Project-Specific Loss of Productivity Analysis Methodologies

Commissioned by:

Mechanical Contractors Association Of America (MCAA)

National Electrical Contractors Association (NECA)

Sheet Metal And Air Conditioning Contractors' National Association (SMACNA)

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This white paper has been prepared as an independent guide for contractors who are required to, or choose to, prepare project-specific labor inefficiency analyses. This document is neither a commentary on nor an evaluation of the recent ELECTRI International, PANDEMICS AND CONSTRUCTION PRODUCTIVITY: QUANTIFYING THE IMPACT or New Horizons Foundation, PANDEMICS AND PRODUCTIVITY: QUANTIFYING THE IMPACT studies on COVID-19 labor inefficiency.

Foreword

This white paper, *Project-Specific Loss of Productivity Analysis Methodologies,* is a stand-alone discussion of accepted methodologies for quantifying loss of productivity impacts, irrespective of causality. Loss of Productivity impacts can be felt by all trades on a project:

- when a project schedule is delayed and/or accelerated,
- when various trades are improperly stacked upon one another,
- when the continuity and flow of the work activities is disrupted, and
- when a substantial amount of change is introduced into a construction project.

The degree of impact may vary by trade, but no trade is immune from sustaining impacts on problem projects. The Mechanical Contractors Association of America (MCAA), National Electrical Contractors Association (NECA) and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) have aligned the MEP trades in full support of the methodologies described in this white paper as industry-accepted approaches to quantifying those impacts when making requests for equitable adjustment (REA) and delay claims.

There is no question the ongoing COVID-19 pandemic has impacted the construction industry as a whole, including the mechanical, electrical, and plumbing (MEP) trades. ELECTRI International (NECA's research and education foundation) and the New Horizons Foundation (SMACNA's research and education foundation) have each published results of studies quantifying loss of productivity impacts of COVID-19 on work in their respective trades. Those studies can be found here:

ELECTRI International: ***https://electri.org/product/pandemics-and-construction-productivity-quantifying-the-impact-final-version/***

New Horizons Foundation: ***www.newhorizonsfoundation.org/project/pandemics-and-productivity-quantifying-the-impact-report/***

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This is a companion piece, a stand-alone discussion of accepted methodologies. Its intent is to provide insights into acceptable methodologies for quantifying loss of productivity due to COVID-19 or other unforeseen causes of project disruption impacting productivity.

MCAA
Mechanical Contractors Association of America

ABOUT THE MECHANICAL CONTRACTORS ASSOCIATION OF AMERICA (MCAA)

The Mechanical Contractors Association of America (MCAA) is the premier trade association for construction and service firms participating in the mechanical, plumbing, HVAC, HVACR service and industrial piping industries. The MCAA serves the unique needs of its company members by providing over 500 high-quality educational materials and programs to help them attain the highest level of managerial and technical expertise. MCAA includes the John R. Gentille Foundation, Mechanical Service Contractors of America, the National Certified Pipe Welding Bureau, the Plumbing Contractors of America, and the Manufacturer/Supplier Council. MCAA is governed by an executive committee and a board of directors and each subsidiary has its own governing structure. Committees and task forces carry out work in specialized areas, such as safety, labor relations and estimating.

NECA

ABOUT THE NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA is the voice of the $171 billion electrical construction industry that brings power, light, and communication technology to buildings and communities across the United States. NECA's national office and 118 local chapters advance the industry through advocacy, education, research, and standards development. Electrical contractors perform specialized construction work related to the design, installation, and maintenance of electrical systems. Whether high-voltage power transmission or low-voltage lighting, electrical contractors ensure these systems work in a safe, effective, and environmentally-sound manner. NECA represents electrical contractors from firms of all sizes performing a range of services. ELECTRI International, founded by NECA in 1989, serves as the electrical construction industry's foundation through its research, education, and outreach portfolio of programs.

SMACNA

ABOUT THE SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA is an international trade association representing 3,500 contributing contractor firms and is a leader in promoting quality and excellence in the sheet metal and air conditioning industry. SMACNA members are responsible for effectively delivering the clean air Americans breathe in offices, homes, and hospitals; for many of the attractive facades you see on today's stadiums and office buildings; and for the comfortable, healthy, and safe living environments in which our citizens live out their daily lives. SMACNA has national offices in Chantilly, Va., outside of Washington, D.C., and on Capitol Hill.

The contents of this white paper were prepared and peer reviewed by construction industry experts and authors of MCAA's Change Orders, Productivity, Overtime: A Primer for the Construction Industry guide, Paul Stynchcomb, CCM, PSP, CFCC, and Professor William Ibbs, Ph.D. of The Ibbs Consulting Group. The guide was developed to assist construction contractors, their customers, and others involved in construction projects in determining the costs associated with unplanned events, circumstances, and factors that may impact the outcome, productivity, and schedule of those projects. MCAA's Change Orders, Productivity, Overtime: A Primer for the Construction Industry is a nationally recognized document serving as a guide for more than three decades to support requests for equitable adjustment and delay claims.

This publication is not intended as a source for absolute percentages or costs. Rather, this paper is a planning tool to enable the early identification of obstacles to a successful project and to manage such obstacles proactively in order to mitigate or eliminate their impact on the bottom line, thereby benefitting all of the project participants. In May 2020, this primer received endorsements from the American Subcontractors Association (ASA), National Electrical Contractors Association (NECA) and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

Introduction

Loss of labor productivity (LoP) is a complex and potentially costly issue. It is complex because of the myriad of contracts and subcontracts that exist between the MCAA, NECA and SMACNA (hereinafter "MEP") member firms and prime contractors and/or owners. LoP is also complex because of the multitude of national, state, and local government directives and guidelines that are triggered by claims such as COVID-19, governmental orders to start and stop work as essential or non-essential services, specific mandated work protocols to ameliorate the COVID transmission hazard in the work place, civil unrest, or wildfire events, are to be handled.

The writers of this companion piece to the 2020 ELECTRI International, *PANDEMICS AND CONSTRUCTION PRODUCTIVITY: QUANTIFYING THE IMPACT* and New Horizons Foundation, *PANDEMICS AND PRODUCTIVITY: QUANTIFYING THE IMPACT* publications, encourage contractors planning to file a Request for Equitable Adjustment for COVID-19 LoP and delay claims to start by having their experienced construction personnel, such as legal counsel and consultants, perform a thorough review of the applicable contract documents, including executed change orders, payment applications, correspondence and governmental directives, before embarking on the preparation of a COVID-19 LoP and/or delay Request for Equitable Adjustment (REA).

Contractors contemplating preparing an REA or claim must persuasively demonstrate the "triad of proof":

- causation of the harm
- liability for the harm
- identification and quantification of the resultant injury.

Once a contractor is satisfied that the firm has a contractual and legal right and an avenue for recovery of LoP and/or delay damages, then the contractor preparing the REA or claim (the "claimant"), must choose the method of quantification. In their publications, ELECTRI International and New Horizons Foundation have provided inefficiency factors derived from a nationwide study. However, those generalized inefficiency factors will probably not suffice in a claim and the claimant may be faced with the requirement from a prime contractor or owner to prepare a project-specific LoP and/or delay analysis. This stand-alone companion white paper addresses that potential.

Once a contractor is satisfied that the firm has a contractual and legal right and an avenue for recovery of LoP and/or delay damages, then the contractor preparing the claim must choose the method of quantification.

There are several methods of performing a project-specific LoP quantification analysis. For further reading on the preferential hierarchy of LoP quantification methodologies, refer to the Recommended Practice RP No. 25R-03, published by the Association for the Advancement of Cost Engineering International ("AACEi") and a forthcoming Standard by the American Society of Civil Engineers. In order of preference and acceptance by courts, boards of contract appeals, and arbitration panels, the methodologies are:

1) Measured Mile Method
2) MCAA Factors Table
3) Ibbs Study Cumulative Impact Study
4) Modified Total Cost (Labor Hour) approach

The Measured Mile Method

Unquestionably, the measured mile method of LoP quantification is the most preferred method available to a contractor attempting to quantify labor inefficiencies. The measured mile method compares the claimant's labor productivity in an unimpacted, more practically, a less impacted area or time frame on a project to an impacted area or time frame on the same project. The two periods or project areas should be reasonably similar in terms of factor such as work type, means-and-methods, crew type and size, and supervision.[1] The claimant must be able to access labor productivity records that document the field craft labor hours required to install a measurable unit of work in both the less impacted and the impacted project area or time frame.

The difference in productivity rates produces an impact percentage that can then be used to compute the unimpacted or less impacted "should have spent" labor hours on the project. To use the measured mile method, the claimant need not have tracked actual labor hours required to install quantifiable units of work as the work is actually being installed. However, the contractor's labor tracking system (e.g., labor performance reports as described herein) needs to be sufficiently detailed and accurate to allow for the assessment of the actual labor hours expended to accomplish a work activity by way of an "after the fact" material take-off. If the claimant's labor tracking records identify the hours spent by activity codes, and a material take-off can be performed for each activity code, the claimant can then determine the productivity rate ratio; that is, actual labor hours required to install a known quantity of material in an impacted area or time frame as compared with the productivity in a less impacted area or time frame. These sorts of measured mile analyses can be, and usually are, performed even after the project is complete.

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The Labor Performance Report (Example of Detailed Activities)

Activity ID Code	Activity Description	Planned Hours	CO Hours	Rev Plan	Last % C	Current % C	Earned Hours	PT AH	C Act Hrs	Wk -2	Wk -1	Cw
7550	Inst CHWS&R Mains Area B	500		500	30	50	250	300	450	-75	-150	-200
7570	Inst CHWS&R Brnchs Area B	700	50	750	10	20	150	120	200	-40	-45	-50
7590	Connections @ Mech Equip	100		100	10	15	15	10	12	0	0	3

1 For a further detailed reference regarding the application of the measured mile method, refer to the MCAA's 2020 edition of *Change Orders – Productivity – Overtime: A Primer for the Construction Industry,* pages 163-180. Also refer to "Practical Ways to Identify Measured Miles," Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, February 2017, authored by William Ibbs, PhD and Josh Chittick.

For example, if a claimant's labor tracking system identifies the actual labor charges to install a quantifiable amount of a particular material (e.g., pipe, conduit or sheet metal duct) in a discrete area of a project (e.g., by drawing number) and the claimant's labor records document the labor hours actually expended to install the measured quantity of material in both the less impacted and the impacted areas or time frames on the same project, the claimant can prepare a measured mile comparison. It is also important to note that reported cases at the major boards of contract appeals have made it clear that an exact match of materials is not required in a measured mile comparison.

Many contractors contemporaneously maintain planned versus actual earned value labor reporting as shown in the example above. Presuming that the contractor can perform a take-off of the materials contained in the listed activities, then a measured mile analysis can potentially be performed. The analysis is a comparison of actual labor hours expended per measurable unit of work in a less impacted and impacted area or time frame.

As mentioned, the rule is ***reasonable similarity.*** Thus, if the activity code in the example on page 4 is described as 'Feeder Conduit 2" to 6"', the comparison could include conduits of various sizes. The reported decisions at the major boards of contract appeals evaluate material types, jointing methods, location of the work, skill sets and availability of craftworkers and their supervisors, weather conditions, schedules, and other factors that need to be *reasonably similar* between the less impacted and the impacted areas or time frames.

The measured mile comparisons between the less impacted and impacted project areas or time frames are used to compute the *"should have spent"* labor hours in the impacted areas. If the claimant measures a production rate of ***n*** number of labor hours to install a known quantity of material in the less impacted area or time frame, that productivity factor can be applied to the take-off of similar conduit in the impacted area or time frame. The claimant then subtracts the *"should have spent"* labor hours from the actual hours expended to solve for the inefficient labor hours.

Actual productivity factor to install EMT in the less impacted area or time frame:

Quantity of EMT in the impacted area or time frame:	*n* labor hours/foot of EMT
Should have spent labor hours:	actual productivity rate to install a foot of EMT in the less impacted area or time frame
Claimed labor hours:	700' of EMT x less impacted labor productivity hours per foot = *should have spent hours*

Figure 1 – Determining Claimed Labor Hours

Actual labor hours expended in the impacted area or time frame to install the EMT (Minus) the *"should have spent"* hours as calculated above = LoP claimed hours.

The above measured mile calculation results in a subtraction of the *should have spent* labor hours from the actual hours spent to install the 700 linear feet of EMT in the impacted area or time frame. The resultant value is the amount of inefficient labor hours that will be claimed. This method has the marked advantage of avoiding a reliance upon the claimant's bid estimate or labor plan. Only the actual labor expended on the project is considered in the quantification of the loss of labor productivity.

Similarly, referencing the Figure 1 example above, a piping contractor would measure the labor hours required to install a foot of a particular size and type of pipe material in the less impacted area or time frame, and would compare the productivity rate achieved in the impacted area or time frame. The piping contractor would utilize the productivity rate in the less impacted area or time frame as the "should have spent" labor hours, and would then subtract those hours from the labor hours expended in the impacted area or time frame. The difference between the actual hours expended in the impacted area or time frame and the actual hours expended in the less impacted area or time frame yield the hours of claimed inefficiency.

For sheet metal contractors, most frequently a measured mile productivity rate is measured in pounds of duct installed per hour of labor. As with electrical and piping contractors, it is important to measure similar materials, thus the similarity of duct pressure rating, and fitting density, are important considerations. As with the examples above, the sheet metal contractor would derive from the labor reports the productivity rate (usually in pounds per hour) in a less impacted area or time frame and compare that with the productivity rate in an impacted area or time frame. The productivity rate in the less impacted area or time frame (the "should have spent" rate) would be subtracted from the productivity rate in the impacted area or time frame, yielding the hours of inefficiency to be claimed.

Once the claimant has recorded the labor hours required to install the measurable quantities of materials in the less impacted and the impacted areas or time frames, the data can be plotted graphically to depict the relative productivity rates. As with any labor loss of productivity REA or claim, a detailed narrative explaining the conditions or events that caused the loss, the bases for recovery, and the quantification of the loss should form a part of the REA or claim. This is sometimes called the "cause and effect" nexus. While the courts and boards of contract appeals do not require that the quantification of the loss of labor productivity be the product of a precise calculation, the triers of fact do require that a connection be drawn between an impacting event and the resultant loss of labor hours.

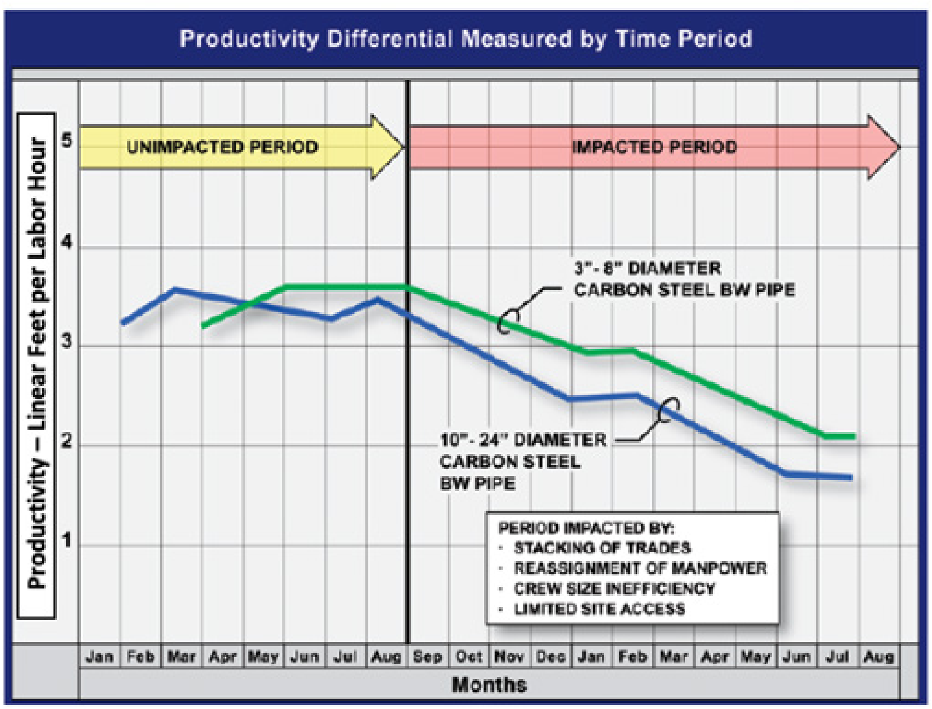

Figure 2 – Sample Productivity Graphic by Time Period

For a much more detailed explanation of the measured mile method, refer to the MCAA publication cited herein, 2020 edition, pages 163–180.

The MCAA Publication and the Labor Inefficiency Factors Table

In 1971, the Mechanical Contractors Association of America, Inc. published “Factors Affecting Labor Productivity.” These Factors have been used in many claims to quantify a contractor’s LoP. Moreover, the MCAA Factors have been widely accepted by courts, boards of contract appeals and arbitration panels as a reasonable means for a contractor to quantify (estimate) its LoP. The MCAA Factors’ table and method of application are described in detail in the MCAA’s 2020 publication entitled *Change Orders – Productivity – Overtime: A Primer for the Construction Industry* ©.

The MCAA Factors’ table contains 16 categories of potential LoP impacts and details three impact intensity percentages for each category. The MCAA Factors can be reviewed on pages 135–136 of the referenced MCAA publication.

The MCAA Factors, including the entire MCAA publication cited herein, has been endorsed in its entirety by NECA and SMACNA, and has been fully supported by the American Subcontractors Association. NECA has specifically stated in its endorsement of the MCAA’s publication: “NECA has endorsed this publication as being applicable to the electrical trade and helpful to NECA member firms.” Similarly, SMACNA’s endorsement reads: “SMACNA has endorsed this publication as being applicable to the sheet metal and air conditioning trades and helpful to SMACNA member firms.” Thus, the MCAA LoP Factors have been found applicable to MEP contractors and have gained wide acceptance in the industry.

The labor inefficiency Factor table is depicted below:

The MCAA Factors productivity tables and user instructions are contained in the MCAA’s publication titled “Change • Orders Productivity • Overtime A Primer for the Construction Industry” pp 135-136

Factor	Percent of Loss per Factor		
	Minor	Average	Severe
1. STACKING OF TRADES: Operations take place within physically limited space with other contractors. Results in congestion of personnel, inability to locate tools conveniently, increased loss of tools, additional safety hazards and increased visitors. Optimum crew size cannot be utilized.	10%	20%	30%
2. MORALE AND ATTITUDE: Excessive hazard, competition for overtime, over-inspection, multiple contract changes and rework, disruption of labor rhythm and scheduling, poor site conditions, etc.	5%	15%	30%
3. REASSIGNMENT OF MANPOWER: Loss occurs with move-on, move-off men because of unexpected changes, excessive changes, or demand made to expedite or reschedule completion of certain work phases. Preparation not possible for orderly change.	5%	10%	15%
4. CREW SIZE INEFFICIENCY: Additional workers to existing crews “breaks up”original team effort, affects labor rhythm. Applies to basic contract hours also.	10%	20%	30%
5. CONCURRENT OPERATIONS: Stacking of this contractor’s own force. Effect of adding operation to already planned sequence of operations. Unless gradual and controlled implementation of additional operations made, factor will apply to all remaining and proposed contract hours.	5%	15%	25%
6. DILUTION OF SUPERVISION: Applies to both basic contract and proposed change. Supervision must be diverted to (a) analyze and plan change, (b) stop and replan affected work, (c) take-off, order and expedite material and equipment, (d) incorporate change into schedule, (e) instruct foreman and journeyman, (f) supervise work in progress, and (g) revise punch lists, testing and start-up requirements.	10%	15%	25%
7. LEARNING CURVE: Period of orientation in order to become familiar with changed condition. If new men are added to project, effects more severe as they learn tool locations, work procedures, etc. Turnover of crew.	5%	15%	30%
8. ERRORS AND OMISSIONS: Increases in errors and omissions because changes usually performed on crash basis, out of sequence or cause dilution of supervision or any other negative factors.	1%	3%	6%
9. BENEFICIAL OCCUPANCY: Working over, around or in close proximity to owner’s personnel or production equipment. Also badging, noise limitations, dust and special safety requirements and access restrictions because of owner. Using premises by owner prior to contract completion.	15%	25%	40%
10. JOINT OCCUPANCY: Change cause work to be performed while facility occupied by other trades and not anticipated under original bid.	5%	12%	20%
11. SITE ACCESS: Interferences with convenient access to work areas, poor man-lift management or large and congested worksites.	5%	12%	30%
12. LOGISTICS: Owner furnished materials and problems of dealing with his storehouse people, no control over material flow to work areas. Also contract changes causing problems of procurement and delivery of materials and rehandling of substituted materials at site.	10%	25%	50%
13. FATIGUE: Unusual physical exertion. If on change order work and men return to base contract work, effects also affect performance on base contract.	8%	10%	12%
14. RIPPLE: Changes in other trades’ work affecting our work such as alteration of our schedule. A solution is to request, at first job meeting, that all change notices/bulletins be sent to our Contract Manager.	10%	15%	20%
15. OVERTIME: Lowers work output and efficiency through physical fatigue and poor mental attitude.	10%	15%	20%
16. SEASON AND WEATHER CHANGE: Either very hot or very cold weather.	10%	20%	30%

Figure 3a – MCAA Factors Productivity Tables

The MCAA Factors contain many categories of project-specific LoP impacts that can occur on construction projects. The MCAA Factors table is reprinted herein and can be accessed by NECA member firms at the website ***www.mcaa.org***. Within the 16 MCAA Factors, the following may be applicable to many COVID-19 impacted construction projects:

The MCAA factors have proven to be a reliable means of estimating the loss of labor productivity on construction projects for over 30 years. The specific values shown in the factor tables must be applied with careful consideration and a review of the facts surrounding the events, which caused the loss of productivity. The applications of the various MCAA factor percentages will vary as project conditions dictate. This chapter will provide specific guidelines and examples of several methods of application for the proper use of the MCAA factors in calculating the loss of labor productivity on construction projects.

What types of CV-19 LoP impacts can be described by the 16 MCAA Factor categories?

#1 Stacking of Trades
#3 Reassignment of Manpower ("Disruption")
#4 Crew Size Inefficiency
#5 Concurrent Operations
#6 Dilution of Supervision
#7 Learning Curve
#11 Site Access
#12 Logistics (Material Supply Chain)
#14 Ripple Effect
#15 Overtime
#16 Unanticipated Weather Impacts

Figure 3b – MCAA Factors Productivity Tables

Each MCAA Factor description is associated with an intensity factor: Minor, Average and Severe. The Factor descriptions and the related intensity levels must be assessed, and assigned to the specific project under study, by those knowledgeable about conditions on the project. That includes foremen, superintendents, and project management personnel.

The MCAA Factors' table contains 16 categories of potential LoP impacts, along with three impact intensity percentages for each category.

Once the MCAA Factor categories and intensity levels are chosen for the specific project under study, then the timing of those impacts must be identified. LoP is seldom linear in its impacts on a construction project. For this reason, the MCAA publication recommends that the Factors be applied in a temporal manner—impacts measured over time.

LoP impacts of COVID-19 may fluctuate over time. These fluctuations may arise from changing governmental regulations, new protocols intended to help prevent the spread of the virus or changes in the severity of the outbreak. COVID-19 LoP claims may range from a historical period, for instance from late February 2020 to the present, and then from the present to sometime in the future, depending on the nature and structure of the REA. The actual labor hours expended in an historical period will have the inefficient LoP hours embedded in the total labor hours recorded by the claimant. Thus, the actual (historical) hours in a COVID-19 LoP analysis will have to be factored differently from the LoP hours in a prospective analysis.

The following example depicts what may be a typical project-specific LoP analysis using the MCAA Factors.

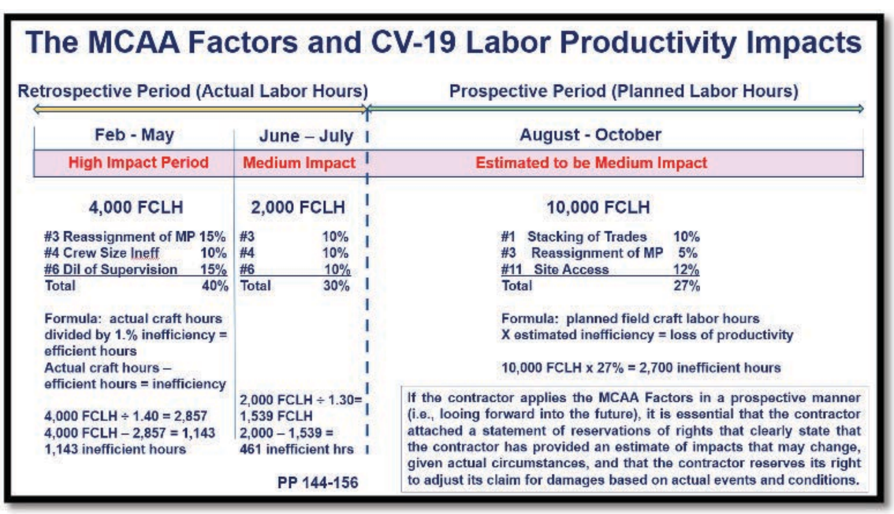

Figure 4 – Project-specific LoP Analysis Using MCAA Factors

In this application example, the historical labor hours show an estimated impact of 40% using the MCAA Factors in one period, and an estimated impact of 30% in another historical period. As noted, LoP can be expected to fluctuate over time. The percentage of inefficiencies derived from the selected MCAA Factors are not simply multiplied against the actual hours since those hours already contain the labor inefficiencies. The retroactive formula defined in the MCAA publication is applied to the historical hours to remove the imbedded LoP hours, as shown above. For the hours used for a prospective (forward-looking) analysis, the estimated total LoP percent is multiplied against the estimate/forecasted labor hours moving forward.

The authors strongly recommend that a contractor making a claim for LoP thoroughly review MCAA's publication and also consider the delay implications of LoP. Without added resources, LoP will, in most cases, increase the planned duration of activities in the construction schedule. Thus, in addition to the quantification of LoP labor hours, the contractor making the claim must also assess how those added labor hours may affect the critical path of the construction schedule.

As detailed below, LoP may result in critical-path, schedule-delay impacts that should be evaluated by the contractor when making a comprehensive COVID-19 REA.

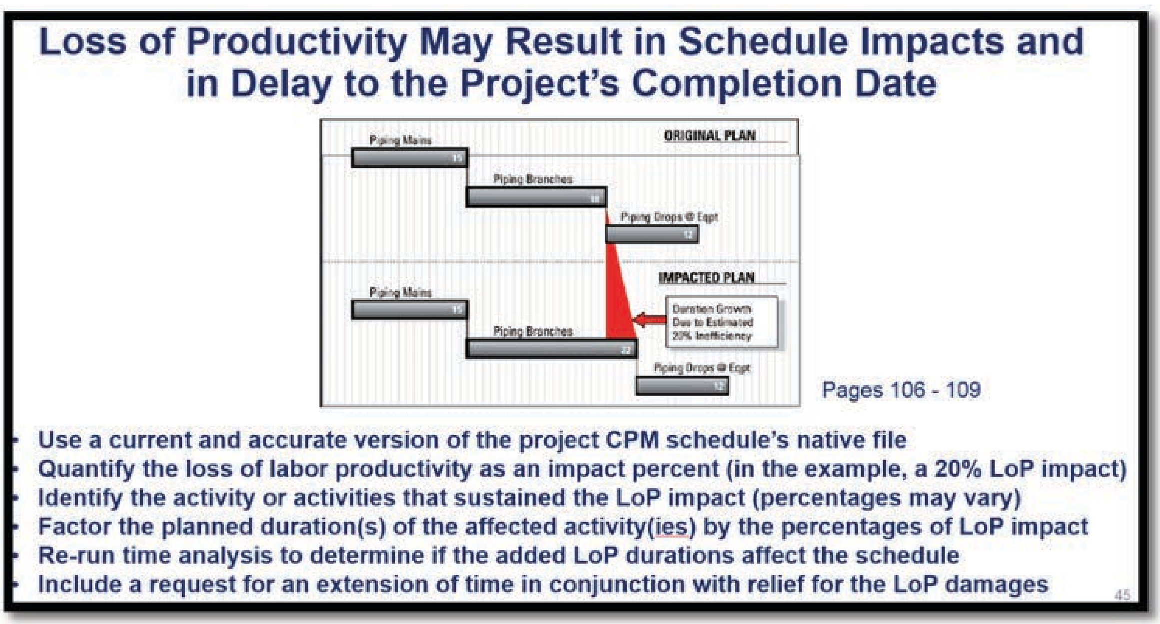

Figure 5 – Schedule Impacts and Project Completion Delay

The Ibbs Study Method

Another approach that can help contractors and owners assess the impact of virus-related change is found in work conducted by Professor William Ibbs, Ph.D., of the University of California at Berkeley (one of the authors of this white paper). With support from the Construction Industry Institute (“CII”), Dr. Ibbs has performed empirical research studies that correlate the quantitative impacts of change on labor productivity. Project owners and contractors provided the Berkeley research team with cost, labor-hour, schedule, change, and productivity data for hundreds of projects over the past twenty-five years.

The team developed statistical models and curves such as those shown in Figure 1 to correlate the amount of change a project incurs with its resulting productivity. The information was normalized to eliminate bid and field execution errors and other anomalies. The projects included both domestic and foreign work, as well as public and private projects with different delivery systems. They ranged in size from $2 million to $14 billion, with a median value of $44 million. This provided a set of data representative of the construction industry.

One result of this research is the statistical relationships depicted In Figure 6, where the vertical axis measures the Productivity Index (PI), and the horizontal axis measures the amount of change. The three curves in this figure depict the consequences of time and identify the effect of “early,” “median,” and “late” changes. PI is the ratio of planned productivity to actual productivity. Therefore, a PI above 1.0 represents good project performance.

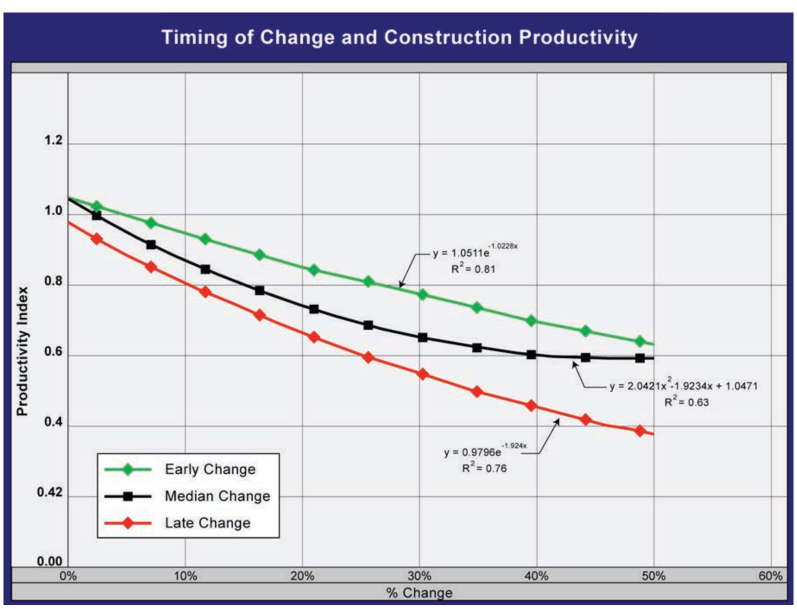

Figure 6 – Change vs. Productivity

Figure 6 also demonstrates that projects with late changes are likely to encounter much more disruption and loss of productivity. For example, at a 10% change, the late curve has a 20% productivity loss, whereas the normal curve has a 10% loss. Moreover, early and normal projects that have small amounts of change (less than four percent) may still encounter a PI value greater than 1.0, while late-change projects always demonstrate a PI value less than 1.0.

This model can be used to assess the impact consequences of COVID-related changes. As an example, consider that a project originally had 10,000 labor-hours of work plus 1,500 labor-hours of changes identified as directly related to the virus (e.g. cleaning time, rework time, extra travel time, etc.). Then, the change amount of this extra COVID-related work would be 15%. For a median timing project, the PI would be 0.80, or a 20% loss of productivity. That 20% factor would then be multiplied by the number of labor-hours expended during the time of the virus's influence on the project.

It is important for both the claimant and its expert to understand how the data were collected, the types of projects that were included in the study, and when the changes occurred on the project under study.

When planning to use statistical analyses such as the Ibbs study, it is important for both the claimant and its expert to understand how the data were collected, the types of projects that were included in the study, and when the changes occurred on the project under study. The expert should be able to describe how the change-related labor hours were collected, how the timing of the changed work was established, and how the actual contract labor hours were computed. The formula for calculating the loss of labor productivity using the Ibbs study requires potential adjustments to the labor hour data. For instance, the claimant's estimate should be evaluated to determine if it is reasonable. If errors are discovered, those hours must be adjusted in the calculation. Similarly, adjustments to the actual hours must be made if any self-inflicted errors are identified, such as bid errors or field execution errors by the contractor.

More information can be found by contacting Dr. Ibbs and by reviewing his website ***(www.IbbsConsulting.com)*** and publications, including the following:

1. Ibbs, C.W., "Quantitative Impacts of Project Change: Size Issues," *Journal of Construction Engineering Management,* September 1997, 123(3), 308-311
2. Ibbs, C.W., "Impact of Change's Timing on Labor Productivity," *Journal of Construction Engineering and Management,* ASCE, November 2005, 131(11), pp. 1219-1223

For a better understanding of the cumulative impact approach, readers can review a detailed chapter on this topic, co-written by the authors of this white paper, in MCAA's publication cited herein, pages 181–214.

The Modified Total Cost (Labor Hour) Approach

While the modified total cost (labor hour) method (MTC) of labor inefficiency quantification is one of the least favored methods, it does have a value in virtually any loss of productivity REA. One value of this approach is to demonstrate the actual labor hour loss on the project to the prime contractor, owner or trier of fact who will review the REA or claim. The MTC is more of an approach than it is a method of quantification It is called a "modified" approach because it identifies adjustments that the claimant has taken to reduce the final unallocated labor loss amount.

A typical MTC in labor hours is shown below:

The Modified Total Cost (Labor Hour) Method to Quantify CV-19 LoP Impacts

In the AACEi's hierarchy of preferred methods to quantify a loss of labor productivity, the two methods at the bottom of the list are the Modified Total Cost (Labor Hour), "MTC" method and the Total Cost method. One reason for this low ranking is due to the lack of particularization and specificity provided by these methods.

However, using any LoP methodology, the presenters recommend that the claimant prepare a MTC approach using field craft labor hours and not dollars or costs. Why – because this method identifies the maximum amount the claimant can claim without citing a "windfall" or "loss of profit" in labor hours.

The MTC formula:

1) Total field craft labor hours actually expended on the project
2) (Less) the original estimated, or planned, field craft labor hours
3) (Less) approved change order field craft labor hours
4) (Less) pending PCOs or unapproved change order field craft labor hours
5) (Less) time and material ticket field craft labor hours
6) (Less) estimate labor adjustments for missed items or improper factoring
7) (Less) field craft labor hours to repair/address contractor errors in the field

8) Results in the total unallocated field craft labor hour loss on the project

The total unallocated field craft hours derived from the MTC (Labor Hour) approach can be compared with the LoP quantifications derived by use of other, more specific methodologies, such as the measured mile or MCAA Factors' methods. It can also be used as a stand-alone quantification approach, although not favored.

Figure 7 – Modified Total Cost Method

The MTC is more of an approach than it is a method of quantification.

Each downward adjustment (i.e., "modification") requires an explanation by the claimant. This approach is frequently used by claimants in conjunction with a more definitive methodology such as a measured mile analysis or by the use of the MCAA Factors. The purpose is to show the maximum recovery by the claimant, and to compare that amount of labor hours with the hours derived by the more favored methodology. Modified Total Cost can also be used in conjunction with the MCAA Factors method to show the downward adjustments made by the claimant in the base labor hours used in the Factors' method. Be aware that when including a Modified Total Cost component in an REA, the claimant may be faced with the four-part test:

1. The nature of the claimed losses makes it impracticable, if not impossible, to determine damages in any other more particular manner.

2. The contractor’s bid estimate was reasonable and free from measurable errors.
3. The contractor’s actual costs were reasonable and that the claimant attempted to, or did, mitigate a portion of the damages.
4. The contractor was not responsible for the events leading to the damages being claimed.

Conclusion

The presence of the COVID-19 pandemic can have the effect of reducing a contractor's labor productivity and causing project delay. The contractor contemplating preparing an REA or claim should carefully follow all notice and quantification requirements contained in the contract.

As noted in the introduction above, the contractor should have an experienced construction attorney carefully review all relevant project documents and governmental directives regarding COVID-19 claims for relief before embarking on the preparation of an REA or claim. Once the contractor determines that:

- there has been a harm not of the contractor's own making
- an entitlement to recovery exists, and
- the harm can be identified and quantified

then a careful review of the potential methods of recovery should be undertaken. The methods described in this publication can provide the contractor with options to employ to enhance the potential of recovery or relief.

About the Authors

William Ibbs, PhD, is professor and group leader of the Construction Management program in the civil engineering department at the University of California at Berkeley where he teaches both undergraduate and graduate courses in construction management. In addition to his academic career, Ibbs chairs the IBBS Consulting Group. He has served as an expert witness and project neutral for over thirty years, qualifying to testify in federal and state courts, and international arbitration. His academic research work includes the impact project change has on labor productivity, schedule, and cost. That research work has led to a consulting practice on matters involving loss of productivity, schedule delay and disruption, project management standard of care, construction defects, construction accounting, personal injury, takeovers, and loss of economic value.

Ibbs and his company have worked on some of the biggest, most complex projects in the world including Boston's Big Dig, refineries, chemical plants, hospitals, process plants, transit systems, and nuclear and conventionally-fueled powerplants. Clients include various large, global private sector and public entities throughout the US, Africa, Asia, Europe, the Middle East, and South America. He has testified before the California senate on the High-Speed Rail and Bay Bridge projects. Prior to his academic career, he worked as a project engineer and project manager on industrial projects. Much of that work included measuring productivity, quantifying loss of productivity, and developing and implementing productivity improvement programs for contractors.

In light of his standing, Professor Ibbs was selected by his peers and the American Society of Civil Engineers to chair a committee that is establishing International Standards for Identifying, Quantifying, and Proving Loss of Productivity Claims.

Paul L. Stynchcomb, CCM, PSP, CFCC, is the Principal of Vero Construction Consultants Corp. and a Sub-Consultant to the Ibbs Consulting Group. For the past 36 years, he has served the construction industry as an expert in CPM scheduling, construction management, contract administration, and labor productivity. Prior to 1984, Stynchcomb held construction management positions in several major U.S. construction firms. He has been qualified as an expert in critical path method (CPM) scheduling, construction management, contract and subcontract administration, delay and cost impact analysis and loss of labor productivity in federal and state courts, boards of contract appeals, the Court of Federal Claims and before tribunals of the AAA and ICC.

In 2012, Stynchcomb co-authored "How to Estimate the Effects of Cumulative Impacts," a chapter published by the Mechanical Contractors Association of American, Inc. (MCAA) in its management guidebook and has also authored many other technical chapters in the guidebook. Over the past 34 years, he has taught construction professionals the principles of CPM scheduling, claims prevention and labor productivity analysis.

Stynchcomb is a member of the Project Management Institute, American Society of Civil Engineers, Association for the Advancement of Cost Engineering, Construction Management Association of America and the American Society of Military Engineers. He has been examined and certified by the Construction Management Association of America as a Certified Construction Manager (CCM) and by the Association for the Advancement of Cost Engineering as a Planning and Scheduling Professional (PSP) and as a Certified Forensic Claims Consultant (CFCC).

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