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PLANNING FOR ADVERSE WEATHER

TCM Framework: 7.2 – Schedule Planning and Development
8.1 – Project Control Plan Implementation

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INTRODUCTION

Planning for adverse weather and modeling that planning in the project schedule is an essential practice for successful projects. This recommended practice (RP) for planning for adverse weather is intended to provide a guideline, not to establish a standard. It provides guidelines developed primarily for engineering and capital construction projects but can be adapted for any type of project or program where weather planning is required.

This RP is intended to identify numerous methods used to plan for normal adverse weather, provide recommendations as to the best approach to identifying historical data sources, how to extrapolate that data into future planning data, explain and critique weather planning methods, and recommend approaches for managing actual weather documentation compared to planned. This RP does not identify a single best method. Instead, the positive and negative aspects of each method should be considered in light of the contract along with the facts for the project in question. Further, this RP does not address the legal ramifications or forensic schedule delay analysis considerations one must address when adverse weather delay is in contention.

This RP serves to provide guidance in the absence of contractual requirements as well as potential guidance in writing specifications for adverse weather planning. If adverse weather planning is addressed in the contract, planning and modeling should be in compliance.

OVERVIEW

According to the Merriam-Webster Dictionary, weather is defined as the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness. In other words, what happens around us all of the time; hot or cold, sunny or cloudy, rain or snow, windy or still, weather happens all around us regardless of severity.

The following weather-related terms and definitions are used throughout this RP:

NORMAL WEATHER — That kind of weather, which could be expected for a period of time, based upon the historical weather experience of the locale.

UNUSUALLY SEVERE WEATHER — That kind of weather, which is in itself severe and can be of violent nature. If the average weather over time is significantly different from the normal then it is said to be other than normal. In either case, if such weather affects the job and causes a delay, it may be excusable and form the basis for a contract adjustment for time and possibly money once all relevant contract clauses are considered.

ADVERSE WEATHER — Normal weather events that negatively affect the productivity of workers and/or which may affect project's critical path or consume float. Adverse weather is defined differently depending on the location of a project and cannot be standardized for all projects or locations, but represents conditions that should be expected during project execution.

WEATHER EVENT — A storm or significant weather condition that stops or appreciably hinders work until it has passed or the effects of the weather condition have dissipated. This may include rain, rising water, snow, ice, extreme cold, high winds, extreme heat and/or high humidity, or other weather related occurrence. The weather

January 22, 2014

event may not be localized at the site as in the case of flood water from an upstream rain event or preparations for a hurricane that does not actually pass through the site.

WEATHER DAY — A work day that was stopped and/or had appreciably hindered work progress due to a weather event.

PLANNED ADVERSE WEATHER DAY — Expressed as the number of days within a period of time (typically months) that a project can be expected to be affected by adverse weather. The number of planned adverse weather days is calculated by a review of historical weather data obtained by a reliable weather source supplemented or validated by actual experience at or near the work site.

UNUSUALLY SEVERE OR ADVERSE WEATHER DAY — Expressed as the number of days of actual significant weather events that stopped or impacted a project. From a contractual delay analysis standpoint, those days are compared to the number of days originally planned for in the schedule to identify excusable time extensions; i.e.: weather that negatively affects the project production in excess of the expected normal or adverse weather.

WEATHER PREPARATION DAY — A day where direct work progress ceases going forward while the project makes preparation for an upcoming weather event, e.g. boarding up windows before a hurricane, making the site safe by securing loose materials and unfinished structures and dismantling or securing cranes from expected high winds to mitigate any potential damage to the work.

WEATHER RECOVERY DAY — A day where a project is unable to resume work due to the after-effects of a weather event such as excessive flooding and mud after a rain storm. This would also include the time necessary to duplicate the status just prior to the weather event.

Planning for Adverse Weather consists of:

- Identifying sources for historical adverse weather data applicable to the project site.
- Interpretation of that historical data and rendering it useful for planning and schedule modeling.
- Examining various planning approaches for adverse weather to determine the most appropriate method, which models the expected periods and durations of weather events in order to produce reasonable and appropriate dates in the schedule.
- Accounting for actual adverse weather to provide accurate as-built schedule as well as the basis for consideration of possible time extensions due to unusually adverse weather.

The purpose of weather planning is to establish a consistent approach to ensure that the as-planned schedule provides appropriate planning to accommodate planned adverse weather days during the project execution. The planned adverse weather days may be based on historical norms, relevant location experience or as may be dictated by a contract condition.

The planner or scheduler provides assistance to the project management team in choosing the appropriate methodology for implementing adverse weather planning. He or she provides input so that the as-planned schedule includes appropriate allowances for adverse weather to ensure reasonableness, and provides an approach to account for actual adverse weather, allowing for analysis of unusually adverse weather and any entitlement to time extensions due to those unusually adverse weather conditions.

BACKGROUND

This recommended practice is intended to provide guidance for any project that has scope of work or portions of the scope of work that is/are subject to delay or disruption due to adverse weather conditions.

Identification of Sources for Historical Data

Historical data includes sources of objective, factual information recording actual weather conditions, generally at least daily, in a widespread range of locations, from professional weather bureaus.

Historical data sources are used to plan for future weather in a schedule under the assumption that the average weather in the past will represent a reasonable model of similar future weather conditions. It is important that legitimate sources of actual weather conditions are used for the basis of planning so the plan will be as realistic as possible.

Further, it is important to document in the schedule basis documentation the data used, any analysis performed, weather calendars used and assumptions made about the inclusion or exclusion of weather days in the schedule.

From a legal dispute resolution standpoint, the choice of data sources is important as it may be questioned in the event of a dispute. Use of a less accurate source could undermine the legitimacy of a time extension request. For that reason, it is important to document the basis and assumptions made during weather planning in the schedule basis documentation[4].

Historical adverse weather data sources would be used when a project has activities that will be performed under the influence of weather. This includes all forms of precipitation including rain, snow, hail, sleet, as well as any other weather influences such as high or low humidity, high winds, high or low temperatures, shortened daylight times, and even air borne particle conditions such as dust and pollution.

Secondary effects from the primary adverse weather conditions could include a variety of issues such as; rising and flood waters, limited visibility, mud conditions limiting accessibility or halting earthwork operations, mold or mildew conditions requiring abatement, snow and ice removal needs, masonry, concrete, or roofing work stoppages due to low temperatures, and reduced crane operating hours due to high winds. These secondary effects can create conditions that cause the same lost time as primary conditions, and as such, should be included as part of the adverse weather planning.

Adverse weather is variable based on locations, time of year, and other local conditions (natural and man-made). Since weather is locality driven, the adverse weather planning data should be captured from a source that experienced weather conditions similar to that expected at the project's location.

Within the CPM model, those activities that are weather dependent or related should be identified such that they can be filtered out separately from the non-weather related activities. This will allow weather planning to be applied only to the activities that are likely to suffer from adverse weather. Extensive weather planning is not normally used for projects that are unlikely to be affected by adverse weather, such as indoor renovation projects, or projects in stable climate regions. Care should be taken in these cases to ensure that no secondary weather conditions might affect the work, such as humidity that could affect indoor finish work. It is important to note the assumption of the lack of necessity to plan for adverse weather in the schedule basis documentation.

While the examples within this RP are taken from examples within the United States, it is important to note that there are many sources around the world, from both government and private organization that provide historical weather data.

The most common and available source for historical weather conditions in the United States is the U.S. Government Department of Commerce agency, the National Oceanic and Atmospheric Administration (NOAA). NOAA operates the National Weather Service (NWS), which produces forecasts and warnings, as well as radar tracking of storms for regions across the United States. NWS produces contemporaneous precipitation analysis with archives of records, based on readings taken at the NWS offices across the country. The NWS also publishes the National Weather Service Climate Pages, which offer local Weather Forecast Office data of weather information.

NOAA also operates the National Climatological Data Center which is the world's largest archive of climate data, offering some free data and some subscription-based services.

The Internet is a rich source of weather data. Countries, universities and private organizations are constantly collecting, analyzing and publishing global weather data. Be sure to 'trust, but verify' any source used. Several representative sites include:

- www.worldclimate.com
- www.weather.org
- www.bom.gov.au
- www.climate-charts.com

There are private organizations that record and provide weather data such as Weatherbase (www.weatherbase.com) with its database of information for over 15,000 cities, the Weather Underground (www.wunderground.com) with access to nearly 40,000 weather stations and their historical data, the Washington Post (www.washingtonpost.com/weather) providing information for 2,000 cities, and World Climate (www.worldclimate.com) offering worldwide climate data in a database of over 80,000 records.

The U.S. Army Corps of Engineers (USACE) provides a summary of non-work days per month due to predicted adverse weather, for various regions around the country based on USACE project experience combined with their analysis of historical weather data. The USACE uses the NOAA data, analyzes that data, and summarizes it into reasonable expected loss of time due to adverse weather.

Other sources of local historical weather data include individual United States State Departments of Transportation (DOT), providing work days by month, local Associated General Contractors (AGC) offices, who provide a count of rain days, airport records providing wind and rain data, and state meteorologists who may be affiliated with universities that collect and analyze data on an ongoing research basis.

In the United States, only NOAA can provide records certified by the U.S. Government such as might be required as support documentation when providing analysis related to delays or disruption due to adverse weather. Any well-established weather station with an uninterrupted appropriate history can be used to establish a history in a particular location in order to calculate normal weather averages and establishing a planned adverse weather calendar that will assist in project planning.

The amount of information available on the NOAA sites is almost overwhelming, so the data should be evaluated and understood in advance of needing to use the information in planning. The data compiled from NOAA can be voluminous and hard to read and interpret. If the NOAA data is used, a decision will need to be made as to what constitutes a historical non-work weather day due to adverse weather.

Further, if the data is to be used in a claim or litigation, project-level statistical analysis should be supplemented by a professional statistical analysis that can survive legal scrutiny.

Weather records may supply the inches of rainfall, or inches of snowfall, but do not indicate if it was possible to work during that time. For example, precipitation of more than 1/10 of an inch could be considered significant enough to halt activities that are under the influence of that weather. When the precipitation accumulates in the range of one inch, it is possible that it will create wet conditions such that work on the day following the day of precipitation will be impacted. This is sometimes called a weather recovery day or mud day, and indicates that the precipitation has halted but the site is still affected by the wet conditions.

Another consideration is a weather preparation day, where work is stopped in order to prepare of a forecasted weather event such as a hurricane. These conditions and limitations should be taken into account when evaluating the historical data for use in planning for adverse weather.

However, location is relative and all weather events are dependent on the location. 1/10 of an inch of rain in Los Angeles will affect work differently than the same amount of rain in Portland, Oregon. Similarly extreme cold and wind speeds will be treated differently in Chicago than in Atlanta The definition of a weather event needs to be decided early and should consider only the regional weather and how it affects local conditions and local projects.

A decision will need to be made as to what period of time is statistically significant when selecting historical weather data. Generally, an average of three to five or ten years of data is considered to provide a sound basis for prediction of future adverse weather. Other scientifically prepared statistically significant procedures can be used to select high probability future non-work days due to adverse weather.

Interpretation of Historical Data

Interpretation of historical data involves taking the available statistical data and rendering it useful and relevant for planning for adverse weather in the as-planned schedule.

The purpose of interpreting historical weather records is to provide legitimate and relevant anticipated adverse weather for the overall period the project planned to encompass so it can be used to make appropriate allowances for non-work time that the project should expect to be affected by adverse weather. Such analysis translates historical records into reasonable usable predictive data to be integrated into the as-planned schedule.

Interpretation of historical weather records is only used if the contract does not define either an average expected non-work time for adverse weather on a periodic basis to be used in the as-planned schedule or some other weather planning basis.

There are two basic ways to interpret the historical weather records; by use of simple non-work averages and by use of statistical analysis. Both approaches require use of historical weather records from the same location as the project being planned.

Non-Work Averages Method

Historical weather data can supply an average non-work days lost to adverse weather in the period being analyzed, with the average precipitation each day, the average wind speeds at different times of day, humidity, temperature, cloud cover, and other adverse conditions. The planner/analyst should provide parameters for each of these conditions that would result in adverse weather in the region where work is to occur, i.e.: weather that forces shut down of 50% or more of the project, the work day, or personnel, for critical activities.

These parameters may be in these ranges, but might differ depending on the project location:

- Precipitation
  - More than ½" accumulation of rain, snow, ice, or sleet or water equivalent
  - Affects all exterior work/weather sensitive activities
  - Mud conditions on an exposed site can cause increased non-work time that extends beyond the precipitation exposure. Judgment should be used in determining what is reasonable to expect; for example, on a stripped earthwork site with poor drainage, it is likely that one day of more than 1" accumulation of precipitation will create muddy conditions for at least another day and may

require significant rework to put the project back to where it was before the weather event. The greater the amount of precipitation, combined with the conditions after the precipitation, the more mud/recovery days that will follow. Working in mud conditions may also damage existing site locations or installations.

- Wind speeds
  - Winds over 40 or 45 mph is generally cause to automatically shut down the tower cranes
  - Lower speeds still affect tower crane use, or other hoisting or erection of wind sensitive materials, as well as work in desert or beach conditions due to sand and dust storms
  - This is materials-sensitive in that some materials cannot be hoisted, such as siding, but other materials could be hoisted if properly handled for the wind. So the activity's work scope affects this determination.
  - High wind speeds between 20 mph and 40 mph may cause disruption in the installation of roofing material, glazing, siding, wall forms, framed walls and sheer walls being installed by hand or smaller equipment.
- Humidity
  - Very high humidity in the range of 90% may make work conditions seem much hotter than the ambient temperature, impact productivity, and can cause humidity-sensitive materials to swell and impede efficient installations.
  - Very low humidity in the range of 25% may make it very difficult to install pavements due to high dust, and may cause humidity-sensitive materials to shrink such that severe swelling should be anticipated once the humidity returns to normal
- Temperature
  - Low temperatures below the range of 40 degrees F. may prevent installation of materials that include adhesives, cements, or high temperature installation conditions. Extreme low temperatures may cause problems with productivity and workers health and safety.
  - High temperatures above the range of 95 degrees F. may cause problems with installation of concrete and coatings. Extreme high temperatures may cause problems with productivity and workers health and safety.
- Other conditions should be reviewed to anticipate the likelihood of those conditions affecting the specific project.
- Safety is always a primary consideration and all of the above identified weather concerns should take into account health and safety considerations that may stop work and/or significantly hinder progress.

Statistical Analysis Method

The statistical approach has been developed in detail by planning experts It has been noted that, "a review of historical information over many years provides evidence that weather can be predicted within a range that is acceptable for planning purposes."[3] This approach requires the use of NOAA data in detail, converted to a spreadsheet or database in order to perform data filtering and calculations. Once the data is extracted into the database or spreadsheet, the historically anticipated "normal" conditions can be summarized to a value by day by year, for instance, precipitation in inches by day by year.

Once the anticipated weather conditions are properly statistically organized, there is still a subjective identification of what is significant in adverse weather with the type of condition for the current project. This allows for identification of specific days and the probability of the condition occurring in planning periods. Then a threshold must be chosen to limit the days based on the probability of the condition occurring, and that provides a chart of days of adverse weather per month, identifying the probable days with the adverse weather condition such as precipitation.

The project team needs to define for the project at hand what is a "weather event". This could include information such as in the following table, but is relative to the project's location and what is considered normal adverse weather.

Number of Days with Rain Above	0.10"
Number of Days with Wind Speeds Above	10 mph
Number of Days with Cold Temperatures Below	0˚ Fahrenheit
Number of Days with Hot Temperatures Above	110˚ Fahrenheit

With the adverse weather days defined, the next step is to compare the average available work days with the historic average adverse weather days, and once these two data points are correlated, a non-work calendar of predicted adverse weather can be compiled.

Blended Approach – Statistical Analysis Provided by USACE

There is a third approach that is a blend of the two, performed by the USACE in their publication of monthly non-work days due to adverse weather in various office locations, and if this data is available, use of the results is economical, reasonable, and likely to stand up in a technical forensic analysis. This specific data is only available for USACE Districts, so it may not be relevant in other countries. The USACE through the Department of Defense offers a publication in the Unified Facilities Criteria (UFC) system called, "Design Engineering Weather Data", which describes historical data records and the process used for "planning construction and building operation", as well as mechanical equipment design.

All parameters should be defined in the Schedule Basis so that reviewers have an opportunity to consider the reasonableness of the parameters in use in interpreting the historical records. With this definition, the ranges of adverse weather conditions are available for anyone to accept, challenge, or discuss the need for adjustments.

The time of day for adverse weather should be reviewed because it could have a significant reduction or increase of impact on work activities. For example, if an area typically experiences most of the adverse weather near or after the end of the work day, that might reduce the effect of that adverse weather on project performance, or could simply move the effect to the next day

The determination of the parameters to use in planning is clearly subjective, so the goal is to be as reasonable as possible and provide rationale for the determination, especially if it may appear to be biased towards more or less adverse weather planning. All this analysis and these determinations and assumptions must be fully documented in the Schedule Basis.

Methodology for Planning for Predicted Adverse Weather

Methodology for planning for adverse weather is the strategy and implementation used to develop a schedule that produces reasonable and historically consistent dates that take into account the adverse weather conditions that would be expected for a project in a specific location during a specific time frame.

Planning for adverse weather helps produce schedule dates that have a higher likelihood of accuracy so that the schedule is resilient enough to be useful in a specific location and time frame. Adverse weather may easily reduce the productivity of work on a project to a greater extent than planned, including complete shutdown of the project's weather-sensitive work. If a schedule is produced that does not take into account that the future adverse weather at the project site and time will be similar to the actual history of adverse weather conditions at the same location and time , there is a high likelihood of slippage of planned dates, with the resulting reduction in credibility of the schedule. The planning involves choosing a methodology that is credible, reasonable, and easy to maintain while requiring as few schedule revisions to maintain the system as possible.

Use of a methodology to plan for adverse weather is important when the project has activities that are exposed to adverse weather conditions and historical adverse weather records are available.

In addition, planning for adverse weather using a transparent and reasonable methodology provides a clear baseline for the project expectations for adverse weather losses. Unusually adverse weather, defined as weather that is worse than the historical records would suggest, can be analyzed for extensions of time requests compared to this benchmark of planned adverse weather. Generally, unusually adverse weather would entitle the contractor to an excusable time extension.

These recommendations are made in order to appropriately plan for weather delay, and therefore avoid situations where a delay to the end date is caused by weather that should have been anticipated through historical data analysis, and additionally to avoid situations where potentially legitimate claims for time and maybe money are rejected because of a general lack of consideration of weather as an expected factor in contract completion.

Description of Industry Practices

Owners can request that contractors mitigate in planning for adverse weather, if they are willing to fund any additional costs due to that mitigation. This should be carefully analyzed before including contractual language related to mitigation requirements as it increases the risks on the contractor and could greatly impact the contract price.

The practices that appear to be used most often in the construction industry for planning for adverse weather include; increasing activity durations, using weekends for “make-up” days, using a weather allowance activity just prior to substantial completion to house adverse weather time for the entire project, and the use of weather calendars or a combination of approaches. The choice of approach may be influenced by contract requirements and risk shifting provisions related to how the parties deal with weather risk.

For Critical Path delay issues related to adverse weather, the most common impact is from work activities that fall upon good weather periods in the baseline schedule but with updates and changed conditions, are shifted into areas of greater non-work expectations caused by historical weather norms. With good weather planning, the schedule should show a delay immediately upon updating or incorporation of a changed condition model in the schedule demonstrating the affect on when work that might be shifted into future periods of higher risk of adverse weather. Analysis of the update or changed condition would then include preparation of a request for time extension. The methodology and considerations in developing a proper delay and time impact analysis is beyond the scope of this Recommended Practice but can be found in other AACE documents.

Use of Increased Activity Durations

The use of increased activity durations, for activities that are exposed to adverse weather in the as-planned schedule, is an occasionally used methodology for planning because it seems to be simple, fits into the bar chart planning mentality, and appears on the surface to be a legitimate approach. However use of increased activity durations in a CPM model does not provide reasonable weather planning, which makes this approach difficult to accurately model the dynamic nature of actual work progression and effects of weather on individual weather sensitive activities. This approach is never appropriate since it does not allow for the dynamic movement and changing nature of the critical path.

The problems with this approach include:

- Weather planning is placed in the as-planned schedule during the appropriate season or expected weather conditions, but as soon as the schedule is updated and compressed or prolonged, the activities that had durations increased as a result of planned adverse weather may no longer be planned to execute during that planned weather condition
- In addition, when activities that did not have durations extended due to the as-planned schedule originally showing execution during periods of good weather and subsequently advance or slip due to progress, those activities no longer contain adequate durations for the adverse weather.
- Since some activities have increased durations, evaluation of the activity durations' reasonableness is harder and potentially not possible.
- Use of artificially increased activity durations makes accurate progress monitoring, reporting and controlling a difficult and time consuming process, while calling into question the accuracy of any earned value reporting and analysis.

<u>Use of Extended Shifts or Weekend Makeup Days</u>

The use of weekends to make up for lost weather time is a popular methodology for contractors because it is simple, requires no work to implement, and appears on the surface to be a legitimate approach, but in effect does not provide dedicated weather planning. The approach can be appropriate when the climate does not typically demonstrate large swings in adverse weather.

The problems with this approach include:

- This approach works under all conditions except for those situations where required planned non-work days exceed the number of weekend days, or where adverse weather occurs consecutively greater than two days such that the weekend will not provide adequate replacement.
- While this approach may work in the early phases of project, as the project nears completion and/or in the last quarter of the overall duration, weekend weather mitigation work will never suffice to fully recover from the time lost due to weather.
- This approach should provide a limit of two days a week before excessive adverse weather merits a time extension.
- An Owner could take the position that the Contractor has planned for two days of adverse weather in each 5-day workweek.
- The weekends may not fall appropriately in allowing make up time.
- Subcontractors may ask for overtime when required to work weekends unless it is addressed contractually.
- Contractor supervision will have to work on the extra weekend workdays.
- Any Owner furnished supervision or inspection will have to be available if weekend work is needed. Some municipalities may not be willing to inspect on weekends at all.
- Does not account for seasonal variations
- Reduces the Contractor's opportunity to use weekends to mitigate low productivity periods caused by non-weather related issues.

<u>Use of an Allowance Activity to Store Predicted Adverse Weather Time</u>

The methodology of using an activity (commonly referred to as a "weather allowance") just prior to the "substantial completion" milestone or the "dry-in" milestone to "store" adverse weather time appears to be somewhat popular with many U.S. federal, state, local, and school agencies. This methodology includes summing all the expected adverse weather non-work days and using that total as the duration for a weather activity (sometimes called a "weather allowance", “weather bank” or “weather bucket”) that is inserted into the project immediately prior to the substantial completion or dry-in activity.

This duration is typically monitored on a monthly basis and reduced as necessary to accommodate the amount of actual adverse weather experienced during that month.

The actual adverse weather is generally monitored by the project team, with the Owner/CM and the Contractor determining each week the total number of days that were lost due to adverse weather and summing those to account for the total in the reconciliation each month. This includes determining how the contract addresses this issue, or if silent, determining if critical activities were unable to progress at some benchmarked rate, such as more than half a day on a lost work day, which would include adverse weather conditions as well as secondary conditions such as muddy site conditions. A report or minute item is usually issued that identifies the actual adverse weather and authorizes the appropriate reduction of the weather allowance activity duration.

Often, the project team analyzes the remaining amount of time in the weather planning activity duration to determine if it is adequate for the completion of the project. This is considered good practice for this methodology to ensure that the depletion of the weather allowance does not remove adverse weather planning from the remainder of the project.

Problems with this approach include:

- All activities in the project or prior to the “substantial completion” or “dry-in” milestone are subject to the adverse weather whether or not the work modeled by those activities are subject to weather events
- There may be a failure to provide adverse weather planning for site development work that is outside the path of the dry-in activity if that is the activity chosen as the successor to the weather allowance activity.
- The inclusion of the weather-planning activity at the end of those paths containing non-weather-related activities will artificially reduce float values along those paths, making those activities appear to be critical more quickly or in general more likely to appear on the critical path.
- The critical path is less reliable since the network does not calculate properly for those activities that are falsely affected by the weather bank activity. The result is very similar to too much logic that tends to increase the number of activities on the critical and near-critical paths.
- An Owner’s CM would (or should) likely reject that schedule because it artificially conceals float on the non-weather related activities. This approach potentially sequesters float when the project does not actually experience the modeled adverse weather. Float that is gained as a result should be returned and made available to the project for the use of the project. This raises the issue of who owns the float that should be available to those activities that are not weather-dependent as well as improvements in actual adverse weather gain which is outside the scope of this RP.
- The weather allowance requires additional work in monthly monitoring and adjusting of that weather allowance activity.
- Weather planning is disconnected from when activities are scheduled to take place relative to the time-of-year level planning considerations. Such disconnects in planning and modeling can lead to planning forecasts with no credibility.
- There is no directed use of the time allowed for weather planning; every need is often satisfied by reduction of the weather allowance without this consideration.
- The project schedule is built as though there will be no weather interruptions to the project so that all early dates are too optimistic. <u>The ONLY activity in the entire schedule which has dates adjusted by weather planning is the milestone that is the successor to the weather allowance activity</u>. This makes the dates used to manage the schedule much less realistic and it does not make sense to plan for weather but not use that planning to provide more reasonable dates in the schedule.
- This approach does not allow the schedule to automatically and immediately predict delay when activities are shifted into heavier weather periods. There may be a delay that is caused by a changed condition that shifts weather sensitive activities into a period of worse adverse weather than originally scheduled. With a

January 22, 2014

weather calendar, when the weather-related activities are shifted, the project automatically shows a delay. However, with the weather allowance approach, the delay goes unnoticed at the time because the time is just taken from the allowance activity, and mitigation is actually provided by removing weather planning from the rest of the activities in the schedule.

- The delay is only a weather delay after the weather allowance is used up, so it doesn't align with when the actual delay occurred.
- Standards for the use and removal of "weather days" from the allowance have not been established, allowing disputes between parties on how many "weather days" have been used and whether or not the current number of "weather days" remaining in the allowance is correct.
- Long projects, generally over one year, tend to have large number of "weather days" within the allowance, and parties are tempted to use those days to reduce legitimate delays not related to weather.
- The Owner may develop an unrealistic feeling that there is contingency time in the schedule and tends to forget that this contingency is really only for adverse weather and not available for the Owner's use.
- Unused weather days are often referred to as a means for one party or the other to reduce delays to the project not related to weather, and is arbitrarily used as a way to bring a project back on track without proper time impact analysis.

In order to reduce the problems created by using a weather allowance stated above, the following is recommended (reference the monthly planned adverse weather chart below for examples):

J	F	M	A	M	J	J	A	S	O	N	D
10	9	9	5	2	2	0	0	3	6	6	9

Planning for Adverse Weather

- The weather allowance is determined by how many weather days have been established by month, using the months when the project will be in construction.

    - (Ex: the project is 1 year in duration starting March 1st; the first and last months are administrative; and construction starts April and ends in January; with a total of 43 planned adverse weather days)

- The weather allowance activity should be linked to all weather affected activities and the completion milestone associated with the project schedule.

- Non-weather sensitive activities should not be linked to the weather allowance, but instead to the completion milestone.

- Careful consideration should be made when creating the schedule that the path of activities with the potential for weather delay be linked in a manner that will end with the weather allowance before completion, whether this is the longest path or not. There should be no "dropped" logic with weather sensitive activities that are not tied into the path to the Weather Allowance Activity. (An example would be grading, foundations, structure, roof & exterior, sitework, paving, planting, etc.)

- Non-weather activities that cannot start until dry-in need to be linked to the individual dry-in activities for the area (Ex: installation of drywall may need to be linked to roofing, and exterior plaster).

Maintenance of Actual Adverse Weather (Removal of "weather days" from the Weather Allowance)

When a defined weather event interrupts a critical activity (meaning the weather sensitive activity must be on the critical path in order for the allowance to be used) the following maintenance process should be implemented, ensuring that it complies with any contract language:

- Notifications to the Owner are provided that a weather day is being removed from allowance by the Contractor

- Documentation in the Schedule Basis to note the weather day removal from allowance

- Weather days are recorded by adding an activity on the day of the event, log notes, or other notations should be made in the schedule update narrative

- Unused "weather days" for each month are removed from the weather allowance activity after the month has passed without weather interruption.

    - (Ex: There are 10 weather days allowed for January, but there were only weather events on 3 days. The remaining 7 weather days should be removed from the weather allowance activity duration in order to release that float back to the project)

- The use of weather allowance days should not be used directly by any party to mitigate a delay not caused by weather. Instead, unused weather days should be returned to the schedule as float to the project where they would become available for use as needed. This is done by an appropriate reduction in the weather allowance planned for the time period under analysis.

- When a project has been delayed, and a time extension granted, the Weather Allowance activity could have additional weather days added in order to provide any additional adverse weather planning included in the time extension.

    - (Ex: The original project time was scheduled to complete by 31 December, and an additional 21 calendar days been added by change order. The new completion date is 21 January. Three weeks have been added (3/4 month) to the end of the project; (10/3 or 3) days could be added to the Weather Allowance activity to allow for weather events during the extended time of the project.)

Use of Weather Calendars

The use of weather calendars to model adverse weather is a very popular method of weather planning for the as-planned schedule. Calendars should show non-work days on a monthly basis, with the non-work days selected at random across the weeks of the monthly calendar, using the industry average number of days as determined in the interpretation of adverse weather data. While truly random numbers are difficult to create, it is possible to use spreadsheet formulas if required. The assignment of the non-work days should be over a seven-day week since weather records are compiled on seven-day weeks, which will cause some of the non-work days due to weather occurring on weekends.

Use of random allocation of expected weather days in the CPM schedule calendars allows the CPM network to automatically calculate and restricts the adverse weather planning to the appropriate season, forcing weather-related activities, as they shift due to changing conditions, to take on the appropriate non-work time of the season. This approach accommodates delay analysis and provides accurate predictive results as a result of adverse weather in any conditions of delay and disruption.

In planning for an average number of weather days to include in an as-planned schedule, the following chart represents adverse weather predictions for Tidewater, Virginia, collected and analyzed from the National Weather Service's 10-year average for adverse weather days in this region. These numbers are specifically pulled from the USACE UFGS for the Norfolk District, but the numbers are very similar to those used by other federal and state contracting agencies for this location. The USACE captures historical data on the quantity of adverse weather days to allow in a plan from the local NWS publications. Using USACE data for a particular location is useful because extracting adverse weather days directly from the NWS requires a judgment of how much precipitation is required to define a non-work day at this location. The USACE has already made good judgments, backed by their historical records, in converting inches of precipitation per day into non-work days for a particular location. Be mindful that USACE's typical project for which it defines anticipated weather days may not be sufficiently similar to the project to be planned.

Using National Weather Service data for estimating purposes, the Contractor should plan for the following number of adverse weather days, based on schedule planned in 2005, in the Norfolk, Virginia area: .

Month	J	F	M	A	M	J	J	A	S	O	N	D
Adverse Weather Days	9	9	9	6	7	6	7	7	5	6	7	9

Weather days in excess of these numbers are deemed Unusually Severe or Adverse Weather days and as such would normally be subject to a legitimate time extension. In order to track these planned normal adverse weather days, and plan for the activities that they affect, the following process would be appropriate:

- Develop the baseline schedule based on a 5-day workweek.
- Identify all activities that are subject to weather and code them for easy filter selection.
- Develop a separate project calendar (the "weather calendar") within the scheduling software, showing the appropriate number of adverse weather days per month. Ensure that this calendar matches the main project 5-day workweek.
- Using the predicted days of adverse weather per month, apply the count of days randomly across either the month or, assign them in the weekly proportion across each week. Spread the days out so they are not contiguous because that will tend to show gaps in the work and confuse users of the schedule.
- Include the weekends in the full week of assigning non-work days, since NWS tracks calendar-week adverse weather, not work-week adverse weather
- Apply this calendar to the activities affected by weather activities, identified in step (2).
- Calculate the new finish date and compare to the benchmark. If the project shows a prolonged completion, check to see if the extended date is due to the added activities to model adverse weather conditions.
- Review planned non-work days that may appear in a contiguous fragnet, such as between completion of formwork and the concrete pour. If the schedule user looks at this carefully, it could appear confusing.

In this way, should a spate of unusually severe weather days occur, the project manager now has the means to claim for time, since he has reasonably and responsibly planned for weather in the submitted and approved project schedule, and since he can document when the number of days that actually occurred were in excess of historical averages. It is important to note, from a claims perspective, that in order to claim for time in the case of "unusually adverse weather" the weather must not only occur (and be documented), it must also affect the completion of a critical path activity (i.e. an activity with no float and/or on the Longest Path) such that the prediction of project completion is prolonged.

It is also necessary to define what a lost weather day really means; the job records must show that work ceased, or manpower was effectively reduced to approximately half of the typical workforce, or the work was shut down for the day or a large part of the work day, and that the work cessation was not at the end of the workday. Lost weather time can also include conditions such that work could not occur, such as mud days when the site is too muddy to put equipment to work. Review of the historical weather conditions can help in planning for the effects of secondary conditions on the project.

Not properly accounting for these days, recognized as authoritative by both federal and state contracting agencies, will have two potential impacts. First, the schedule could be considered to be flawed and not realistically represent when the work will be performed, and will potentially mislead the contractor and/or the owner. Secondly, the impact of any delay will be masked because of the inaccurate calendar, and in absence of any reasonable plan, a claim will likely be rejected.

The problems with this approach include:

- When using weather calendars, there is an effect on the float path from non-work time programmed in weather calendars as activities move from a period of full production into a period when the calendar has more non-work days to model the planned weather, during updates of the schedule.
- If a schedule is organized by Total Float, there will likely be a jump in the Total Float value when the activities on the same path are driven by weather calendars which increase the number of days of non-work to model the adverse weather.
- If the weather calendars are not actualized, then Actual Durations for those activities that are affected by weather will not be accurate.

One approach that is sometimes used for planning is that of increasing durations to accommodate adverse weather, and this is a poor method and not recommended. This approach reduces transparency such that durations no longer can be verified by calculations of resources and quantities, the amount of time that is concealed in the durations, as contingency for adverse weather, is unknown, and has one other even more serious drawback, that of the failure to accommodate a dynamic schedule. The additional time for adverse weather that is added to the duration is only season-related in the static baseline schedule. As soon as the project schedule changes, the durations become inappropriate for the activity season schedule and activities with increased duration for winter work will be scheduled for summer work while activities with no planning will be scheduled for winter work.

There may be a lack of credibility if a standard number such as “three days per month, every month, all year” is used, as it indicates that no analysis techniques were employed to arrive at the conclusion.
Some projects may be appropriate for statistically significant approaches.

Weather Impact Days: Before and After a Weather Event

As noted previously a significant weather event may result in lost time or productivity impacts before or after the event itself. The most commonly used example is when a cyclone or hurricane event draws near a project site. Days may be spent evacuating the site and preparing it to be as safe as possible in the eventuality of the storms passing through the area is a weather preparation day. If the storm does pass through the area, there will be “mud days” or “recovery days” spent getting the site back to where it was before the weather event became an issue. For this Recommended Practice a “recovery day” is synonymous with a “mud day.”

This example presumes that the weather event from a contractual perspective is not treated as a Force Majeure event in part or in whole. In case of Force Majeure, the contract will govern how the parties have agreed to deal with the issue of excusability and compensability for the event. Such contractual considerations are outside the bounds of this Recommended Practice, but are a consideration the project team must understand when planning for weather.

As it relates to weather preparation and recovery days, the following considerations should be taken into account:

- There are two trains of thoughts on how best to address, or not, the issue of a recovery day. If modeling with use of non-work days in a CPM calendar or using weather allowance activities in front of Milestones, some include preparation and recovery days while others do not as a general principal unless it is clear that historically the activities involved will require such non-work days.
- Preparation and recovery days should be used only as they relate to historically significant weather. If the default is to include preparation and recovery days with each weather event, then the project will have

January 22, 2014

assumed too much risk in the plan and it will improperly elongate the work (activity durations and/or weather allowance activities).

- Recovery days are to get the project back to the point it was just before the weather event started affecting the project. That is more than just mopping up water, picking up damaged work, etc. But also means putting the project's progress and status back to where it was but for the weather event. This would include reestablishing pre-weather event production and productivity levels.

Methodology for Accounting for Actual Adverse Weather

The methodology for accounting for actual adverse weather explains how to ensure that the as-built schedule is accurate when it comes to adverse weather records for the specific project.

Since the as-built schedule is often used for analysis both in prospective trending and predictions of completion as well as for forensic analysis situations, maintaining records of actual adverse weather so that the as-built schedule is as accurate as possible is important. This methodology provides a way to compare the predicted or planned adverse weather to the actual adverse weather both for the current project as well as for the benefit of future projects. This record keeping is used in analyzing potential extensions of time that might be legitimately earned due to that unusually adverse weather.

With each formal schedule update, the methodology for accounting for actual adverse weather is implemented.

This would normally include recording actual lost days of work due to adverse weather and providing some type of report showing the days and the parameters for selecting non-work days.

When considering actual data for a particular project, it is generally considered a non-work day for the relevant work activities if more than 50% of the workday is affected by the adverse weather or if more than 50% of the workforce cannot work. These non-work days contribute to milestone or project delay only if critical activities are affected by the weather event, but may not be considered delaying events if less than 50% of the workforce is affected. There may be circumstances where large crews installing interior finishes are unaffected by whether events, but critical activities outside are usually unable to proceed due to extreme weather, mud, or other weather related events.

While there may be delay that is considered less than the 50% threshold for inability to work and therefore not a non-work day, it is possible that discontinuous non-work due to adverse weather could affect productivity resulting in inefficient production. Inefficiency analysis for disruption is outside the scope of this RP.

No matter the methodology, it is good practice for the Project Manager to confer with the Owner's site agent to confirm lost days due to actual adverse weather.

In the use of weather allowance activities, this methodology includes identification of the non-work days due to adverse weather with generally some type of weekly compilation and negotiation between the Contractor and Owner/CM, as well as keeping records of the total actual monthly non-work days. These records are generally captured in a report that provides the basis for draw down of the weather allowance activity duration as needed. The contract may, or may not, include language related to accounting of such weather events.

In the use of weather calendars, this methodology includes changing the weather calendar from the planned adverse weather to the actual adverse weather. The results of this maintenance are that the Actual Durations for all activities that were affected by adverse weather are accurate. With some reports, such as float dissipation reports or time performance reports, where the reports rely on the Actual Durations, the accuracy and legitimacy of these reports for analysis are greatly enhanced. If activity bar charts have the settings adjusted to "neck" for non-work days, the bar charts will show the adverse weather days on the schedule bar chart. This can be handy for a quick visual check of non-work time in the schedule.

This methodology also includes review of the critical path and delays to determine if any critical path delay is due to unusually adverse weather that is greater than the planned adverse weather. In this review, the analysis should identify any need for an extension of time due to unusually adverse weather losses.

If the weather calendars are not maintained with the schedule update, reports relying on Actual Durations will likely be less accurate.

Generally any time gained during the period due to less adverse weather than planned will be returned back to the project float values if weather calendars are used, but an Owner should not expect to shorten the project by the amount of gained weather planning not used. The float gained will be available to the project for the first need, unless contract terms specifically state otherwise.

RECOMMENDED PRACTICE

Identification of Sources for Historical Weather Data

The most widely accepted and validated source of historical adverse weather data for the United States is NOAA through the National Climatological Data Center, and this is the source recommended for use for United States projects. As NOAA does collect data for a variety of international locations, when lacking better data, the NOAA data may be appropriate to use internationally.

Since the USACE handles the statistical analysis of the NOAA climate data and decisions such as what constitutes a full work day, as well as providing data for each of the local USACE offices, often using the data supplied by USACE is the quickest and easiest way to provide average historical adverse weather data in the U.S.A. or other areas where available.

Interpretation of Historical Weather Data

If the USACE-provided data in their published specifications are available, the recommended practice is to use those non-work days per month. If USACE records are not available for the location of the project, then using simple non-work averages is recommended due to the simplicity of interpretation and ease of understanding by the project participants and other audience.

Methodology for Planning for Predicted Adverse Weather

Of the several methods to plan for weather, the use of weather calendars has the most advantages and least disadvantages, so the Recommended Practice is the use of Weather Calendars. The next best approach is the use of a Weather Allowance Activity to house planned non-work time within the CPM schedule model.

In either case, proper implementation of the practice is essential to provide appropriate, meaningful, and reasonable planning for adverse weather.

Methodology for Accounting for Actual Adverse Weather

For the use of Weather Calendars, the recommended practice for accounting for actual adverse weather includes updating the weather calendar with actual non-work weather days, and review of the lost time to identify any unusually adverse weather delays.

For the Weather Allowance Activity, the recommended practice is to evaluate the actual lost time due to adverse weather each update, and remove that amount of time from the Weather Allowance Activity.

In any case, if the actual adverse weather is in excess of the properly planned adverse weather, there is support for an excusable time extension.

REFERENCES

1. USACE Publication, Design Engineering Weather Data, 28 February 2003, UFC 3-400-02
2. Dictionary, M.-W. (n.d.). Retrieved April 7, 2012, from http://www.merriam-webster.com/dictionary/weather
3. Mike Stone, PSP, Webinar by WPL on “Adverse Weather Planning”
4. AACE International, *Recommended Practice 38R-06, Documenting the Schedule Basis*, AACE International, Morgantown, WV, (latest revision)

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TERMS, ACRONYMS AND DEFINITIONS

Note: Upon acceptance of this RP, these terms and definitions will be removed and incorporated into AACE's Recommended Practice 10S-90, *Cost Engineering Terminology*.

(PROPOSED NEW TERM)
ADVERSE WEATHER — Normal weather events that negatively affect the productivity of workers and/or which may affect project's critical path or consume float. Adverse weather is defined differently depending on the location of a project and cannot be standardized for all projects or locations, but represents conditions that should be expected during project execution.

(PROPOSED NEW TERM)
WEATHER EVENT — A storm or significant weather condition that stops or appreciably hinders work until it has passed or the effects of the weather condition have dissipated. This may include rain, rising water, snow, ice, extreme cold, high winds, extreme heat and/or high humidity, or other weather related occurrence. The weather event may not be localized at the site as in the case of flood water from an upstream rain event or preparations for a hurricane that does not actually pass through the site.

(PROPOSED NEW TERM)
WEATHER DAY — A work day that was stopped and/or had appreciably hindered work progress due to a weather event.

(PROPOSED NEW TERM)
PLANNED ADVERSE WEATHER DAY — Expressed as the number of days within a period of time (typically months) that a project can be expected to be affected by adverse weather. The number of planned adverse weather days is calculated by a review of historical weather data obtained by a reliable weather source supplemented or validated by actual experience at or near the work site.

(PROPOSED NEW TERM)
UNUSUALLY SEVERE OR ADVERSE WEATHER DAY — Expressed as the number of days of actual significant weather events that stopped or impacted a project. From a contractual delay analysis standpoint, those days are compared to the number of days originally planned for in the schedule to identify excusable time extensions; i.e.: weather that negatively affects the project production in excess of the expected normal or adverse weather.

(PROPOSED NEW TERM)
WEATHER PREPARATION DAY — A day where direct work progress ceases going forward while the project makes preparation for an upcoming weather event, e.g. boarding up windows before a hurricane, making the site safe by securing loose materials and unfinished structures and dismantling or securing cranes from expected high winds to mitigate any potential damage to the work.

(PROPOSED NEW TERM)
WEATHER RECOVERY DAY — A day where a project is unable to resume work due to the after-effects of a weather event such as excessive flooding and mud after a rain storm. This would also include the time necessary to duplicate the status just prior to the weather event.

