



تدوین و تصویب برنامه جبرانی (Recovery Schedule)

فرآیند اصولی + چکلیست‌ها + مطالعه موردی
(بر اساس سندی از AACE)

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What we will learn?

- ☐ Purpose
- ☐ Overview
- ☐ Applicability
- ☐ Recommended practice
- ☐ Overarching principles
 - ❖ Fairness
 - ❖ Responsibility
 - ❖ Involvement
 - ❖ Timing

What we will learn?

- ❑ Recovery scheduling and process
 - ❖ Brainstorm lessons learned before need
 - ❖ Identify the need
 - ❖ Create the plan
- ❑ Schedule steps for recovery
 - ❖ Clean-up issues and the schedule
 - ❖ Review efficiency of work
 - ❖ Review durations
 - ❖ Review logic
 - ❖ Review resources
 - ❖ Scheduling actions
 - ❖ General scheduling techniques

What we will learn?

- ❑ Recovery schedule submittal
 - ❖ Components
 - ❖ Schedule narrative

- ❑ Additional topics
 - ❖ Resource leveling
 - ❖ Team cooperation
 - ❖ Actual results
 - ❖ Projects with multiple general contractors

What we will learn?

- ❑ A case study for recovery scheduling in transportation

Prepared by Dr. Alavipour
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Reference



Primary reference

aace
International

AACE International Recommended Practice No. 54R-07

RECOVERY SCHEDULING—AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION

TCM Framework: 10.2 – Forecasting
10.3 – Change Management

“A Case Study for Recovery Scheduling in Transportation”

By Chris Carson, PMP, CCM, PSP, DRMP, CEP, FRICS, FAACE, FGPC
and Noah Jones, PSP

What are the purposes of this guideline?

Purpose



Purpose of This RP

- ❑ This recommended practice (RP) for recovery scheduling is intended to provide a **guideline**, not to establish a standard.
- ❑ As a recommended practice of AACE International, this document provides guidelines for the project scheduler to
 1. Create a **professional recovery schedule** or
 2. Assess the **reasonableness** of a recovery schedule necessary **due** to a change of project status and progress that forecasts late completion

Who can benefit?

Overview



Who can benefit from this guideline?

❑ This recommended practice provides guidelines to **assist**

1. Construction entities submitting the recovery schedule (**the contractor**)
2. Entity reviewing the recovery schedule submittal (**the owner or client**)

to develop, analyze, and respond to the recovery schedule in a **fair** and **reasonable** manner.

- ❖ The use of the term “**owner**” also includes the work performed by their agents such as architect and/or construction manager.
- ❖ In this RP, the use of the term “**contractor**” does not indicate whether it is a prime contractor or subcontractor,
as both are contractors and the issues may be applicable to

Alternatives when the project is not on schedule?



Alternatives when the project is not on schedule

- ☐ **Progress** on a project does **not always** proceed as planned.
- ☐ Given a situation where there are no existing contractual or other legal issues to the **contrary**,
 1. Contractor is normally entitled to complete late,
provided that **compensating damages** (if any) are **paid** at the
appropriate time to the owner.
 2. Owner is normally entitled to direct the contractor to **recover lost time**.

*The question of **who is responsible for paying for any increased costs** due to directed recovery efforts is beyond the scope of this RP.*

How to decide about the time when the recovery schedule should be prepared?



The time when recovery schedule should be prepared

❑ **Many contracts** limit the amount of time that the project schedule may indicate as the **current prediction of project completion**

beyond required substantial completion.

1. Should the **current schedule** indicate that the project is behind an amount greater than the allowable time,

the **owner** and/or its agents may direct the contractor to recover lost time and return the prediction of project completion to the needed date.

2. In addition, the **owner** may decide to simply direct the contractor to recover lost time **even if**

1. **Such a clause does not exist** in the contract or

2. That the specified **limit has not been reached**.

**What requirements
before making
decision?**



Owner decision

- ☐ If the **owner decides** to demand a recovery schedule, care should be taken to ensure that
the owner has not ignored, delayed, or rejected
legitimate time extensions for lost time on a project,
while **demanding** that the contractor recover lost time.
- ☐ When that lost time is due to excusable delays (resulting in the contractor earning the
right to time extensions),
whether compensable or not,
the **owner** is at **risk** when requiring a recovery schedule.

What risks exist here for the owner?



Owner risk

- ❑ The issuance of legitimate time extensions on a project, provided in a timely manner and incorporated into the project schedule, will **minimize the risk** to an owner for potential constructive acceleration claims.

Why recovery schedule is very important?



Recovery schedule importance

❑ **Once directed** to recover lost time,

the **contractor** is normally required to create and submit a schedule plan that describes **how this recovery** of time will be **accomplished**.

❖ We call this schedule a recovery schedule.

❑ Recovery schedules are an important aspect of timely project completion and

this is a major reason that requirements for **recovery schedules** are included in most construction contracts for **large projects**.

❑ They are important as a planning tool as well as a vital **medium of communication**

from the contractor to the owner about **changes** to be made to the **schedule** to

bring the forecast for project completion back to an on-time, or

at least acceptable, basis.

Is there any protocol?



Structured approach

- ❑ There is no industry established protocol for the **best way to recover a schedule**, and the **different parties** involved normally have different motivations driving their very different recommended solutions.
- ❑ This RP provides a structured approach that attempts to **reduce construction time**
 1. At the **least cost** and
 2. While **minimizing claims** opportunities.

Where this RP is applicable?

Applicability



When to use this RP?

- ❑ This recommended practice is oriented to critical path method (CPM) schedule analysis and
is applicable only to recovery schedules that take place **during execution of the work**, and
are used to attempt to regain lost time and to cause the project to complete earlier than the current schedule update forecasts.
- ❑ This RP does **not address acceleration schedules** which are designed to
 1. Provide earlier completion than contractually required or
 2. Used to gain time on a project which is **not running behind contractual completion**.



When to use this RP?

- ☐ **Current status** in schedules on projects that require recovery
 1. May indicate **negative float** or
 2. May show **late completion**.

- ☐ In both cases the **goal** is to
 1. Eliminate the **negative float** or
 2. **Bring** the predicted completion date **back** to the earlier, contractual date, or
 3. At least **reduce that delay** to a reasonable minimum.

Overarching Principles

- ❑ The fact that a **contractor submitted** a recovery schedule does not imply or require that the contractor execute the planned changes at **no cost to the owner**.
- ❑ The fact that the owner accepted a recovery schedule does **not indicate owner responsibility** for
time, cost, quality, or material issues arising from the
execution of the plan change.
- ❑ The circumstances and responsibility for the project **being late** (as well as the contract language) should be considered and **documented**
before responsibility may be assigned.
 - ❖ A separate document detailing the assumptions and responsibilities incurred should accompany a recovery schedule
before any such understandings can be assumed (see section on Narrative).

- ❑ The **recovery schedule** should be a reflection of the contractor's intent to take steps to **improve** progress so as to achieve earlier project completion than **currently predicted**.
 - ❖ Generally this earlier progress than predicted is the **contractually agreed** upon completion date.
- ❑ Since a recovery schedule is the formulation of the contractor's plan to recover time, the recovery schedule is created by the contractor.
- ❑ As with the **approved progress schedule**, the recovery schedule is created and managed by and is the responsibility of the contractor.

What if EOT is submitted?



Responsibility

□ If

Difference between acceleration and recovery?

there are **requested time extensions** that are under review by the owner that would **eliminate the need** for a recovery schedule, and

the **owner still requires** the preparation of a recovery schedule,

the **contractor** should notify the owner that the **recovery schedule** might become an acceleration schedule, either

1. **Directed**

2. **Constructive**

with the **associated risks** to the owner.

Difference between directed and constructive acceleration?

Directed acceleration typically occurs when under contract provisions, an owner or construction manager issues a specific order to its contractor to: 1) complete the project earlier than the originally scheduled completion date, or 2) utilize overtime, additional shifts, and/or extra engineering or construction labor, supervision, or equipment to complete the base contract work plus additional or changed work within the original contract time. A general contractor may also issue such orders to a subcontractor. These measures may increase costs that would otherwise not have been incurred.

Constructive acceleration typically occurs when a construction contractor encounters excusable delays, which may be compensable or noncompensable, during its performance of the contract work, such as design changes, added scope, unusually severe weather, differing site conditions, acts of God, or owner-caused delays. Depending on the contract terms, the contractor may then be entitled to a time extension equivalent to the time that the excusable delays extended the project's critical path. The contractor is constructively accelerated when it is not granted the time extension. The contractor must then decide whether to accelerate its performance to meet the mandated completion date and incur increased costs to do so.

What does it mean if the owner accept the recovery schedule?

- ☐ The **owner indicates** his willingness to accept the recovery schedule as an acceptable plan by accepting the submitted revised schedule,
but the **acceptance does not imply** owner participation or direction in the contractor's means and methods,
only that the owner agrees that the plan seems reasonable and the schedule appears to represent the contractor's plan.
- ☐ **Owner acceptance** of the recovery schedule **does indicate** that the **owner agrees** to work within constraints on owner-responsible activities shown in the recovery schedule.

What if the construction manager develops this schedule?

❑ On some projects, the **construction manager** may develop the recovery schedule and when this is the case,

it is **vital that** the **contractors affected** by the **schedule** participate and collaborate with the recovery schedule development.

- ❑ A **lack of timely agreement** on the steps used in the recovery schedule could result in contractor acceleration, cost overruns, late project delivery, and disputes.
- ❑ It is important to keep in mind that **when a recovery schedule is required**, project status and situations already **exist** that have **raised the risk of completion** for the project, so **development and approval** of a recovery schedule should be **carefully thought out**.

- ❑ The **first step** when the owner considers the need to require a recovery schedule is to **review** the contract and specifications for any language that dictates the use of recovery schedules.

What if pertinent language is absent?

❑ Absent that **pertinent language**, a reasonable approach to timing suggests **several factors to consider** in order to make the decision;

1. Extent of slippage of contractual milestones,
2. Amount of time remaining to complete the project,
3. Availability of resources,
4. Existing resource consumption on the project, and
5. Costs of project delay.

Should it be proactive?
How?

❑ Since a recovery schedule is generally developed at a time when the project is **struggling with progress**,

it is **vital** that the development of the schedule is proactively approached and advances to completion as soon as possible.

What if the development takes time?

- ☐ If it appears that the **development may take some period of time**,
it might be worthwhile to provide a short interim recovery planning schedule to
put some changes in field operations in place right away.
- ☐ The **sooner the field employees** see a recovery effort,
even if it is the short interim plan,
the **more successful** the recovery will be.
- ☐ It is **important for the owner** to provide **timely and thorough** review of the
recovery schedule.

Recovery Scheduling and Process



Brainstorm lessons learned before need

- ❑ **Prior to starting a project**, a good checklist and process can be developed through a **brainstorming session**

with the scheduling professionals and project management team.

- ❑ This allows the entire team to provide lessons learned and raises the topic of recovery scheduling ideas

so that the team will be **prepared to move quickly** once there is a **need established** in the project for a recovery schedule.



Identify the need

- ❑ When a **recovery situation** arises,
the schedule should **first be treated** as
if the **same conditions exist** that might require a time impact analysis (TIA) to be provided.
- ❑ Just as the value of a **TIA is dependent** on the quality of the schedule prior to analysis,
the **value of a recovery** schedule is dependent on the quality of the schedule prior to recovery.

This means that the schedule needs to be a good, accurate model of the current state of the project, including accurate dates, complete scope of work, and represents the project management team's plan using their means and methods of construction.



Identify the need

- ☐ It should be stressed that a **recovery schedule** is separate and distinct from a **TIA**.
- ☐ The **requirement for creating one**
does **not imply** the requirement for **creating the other**.

THIS IS VERY IMPORTANT



Create the plan

- ❑ As the **recovery schedule** is generally the responsibility of the contractor,
unless otherwise specified in the contract,
the **contractor has the final say** as to the **membership of the team members** to be involved in its creation.
- ❑ For **contractor schedules**, an owner representative may attend the planning sessions when appropriate.
 - ❖ The **contractor may feel that** the **benefits of maintaining** proprietary information, internal cohesion, and actual cost figures
may **outweigh the benefits** of full inclusion of all project participants.
- ❑ If the recovery schedule is prepared by the **construction manager (CM)**,
then it should be **up to the CM to** determine the makeup of the team.



Create the plan

- ☐ The recovery schedule pre-planning meeting could follow an agenda such as is outlined here.
- ☐ This **general outline of steps** to take once a project is in **need of recovery** includes:
 - Review the contract documents for language and direction for the need and preparation of a recovery schedule
 - Clean up issues and update schedule
 - Document existing project condition and status



Create the plan

- ❑ The recovery schedule pre-planning meeting could follow an agenda such as is outlined here.
- ❑ This **general outline of steps** to take once a project is in **need of recovery** includes:
 - Develop historical data statistics
 - Project wide
 - Critical path slippage
 - Near-critical path slippage
 - Non-critical path slippage
 - Engineering issues
 - Late Issued for construction (IFC) drawings, IFC drawings with holds, revisions to IFC drawings
 - Late specifications, revisions to specification
 - Voluminous and/or significant requests for information
 - Procurement issues
 - Submittal and approval status
 - Future delivery constraints
 - Long lead time procurement concerns
 - Trade specific
 - Production
 - Efficiency
 - Trades at risk of further slippage
 - Trades performing better than planned



Create the plan

- ❑ The recovery schedule pre-planning meeting could follow an agenda such as is outlined here.
- ❑ This **general outline of steps** to take once a project is in **need of recovery** includes:
 - Review the quality and accuracy of the network to the right of the data date to ensure that it represents a legitimate and appropriate model of the project construction plan. Make corrections as appropriate.
 - Look for opportunities for improvement/gain
 - Efficiency
 - Parallel critical path work
 - Out-of-sequence work
 - Inaccurate calendars
 - Soft logic potential changes
 - Resources
 - Preferential
 - Space or location
 - Verify requirements or redefine requirements for milestones and substantial completion
 - Make appropriate changes to schedule
 - Obtain project approval
 - Check recovery success
 - Repeat cycle if necessary
 - Document changes

Schedule Steps for Recovery

- ❑ If **brainstorming** was used to develop lessons learned for recovery scheduling, then there would be a **checklist** of those lessons that **can be applied** to the development of the recovery schedule.
 - ❖ The **potential for the scheduler** to provide technical recovery suggestions as well is very important.
- ❑ Not only are there legal ramifications, but good schedule maintenance and analysis can provide much insight into **potential recovery efforts**.
 - ❖ *For instance, identify whether the recovery effort is needed due to contractor problems (inexcusable delays), or is actually an acceleration effort that is due to problems outside the contractor's control (excusable delays).*

Let's see some vital tips!



Inexcusable and excusable delay recovery

❑ If **inexcusable delay recovery** is not required,

then there is a **vital process** of notification and involvement of the **owner** in the discussion that should happen.

What happens when excusable delays recovered
without notification or permission?



Inexcusable and excusable delay recovery

- ❑ Recovering excusable delays **without** notification or permission will just
 1. **Build up total float** that is available for the project to use **without cost** and
 2. Perhaps **move** simple delay to disruption with all the **complications of analysis and proof.**
 - ❖ In addition, if **recovery is necessary** due to inexcusable delays, it is better **not to attempt** to recover more time than needed to get back on schedule (recover to $TF=0$).

Detailed steps while developing the recovery schedule

❑ The detailed steps to take in developing the recovery schedule include:

1. Clean-up Issues and the Schedule
2. Review Efficiency of Work
3. Review Durations
4. Review Logic
5. Review Resources
6. Scheduling Actions
7. General Scheduling Techniques



Clean-up issues and the schedule

a. First, upon recognition that recovery is necessary,

verify the current schedule accuracy in
data and logic.

❖ Make sure that it reflects the **current project delivery management**.



Clean-up issues and the schedule

b. If possible, clean up any outstanding claims or potential time impact issues

before starting on the recovery effort,

❖ However, any **lingering disputes** should follow dispute resolution procedures outlined in the contract.

✓ This will **keep from mixing and confusing**
legitimate time extensions with recovery gains.



Clean-up issues and the schedule

c. Determine the causal activities for the **current delays**.

❖ Ideally this is done monthly so there are **no old issues and old delays**,

but if it was **not done**,

now is the time to prepare the analysis.

✓ It is important that **potential concurrent delays** are identified and analyzed.



Clean-up issues and the schedule

d. **Identify** the trades that have **contributed to any delays**;

put them on notice that they have caused delays and need to recover their own delays,

but be **very careful** that the recovery effort does not count on contractors that have **demonstrated an inability to meet their company commitments** in the baseline or previous updated schedules.

❖ Very often, the trades that have contributed to delay are the trades that are needed to recover, however, reliance on those trades to perform at a more efficient rate than they have been able to demonstrate will contribute to failure of the recovery schedule effort.

✓ If recovery is to succeed, **alternate approaches** to relying on these trades will need to be used.



Review efficiency work

a. **Hold** a recovery meeting with the **major contractors** and **solicit their input** to identify **areas of inefficiency**.

❖ Involve the foremen and superintendents, and discuss

- ✓ Practical crew sizes,
- ✓ Breakdown of crews,
- ✓ Materials and equipment flow and availability, and
- ✓ Isolate problems that might cause delay.



Review efficiency work

b. **Identify** disruption issues **between trades** which impact one trade's completion.

❖ Sometimes it is the **trade** that appears to be ahead of schedule that is taking **advantage of open space**

but may really be **creating conditions** that will **impede later progress**.

✓ Make sure that this is reasonable; **there was some rationale** to the original sequencing and

if that sequencing changes, the rationale is subject to be reviewed.



Review efficiency work

c. **Check** the historical data for slipped start dates;

this might be an indication of **project management difficulties**.

❖ Find out **if the slippage** is due to a specific trade that
needs **more mobilization time** and

use this information to analyze the **rest** of the schedule.

❖ Often the **superintendent has not done** a great job of making sure the
jobsite is really ready for the **next trade**.

✓ This is generally an area that can yield improvement.



Review efficiency work

d. **Review** progress on the project and **compare** to the baseline schedule.

❖ **Identify** all basic changes in **sequencing** and

determine rationale (if there is any) for the changes.

✓ Often the workmen **perform work** that is off-schedule

without making any decision to do so.



Review efficiency work

e. **Take** a fresh look at the sequencing for the **entire project**;

determine if there is **any potential** for parallel critical paths.

- ❖ Separate out the **potential parallel string** of activities and verify that there is **opportunity** for concurrent work.



Review duration

a. **Take a hard look** at the limitations and priority of recovery based on the **length of paths**.

❖ Looking at **multiple paths** with the same total float values,
the paths with the **least number of activities** will highlight the more important activities to **focus** on for recovery

because there is more opportunity;

they are the **more likely** to carry the **most individual activity risk**.

✓ This addresses the **problem with total float**;

✓ TF is a path value, **not an activity value** and as such,

long paths will **expose too many trades** to the
available total float



Review duration

- b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);
these are the **areas to chase**.



Review duration

b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);

these are the **areas to chase**.

- ❖ i. **One software company** that **no longer exists** used to call this the “Tipper” report; producing a total performance ratio (TPR) for each trade,
with $TPR = AD/OD$.



Review duration

b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);

these are the **areas to chase**.

❖ ii. This **report will also indicate** which trades are routinely not performing (TPR ≥ 1) as planned and perhaps **causing problems**.

✓ This reporting is dependent on **accurate actual dates** in the schedule and may **even require that calendars** are actualized to maintain as-built data accuracy.



Review duration

b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);

these are the **areas to chase**.

- ❖ iii. **Most schedulers** will generally build some amount of coordination time, **not to be confused** with risk adjusted contingency planning, into the schedule that is designed to **deal with** mobilization, demobilization, site access and site cleanup, as well as materials distribution for individual trade contractors.

- ❖ This is **prudent scheduling** unless it **consumes so much time** that it is really **sequestering float**,

What does sequestering float mean?

but **only a naïve scheduler** would produce a schedule that has no time allowed for internal coordination issues.



Review duration

b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);

these are the **areas to chase**.

❖ iii. Using any of this available coordination time across the board **can be a part of any recovery effort**.

✓ This is done by **review** of the historical record to see if any trades are typically operating at **lower durations than planned** due to increased efficiency, and

entering into a discussion with any trade that experiences this increased efficiency for that trade to be **instrumental in the recovery schedule**.



Review duration

b. **Check** the historical records to see **which trades routinely complete work** (actual durations) in less time than planned (original durations);

these are the **areas to chase**.

❖ iii. This is also the time to review any lags between activities that were introduced **in order to provide coordination** and/or **mobilization** or **demobilization time**.

✓ If the **historical records indicate** that the lag time is not needed, perhaps because the trades are **operating within their durations** to include coordination/mob/demob, than it **may be possible to remove** any of that type of lag time.

- a. **Identify** all out-of-sequence work that has occurred.
- b. **Identify** and **separate** all hard (physical constraints) and soft (resource, preferences, and space constraints) logic.



Review resources

a. If the schedule is resource loaded, run **reports to compare** planned resources against actual resources.

- ❖ If **critical path activities** are under-manned in particular,

1. Put these contractors on notice, and
2. Monitor improvement.

- ❖ Use this information to **evaluate durations** as well;

- ❖ if the **resource usage** is lower than planned and
the **actual durations** less than planned,

there is **contingency time** built into the durations.



Review resources

b. **Filter** the schedule by areas, and **look** at the total resource table for **each area**.

❖ **Consider** whether the **quantity of workers** in each area is reasonable.

❖ **Look** at a specific time period;

can 22 workers actually work on the same day in the mechanical room of this project?

✓ This **allows decisions** about resource allocation to be made based on **critical path activities**.



Review resources

c. **Load** activities with crews if the schedule is **not resource loaded**.

- ❖ Run a resource table for at least the three week look-ahead schedule, and **visually** see where there are conflicts with the **numbers of crews** for each **trade**.
- ✓ This is a **source for slippage**: **discuss** this with the contractors.



Review resources

- i. First, **identify** conflicts where the over-manning requirements can be met by simple manual leveling;

move the activities which have reasonable TF values
out of the problem time **zone**.



Review resources

ii. **Second, discuss** bringing in additional resources specifically for those **activities** that are **stacked beyond** the current total crew count capacity, **but are critical.**

- ❖ Have this **discussion** in a targeted and short-term manner,
not just to have the **contractor add manpower.**



Review resources

- d. **Identify** the soft logic that is **related only** to resources and **determine if** there is an **opportunity to remove some** of those relationship ties, especially for the critical path trades.
- ❖ This normally would **involve concurrent work** so it could **take additional resources**.



Review resources

e. **Take** a serious look at any **strings of repetitive tasks** and **see** if those areas could be **handled** by setting up crews

that **follow each other**, keeping the same crew members.

☐ This can

1. **Minimize** learning curves and

2. **Add** some **pressure** on each crew from the succeeding crew,

as with excavation, pile cutoffs, formwork, rebar and pouring pile caps, letting the crews compete and chase each other around the job in sequence.



Review resources

f. **If** the schedule is cost or resource loaded,

use the earned value calculations to

help **identify** trades that need to increase production;

❖ **Any trade** that has earned value metrics less than planned values

is likely to have a **problem with over-stacking** of workmen at the **end of the project**.



Scheduling actions

a. Review sequencing and activities

required for **substantial completion**,
verify that they are correct.

Revise logic if required.

- ❖ This is the **opportunity** to
redefine **substantial completion** in order to **resequence work**
that might **not have to be done** for substantial completion, and
the same is **true** for interim milestone definitions.



Scheduling actions

b. **Working** with the critical path,

start at the data date, and

look at every relationship.



Scheduling actions

i. **Identify** any possibilities to work out-of-sequence and **adjust** the schedule to allow concurrent work.

❖ For example, a **typical example** would be a **finish-start (FS) relationship** between drywall finishing and its painting successor.

✓ If it is a **large room (area)**, the painting could **start on the portions** of the room where the drywall is complete.

✓ In this case, a **start-start (SS) relationship with a lag** (in addition to a **finish-finish (FF) relationship with a lag**) would be possible.

○ These types of relationships requiring lags should

minimize the size of the lags to **avoid sequestering float**.



Scheduling actions

ii. **Focus** on dissimilar trades when adjusting to allow concurrent work.

- ❖ This can help to **prevent** ramping up manpower.
- ❖ **Watch** overloading specific project **areas**, such as commercial kitchens.



Scheduling actions

iii. **Compare** out-of-sequence work with **soft logic** and **see** if the out-of-sequence work has actually **changed the plan**.

- ❖ If this **new plan works**, then use the out-of-sequence work to **continue** with this revised logic (**remove soft logic in future work**).
- ❖ If the plan called for **2 weeks of metal stud framing on the first floor** before starting the plumbing rough-in, and the **plumbing rough-in** started after 1 week, then **modify the schedule** to follow this same process in future areas.



Scheduling actions

- iv. **When changing** FS to SS or FS with negative lags,
be sure to **terminate the relationships** with a FF relationship to
control which activity will finish first,
if the **software platform supports it**,
as identified in the example **presented above**.

c. **Add** another workday;

go from a **5 day workweek to a 6 day workweek** for the critical trades,
without going to overtime.

❖ See if they can **bring** in outside resources to **fill the additional time**,

but make sure that those trades are committed to this effort.



Scheduling actions

d. **Finally**, put the critical trades on overtime, but this should be one of the **very last resorts**.

- ❖ Remember that unless that trade has proven **their ability to perform** within their original durations,

this won't work.

- ❖ Also, be aware of the risks and inefficiencies of **overtime** work in general.

General scheduling techniques

b. **Review** all the different types of disruption and **ensure** that those issues are not happening on the project.

- ❖ This includes

- ❖ Lack of productivity,

- ❖ trade stacking

- ✓ Important issue to review if the recovery schedule contains a lot of SS with lag relationships that were formerly FS relationships

- ❖ Dilution of supervision,

- ❖ Inefficient work flows, and

- ❖ A number of other problems that typically occur on jobs that are running behind.

General scheduling techniques

c. **Provide** interim milestones in the schedule to **mark important events**;

- ❖ *Dry-in, site close-in, completion of rough-ins, exterior façade completion.*
- ❖ **Celebrate** the completion of each interim milestone;
 - ✓ This is a **psychological issue** and can raise the production level of the entire project.
- ❖ **Lack of motivation** is a type of disruption and should be managed.
- ❖ **All workmen** want to be part of a successful and motivated project team so the **more success** can be celebrated and discussed, the **better the attitudes** and **more cooperation** on the job.

General scheduling techniques

d. **Review** all calendars on the project, and **assess** non-work time.

- ❖ **Verify** that **correct calendars** are used appropriately.
- ❖ This is an opportunity to **pick up time**,
especially if the use of **weather calendars** can be **reduced**.

General scheduling techniques

- e. **Review** job adverse weather history to assess risk, and
check into possibility of **reducing adverse weather** non-work days.

Once all these steps are **complete**, and
the **appropriate changes** are incorporated into the **schedule**, and **documented**,
the **project team** should **review** and **approve** the recovery schedule.

Recovery Schedule Submittal



Components of recovery schedule submittal

- ❑ **At a minimum**, the recovery schedule submittal consists of
1. A schedule narrative and
 2. A copy of the schedule's native electronic database in a **form consistent** for archiving and transference to other project participants such as the owner.
 3. Just as in a schedule update, **additional schedule submittal components** may also include
 - i. Printed CPM reports and graphics,
 - ii. Data tables to substantiate the claimed progress,
 - iii. Early/actual/late progress and budget curves (s-curves,) and
 - iv. Related progress and resource graphics, as required by the contract.



Schedule Narrative

☐ The recovery schedule narrative

adds and supports understanding of the schedule revisions.



Schedule Narrative

❑ A narrative may include the following items:

1. **Identification** of significant reasons for the slippage that forced requirement for the recovery schedule,
2. **Status** of progress against contractual milestones to date, showing gains from the recovery schedule
3. **Review** of the critical path activities showing in the recovery schedule,
4. The **status** of engineering deliverables (drawings, specifications, etc.)
5. The **status** of major project material and equipment procurement,
6. **Assumptions** used to create the recovery schedule,
7. **A list of all changes** made to the logic or planned durations during the development of the recovery schedule,



Schedule Narrative

☐ A narrative may include the following items:

8. **Project risk analyses**, especially addressing any additional risks (threats or opportunities) that are exposed or resolved by the recovery schedule,
9. Project schedule concerns and issues, and
10. **Expectations** of actions required by the owner in order to achieve the recovery plan.

Additional Topics



Resource leveling

- ❑ As in update schedules, the use of automatic resource leveling software could become an **issue**.
- ❑ In the recovery schedule mode, the **project is already in trouble** with the production and resources,
so adding the **additional complications** of automatic resource leveling to the process is generally **not advised**.
- ❑ This does **not mean** that **resource considerations** should be ignored.
- ❑ It is important that the project team understands the available resource pool, **analyzes** the historical resource usage, and **clearly commits** the available resources to the priorities defined in the recovery process.
- ❑ In the schedule recovery steps listed above, manual leveling of resources is **recommended**, and this is the preferred method of planning the resource changes.



Team cooperation

- ☐ **Once** the recovery schedule submittal is approved, it is essential that all parties **cooperate** on the accomplishment of that plan.
- ☐ At the very least, the **owner and contractor** are both responsible for not hindering the application of the approved recovery plan,
as this **may constitute a breach of contract**.



Actual results

- ❑ A **recovery schedule** is just a plan and like the **original construction plan**, **actual progress** may deviate from planned progress.
- ❑ **While** the contractor may be required to **attempt to execute their approved recovery plan**,
it is **unusual to hold the contractor** accountable for perfect completion of the plan.
- ❑ The contractor may **later elect to modify** their work plan based upon new events and issues.
- ❑ Actual damages may **still be accessed** for late project delivery, but the failure to accomplish a recovery plan
does **not constitute a failure to comply** with contractual recovery requirements,
so it does **not typically** constitute a **breach of contract**, unless so specified.



Projects with multiple general contractors

❑ When the **owner** requests a recovery schedule of a general contractor on a multiple contractor project,

the **guidelines provided** in this RP should be followed but additional emphasis should be given to the following topics:

- ❖ How the **schedule development** is handled
- ❖ The **contract language** concerning scheduling and scheduling responsibilities
- ❖ The **involvement and participation** of the individual contractors related to scheduling

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Projects with multiple general contractors

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Case Study in Transportation

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“A Case Study for Recovery Scheduling in Transportation”

By Chris Carson, PMP, CCM, PSP, DRMP, CEP, FRICS, FAACE, FGPC
and Noah Jones, PSP

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Introduction

Introduction

When transportation projects fall behind, it can be very difficult to regain the lost time, and even harder without increased costs. This paper walks the reader through the resolution of a schedule recovery need for a transportation project which suffered significant production losses by analyzing the project, identifying specific opportunities for acceleration, hosting a recovery workshop, and implementing the solutions. This structured and cost effective case study for recovery uses a successful completed project for which the authors provided Project Controls, specifically Schedule Review and support, and demonstrates the technical scheduling process used to recover the time.

Background – Project description

Background

Project Description

The approximately \$40M Hampton Boulevard project depresses the grade of a four lane thoroughfare leading to Naval Station Norfolk in order to change grade crossings to bridges and remove traffic interruptions. The Project also includes constructing two bridges, one each for rail and traffic overpasses. The work was divided into four phases. Phase 1 consisted of Building the detour road at the current grade around the primary construction area rerouting all four lanes to the north side while maintaining access for side streets. Phase 2 consisted of demolishing existing Hampton Boulevard, relocating rail access to the terminal, driving sheet piles, excavating to the new grade for approximately 60% of the project, driving piles, pouring slabs, and building bridges over the excavated area. Phase 3 consisted of driving sheet piles, excavating the remaining 40% of the Project, driving piles, pouring slabs and tying into Phase 2 completed work. Phase 4 is the traffic shift to the newly built roadway, demolishing the detour road, and landscaping. The Original Duration for the Project was 1223 calendar days or just over 40 months.



The purpose of this project is to separate the rail traffic servicing the adjacent Norfolk International Terminal (NIT) from the heavy automobile traffic. The current alignment also poses a problem for the Navy. If the Navy recalls all personnel but doesn't get cooperation from the Terminal on the rail traffic, it could negatively affect operational readiness.



Background – Schedule model

Schedule Model

The Baseline Schedule was a 672-activity Critical Path Method schedule (“CPM”) that was reasonable and appropriate. The scheduling environment on this job was one of cordial cooperation. We were able to discuss issues with the contractor and resolve disagreements relatively easily.



Statement of recovery need

Statement of Recovery Need

The problem arose when the completion date slipped and the contractor felt that he had exhausted all logical mitigations he could make and still have faith in the schedule as a reasonable and achievable plan to complete the Project. VDOT requested that the contractor provide a recovery schedule. The Contractor wanted relief from liquidated damages; however, the Owner decided that releasing the Contractor from liquidated damages was not in VDOT's best interest. As the consultant to VDOT providing schedule review services, we proposed a schedule recovery workshop to address the production slippage.

RISK ANALYSIS

Immediate risks include on-going Railroad sub track work including Track 4, Relocated Lead Track, Tie ins to Existing Tracks, and up-coming cut-to-waste work. Storm drainage also carries high risk. There are also multiple areas of potential risks remaining in the Project, as shown in the Risk Register, Attachment #3. Alpha has identified upcoming activities that are most likely to be impacted by the risks identified. To ensure that the Project progress is not impacted, both the Contractor and VDOT should monitor the work noted.

There were 68 Missed Early Start Dates, 59 of which were not started within the period. There were 83 Missed Early Finish Dates, 72 of which were not finished within the update period. This may result in stacking of resources and cause further delay. Activities may become critical as the Project progresses if activities remain un-started or continue beyond predicted finish dates. A Complete list of activities that missed their early start dates can be found in Attachment #4 and activities that missed early finish dates will be listed in Attachment #5.

Statement of recovery need – Schedule status

Schedule Status

The schedule at this point had gone through six months of a “slip and recover pattern” where the Contractor updated the schedule, noticed the slip and mitigated that slip through logic changes. In most cases, the logic changes were carefully thought out and implemented, but eventually reasonable changes did not provide the recovery needed, and actions were taken in an optimistic manner anticipating higher production and increased crew resources.

The Contractor’s management team had reviewed the schedule and concluded that there were no more cuts to be made, or durations to be trimmed, and no other options than to ask for relief.

Statement of recovery need – Goal

Goal

The goal of any Schedule Recovery Workshop is to come together to brainstorm ideas for sequencing, opportunities for additional resources to shorten durations, site conditions or changes that would enable a time savings.



Recovery workshop – Preparation

Recovery Workshop

Preparation

In preparation for the Recovery Workshop, all of the participants should prepare a bulleted list of suggestions for discussion with the group. Sending the list ahead of time allows the Contractor time to evaluate these ideas which helps the Recovery Workshop proceed without becoming an interrogation of the Contractor to which there are no answers at this time.

- Cure for 7 days is a VDOT standard, but on the schedule it shows cure driving the CP as if no other work is ongoing in adjacent areas. Is this an accurate model of the real world?
 - What about the use of Curing Compound to maintain the cure after the forms are removed? Does this impede adjacent work?
- What is the constraint to driving the sheet piling on both east and west sides concurrently?
- Two tie back crews running concurrently on both sides would help speed the excavation.
- What about two Cranes for pile driving both sides of the excavation concurrently?
- Fabricating Piles will be from Mid December to Mid Jan, which may be slow months for the fabricator. What about verifying the expected capacity availability of the fab plant at that time? If they can commit to greater production rates, it would help.
- Activity #3AAR0050 "CONCRETE MEDIAN - 15+80 TO 11+88 - HAMPTON BOULEVARD" is a 19 Work Day activity that may need to be broken up to accurately reflect the planned sequence of construction. This further breakdown of the activity could allow staged successors, picking up time.
- Is there a reason for not paving both sides North and South bound concurrently? If paving is driven by physical logic rather than resource logic (assuming one pile driving rig),
- Activity #3AARN040 "PAVE NB 15+60 TO 11+60 - HAMPTON BOULEVARD" is linked in as a successor to the Sidewalks being complete. It appears that this sidewalk is poured between C&G, so paving should be able to start once the C&G has cured sufficiently.



Recovery workshop – Preparation: Brainstorming

Brainstorming

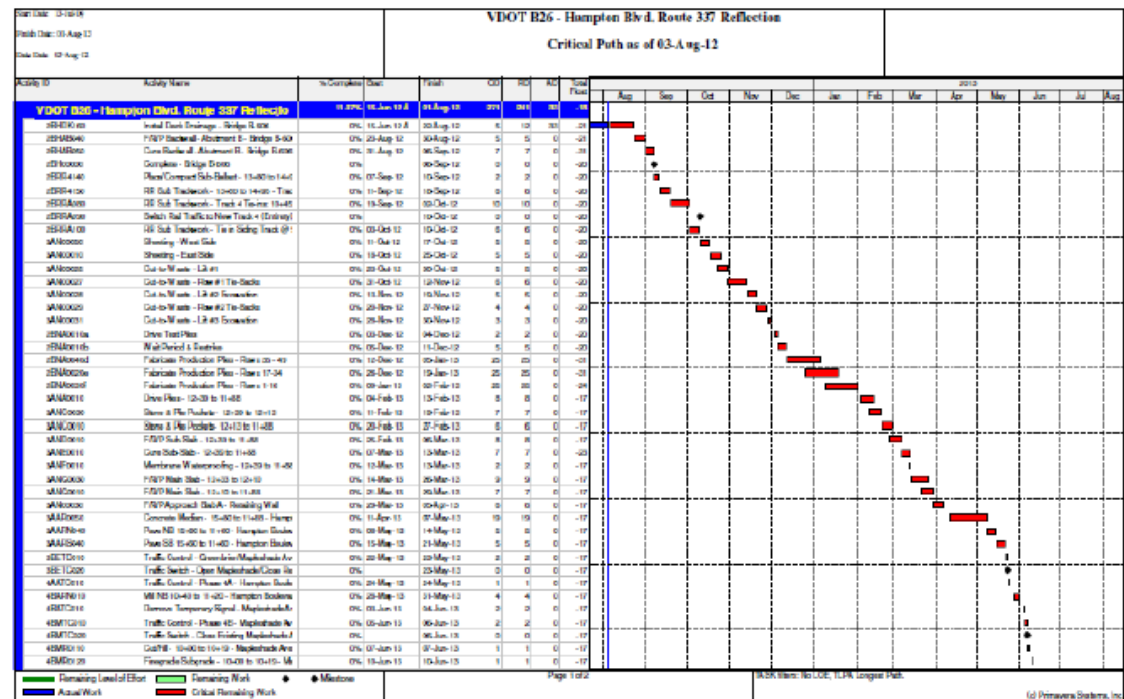
Brainstorming is critical to allow all participants the chance to contribute and comment. This is a vital part of obtaining the buy-in of all of the participants.

Most effective recovery efforts involve revisions to both the Longest Path and the Near Critical work that becomes the Longest Path as changes to the previous Longest Path shorten the work duration.

Recovery workshop – Preparation: Preliminary analysis

Preliminary Analysis

In this case, the authors' brainstorming was facilitated by using the most current updated schedule, filtered to show only the Longest Path, Critical and Near-Critical paths up to the value of the time needed to recovery, which was approximately 45 calendar days. The filtering was done by defining the Critical Path to include all activities up to 45 days of Total Float, inclusive. These are the activities that control project completion for the recovery time frame and all of these activities may need recovery in order to meet the goal.





Recovery workshop – Preparation: Preliminary analysis

This approach is much more efficient than starting with just the Longest or Critical Path, which is the typical approach by most schedulers. Starting with the longest pole in the tent, the Critical Path, simply solves the apparent problem, but as the Critical Path is recovered, those activities slip off the path and some other secondary Critical Path takes over, requiring another recovery effort.

Once the schedule is filtered to the recovery duration, the next step relates to choosing the best opportunities for recovery. In recovery efforts, there are generally two choices; fast-tracking or compressing. Fast-tracking is changing the sequencing and logic so as to create more concurrent work, potentially changing one Longest Path into two shorter Longest Paths of the work that does not depend on the original predecessors. Compressing generally requires shortening of durations by adjusting productivity rates with increased efficiencies or increased crews.

The recovery brainstorming should look at both options. Fast-tracking the project is less likely to increase costs than compressing so that is the obvious preferred approach.

Fast-tracking opportunities should start with review of the Critical Paths to see where there might be soft logic driving the Critical Path. Soft logic, which could be resource-driven or simply preference-driven, can often be revised to allow more parallel or concurrent work. Some of the opportunities for fast-tracking are recognized by the longer durations; leading to opportunities to subdivide large scope activities into multiple activities which might be able to progress concurrently.

Recovery workshop – Preparation: Preliminary analysis

The approach to prioritize this effort starts with changing the sorting of the schedule from Early Dates to Original Durations, with the larger ODs listed first as those are the best opportunities.

Activity ID	Activity Name	% Complete	Start	Finish	ED	OD	AD	Float
VDOT B26 - Hampton Blvd. Route 337 Reflectio		75.41%	13-Jul-09 A	01-Aug-13	980	241	739	-18
GC-11	Survey	70.39%	13-Jul-09 A	01-Aug-13	814	241	750	-18
GC-1	Trailer	70.06%	13-Jul-09 A	01-Aug-13	805	241	750	-18
2BNA0030f	Fabricate Production Piles - Rows 1-16	0%	09-Jan-13	02-Feb-13	25	25	0	-24
2BNA0020e	Fabricate Production Piles - Rows 17-34	0%	26-Dec-12	19-Jan-13	25	25	0	-31
2BNA0040d	Fabricate Production Piles - Rows 35 - 49	0%	12-Dec-12	05-Jan-13	25	25	0	-31
3AAR0050	Concrete Median - 15+80 to 11+88 - Hamp	0%	11-Apr-13	07-May-13	19	19	0	-17
4BBR0010	Demo Hampton Blvd. Detour Road	0%	18-Jun-13	01-Jul-13	10	10	0	-17
2BRRA080	RR Sub Trackwork - Track 4 Tie-ins: 10+45	0%	19-Sep-12	02-Oct-12	10	10	0	-20
3ANG0030	F/R/P Main Slab - 12+33 to 12+10	0%	14-Mar-13	26-Mar-13	9	9	0	-17
3AND0010	F/R/P Sub-Slab - 12+39 to 11+88	0%	25-Feb-13	06-Mar-13	8	8	0	-17
3ANA0010	Drive Piles - 12+39 to 11+88	0%	04-Feb-13	13-Feb-13	8	8	0	-17
3ANC0030	Stone & Pile Pockets - 12+39 to 12+13	0%	11-Feb-13	19-Feb-13	7	7	0	-17
3ANG0010	F/R/P Main Slab - 12+10 to 11+88	0%	21-Mar-13	29-Mar-13	7	7	0	-17
3ANE0010	Cure Sub-Slab - 12+39 to 11+88	0%	07-Mar-13	13-Mar-13	7	7	0	-23
2AUR0070	Storm 3-5,3-3,3-2,3-1	0%	06-Jul-13	16-Jul-13	7	7	0	-17
2BHAR050	Cure Backwall - Abutment R - Bridge R-606	0%	31-Aug-12	06-Sep-12	7	7	0	-31
3ANC0010	Stone & Pile Pockets - 12+13 to 11+88	0%	20-Feb-13	27-Feb-13	6	6	0	-17
3AN00030	F/R/P Approach Slab A - Retaining Wall	0%	29-Mar-13	05-Apr-13	6	6	0	-17
3AN00027	Cut-to-Waste - Row #1 Tie-Backs	0%	31-Oct-12	12-Nov-12	6	6	0	-20
2BRRA100	RR Sub Trackwork - Tie in Siding Track @	0%	03-Oct-12	10-Oct-12	6	6	0	-20
2BRR4150	RR Sub Trackwork - 13+80 to 14+95 - Trac	0%	11-Sep-12	18-Sep-12	6	6	0	-20
3AARS040	Pave SB 15+60 to 11+60 - Hampton Boulev	0%	15-May-13	21-May-13	5	5	0	-17
3AARN040	Pave NB 15+60 to 11+60 - Hampton Boulev	0%	08-May-13	14-May-13	5	5	0	-17
2BNA0010b	Wait Period & Restrike	0%	05-Dec-12	11-Dec-12	5	5	0	-20
3AN00028	Cut-to-Waste - Lift #2 Excavation	0%	13-Nov-12	19-Nov-12	5	5	0	-20

Recovery workshop – Preparation: Preliminary analysis

This project had an activity for concrete curb and gutter (C&G), with monolithic sidewalk, that separated the lane directions, with a single large duration of 18 WD. After review of the plans, it appeared that the C&G activity could be divided into two activities to allow two crews and work on both directions of traffic to occur at the same time.

All options should remain on the table, and this means that some of the suggestions will turn out not to be viable once analysis is done. An example of this was the opportunity identified in the Activity names "Fabricate Production Piles", which appeared to offer acceleration options from either faster fabrication or quicker delivery.



We also reviewed predecessors to the fabrication activities to examine other opportunities with starting earlier. The schedule showed three groups of production piles to be fabricated, totaling 25 work-days, which is five weeks, and even with the overlap between groups, the entire process was shown to require 6 weeks.

Drive Test Piles	0%	03-Dec-12	04-Dec-12	2	
Wait Period & Restrike	0%	05-Dec-12	11-Dec-12	5	
Fabricate Production Piles - Rows 35 - 49	0%	12-Dec-12	05-Jan-13	25	
Fabricate Production Piles - Rows 17-34	0%	26-Dec-12	19-Jan-13	25	
Fabricate Production Piles - Rows 1-16	0%	09-Jan-13	02-Feb-13	25	
Drive Piles - 12+39 to 11+88	0%	04-Feb-13	13-Feb-13	8	
Stone & Pile Pockets - 12+39 to 12+13	0%	11-Feb-13	19-Feb-13	7	

Recovery workshop – Preparation: Preliminary analysis

This opportunity proved not to offer any good options to reduce time, even though it was high on our list.

Other opportunities for recovery included identification of dead time in the longer sequences, such as the Activity names, "Concrete Median". This activity was scheduled for the full median installation, requiring 19 work-days.

F/RP Approach Slab A - Retention Wall	0%	20-Mar-13	05-Apr-13	8	8	0	-17
Concrete Median - 15+80 to 11+88 - Hamp	0%	11-Apr-13	07-May-13	19	19	0	-17
Pave NB 15+00 to 15+00 - Hampton Boulev	0%	06-May-13	14-May-13	9	9	0	-17
Pave SB 15+60 to 11+60 - Hampton Boulev	0%	15-May-13	21-May-13	5	5	0	-17

Recovery workshop – Preparation: Preliminary analysis

After review of the fast-tracking opportunities, the next step is to examine compressing the schedule. This requires a review of the quantities and production rates that were used to estimate the durations of activities.

The large duration sort of the Critical and Near-Critical Path filters is a good layout to use to examine the compression opportunities as well. The small durations will likely not yield much savings, whereas the large durations could generate significant savings for the recovery effort.

In this project, the authors reviewed the production rates of the work to see if there were any good opportunities to improve productivity, and discovered that the C&G production rates were based on hand forming and pouring the concrete. If the Contractor could bring in a curb machine instead of hand forming the C&G, the production rate could be increased dramatically.





Recovery workshop – Preparation: Preliminary analysis

The brainstorming session continues in this way, addressing all ideas and examining the schedule in as many innovative ways as possible. But the success is based on a technical review of the schedule – remember that the schedule is the technical model of the project plan; if the model is accurate, it will help expose efficiencies in the plan that are not being taken into account.

Facilitating workshop – Opening statement

Opening Statement

The objective at this meeting was to discuss proposed feasible ideas with all sides to determine what changes could be adopted that would result in an achievable recovery schedule.



Facilitating workshop – Opening statement

Discuss Ideas

The result of this meeting is a recovery schedule, but the schedule remains the Contractor's means and methods and sole responsibility.

The beauty of the Recovery Workshop is that different people are looking at the schedule. Individuals perceive the same item slightly differently. This allows for healthy discussion which leads to productive ideas.



Facilitating workshop – Opening statement

Identify Acceptable Targets

Once these ideas have been deemed technically feasible, practical, and discussed with the group, then these specific concepts become the acceptable targets for mitigating the delays in the Project schedule. These targets need to be modeled in the schedule. This list of targets is taken by the Contractor who then needs to perform an analysis to determine which, if any, may be applied to the CPM to produce the Recovery Schedule.

Output / Results – Recovery analysis

Recovery Analysis

Recovery options were analyzed individually and cumulatively. The cumulative analysis is important as the changing Critical Path will make some ideas less feasible or less attractive as the reductions in Critical Path lengths moves the Critical Path to other activities and sequences.

The workshop yielded a list of proposed schedule changes that were acceptable to all parties and saved the Project 38 calendar days. These changes that were ultimately adopted added no cost to the Project and mostly changed the sequencing of work. Paving, sidewalks, curb and gutter were originally scheduled to be completed at the end of Phase 3 for the entire length of the Project. The proposal to break out the work for Phase 2 and complete this early when the area is complete and available for work, rather than waiting for the completion of Phase 3 saved the majority of the time. Other small changes accumulated to the remaining time savings.

Output / Results – Recovery plan acceptance

Recovery Plan Acceptance

The Recovery plan must be acceptable to all parties. Both Parties must analyze the Recovery Schedule for feasibility, resources, compliance with the specifications, and the Owner in particular should review to confirm that the recovery effort does not place new burdens or constraints on his in-house and consultant resources.



Output / Results – Implementation of recovery plan

Implementation of Recovery Plan

Once the Recovery Schedule is approved, it becomes the schedule of record on which Earned Value Management, Earned Schedule Analysis, and Payment Applications will be based. The Recovery Schedule is the new plan to complete the remaining work within the Contract time frame. Future schedule updates will use the Recovery Schedule as the benchmark schedule to create the Updates. The Recovery Schedule or its updates will be used as a basis for any required analysis of potential needs for extensions of time with TIAs for delay events that may impact the job.

It is vital to recognize that recovery scheduling efforts are always more successful when they require the efforts to start immediately rather than counting on a future effort. The project must be turned around to gain recovery, and a small part of the problem is the motivational losses that have occurred due to the recognition of delay. When the project team sees recovery starting and proceeding right away, it helps motivate the entire team to perform at a higher level.

Recovery plans designed to occur in the future can also fail when the project continues to lag or other unforeseen conditions occur to retard performance. The sooner the recovery effort starts, the more likely it will be successful.

Summary / Conclusion

Summary/Conclusion

Every project at some point in the project life-cycle is likely to need recovery efforts, and following a structured approach will improve the opportunities to recover as well as reduce the time and effort to develop the recovery plan. Recovery Workshops provide opportunities for partnering, with the Owner and Consultant/CM participating to help the Contractor meet their goals and commitments.

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

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