EFCOG Report

Evaluation of the Use of Weather Calendars in Risk Analysis Models

Project Delivery Working Group

Risk Management Task Team

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Approvals

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Executive Summary

The Energy Facility Contractors Group (EFCOG) is a self-directed group of contractors of U.S. Department of Energy Facilities. The purpose of EFCOG is to promote excellence in all aspects of operation and management of DOE facilities in a safe, environmentally sound, secure, efficient, and cost-effective manner through the ongoing exchange of information and corresponding improvement initiatives.

The EFCOG Project Management Working Subgroup (PMWSG) established a Risk Management Task Team to promote, coordinate, and facilitate the active exchange of successful Risk Management programs, practices, procedures, lessons learned, and other pertinent information of common interest that have been effectively utilized by DOE contractors and can be adapted to enhance operational excellence and cost effectiveness for continual performance improvement by other DOE contractors.

As part of the EFCOG Risk Management Task Team activities initiatives are identified, prioritized and planned. The planned activities are established in advance of the fiscal year start as part of an EFCOG Project Delivery Working Group (PDWG) Annual Work Plan.

One such initiative is the evaluation of how weather calendars are used in risk analysis model and where their use is beneficial.

This report presents the roadmap for investigations and reviews leading to Risk Management Task Team recommendations. This report, when issued as final, will be Deliverable X.X of the EFCOG PWDG FY2021 Annual Work Plan.

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1.0 Purpose

Multiple approaches can be used to model the potential impacts of weather in risk analyses. These range from simply increasing the positive skew of schedule uncertainty ranges for outdoor construction activities to utilizing metrological data for a specific region. By identifying the circumstance under which a project may benefit by having a more accurate assessment of weather risk a potential cost savings can be realized by either avoiding unnecessary time and effort in developing an overly complex model or conversely by producing a too simplistic model and either being overly conservative, too optimistic or just simply unrealistic resulting in overestimating or underestimating the reserves necessary for the project to respond to realized weather impacts.

> "How do the men who drive the snow plough get to work in the morning?"
> – Steven Wright

The purpose of this report is to investigate methods of accounting for weather impacts in risk analyses with a focus on how weather data can be utilized to enhance analysis, and provide recommendations for when this feature could be used to assist projects in achieving a better assessment of potential weather impacts

The EFCOG FY 21 Work Plan item is shown in Table 1-1:

Table 1-1 EFCOG FY21 Work Plan (Extract)

Investigate the potential benefit of utilizing weather calendars to improve Likelihood and consequence values for weather-related risks	**Recent software developments allow the metrological data for a specific region to be imported and utilized to better assess the risks of adverse weather relative to when work is being performed. By identifying under which circumstances a project may benefit by having a more accurate assessment of weather risk a potential cost savings can be realized.**	**Investigate how weather data can be utilized within the risk software, how it is presently being used (or not used), and provide recommendations for when this feature could be used to assist projects in achieving a better assessment of potential weather impacts.**

This report satisfies this specific item within the FY21 Work Plan.

2.0 Methodology

A roadmap was developed and utilized to plan the path forward of this initiative.

The roadmap is presented in Attachment 1. Each Roadmap activity is described below.

2.1 Develop Roadmap

This initial step is to develop the roadmap which will map out the future activities of this initiative. The roadmap is a living document and can be revised during the execution of this task. The roadmap is shown in Attachment 1

2.2 Define the Need and Desired outcome of the Evaluation

Based on experience across the complex, guidance is needed on when it is appropriate and beneficial to use more advanced weather modelling techniques, e.g., weather calendars, in risk analyses. The outcome of the evaluation will provide recommendations to optimize the modeling of weather phenomena in risk analyses.

2.3 Identify Current Methodologies

The current practices for accounting for/modelling weather impacts in risk analyses will be identified. This will include DOE, DOD and commercial (e.g., ISO 31000).

2.4 Investigate Current Methodologies

The practices and methodologies will be investigated, and overviews developed.

2.5 Document Pros and Cons of Current Methodologies

The pros and cons of each methodology will be identified and documented.

2.6 Develop Recommendations on When to Use Which Methodology

Based on the evaluation of each practice/methodology, recommendations for appropriate use will be developed and presented.

2.7 Team Review Final Report

The EFCOG Risk Task Team will review and comment on the final report.

2.8 Finalize and Issue Report

Comments will be resolved, report finalized, approved and issued.

3.0 Purpose of Evaluating the Use of Weather Calendars in Risk Analysis Models

The goal of evaluating the use of Probabilistic Weather Calendars is threefold:

To develop a clear understanding of how various projects account for weather in terms of duration and cost. Reviewing the most prevalent approaches for accounting for the potentially substantial time and resources required as a result of weather is obvious first step. In identifying this approach, the focus projects are those projects being performed in the Department of Energy, Department of Defense in addition to general commercial projects (Construction, D&D, Lifecycle Extension, etc.). The various approaches act as the bases for both the anticipated quantification effort in addition to providing real world examples for the market impact that weather can have on a given project.

To identify the benefits and drawbacks for each of these approaches. Just as each project is different, both in scope and resources (cost/time) each project is equally diverse in its need for predictive modeling. Projects of short duration, low exposure to the elements, homogenous or weather independent performance or those where intra-climate analogous estimates are readily available may not require deep analyses during estimation and modeling, while one-off or projects completed in a multitude of weather exposures may benefit more from analyses.

To provide best practice recommendations for quantifying weather impact (both in terms of methodology and implementation for a given project). This should be actionable for project management professionals regarding the most efficient and predictive approach in quantifying the temporal and financial impact of weather for their projects. Based upon the current available best-practices, project variables (complexity, location, exposure to elements). Weather forecasting models are in use for various portfolio books of business, as they face repeatable and consistent factors of performance. This approach is somewhat different, in terms of seasonality and impact upon heterogenous activities within a given project model. Given these different set of circumstances, what methodology would be serving a project manager in their attempt to accurate build models that include all non-deterministic variables for a project plan, including weather.

4.0 Methodologies for Modeling Weather Impacts

4.1 "Work/Non-Work" Criteria

One method for ensuring that a probabilistic project model is weather risk informed is the generation of statis weather impacted calendars. This can be achieved in a fashion similar to how a static scheduling calendar has its work and non-work days established. These work and non-work days are first selected based upon the working schedule (Weekend off/on, 4 x 10s, Sundays off; week on/week off, 9 x 9's calendars, etc.). They can then be further detailed by designating a span of calendar days as non-work days (e.g. school teachers off for the summer, outdoor poolside lifeguards off during cold months, etc.).

Utilizing this method allows the Risk Analyst to designate clear non-working calendar spans that can represent the beginning of non-working periods, due to weather, and can then terminate these non-working periods when weather would again be assumed to be a non-factor. This approach can be utilized for freeze & thaw periods, impassable sea conditions, effects based upon freezing of a body of water, unfavorable conditions for certain construction activities, or incompatibility with certain construction material, or even, in extreme conditions, inhospitable conditions for human work. As the Models generate various iterations, these non-working periods factor in weather delays in a binary fashion, resulting in work being split or delayed until the designated non-work period is finished. This designation is deterministic, being established by subject matter experts, implications based upon historical data review, etc.

4.2 Threshold Identification

The methodology most frequently used to date would be the identification of an impacted threshold. With this approach the Risk Analyst identifies a given threshold upon which he/she base their assumption that a given weather event will impact a particular project. Once this weather-specific risk is identified, the quantification steps further defined the area and anticipated duration and resource usage impact that would occur as a result of the weather risk being realized.

The Impact duration and resource impact values are quantified along with the non-weather informed Risks which are identified within the risk register. These impacts are then assigned to the activity(ies) which are likely to be impacted by the negative weather event. The various weather events which will occur will affect different activities differently. This is to say that a similar weather occurrence will not have the same magnitude of negative effects or may even avoid a negative effect all together. One phenomenon noted when attempting to utilize these impacts, however, is that these impacts may end up impacting a model asynchronously with the actual time of year in which they occur in nature/reality. Said another way, at different percentile values the analyst may find that excessive snowfall threat may occur at a time of year when snow does not normally occur in the clime of a given project.

4.3 Probabilistic Weather Calendars

The third method for modeling the temporal, resource and financial impacts of weather upon a project is the generation and use of a Probabilistic Weather Calendar (PWC). For this discussion it will be assumed that these PWCs will be generated in support of an Integrated Cost-Schedule Risk Analysis (ICSRA). As with the generation of any calendar, the generation of a PWC calendar is very similar. The production of these Risk Calendars develop a series of non-work and work days but, while using the probabilistic calendar methodology, allow for a certain probability of occurrence for the ability to conduct for or for work execution to be delay. These PWCs are utilized within the ICSRA Monte Carlo analysis to allow variability within the deviations between iterations. They not only allow for the differences between different days of the week, different hours of the day, differences between performance years or between seasons of a given year, as any calendar does, but they also to allow for variability between different iterations. Said another way, they allow for a given date to be a work day during one iteration, but to be a non-work day on a previous or successive iteration.

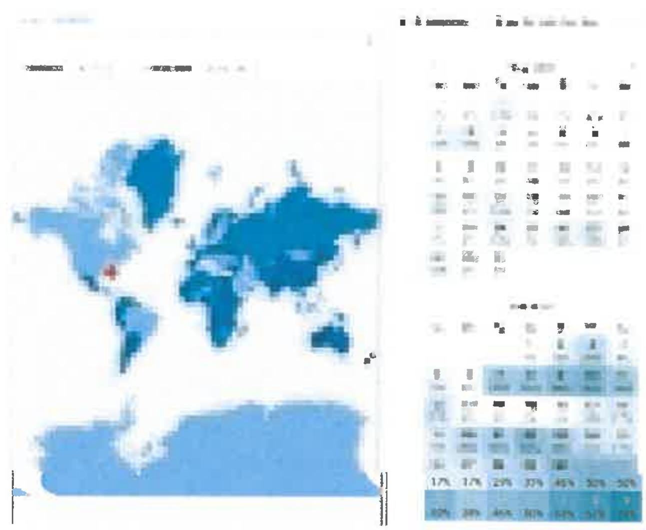
During the development of these calendars, it is important to assess many factors of one's project. A prudent Risk Analyst will review his project for the types of climes and weather patterns will typically exist at the various locations of the project. The Risk Analyst will also discern which specific weather patterns or conditions would be likely to affect the project in question. This line of question is just as concerned about the vulnerability of the project to weather as it is of the likelihood of different weather patterns and conditions occurring within a given project.

Building upon the development of the calendar is the identification of impacted activities. As is the case with regular scheduling software calendars, probabilistic calendars need to be generated, reviewed and fully understood prior to being placed in the set of options for a given risk model. Once, however, these PWCs are fully generated and vetted, a review with subject matter experts for applicability within the various areas of scope within their project is necessary. By discerning which activities are susceptible to various weather events, patterns or objective indirect results of weather, an SME and Risk Analyst can go about completing the list, or assigning, these PWCs to the activities underneath his or her responsibility.

Once the generating and assignment of Probabilistic Weather Calendars has been completed for a Deterministic Schedule, the step of progression is to go about assessing the impact of the given schedule (s). Through a ICSRA probabilistic analysis a Risk Analyst can perform the iterations necessary and generate the compiled data sets required to identified the magnitude and frequency that the developed PWCs have upon a given model. These Drivers/Tornado Charts and Sensitivity Analyses developed as a result of modeling the full Deterministic Schedule and Risk Register can provide valuable insight to allow each of the stakeholders of the risk process to discern whether or not the PWCs are have an affect on the project's ICSRA which is correct both in magnitude, reasonability can be rationally defended by the project team.

In order to properly time-phase and quantify resources and activities within a probabilistic model, a probabilistic weather calendar should be produced for each variable noted above which would impact the project in question. necessary for proper allocation. Once the probabilistic calendar is generated for each of the aforementioned factors, these probabilistic calendars should be assigned to all appropriate tasks. Screening of these tasks should be completed as part of the Deterministic Schedule build and should have both the input and buy-in of the supporting Subject Matter Experts responsible for commission and/or executing this work.

Example Probabilistic Weather Calendar



The generation of these Probabilistic Weather Calendars (PWC) should be specific to the clime where the given activities will be executed (This may be separate from the locale which the project management may be performed). The PWCs should be as robust and specific to the tasks as is necessary to generate go/no-go criteria for efficacious and product tasks execution. Each of these criteria will depend upon the task being completed and the various factors necessary to attain the speed and level of performance necessary to meet the project deliverables and expectations (usually already identified in order to product deterministic duration and resource usage/variability for the assigned tasks).

5.0 Pros and Cons of Methodologies

ID	Methodology	Pros	Cons
4.1	Work/Non-Work Criteria (Static Criteria)	• New calendar is able to be generated quickly and relatively easily.	• Changing deterministic calendar could negatively impact the existing deterministic schedule dates & logic

		•New calendar is easily assigned within deterministic schedule. •Easy to replace existing deterministic schedule calendar • Able to be applied to the exact activity(ies) which could be affected by the negative weather event.	• Additional Quality Assurance Step needed in order to ensure resulting deterministic schedule meets expectations • Subjectivity of anticipated weather impacts
4.2	Threshold Identification	• Less extensive effort to establish probabilistic Risk Register items • Very quick assignment to identified impacted task(s) • Easy to assign multiple weather impacts to the same task(s)	• Unable to always be applied to the exact activity(ies) which could be affected by the negative weather event. • Marked subjectivity of anticipated weather impacts •Impact of weather events is difficult to throttle being alternatively in/excessive •Very dependent upon the assigned activities within the schedule •Difficult to quantify, avoid double counting multiple weather factors occurring simultaneously. •Impacts occurring during certain seasons may probabilistically affect impacted activities asynchronously.
4.3	Probabilistic Weather Calendars	• Objectivity of anticipated weather impact • Able to be applied to the exact activity(ies) which could be affected by the negative weather event. • Able to assign multiple weather impacts to the same task(s) •Less dependent upon the activities selected • Modeled values more aligned with historical impact based upon data	• More extensive effort to establish probabilistic calendar • Requires historical data for applicable project location • Multiple weather impacted calendars require additional effort to generate

6.0 Conclusions

In order for a project manager to ensure that he/she provides guidance regarding the proper allocation of time and resources for their projects it is imperative that an analysis of whether or not the project will be susceptible to weather be completed. The variability, even if ruled out, must be determined by a thorough analysis of the project through proper initial screening and following by quantitative analysis if necessary. This can be best completed by completing a 2-step process:

- Initial Screening
- Decision on Methodology to be used

6.1 Initial Screening

An initial set of questions should be asked of the project Subject Matter Experts (SMEs) in order to discern whether the effort necessary to complete a more in-depth quantification of weather impact on a project should be completed, or would be worth the time and effort necessary to properly generate. Such questions, if answered in the affirmative, would indicate that a further quantitative exploration would be worth investigating:

- Does my project contain tasks which can be in/directly affected by excessive ambient, soil or water temperature?
- Does my project contain tasks which can be in/directly affected by insufficient ambient, soil or water temperature?
- Does my project contain tasks which can be in/directly affected by excessive precipitation?
- Does my project contain tasks which can be in/directly affected by insufficient or excessive wind?
- Does my project contain tasks which can be in/directly affected by extreme weather events?
- Does my project contain tasks which can be in/directly affected by sunlight or cloud cover?
- Does my project contain tasks which can be in/directly affected by excessive/inefficient sea patterns/wave amplitude?

6.2 Decision on Methodology to be used

Given these various set of circumstances and challenges facing each project, a one size fits all approach may never be generated. This being the case, a prudent Project Manager, along with their Risk Analyst and Project Team Members, have a viable alternative to incorporate temporal and financial outlays necessary for project success. Through use an ICSRA that is weather impacted a confidence interval which includes weather variability can be generated in a straight forward manner which minimizes project failures and maximizes the timely attainment of project deliverables.

7.0 Recommendation

It is recommended that Risk Analyst on DOE projects take the time to consider the potential exposure that their projects have to weather, including direct and indirect vulnerabilities to extreme weather and normal weather variations.

After a thorough investigation is completed utilizing SMEs and using the set of questions identified in Section 6.1 the Risk Analyst should make a recommendation to the project Manager for a path forward for inclusion of weather-related risks in the project risk analysis.

If the recommendation is to develop an in-depth assessment and inclusion of weather-related risks, then the Risk Analyst should take the time to generate, assign and deploy Weather-specific Probabilistic Calendars to include within their project's risk model.

8.0 References

8.1 DOE O 413.3B, Program and project management for the Acquisition of Capital Asset Projects, Chg. 5; 12-Apr-2018.

8.2 DOE G 413.3-7A, Risk Management Guide, Chg. 1; 22-Oct-2015

8.3 DAES 2006 Risk Guide; Characteristics of Successful Risk Management Approaches

8.4 ISO-3100: International Standard; Risk Management – Principles and Guidelines

8.5 NASA Risk Management Handbook; NASA/SP-2011-3422, Version 1.0, November 2011

8.6 SAP-OCE & PMS – 413.3B-B-05 Management System: Project Management- Procedure: Risk Management; 2/26/20215 Rev.0

Attachment 1 –Evaluation of the Use of Weather Calendars in Risk Analysis Models and Recommendations Roadmap