.

Late Finish (LF) – In a network diagram schedule, the latest time an activity can be finished.

Late or Defective Material or Equipment Furnished by Others (also Owner-Furnished Items) – Failure to receive, or delay in receiving property, equipment, tools or data in violation of the contract; receipt of property, equipment, tools or data unsuitable for their intended use. If the owner was responsible for delivering such material or equipment through its other vendors, suppliers, or contractors, the contractor may be entitled to recover its delay costs if the activities in its schedule that were affected by not having the necessary material or equipment were on the critical path of the project schedule at the time that the equipment or material were needed and if the contractor was not responsible for other concurrent delays at that time.



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Late Start (LS) – In a network diagram schedule, the latest time an activity can be started.

Latent Defect – A hidden flaw, weakness or imperfection in a design or constructed component (or entire) facility which a designer or contractor knows about, but the owner cannot discover by reasonable inspection.

Leonard Study – A study entitled “The Effects of Change Orders on Productivity,” sometimes referred to as the Leonard Study, was prepared in 1988 as a master’s thesis by Charles A. Leonard at Concordia University, Quebec, Canada. Leonard analyzed data from 90 cases drawn from 57 different construction projects to identify and quantify the effects of change orders on productivity.⁷

Level of Detail – The successively lower elements within the hierarchy, with each element being a further breakout of the next higher element.

Leveling Resources – The technique of scheduling the use of resources in a way that avoids wide fluctuations in resource demand. Resources generally cost less and are more easily managed if they are scheduled at a steady rate.

Liquidated Damages – Liquidated damages (also referred to as liquidated and ascertained damages) are damages whose amount the parties designate during the formation of a contract for the owner to collect as compensation upon a specific breach (*e.g.*, late performance) by the contractor. When damages are not predetermined/assessed in advance, then the amount recoverable is said to be actual damages to be agreed or determined by a court or tribunal in the event of breach.

A liquidated damages clause may not be enforced if its purpose is to punish the contractor in breach rather than to compensate the owner (in which case it is referred to as a penal or penalty clause). One reason for this is that the enforcement of the term would, in effect, require an equitable order of specific performance.

For a liquidated damages clause to be upheld, two conditions must be met. First, the amount of the damages identified must roughly approximate the damages likely to fall upon the owner seeking the benefit of the term. Second, the damages must be sufficiently uncertain at the time the contract is made that such a clause will likely save both parties the future difficulty of estimating damages.

Logic Network – A diagram used to identify the sequence and relationships of the Critical Path Method (CPM) schedule activities. The logic network complements and supports the WBS and establishes and gives direction to the work packages and tasks.

Long-Lead Item – Some component of the project, often a critical piece of equipment or material, that requires a significant amount of time to acquire, and thereby represents a potential threat to schedule achievement.

⁷ See Leonard, Charles A., “The Effects of Change Orders on Productivity,” M.S. Thesis at Concordia University, 1988.



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Loss of Productivity – The contractor’s actual man-hours per unit of work, such as man-hours per unit of quantity installed, are greater than its planned man-hours per unit of work.

Lump Sum Turn Key (LSTK) Contract – A Lump Sum Turnkey Contract is a fixed price agreement in which a contractor designs, constructs, and manages a project until it is ready to be handed over to the owner and operation can begin immediately. LSTK contracts are suited in cases where the scope of the work is well defined, the work can be quantified, and no change orders are anticipated. However, the contract would typically contain a changes clause for certain events or modifications, and for time extensions under certain circumstances. A comprehensive allocation of risks is appropriate for a LSTK Contract.

Maladministration – A contractor has the right to enjoy least-cost performance. Unless specified in the contract, the owner may not interfere with the contractor’s sequencing of work or methods of construction. Maladministration is an entitlement recognized by the courts that allow contractors to recover costs when the owner’s actions or inactions interfere with the contractor’s work.

Maladministration rulings are often based upon the doctrine of implied warranty that provides “an implied provision of every contract, ... that neither party to the contract will do anything to prevent performance thereof by the other party, or that will hinder or delay him in its performance.”⁸

Examples of maladministration may include: constructive change, communication failures, overzealous inspection, interference with the contractor’s work, failure to coordinate the project, rejection of or-equal substitutions, unreasonable disapproval of proposed subcontractors, failure to respond to requests for information, misinterpretation of the specifications, or failure to recognize valid change order requests.

Management Reserve – The portion of a project’s or contract’s total allocated budget withheld for management control purposes, rather than designated for the accomplishment of a specific work element or set of work elements.

Master Schedule – A master schedule is compiled to show (1) the total time available for the entire job if it must be finished by a certain time, and (2) how the various portions of the job are to be scheduled.

MCAA Factors – The Mechanical Contractors Association of America (MCAA) issued Bulletin No. 58 in 1976, entitled “Factors Affecting Productivity.” This document lists sixteen factors which potentially impact productivity and provides a range of productivity losses for each factor, dependent on the severity of the conditions. The factors include: Stacking of Trades; Morale and Attitude; Reassignment of Manpower; Crew Size Efficiency; Concurrent Operations; Dilution of

⁸ *George A. Fuller Co. v. United States*, 69 F. Supp. 409 (108 Ct. Cl. 1947).



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Supervision; Learning Curve; Errors and Omissions; Beneficial Occupancy; Joint Occupancy; Site Access; Logistics; Fatigue; Ripple; Overtime; and Season and Weather Change.⁹

Measured Mile Analysis – This methodology computes productivity of work performed by measuring a contractor’s actual productivity rate achieved in a baseline time frame or area of lesser impact (the measured mile) and compares that productivity to the contractor’s actual productivity in a different time frame or area of impact where a specific problem or series of problems have occurred that were not present during the measured mile period. The difference in productivity rates can be viewed as the effect of the problems on productivity.

The following steps should be employed by the analyst in preparing a measured mile analysis:

1. Determine the discipline (*e.g.*, pile driving, concrete work, or piping) and scope of work (*e.g.*, all piping, System 2100 piping, or six-inch carbon steel piping) to be used in the analysis.
2. Determine the measured mile period of performance where the work was not negatively impacted by problems that were caused by the owner.
3. Estimate the contractor’s labor productivity in the measured mile period.
4. Estimate the contractor’s “should have been” cost based upon actual quantities of work and its measured mile productivity during the impacted period, making any adjustments necessary for contractor-caused problems during the impacted period that were not present in the measured mile period.
5. Estimate the loss of productivity due to the alleged owner-caused impacts using the difference between the contractor’s actual costs and its “should have been” costs, as adjusted for contractor-caused impacts.
6. Develop specific cause-effect matrices and narratives explaining how owner-caused impacts lead to decreased labor productivity.

Milestone – An important or critical event and/or activity that must occur in the project cycle in order to achieve the project objectives.

Modified Total Cost Damages Method – The modified total cost approach is a damages analysis method whereby the claim amount is produced by calculating the difference between an adjusted in-place value and an adjusted bid amount. The adjusted in-place value is determined by taking the project’s in-place value (total field costs plus overhead, profit and bond) and adjusting it downward

⁹ “Factors Affecting Productivity,” Mechanical Contractors Association of America, Bulletin No. 58, 1976.



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for identified contractor-caused performance errors and other noncompensable costs.¹⁰ The adjusted bid amount is determined by adjusting the original bid (contract) amount for executed change orders and identified bid errors. The modified total cost method is similar to the jury verdict method, except that the contractor presents the claim value by adjusting the total costs for noncompensable costs and bid errors rather than the “jury” or “trier of fact” making these adjustments.

Negative Float – In a Critical Path Method (CPM) network, if a condition exists wherein the early finish time is later than the late finish time for an activity or series of activities, the condition results in negative float values. Negative float indicates project delay.

Organization Breakdown Structure (OBS) – The hierarchical system depicting levels of responsibility within a performing organization, in terms of groups, divisions, projects, or responsible teams.

Out-of-Sequence Work – By not planning the work in a logical manner, crews are moved around excessively and productivity declines. If the contractor can demonstrate that the owner is responsible for the need to perform work out-of-sequence, the contractor may be entitled to recover its loss of productivity costs for such problems.

Overhead – Overhead, overhead cost or overhead expense refers to an ongoing expense of operating a business. The term overhead is usually used to group expenses that are necessary to the continued functioning of the business but that do not directly generate profits. Overhead expenses are all costs on the income statement except for direct labor and direct materials. Overhead expenses include accounting fees, advertising, depreciation, insurance, interest, legal fees, rent, repairs, supplies, taxes, telephone bills, travel and utilities costs.

Overtime – Working more than a standard work week as defined by the contract. Fatigue, increased absenteeism, decreased morale, reduced supervision effectiveness, and poor workmanship results from the excessive use of overtime and causes productivity loss. If the owner is responsible for the need to work more overtime than is contemplated by the contract or by the contractor’s reasonable work plan, such as a failure to grant a reasonable time extension for excusable delays, the contractor may be entitled to recover its increased labor costs and its loss of productivity costs that result from such work requirements.

Parametric Cost Estimating – A Cost Estimating Methodology, using statistical relationships between historical costs and other program variables such as system physical or performance characteristics, contractor output measures, and manpower loading, etc. This estimating technique employs one or more cost estimating relationships for the measurement of Costs associated with the development, manufacture, and/or modification of a specified end item based on its technical, physical, or other characteristics.

¹⁰ See *Great Lakes Dredge & Dock Co. v. United States*, 96 F. Supp. 923 (119 Ct.Cl. 1951); *Sovereign Construction Company, Ltd.*, ASBCA No. 17792, 75-1 BCA ¶ 11,251, at 53,606.



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Performance Criteria – The fundamental technical, operating, and design requirements necessary to develop an operation and/or design. These criteria include such items as minimum performance capabilities, reliability, independence, separation, operating costs, and safety. The criteria incorporate operational and regulatory requirements, industry codes and standards, and engineering experience.

Performance Measurement Baseline – The time-phased budget plan against which project performance is measured. It is formed by budgets assigned to scheduled cost accounts.

Performance Measurement Criteria – The performance measurement criteria quantitatively define what products or tasks need to be accomplished to achieve the primary goals of the project and what constitutes satisfactory completion of those tasks.

Planning – Planning precedes scheduling and is more general in its view of the project. The purpose of planning is to identify and set forth the overall objectives of the project.

Planning Packages – The element of a cost account containing scope, schedule and budget for those efforts in the far-term, where detail planning of those efforts is unpractical. Scope is understood, but not clearly defined.

Poor Morale of Craft Labor – Labor enthusiasm and productivity declines as work is continually changed and excessive rework is required. If the contractor can demonstrate that the owner is responsible for such problems, the contractor may be entitled to recover its loss of productivity costs for such problems.

Productivity – Productivity is a measurement of rate of output per unit of time or effort, usually measured in either engineering man-hours or construction labor hours. Examples of productivity measurements are engineering drawings completed per man-hour or cubic yards of concrete placed per man-hour.

Program – An organized set of activities directed toward a common purpose or goal undertaken or proposed in support of an assigned mission. It is characterized by a strategy for accomplishing a definite objective(s) that identifies the means of accomplishment, particularly in qualitative terms with respect to work force, material, and facility requirements. Programs are typically made up of technology-based activities, projects, and supporting operations.

Program Evaluation Review Technique – The Program (or Project) Evaluation and Review Technique, commonly abbreviated PERT, is a model for project management designed to analyze and represent the tasks involved in completing a given project. PERT was developed primarily to simplify the planning and scheduling of large and complex projects. It was able to incorporate uncertainty by making it possible to schedule a project while not knowing precisely the details and durations of all the activities. It is more of an event-oriented technique rather than start- and completion-oriented, and is used more in R&D-type projects where time, rather than cost, is the



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major factor. PERT uses deterministic networks with mean durations derived from a specialized version of the Beta distribution; the mean duration is set at Expected time (TE): the best estimate of the time required to accomplish a task, assuming everything proceeds as normal (the implication being that the expected time is the average time the task would require if the task were repeated on a number of occasions over an extended period of time). PERT uses deterministic analysis of a network with mean durations derived from a special simplified version of the beta distribution. The mean duration in PERT is found with the formula $T = (L + 4ML + H) \div 6$, where T is duration and L, ML and H are the least, most likely and highest durations assessed by subject matter experts.

Progress Payments – Payments made to a contractor, during the life of a Fixed Price Contract, on the basis of a percentage of his incurred total cost or total direct Labor and material cost. The amounts are usually based upon actual expenditures and work performed at a particular stage of completion, or are a predetermined value based on the completion of certain milestones.

Project – A unique major effort within a program that has a firmly scheduled beginning, intermediate, and ending date milestones; prescribed performance requirements; prescribed costs; and close management, planning, and control. The project is the basic building block in relation to a program that is individually planned, approved, and managed.

Project Baseline Schedule – The configuration-controlled, project schedule supporting the contractual and internal deliveries of the project. This document, once approved and resource-loaded, becomes the basis for the performance measurement baseline.

Project Control – The planning, scheduling, budgeting, estimating, work authorization, cost accumulation, performance measurement, reporting, change control, documentation, and other systems used to plan and control the work.

Project Control System (PCS) – The planning, scheduling, budgeting, estimating, work authorization, cost accumulation, performance measuring, change control, and documentation system used to plan and control the scope, cost and schedule for performance of the work.

Project Management Plan (PMP) – A set of documents designed to describe with sufficient detail the policies, standards, strategies, approaches, processes, conditions, parameters, objectives, and deadlines of the project.

Project Manager – An individual in an organization who is responsible for the management of the project. The person held responsible for accomplishing the project scope, schedule, and cost objectives.

Project Office – The organization responsible for overall management of the project. The project office may be system or product specific, or may be responsible for many projects in a specific phase of the product.



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Quality Assurance – All planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily in service.

Quality Control – All actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements. Quality control is the regulatory process through which one measures actual quality performance, compares it with standards, and acts on the difference.

Quantum Meruit – For various reasons, the contractor may be unable to recover damages under the original contract. When this occurs, recovery may be pursued under a quasi-contractual remedy known as *quantum meruit*, which simply means “as much as he deserves.” Such situations may occur when the contract is found to be unenforceable or when the contractor performs extra work that is not covered by the original contract. Where *quantum meruit* recovery is sought, the contractor will set forth its determination of the reasonable value of the benefit conferred upon the owner. All competent evidence of actual expenditures of the contractor will usually be considered by the court in determining that reasonable value.

A contractor may recover under a theory of *quantum meruit* if it can prove substantial performance on the construction contract and an endeavor on its part in good faith to perform fully under the contract. An intentional departure from the requirements of the contract is per se not in good faith unless the failure is: (i) caused at least in part by the defendant, or (ii) the departure is so trifling so as to be *de minimis*. Additionally, a party seeking recovery under a theory of *quantum meruit* which has been terminated wrongly is excused from proving substantial performance of the entire contract, but it must prove substantial performance and an intention to completely perform up until the date of termination.

Quantum meruit may apply when an express contract is abandoned. Courts will seek a remedy such that the contractor is to be paid the reasonable value of its work.

Relationship – A relationship of an event to a succeeding activity in which the activity may not start until the event preceding it has occurred. The term “constraint” is also used to indicate a relationship of an activity to a succeeding event in which the event cannot occur until all activities preceding it have been completed.

Requests for Information (RFI) – A formal request by the contractor for information or clarification of drawings, specifications, or work scope that may be unclear, ambiguous, or not yet provided to the contractor to perform its work.

Responsibility Assignment Matrix (RAM) – A document that integrates an organizational breakdown structure (OBS) and work breakdown structure (WBS) to assign total contract work scope to responsible parties by WBS element.



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Rework and Errors – Correction of work due to engineering errors or improperly performed installations results in productivity loss. The party responsible for engineering errors is responsible for the resulting delays and productivity loss costs. The contractor is usually responsible for improper installations unless contractually stated otherwise, such as in a cost plus or time and materials contract where it is stated that the owner pays for all costs.

Risk – That level of uncertainty at which a decision maker knows, at least, the possible results of an action and can attach subjective probabilities to them.

Schedule Baseline – The time-phased plan with a logical sequence of interdependent activities, milestones, and events necessary to complete the project. The schedule baseline must be formally changed during the execution of the project when required.

Schedule Contingency – The duration of time calculated that is in addition to the total project duration calculated using activities and logical relationships. This duration is in addition to the time required to complete all activities in the project schedule. The schedule contingency is managed by the Project Manager and may be applied as deemed necessary to maintain the schedule baseline.

Scheduling – Scheduling establishes the intermediate goals that, if accomplished, will result naturally in the achievement of the stated objectives. Planning a project involves scope reviews, contract completeness reviews, resource planning, work schedule assignments, calendars, facility utilization planning, management methods, organizational structures, capital expenditure planning, contracts, procurement, and more.

Scheduling Difficulties/Failure to Coordinate the Work (Coordination Problems) – Failure of the contractor to properly sequence or coordinate work, adhere to project schedule, timely update schedule, or provide accurate scheduling information; illogical work scheduling or sequencing; manipulation of schedule which stops, delays, disrupts, or hinders the contractor's on-going or planned work. The contractor is typically responsible for such scheduling and coordination of its labor, vendors, and subcontractors, and as such, is responsible for the delays and disruptions that result therefrom. If, however, the owner is contractually responsible for such scheduling and coordination, the contractor may be entitled to recover its delay and disruption costs if the activities in its schedule that were affected by such lack of scheduling and coordination were on the critical path of the project schedule at the time that the problems occurred and if the contractor was not responsible for other concurrent delays at that time.

Scope – In baseline management terminology, the term scope refers to those performance and design requirements, criteria, and characteristics derived from project needs that provide the basis for project direction and execution.

Spearin Doctrine – If a contractor incurs damages because of problems with the owner's drawings and specifications, the contractor usually can base its request for an equitable contract adjustment on



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entitlement supported by the Spearin Doctrine.¹¹ In most cases, the courts and boards have relied on the implied warranty established by this benchmark case to find in the contractor's favor.

The Spearin court said,

“But if a contractor is bound to build according to plans and specifications prepared by the owner, the contractor will not be held responsible for the consequences of defects in the plans and specifications.”

Stacking of Trades – Multiple trades working in the same location such that the contractor's work cannot be performed efficiently. Less than optimum work space may cause interference from other workers of the same trade or workers from other trades, resulting in productivity loss. If the owner was responsible for the problems that resulted in trade stacking, the contractor may be entitled to recover its loss of productivity costs.

Statement/Scope of Work – A description of a facility or product to be provided or service to be performed; a statement of requirements.

Strikes – Any unforeseeable strike or refusal by workers to perform work. Unless the contract bars relief for even unforeseeable strikes, the contractor may be entitled to recover its delay costs if the activities in its schedule that were affected by the strike were on the critical path of the project schedule at the time that the strike occurred and if the contractor was not responsible for other concurrent delays at that time.

Subcontractor Delay – Actions or inactions of a subcontractor that stop, delay, disrupt or hinder the prime contractor's on-going or planned work. Delays and disruptions by subcontractors are usually the contractor's responsibility unless the owner caused such problems.

Superior Knowledge/Misrepresentation – Performance undertaken by the contractor without knowledge of facts that the contractor later learns are vital to its performance, the contractor had no reasonable way of learning the facts, and the owner knew the facts and either failed to disclose them or deliberately concealed them. If the contractor is delayed, disrupted and incurs increased costs as a result of such superior knowledge, the contractor may be entitled to recover its direct costs resulting from such problems. The contractor may also be entitled to recover its delay costs if the activities in its schedule that were affected by such problems were on the critical path of the project schedule at the time that the problem occurred and if the contractor was not responsible for other concurrent delays at that time.

Suspension – Owners have the right to suspend work on a part or the whole contract. The duration of the stop work order must be of reasonable length and the suspension must be of valid cause. Thirty days for analysis of an unexpected and major change may satisfy the tests of length and

¹¹ *United States v. Spearin*, 248 U.S. 132 (1918).



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cause; 180 days for a family illness fails both tests and a breach of contract may be the result. Only the owner has the right to suspend work; the contractor cannot initiate a suspension. However, the contractor can halt, stop, curtail, or alter its operations in the face of massive change on the premise of damage mitigation. The difference is one of style, not content.

Suspensions of work are typically a form of delay, and should be thought of as such. In certain situations, however, it may be useful for a contractor to characterize an event as a suspension of work rather than as a delay. Such may be the case if the contract contains a “no damage for delay” clause. It is important to recognize when a delay situation may fairly be characterized as a suspension of work as well as a delay in order to achieve some particular benefit.

Suspensions and delays in the progress of a construction project invariably cause damage, either in the form of loss revenue or in the form of extra expenses. In order to determine whether a contractor will be entitled to damages, one must look to the cause of the suspension or delay and at the express and implied obligations and assumptions of risk in each particular contract.

Technical/Scope Baseline – A document or a set of documents formally designated and approved at a specific time that define the Scope of Work to be performed. Technical baselines, plus approved changes to these baselines, constitute the current configuration identification.

Termination – Virtually all construction contracts expressly recognize the right to terminate the contract for the default of the other party in certain specific circumstances. Such provisions also recognize the right of the innocent party to recover damages resulting from the default and resulting termination. If the owner cancels for failure of the contractor to prosecute the work in accordance with the contract provisions (*i.e.*, default), the owner may recover the additional costs of completing the work beyond the original contract amount. Even in the absence of an express termination provision, there generally exists an implied right to terminate a contract if the other party has materially breached the contract, and to sue for damages.

In addition, many public contracts and an increasing number of private construction contracts contain “termination for convenience” clauses that authorize the owner (or prime contractor) to terminate the prime contractor (or subcontractors) even in the absence of default. If the owner cancels the contract for its own convenience, a contractor is entitled to costs incurred for work completed and materials on hand, including overhead and profit on such work, plus all costs incurred in closing out subcontractor and supplier contracts. A contractor may cancel for owner default such as insolvency or bankruptcy.

Key words associated with termination claims include: behind schedule, failure to prosecute work, failure to make payments, dismantling operations, deactivation of personnel, discontinuation costs, cessation of labor, equipment removal, utility cut-off, unexpired leases, inventory, post-cancellation, lost profits, settlement costs, and severance pay.



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Termination comes in two forms. Termination for Default should be avoided. The machinery of payment under a default is difficult and almost always results in litigation. Termination for Convenience is commonly resolved by paying the contractor its actual costs plus a reasonable profit. It is an exhaustive exercise in cost analysis and fine print reading.

Time and Materials Contract – A hybrid of a Fixed Price and a Cost Plus contract in which the owner pays the contractor for the cost of labor hours and materials, plus a fee. This type of contract is typically used when the work cannot be clearly defined and the total costs cannot be accurately estimated.

Total Cost Claim – A total cost claim contends that the claimed costs are not caused by the actions or inactions of the contractor and are caused only by the factors for which the owner is responsible, and does not detail separate damages as being the result of each specific event. To succeed in a total cost claim, the contractor must establish that:

- the bid must be shown to be reasonable;
- the actual costs must be shown to be reasonable;
- all events contributing to the loss must be compensable;
- it must be demonstrated that there is no other way to calculate the claim; and
- it must be demonstrated that the contractor did not contribute to the increased costs in any way.

Total Estimated Cost – The budgeted costs for land, design, construction, equipment, escalation, and contingency for a given project.

Total Float (TF) – See Float.

Undistributed Budget – Budget within the performance measurement baseline applicable to the work effort that has not yet been identified to both a responsible organization and a WBS element.

Uniform Commercial Code – The Uniform Commercial Code (UCC or the Code), first published in 1952, is one of a number of uniform acts that have been promulgated in conjunction with efforts to harmonize the law of sales and other commercial transactions in all 50 states within the United States of America.

Unit Cost – Usually total cost divided by units of production, but can consist of smaller elements and their associated unit costs that make up the total unit cost.

Unit Cost Contract – A type of contract whereby the contractor provides unit costs for performing certain work, such as a cost per cubic yard of concrete installed, cost per foot of 2-inch pipe installed, etc. The unit price includes all of the contractors' direct and indirect costs for performing the work, including profit.



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Unjust Enrichment – It is a general principal of contract law that a successful claimant in a breach of contract case is entitled to be put back in the same position it would have held had the breach not occurred. The doctrine of unjust enrichment provides that a “person shall not be allowed to profit or enrich himself inequitably at another's expense.”¹² Under unjust enrichment, the defendant (owner) unjustly receives and retains something of value at the plaintiff's (contractor's) expense. Unjust enrichment precedes restitution, which is the restoration of the contractor and owner to a just and equitable state. Unjust enrichment is the act or state of imbalance or inequity and restitution is the return to equity.

The owner might, for example, be in possession of a mineral processing plant that is substantially complete for which it has paid no money to the contractor. This situation is clearly inequitable, and the court may apply what amounts to a *quantum meruit* approach to determine the damages to be awarded to the contractor. In these circumstances, the person(s) determining the award of damages may disregard the specific terms of the contract and look to the value of the work performed.¹³

When unjust enrichment occurs in commercial transactions, restitution can be achieved simply by returning the purchased goods. For example, if a shipment of lumber was not paid for by the recipient, restitution would simply be to return the lumber. In general, restitution cannot be achieved in the construction industry simply by returning materials or items to the contractor if the items were installed or work was performed. The disassembly of a process plant will not give a contractor restitution. Instead, the contractor must seek to recover the reasonable value of the work performed, *i.e.*, damages, as determined through the dispute resolution process defined in the contract.

Unusually Severe Weather – Weather conditions that deviate substantially from the norm, average, or reasonably expected weather for the particular locality of the project and the current season of the year. Deviations may take the form of otherwise normal conditions, such as rain, snow or extreme temperature, that persist for an unusually long period. A contractor may be able to receive a time extension for unusually severe weather if the work that was affected by such weather conditions was on the critical path of the project when such unusually severe weather occurred. Depending on the existence of contractual provisions stating otherwise, a contractor may be able to recover its increased direct and time-related costs that result from unusually severe weather, and recovery of time-related costs would also be dependent on whether the contractor was responsible for other concurrent delays at that time.

Variable Costs – Raw material costs, by-product credits, and those processing costs which vary with plant output (such as utilities, catalysts, and chemicals, packaging and labor for individual operations).

¹² *Black's Law Dictionary*, 1705. (4th ed.1968).

¹³ Restatement (Second) of Contracts § 344 (c) and comment a; c. McCormick, Damages § 164, at 642 (1935); *United States ex rel. Bldg. Rental Corp. v. Western Casualty & Sur. Co.*, 498 F.2d 335, 338 (9th Cir. 1974); *B.C. Richter Contracting Co. v. Continental Casualty Co.*, 230 Cal. App. 2d 491, 499-500, 41 Cal. Rptr. 98, 104 (1964).



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Variance – The difference between the expected/budgeted/planned and actual results.

Variation in Quantities – A component of a claimed cost overrun often relates to the cost, quantity, and quality of the materials that the contractor claims to have used on a construction project. In construction contracts, materials are frequently bought on a unit price basis where the parties obviously contemplate some variation in quantity from the contract estimate. Typically, a contractor buys material, adds some form of a mark-up, and passes the cost on to a project owner. Things become somewhat complicated when an owner, often in an effort to reap cost savings, reduces the specification in anticipation of a credit. The contractor might not pass on the full savings it achieved from the owner's change. A Variation in Quantity clause is often used by owners to cover the situation where the actual quantity varies from the estimated quantity because of imprecise estimates. Of prime importance to the contractor is whether its unit prices are sufficient to cover its overhead and other costs if the number of units significantly changes from the estimated quantities used to prepare its bid.

Another area of dispute is the limitation on variations. Such disputes exist both with respect to variations simply in quantities of work that are paid pursuant to a schedule of unit prices and with respect to variations that are additional works. Many contracts include a provision that, after a given percentage of variation, for example 25 percent, there can be an adjustment to the unit price. These clauses are generally enforceable and are included in contracts in order to avoid disputes. On the other hand, many contracts are silent. In this latter case, looking from an owner's viewpoint, if the variation relates to the quantities of work as they were shown in the tendering documents, a frequent argument is that since the quantities were represented to be only approximate, there is no entitlement for a contractor to claim, irrespective of the final quantities.

The owner is also entitled to material of a quality consistent with the specifications. The delivery records and supplier invoices can provide extensive information to determine whether the material was of the prescribed quality. If, for example, plumbing specifications required schedule 40 PVC pipe for sewers and the contractor substituted schedule 21 PVC pipe, there would be a significant reduction in quality and a corresponding cost reduction. Similarly, a paving contractor may attempt to substitute thicker layers of cheaper base course hot mix in lieu of the specified wearing course hot mix. In both cases, the owner is left with an inferior product. If it has paid for the specified material, it has a cost claim against the contractor.

War and Other Hostilities – War, civil unrest, or other combative hostilities that stop, delay, disrupt or hinder the contractor's on-going or planned work or its ability to secure necessary labor, materials, supplies or tools. Such events are typically covered by the *Force Majeure* clause of a contract and entitle the contractor to a time extension unless the contractor was responsible for other concurrent delays at that time.

WBS Dictionary – The WBS dictionary lists and defines the specific WBS elements for the WBS and consists of an Index and Element Definitions.



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WBS Dictionary Element Definition – The element definition describes the elements contained in the WBS dictionary index.

WBS Dictionary Index – The index lists the preliminary elements extended to the lowest level required. The configuration-controlled documents that clearly define and account for the planning and execution of all work required by the contract.

WBS Elements – The individual products specified in the WBS are termed WBS elements. Each element is a discrete portion of the WBS and is composed of either an item of hardware, a service, or data.

WBS Level – The WBS level represents the location of the various WBS elements in the multi-tier framework of the WBS. Descending levels provide increasingly detailed definitions of the end product.

Work Authorization – A documented process or system that ensures work is properly authorized and assigned at the appropriate organizational levels prior to beginning the work.

Work Breakdown Structure – The WBS is a multi-tier framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. The WBS should be organized such that each element can be estimated, scheduled, and budgeted and work progress can be reported.

Work Package – Subdivisions of the lowest level WBS element accorded detailed scope, schedule (start and finish points), budget, a description of scope (including activities) and responsible manager.

Work Scope – The work scope is an objective plan that constitutes the work necessary to plan, execute, and control the program that will be approved and meet technical requirements.



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About the Author



Richard J. Long, P.E., is Founder and CEO of Long International, Inc. He has over 40 years of U.S. and international engineering, construction, and management consulting experience involving construction contract disputes analysis and resolution, arbitration and litigation support and expert testimony, project management, engineering and construction management, cost and schedule control, and process engineering. As an internationally recognized expert in the analysis and resolution of complex construction disputes for over 30 years, Mr. Long has served as the lead expert on over 300 projects having claims ranging in size from US \$100,000 to over US \$2 billion. He has presented and published numerous articles on the subjects of claims analysis, entitlement issues, CPM schedule and damages analyses, and claims prevention. Before forming Long International, Mr. Long was Senior Vice President, Contract Administration for a major electrical and mechanical contractor. In this role, he had corporate-wide responsibility for technical management and oversight of the preparation and resolution of construction claims. In addition, he was responsible for the development, training, and implementation of project management policies and procedures to ensure that profit, cost, schedule, scope, quality, and safety objectives were achieved. Mr. Long managed for thirteen years the construction claims practices of two large consulting firms. Prior to his consulting career, Mr. Long gained 13 years of project management and process engineering experience on petroleum refining, oil shale, synfuels, mining and power generation projects with Tosco, Fluor, and Conoco. Mr. Long earned a B.S. in Chemical Engineering from the University of Pittsburgh in 1970 and an M.S. in Chemical and Petroleum Refining Engineering from the Colorado School of Mines in 1974. Mr. Long is based in Littleton, Colorado and can be contacted at rlong@long-intl.com and (303) 972-2443.