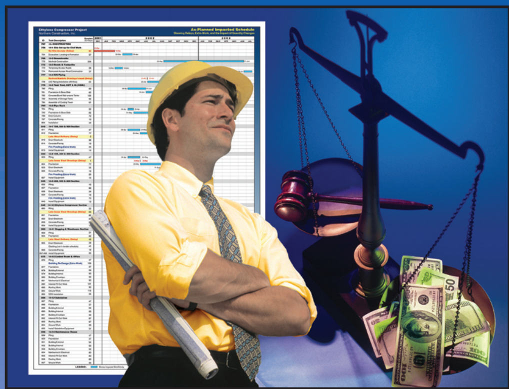

Verification of As-Built Dates—The Often Neglected but Needed Step for Schedule Delay Analysis

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1. INTRODUCTION

A contractor was significantly delayed during the performance of its engineering, procurement, fabrication, and construction (EPFC) work on a petrochemical facility project. The original execution schedule was planned for 36 months but the actual duration was 54 months. As a result, the project suffered a total of 18 months of overall delay. The main reasons for delay originated from dozens of owner approved change orders as well as execution errors and problems caused by the EPFC contractor and its subcontractors.

During project execution, the EPFC contractor experienced $40 million in both extended project general condition costs and other delay-related damages. During the latter stages of the project, the EPFC contractor prepared and submitted a preliminary and relatively unsupported request for an equitable contract adjustment to the owner. After several unsuccessful settlement attempts, the EPFC contactor sued the owner for the recovery of $40 million in damages as allowed through the dispute resolution clause within the contract document, which stipulated binding arbitration.

After project completion, the EPFC contractor spent the next 16 months and expended millions of dollars on unrecoverable costs for legal and consulting fees in preparation of arbitration, including tasks needed for mediation, financial audits, schedule delay analyses, quantification of damages, discovery, interrogatories, depositions, position papers, and a final expert report. In addition, the EPFC contractor invested thousands of non-claimable internal staff hours to assistance both the legal team and expert team in clarifying issues, providing technical assistance, and researching and interpreting project documents.

As prescribed by the contract documents, the EPFC contractor was required to implement industry-recognized schedule delay analysis methodologies using its contemporaneous project schedules to demonstrate entitlement to a time extension and quantify the number of compensable delay days. The EPFC contractor's Project Execution Plan, which was part of the contract documents, specifically required monthly status schedule updates with verified actual start dates, actual finish dates, activity percent complete values, and remaining duration values.

The EPFC contractor's expert identified 12 consecutive periods of time or analysis windows that spanned the entire actual project duration of 54 months, which comprised the approved baseline schedule, monthly schedule updates, and final as-built schedule. The number of activities for each schedule update averaged around 4,500 to 5,000 per update.

The EPFC contractor's expert prepared 12 separate Time Impact Analysis schedules for each analysis window to justify a cumulative extension of time. The expert then prepared 12 separate As-Built But-For Analysis simulation schedules for each analysis window to determine the number of compensable delay days but-for owner-caused delays. These detailed schedule delay analyses took the EPFC contractor's expert more than a year to prepare and consumed

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considerable resources and analysis costs. The results of the various analyses formed the foundation, basis, and justification for recovery of delay damages which were incorporated into the EPFC contractor's expert report.

As required by the arbitration case management schedule, both the owner and EPFC contractor exchanged expert reports 30 days prior to the start of arbitration. In reading the owner's expert report, the EPFC contractor was dismayed to find that the owner's expert determined that the EPFC contractor's various schedule delay analyses were defective, faulty, and without merit. When examining and comparing the EPFC contractor's schedule data with other contemporaneous project records, the owner's expert found the EPFC contractor's project schedules were replete with incorrect, unsubstantiated, and conflicting as-built date information which cast doubt on the EPFC contractor's calculations of time extension days and compensable delay days, without first correcting the numerous as-built date problems.

The EPFC contractor's credibility was damaged because it neglected to perform any as-built date verification that would have allowed for the identification and reconciliation of these numerous and obvious as-built date problems. Moreover, the EPFC contractor did not have a cogent rational for using questionable as-built date information. It would have been impossible for the EPFC contractor's expert to correct all of the as-built dates problems identified in the owner's expert report and redo its analysis within the 30 days before arbitration. As a consequence, on the starting day of arbitration, the EPFC contractor decided to settle with the owner for its delay claims at a mere fraction of the $40 million value.

The purpose of this article is to promote awareness and discussion regarding the importance and necessity of verifying the accuracy of as-built schedule dates prior to performing of a schedule delay analysis. Although time consuming to perform, the validation of the actual start and finish dates is an essential first step of a credible schedule delay analysis.

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2. AS-BUILT DATE VERIFICATION SHOULD BE CONSIDERED BEFORE STARTING A DETAILED SCHEDULE DELAY ANALYSIS

Schedule delays on large and complex projects are almost always costly and complex. Usually, schedule delays on these types of project are numerous, spanning weeks or months and affecting all phases of the project. Resulting impacts are likely to cost the owner, contractor, or both parties millions of dollars due to missed contractual deadlines, liquidated or actual delay damages, extended project overhead costs, and lost labor productivity. Delay claims associated with these types of projects can take months or years to prepare and cost millions of dollars in legal and consulting fees to resolve.

To meet a level of objective scrutiny or legal examination, it is absolutely critical that the information used to perform a retrospective schedule delay analysis be factual, accurate, and reliable. Key project information needed for measuring and proving quantifiable schedule delay is primarily based on available and reliable as-built dates for the start and finish of all schedule activities. This data includes both the recorded as-built dates contained within the contractor's various execution schedules and the as-built dates used for documenting impacting events that caused schedule delay. However, the as-built date verification process is often overlooked or neglected. In many situations, owners and contractors do not want to incur the time and resources that are necessary to obtain reliable as-built date information to support costly schedule delay analyses.

If the underlying as-built date information is inaccurate or in conflict with other contemporaneous project records, then the results from any schedule delay analysis may be suspect. The calculated number of delay days caused by either the owner or the contractor may be incorrect. The as-built critical path may be wrong or could change to reveal a concurrent contractor delay had the correct as-built date information been used. Hence, the claimed delay damages may be inaccurate.

Use of inaccurate as-built date information may result in an owner agreeing to an overstated delay claim or perhaps a contractor's entitlement to compensable delay may be understated. Therefore, when facing numerous disputed and contentious schedule delay issues on large and complex projects, or any type of engineering and construction project, reliable as-built date information should be thoroughly researched and investigated.

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3. COMPLEX SCHEDULE DELAY ANALYSES REQUIRE RELIABLE AND SUPPORTABLE AS-BUILT DATES

Changes occur on almost all projects and often lead to delays and other impacts. Some typical reasons for a schedule delay analysis include, but are not limited to, relief from liquidated damages assessed by the owner, change order impacts to the driving critical path, justification of a time extension, and recovery of compensable delay. In support of a contractor's schedule delay claim, contractors will normally utilize one or several different types of schedule delay methodologies (*e.g.*, Time Impact Analysis, As-Built But-For Analysis, or others). AACE International's Recommended Practice No. 29R-03, dated April 25, 2011, provides guidelines on nine different categories of schedule delay methodologies that can be applied proactively during project execution or retrospectively after project completion. A summary list of the different guidelines for schedule delay analysis methodologies or Method Implementation Protocols (MIPs) within the AACE International's Recommended Practice (RP) No. 29R-03 include:

- MIP 3.1 – Observational/Static/Gross
- MIP 3.2 – Observational/Static/Periodic
- MIP 3.3 – Observational/Dynamic/Contemporaneous As-Is
- MIP 3.4 – Observational/Dynamic/Contemporaneous Split
- MIP 3.5 – Observational/Dynamic/Modified or Recreated
- MIP 3.6 – Modeled/Additive/Single Base
- MIP 3.7 – Modeled/Additive/Multiple Base
- MIP 3.8 – Modeled/Subtractive/Single Simulation
- MIP 3.9 – Modeled/Subtractive/Multiple Base

For each of the different types of schedule delay analysis methodologies, the basic building blocks needed for a dependable schedule delay analysis are reliable and supportable as-built dates. This is a fundamental requirement consistent with the guidelines established by Recommended Practice No. 29R-03, Source Validation Protocol (SVP) 2.2: As-Built Schedule Sources, Reconstruction, and Validation, and SVP 2.4: Identification and Quantification of Discrete Impact Events and Issues.

3.1 TIME IMPACT ANALYSIS EXAMPLE

A well-known industry schedule delay analysis methodology is the Time Impact Analysis (*i.e.*, AACE International's RP 29R-03 MIP 3.6 and MIP 3.7). The Time Impact Analysis (TIA) generally models owner-caused and other excusable delay impacts that are added to the planned CPM schedule to determine the number of days of time extension entitlement to the contractor. Figure 1 is an example of a conceptual TIA application for a simple sequence of work.

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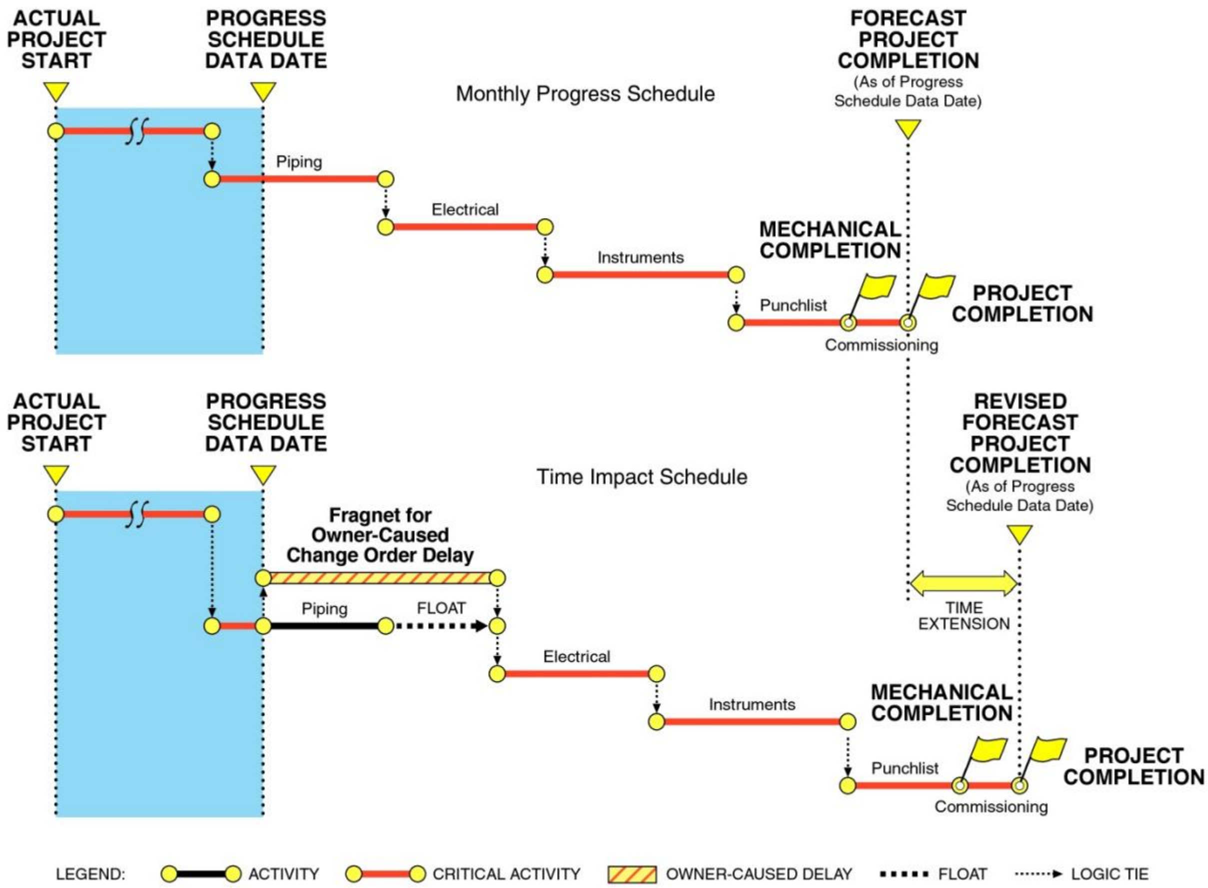
Figure 1
Conceptual Time Impact Analysis Example



As depicted in Figure 1, the project schedule is updated to depict the work progress immediately before an owner-caused or other excusable impact occurs. In this example, the impact is an owner-caused change order delay which is inserted into a copy of the monthly progress schedule. The new schedule file containing the inserted owner-caused impact is the TIA modeled schedule. The TIA modeled schedule is calculated to determine if the project completion date slipped compared to the original project completion before the fragnet was inserted. In the Figure 1 example, the added owner-caused fragnet activity resulted in slippage to the project completion date which may result in the contractor's entitlement to a time extension.

In terms of actual progress, the blue highlighted area represents the reported as-built conditions which includes as-built dates as of the progress schedule's data date. The blue highlighted area also represents the current status of the piping activity which was in progress as of the data date. Yet, it is not uncommon for other contemporaneous project records to show different or conflicting as-built information and status as of the progress schedule's data date for the piping activity. For example, the contractor's schedule update shows the actual start date for the piping activity before the progress schedule data date. In contrast, the contractor's cost and labor hour reports did not confirm the current as-built start date, which showed an actual start date for the piping work after the current data date. Further, the contractor's monthly progress report recorded an actual start date for pipe work a week later than the contractor's cost and labor hour report. What is the correct actual start date? More specifically, which actual start date is more reliable?

If the results of an as-built date verification task show that the piping activity had not started as of the progress schedule data date, then the original finish date for the piping activity, as shown in Figure 1, would calculate a later forecasted finish date. Then, the forecasted dates for all successor activities to the piping activity would also calculate later dates including later finishing forecasted dates for mechanical completion and project completion. Until the monthly progress schedule is corrected with validated as-built dates and progress percent complete data, any subsequent TIA modeling would be faulty if based on incorrect actual progress data.

3.2 ADDED FRAGNET AND IMPACT EVENTS REQUIRE AS-BUILT DATE VERIFICATION

An equally important step is to ensure verifiable as-built dates for added fragnet impacts or other delay events that are inserted into the analysis schedule for the TIA model. For the TIA methodology, fragnet impacts or other delay events are inserted into the TIA schedule based on the actual date information. On an impacted project where a contractor is trying to obtain a time extension from the owner, the contractor will have to research its contemporaneous project records (*i.e.*, daily reports, change order files, transmittal logs, etc.) to identify and quantify the impacts needed to insert these fragnets into a TIA modeled schedule.

In the example shown in Figure 2 below, the identified added owner-caused change order duration delays were obtained from contemporaneous daily reports from the contractor, which provided the most reliable as-built information when the change order work affected the finish of the activity to prepare isometric drawings and the finish of the activity to install piping. The recognized change order duration delays were then added to the TIA modeled schedule, and then the TIA modeled schedule was recalculated. The TIA modeled schedule showed that the overall completion date slipped compared to the original completion date before the duration delays were inserted. Figure 2 is a graphical summary.

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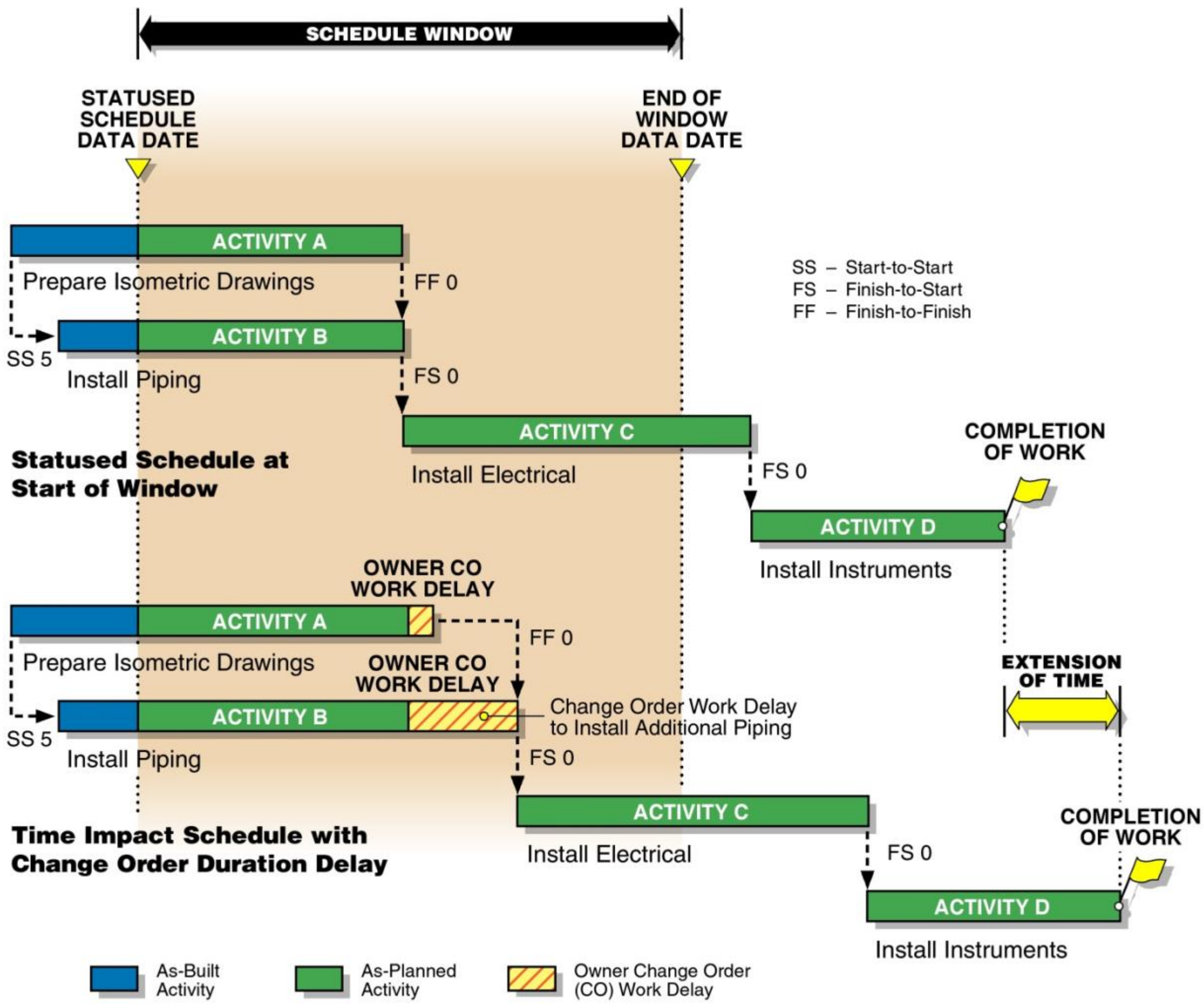
Figure 2
Identified Owner Change Order Delays Based on As-Built Dates Affecting Activities A & B



Other contemporaneous project records will also have as-built information regarding potential delays, and it is likely that the as-built information from the other sources may have conflicting as-built information compared to the actual durations used in the TIA modeled schedule. Therefore, a highly advisable practice is for the contractor and owner to invest the needed research, time, and cost to determine the most reliable as-built date information for TIA inserted impacts, including the reconciliation and resolution of any conflicting as-built information.

In addition, it is not atypical for impacting events with verified as-built dates to not align with the verified as-built dates for affected existing activities in the analysis schedules. For those cases, it may be necessary for the contractor and the owner to perform additional as-built date verification to determine the most reliable as-built dates when as-built date conflicts exist between identified impacting events and affected existing schedule activities. All as-built date verification and reconciliation tasks must be thoroughly documented.

3.3 AS-BUILT BUT-FOR ANALYSIS EXAMPLE

The As-Built But-For (ABBF) schedule delay analysis is a retrospective analysis technique that simulates the as-built condition of the work activities already completed. This analysis methodology is an excellent technique for determining compensable delay days as well as assessing concurrent contractor delays. The ABBF determines the earliest date that the required overall project completion activity dates could have been achieved but-for the owner-caused compensable delays (*i.e.*, AACE International's RP 29R-03 MIP 3.8 and MIP 3.9). This methodology is also called a Collapsed As-Built Schedule Analysis.

The amount of delay determined from the ABBF analysis quantifies the contractor's entitlement to receive compensable delay damages, which may be different from its entitlement to receive a time extension. A simulation model of the as-built schedule, also called an as-built calculation schedule, is developed with schedule logic and activity durations that calculate the same start and finish dates as the as-built dates in the as-built schedule. Figure 3 is an example of a conceptual ABBF analysis for an as-built schedule of a simple work sequence.

As shown in Figure 3, the owner-caused and contractor-caused delays are then identified in the as-built calculation schedule. The owner-caused delays are removed from the as-built calculation schedule, leaving the contractor-caused delays in the modeled schedule. The as-built calculation schedule is then recalculated or scheduled again. If the new calculated completion date collapses to an earlier completion date but-for or absent owner-caused delays, then the contractor would be entitled to recover compensable delay equal to the difference between the as-built completion date versus the ABBF completion date. In Figure 3, the ABBF analysis resulted in 10 work days (WDs) in compensable delay to the contractor, but-for owner delays.

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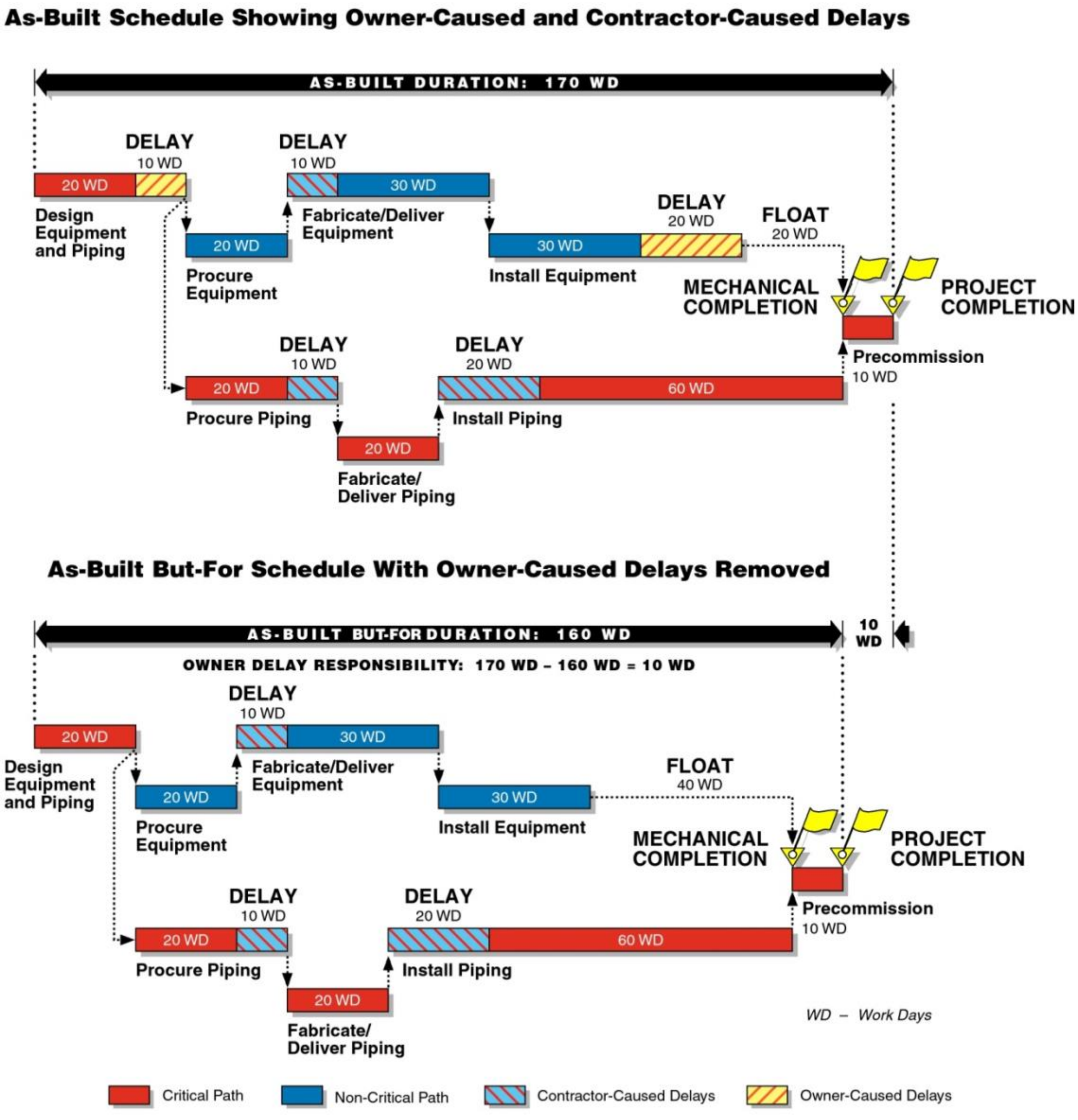
Figure 3
Conceptual As-Built But-For Schedule Analysis Example



Note: Because of contractor-caused delays on the critical path, the Project Completion could have been achieved only 10 WD earlier if the owner-caused delays did not occur. Therefore, the owner's responsibility for a compensable delay is 10 WD.

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Since the ABBF analysis models the as-built conditions as recorded in the project schedules, the validity of the methodology is wholly dependent on the accuracy and reliability of the as-built progress information contained within contemporaneous project schedules, including actual start and finish dates, actual activity and relationship lag durations, actual progress percent complete values, and actual delay event dates and durations affecting existing work activities. If a substantial number of actual start or actual finish dates are incorrect, then the accuracy of the ABBF simulated model will also reflect incorrect as-built date information and the veracity of the ABBF analysis results may be flawed.

Until the as-built dates are verified, the correct number of actual duration days and potential owner-caused delay days contained within the actual duration is questionable. For example, a contractor's as-built calculation schedule included an "Install Piping" activity on the as-built critical path, with an actual start date of June 1, 2012 and actual finish date of August 1, 2012. Based on these dates, the actual duration was 62 calendar days (CDs). The owner acknowledged that its owner-provided specialty valves were delivered late, and the late delivery likely delayed the completion of the install piping activity from July 15, 2012 to the completion of the activity on August 1, 2012. The resulting owner delay duration was calculated at 18 CDs. Thus, based on this information, the contractor was expecting to receive 18 CDs of compensable delay due to the late delivery of owner-provided specialty valves as a result of the ABBF analysis. Table 1 is a summary of the as-built information.

Table 1
As-Built Summary Information for As-Built Critical Path Activity B and Late Valve Delivery Activity by Owner

As-Built Critical Path Activity/Impact Description	Actual Start	Actual Finish	Actual Duration in CDs
Schedule Activity B – Install Piping	01Jun12	01Aug12	62 CDs
Identified Owner Delay within Activity B As-Built Duration (Late Valve Deliveries)	15Jul12	01Aug12	18 CDs

If the contractor's estimated daily project overhead cost was $30,000 per day, the contractor's compensable delay recovery value would be $540,000. However, while researching the contractor's weekly reported pipe labor hours and costs, the owner verified that the Install Piping activity actually finished on July 18, 2012 and not on August 1, 2012 as shown in the contractor's as-built calculation schedule. For this example, the contractor was forced to accept the July 18, 2012 finish date based on its reported pipe labor hours and costs because the contractor could not provide the owner with any corroborating contemporaneous project records that would justify the

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August 1, 2012 finish date in the contractor's original as-built schedule. Table 2 is a revised summary of the as-built information including verified as-built date information.

Table 2
As-Built Summary Information for As-Built Critical Path Activity B and Late Valve Delivery Activity by Owner with Verified As-Built Dates

As-Built Critical Path Activity/Impact Description	Actual Start	Actual Finish	Actual Duration in CDs	Verified Actual Start	Verified Actual Finish	Verified Actual Duration in CDs
Schedule Activity B – Install Piping	01Jun12	01Aug12	62 CDs	01Jun12	18Jul12	55 CDs
Identified Owner Delay within Activity B As-built Duration (Late Valve Deliveries)	15Jul12	01Aug12	18 CDs	15Jul12	18Jul12	4 CDs

As shown in Table 2, the owner's as-built date verification resulted in an earlier as-built finish date of July 18, 2012, which reduced the contractor's expected compensable delay from 18 CDs to 4 CDs. Using the same estimated daily overhead rate of $30,000 per day, the contractor's compensable delay recovery value would drop to $120,000 or a savings to the owner of $420,000. As demonstrated in this example, as-built date verification can directly affect the accuracy of potential compensable delay days and follow-on compensable delay recovery.

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4. SOURCES OF RELIABLE AS-BUILT DATES

Typically, a contractor's schedule updates should contain the most complete and accurate source of as-built dates since they are almost always required contractually to be maintained contemporaneously during project execution. It is preferable to rely on the as-built date information within the contemporaneous schedule updates as an accurate source of as-built dates unless the dates are shown to be inaccurate. In addition, it is not uncommon that a contractor's latter schedule updates contain hundreds of activities missing as-built dates. Therefore, a prudent contractor should perform as-built date verification of all project activities in support of its schedule delay analysis. Verifying the accuracy of as-built data has the following benefits:

- Corrects inaccurate and inconsistent dates in the schedule updates;
- Corrects inaccurate or incomplete progress;
- Facilitates accurate measurement of delay;
- Strengthens the credibility of the as-built schedule to support expert opinions; and
- Can be used to discredit the opposition's schedule analysis if they relied on inaccurate as-built dates.

Key contemporaneous project documents provide a good source of as-built date information to determine reasonable as-built dates for both schedule activities and impacting events. The following is a list of project records to utilize, if available:

- Contractor's daily reports
- Weekly or monthly progress reports
- Change order files including labor and material cost estimated for man-hours required to perform the changed work
- Pay application data
- Productivity reports
- Installed quantities reports
- Deficiency reports
- Material receiving logs
- Transmittal logs
- Drawing logs
- Superintendent diaries
- Meeting minutes,
- Project correspondence
- Field notes and timeline data
- Time-dated photographs
- System turnover data

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At a minimum, review and analysis of these types of contemporaneous project records should be used to bolster, identify, or adjust the as-built schedule information contained in the analysis schedules as well as support impacting events. Certain contemporaneous project records may be analyzed to confirm as-built start and finish dates in the contractor's schedules. For example, a piping activity's actual status achieved 100 percent progress on Friday, January 31, 2014, and the contractor's schedule update used an actual finish date of January 31, 2014. The contractor's Turnover package showed the last pipe spool installed was recorded on the same January 31, 2014, thereby supporting the as-built finish date used in the schedule update.

The contractor's schedule update also showed the piping activity's successor pipe testing activity with an actual start date on Monday, January 27, 2014 which was four days earlier than the verified actual finish date of January 31, 2014 for the predecessor piping activity. Although the planned logic required the piping activity to be 100 percent complete before the successor pipe testing activity could start, analysis of the installation dates for pipe spools contained in the turnover package reported that 98 percent of all piping spools were installed prior to the pipe testing activity's actual start date of January 27, 2014. Therefore, based on interpretation of the data contained in the Turnover package, it is reasonable to conclude that the actual start date of January 27, 2014 for the pipe testing activity was accurate based on the rationale that 98 percent of all of the predecessor work was completed prior to January 27, 2014, and that testing could start on certain piping before all the piping installation work was completed. Hence, the analysis and interpretation of contemporaneous project data may directly or indirectly provide the data to validate as-built schedule dates. Other contemporaneous project records may justify changing as-built start or finish dates.

4.1 DATE VERIFICATION STRUCTURE AND CODES

As-built date verification will help to alleviate controversy regarding potential date-related disputes. Owners and contractors should invest the time and resources necessary to validate the accuracy and reliability of as-built date information. A thorough as-built date verification exercise will most likely identify numerous cases of conflicting as-built date information between different contemporaneous project documents. For example, a contractor's equipment installation log recorded an actual finish date for a piece of installed equipment which is the same actual finish in its as-built schedule, but a time-dated photograph on the same date showed only a partially installed piece of equipment.

The question becomes the following: Which date is more reliable? Therefore, as part of an as-built date verification process, an owner or contractor should evaluate the reliability of the source documents used to validate the as-built dates used for schedule delay analysis. This verification is accomplished by developing a hierarchical structure that gauges the relative reliability of the as-built dates verified in the various schedules. Figure 4 graphically presents a

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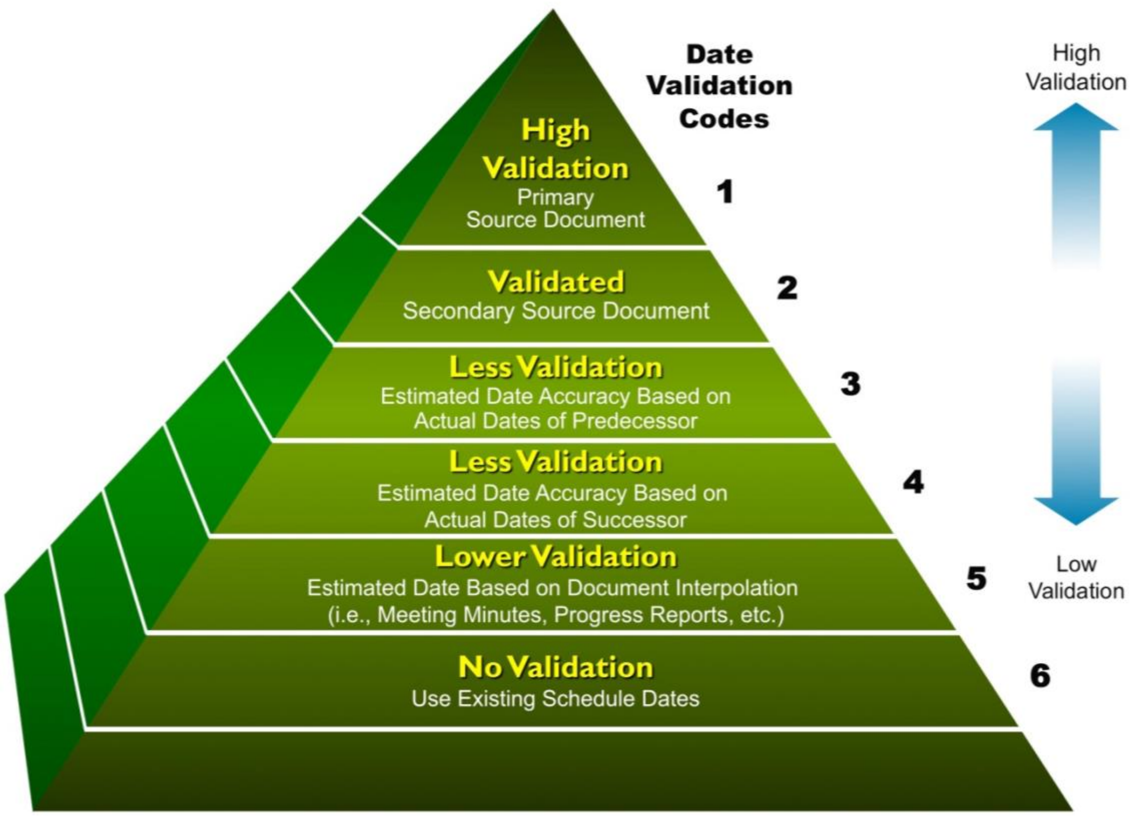
conceptual example of a hierarchical structure for the reliability of as-built date verification source documents.

Figure 4
As-Built Date Verification Hierarchical Structure Example



As presented in Figure 4, the date validation codes and definitions provide a measure of the reliability of the as-built date source documentation accuracy for each validated actual start or finish date. The date validation reliability codes can also be defined in a table that provides a more detailed explanation of the date validation process, as shown in Table 3 below.

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Table 3
Sample Schedule Activity Validation Structure for Verified As-Built Dates

Supporting Verification Document Description	Date Validation Code	Validation Comments
Date Verified by Primary Source Document (*i.e.*, letter, daily report, diary, date-stamped photo)	1	High Validation
Date Verified by Secondary Source Document (*i.e.*, tabular logs)	2	Validated
Date Verified Based on Actual Predecessor Dates	3	Less Validated – Estimated Date Accuracy
Date Verified Based on Actual Successor Dates	4	Less Validated – Estimated Date Accuracy
Date Verified Based on Interpolation of Project Documents (*i.e.*, Meeting Minutes, Progress Reports, etc.)	5	Lower Validation – Estimated Date Accuracy
Use Existing Schedule Dates	6	No Validation

As shown in both Figure 4 and Table 3, lower as-built date validation codes relate to higher as-built date validation accuracy and higher reliability of the as-built source documentation. Primary source documents such as letters, daily reports, or time-stamped photographs are typically considered to have a higher reliability for accuracy than secondary source documents such as logs that compile data from other records. Some activity actual dates may be estimated based on validated predecessor or successor actual dates. Other activity dates may be estimated based on the interpolation of dates found in meeting minutes or progress reports, which may indicate that an activity has been completed without providing the exact date. Typically, estimated dates are considered to be less accurate and reliable than actual dates recorded in primary source documents.

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5. CONCLUSION

When contractors or owners are faced with project schedule delays, as-built date verification based on contemporaneous project records should be performed to support a schedule delay analysis. This schedule data verification includes the as-built date information for both schedule activities and impacting events. This date verification is especially advisable when trying to obtain an extension of time or compensable delay recovery on large and complex projects when numerous delay issues are not fully defined or recognized and the parties are deeply polarized regarding the delay issues. Delay-related costs and damages on these types of projects can be substantial, and neglecting to perform as-built date verification creates unnecessary and avoidable risk in recovery of delay-related costs.

As-built date verification eliminates extensive rework of the schedule analyses due to conflicting or incorrect as-built information. When multiple contemporaneous project records show conflicting as-built date information, use of date verification codes to define and determine the most reliable as-built date information is recommended. The main objective is to ensure that the as-built dates used for schedule delay analysis are reliable, supportable, and can withstand scrutiny from adverse parties. It can be very costly to learn about numerous as-built date problems contained within your schedule delay analysis only a few weeks before the start of the arbitration hearings.

About the Author

Ronald J. Rider, M.B.A., *is a Senior Principal with Long International and has over 30 years of experience in construction project management and contract dispute resolution. Mr. Rider has performed CPM schedule development, project cost control, cost and labor hour variance modeling, impact identification and causation, change order pricing and resolution, retrospective schedule delay, time extension and acceleration analyses, concurrent delay assessments and damages quantification. Mr. Rider's experience includes petrochemical, oil refinery, power, commercial, industrial, road/highway, transit, hospital/medical, airport and casino projects. He holds a B.S. degree in construction management from Colorado State University and an M.B.A. degree from the University of Colorado. Mr. Rider is based in the Denver, Colorado area and can be contacted at rrider@long-intl.com and (303) 346-5836.*