AACE INTERNATIONAL RECOMMENDED PRACTICE

52R-06

PROSPECTIVE TIME IMPACT ANALYSIS - AS APPLIED IN CONSTRUCTION



AACE INTERNATIONAL

AACE® International Recommended Practice No. 52R-06

PROSPECTIVE TIME IMPACT ANALYSIS – AS APPLIED IN CONSTRUCTION

TCM Framework: 6.4 – Forensic Performance Assessment
7.2 – Schedule Planning and Development
10.2 – Forecasting
10.3 – Change Management

Rev. May 4, 2017

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

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PURPOSE

This recommended practice (RP) for prospective time impact analysis (TIA) is intended to provide a guideline, not to establish a standard. This recommended practice of AACE International on TIA, as applied in construction industry projects and programs, provides guidelines for the project team to assess and quantify the effects of an unplanned event or events on current project completion. While TIAs are usually performed by a project scheduler and can be applied on a variety of project types, the practice is generally used as part of the total cost management (TCM) change management and forecasting processes.

KEY TERMS

The following terms are used throughout this recommended practice; please refer to the latest revision of RP 10S-90, *Cost Engineering Terminology* [1] for the current definitions.

- EVENT
- FRAGNET
- UNIMPACTED SCHEDULE
- IMPACTED SCHEDULE
- TARGET ACTIVITY
- DELAY

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OVERVIEW

This recommended practice focuses on the basic elements necessary to perform a time impact analysis (TIA) to a construction project CPM schedule. Necessary considerations and optional analysis practices are described. The TIA is a *forward-looking*, prospective schedule analysis technique that adds a modeled event or events to an unimpacted schedule to determine the potential impact of that event(s) to the longest path and therefore project completion. The prospective TIA procedure is performed while a project is on-going, and thus has a *forward-looking* or a *prospective analysis* perspective in near-real time context. Retrospective (forensic) TIA is not typically required during the execution of a project as a prospective TIA is a forecast designed to facilitate a timely contract adjustment prior to the actual work being completely performed. Retrospective TIA analysis is addressed in AACE International Recommended Practice 29R-03, *Forensic Schedule Analysis.* [2]

This TIA practice concerns itself with time aspects, not cost aspects of projects. The time impact must be quantified prior to determining any potential cost implications. No practical advantage is obtained by including cost factors into a time impact analysis. Linking time and cost into one analysis implies that time impacts are a function of costs, which for the purposes of a prospective TIA is not necessarily true. Separating time analysis from cost analysis makes TIA inherently easier to accomplish and accept contractually, thereby eliminating the cost-driven considerations.

A TIA may also be performed in-house to evaluate the potential or most likely results of alternatives being considered by the contractor in terms of means and methods of completing the project. This is commonly referred to as a *what-if analysis*.

RECOMMENDED PRACTICE

Unplanned events on a construction project are inherently unavoidable. If the party responsible for executing the scope of the contract (contractor) has been delayed by the effects of a change in the work or an event that was beyond its ability to reasonably foresee and plan as contracted, then the entity responsible for overseeing performance of the contract (typically, the owner) may be obligated to adjust the contract, depending upon the terms and conditions of contract.

TIA is a simplified analytical procedure oftentimes specified on construction projects to facilitate the award of excusable days to project completion, due to delays caused by events that were not the responsibility of the contractor. The TIA process may also be used by the contractor as an internal method to evaluate alternatives to regain or improve project completion.

Construction law in most localities require the injured party (in this case the contractor) to petition for a contract time extension, if they have been delayed by events not under their control. To this goal, many contracts specify that a TIA be prepared and submitted to objectively substantiate the contractor's request for a project time extension. Once the duration of time has been agreed upon then the added time-related costs of such a delay can be determined in terms of the contract.

The TIA procedure should be reduced to the most basic level possible and still reflect a reasonable assessment of the result of a delay caused by an event. It is recommended that the time adjustment to the contract be calculated in a timely manner, using an agreed upon method, with the results appropriate to the actual delay to a reasonable degree of certainty. In addition to validating the contractor's entitlement to the issues the contractor claims impacted the project schedule, the owner should approve or reject this TIA based on the validity of the logic, durations, and all other revisions presented in the fragnet. Time impact analysis is not an attempt to simulate past or future reality. It provides a forecast estimate of the impact to the critical path and completion milestones based on the assumptions and plan to execute the changed and, otherwise, impacted work. It is a recognized analytical technique intended to facilitate a reasonable estimation of the time impact to the project caused by a single event or series of events.

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The prospective TIA procedure is performed while a project is on-going, and thus has a *forward-looking* or a *prospective analysis* perspective in near-real time context. Retrospective (forensic) TIA is not typically required during the execution of a project as a prospective TIA is a forecast designed to facilitate a timely contract adjustment prior to the actual work being completely performed.

The longer the period between the event and the approval of the TIA, the less useful and valid the prospective TIA becomes. Because *time* is the event being negotiated, the value obtained from a timely resolution of this contractual adjustment is greatly diminished by delay in preparation and/or approval of the TIA. Delay in approval of a TIA may result in a supplemental claim by the contractor of constructive acceleration. Also with the passage of significant time, the owner may feel that delays caused by the contractor have diluted any impacts previously known to have been caused by the owner. At some point, delay in preparation and/or approval of a TIA so diminishes the value of the analysis that a more thorough retrospective, forensic analysis becomes more appropriate as any impact will have been absorbed and subject to actual data, not estimated.

The TIA is typically associated with the modeling of the effects of a single change or event, however if several events occur within the same update period, their total effect could be modeled in the same analysis. This would be important if there are multiple delay causes that are assigned to different parties and it is necessary to identify and isolate any added float form an initial delay that might reduce critical path delay for a later delay event. It requires a critical path method (CPM) schedule that is able to show the pure CPM calculation differences between a schedule that does not include an event and one that does include an activity modeling the event. The difference for project completion, between the non-impacted schedule and that of the schedule with the impact, is considered to be the impact of the event for time extension considerations.

TIA assumes that the most recently reviewed schedule update, just prior to the actual event, correctly displays the project status and logical sequence of work involved on the project at the time of the event. It also assumes that the contractor's and owner's responses to that event are independent of the rest of the project and that the actual event will not result in a change in the project work plan except as required to specifically accommodate the changed condition. In effect, a TIA assumes that the CPM schedule, in-effect at the time of the event, is both accurate and *frozen* and will not change (other than the change brought about by the event.) The above assumptions provide a means of quickly analyzing the impact of the event, but they can also introduce subtle (and sometimes not so subtle) inaccuracies under certain conditions.

There will be times when the most recent formal update schedule does not accurately represent the status of the project at the time the event in question occurs. If there has been a significant passage of time, or a major shift in the status or flow of the work between the update and the event, it may be appropriate to update the schedule to the day before the event. This updated schedule would then function as the unimpacted schedule.

Before a TIA may be accomplished, a reviewed CPM schedule, with a status date immediately just prior to the delaying event, must be developed that has no reference to the delay in question. Maintaining a set of timely, reviewed, schedule updates is very important to the TIA success.

Comparison Guideline

As a general guideline, prospective TIA is more or less acceptable and useable for the determination of event impacts under the following circumstances:

More Useable:

- **<u>Frozen work plan.</u>**
  If the contractor has not been given remediation direction and is not able to redeploy his work force in order to remain in readiness for resumption of work, then the work plan is said to be *frozen* and the assumptions inherent in a TIA remain valid.

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- **Forward looking.**
  Events expected to occur or occurring at the present time are better subjects for a prospective TIA than those that have already finished.

- **Short duration of delay.**
  In general, TIAs are intended to model events of less than one reporting period (typically one month). If longer periods are considered, an additional step (detailed below) must be considered. This optional step is needed to address the legal requirement and natural tendency of the contractor to mitigate any event related delays where the mitigation does not involve additional costs. Mitigation effects become more pronounced as time progresses after an event has occurred.

Less Useable:

- **The more the schedule update does not reflect actual conditions at the time of the delay.**
  The longer the time period between the date that the schedule update reflected the status of the project (the schedule's *data date*) and the date of the start of the event, the more conditions will have changed between the planned forecast schedule and the actual work schedule before the time or effect of the delay is modeled. The schedule update used to model the event must reasonably reflect the work plan in effect at the time of the delay.

- **The less linear (or serial in nature) of the work plan.**
  Work plans based upon resource considerations are more easily adjusted without detriment to the project completion or planned expenses than those based upon physical constraints. Resources may possibly be redeployed to areas not affected by the delay (either as mitigation or a natural plan to execute work). Work plans involving physical process steps dependent upon earlier work being completed (serial in nature) will likely be harder to mitigate.

- **If more mitigation was accomplished during the delay.**
  This can have the opposite effect of that of a *frozen* work plan. The more work that was performed *out-of-sequence*, the more construction restrictions waived, the more effort that is performed by either the owner or contractor on behalf of reducing the effects of an event upon project completion, the less effective a TIA will be in modeling the effects of a delay event.

- **Actual durations are available for event activities.**
  Using actual durations in place of estimates then suggests the need for a review of operational efficiency of the actual work and the removal of any of the time also spent on contract work during the event period. In addition, the tendency for parties to wait and observe the actual durations is in conflict with the primary purpose of timely resolution in TIAs.

Specification

The process diagram in Figure 1 depicts a recommended TIA procedure.

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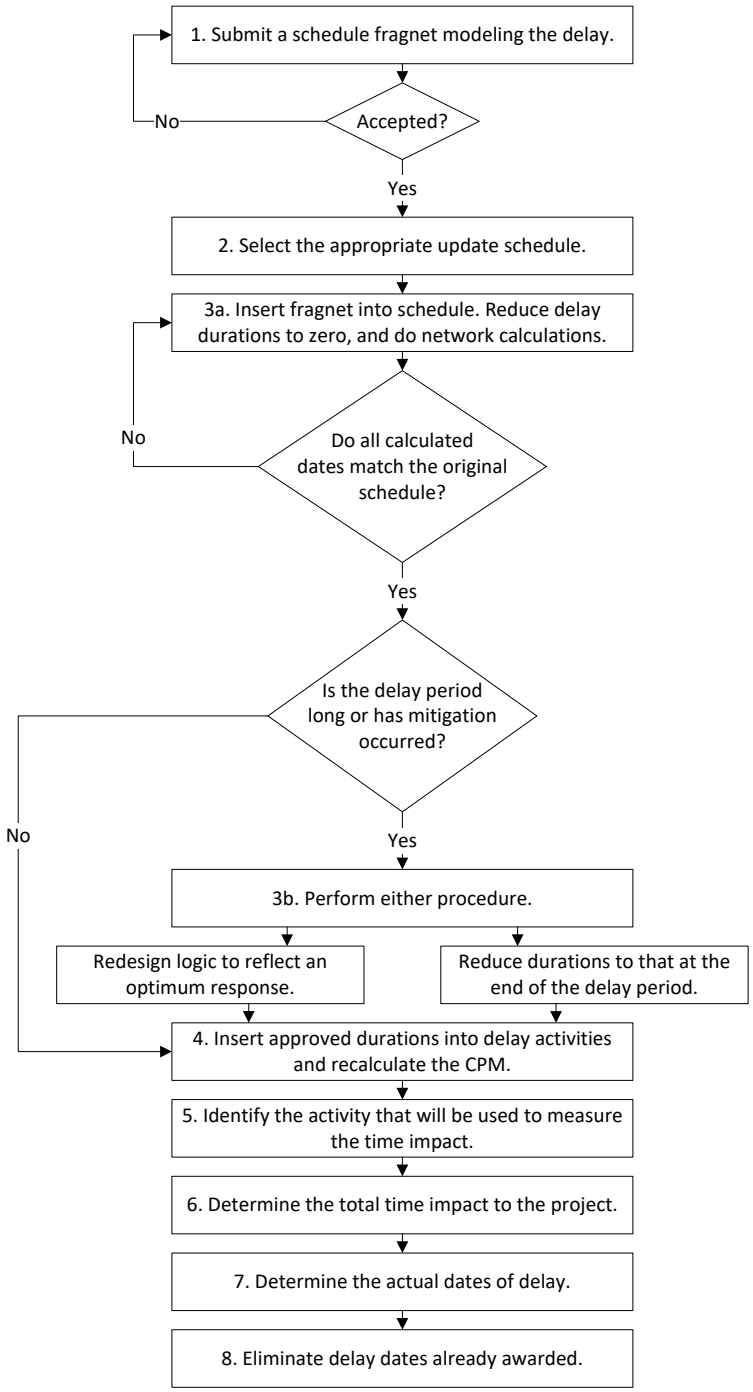


Figure 1 — Recommended TIA Flow Chart

A prospective TIA is accomplished by following these steps:

STEP 1: Model the event with a schedule fragnet. The schedule fragnet should consist of the activities modeling the event or changed conditions as well as a subset of the activities in the project schedule that will be involved directly with the event along with the existing activities with relationships to the event activities. The collection of data and facts to support this fragnet is a major portion of its creation. For ease of comprehension and review, the event should be described as simply as possible. Use the fewest number of activities and relationships added in order to substantially reflect the event's position in the schedule. Shown detail should be consistent with the

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nature and complexity of the change or event being modeled. Added activities should be numbered in a logical manner and appropriately named to make it easy to distinguish them as new activities associated with the delay. All new/changed activities should be appropriately coded (e.g. "Delay event No. XYZ") and included in the schedule basis or written narrative documentation. It is possible that the modeled event could be entirely comprised of existing activities with modified durations.

Care should be used to correctly define the change or event activities and describe the logical insertion into the fragnet. Existing activities and logic should be left intact whenever possible except to incorporate the fragnet. Added relationships may cause some of the existing relationships to become redundant to the CPM calculation, but relationships should only be deleted when the retention of that relationship is no longer valid and/or would negate the actual work restraints on the project. This possibility will be tested in Step 3a when event durations are temporarily reduced to zero. Redundant relationships caused by the additional inserted logic should be left in the schedule wherever possible and should not affect the overall result.

It may be acceptable to add an event as a successor to an activity when in fact, that delay occurred during the activity and delayed its completion. It is also acceptable and typically provides better analysis results to split the existing delayed activity into two activities, with one representing the portion of the planned work to be performed before the delay, and the other portion of the planned work after the delay, as long as the combined durations of the split activities equals the original duration of that activity. A narrative report listing all modifications to the unimpacted schedule should be prepared and submitted as part of the TIA.

Cost Considerations

It is intended that the TIA separate time from cost considerations. Costs should be derived after time has been established, not traded back and forth as a negotiating position. To this end, the impacted fragnet should first be isolated from the schedule to be analyzed. Owners who claim that they cannot approve a fragnet until they know the extent of the impact on project completion are simply trying to negotiate costs as they negotiate time. They are making time a function of costs. The time impact is a function of the impacting activity and not the other way around. Care should be used to correctly define the change or event activity and describe the logical insertion into the fragnet. If this is done correctly, the ultimate results of the TIA will also be correct.

Based on the owner's preferences they should review the analysis and results, may wish to negotiate (if necessary), and ultimately agree on the fragnet before proceeding with the further steps, or combine all of the following steps into one.

STEP 2: Select the appropriate unimpacted schedule update. The appropriate schedule should be the last owner reviewed schedule statused and updated prior to the time of the change or delay. The baseline schedule should be used if the delay began prior to the first schedule update and the critical path has not significantly changed since the baseline.

If the time interval between the start of the event and the last reviewed schedule update is too great (or if significant deviation to the schedule was experienced between the last status date and the start of the delay), the contractor may elect to first provide a new schedule status and update with a status date immediately prior to the start of the delay. Before this new update schedule is to be used, it should first be submitted to and reviewed by the owner.

The schedule to be impacted is called *the unimpacted schedule.* The status date of the unimpacted schedule shall be the same as the status date of the impacted schedule.

Constraints not required by contract and/or not included in the reviewed baseline schedule should not be included in the analysis. Other constraints may be considered on a case-by-case basis, but this should be fully documented. The object is to remove constraints that do not affect the contract assumptions made when the

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contract was awarded. The unimpacted schedule should also be reviewed for material errors prior to being used for this time impact analysis, including open ended logic.

A TIA is only valid if the CPM software being used to model the effects of an event properly shows the effects of the CPM calculations. This includes the consideration of a status date, out-of-sequence progress, and actual activity status. The schedule should not allow any un-started activity to be scheduled prior to the status date. Also, it should not allow for a prediction of early completion for an unfinished activity prior to the status date. Work actually performed on activities that are not logically able to begin should be considered and used if significant. The schedule should not contain activities with actual starts or actual finishes later than the status date.

STEP 3a: Insert the fragnet into a copy of the unimpacted schedule prepared as described above. Using the accepted fragnet as a template, add the impact activities and logic. Make the accepted activity adjustments to the existing activities as necessary to mirror the fragnet. Set the duration of the inserted fragnet event activities to zero and recalculate the CPM. At this point in the analysis, all computed and actual dates in the impacted schedule should match that from the unimpacted schedule. As a general rule, if dates do not match, then corrections to the inserted fragnet activities may be necessary. As with any model, exceptions are possible, especially with complicated events.

OPTIONAL STEP 3b: If the event time period involved is long, or if substantial mitigation of the delay has occurred, then an optional step may be needed to consider the effects of mitigation especially if the events are multiple or complex. This step is necessary if mitigation efforts by either the owner or contractor have modified the actual impact of an event on project completion. Skipping this step in this circumstance may result in a calculated time impact that does not closely relate to the actual impact. There must be a correlation between calculated and actual for a proposed TIA to be acceptable. It may be necessary to perform a forensic analysis to determine the effects of the actual impact of the substantial mitigation already performed and then provide a prospective TIA to determine the effects of the future or not-absorbed delay.

Most contracts today require the parties mitigate the effects of any change or delay to the extent practical. If Step 3b is not implemented, a statement should be provided within the TIA to explain why this step was unnecessary. The reasons for not implementing Optional Step 3b may include the following: a frozen work plan, forward-looking impact analysis, and shortness of duration of the event.

In lieu of actually redesigning the logic, that was in effect when the delay occurred, to that which was actually used after the delay occurred, the contractor may elect to revise the remaining duration status of every activity in the schedule to the remaining duration status evidenced at the time of the forecasted end of the delay. This revision of the status to the impacted schedule will reflect the resultant effects of mitigation of the project. Activities partially performed out-of-sequence will still exist as successors to the impacted activity, but their remaining durations will be reduced to reflect the work performed during the event period. It may be necessary to modify relationships in consideration of *retained logic*.

All changes made to the schedule to satisfy the Step 3b requirements should be fully documented and included as part of the TIA submittal. They should be documented in the schedule basis or written narrative (existing or standalone for the TIA). These changes are typically subject to review by the owner.

STEP 4: Insert the durations used in the fragnet into the added event activities and re-compute the CPM.

STEP 5: Identify the activity that will be used to measure the impact. This analysis is primarily interested in the estimated early completion of the last project or contract milestone prior to demobilization (usually substantial completion.) This identification is important for any subsequent entitlement for time related damage. The delay or acceleration effect to all critical and near critical paths should be analyzed, noted and documented.

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STEP 6: Determine the correct time impact for the project delay. If the contract specifies work days, this unit of measurement should be made in work days. If the contract specifies calendar days or specifies an absolute date for completion, then the unit of measure should be made in calendar days.

STEP 7: Determine the modeled dates of the delay. It is understandable that the duration of the event does not always equal the duration of any delay. Using the unimpacted schedule, determine when the successor activity to the event impact actually became a project critical activity. On schedules without negative float, the activity will be predicted to become project critical on the computed late start date. The first date of delay due to this impact will be the next day after the activity late start date. For original update schedules that do show negative float, the start or delay date will simply be the first day of the delay event. Every day after this start of delay will be labeled a delay day (counting work days or calendar days as appropriate) until the number of delay days is exhausted.

The above procedure assumes (either by contract or standard default) that project float belongs to the party who uses it first. It also assumes that the project does not meet all legal requirements for a declared early project completion. If either of these assumptions is incorrect, then the appropriate adjustment should be made in counting the delay days.

STEP 8: Eliminate delay dates from the TIA request that have previously been awarded. Every date determined to be a delay date will be excusable to contractual milestone completion, providing that this date has not already been awarded as a delay date due to a prior TIA or other excusable event, such as an adverse weather date. Should the day already be designated as an excusable delay date, then this day will be considered concurrent in terms of a previous delay. In no event will a single date be granted an additional excusable day if it has previously been granted one for any other reason. In other words, no single date may be assigned more than one day of excusable delay.

Concurrent Delay Analysis

Many contracts require a TIA to include an analysis of concurrent delays (especially attributable to the party not responsible for the delay being analyzed in the TIA). This is because most contracts will consider concurrent delay days as excusable, but not compensable; that is, the contractor is entitled to a time extension for concurrent delay, but is not entitled to any time-related costs.

Step 7 above will ensure that the prospective TIA analysis will eliminate the counting of time extensions of concurrent days already granted in earlier TIA analyses. The only possible remaining concurrent delay events, to be considered, result from actual independent delays caused by the contractor during the delay time in question. While important as a cost impact issue, this has no bearing on a TIA. An excusable delay should be granted regardless of any contributing contractor concurrent delay on that same date, provided that the terms of the contract do not specifically preclude this result. There is no single legal definition of the term *concurrent delay;* refer to RP 29R-03 for further discussion.

Under truly prospective circumstances, actual independent delays caused by the contractor cannot be identified and analyzed because they have not yet occurred. An after-the-fact implementation of the prospective TIA that includes the analysis of actual independent delays may produce inaccurate results due to the mixed use of prospective and retrospective viewpoints. It is therefore recommended that analysis for concurrent delays be performed using a retrospective TIA method.

In summary, no useful purpose is served in requiring the contractor to submit a concurrent delay analysis as a precondition to submitting a TIA. This requirement adds a *forensic-like* complexity to what is intended to be a quick and easy process, creating a technical barrier to accomplishing the TIA task. Additionally, a prudent owner will have to reproduce this concurrent delay analysis from the owner's prospective and negotiate a consensus. Concurrent delay analysis is not an integral part of a TIA and should be deferred until after the number of excusable delay days is resolved.

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Comparison of Calculated Results with Actual Observance

TIA is not an attempt to simulate reality, only to approximate it. It is a recognized analytical technique intended to facilitate a reasonable estimate of the time delay to the project caused by a single event or a discrete series of events. To illustrate this point, consider an example where the impact may be judged to involve 3 days while it actually only required 2 days to complete with acceleration. The correct value to use in the TIA would be 3 days, as the saved duration was counter-balanced by the increased costs of acceleration. By using 3 days in this example, the issue of acceleration is eliminated.

It is not reasonable to require that a delay modeled in a TIA manifest itself in that exact number of days that a project actually ends up being late. In addition to the possibility that the durations of the activities inserted into the analysis were incorrectly estimated, this can also be partially due to the extenuating effects of acceleration and mitigation. In addition, other delays (including the contractor's own inefficiency) may also contribute to actual late project completion. Mitigation and acceleration efforts by either, or both the contractor and owner, may mitigate the actual impact on the project completion date as well. In practically all cases, a construction project will experience enough deviations from the planned baseline schedule so as to make the manifestation of any single delay un-attributable to any particular day at the planned end of the project.

Awards of time from a TIA are intended to include the consideration for actual acceleration and disruption in response to a delay. Acceleration and disruption accompanying the delay may be considered to be incorporated in a TIA, and may account for the apparent difference between predicted and actual effects of a delay. While imperfect, the ease and quickness of preparing and reviewing a TIA should compensate for the lack of exactness in modeling the exact features of the impacts to a project due to delay.

REFERENCES

[1] AACE International, Recommended Practice No. 10S-90, Cost Engineering Terminology, Morgantown, WV: AACE International, Latest revision.

[2] AACE International, Recommended Practice No. 29R-03, Forensic Schedule Analysis, Morgantown, WV: AACE International, Latest revision.

[3] H. L. Stephenson, Ed., Total Cost Management Framework: An Integrated Approach to Portfolio, Program and Project Management, 2nd ed., Morgantown, WV: AACE International, Latest revision.

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