فرآیند جامع آنالیز تاخیرات در پروژه

بخش هفتم:

آنالیز زمانی تاخیرات

آنالیز زمانی تاخیرات قبل از وقوع تاخیر

(Contemporaneous Schedule Analysis)

ارائه دهنده:

سید محمدرضا علوی‌پور

CMAA Authorized Trainer

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- Critical path techniques
  - Delay analysis key terms – Review
  - Delay analysis using prospective methods
    - Impacted as planned analysis (IAP)
    - Time impact analysis (TIA)
- Non-critical path techniques
- Delays by subcontractors

Time Impact Analysis (TIA)

(TIA vs. IAP)

Time impact analysis vs. impacted as planned

Factor	TIA	Impacted Baseline
Time Required	Moderate to High depends on data	Lesser Time required compared to TIA
Level of Effort	High	Moderate

Time impact analysis vs. impacted as planned

Comparing Factor	TIA	Impacted Baseline
Expertise Level Required	High	Moderate
Complexity	High	Low
Data Requirement	High	Moderate

Time impact analysis vs. impacted as planned

Comparing Factor	TIA	Impacted Baseline
Accuracy of Result	More accurate with Perspective Analysis	Moderate
Prospective or Retrospective Application	Both, Prospective and Retrospective	Both, Prospective and Retrospective

Time impact analysis vs. impacted as planned

- ✓ Many Methods available for Delay Analysis
- ✓ Each method could give different results
- ✓ Many factors to be considered while selecting one
- ✓ Most Important – contractual requirement
- ✓ Owners should give more options
- ✓ Contractors should not always go for simplest one

Non-Critical Path Techniques

Techniques

- Under some circumstances, a critical path project schedule is **not available for a project**.
- It is more prevalent in **smaller projects**.
- When faced with this **challenging set of circumstances** one of the following methods can be **considered** to determine the impact of a delay, however not recommended.
    1. **S-Curve**
    2. Global impact
    3. Net impact

S-Curve

- The **S-curve method** makes use of a **time-cost chart** where the **cumulative expenditure** during the construction period is expressed.
- The one **axis** of the chart depicts project expenditure and the other project duration.
- To apply this method a **baseline S-curve** and an **as-built S-curve** without any additional cost are required.
- This method is based on the **assumption** that **slow progress** would result in a **lower than planned expenditure**.
- By **comparing** the baseline S-curve with the as-built S-curve the **impact of the delay** can be determined.

Is it correct?

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S-Curve

There is a widely held

but mistaken belief

that the dollar value of the work performed is directly related to the

time progress of the job.

Let's see some of the arguments!

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Delay analysis based on dollars

Example

- ***Contractor*:** I was able to complete **90 percent of the work** in **ten months** on the job. Then, **because** of the **Owner delays** in **inspection** and **punch list**, it took **four months to complete** the **last 10 percent of the work**.

- ***Owner*:** During the **period** of the **claimed delay** to the Contractor, he was able to **perform 25 percent of the dollar value** of his work on the Project. The **dollar value** of work accomplished during that period **reflected** the **same rate of progress** as that **before and after the delay**. Therefore, we could **not possibly** have **delayed** the **Contractor**.

Which one is true?

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Delay analysis based on dollars

Example

- **While** **both** of these arguments may **appear** **plausible** and **logical**, there is **no quantifiable linear relationship** between **time progress** and **dollars** on **any Project**.

1. The **dollar value** at each stage of the Project **depends** on the **(1) nature** and **(2) cost assigned** to the specific activities completed.
   - For instance, some **high-dollar-value** items of work may be performed in a **short period of time**, whereas some **low-dollar-value** items of work may **take more time**.
2. Dollar value method does **not identify** and **track** the activities on the **critical path** of the Project, as the **most reliable method** for determining delays.

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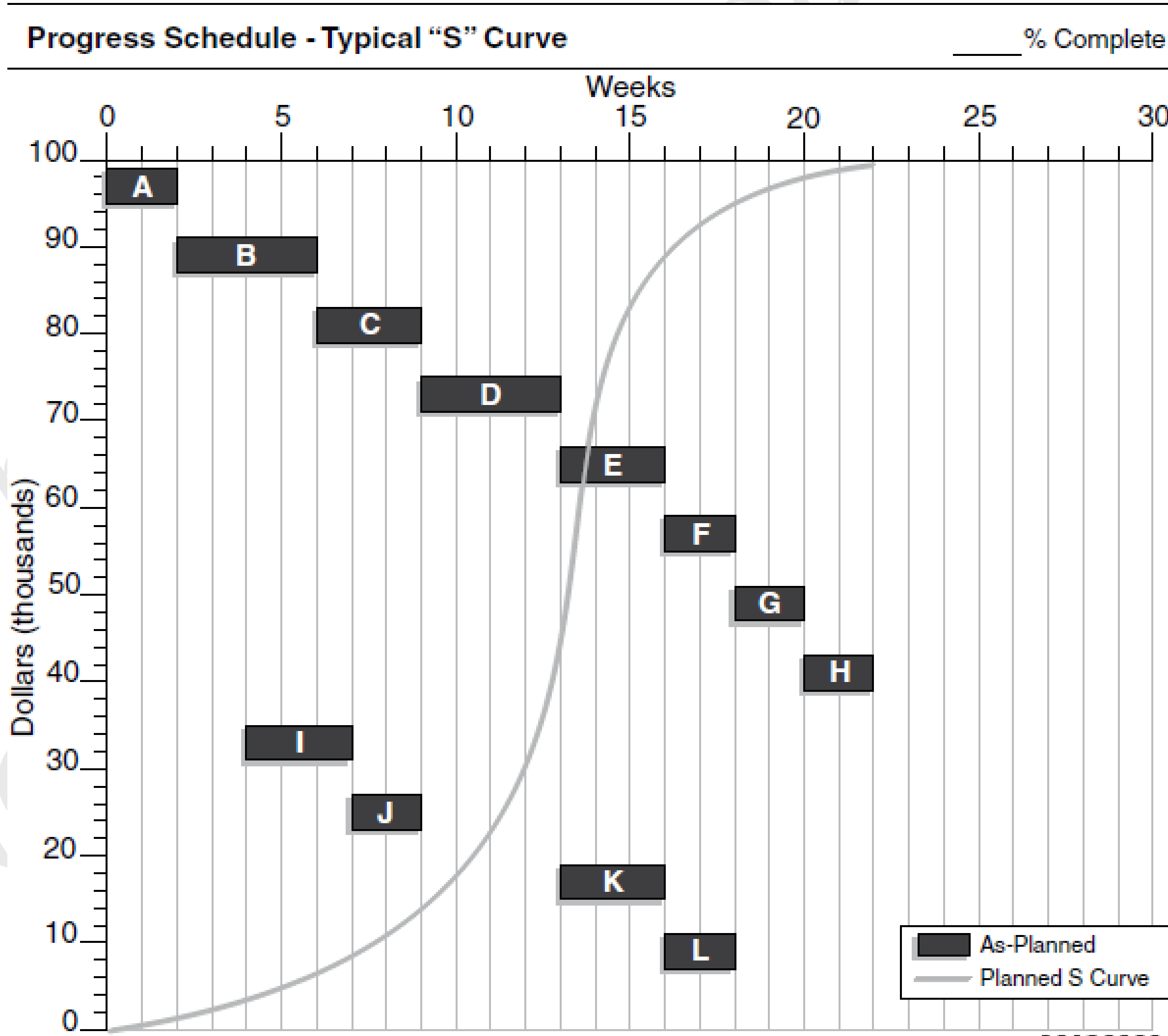
Delay analysis based on dollars

❑ S-Curves

❖ In the **past**, the **Corps of Engineers** required **Contractors** to **provide** **"S" curves** to show **job progress**.

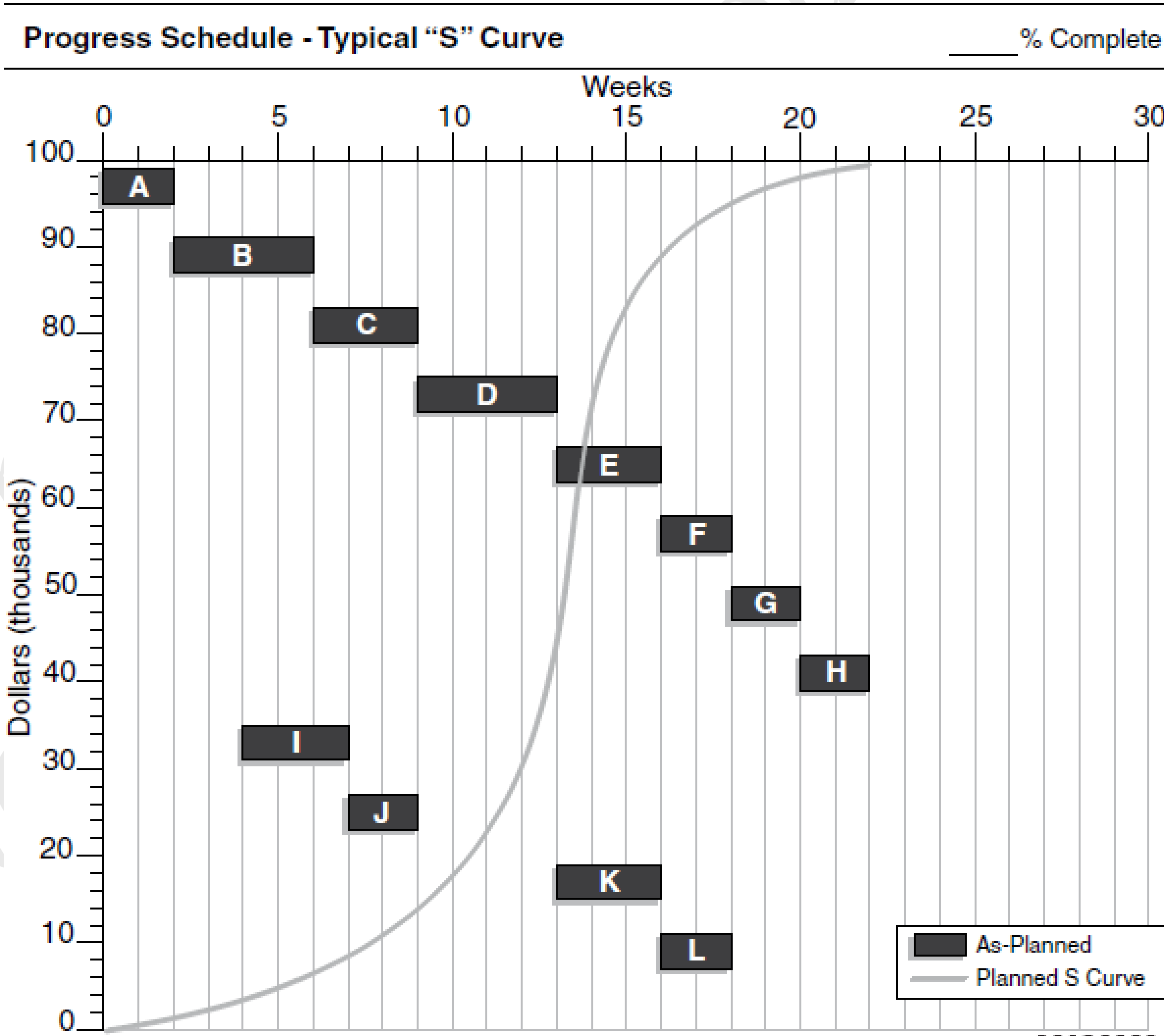


Delay analysis based on dollars

❑ S-Curves

1. The **Contractor** provides a **<u>bar chart of the major activities</u>** on the job and **applies** the **dollar value** from the **schedule of values** to the **<u>bar chart</u>**.

❖ By **<u>summing</u>** the **dollars over time**, an **<u>"S" curve</u>** is **generated**.

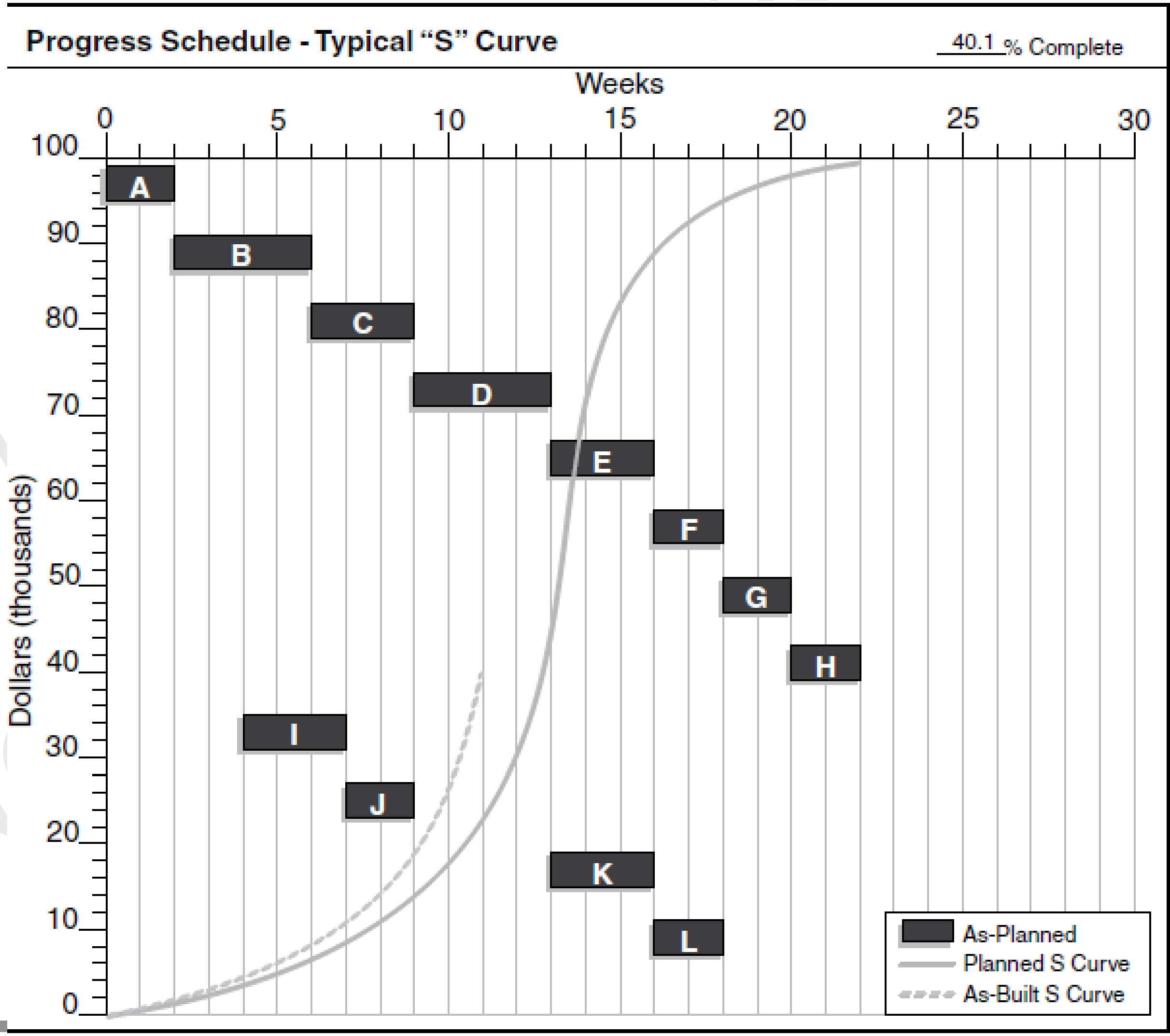


Delay analysis based on dollars

❑ S-Curves

2. The **Contractor** must then **submit** an **updated "S" curve** with **<u>each monthly pay request</u>**.

❖ **<u>Unfortunately</u>**, the **monthly submission** also has an **entry** for **"progress to date,"** **recorded** as a **percentage.**

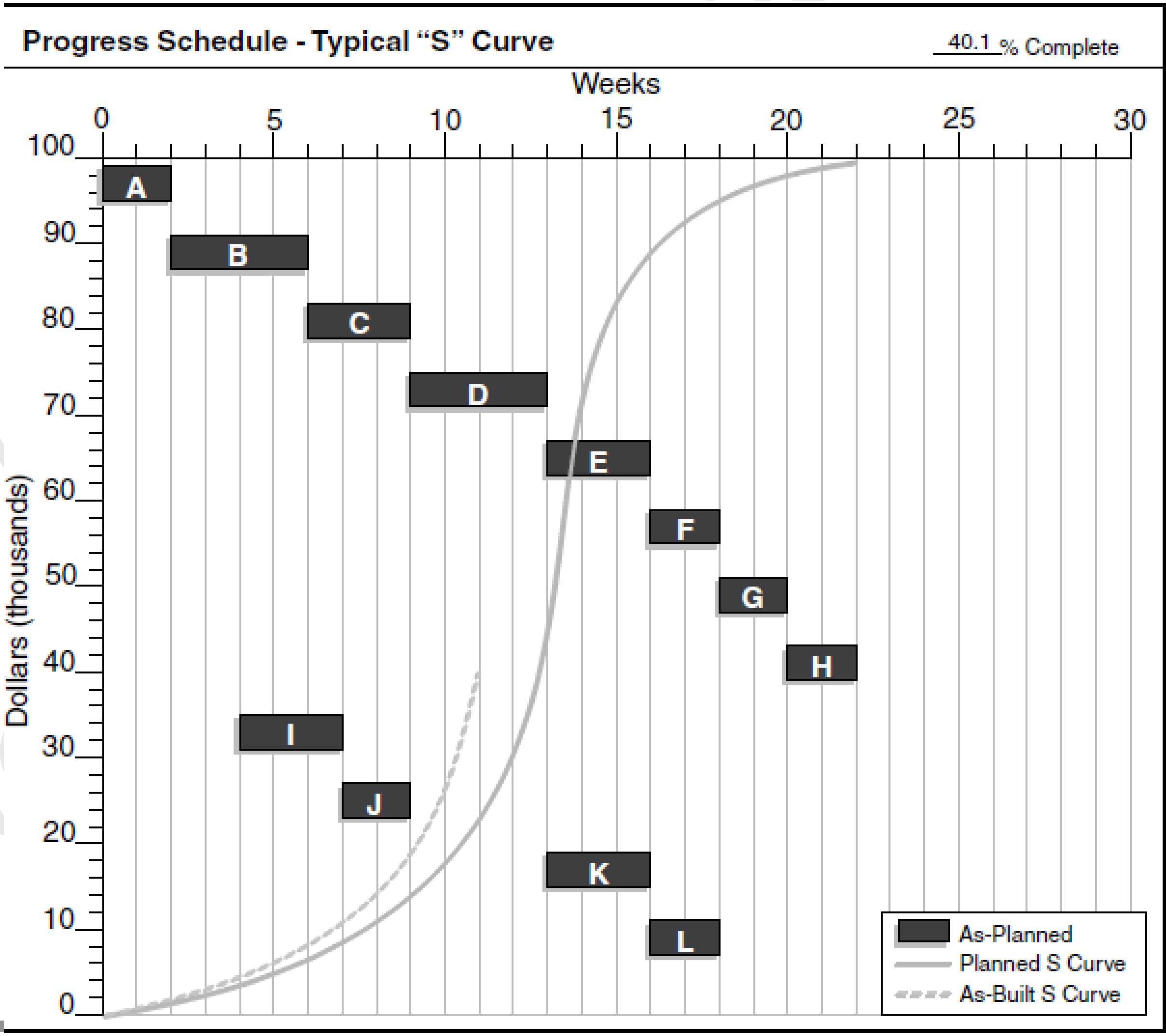


Delay analysis based on dollars

❑ S-Curves

❖ **This update** has often been **used** to **measure** the **<u>Contractor's progress</u>** in time, which is **very often misleading**.

❖ **<u>"S" curves</u>** developed from a **Contractor's total billing dollars** do **not measure** the **<u>time progress</u>** of the Project but **merely show** the **<u>progress of billings</u>** over the course of time.



Delay analysis based on dollars

S-Curves

- There are **several reasons** why the we **do not recommend** using an this kind of **"S" curve** for **determining job progress**.

  1. The **original planned "S" curve might not be accurate** due to **"front end loading,"** or other factors.
  2. The **updated "S" curve** information **might** be **misleading** because of **payments** for **stored materials** and **equipment**.

The Contractor could overbill or "front end load" its bid items to recover its costs as early as possible, and, therefore, reliance on the "S" curve could portray more "progress" than had actually occurred.

Because they are unreliable, time-to-dollar relationships should not be used to establish delays on a Project.

Delays By Subcontractors

Delays by subcontractors – State of the problem

When a Project is managed by a well-thought-out and periodically updated CPM schedule, the analyst has many tools at his disposal to determine the delays to the Prime Contractor's performance period.

However, in the case of delays to the Subcontractor's performance period, these tools are less effective.

As a result, we must apply a more in-depth knowledge of both the subcontracting process and of the Project management process in order to determine the most appropriate way to resolve disputes related to Subcontractor delays.

Delays by subcontractors – How to investigate and analyze delays?

1. **When investigating** potential delays to a **Subcontractor's performance**, we **begin** by **evaluating** the **performance requirements** of the **subcontract** (**contract with SC)**.
   - ❖ The **objective** of this **evaluation** is to **determine** the **period of performance** for which the **Subcontractor is obligated** **under** the **terms of the subcontract**.
     - ✓ **Often**, a **Subcontractor** is required to **perform its work** **according** to the **Project schedule**.

Delays by subcontractors – How to investigate and analyze delays?

2. **If required to perform according to the project schedule:**
   - **Typically**, the **Prime Contractor** reserves **its right** to **modify the schedule as necessary** to **complete the work** in a **timely fashion**.
     - The **subcontract** will then **require** the **Subcontractor** to **perform according** to these **modifications** as well.
       - Because these **modifications** are **not known** at the **time of the subcontract agreement**, there is a **certain expectation** that the parties have regarding the **Subcontractor's performance period** that results in **negotiation before** signing **subcontracts**.

While the Subcontractor typically takes on some risk regarding the Prime Contractor's right to modify the schedule, this risk is typically not without limits in subcontracts.

Delays by subcontractors – How to investigate and analyze delays?

2. **If required to perform according to the project schedule:**

- **What limits in subcontracts?**
  - The **Contract CPM schedule** will **identify** **early and late dates** for **all of the Subcontractor's work activities**.
    - ✓ The **Subcontractor** is obligated to be **on site** from the **projected early start date** of its **first activity** to the **late finish** of its **last work activity**.
      - o The **work activities** **do not need** to be **performed** on the **early dates** for the Project to complete on time.
        - ➢ **Thus**, **performance** of the work **within** the e**arly and late date** ranges are **foreseeable**, **even if** such performance **affects** the **continuity** of the **trade Subcontractor's work activities**.

Delays by subcontractors – How to investigate and analyze delays?

Unlimited modifications to the sequence and duration of the work are generally not anticipated by the parties.

Modifications by prime contractors should be limited in subcontracts

Delays by subcontractors – How to investigate and analyze delays?

2. **If required to perform according to the project schedule:**
   - **Unlike the Prime Contractor's contract performance period**, which is generally expressed in the **Contract**, the parties may be **unable to agree** on the **subcontract period of performance**.
     - In such cases, the **parties** will **prepare** their respective arguments based on the **subcontract performance period they believe** to be **correct** and **every subcontract** has **its own condition**.

Delays by subcontractors – How to investigate and analyze delays?

3. **Once the subcontract period of performance has been established**
   - A **comparison** to the **Subcontractor's** **actual performance period** provides a measure of the **total delay** experienced by the **Subcontractor**.

But this is only the beginning of the story

   - **Next**, it is necessary to **determine the causal link** between the **actions of the parties** and the **delays incurred** in order to determine **if** the **Subcontractor's delays** were **caused** by **others**.

The Subcontractors may be able to recover the delay costs caused by others (usually overhead costs)

Delays by subcontractors – How to investigate and analyze delays?

3. **Once the subcontract period of performance has been established**
   - It is **necessary** to **determine** the **critical path of the Subcontractor's work**.
     - The **critical path** of the **Subcontractor's work** is the **longest path of activities leading** from the **first work activity** to be performed by the **Subcontractor to the last**.
       - ✓ **This path** may consist of **some** or **all** of the **Subcontractor's work activities**, as well as **work activities** performed **by others**.
         - o Because **these activities** are **integrated** within the **entire schedule network**, the **analyst cannot simply isolate** the **Subcontractor's work activities** and **evaluate** the paths among these in a **vacuum**.

Delays by subcontractors – How to investigate and analyze delays?

3. **Once the subcontract period of performance has been established**

As a result of these complexities, it may not be possible to <u>determine</u> the longest path between the Subcontractor's start and end points through <u>electronic analysis</u> of the schedules.

- **As an alternative**, it may be **necessary** to **determine** the **Subcontractor's critical path** through a **detailed evaluation** of the **<u>Subcontractor's daily work progress</u>**.

This evaluation is similar to the <u>As-Built Delay Analysis</u> discussed later.

Delays by subcontractors – How to investigate and analyze delays?

4. **Process of a detailed evaluation of the subcontractor's daily work progress begins**

- This **process** **begins** with the **preparation** of a **detailed as-built diagram** that **tracks** **all** of the **Subcontractor's actual performance**.
  - This **performance** is then **compared** to **all of the available planned performance information**.
    - ✓ To begin with, the **analyst** **determines** if the **Subcontractor** was **able** to meet **planned durations** for its work and, if not, **why not**.
      - Did the Subcontractor provide **sufficient resources** to accomplish the work?
      - Was the Subcontractor **in control of the pace** of the work, or was **something else controlling the pace**?

Delays by subcontractors – How to investigate and analyze delays?

4. **Process of a detailed evaluation of the subcontractor's daily work progress begins**
   - By evaluating the **Subcontractor's as-built work performance** moving forward **through the Project** and considering the **work that remains**, we can **determine:**
     1. **Critical path** of the subcontractor's work
     2. **Factors** that extended the work along this path

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آنالیز زمانی تاخیرات

آنالیز تاخیرات در شرایطی که برنامه زمانبندی وجود ندارد!

ارائه دهنده:

سید محمدرضا علوی‌پور

CMAA Authorized Trainer

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- Introduction
- STEP 1: Use of contemporaneous documents for sequence and timing
  1. Contract documents
  2. Correspondence between the general contractor and the owner or owner's representative
  3. Subcontract agreements
  4. Correspondence with subcontractors
  5. Partial schedules produced during the project
  6. Meetings minutes
  7. Daily log or diary entries by either the general contractor's personnel or the owner's representative
  8. Purchase orders with suppliers
- STEP 2: Use of as-built analysis to quantify delays

Introduction

- The **preceding sections** discussed the performance of a delay analysis using a **detailed CPM schedule**.
- **This section** addresses the **"worst case"** situation: the Project with **no as-planned schedule**.
- This is the **most difficult situation** in which to perform a delay analysis.
- Again, as the **available information decreases**, the **analyst** must make **more assumptions**, and the analysis becomes **more subjective**.

However, while this type of analysis is difficult, it is not impossible.

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Introduction

IMPORTANT NOTE:

When no schedule exists or the schedule so flawed, the analyst may be tempted to create an "after the fact" schedule, reasoning that it will allow the analysis to be more precise.

It is best not to create such a schedule, but sometimes it is unavoidable!

This practice may bias the analysis and not reflect the Contractor's original planned sequence of the work.

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Introduction

- **Two steps** should be adopted in this case:
  1. Use of **contemporaneous documents** for **sequence** and **timing** to
     - ✓ **Define** some form of an **as-planned schedule**

       or

     - ✓ **Establish** a **general sequence**
  2. Use of **as-built analysis** to **quantify delays**

STEP 1: Use Of Contemporaneous Documents For Sequence and Timing

STEP 1: Use of contemporaneous documents for sequence and timing

- When there is **no as-planned schedule**, it is usually because the **General Contractor** did **not prepare** a **schedule** for the Project.

- In this situation, the **analyst** should begin by **reviewing all available documentation** to determine **if** any **information exists** that may **provide:**
  1. Some idea of a **proposed sequence** of the work for specific activities
  2. Some idea of a **proposed timing** for specific activities

What documents should be investigated in this case?

STEP 1: Use of contemporaneous documents for sequence and timing

- **The analyst should investigate the following documents:**
  1. Contract documents
  2. Correspondence between the general contractor and the owner or owner's representative
  3. Subcontract agreements
  4. Correspondence with subcontractors
  5. Partial schedules produced during the project
  6. Meetings minutes
  7. Daily log or diary entries by either the general contractor's personnel or the owner's representative
  8. Purchase orders with suppliers

STEP 1: Use of contemporaneous documents for sequence and timing

1. **Contract documents**

- The **contract documents** for any specific **sequence**, **phasing**, or **staging** specified as a requirement on the project.
  - *The **Contract** **required** that **all abutment work** be **completed** before **any paving** was **performed** on the approaches.*
  - *The **Contract** also required that **completion** of the Project **occur** by the **middle of the 24th week**.*

Special Conditions of the Contract-West Street Bridge-Section 1.01, paragraph 5.a:
In staging its work the contractor must complete all abutment construction activities prior to paving of the approaches on both the east and west sides of the bridge.

Special Conditions of the Contract-West Street Bridge-Section 0.01, paragraph 3.b:
TIME FOR COMPLETION: All contract work must be completed by the middle of the 24th week after the Notice to Proceed.

STEP 1: Use of contemporaneous documents for sequence and timing

2. <u>Correspondence between the general contractor and the owner or owner's representative</u>

- The **correspondence** for **references** to **<u>sequence</u>** or **<u>timing</u>**, **even if** only for a **portion** of the project.
- *The Contractor planned to work from east to west, or from abutment #1 to abutment #2, and from pier #1 to pier #3.*

June 15, 2007

John Lewis
Owner's Representative
Job Trailer
West Street Bridge
Podunk, New York 00001

June 15, 2007 contractor correspondence

Dear Mr. Lewis:

As we discussed yesterday during our meeting, we plan to work our construction operations on the West Street Bridge from an east to west direction. In other words, we will construct abutment #1 first and then abutment #2. Our paving of our approaches will follow the same sequence.

Similarly, our operations on the piers will progress from east to west direction, starting with pier #1 and progressing through pier #3.

I trust this answers the question you raised, and you can notify the Township authorities accordingly so they may effect the appropriate detours during the course of the project.

Sincerely,
Joe Super
Ace Construction

STEP 1: Use of contemporaneous documents for sequence and timing

- *The* ***Owner's representative*** *noted that the* ***review and approval*** *of the shop drawings for the reinforcing steel in the pier caps had* ***taken longer*** *than required and were* ***not returned to the Contractor*** *until <u>five weeks later than requested</u>.*

August 20, 2007 owner correspondence

August 20, 2007

Mr. Joe Super
Ace Construction
Job Trailer/West Street Bridge
Podunk, New York 00001

Dear Mr. Super:

Returned herein are the shop drawings submitted by Ace Construction for the reinforcing steel for the pier caps. As you will note, the drawings are approved as noted. Fabrication of the reinforcing steel can begin in accordance with the corrections noted.

I must note these drawings are being returned to you five weeks later than you requested. There are two reasons why the return of the shop drawings is five weeks beyond your requested date. First, you did not allow the engineer adequate time to review the drawings. As a minimum, the engineer requires three weeks to review, but you allowed only one week if they were to be returned within the time frame requested.

Second, the drawings were not prepared in accordance with normal shop drawing practices and consequently required much more time to review. As submitted, the drawings were extremely difficult to understand. While the engineer could have returned them disapproved and required resubmission in the proper manner, it was decided to take the extra time to correct them on the first submission in order to expedite the process.

If you have any questions, please feel free to call.

Sincerely,
John Lewis
Owner's Representative

STEP 1: Use of contemporaneous documents for sequence and timing

3. <u>Subcontract agreements</u>

- Subcontract agreements to look for **any sequence** or **timing** dictated to the **<u>subcontractors</u>** by the **general contractor** concerning specific **subcontract work**.

STEP 1: Use of contemporaneous documents for sequence and timing

4. Correspondence with subcontractors

- Correspondence with subcontractors for **any discussion** concerning **schedules**, **sequence**, or **timing**.

- *The Contractor planned on erecting the steel at the beginning of the 13th week of the Project*

June 25, 2007

Mr. Grey Ferrous
Ferrous Steel Erectors
Iron Street
Steeltown, New York 00002

June 25, 2007 correspondence to subcontractor

Dear Mr. Ferrous:

In accordance with our previous conversations, Ace Construction will require the delivery and erection of the steel for the West Street Bridge to begin by the beginning of the 13th week of the project. Based on your present fabrication schedule, it appears that this should not be a problem.

Please be advised that time is of the essence on this contract. In the past, we have had problems with steel suppliers promising delivery dates and not adhering to them. Action such as this will not be tolerated on this project. Your delivery and erection of steel is critical to our timely completion of the project.

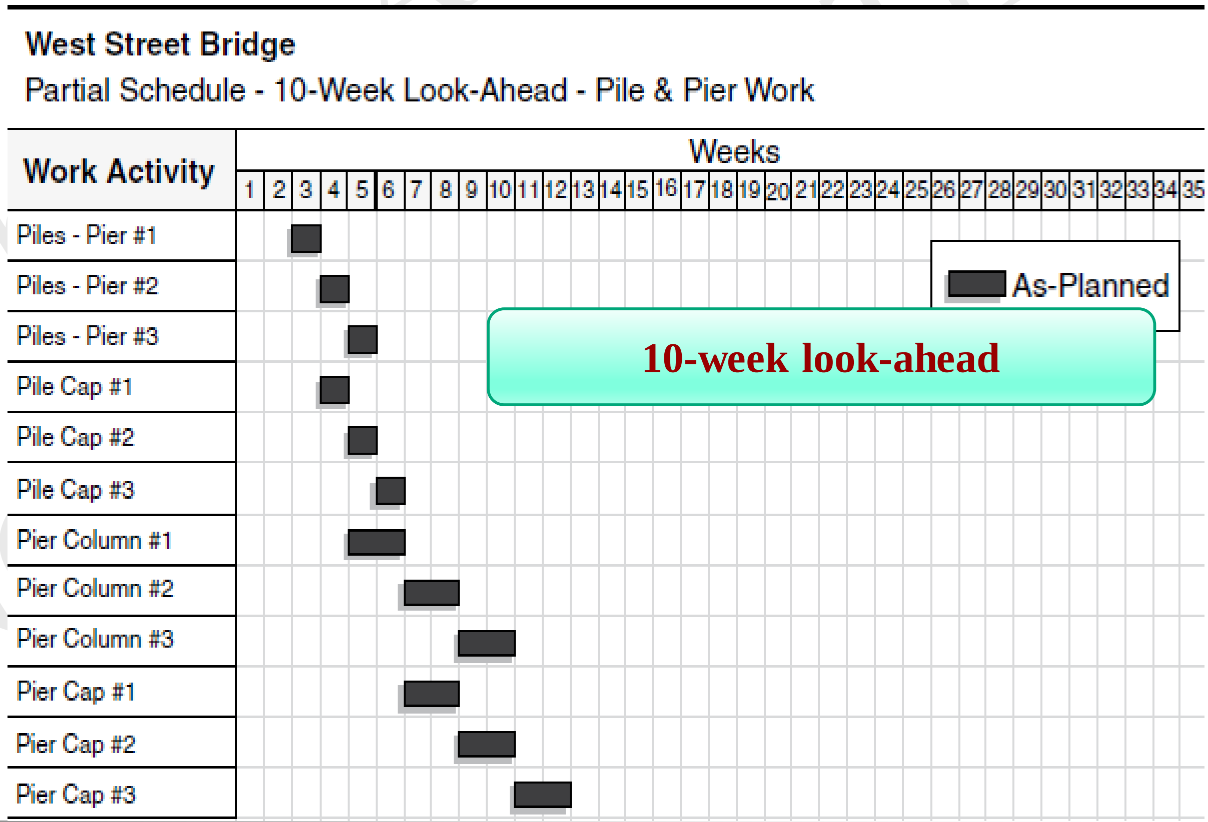
Sincerely,
John Lewis
Owner's Representative

STEP 1: Use of contemporaneous documents for sequence and timing

5. <u>Partial schedules produced during the project</u>

- Partial schedules produced during the project, which may describe **<u>any planned sequence</u>** or **<u>timing</u>** for **portions of the project**.

- *The Contractor produced at least <u>one ten-week "look-ahead" schedule</u> that addressed the work on the piers and described the specific sequence for this work, including the piles, pile caps, pier columns, and pier caps*



STEP 1: Use of contemporaneous documents for sequence and timing

6. Meeting minutes

- Meeting minutes for **any discussions** concerning **scheduling**, particularly the **preconstruction meeting minutes**.
- *The Contractor anticipated a two-week duration for the forming,* ***reinforcing, and placing of*** *each of the concrete deck spans*

Pre-construction meeting minute

Contractor noted that the forming, reinforcing, and placing of the concrete deck spans will take two weeks per span. Contractor will proceed from east to west constructing span #1 through span #4.

STEP 1: Use of contemporaneous documents for sequence and timing

7. **Daily log or diary entries by either the general contractor's personnel or the owner's representative**

- *The Contractor expected four-week durations for each of the* ***abutments*** *and two-week durations for each of the* ***approaches****.*

Inspector's Daily Diary (Excerpt)

Daily diary

During discussion today with Joe Super (Ace Construction), he noted that the abutment work would take about four weeks to perform for each abutment, and the paving of the approaches would take about two weeks for each side of the bridge. Joe noted that the existing abutment sills are acceptable as shown on the contract drawings. Therefore, they can accept the steel as is. The remainder of the work on the abutments can be performed either before the steel is in place or after it is set. He is going to try to have the abutments completed before he sets any steel, since the work will be easier that way. However, he is concerned about the lead time allowed for obtaining the epoxy material called for in the contract. He said that, if necessary, he would set the steel so as not to delay the deck work that he feels controls his completion of the job.

STEP 1: Use of contemporaneous documents for sequence and timing

8. **Purchase orders with suppliers**

- **Purchase orders with suppliers** that show **planned dates for delivery** of materials or equipment.

STEP 1: Use of contemporaneous documents for sequence and timing

Conclusion based on the information reviewed

1. The contract required that all abutment work be completed before any paving was performed on the approaches. The contract also required that completion of the project occur by the middle of the 24th week ***(from Fig. 1).***
2. The contractor planned to work from east to west, or from Abutment #1 to Abutment #2, and from Pier #1 to Pier #3 ***(from Fig. 2).***
3. The owner's representative noted that the review and approval of the shop drawings for the reinforcing steel in the pier caps had taken longer than required and were not returned to the contractor until 5 weeks later than requested ***(from Fig. 3).***
4. The contractor planned on erecting the steel at the beginning of the 13th week of the project ***(from Fig. 4).***
5. The contractor produced at least one, 10-week "look-ahead" schedule that addressed the work on the piers and described the specific sequence for this work, including the piles, pile caps, pier columns, and pier caps ***(from Fig. 5).***
6. The contractor anticipated a 2-week duration for the forming, reinforcing, and placing of each of the concrete deck spans ***(from Fig. 6).***
7. The contractor expected 4-week durations for each of the abutments and 2-week durations for each of the approaches ***(from Fig. 7).***

STEP 1: Use of contemporaneous documents for sequence and timing

- The **analyst** should use **all the available information** to:
  1. **Define** some form of an **as-planned schedule** or
  2. **Establish** a **general sequence**

     for the **work** on the Project for **different points** or **portions** of the Project.

Based on this information, the analyst can proceed with the analysis, despite the lack of a complete as-planned schedule.

STEP 1: Use of contemporaneous documents for sequence and timing

- Keep in mind that the **goal is not** to prepare an **"alternative" or "after-the-fact" baseline** or **new as-planned schedule** for the project.
  - Rather, the goal is to **mine the project information** in search of the **contractor's original plan** for construction.
- To the extent a "planned" schedule is **drafted as the basis of the analysis**, it should be done so with
  1. Only the information that can be gleaned from **project documents**, such as the examples outlined in this course,
  2. **Mandatory sequencing** dictated by the physical construction attributes and conditions.
  3. **Understanding** that the as-planned is **incomplete and limited** in terms of its **precision**.

STEP 2: Use Of As-built Analysis To Quantify Delays

STEP 2: Use of as-built analysis to quantify delays

- Although **no updated schedules exist** for this Project, **detailed daily reports** do **exist**.

- **Daily reports** allow the analyst to **prepare an as-built diagram** for the job.

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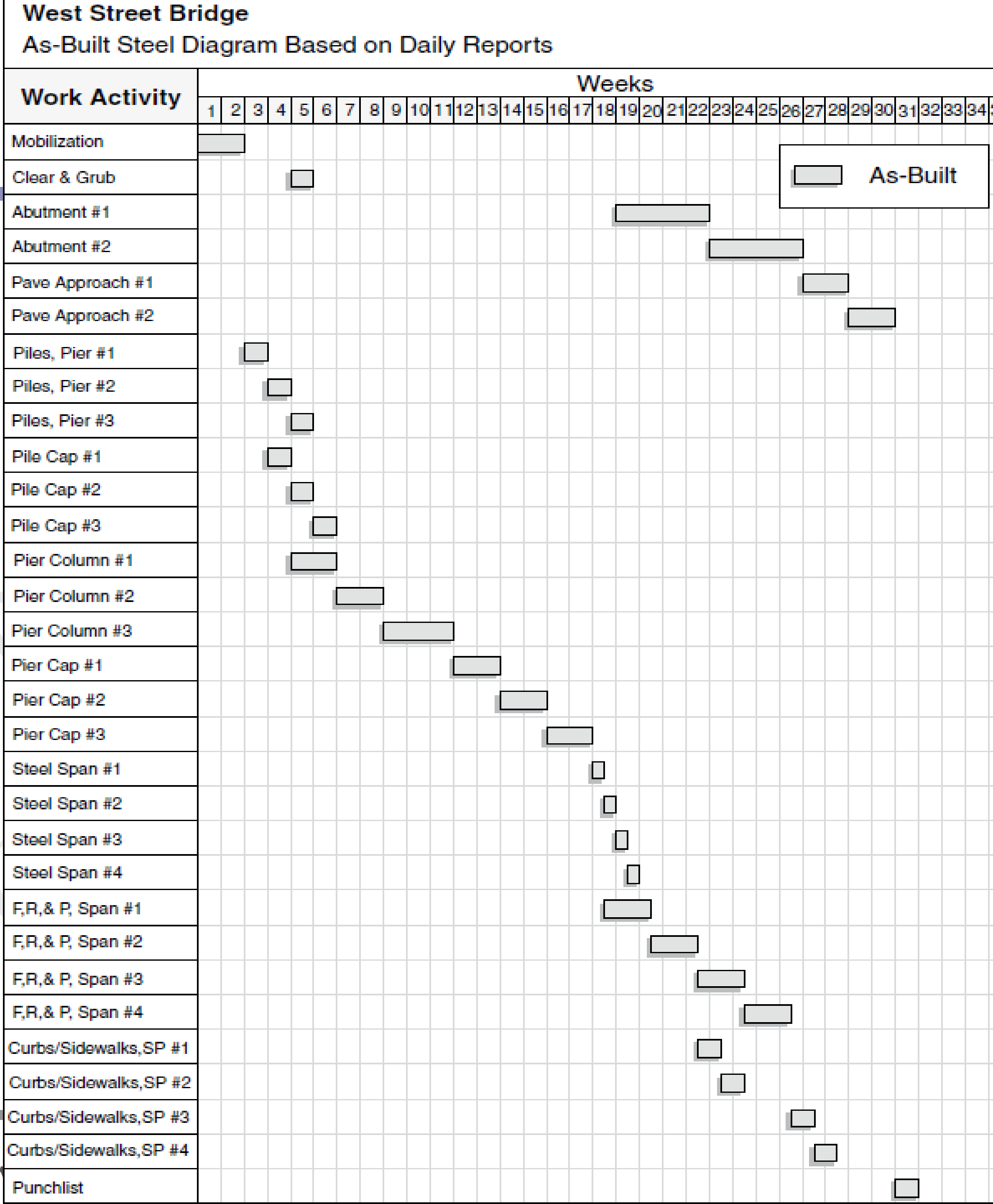
STEP 2

- In reviewing the **as-built diagram**, the **first obvious** conclusion is that the Project was **delayed seven and one-half weeks**.
  - It was to be **completed** by the **middle of the 24th week** but was **not actually finished** until the **end of the 31st week**.
    - ***This is net delay***

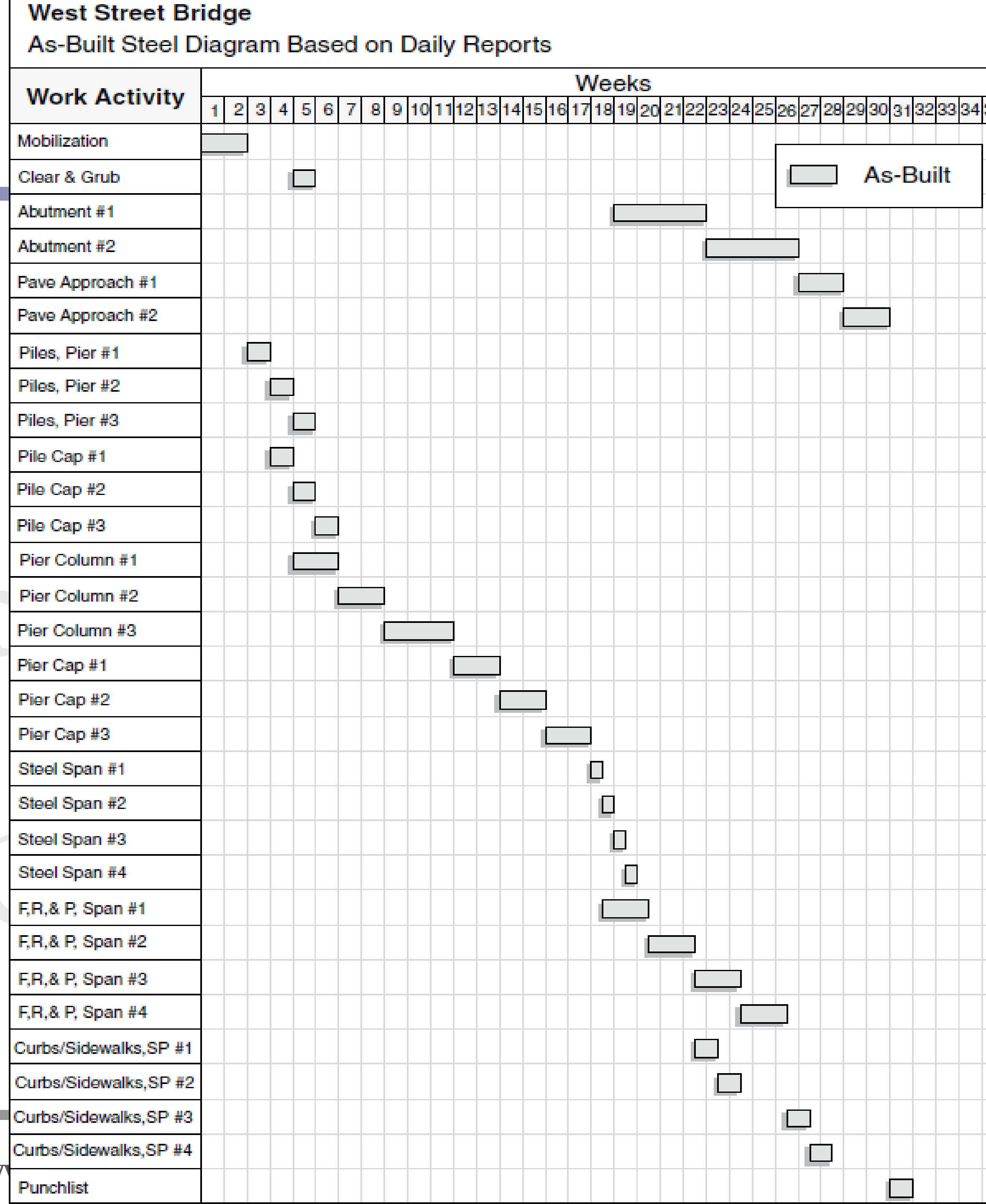


STEP 2

- **Analyst** must account for at least **seven and one-half weeks of net delay**.

- The delay **could**, in fact, be **greater <u>if</u>** the C**ontractor had planned** to **finish** the Project **<u>early</u>**.
    - However, **<u>no such plans</u>** were indicated in the **Project correspondence**, so this **assumption** will **not be made**.

- The **as-built diagram** also shows that the **<u>Contractor did wor</u>**k from **east to west as planned**.



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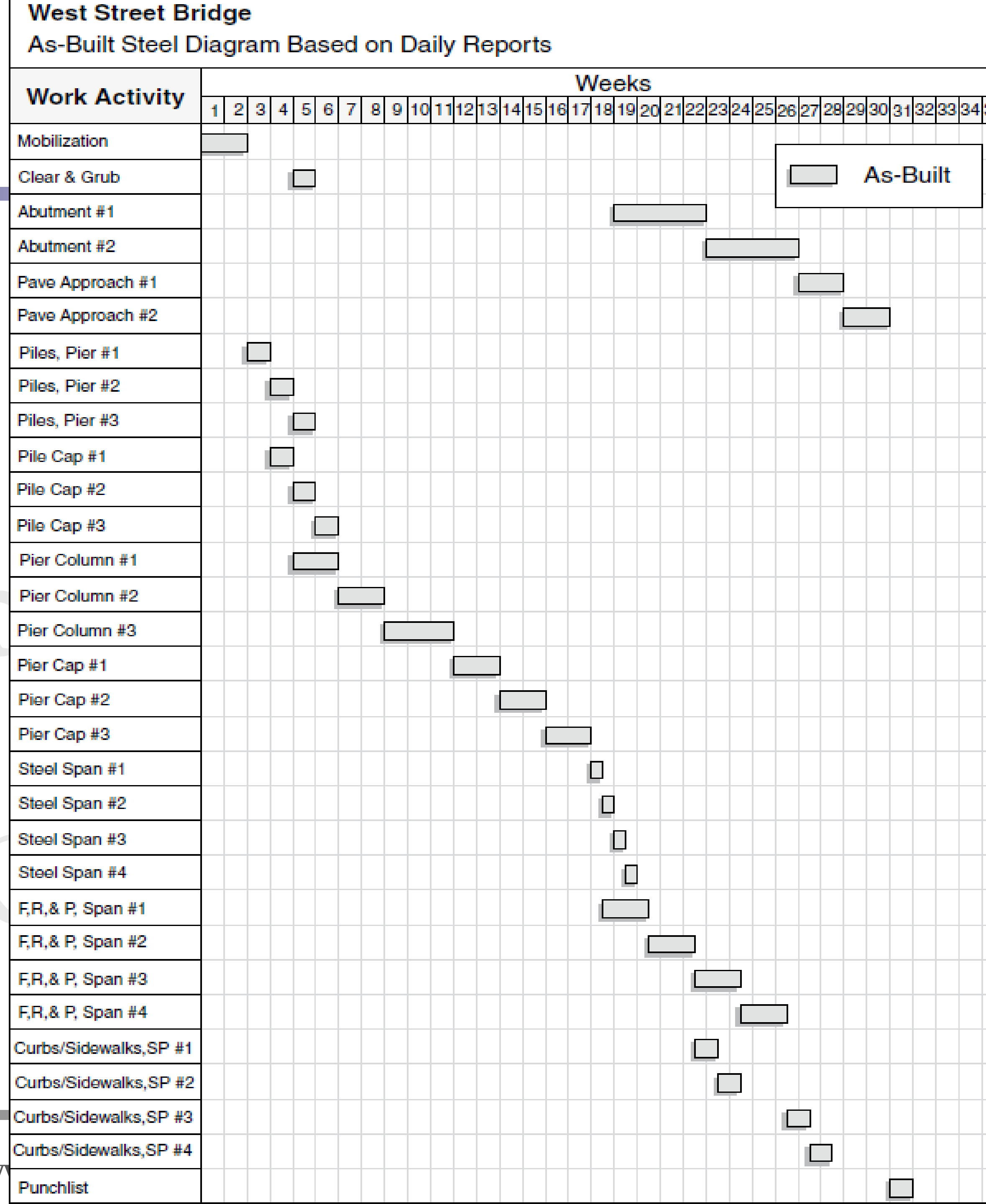
STEP 2

- Based on the **letter** to **<u>Ferrous Steel Erectors</u>**, the Contractor planned to **start steel erection** at the beginning of the **13th week**.

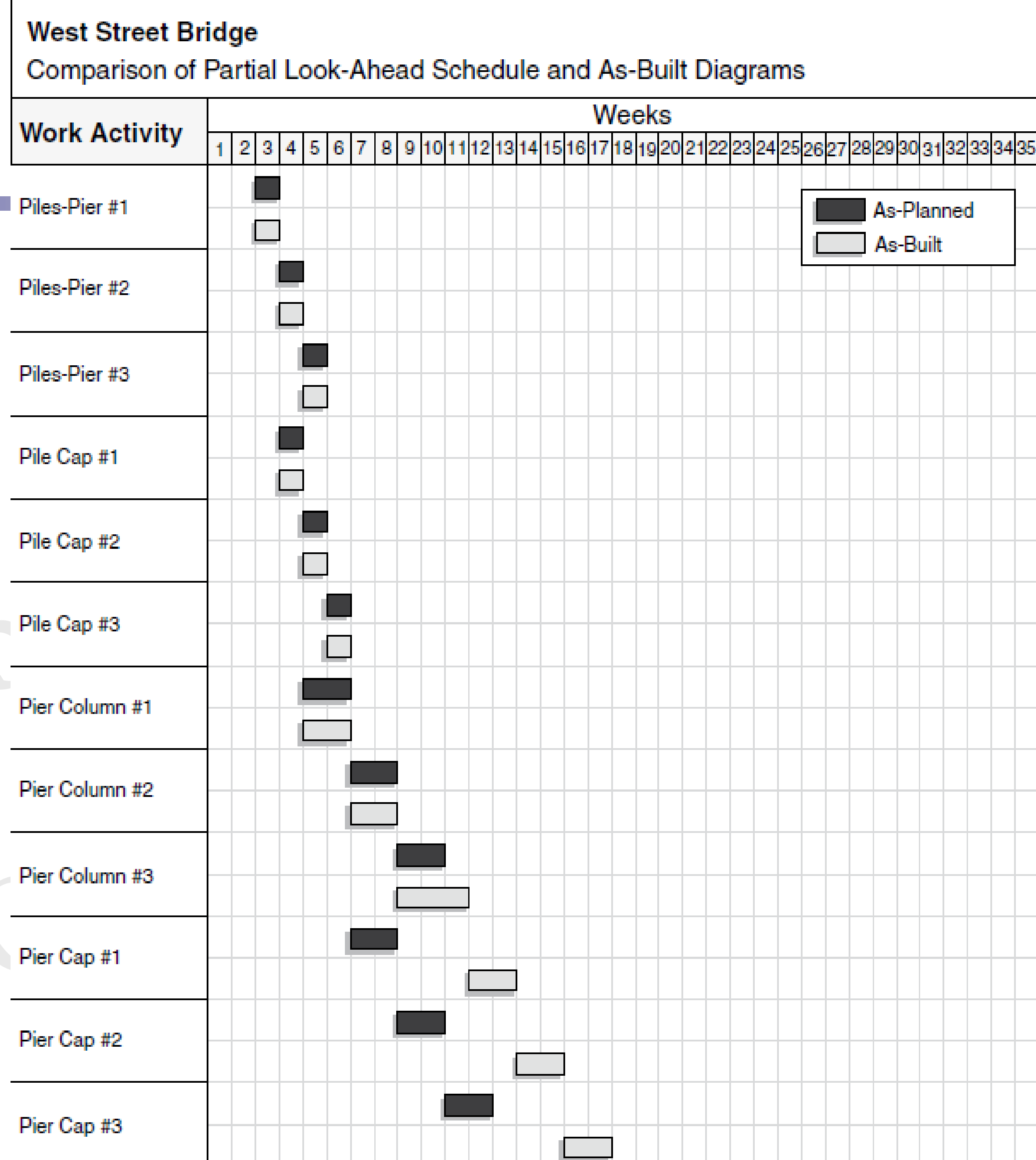
- The **as-built diagram** shows that **steel erection** began at the **beginning** of the **<u>18th week</u>**.

***A five-week delay** can be identified for the **start of the steel erection**.*



STEP 2

- **Analyst** **breaks down** the activities that **precede** the **start of steel erection**.
- **Analyst** uses the **ten-week “look-ahead” schedule**, which the **Contractor produced** at the **end of the second week** of the Project.

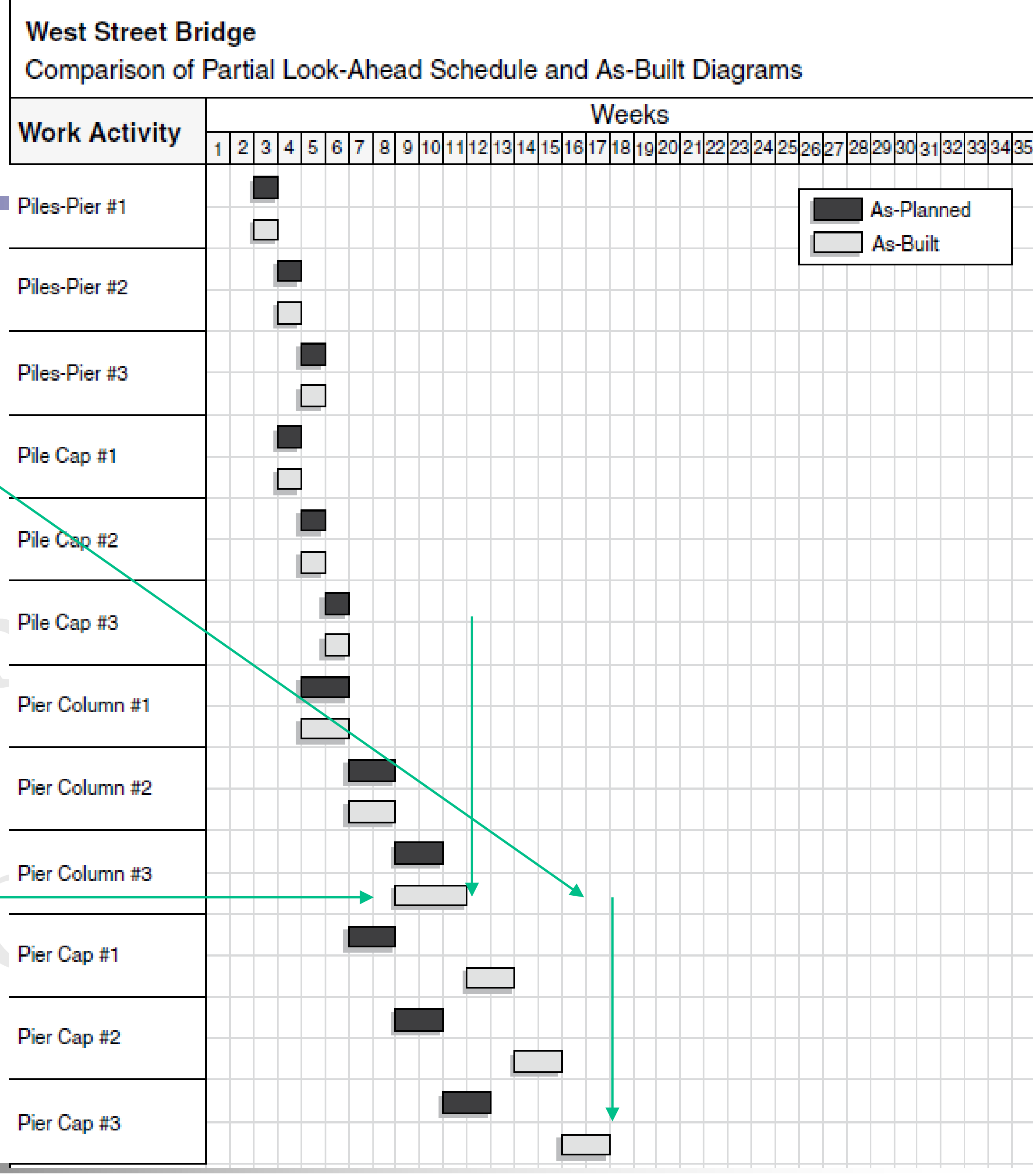


STEP 2

- A **comparison** shows that a **delay** occurred to the **<u>construction of the pier caps</u>**.

- A **delay** also appears in the **<u>construction of pier column #3</u>**, which took **three weeks instead of two weeks** to complete.

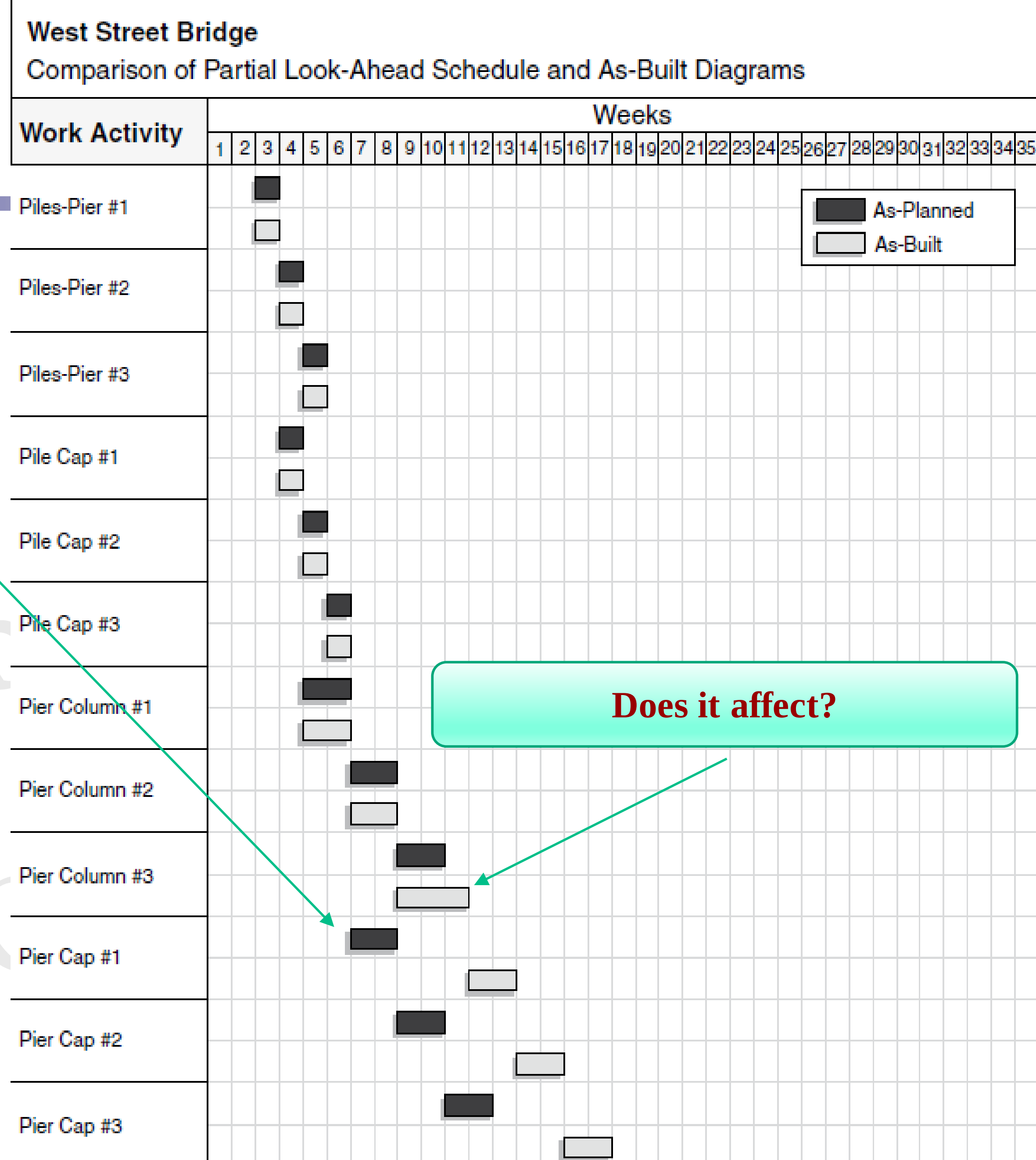
Is it the first critical delay?



STEP 2

- A **comparison** shows that the **controlling delay** was the **delay** to the **Pier Cap #1.**

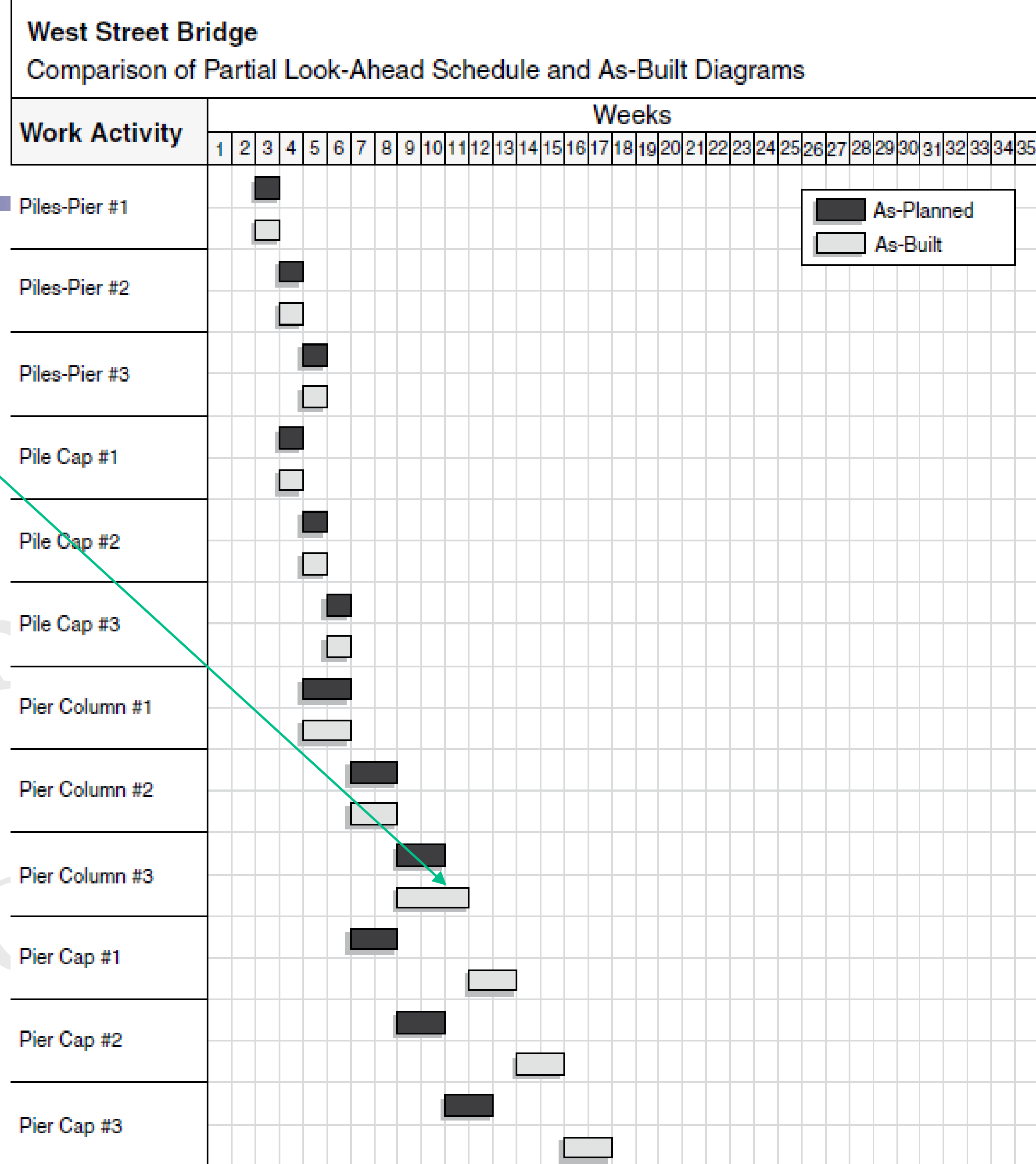
- This may have been the **result** of the **five-week delay** in **approval** of the **shop drawings** to which the **Owner's representative** had referred in **correspondence** *(Fig. 2)*.



STEP 2

- It does **not appear** that the delay in the **completion of pier column #3** affected the **completion of the Project**.

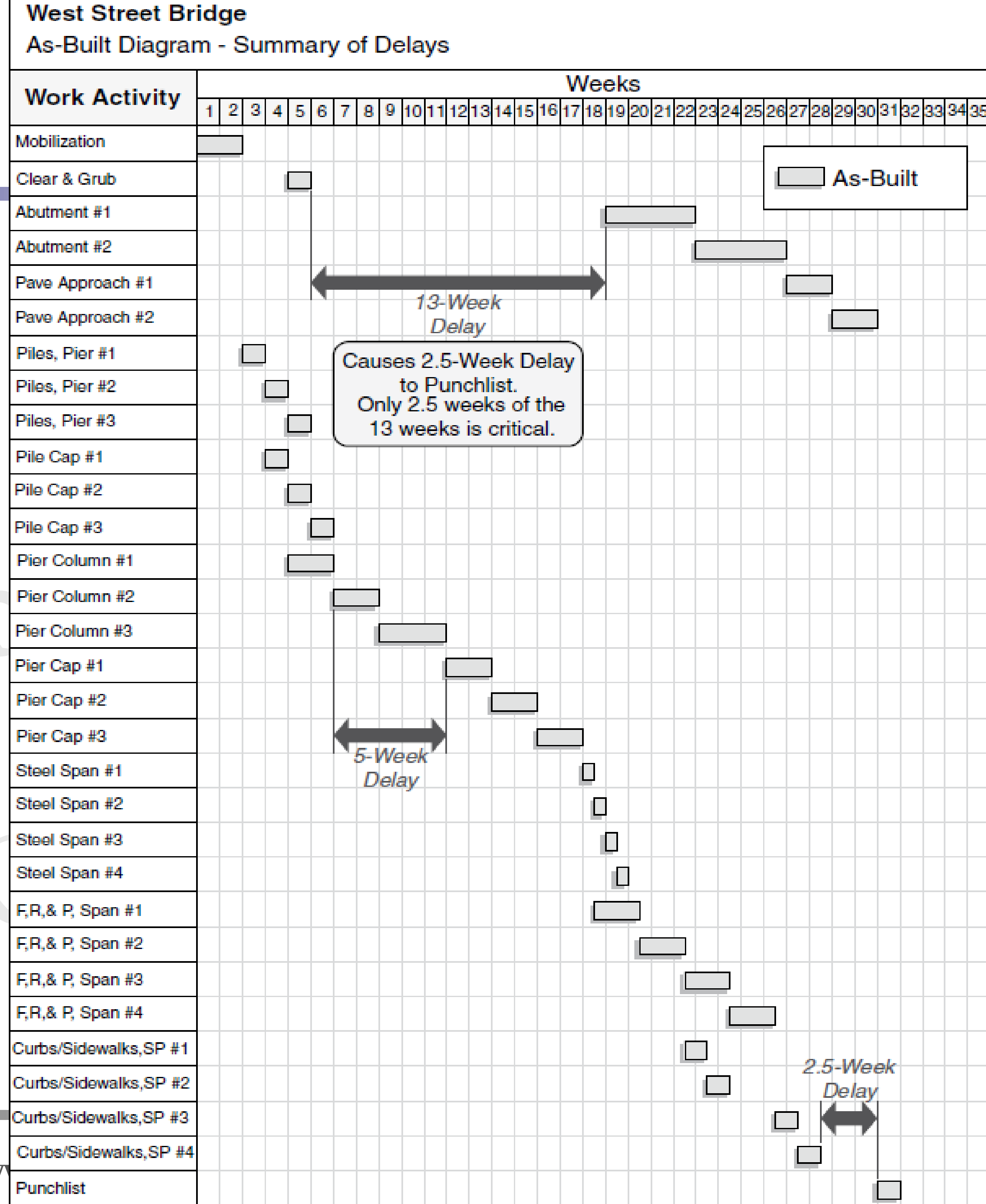
- The **remainder of the work** along the **pier/deck path** appears to have been performed in a **logical, sequential fashion** and **does not** indicate **further delay**.



STEP 2

- There is, **however**, a **gap** between the **completion** of the **curbs** and **sidewalks** and the **beginning** of the **punch list work**.

- The **punch list work** did **not start until** the **abutments** and **approaches** were completed.

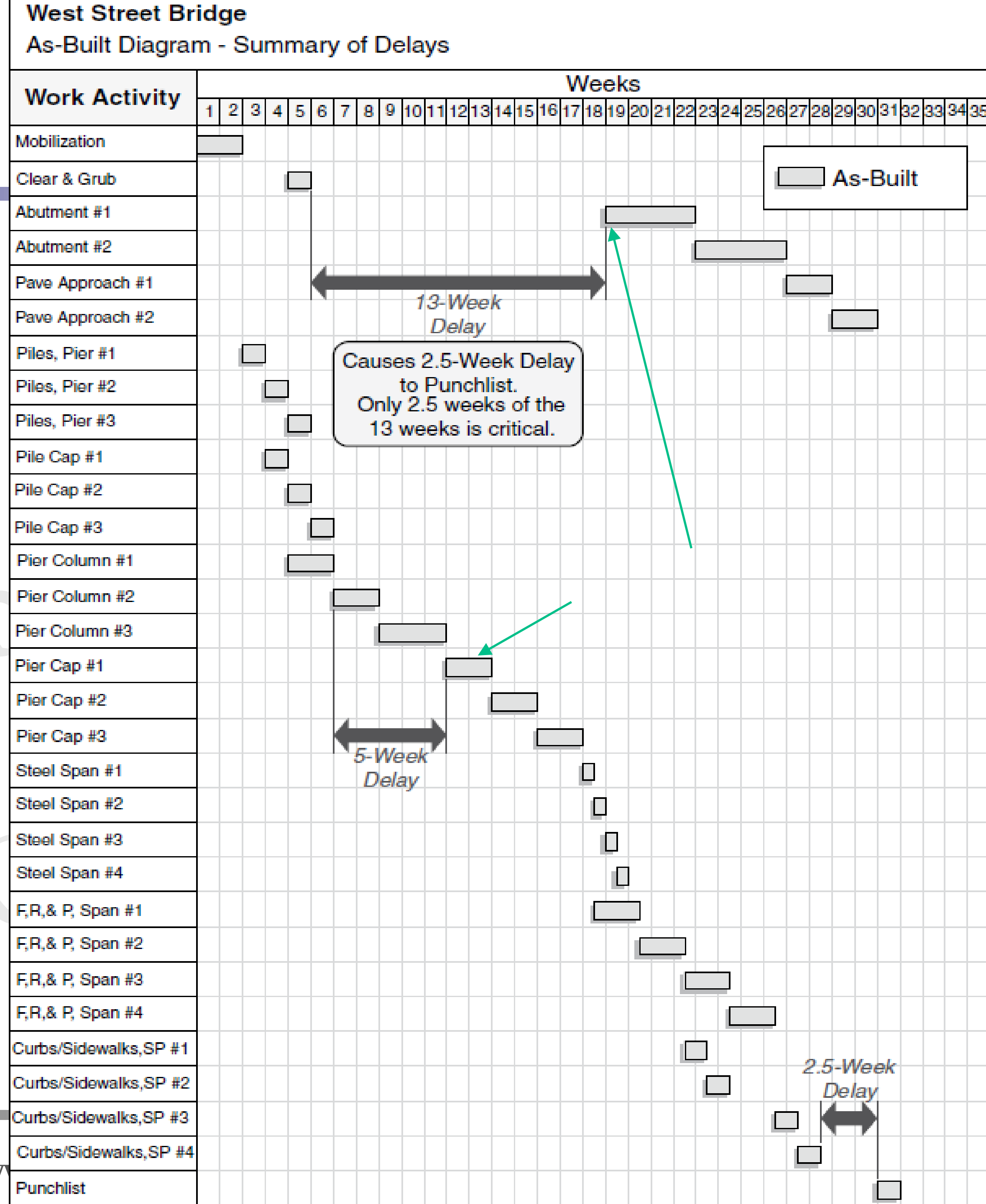


STEP 2

- The **delay of seven and one-half weeks** is from:

(1) Five weeks of delay to the **start** of the **pier cap work.**

(2) Two and one-half weeks of delay to the **start** of the **abutment/approach work**.



فرآیند جامع آنالیز تاخیرات در پروژه

بخش نهم:

آنالیز زمانی تاخیرات

آنالیز زمانی تاخیرات بعد از وقوع تاخیر و اختلاف

(After-the-Fact Schedule Analysis)

ارائه دهنده:

سید محمدرضا علوی‌پور

CMAA Authorized Trainer

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

ACEMI

What we will learn?

- After-the-Fact schedule analysis
  - Concepts
  - Retrospective IAP and TIA
  - Time slice windows analysis (TSWA)
  - As-planned vs. as-built windows analysis (APAB)
  - Retrospective longest path analysis (RLPA)
  - Collapsed as-built analysis (CAB)
- How to choose the methods?
- The most three types of logic
- Effects of three logic types on delay analysis

ODCC

After-the-Fact Schedule Analysis

(Concepts)

Why after-the-Fact schedule analysis needed?

- **Contractors frequently assert** that they have been **delayed** for **reasons beyond** their **control**.
- **Owners often remain unconvinced** that the Contractor is legitimately entitled to a **time extension or delay**, **acceleration** and **loss of productivity damages**.
- **Large dollar amounts** may **hinge** upon the **outcome of a dispute** over **project delay**.

Consequently, a thorough retrospective schedule analysis of all project delays is essential for the equitable resolution of delay and impact-related construction disputes.

Why after-the-Fact schedule analysis needed?

- **Owner** may be **contractually** entitled to **recover either**:
  1. **Liquidated damages** for delay caused by the contractor
  2. **Actual damages** for delay caused by the contractor

Observational vs. Modeled

- **Forensic schedule analyses** generally can be **classified** into **two types of methodologies**:

1) **Observational**
   - Observational techniques typically **consist** of using (1) **contemporaneous schedules** + (2) **only modifications** for **obvious** and **significant errors**.

2) **Modeled**
   - Modeled techniques **include** **(1) addition** or **subtraction** of **activities** **and or** (2) **logic** to **model impact events**.

Do we need to change and correct the schedule even after-the-fact?

Why after-the-Fact schedule analysis needed?

- The **Prospective methods** of delay analysis may **no longer** be **appropriate** if the **delay** already **occurred**.
  - **CP 4** should **not be used** in this case
    - ✓ Then, there should be a **provision** that **addresses** the consideration of EOT applications:
      1. **After completion of works**
      2. **After the occurrence of delay events or its impact**

Contracts should include provisions as to what procedure should be used when delays already occurred.

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

- **Courts and boards** typically attach a presumption that **contemporaneous CPM** schedules are **correct** and

  schedules should be **presumed correct unless otherwise** shown to be **inaccurate**.

See, e.g., *Appeal of Santa Fe, Inc.*, VABCA No. 2168, 87-3 B.C.A. (CCH) ¶ 20104 (Aug. 25, 1987) "We do not find that the November revisions were necessary to "correct" the October CPM. Rather, the November CPM merely reflected a different plan for further prosecution of the work which differed from the previous plan. However, the adoption of an alternate method of performance in the later CPM does not, of itself, contradict the existence of a delay as shown in the preceding CPM. There is a rebuttable presumption of correctness attached to CPM's upon which the parties have previously mutually agreed. In the absence of probative evidence, not present in this appeal, that the delay shown was not in fact sustained we will rely on the October CPM for the period it was in effect, i.e., through the end of November 1981. For the subsequent period, we will rely on the November CPM. To put it another way, in the absence of compelling evidence of actual errors in the CPM's, we will let the parties 'live or die' by the CPM applicable to the relevant time frames."

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

- **Changes** to schedules made after the fact, such as **after project completion**, should be **limited to special circumstances**.
  - Changes to the schedules may include changing
    1. Activity durations,
    2. Logic,
    3. As-built dates,
    4. Constraints, or
    5. Other schedule information often kept in the schedule software.

When changes may be appropriate?

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

- When **significant errors** are found in the schedule, **after-the-fact schedule** adjustment to fix the errors **may be allowable**.

See, e.g., *Neal & Company, Inc. v. U.S.*, 36 Fed. Cl. 600 (1996) analysis accepted where government's expert prepared a new baseline schedule after the project to add in logic ties for labor that were missing, then re-updated the schedule.

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

❖ For example, <u>logic errors</u>, <u>missing scope</u>, or <u>palpable incorrect durations</u> may have to be **adjusted** before utilizing the schedule for **delay analysis purposes**.

See, e.g., *Appeals of States Roofing Corp.*, ASBCA No. 54860, 10-1 B.C.A. (CCH) ¶ 34356 (Jan. 12, 2010) "In any event, the credible evidence supports the finding that the adjustments [contractor's expert] made were exactly as he described them: minor corrections to logic errors relating to submittals. The Navy did not dispute that there were such logic errors in the schedule and, to the extent there were, we consider correction of them to be in keeping with good scheduling practices.");

Which <u>logic</u> should be corrected?
Should we also change discretionary constraints?

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

10.5 Changes to schedules generally may be made to correct **necessary physical** or **contractual constraints**

but typically **not the contractor's preferential sequencing**

*CPM schedules generally should be **modified** only after the fact to **correct errors** in physical constraints or contractual constraints*

The burden of proof of changing lies with whom?

Changing schedules after-the-fact

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

- **Burden of proof** of changing the schedules **after they are prepared and used during the project**

  lies with the **party making the changes**.

  As a result, any changes made after the fact should be made with good justification and be carefully documented and explained.

  See, e.g., *J. A. Jones Construction Co.*, ENGBCA No. 6252, 97-1 B.C.A. ¶ 28,918 (1997) "The more a contractor departs in litigation from its contemporaneously-prepared schedules, the greater the need to explain and justify the reasons and assumptions underlying such departures."

So, let's look at the FSA methods?

FSA methods

- There are **several industry accepted methodologies** for **forensic schedule analysis**.
- **SCL** says **four forensic** methods
- **AACE** says **nine forensic** methodologies
- **Others** say **seventeen or more**
- **An argument** could be made for a **near infinite number**

- We will discuss **major types**

In order to avoid or at least minimize disputes over methodology, it is recommended that the parties try to agree an appropriate method of delay analysis for both contemporaneous and after-the-fact.

FSA methods – SCL Protocol

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	• Logic linked baseline programme. • Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	• Baseline programme. • As-built data.
Retrospective Longest Path Analysis	Effect & Cause	Retrospectively	Retrospectively	• Baseline Programme. • As-built programme.
Collapsed As-Built Analysis	Cause & Effect	Retrospectively	Retrospectively	• Logic linked as-built programme. • A selection of delay events to be modelled.

FSA methods - AACE RP29R-03

Observational	As-Planned As-Built	Gross	As-Planned vs. As-Built (MIP 3.1)
		Periodic	As-Planned vs. As-Built (MIP 3.2)
	Contemporaneous Period Analysis (Windows)	Contemporaneous As-Is	Contemporaneous Period Analysis (MIP 3.3)
		Bifurcated Contemporaneous	Bifurcated CPA (MIP 3.4)
		Recreated / Modified	Recreated CPA (MIP 3.5)
Modeled	Time Impact Analysis	Single Base	Impacted As-Planned (MIP 3.6)
		Multiple Base	Retrospective TIA (MIP 3.7)
	Collapsed As-Buiult	Single Simulation	Collapsed As-Built (Single) (MIP 3.8)
		Multiple Simulation	Collapsed As-Built (Multiple) (MIP 3.9)

FSA methods – Comparison

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					

The table above shows the evidence required for each delay analysis method. The table has been simplified.

After-the-Fact Schedule Analysis

(Retrospective IAP and TIA)

Retrospective time impact analysis – Definition

- **AACE** Talks about this **method**
- **Very similar** to **prospective time impact analysis**

1. **Baseline** can be **used** for this analysis (**Impacted as-planned**)
2. **Contemporaneous update** can be **used** for this analysis (**Retrospective time impact analysis**)

- AACE **method implementation protocol (MIP) 3.7and 3.8** say:
  - ✓ **Impacted as-planned** is **less accurate** than **retrospective time impact analysis.**

Retrospective time impact analysis – How to use?

1. Take a **contemporaneous schedule and revise** it based on **actual** situation = **As-built**
2. Take a **delay event**
3. Use its **actual duration (start** and **finish** times**)**
4. **Insert actual duration** and a **delay event** into the **contemporaneous schedules** that is **revised to date = As-built**
5. **Show** that **event's alleged impact** on the **contractor's update**.

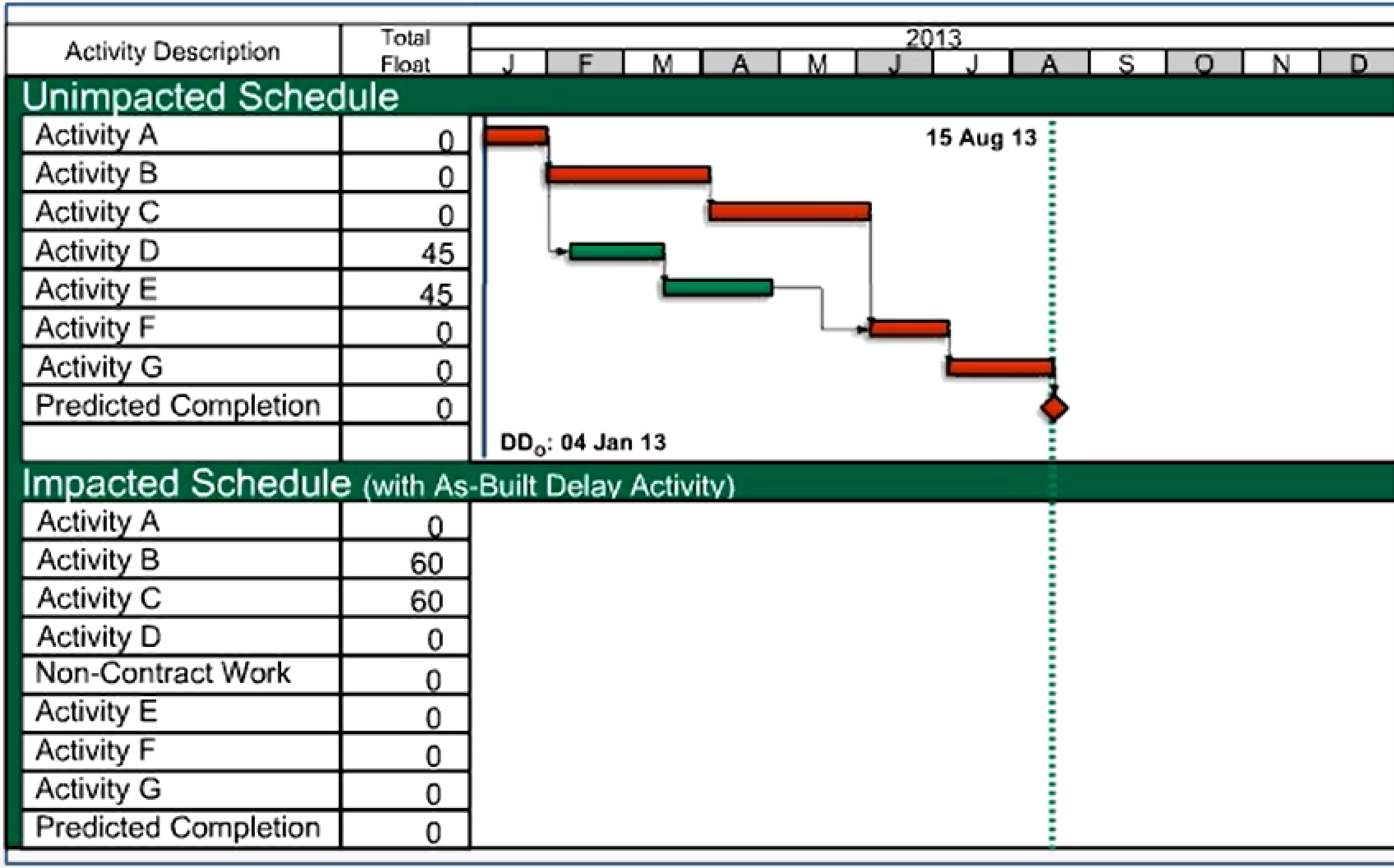
Unimpacted Schedule

- Impacted As-Planned uses the original baseline schedule as the unimpacted schedule.
- TIA typically uses one of the updated schedules, though implementations vary..

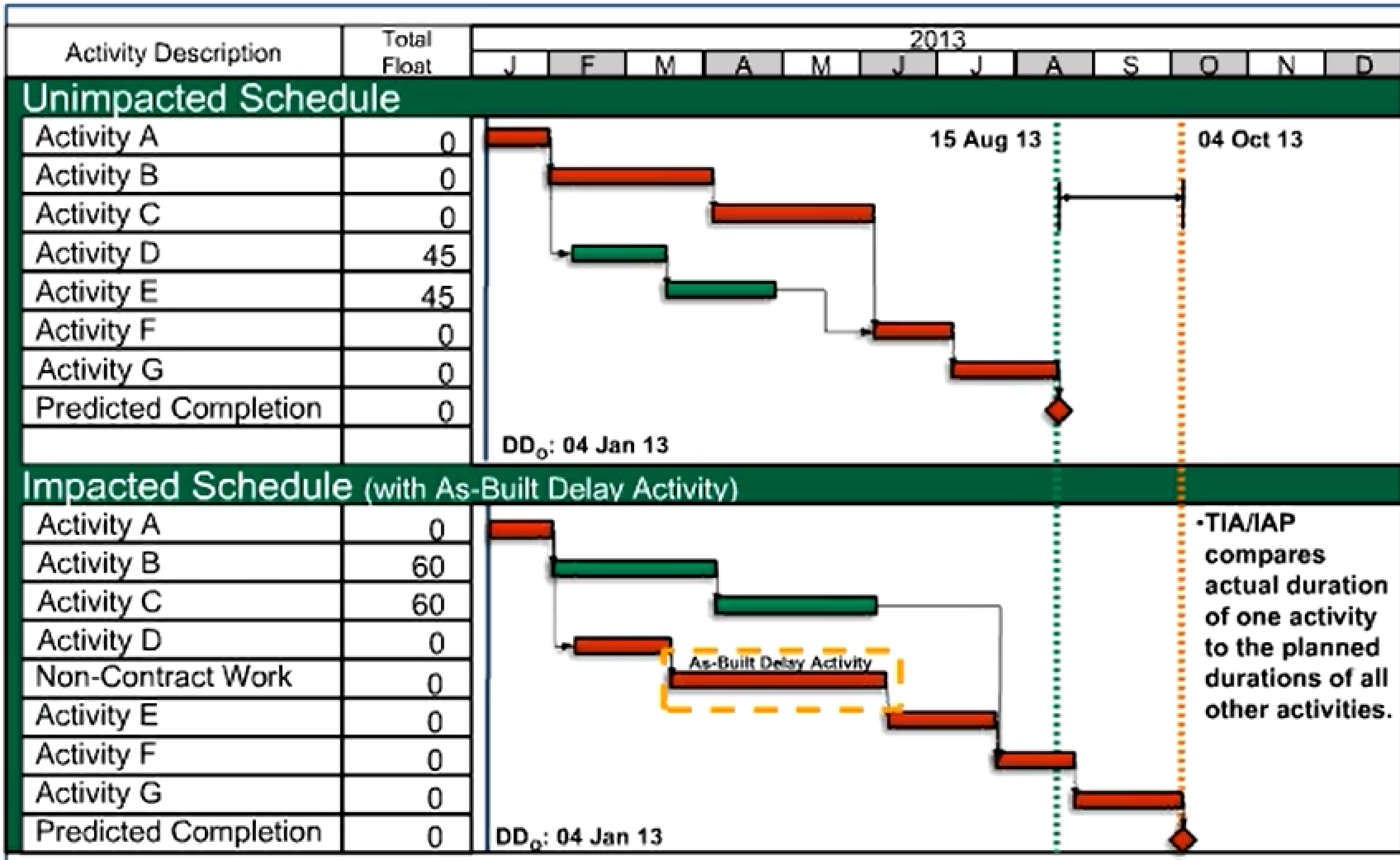
Impacted Schedule

- Schedule with an identical data date, and which is logically identical to the Unimpacted Schedule, except for the As-Built Activity.
- As-Built Activity is inserted into the network, logically tied into the impacted activity.

Retrospective time impact analysis – Example



Retrospective time impact analysis – Example



Retrospective time impact analysis – Example

General Information

Project Planned Start Date : 12,March,2012.

Project Planned Finish Date : 22,April,2013.

Available Updates Programme : 4 Programme

Retrospective time impact analysis – Example

- This has **not been performed event by event** because we don't know whether EDE or CDE occurred first in many places! **NON-INTEGRATED**

How to handle **concurrent delays**?

Window Technique – Case study- Window 0

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay: Contractor	Delay: Employer	Total Entitlement
W0	10-Mar,2012	10-Apr,2012	31	P0	Appr. Baseline A.01	22,April, 2013	0	0	
				P1	P0+Delay Events	13,May, 2013		21	
				P2	P1+Progress update on DD	14,May, 2013	1		
Total Window Entitlement									22

Retrospective time impact analysis – Example

Window Technique – Case study- Window 1

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W1	11-Apr,2012	31-Dec,2012	264	P3	Approved P2	14,May, 2013	0	0	
				P4	P3+Delay Events	25,May, 2013		11	
				P5	P4+Progress update on DD	3,Jun , 2013	9		
Total Window Entitlement									20

ODCC

Retrospective time impact analysis – Example

Window Technique – Case study- Window 2

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W2	1,Jan,2013	1,Feb,2013	264	P6	Approved P5	3,Jun , 2013	0	0	
				P7	P6+Delay Events	9,July, 2013		36	
				P8	P7+Progress update on DD	21,July, 2013	12		
Total Window Entitlement									48

Retrospective time impact analysis – Example

Window Technique – Case study- Window 3

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W3	2,Feb,2013	22,Apr,2013	79	P9	Approved P8	21,July, 2013	0	0	
				P10	P9+Delay Events	15,Aug, 2013		25	
				P11	P10+Progress update on DD	15,Sep., 2013	31		
Total Window Entitlement									56

Retrospective time impact analysis – Example

Window Technique – Case study- Summary

Window	Window Start	Window Finish	window Duration	Programme	Programme	Project Finish Date	Delay		Total Entitlement
							Contractor Delay	Employer Delay	
Window 0	10-Mar-12	10-Apr-12	31	P0	Approved BaseLine	22-Apr-13	0	0	
				P1	P0+Delay Events	13-May-13		21	
				P2	P1+Progress update on DD	14-May-13	1		22
window 1	11-Apr-12	31-Dec-12	264	P3	Approved P2	14-May-13			
				P4	P3+Delay Events	25-May-13		11	
				P5	P4+Progress update on DD	3-Jun-13	9		20
Window 2	1-Jan-13	1-Feb-13	31	P6	Approved P5	3-Jun-13			
				P7	P6+Delay Events	9-Jul-13		36	
				P8	P7+Progress update on DD	21-Jul-13	12		48
Window 3	2-Feb-13	22-Apr-13	79	P9	Approved P8	21-Jul-13			
				P10	P9+Delay Events	15-Aug-13		25	
				P11	P10+Progress update on DD	15-Sep-13	31		56
Total Entitlement							**53**	**93**	**146**

Retrospective time impact analysis – Pros and cons

- ✓ **Specifically designed** to measure project delay caused by **added or changed** work that was **not included in the project schedule**.
- ✓ **Sisters** to prospective time impact analysis
- ✓ Recognized by **Federal boards** in USA
- ✓ Can be **acceptable** analysis solution for **complicated networks**

Retrospective time impact analysis – Pros and cons

- × **Can** be **extremely complicated**
- × **Subject** to excessive **expert decision making**
- × **Susceptible** to **unintended** or **intended manipulation**
- × **Extremely sensitive** to the order of **fragnet insertion**
- × **True concurrency** and **primacy of delays** may be **ignored**
- × **Nature or cause** of the delay.
  - × Some delays may be caused by the **addition of work**
  - × **Suspension delays** occur because work cannot occur.
    - × **Despite this difference**, the Retrospective TIA treats these causes of delay the same.

Retrospective time impact analysis – When to use?

- When there are
  1. Logic linked baseline schedule
  2. Delay events to model
  3. Contemporaneous schedules with process information

*In summary, the Retrospective TIA, though widely used, is problematic on many levels. If used, it should be used with **great caution**.*

After-the-Fact Schedule Analysis

(Time Slice Windows Analysis (TSWA))

FSA methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	• Logic linked baseline programme. • Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	• Baseline programme. • As-built data.
Retrospective Longest Path Analysis	Effect & Cause	Retrospectively	Retrospectively	• Baseline Programme. • As-built programme.
Collapsed As-Built Analysis	Cause & Effect	Retrospectively	Retrospectively	• Logic linked as-built programme. • A selection of delay events to be modelled.

FSA methods

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					

The table above shows the evidence required for each delay analysis method. The table has been simplified.

Time slice windows analysis – Definition

- **Also** referred to **"snapshot"**, **"windows"** and **"contemporaneous period"** analysis
- Commonly used **observational method**
- It requires a **reliable series** of **contemporaneously updated baseline (TIME SLICES)** schedules reflecting an **accurate status** of the works at various snapshots (**being the time slices**).
- **Most experts** say that this is the **most accurate method**.

Why?

Time slice windows analysis – Definition

- **SCL Protocol:**
  - The **series of time slice programmes** reveals
    1. **Contemporaneous or actual critical path** in **each time slice period** as the works progressed and
    2. **Critical delay status** at the **end of each time slice**,

       thus allowing the analyst to conclude the **extent of actual critical delay** incurred within **each window**.

       *Thereafter, the **analyst investigates** the project records to determine **what events might have caused** the identified critical delay in **each time slice period.***

Time slice windows analysis – Definition

- AACE **method implementation protocol (MIP) 3.3, 3.4 and 3.5** say:
  - **Most often** performed **after project completion (retrospective)**, but **can** be done while project is **ongoing** as well.
  - **Compares** **two schedules** with **successive data dates** in order to determine the **driving critical activities**.
  - **Relies heavily** on the **contemporaneous** understanding of **criticality**
    - ✓ Because **every time** the **critical path** may **change**

Time slice windows analysis – How to use?

Pre-impact Schedule

- Most recently accepted schedule with a data date prior to the event.
- Schedule may also be updated to the day prior to the event.
- Does not contain the fragnet.

Post-impact Schedule

- Schedule which is logically identical to the Pre-Impact Schedule, except for progress.
- Does not need the fragnet (though it may be inserted with actual dates for record keeping).
- Recalculated as of the next appropriate data date.

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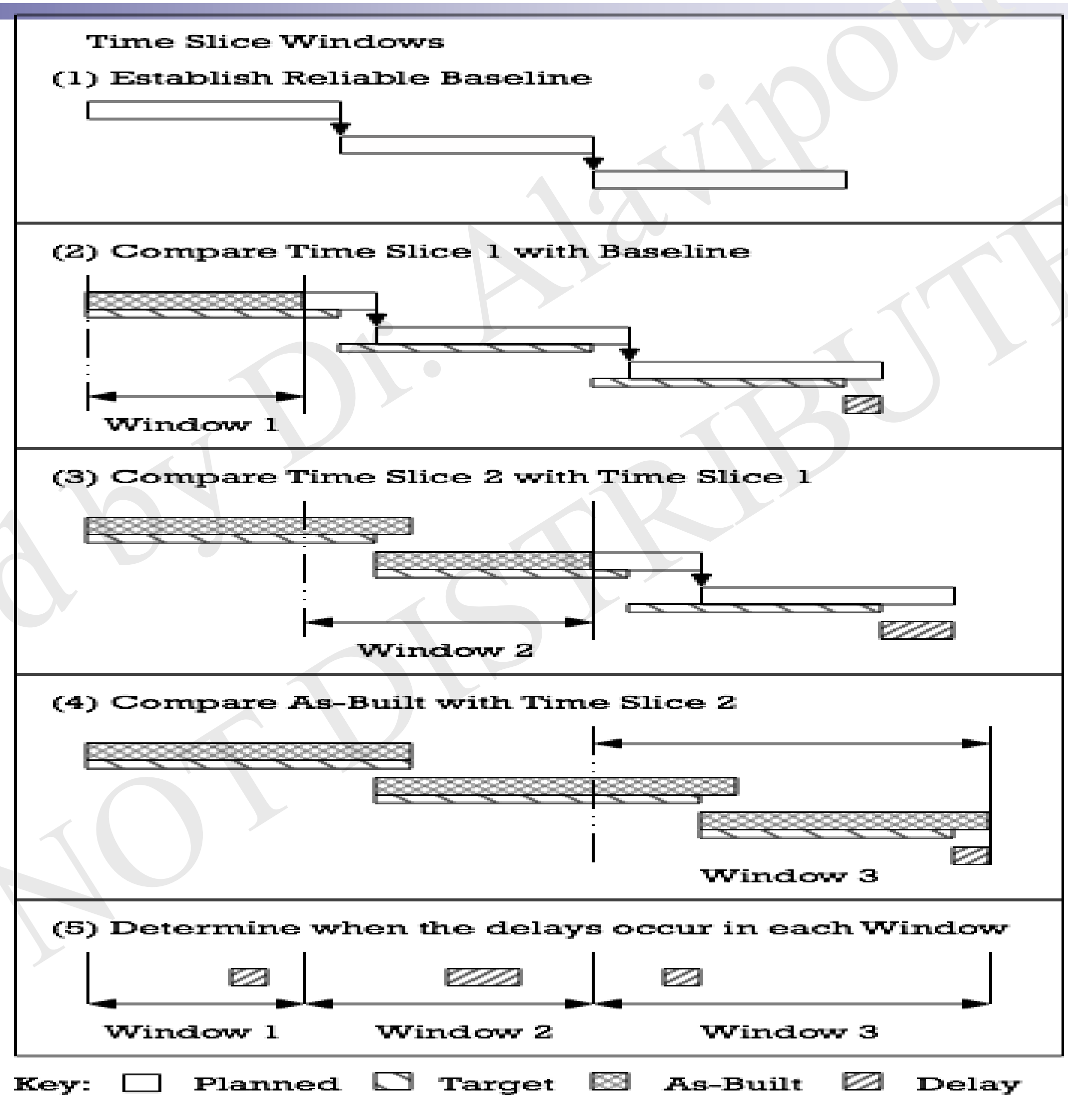
Time slice windows analysis – How to use?

1. **Logic linked baseline schedule** is **updated** at **regular intervals**, **usually monthly**.
2. **Each update** provides a **"snapshot"** status or **"time slice"** at the **point in time**.
3. The **analysis** at the **start** and **end** of **each window** are compared to assess
   1. **How much delay** occurred
   2. Identify **which activities** were **delayed**

   within each window.
4. Thereafter, the analyst **investigates** the **project records** to **determine** what **events** might have **caused** the **identified critical delay** in **each window**.

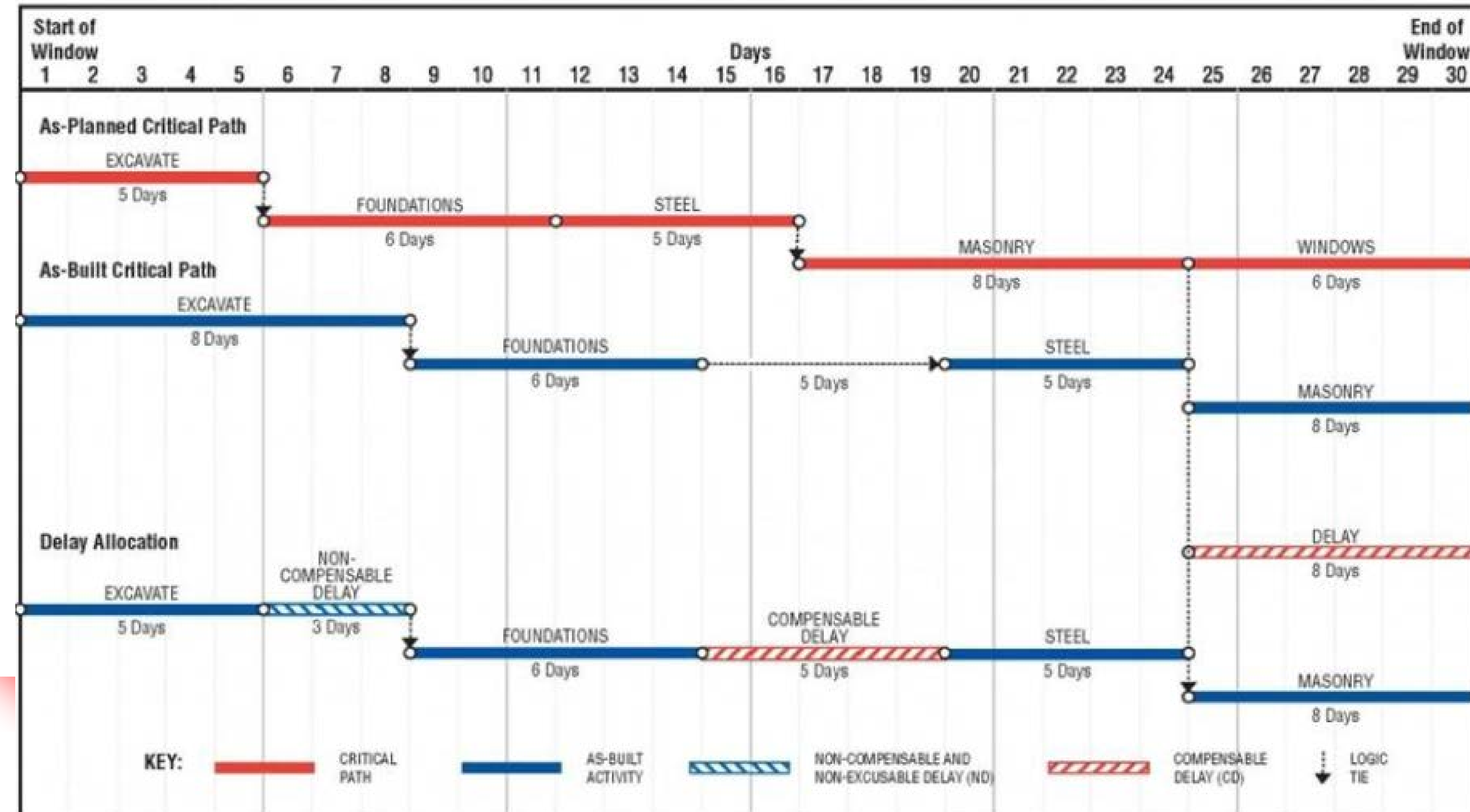
*For **each time slice schedule** the analyst **needs** to **verify** that the **historical components** reflect the **actual progress of the works**.*

Time slice windows analysis – Example

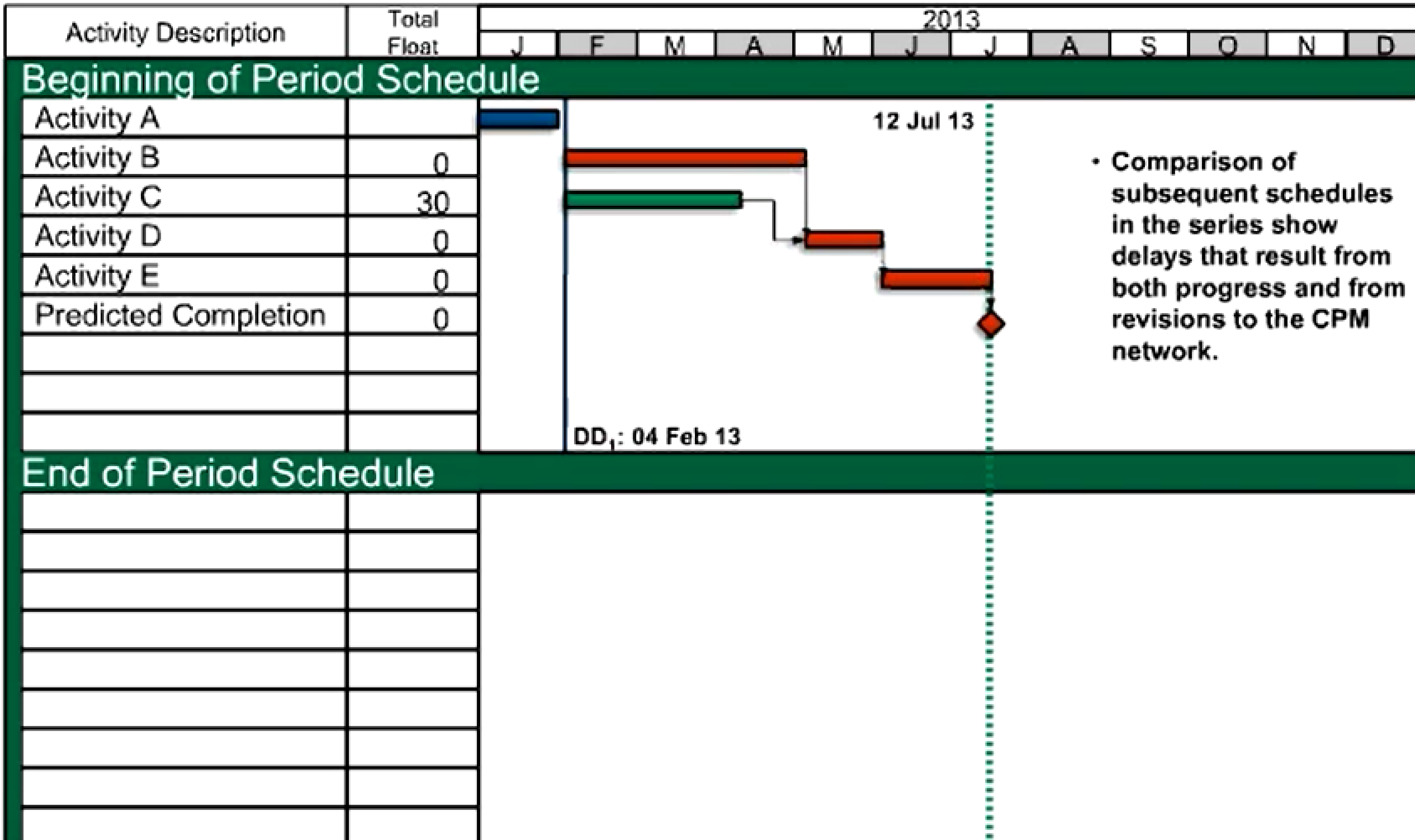


Time slice windows analysis – Example

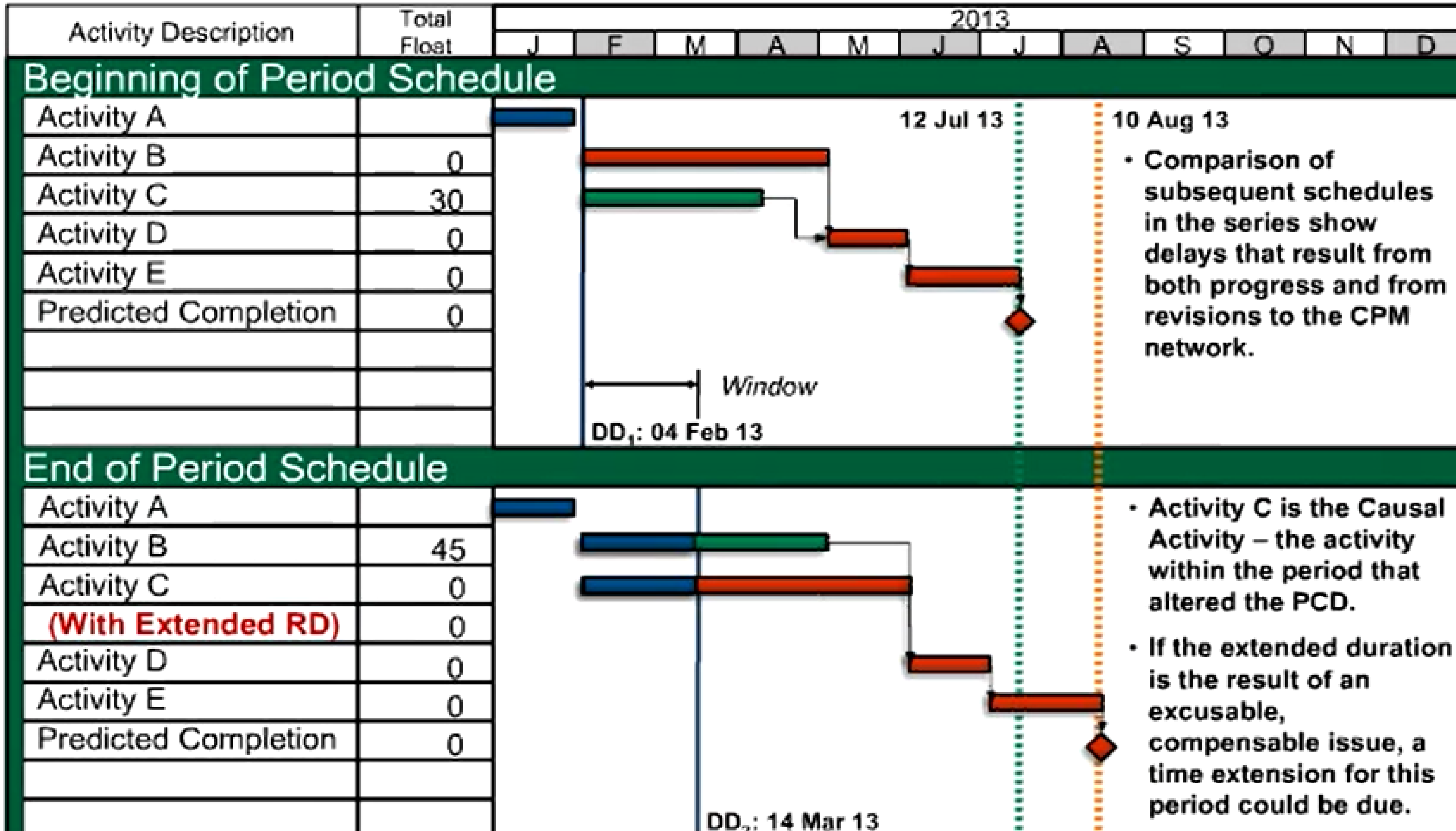
- Prepare the table of CDE, EDE, and concurrent from the as-built data.
  - For this purpose we need to adopt window-based approach on the occurrence of a delay



Time slice windows analysis – Example

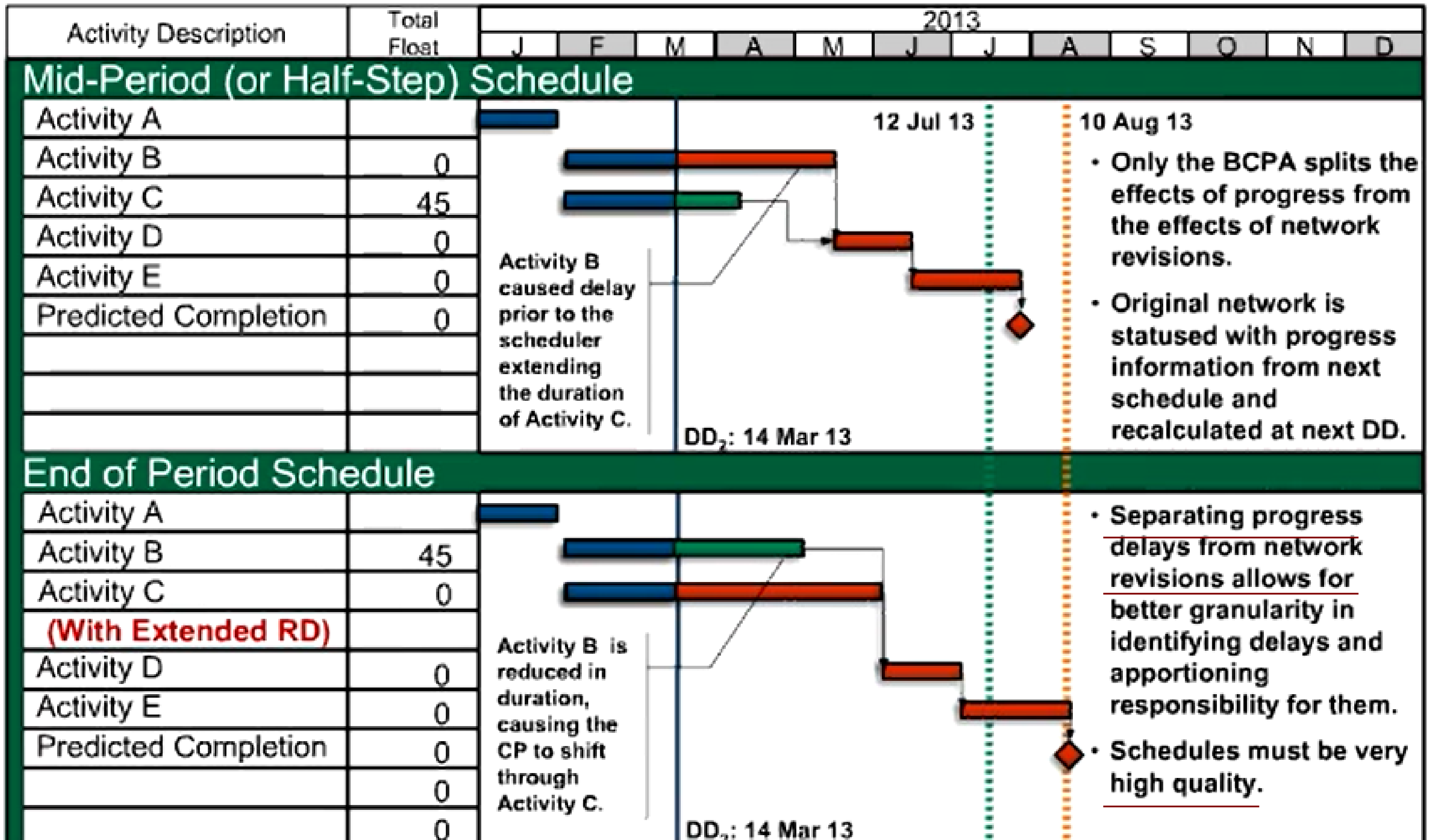


Time slice windows analysis – Example



Time slice windows analysis – Example

BCPA = BIFURCATED CONTEMPORANEOUS PERIOD ANALYSIS



Time slice windows analysis – Example of court decision

Contractors need to anticipate that a court or board may express a preference for contemporaneously updated schedules over after-the-fact as-built schedules when assessing delay claims. The decision of the Armed Services Board of Contract Appeals, *Hedgecock Elec., Inc.*, ASBCA No. 56307, 12-2 BCA ¶ 35,086, illustrates this point.

Time slice windows analysis – Pros and cons

- ✓ Divides the project into manageable time periods, and therefore reflects the impacts on periodic basis.
- ✓ **Extremely accurate** if: (1) **accurate updates (contemporaneous schedule)** and (2) **bifurcated methodology**
  - ✓ **But not always** all of them
- ✓ **Probably** the **most** widely **used** by **experts**
- ✓ **Commonly accepted retrospective** analysis technique by almost **all courts**
- ✓ **Dynamic analysis** (**contemporaneous critical path**)
- ✓ **Can** be used for **after-the-fact** schedule (**retrospective delay impact**)
- ✓ It **considers actual progress** and **changes (not hypothetical)**
- ✓ **Concurrent delays** can be considered
  - × If windows are large, it could also cause a problem

Time slice windows analysis – Pros and cons

- **Contemporaneous** schedule updates must be **validated** as **accurate**
  - **Systematic schedule updates** are required.
- **High** in terms of **cost** and **time** (more than other methods)
- **Subjective** in that choice of **window affects outcome**
  - If **one window** (**update**) is **not accurate**, the **result** will be **subjective**
- It **requires** a **detailed data** to analyze

Time slice windows analysis – When to use?

- When we have a **reliable series** of **contemporaneously updated baseline** schedules reflecting an **accurate status** of the works at **various snapshots** (being the **time slices**). It has **three criteria**:

1. The **logic linked baseline** must be **detailed** and **no flaws** be in the schedule
2. The **historic element** of each **snapshot schedule** must be developed from **accurate** and **detailed as-built data**
   - If **regular detailed progress** data is **not available**, then it is **highly unlikely** that this method can be **used**
3. The **future element** of **each snapshot schedule** should **accurately** and reasonably represent the **status** of the **works** on the **analysis date**.

Time slice windows analysis – Practical procedure

- The **steps** for performing a **contemporaneous period analysis** are summarized below:

1. Become familiar with the project and relevant documents
2. Perform a high level review of the available project schedules
3. Select schedule windows
4. Identify the critical and near-critical paths
5. Perform a detailed review of the schedules selected for the analysis
6. Determine the changes made between the schedules selected for the schedule windows
7. Make copies of the analysis schedules and implement necessary corrections
8. Develop variance tables to calculate date and duration variances
9. Research activity impacts and allocate responsibility for delays
10. Sum and document the results

Time slice windows analysis – Practical procedure

1. **Become familiar with the project and relevant documents**

- **Review** the **contract** and **understand** the **contract documents**
- **Note** any **contract provisions** pertaining to a **claim situation**
- **Understand** the **contract completion dates**
  - **Specify** if the **contract** requires **any interim completion milestones prior** to **overall project completion**.
- **Evaluate change orders** to **understand** how the **contract** has been **modified** and **if any time extensions** have been **executed** as part of any **change orders**.
- **Review contract scope of work** and **know** the **parties** to the **contract**.

Time slice windows analysis – Practical procedure

2. **Perform a high level review of the available project schedules**

- **Electronic schedules** should be provided.
- **Analyst** should **review** the following:
  1. **Available schedules**
  2. **Number of activities** and **relationships** in each available schedule file
  3. **Changes** that **occur** **between** each of the **contractor's schedule updates**

Time slice windows analysis – Practical procedure

2. Perform a high level review of the available project schedules

- **Contractors** are required to provide **monthly schedule updates**, **but additional updates** may be **available** that model **certain impacts** or "**what-if" scenarios** completed by the contractor.
  - Additionally, a **prudent contractor** on a **large** and or **difficult project** may elect to:
    1. **Update** the schedules **more than once a month**
    2. **Update** a schedule in **conjunction** with a **large impact or change order**

Time slice windows analysis – Practical procedure

2. Perform a high level review of the available project schedules

- **After initial review**, **several schedule** should be selected for a **more thorough review**.

Items to review and note include:

1. Activity ID structure
2. Level of detail in activity names
3. Existence and quality of a work breakdown structure and/or activity coding
4. Open-ended activities
5. Number and types of activity constraints
6. Calendars used and the types of activities assigned to each calendar
7. Cost and resource loading assignments

Determine which activity will be used to track the completion of the project. It can be final or substantial completion.
This activity will be used in the delay analysis to quantify delay in each schedule window.

Time slice windows analysis – Practical procedure

3. Select schedule windows

- **Now**, the **analyst** has an **understanding** of **contract requirements** and **project schedules**.
- The **analyst now** should **select** the **schedules** that will be used as the **beginning** and **end** of the **schedule windows**.
  - **These windows** become the **periods of time** that will be **studied** in the analysis.

Time slice windows analysis – Practical procedure

3. Select schedule windows

Timing of significant milestones, impacts, and delay events are important factors to select the beginning and end of the schedule windows.

The entire project may not need to be part of the analysis

- **AACE says:**

*Every update may **not be used**. **However**, **every update** should be **considered**.*

*Accuracy is **reduced** if **updates are not evaluated** for **multiple-month periods when schedule revisions** or **changes** in sequence **occurred** to the project plan.*

Time slice windows analysis – Practical procedure

3. Select schedule windows

- Identify the **contractor's as-planned CPM programme** and **contemporaneous progress updates** through to completion.
- **Once the schedules are selected**, the schedule **data dates** establish the **beginning** and/or **ending dates** of the **schedule windows**.

Table 1
Sample Schedule Windows

Window No.	Schedule Window Dates	Schedule Data Date (Beginning of Window)	Schedule Data Date (End of Window)	Length of Window (Cal. Days)
1	21 October 2013 – 28 January 2014	21-Oct-2013	29-Jan-2014	101
2	29 January 2014 – 20 March 2014	29-Jan-2014	21-Mar-2014	52
3	21 March 2014 – 27 July 2014	21-Mar-2014	28-Jul-2014	130
4	28 July 2014 – 25 October 2014	28-Jul-2014	26-Oct-2014	91
5	26 October 2014 – 5 December 2014	26-Oct-2014	06-Dec-2014	42

Time slice windows analysis – Practical procedure

4. Identify the critical and near critical paths

a) Based on total float:

- Determine the **most critical activities** in **each window** by identifying the activities with the **least amount of positive total float** ***(near critical path)***
- Determine the **most critical activities** in **each window** by identifying the activities with the **greatest amount of negative total float**

b) Based on longest path:

- Tasks which were **predecessors to "driving" critical activities** along each path

c) Concurrent as-built critical paths

Time slice windows analysis – Practical procedure

4. Identify the critical and near critical paths

- **Review** and **document** the **critical** and **near-critical paths** for selected **schedule windows**.
- The **paths** then must be **checked** for **reasonableness** (**THIS WILL BE TALKED IN NEXT STEP**).
  - **Constraints**, **lags** and **logics** should be **checked** **before** the **analysis**
  - **Analyst** should **document** these **issues** and **identify** if **corrections** to any activities are necessary.

The coding of the critical and near-critical paths is an important step!

This step is often omitted due to time and budget constraints because it is time consuming to document and determine the actual dates and as-built schedules.

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

- **Upon reviewing** and **coding** the **critical** and **near-critical paths**,
  each schedule should be **reviewed** in **detail**
  to determine **if any schedule corrections** are necessary.

- It is **important** to:
  1. **Evaluate** the **quality** and **reasonableness** of the **schedules**
  2. **Identify items** that may be **necessary** to **correct** to ensure **schedule accuracy**

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

- **Typical items** that can **affect** the analysis include**:**
  1. Excessive number of open-ended activities
  2. Overuse of constraints
  3. Activity and logic changes
  4. Duration changes
  5. Calendar changes
  6. Activities with unreasonably large total float values
  7. Inconsistent use of schedule calculation methods
  8. Incorrect as-built dates
  9. Excessive positive or negative relationship lags

Any deficiencies in any above items should be corrected before critical and near-critical paths are found.

Let's talk about some of them!

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

- **Open-ended activities**
  - One of the **most fundamental quality checks**
  - **Activities** that **lack** a **predecessor**, **successor**, or **both**
  - **Exception** to this is the **project start** and **completion activities**
  - A large number of **open-ended activities** will **create** **float values** and **forecasted completion dates** that may be **incorrect** and they **MUST BE CORRECTED**.

Time slice windows analysis – Practical procedure

5. **Perform a detailed review of the schedules selected for the analysis**

- **Overuse of constraints**
  - Use of a constraint **restricts** the **start or finish of an activity**.
  - The **use of a few soft constraints** is **not bad practice**, however **a large number** of constraints should be **avoided**.
    - This **restricts** the **normal forward and backward path** scheduling calculations.
    - The **misuse** of constraints may **generate** **artificial activity dates** and **float values**.

The analyst must evaluate the relevance of the constraint to determine

(1) Reason for its use

(2) If the constraint should be removed from the schedule

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

Use of calendars

- **Several aspects** of the project calendars **must be considered**.

1. **Calendars themselves should be considered.**
   - ✓ **Note** if the **specific calendars** were **changed** **during the evolution** of the schedules.
     - o A five-day, eight-hour per day calendar may have been changed to a five-day, ten-hour per day calendar.
2. **Note if the calendars include planning for adverse weather.**
   - ✓ A **properly developed schedule** will include **anticipated lost time** due to **inclement weather**.
     - o This should be based on **contractual requirements** and **historic weather data** specific to the geographical area of the project
3. **Determine if activities had a calendar change during the selected schedule window**

Changes between schedule updates are discussed in next step

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

- **Other common schedule deficiencies include the following:**
  - Incorrect and inconsistent use of as-built dates;
  - Activity planned durations that are inconsistent with the Contractor's bid estimate calculations;
  - Missing contractual scope of work;
  - Lack of contractually required completion activities;
  - Overuse of constraint dates;
  - Missing predecessor or successor logic ties creating open-end activities;
  - Inadequate depiction of equipment and materials procurement and delivery activities;
  - Inaccurate predecessor logic for Owner approval activities;
  - Lack of a contractual Owner approval period for submittal and turnover packages;
  - Lack of reasonable project punch list and demobilization periods;
  - Inconsistent use of Calendars, Progress Override and Retained Logic schedule calculation options; and
  - Unrealistic as-built logic relationships indicating out-of-sequence progress.

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

- In **addition** to **deficiencies**, **changes** made between **schedule updates** should be identified.
  - Any **delays** or **acceleration** efforts that **added** or **removed** should be identified.

- **Three common changes:**
  - Logic changes
  - Activity changes
  - Duration changes

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

- **Logic changes**
  - Analyst **must** document:
    1. Any **activity additions** to schedule **logic**
    2. Any **activity subtractions** from schedule **logic**
    3. Any **modifications** to schedule **logic**

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

- **Activity changes**
  - **Check** the **consistency** of **activity IDs** and **names**

If activities are continually changing IDs and names, the analyst may conclude that the contractor's scheduling was not in accordance with industry accepted and standard practices.

In this case, it is very difficult to perform the analysis

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

- **Duration changes**
  - **Contractors** may **modify** the **scope** of an activity by adjusting the **original or remaining duration**

Although this is not the good practice, if the analyst notes a delay to an activity that was caused by increased original or remaining duration of an activity, the changed duration will need to be researched to determine if the increase was justified.

When faced with delays in the schedules, many contractors will simply reduce activity durations to mitigate delay.

This is often done without any basis. These instances must be noted for the analysis.

Time slice windows analysis – Practical procedure

7. Make copies of the analysis schedules and implement necessary corrections

- **Each of the corrections** identified in **prior analysis steps** is **implemented** in **this step** and **each change** must be made in **all of the analysis schedules**.

- **Analyst** should make **copies** of the **original schedule files**, **prior** to making **changes**.
  - **Any changes** to the schedule should be **made** in **copies of the original files.**

- The corrections to the schedules are an acceptable part of AACE 29R-03:

  *The **issue of correcting** the schedule is one of **balance** and **reasonableness** and, for this reason **corrections** should **not be made across the board** or **automatically!***

Time slice windows analysis – Practical procedure

7. Make copies of the analysis schedules and implement necessary corrections

- **Review critical and near-critical paths**
  - The **critical** and **near-critical paths** must be **re-evaluated** to **determine whether if** the **corrections** or **modifications** to schedule cause any **changes** to **critical or near-critical paths**.
    1. If no changes, analyst can proceed to next step
    2. If changed, additional research is required
       - The change should be identified.
       - The validity of the change must be reevaluated.
       - The nature of the change should be discussed and identified.

*In some cases, if the **owner** is **uncertain** and the **project team** is **unavailable** (as is sometimes the case in forensic analysis), the **analyst** must **make a decision** on the **best option** and which **critical path** reflects the work as of the **data date**.*

This decision must not be made in the best interests of the owner, but must reflect the most accurate portrayal of the project record.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- **After identification** and **confirmation** of the **critical and near-critical paths**, analyst should **develop variance tables** for **each window** which calculate
  1. **Date variances** for **each activity** within the **schedule windows**
  2. **Duration variances** for **each activity** within the **schedule windows**

Why we need the variance calculations?

*Because **delays** can be the **result** of*

1. *An activity **not starting on time** and/or*
2. *An activity **taking longer than planned**,*

*it is **necessary** to perform **variance calculations** for the **date** and **duration** of the activities.*

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- For this step, **analyst** typically **exports** the **activities** and **associated data** to a **spreadsheet.**

Keep a record of the float values for all of the driving activities in a "float map" which tracks the gain and loss of float against each driving activity through all of the the available contemporaneous progress records.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- **Variance tables** should be developed using the **spreadsheets** for the **two schedules** which correspond to the **beginning** and **end** of a **schedule window**.
  1. **Each spreadsheet** will be the **summary** of the **window**
  2. **Each spreadsheet documents** the **variance** (**gain** or **delay**) for each activity's
     - Original duration
     - Remaining duration
     - Start date
     - Finish date

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

Table 2
Sample Variance Table

Activity ID	TF (Days)	Activity Status	LI CP	05-Sep-13 OD (Days)	05-Oct-13 OD (Days)	OD Var. (Days)	05-Sep-13 Start Date	A	05-Oct-13 Start Date	A	Start Var.
D1590	-51	Not Started	CP1	8	8	0	07-Oct-2013		14-Nov-2013		38
M1500	-45	Not Started		1	1	0	13-Sep-2013		22-Oct-2013		39
M2010	-43	Not Started		6	4	-2	11-Sep-2013		11-Oct-2013		30
S1480	-51	In Progress	CP1	10	13	3	24-Jun-2013	A	24-Jun-2013	A	0
S1620	-45	Not Started		5	12	7	07-Sep-2013		17-Oct-2013		40
S1760	-38	In Progress		9	9	0	03-Sep-2013		05-Sep-2013	A	2
S1835	-51	In Progress	CP1	6	6	0	28-Jun-2013	A	28-Jun-2013	A	0

TF – Total Float CP – Critical Path OD – Original Duration A – Actual Var. – Variance

- Finish variance and remaining duration variance not shown.
- Activity name has been omitted , but should be included.
- This should be prepared for each window.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- **After** the **table** is **developed**, the **spreadsheet** should be **filtered** for the **critical and near-critical activities** to determine which activities are the **causes of delays** in the **window**.

- The **activities** that are **found** to be the **causes of delay** in **each window** may be **referred** as **critical path originating activities**.

- **These activities** must be **researched** to **determine** the **allocation of delay**

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

Investigate the cause of delay to the driving activities in each period where a measurable loss or gain is identified

- For **each critical path identified** in the **prior step**, the **schedules** and **contemporaneous project documentation** must be **researched** to:

  determine the **factor or factors** that may have **caused** the **start delay** and/or **extended activity duration**.

- **Activities** and **logic** may have been **modified** as **acceleration measures**, or **delay** may have been added via **duration adjustments**.
  - **If** these instances are **noted**, the **project record** must be **analyzed** to determine **if** these **changes** were **supported**.

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

- **Determine** the **factor or factors** that **may have caused** the start delay and/or extended activity duration
- A **sample** of **documented critical paths**, **originating activities**, and **delay summary** are included in the table below:

Table 3
Critical Paths and Originating Activities

Critical Path	Activity ID	Activity Description	Delay Summary
1st Critical Path	A1800	Excavate for Sump A19	22 day finish delay
	A1790	Install Sump A19	15 day start delay due to excavation – OD/RD decreased from 12 to 4 days
	A1810	Excavate for Underground Sump Tank	5 day OD/RD decrease
2nd Critical Path	P1825	Complete Pipe delivery for 30" Raw Water Line	36 day finish delay
	P1775	Install Raw Water Piping	15 day finish delay
	P1750	Backfill Raw Water Piping	8 day start delay and 25 day finish delay

OD – Original Duration RD – Remaining Duration

How to allocate responsibility? Let's see my approach!

ذکر مطالب فوق

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

1. **If there is one type of delay in each window (EDE, CDE, or concurrent)**
   a) If Delays to the originating activities > total delay recognized in the window

      the **contractor most likely** implemented **acceleration measures** in the schedules for the **window**.

      ❖ Although the **maximum delay is 36 days**,

      if the **total delay** was **ten days during the window**,

      the analyst would allocate the ten days of delay, not 36 days.

   b) If Delays to the originating activities = total delay recognized in the window

      You can easily allocate all delays

   c) If Delays to the originating activities < total delay recognized in the window

      There should be a problem and you should review the result

What if there are two or more types of delays in a window?

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

2. If there two or more types of delays in each window (EDE, CDE, or concurrent)

a) If you have updates immediately **before and after** the time when each different type of delay occurs ***(bifurcated updates)***

There would be no difficulty to calculate (similar to Case 1)!

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

2. If there two or more types of delays in each window (EDE, CDE, or concurrent)

b) If you do not have bifurcated updates and other delays also exist in a window

i. If EDE (10) + CDE (5) = total delay recognized in the window (15)

No concurrent delays = *Allocate based on each delay*

ii. If EDE (10) + CDE (5) > total delay recognized in the window (12)

a) Primacy of delays = *One that occurred first may have created float for others*

❖ *You may perform **collapsed as-built analysis***

b) Concurrent delays = *May concurrent delay exists in the window **(3).***

❖ *If you don't know the **time of occurrence**, you need to accept functional theory and overlook primacy of delays*

EDE = 10 -3 = 7 & CDE = 5 – 3 = 2, Concurrent = 3

iii. If EDE (10) + CDE (5) < total delay recognized in the window (17)

There should be a problem and you should review the result

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

<u>Apportion responsibility</u> for the loss or gain measured in each window by reference to the driving activity and causative events documented in the contemporaneous records.

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

- It is also **necessary** to research any **potential weather impacts** during the **window** to **determine** if **part**, or **all**, of the delay is **due to adverse weather**.

- **Lost time** due to **inclement weather** may change the **apportionment of delay** **if** the **weather delay** is **concurrent** with a **contractor delay**.

- **Weather delays** that are **excusable**, may **not be compensable**, **however** the **contract terms** should be **reviewed** **prior** to **allocating delay** due to weather.

Time slice windows analysis – Practical procedure

10. Sum and document the results

- The **analyst** must perform these steps and allocation for **each of the schedule windows**.

- **Upon completion** of the exercise, the **total delay allocation** should be **summed** and **documented**.

After-the-Fact Schedule Analysis

(As-Planned vs. As-Built Analysis (APAB))

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش

تهران، بلوار فردوس شرق، مجتمع آبگینه، طبقه سوم اداری، واحد C42

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۵۰

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۴۵

www.dralavipour.com

info@dralavipour.com

@acemi_social

@alavipour_pm

@IRANACEMI

@alavipour_pm

ACEMI