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File: Productivity

B u l l e t i n

Factors Affecting Labor Productivity

Instructions on the use of MCAA's Labor Factors are provided in the section of this bulletin titled "How to Use the MCAA Labor Factors."

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%

Factor	Percent of Loss per Factor		
	Minor	Average	Severe
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%

Connecting the "Cause" and "Effect" in Loss of Productivity Claims

By Gerson B. Kramer

Gerson B. Kramer began acquiring his vast experience in measuring differential productivity during his first post-college job at the Department of Labor's Bureau of Labor Statistics. After graduating from George Washington University School of Law, Mr. Kramer joined the Justice Department's Court of Claims Section and later the Commerce Department's Appeals Board. For ten years prior to his retirement, Mr. Kramer served as chairman and chief administrative judge of the Department of Transportation's Contract Appeals Board. In that capacity, Mr. Kramer heard cases involving contractors' claims for loss of labor productivity and authored a reported decision on one of the government's largest inefficiency cases in the history of any major board of contract appeals.

The construction industry is one of the leading capital industries that drive the U.S. economy. As an industry, it depends to a great extent upon labor productivity to remain profitable. Yet, many construction firms do not maintain the necessary records to supply the quantification of its labor productivity.

A contractor needs to maintain accurate contemporaneous productivity records to manage its labor forces and to serve as a foundation in the event of a productivity claim. While the courts and boards have established the principle that a contractor need not compute its loss of productivity with exactness, it would appear that accurate recording of a contractor's productivity is simply a management necessity to ensure profitability, irrespective of the portent of an inefficiency claim.

One of the fundamental issues that a trier of fact considers in hearing a contractor's inefficiency claim is "cause and effect." Important in the consideration is the question of whether or not the contractor's claims as to productivity impacts comport with the quantum being sought. In my experience, "productivity" can be summed up as the efficiency that contractors achieve in converting inputs to outputs. In the construction industry, this usually means the conversion of labor hours to a quantity of installed materials, such as tons of steel erected, cubic yards of concrete poured or linear feet of pipe installed. However, where productivity is concerned, there is no general agreement and no "black letter" law as to how this is to be quantified. This is equally true of quantifying the loss of productivity. Furthermore, standard cost accounting categories and standard monetary categories do not readily yield the necessary quantifications of labor productivity or loss of productivity. Neither the IRS nor the vast majority of construction CFOs arrange for, or demand, the reporting of the necessary elements to calculate or quantify productivity or its loss.

This lack of quantification on productivity or its loss becomes problematical when disputes arise. The disputes process that is presented to tribunals calls for magistrates to make findings of fact on

very specific matters. Although there is currently no accepted empirical study that delineates a specific methodology or a particular means of record keeping to prove productivity or the loss of productivity, one method of labor productivity quantification that has achieved a relatively high level of acceptance is known as the “measured mile” analysis. This methodology is highly dependent upon the contractor’s books and records and also upon the presence of an unimpacted and impacted area or period by which a production ratio can be computed. While this methodology has been well received by the courts and boards, it is also true that this methodology cannot be applied on many construction projects for a host of reasons, two being the lack of detailed productivity record keeping and the lack of suitable or comparable unimpacted areas or time frames. The inability to prepare a measured mile analysis does not, in and of itself, bar a contractor’s loss of productivity claim. In such cases, the contractor must apply a different methodology to connect the cause and effect.

It is a fact that the MCAA factors have been in use for over 30 years in furnishing a means of estimating loss of productivity in construction matters. One of the most beneficial and advantageous facts is that the MCAA factors require users to consider carefully the narrative facts and project events or milestones with the trends shown by the numbers. “How to Use the MCAA Labor Factors” repeatedly instructs users to assess carefully each and every element of fact along with the use of the percentage factors provided by “Factors Affecting Labor Productivity.” Direct and indirect impacts need to be quantified carefully in conjunction with the specific events of the project.

This process of matching the facts with the claimed loss of productivity is designed to provide the deciding tribunals with a degree of confidence necessary to reach the ultimate decisions. It is well recognized that a contractor does not have to prove its loss of productivity with mathematical exactitude; however this does not relieve the contractor from making a compelling case as to the specific causes of the impacts and to connect then with a logical effect. In this regard, the MCAA factors have been found to be a reliable means of estimating a contractor’s loss of productivity caused by individual categories of causation. For this reason, “How to Use the MCAA Labor Factors,” which outlines how to use the MCAA factors to arrive at a reasonable estimate of productivity or loss of productivity, should furnish much needed and useful guidance to users who need to estimate productivity quantities and costs.

MCAA thanks Judge Kramer for providing this introduction.

How to Use the MCAA Labor Factors

Introduction

Since 1971 the MCAA has offered "Factors Affecting Labor Productivity" in its *Management Methods Manual.* Known as the "MCAA factors," they have been used by contractors to forward price estimated losses of labor productivity in change order proposals, and to retroactively price estimated losses of labor productivity in the whole after the completion of a project. Since their introduction in 1971, the factor titles, descriptions and the percentage of estimated impacts have remained unchanged.

"How to Use the MCAA Labor Factors" has been developed to provide detailed explanations suggesting the proper use of the MCAA factors in estimating losses of labor productivity for both forward and retroactively priced change requests and for performing labor productivity analyses.

Also included are some points of consideration when assessing change order conditions and contract language that may affect the contractor's ability to recover its damages. However, this chapter offers no legal opinions or conclusions and the contractor should review all project documents and conditions with counsel.

This chapter has been prepared to assist the contractor with the quantification of the loss of labor productivity caused by occurrences described by the various MCAA factors. Of all construction-related subjects, the proof and quantification of the loss of labor productivity are recognized as among the most difficult and complex to describe. An attempt has been made to avoid the overly scientific and complex. It is understood that quantifying a loss of labor productivity is oftentimes based on an estimate of losses. However, by the very complex nature of the issue of the quantification of labor productivity loss, detailed explanations and qualifications of applications must be offered to the contractor.

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.

It is important to note that the MCAA factors have gained wide acceptance in the construction industry and before various courts, boards of contract appeals and tribunals of the American Arbitration Association. For example, reference the Appeal of Clark Concrete.[1] In this recent decision by the General Services Board of Contract Appeals, the board wrote, in part:

> "To assess the impact of unanticipated conditions on productivity ... P&K used a manual published by the Mechanical Contractors Association of America (MCA). ... P&K has used it on other

> projects to measure similar impacts, and the publication is generally accepted in the mechanical industry for this purpose. ... We have previously accepted the use of this manual for this purpose as well. Stroh Corp., 96-1 BCA at 141.132; also see Fire Securities Systems, Inc., VABCA 3086. 91-2 BCA 23,743 at 118.902. ... The manual lists various types of impacts, and for each, a percent of labor costs which represents loss of labor productivity under each of minor, average, and severe impacts."

Coupled with credible testimony, the MCAA factors can be useful to contractors, owners, boards of contract appeals and other courts and tribunals for the purpose of estimating a contractor's loss of labor productivity.

There are many definitions for the impact costs associated with a productivity loss on a construction project. The Department of Veterans Affairs Board of Contract Appeals in one decision offered the following cogent explanation:

> "Impact costs are additional costs occurring as a result of the loss of productivity; loss of productivity is also termed inefficiency. Thus, impact costs are simply increased labor costs that stem from the disruption to labor productivity resulting from a change in working conditions caused by a contract change. Productivity is inversely proportional to the manhours necessary to produce a given unit of work. As is self-evident, if productivity declines, the number of manhours of labor to produce a given task will increase."

The board continued in its explanations of inefficiencies:

> "Direct impact is generally characterized as the immediate and direct disruption resulting from a change that lowers productivity in the performance of the changed or unchanged work. Direct impact is considered foreseeable and the disrupting relationship to unchanged work can be related in time and space to a specific change. Cumulative impact is the foreseeable disruption of productivity resulting from the "synergistic" effect of an undifferentiated group of changes. Cumulative impact is referred to as the "ripple effect" of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships. This phenomenon arises at the point the ripple caused by an indivisible body on two or more changes on the pond of a construction project sufficiently overlap and disturb the surface such that entitlement to recover additional costs resulting from the turbulence spontaneously erupts. This overlapping of the ripples is also described as the "synergistic effect" of accumulated changes. This effect is unforeseeable and indirect. Cumulative impact has also been described in terms of the fundamental alteration of the parties' bargain resulting from the change."[2]

The Armed Services Board of Contract Appeals has also found that two types of productivity impacts can arise from changes to the contract and the board wrote as follows:

> "It is undisputed that the costs of performing changed work include both (a) those costs directly related to the accomplishment of the changed work, called 'hardcore costs,' and (b) those costs arising from the interaction between the changed work and unchanged work

> or expended to offset inefficiencies experienced as a result of changes, called 'impact.' Viewed broadly, 'impact' embraces: the man hours, labor costs, and material costs that are expended to offset inefficiencies experienced as a result of Government-caused or contractor-caused changes or other departures from the plan. Included is the process by which the above inefficiencies in the performance of contract work are created.
>
> Among other things, 'impact' includes: inefficiencies due to overcrowding, over or undermanning, skill dilution, extended overtime, shift work, and local and cumulative disruption.
>
> 'Local [or direct] disruption' refers to the direct impact that changed work has on other unchanged work going on around it. Conceptually, for purposes of this appeal, 'cumulative disruption': Is the disruption which occurs between two or more change orders and basic work and is exclusive of that local disruption that can be ascribed to a specific change. It is the synergistic effect . ... of changes on the unchanged work and on other changes."[3]

It is clear that a contractor must consider both the direct impacts of a loss of labor productivity caused by a change to the contract scope of work, as well as the cumulative impact of changes in scope to the unchanged work. In the past, many contractors have used the MCAA factors only when "forward pricing" a loss of productivity component of a change order proposal. In addition to providing updated general instruction on the uses of the MCAA factors, this chapter seeks to explain how the MCAA factors can also be applied equitably and reasonably when retroactively quantifying the cumulative effects of changes on the productivity of a construction project.

General Discussion of Loss of Labor Productivity

To offer the lowest bid price or negotiated price for a construction project, labor intensive contractors such as mechanical and electrical contractors must plan to control labor productivity. Controlling the productivity of labor during construction is central to maintaining a fair and reasonable profit. When events occur which could not reasonably be foreseen by a contractor during the bidding or negotiating process, and which materially and negatively impact the contractor's labor productivity through no fault of the contractor, the contractor should consider seeking recovery of the costs of the loss of labor productivity.

For the purposes of this chapter, "owner" refers to the party with whom the contractor executed a "contract." If a subcontractor, it could be the general trade contractor; if a prime mechanical/ electrical contractor, it could be the project "owner," whether public or private.

Contractors have long understood that adding new scopes of work to the original work plan can disrupt the flow and rhythm of the otherwise productive crews. The added work often comes at the peak of the planned effort on the project, when craft levels are already at their highest points on the labor curve. Also, added scope often affects the schedule, available work spaces, ability of labor supervisors to effectively manage base contract craft labor, material and equipment procurement and many other productivity-related factors. Sometimes the effects of a scope change/change order, or a series of such changes, on labor productivity can be of a higher dollar value than the

direct cost of the change itself. Assuming that the contractor did not cause the changed conditions, the contractor should seek to recover those losses in labor productivity either within the change order, or, if necessary, at the end of the project when all of the effects of project-wide changes on the total labor productivity can be measured. The courts have stated clearly that exact methods of loss of labor productivity quantification are not a condition precedent for recovery. Boards and courts have recognized the difficulty of measuring productivity loss and allow the contractor to use several methods, including the MCAA factors, to measure such losses.

Often, contract language known as "full accord and satisfaction" language, contained in some change order forms, may require the contractor to attempt to price all categories of productivity loss within the change itself, as estimated values. This is called a forward priced productivity loss and the cost of this estimated loss can be included as a line item in the change order proposal. While it can be highly beneficial to include all estimated impacts within a change order, thus "closing out" the change, many owners refuse to recognize labor productivity impacts caused by scope changes or other factors beyond the control of the contractor. This leaves the contractor in the unwanted position of either not executing change orders due to the risk of waiving its rights or placing a "reservations of rights" statement on each change, which can have the effect of holding open the option of making further requests for equitable adjustment should the contractor suffer productivity losses due to the cumulative impacts of changes in scope on the project.

Productivity loss recovery, which is sought at the end of a project phase or after the project is concluded, is called a retroactive productivity loss analysis. Such retroactive productivity loss analyses take into account the total impacts of all unanticipated categories of potential loss, such as the quantity (in terms of added craft hours) of changes, resequencing, schedule delays and disruptions, overtime and shift work and increase in crew size over the optimum level.

Many experts in the field of productivity loss analysis believe that the only means of recovering a significant portion of productivity loss is to measure such losses in their totality, at the end of the project, particularly when such losses are a result of a large number of scope changes,[4] which add a significant number of craft hours. This is believed to be true because it can be very difficult to evaluate fully the effects of productivity loss caused by one, single change in scope on the contractor's entire labor force, when it may not be known how many changes will be forthcoming in a given time period and how the aggregate of those potential impacts will increase the contractor's overall productivity losses. Such claims are typically called "cumulative impact" claims and are a recognized phenomenon by the major Boards of Contract Appeals. It is understood that on projects pervasively and adversely affected by changes in scope, the only reasonable means of recovery may be through a cumulative impact claim rather than a forward priced, or individually priced, loss of productivity quantification.

Nevertheless, both methods of productivity loss—the forward priced and retroactively priced—are valid, and each project may demand the use of either, or both methods, described herein.

In terms of actually measuring a loss of labor productivity, several methods may be available to the contractor. A highly

regarded method of measuring productivity loss is known as the "measured mile." This approach utilizes actual productivity measurements taken in unaffected and affected portions of a project and, from that data, a productivity ratio is established. However, many contractors do not maintain labor hour tracking and material installation records needed to support this methodology and on some projects, there are no unimpacted labor hours. In such cases, the MCAA factors can be very useful and have been accepted by courts and boards as a reliable means of estimating a contractor's loss of labor productivity.

It must be stressed that the contractor should carefully study the contract general and special conditions, the project schedule, change order forms and other, related documents to understand fully the rights, liabilities, obligations, limitations and remedies which are provided for by the documents that comprise the overall contract. These documents may dictate which method the contractor uses on a given project.

While the trend at the Boards of Contract Appeals had been to define waiver language contained in change order forms as only waiving all impacts (direct and indirect costs) that were "knowable" at the time the change order was signed, the current trend points to much stricter and broader interpretations of waiver language on change order forms. An example of a generally "unknowable" impact is labor inefficiency caused by cumulative impacts: those impacts arising from a multitude of unanticipated labor-intensive changes in scope. Since cumulative impact labor inefficiency claims can only be quantified when all of the changes are known and the work is complete, in the recent past it was successfully argued that a contractor was not understood to have waived its cumulative labor inefficiency impact claim on executed change order forms containing "full accord and satisfaction" language since such impacts are not fully known while the project is active.

In line with the earlier cases, the recent U.S. Court of Federal Claims case of *Bell BCI Company v. United States*, 81 Fed. Cl. 617 (2008) upheld the proposition that cumulative impact labor inefficiency claims were understood to be preserved even in the presence of waiver language on change order forms. However, on appeal, this decision was vacated in part by the U.S. Court of Appeals for the Federal Circuit. The Court of Appeals did not issue a finding as to whether or not the contractor sustained a loss of productivity caused by cumulative impact. Rather, the Court of Appeals found that the broad waiver language contained on the government's change order form had released the government from any and all liability beyond the express relief provided for in the change order itself.

The Appeals Court wrote, "The language [on the change order form] plainly states that Bell released the government from any and all liability for equitable adjustments attributable to Mod 93." The Court further wrote, "if parties intend to leave some things open and unsettled, their intent to do so should be made manifest." As such, the contractor was barred from recovering its cumulative impact labor inefficiency costs for the contract modifications that contained the government's waiver language.

Based on this appeal, it would be wise for a contractor to assume that if broad waiver language is present on the change order form, such language will be viewed as a waiver of the contractor's right to later claim for any added compensation, even for those

costs attributable to a cumulative impact claim that cannot be quantified until the project has been completed. Thus, if a contractor believes that a cumulative impact claim may be forthcoming due to a large volume of labor-intensive changes in scope, change order forms containing broad waiver language should only be executed after careful weighting of the potential cost impact of a waiver (i.e., waiver of future cumulative impact claims) and with the advice of experienced construction counsel.

Use of the MCAA Factors for Forward Pricing Scope Changes

The MCAA factors can be applied to a pricing sheet for a scope change on an itemized basis. Once the direct costs of the change have been estimated—the labor, supervision, material, equipment and other such costs—the contractor can apply one or more of the MCAA factors to the change order breakdown sheet. In order to evaluate properly the estimated, potential impacts to labor productivity of changes in scope, the contractor must determine if the change requires a departure from the contractor's otherwise productive work flow. A change of very limited scope, which may affect only a small crew, and which may occur in a limited and distinct area of the overall project, may have little or no measurable negative impact on productivity. However, such changes in scope are rare. Generally, changes occur in the most active areas, and at times when crews are at or near their peak. These types of changes can have a significant, negative effect on crew productivity.

In order to estimate potential losses of productivity using the MCAA factors, questions can be posed to the contractor's labor supervisor(s) by management:

1.a) Will this change in scope cause us to add craft workers to our current work force, and if so, how many workers will need to be added, when will they be added and for how long?

1.b) Answers to 1.a could lead to adding the appropriate percentage for MCAA factors such as:

- Crew Size Inefficiency
- Learning Curve
- Dilution of Supervision

2.a) Will this change move our crews into unanticipated, severe cold, hot, rainy or windy seasons?

2.b) The answer to this question could lead to a percentage for:

- Severe Weather

3.a) Will this change cause us to shift existing crews to new areas, to stop work where we are, remobilize in another area, then return to finish the original work scope?

3.b) The answer to this question could result in the addition of multiple MCAA factors to the change order pricing:

- Reassignment of Manpower
- Learning Curve
- Dilution of Supervision
- Stacking of Trades
- Concurrent Operations

4.a) Will this change in scope cause us to work in areas which were unanticipated, with other trades, which were not planned for in the same area, and for how long?

4.b) Answers to 4.a could lead to adding the appropriate percentages for MCAA factors such as:

- Stacking of Trades
- Site Access
- Concurrent Operations
- Logistics
- Ripple
- Reassignment of Manpower
- Learning Curve

These are the types of conditions, for the purposes of examples, which can result from the issuance of changes in scope, and which can cause a loss of labor productivity. The contractor must apply the appropriate factor categories and percentages.

"Factors Affecting Labor Productivity" includes three levels of potential productivity impacts—"Minor," "Average," and "Severe." Each level of impact intensity carries its own loss of productivity percentage. The three impact levels indicate the estimated effects of the changed condition on the labor hours being analyzed; i.e., specific hours within the total hours expended, or on the total hours expended on the project depending on the approach being used. Also, the three levels of intensity allow the user to more specifically assign an estimated impact for each of the MCAA factor categories being used, and like the categories themselves, should be applied with care and, if at all possible, with input by those who witnessed the conditions under evaluation.

While this chapter cannot provide for each and every condition under which contractors will choose a particular MCAA factor or factors, or the level of impact intensity, it is obvious that care must be taken to eliminate overlapping factors, to the fullest extent possible. The unrestrained and ill considered choice of multiple factors can lead to unreliable results.

For instance, the factor describing "Morale and Attitude" is a valid, but somewhat amorphous, category of inefficiency. The effects of a decline in workplace morale and attitude can be embodied in several other MCAA factors, such as stacking of trades, overtime fatigue and reassignment of manpower. It would be impossible to determine what portion the impact percentage caused by stacking of trades, overtime fatigue and reassignment of manpower is attributable to the attendant decrease in worker morale and attitude. Thus, by way of the above example, when using other factors that may already include in the loss of productivity factor a consideration for decreased worker morale and attitude, it may be advisable to avoid applying a potentially duplicative factor such as "Morale and Attitude." Another example to consider when striving to avoid factor duplication is the "Ripple Effect." This term of art has been used in several board decisions and is a well recognized phenomenon in the construction industry. This MCAA factor describes the downstream effect on the mechanical contractor of impacts caused to predecessor trades. For example, the mechanical contractor's schedule may be compressed because the building structure was erected late. In order to mitigate the structural delay, the general trade contractor may accelerate the follow on trades by stacking the crews of the various subcontractors, or forcing the subcontractors to work on an overtime basis. In such cases, the loss of productivity may be better classified by the events that result from the ripple effect, such as "Stacking of Trades" or "Overtime Fatigue."

On some projects, a mechanical contractor may add labor supervision in order to mitigate a loss of productivity caused by an unplanned requirement to substantially increase its work force. In such cases, the contractor generally submits a request for equitable adjustment for its added supervisory costs. Such additions of supervision usually do not totally eliminate the contractor's labor inefficiencies. The contractor may have suffered inefficiencies such as "Stacking of Trades," "Logistics," or "Reassignment

of Manpower," which the added labor supervision could not mitigate or eliminate. However, where the contractor's supervisory forces are effectively increased, it may be duplicative for the contractor also to assert productivity losses arising from the MCAA factor "Dilution of Supervision."

Indiscriminate assignment of the MCAA factors can result in estimates that may be overstated and unreliable. Therefore, careful "testing" of each MCAA factor and its impact intensity must be carried out by the contractor. The description of each factor, which has remained unchanged for over 30 years, provides generally ample explanation of the type of impact described in each MCAA factor category.

It is important to understand that the MCAA factors provide a basis for developing reasonable estimates of loss of labor productivity and not for developing a loss with exactness. Thus, when the MCAA factors and their respective impact percentage are chosen, it must be with the intent to connect the cause or causes of the inefficiency with the reasonable effects. The MCAA factor descriptions represent the "cause" and the impact intensity percent represents the "effect" that can result from the conditions described by each MCAA factor. However, care must be taken to consider potential duplication and overlapping when the factor categories are chosen.

Likewise, the assignment of the impact intensity percentage must be chosen with care. For instance, if the change in scope is of a limited nature, on a project with a reasonably small crew size with little or no schedule impact (as opposed to productivity impact), then a "minor" category can be chosen. However, if the change is significant in its scope and requires major rescheduling and/or resequencing, crew size increases, overtime, shifting of work areas, piecemealing of the work and general disruption of the rhythm of the crews, then "average" or "severe" impacts could be the result.

When the factor for "Crew Size Inefficiency" is used, it is most helpful to have on hand a planned craft level chart based on the estimate or the project plan. When attempting to demonstrate that conditions beyond the contractor's control resulted in a loss of productivity, it is very helpful to show graphically what the contractor reasonably expected. Therefore, an estimated/ planned versus actual craft curve is often helpful in graphically depicting the effects of unplanned crew size growth.

The percent values for each category chosen are additive in the change order pricing. Once all of the factors have been carefully evaluated for each changed condition caused solely by the proposed change in scope, the percentages are added together. The total percent is then multiplied against the estimated craft labor hours for the change. For instance:

Change order estimated craft labor hours:	2,750 hours
MCAA factor:	
Crew Size Inefficiency	10%
Learning Curve	5%
Reassignment of Manpower	5%
Total	20%
Estimated Loss of Productivity (2,750 x 20%)	550 hours
Subtotal, Craft Labor Hours:	3,300 hours

As stated previously, this methodology prices the estimated loss of productivity caused by project conditions only on the estimated change order hours. But what about the impacts of change order work

on the unchanged hours? It is infrequent that a change in scope is so segregated from the base contract work that it has no effect on the crews performing unchanged, base contract work. How does the contractor recover the cost of a productivity loss caused by changes in scope to the unchanged work? There are several ways to estimate the impacts to labor productivity of changes to the unchanged work, two of which use the MCAA factors (i.e., the modified forward priced and retroactively priced methods). Another highly regarded method of measuring productivity loss is the "measured mile." This approach utilizes actual productivity measurements taken in unaffected and affected portions of a project, and from that data, a productivity ratio is established. However, as previously noted herein, many contractors do not maintain labor hour tracking and material installation records needed to support this methodology and on some projects, there are no unimpacted labor hours. In such cases, the MCAA factors can be very useful in estimating the contractor's loss of labor productivity.

Modified Forward Pricing for Estimating Labor Loss of Productivity on the Changed and Unchanged Work

It is a well understood principle that when significant changes in scope are issued to a contractor, a loss of labor productivity may affect the change order labor hours and the base contract labor hours. Previously herein, a method was described which only measured a loss of productivity on the estimated change order hours. This segment deals with estimating the effects of significant and pervasive changes in scope on the contractor's entire labor forces, both those working on the changed work and those working on base contract labor; known as "the effects of changes in scope to the unchanged, or base contract, work."

The principle is the same as is often employed to describe the overarching effects of overtime fatigue as it impacts the overtime hours and the straight time hours worked by the overtime crews. Obviously, if a crew works for eight weeks of scheduled overtime, 10 hours per day for six days per week, the fatigue and its resulting effects impact both the straight time and the overtime hours worked by that crew. There is no way to segregate the impacts of this sort of loss of productivity factor between straight time activities and overtime activities.

Similarly, if the owner issues a major scope change, or issues many changes in scope in the same general time frame, it may be impossible for the contractor to segregate the loss of labor productivity to the change order work from the loss of productivity imposed on the base contract work by the changes in scope.

As an example, a crew of nine pipe fitters is working productively on base contract work. The owner issues a change, which requires four of this crew to move to scope change work. The craft supervisor for this crew must now divert his attention from the total crew performing base contract work to setting up the new "sub-crew" performing the scope change work. The remaining five workers' productivity on the base contract work suffers because work is not being laid out as it was when the supervisor was focused only on the planned work of the single crew; answers to workers' questions take longer to resolve and materials and tools are frequently "borrowed" from contract work to perform scope change work. These impacts are defined by "Dilution of Supervision," "Reassignment of Manpower" and perhaps other MCAA factor categories. This is only one

example of how a change in scope can affect the productivity of both the change order hours and the base contract hours.

When attempting to estimate and recover such losses in labor productivity when changes of a significant magnitude affect the base contract work force, a modified approach can be employed. It is called a “time specific” MCAA factor method. The “time specific” method is used for both this modified forward pricing method and the retroactive pricing method (with slightly different rules), which will be described later in this chapter. The “time specific” method also requires significantly more information than does the standard forward pricing method, but it attempts to quantify loss of labor productivity to both the change order and base contract hours.

This method has some requirements, which may not be possible to meet because of problems inherent with the issuance of change orders. Some of the field conditions which can restrict or eliminate the effective use of this method include:

1) Unknown timing of owner’s approval of the change order “notice to proceed;”

2) Lack of foreknowledge on the part of the contractor regarding pending changes in scope which are to be released by the owner for pricing;

3) Performance of the scope change work without change order execution; and

4) Not knowing what existing crews will be affected by the change order work.

Since these conditions are very prevalent on construction projects, the contractor may still be left with only three options: 1) use the method which limits loss of productivity estimates to the change order hours only; 2) wait until the project is over and perform an overall loss of productivity analysis; or 3) forego making any attempt to recover the loss of productivity costs from the party making the change.
However, if the project conditions allow the use of the modified approach, the general format is as follows:

1) The time frame of when the change order work will be performed must be known or estimated—in days, weeks, or at most, monthly increments.

2) The conditions of the change in scope must be known—what types and magnitudes of impacts are anticipated.

3) The planned craft hours for the affected period must be ascertained from estimates, labor plans or other

C.O. Impact Period	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Orig Planned Hours	400	400	600	600	720	800
Est C.O. Hours	80	160	320	400	400	160
Revised Planned Hrs	480	560	920	1,000	1,120	960
Learning Curve	5%	5%	5%	0%	0%	0%
Dil of Supervision	0%	10%	10%	10%	10%	10%
Crew Size Ineff	0%	0%	10%	10%	10%	0%
Total MCAA factor	**5%**	**15%**	**25%**	**20%**	**20%**	**10%**
Est Loss of Productivity	**24**	**84**	**230**	**200**	**224**	**96**
					Total	**858**

labor forecast reports.

4) The crews which could be affected by the change must be known (i.e., some changes may only affect certain physical areas of an overall project, and therefore, not the entire work force).

5) A table is prepared with planned hours per period (day, week or month) across the top, including the estimated change order hours. The appropriate MCAA factors are listed along the "*y*" axis of the table. Under each time period, the appropriate MCAA factor percentage is estimated. The percentages may change from period to period based on the estimated impacts. The percentages are then totaled and multiplied against the total, estimated/planned craft hours.

6) An example of a resulting table follows:

In this example, a specific time frame has been evaluated for estimated impacts. This more specific method permits the contractor to make MCAA factor applications, which can vary as estimated conditions vary. This is actually more realistic and compares well with what actually happens in the field when changes are issued, or when acceleration or other impacts occur. In reality, as time and conditions in the field change, the MCAA factors can change as well and the estimate should reflect this fact.

For instance, if the MCAA factor "Learning Curve" is applied to a change, which is estimated to have a long term effect, this factor may only be applicable for the first two to four weeks of the impact, as new workers become familiar with the work area. This methodology allows for a more precise estimation of loss of labor productivity impacts.

Similar to the concept of performing time specific analyses, it is also appropriate to determine if the contractor's entire crew will be affected by the changes. If a change in scope only affects a separate and discrete area of the project, it may not be appropriate to impact the total crew hours by a loss of productivity factor. It is generally appropriate to use the MCAA factors on only those crews that will be affected by the changed condition.

Unfortunately, many owners simply do not recognize the effects of significant or numerous changes on the productivity of the base contract labor. However, virtually all contractors recognize this condition as a costly loss of labor productivity. Therefore, the contractor is frequently left with only one option, a post-project measurement of productivity loss caused by conditions that are not the fault or responsibility of the contractor.

Impacting the Project Schedule Using the MCAA Factors

This chapter does not deal with the development of the schedule time impact analysis ("TIA") or "fragnet." However, contractors should impact the current project schedule activities with the loss of productivity estimates derived from using the MCAA factors.

For instance, a contractor originally planned a series of activities as shown below. One of the activities was adversely affected due to a change, resulting in a 20% impact to productivity. Inefficiency can impact schedule durations and as such, the duration of the affected work must also be factored. Unless crews are added, the originally planned duration for "Piping Branches" would increase from 18 days to 22 days as a result of the 20 percent impact to productivity.

The loss of labor productivity will, in general, cause planned activities to take longer to perform, because the productivity ratio of 1:1, which was most likely used as the basis of the activity duration estimate, is no longer accurate. The contractor will no longer receive one hour's production for an hour planned, but rather some production rate less than the plan. Therefore, unless crews and supervision are added to the schedule in such numbers and with such care so as to accommodate the loss of productivity, the work activities will take longer than planned.

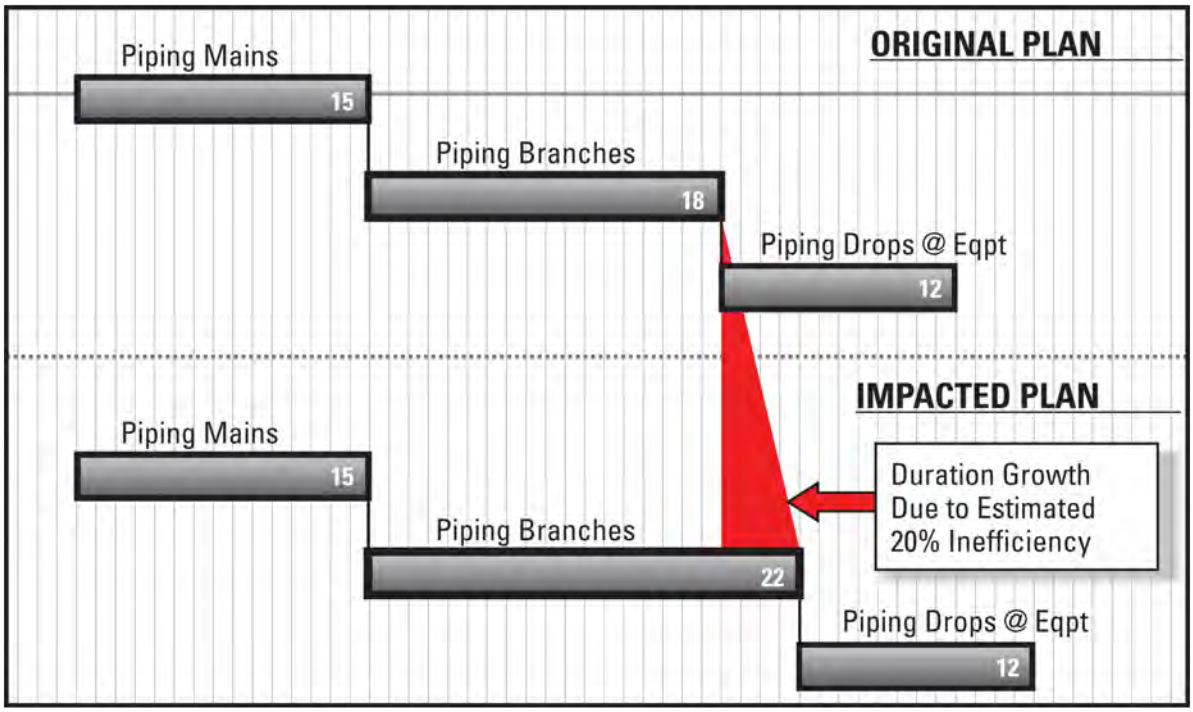
In this example, the 18-day planned activity in the series will take approximately 22 days each to perform, given an estimated loss of productivity of 20 percent. The adjustment of the project schedule for estimated losses in productivity can have a significant impact on the critical path, and on forecasted job costs. As can be seen in the graphic at the bottom of the page, the extension of a duration of a planned activity by adjusting the duration for an estimated loss in productivity using the MCAA factors can materially affect the schedule.

Retroactively Pricing Losses of Labor Productivity Using the MCAA Factors

In many instances, the only option for a contractor attempting to recover a loss of labor productivity caused by changed conditions is to wait until the project is over and review the actual loss; planned versus actual. Such claims are sometimes known as "cumulative impact" claims. The "plan" can be the original estimate of craft hours or the preconstruction target plan. Before a contractor makes a claim for a loss of labor productivity at the conclusion of a project, several obvious considerations must be made, including:

1. Was the estimate/plan of craft hours accurate and reasonable?

2. Were the conditions, which caused the loss of productivity, reasonably foreseeable when the project was bid/negotiated?



3. Did the contractor cause this loss of productivity?

4. Were the principal causes for the loss of productivity the responsibility of identifiable parties?

5. Will the potential cost of recovery exceed the loss?

There are a series of important legal considerations which could be added to this list which can only be addressed between the contractor and his construction counsel, and which are not the subject of this chapter. Additionally, this chapter addresses several methods of calculating a loss of productivity using the MCAA factors; however it does not address the means and methods of proving the impacts, often known as the "triad of proof," which includes proving (a) liability; (b) causation; and (c) resultant injury. This is also known as the "cause-and-effect" connection, which is necessary in linking an owner's actions and/or inactions to the contractor's injury. This chapter assumes that the contractor has already determined liability and causation, and is attempting to quantify the "resultant injury" by the use of the MCAA factors.

Assuming that the contractor is satisfied that the loss of productivity is significant and is principally the fault of another identifiable party, and that party is legally accessible for redress, then the contractor must prepare the cause and effect analysis.

Frequently, contractors use the MCAA factors to retroactively price the cumulative effects of changes in scope. Often, the method used by contractors is to multiply the cumulative percentage of losses of productivity as derived from the MCAA factors against the total, actual hours expended, sometimes with, and sometimes without, change order hours included in the total.[5]

This methodology of multiplying the MCAA factor percent against the actual hours is incorrect. The actual hours against which the MCAA factors are frequently multiplied in a contractor's retroactively priced claim for loss of productivity already include the contractor's loss of productivity; therefore multiplying the MCAA factors against the actual hours overstates the loss of productivity. Only by removing the theoretically efficient hours from the contractor's actual hours can the MCAA factors be properly applied in a retroactively priced request for equitable adjustment.

The actual hours must be further adjusted to deduct:

1. Time and materials hours;

2. Hours spent to repair the contractor's defective work;

3. Change orders on which a loss of productivity has already been calculated; (If the contractor has included "forward priced" loss of productivity in individual, executed change orders, and then seeks to recover global losses at the end of the project, these incremental, per change order loss estimates must be factored out of the computations.)

4. Hours associated with executed change orders, where it has been determined that the contractor is barred from recovering the impact caused by the executed change orders;

5. Hours expended by crews that were not affected by a loss of productivity;

6. Other types of productivity losses for which the contractor is responsible (i.e., bid errors)

Also, some contractors simply apply the

total MCAA factor percentage to the total actual hours for the entire project duration. This can, in some instances, lead to inaccurate results because the effects of labor inefficiency can change during the life of the project.

The MCAA factor percentages sometimes change as actual project conditions change. Therefore, it can be useful to assign the MCAA factors to the specific impacted time frames within the overall project duration. In some cases, multiplying an MCAA factor against the total hours expended for the total duration of the project will result in a distortion (on the high side) of the forecasted loss of productivity.

The loss of productivity categories described by the MCAA factors can occur in a nonlinear fashion across the entire duration of a project. To more accurately demonstrate the retroactive loss of productivity on a project, it may be desirable to divide the project into months (or, if possible weeks) and to assign loss of productivity percentages by MCAA categories by time periods, based on the accounts of eye witnesses (field managers, labor supervisors and other fact witnesses) or on documents prepared contemporaneously. Consideration of the areas of the project and the crews working in those areas is very important in performing this analysis. Only the crew hours that have been impacted by the changed conditions should be included in the loss of productivity computations. This is similar to the format for the modified forward pricing method, described previously.

When it is possible to apply this procedure, the types of losses described by the MCAA factors can be more accurately assigned to discrete time periods. The following table shows an example of this type of time-specific assignment of MCAA factors. Different MCAA factor categories can affect different periods of a project and at different percentages of impact intensity. As stated, it may be inaccurate to globally apply the cumulative MCAA factors against the total hours expended on a project. It may, depending on the specific circumstances, be more accurate for the contractor to evaluate the loss of productivity on a periodic, rather than on a total project, time scale.

The following table demonstrates the as-built, retroactive loss of productivity analysis using the MCAA factors, the rows indicate:

1. The actual work period being measured for impacts.

2. The actual, payroll craft labor hours (without supervision).

3. Craft hours deducted for time and material ticket work, the contractor's own deficient work (rework), any estimated, self-inflicted productivity

Contract Period	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45
Actual Payroll Hours	1,600	1,600	1,800	2,400	2,400	3,200
Deducted Hours		–80	–120	0	–120	–120
Revised Actual Hours	1,600	1,520	1,680	2,400	2,280	3,080
Reassignment of Mpw	5%	5%	5%	10%	10%	10%
Dil of Supervision	0%	10%	10%	10%	10%	10%
Crew Size Ineff	0%	0%	10%	10%	10%	10%
Total MCAA factor	**5%**	**15%**	**25%**	**30%**	**30%**	**30%**
Est Loss of Productivity	**76**	**198**	**336**	**554**	**526**	**711**
					Total	**2,401**

losses, crew hours that the contractor believes were not affected by the changes in scope, such as crews working in areas of the project not proximate to the areas where the changed work was performed, and change order adjustments as described herein.

4. The resulting "revised actual hours."

5. The list of the MCAA factor categories being applied.

6. The resulting estimated loss of productivity for each time period.

Note that the total MCAA factor percentage has *not* been multiplied against the revised craft hours. Instead, the percentages have been totaled, the adjusted hours divided by one plus the decimal percent (i.e., 1.05 for the first period in the table), and that result subtracted from the total, adjusted hours. One significant difference between forward estimated and retroactively estimated productivity loss is that the contractor's actual labor hours already include the loss of productivity. Therefore, it is necessary to calculate the productive hours first to avoid overstating the loss of productivity,

For instance, referencing the preceding table, during week 42, the contractor actually expended 1,800 labor hours. However, 120 hours were spent on time and materials work or repairing deficient work and were subtracted from the total, leaving 1,680 as the adjusted labor hours. After removing the contractor's self-inflicted inefficiencies, if any, hours not affected by the changes, or the hours for which the contractor was paid for the inefficiency (i.e., T&M), what remains are actual labor hours that already include the non-contractor caused losses of productivity.

After interviewing the site personnel, if it is determined that a 25 percent loss of productivity occurred, then the contractor must determine the number of hours that were efficient based on that estimated loss. Thus, taking the 1,680 craft hours and dividing that by 1.25 results in 1,344 efficient hours. Had the contractor not suffered any loss, 1,344 hours should have been spent on the work. The difference of 336 hours are those attributed to the identified loss of productivity described by the MCAA factors.

With the above analysis, the hours the contractor should have spent, if no loss of productivity had been encountered, have been calculated (1,344 hours). Since the contractor has estimated that the workers were impacted by a 25 percent loss, the resulting labor hours being claimed for recovery is 336. If the contractor simply multiplied the 25 percent times the adjusted actual hours (1,680 x 25%), the resulting loss would be estimated at 420 hours. The overstatement of loss would have been 84 craft hours (420 – 336) if the MCAA factor calculation had been misapplied.

The "Should Have Spent" Labor Hours in a Retroactive Loss of Productivity Calculation

One of the foundations of a loss of labor productivity claim is to determine how many hours the contractor *should have spent* to perform the work had the contractor not been affected by events caused by others.

The purpose of dividing the actual, adjusted[6] labor hours by 1.n, where *n* is the decimal % of the total of the selected MCAA factors, is to derive the "should have spent" hours on the project. Once the "should have spent" hours have been calculated, then these hours can be subtracted from the total, adjusted actual hours to determine the

hours of lost productivity. In a hypothetical project, one without changes in scope, estimate errors and contractor-caused inefficiencies, the calculated "should have spent" hours should, theoretically, equal the original estimated hours. However, this hypothetical condition almost never exists.

The actual hours are affected by a series of inextricably intertwined events, such as impacts of changes to the unchanged work, impacts caused by the direct hours of change order work to the changes themselves, and other factors that affect the number of labor hours actually expended on a project. Therefore, it is highly unusual when the calculated "should have spent" hours equal the original estimate of labor hours. The frequent inability to match the original estimated hours with the "should have spent" hours only demonstrates that many factors can enter into the total hours expended on a construction project, some of which can be difficult, or impossible, to identify and to quantify on an individual basis.

An example of calculating the "*should have spent*" hours appears in the next column.

The 4,085 hours represent the hours of lost productivity caused by all types of noncontractor caused impacts as calculated using the MCAA factors. The 13,615 hours are the "should have spent" hours if 17,700 adjusted, actual hours were spent and the project suffered an overall productivity loss of 30 percent.

From the following example the obvious question arises—what comprises the difference of 3,615 labor hours between the original estimate and the calculated "should have spent" hours (i.e.,13,615 "should have spent" hours—10,000 originally estimated hours)? The difference will most likely be comprised of the hours expended on scope change/ change order work, the loss of labor productivity caused by the change order/ scope change work and all categories of contractor-caused issues other than the hours subtracted in the "adjustment" phase of the computation (in this example, the subtraction of 300 labor hours which were attributed to the contractor's own forces).

Example:

A contractor estimates a project to require 10,000 hours of field erection labor.

At the conclusion of the project, the contractor determines that 18,000 hours of field labor were actually expended to construct the project.

The contractor determines that approximately 3,000 hours were expended on out-of-scope work, which came in the form of change orders and/or scope changes. The contractor also determines that approximately 300 craft hours were spent removing and replacing work which was improperly installed by the contractor's own forces.

The contractor then reviews the project documents, interviews the management team, and determines that owner-caused problems, such as scope changes, disruptions and acceleration, have caused a loss of productivity on the project. A review of the change orders themselves reveals no language which could bar the contractor from recovering losses of productivity caused by the change orders.

Using the MCAA factors, the contractor interviews the management team and determines that the combined impacts caused by the owner, as described in the applicable MCAA factors, is estimated to be 30 percent. In this simplified example:

10,000 estimated/planned hours

18,000 actual hours less the remedial work of 300 hours = 17,700 hours

17,700 adjusted, actual hours divided by 1.30 (1 + 30%, or 1.30) = 13,615 hours

17,700 adjusted, actual hours less 13,615 "should have spent" hours = 4,085 inefficient hours

When the estimated 3,000 hours in scope change/change order work are subtracted from the "should have spent" hours of 13,615, the result is 10,615 hours. The remaining 615 hours (i.e., 10,615—the estimate of 10,000 hours) are unidentified, non-productive hours for which the contractor is not making claim.

It is often alleged by owners that contractors do not account for their own inefficiencies when calculating a loss of productivity claim. The aforementioned calculation demonstrates that the contractor has not made claim for 615 labor hours, which can be characterized as non-productive labor hours for which the contractor has taken responsibility. By whatever means chosen by the contractor, any contractor-caused loss of productivity must be deducted from the total loss of productivity hours quantified in the contractor's request for equitable adjustment.

In the above analysis, the performance of change order work, as well as the contractor's base contract work, would be performed inefficiently. Consequently, it could be appropriate for the contractor to recover losses of productivity incurred in the performance of change order work as a part of the contractor's overall retroactive loss of productivity analysis as described above. However, as is discussed herein, it may be determined by the contractor's counsel that "full accord and satisfaction" language contained in executed change orders bars the contractor from the recovery of productivity losses on the direct change order hours. In such events, the contractor may deduct the executed change order hours from the total actual hours to arrive at the adjusted, actual labor hours, as described in the appropriate section of this chapter.

In some cases, the interpretation of the "full accord and satisfaction" language is so broad that the contractor's cumulative impact claim is barred in total or in part because such impacts are claimed to arise from the change orders containing such exculpatory language. Therefore, it is *absolutely essential* that the contractor review with counsel all proposed change order forms and other contract documents[7] that seek to limit the contractor's right of recovery—before the contractor executes such documents.

In the event that the contractor, or the contractor's counsel, determines that change order hours will *not* be deducted from the total, actual labor hours, it is necessary for the contractor to remove from the contractor's retroactively developed loss of productivity claim any forward priced loss of productivity hours which were included in the contractor's executed change orders. This is true because the MCAA factor calculation should include all categories of productivity losses, including those caused to the direct hours of the change orders themselves. To leave the forward priced productivity loss estimates in place when using the MCAA factors in a retroactive computation would be "double dipping." In performing a total project, retroactive loss of productivity calculation, it is necessary to deduct the individual forward priced productivity losses, which may have been included in the contractor's individual change orders proposals submitted by the contractor to the owner. This deduction can be included when arriving at the adjusted, actual labor hour total.

The calculated "should have spent" hours may include, in addition to the originally estimated hours: (i) actual change order/scope change hours; (ii) inefficiencies caused to and by the out of scope work (subject to other possible limitations discussed herein); (iii) contractor-caused losses of productivity;

(iv) contractor's remedial work hours; and (v) estimating errors. Consequently, the comparison of the "should have spent" hours to the original estimate is generally not appropriate. What is important is that the owner is not being charged with the "should have spent" hours or for contractor-caused impacts in the retrospective productivity loss calculation as described in the above example and elsewhere herein.

Modified Total Cost Method Check of the Productivity Loss Calculations

When using the retroactive productivity loss analysis, it is prudent for the contractor to check the estimated loss of productivity, which results from using the MCAA factors against the modified total cost method of calculating the loss of labor productivity. The modified total cost method consists of a very simple calculation:

Actual expenditure in hours		A
(Less)	Estimated hours	(B)
(Less)	All types of contractor-caused problems	(C)
(Less)	Change/scope change labor hours	(D)
Claimed loss of productivity hours		E

This section will suggest a simple check on the results of the loss of productivity calculations using the MCAA factors. This very important calculation check is shown as an example at the top of the next column using numbers from the "should have spent" example on page 20:

The remaining 615 labor hours would be the contractor's productivity loss not claimed in the contractor's request for equitable adjustment. These hours would remain as a potentially undefined, but unclaimed, loss of productivity. Nevertheless, it could be concluded that

Total actual hours expended		18,000
(Less)	Estimated hours	(10,000)
(Less)	Contractor's remedial work	(300)
(Less)	Change/scope change hours	(3,000)
Subtotal (hours)		4,700
(Less)	Calculated MCAA factor loss of productivity hours	(4,085)
Total of remaining hours		615

some portion of the 615 hours was attributable to a loss of productivity caused by the 300 hours of remedial work. Thus, with this example, the contractor has taken to its own account a loss of productivity caused by its own actions and/ or inactions.

It is possible, however, for the remaining hours to be a negative number. If the remaining hours are represented by a negative number, it would indicate that the contractor expected a savings in labor, as compared with the contractor's original estimate. While it is not impossible to put forth labor savings in a loss of productivity claim, it does require an added level of confirmation that savings in labor, as compared with the original estimate, would be a reasonable expectation of the contractor.

The reasonable expectation could include a detailed analysis of the originally estimated labor hours, a presence of an historical pattern of proven labor savings by the contractor on past projects, and a verification that the subject project lent itself to a higher-than-anticipated productivity by such factors as the presence of a high degree of prefabrication or repetitive work which was not fully addressed in the original estimate. If the remaining hours indicate labor savings, the contractor will most likely have to demonstrate both the claimed losses and the reasonability of labor savings, as compared with the original estimate.

Special Considerations for "Full Accord and Satisfaction" Change Orders when Calculating the Loss of Labor Productivity

Many public and private owners are including in their change order forms language which attempts to bar the contractor from recovering, at a date after the execution of the change order, any added costs arising from the change, such as loss of productivity. The referenced language—that which attempts to bar the contractor from recovering additional costs arising from the change order after the execution of the change order—is called "full accord and satisfaction" language. The actual wording varies from project to project, and such language is best reviewed by the contractor's counsel before the execution of the project's first change order.

Boards and courts have found that when such language is included on executed change orders, the contractor may be barred from the recovery of added costs arising directly from the change, after the execution of the change order document. In some cases, the application of exculpatory language is applied very broadly to bar the contractor from any further recovery arising from a change order containing such language. It is equally important to note that, in a Veterans Affairs Board of Contract Appeals case,[8] the board found that while the "full accord and satisfaction" language contained on the executed change orders barred the contractor from recovering retroactive, direct losses in productivity on the change order work, it did not bar the contractor from the board's consideration of the alleged losses in productivity caused by the change orders *to the unchanged work*.

In the above referenced Veterans Administration Board of Contract Appeals case, the real party of interest was the electrical subcontractor. The electrical subcontractor did not include any loss of productivity "impact" costs in its change order pricing, and sought to recover loss of productivity in its claim. The VA's change order forms contained "full accord and satisfaction" language. Complicating the matter, there was "reservation of rights" language on the part of the contractor also in evidence.

The board ruled that it was the intent of the parties to resolve all costs directly associated with the executed change orders during the negotiations for change order pricing. However, the decision further stated: "We find that Dynalectric's claims for cumulative impact on unchanged work … survive the accord and satisfaction agreement." The board found that, whereas the electrical subcontractor was barred from recovery of productivity impact costs on the work directly covered by executed change orders, which contained the "full accord and satisfaction" language, it could attempt to recover the cumulative loss of productivity impacts *to the unchanged work*.[9]

Therefore, when the contractor's counsel finds that the contractor has executed change orders which contain enforceable "full accord and satisfaction" language, the contractor may find it advisable to remove from productivity loss calculations the hours (either estimated or actual) associated with the executed change orders. This deduction would form a part of the adjusted, actual hour computation explained herein.

Many contractors do not maintain records which memorialize the actual hours expended on change orders, or which identify when the change order work was actually performed. In such cases, it is necessary to use the estimated change order hours, and to further estimate when the change order

work was performed. This is best accomplished by the onsite managers, as the fact witnesses who saw the work being performed. An analysis which deducts the hours for executed change orders may appear as shown below.

By using this example, the contractor's deficient work and the change order work covered by executed change orders which contained "full accord and satisfaction" language have been factored out of the calculation. However, the impacts of productivity loss caused by changed events on the unchanged work remain.

Court Acceptance of Loss of Productivity Calculations

There are several court and board cases with published decisions which describe the use of the MCAA factors. The recent Appeal of Clark Concrete case, cited previously herein, clearly stated the board's acceptance of the MCAA factors publication in presenting a mechanical contractor's claim for loss of productivity. In S. Leo Harmonay, Inc. v. Binks Manufacturing Company, tried in the U.S. District Court, Southern District of New York in 1984 (No. 82 Civ. 6868), Harmonay sued Binks to recover several categories of project costs, including a loss of labor productivity. In the case, Harmonay's fact witness testified to a productivity loss of 30 percent based on personal observations and the use of the MCAA "manual." The court, in this portion of the case, decided for Harmonay, stating in part, that:

> "... courts have often recognized that the extent of harm suffered as a result of delay, such as the loss of efficiency claim at issue, may be difficult to prove. Thus, courts have recognized that a plaintiff may recover even where it is apparent that the quantum of damage is unavoidably uncertain, beset by complexity, or difficult to ascertain, if the damage is caused by the wrong."

This is an important case which established that even though the loss of productivity cannot be computed with exactness, the impossibility of reaching an exact proof of loss does not bar recovery.10 Also, in the Stroh case, which was previously cited, the General Services Board of Contract Appeals restated two important principals of productivity loss claims; that exact measurement of productivity loss is not a condition precedent for recovery, and in loss of productivity claims, the claimant bears the burden to clearly demonstrate that the cause (for which the claimant was not responsible) resulted in the effect (loss of productivity).

It is fortunate that courts and boards have recognized the difficult nature of quantifying with exactness construction

Contract Period	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45
Actual Payroll Hours	1,600	1,600	1,800	2,400	2,400	3,200
Change Order Hours & Other Deductions		–80	–120	0	–120	–120
Revised Actual Hours	1,600	1,520	1,680	2,400	2,280	3,080
Reassignment of Mpw	5%	5%	5%	10%	10%	10%
Dil of Supervision	0%	10%	10%	10%	10%	10%
Crew Size Ineff	0%	0%	10%	10%	10%	10%
Total MCAA factor	**5%**	**15%**	**25%**	**30%**	**30%**	**30%**
Est Loss of Productivity	**76**	**198**	**336**	**554**	**526**	**711**
					Total	**2,401**

productivity losses and have not found the absence of precise measurements as a bar to recovery. Furthermore, the MCAA factors publication has been recognized as a useful and reliable tool by which loss of productivity impacts can be estimated, particularly when their use is coupled with credible fact-witness testimony.

When a Contractor Must Litigate an Inefficiency Claim

It is usually in a contractor's best business interest to settle, or at least to mediate, a construction dispute rather than to litigate or to take the matter to arbitration. The decision to litigate, or to arbitrate, means handing over the destiny of your case to others. It is usually a better business decision to control your destiny and bring a contentious matter to an amicable settlement, if at all possible.

When a contractor has utilized the MCAA's labor inefficiency factors and then decides to take its loss of labor productivity claim forward for a hearing at arbitration, in a court or before a board of contract appeals, it is helpful to know how the courts and boards have viewed this method of calculating labor inefficiency. As noted previously in this chapter, the MCAA factors, if properly applied, have gained broad acceptance as a reasonable means of estimating a contractor's loss of productivity. However, that does not mean that boards of contract appeals automatically find persuasive contractors' inefficiency claims prepared using the MCAA factors. A contractor should expect probative questioning regarding the factual basis of such claims, how the claim was prepared, who prepared it, and the qualifications and independence of the person testifying on the issue of labor inefficiency.

From time to time, the source of the MCAA factors may be questioned. This issue has been addressed by the MCAA in a Declaration filed in 1999. While the records of the polling and data collection process were not retained in MCAA's files, through historical research, the means of preparation of the factors have been memorialized. Pertinent excerpts from MCAA's Declaration follow:

> The MCAA Factors apparently were developed by the MCAA Management Methods Committee beginning in the late 1960s and continuing into the early 1970s. It is (MCAA's) informed belief that the committee was comprised of MCAA Member representatives who were experienced mechanical contractors. MCAA records show that in April 1969 a "rough draft on the subject of Change Orders in the Construction Industry" was presented to MCAA's Board of Directors…. In May 1970, the Management Methods Committee reported to the MCAA's Board of Directors on a "complete 'in-depth' study of the whole Change Order concept as it affects the construction industry." It is (MCAA's) informed belief that this is the predecessor of the current MCAA Factors. It is also (MCAA's) understanding that the substance of this document has not changed since that time. It is now known as the "Factors Affecting Labor Productivity."…the available documents indicate that the committee and its members were responsible for selecting the titles and descriptions for each of the factors and formulating the percentage values that are set forth in the document. To the best of MCAA's current knowledge, the information contained in the MCAA Factors was gathered anecdotally from a number of highly experienced members of the MCAA's Management Methods Committee. MCAA does not have in its possession any records

> indicating that a statistical or other type of empirical study was undertaken in order to determine the specific factors or the percentages of loss associated with the individual factors.

The process of collecting data such as that which appears in the MCAA factors' table using a polling process is not unusual or proscribed. Such methods have been used to establish losses of labor productivity by many trade associations other than MCAA. The factor descriptions were prepared in advance by the Management Methods Committee. A form was created listing the factor descriptions and three levels of potential impact: "Minor," "Average," and "Severe." The form was then made available to the MCAA member firms for careful review. The intensity data, in the form of the expected impacts percents, were filled in by the MCAA member firms. From this broad polling process, the factor descriptions and the expected impact percentages were reviewed and finalized by the Management Methods Committee and then formalized in the MCAA's publication.

Not only were the factors prepared by experienced and knowledgeable leaders in the mechanical construction industry, the factors have constantly been vetted in the industry for the past 40 years and found to be reasonable and reliable. They have remained unchanged since their first publication and have been accepted by courts, various boards of contract appeals and arbitration panels as useful in estimating a contractor's loss of labor productivity. Moreover, the MCAA factors have been formally adopted by the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) and have been utilized by the National Electrical Contractors Association (NECA) and the Electrical Contracting Foundation in its publication entitled *Factors Affecting Labor Productivity for Electrical Contractors*.

In terms of preparing to utilize the MCAA factors in a litigation or arbitration to establish a claim of lost labor productivity, it is vital that the contractor retain an experienced and independent expert to perform the inefficiency analysis, prepare the expert report, and testify as an independent expert if necessary. In several recent cases in which the MCAA factors were utilized, the Armed Services Board of Contract Appeals has indicated that the testimony regarding labor inefficiency quantification should not be performed by an employee or principal of the claimant, but rather by an *independent* labor productivity expert. That is not to say that credible fact witnesses, such as foremen, superintendents, and project managers should not testify as to the causes and effects of issues adversely affecting labor productivity. Credible fact-witness testimony is very important to establishing the cause and effect nexus. However, if various formulae are to be applied during testimony in litigation or arbitration, including utilization of the MCAA factors, then the use of an independent expert is highly recommended and may be mandatory if an analysis utilizing the MCAA factors is to be credible and reliable.

Even when an independent expert is utilized, it must be underscored that the MCAA factors should be applied in a reasoned manner, relying on the methodology set forth in this chapter. Outlandish and unsupportable inefficiency analyses will draw deserved skepticism from courts and boards of contract appeals. If the MCAA factors are not applied in a proper manner as described in this users' manual, a contractor can expect to face a high bar in its attempts to recover its loss of labor productivity.

Conclusion

The loss of labor productivity is often difficult to quantify with exactness. The MCAA factors can be highly useful to contractors seeking to recover losses in labor productivity due to events not the fault of the contractor. The contractor facing a project that shows the symptoms of delays and inefficiencies should ensure that the contract terms and conditions for timely notice and impact quantification are followed with care. Many otherwise meritorious claims for which the contractor is entitled to recover its fair and reasonable costs are barred because the contractor failed to follow the contract terms as to notice and quantification, or failed to reserve the right to file a delay or inefficiency claim at a point in time after the execution of a change order.

The use of the MCAA factors in forward pricing change orders can result in an overall acceptable recovery of potential loss of productivity in addition to the direct costs of the change. Also, the use of the MCAA factors can result in a more accurate forecast of potential schedule impacts when durations of activities are factored for the estimated productivity loss.

It is essential that contractors weigh the value of recouping reasonable amounts for the indirect costs of change orders along with the direct costs against the potential of gaining a greater recovery by waiting until the end of a project to assess the cumulative effects of all changes issued during the life of the project.
As described herein, in some instances, the only option available to the mechanical contractor may be a retroactively quantified loss of productivity claim. In such cases, the MCAA factors can be applied to the adjusted, actual hours expended by the contractor.

Productivity loss caused by changes in scope, including defective design, unforeseen site conditions, delay and acceleration and change orders, can be real, provable and recoverable. Using the MCAA factors correctly can materially improve the contractor's ability to recover from such losses.

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[1] Appeal of Clark Concrete, GSBCA 14340 99-1 BCA @ 630, 820 (1999).

[2] Appeal of Centex Bateson Construction Co., Inc., VABCA-4613 and 5162-5165.

[3] Triple "A" South, 94-3 BCA P 27, 194, ASBCA No. 46, 866.

[4] "Scope changes" refers to any changed condition that is outside of the contractor's scope of work. These can include added items of work over which there is no dispute (i.e., approved and pending change orders), disputed scope items, differing site conditions, and acceleration proposals.

[5] As noted herein, it is imperative that the contractor carefully read the contract, including all general and special conditions, as well as the change order forms offered for execution by the owner. The contract terms set forth in such documents will, in most cases, dictate the contractor's rights of recovery and obligations for timely notice of delay and inefficiency claims.

[6] Adjusted (reduced) to account for such items as the contractor's remedial work, forward priced inefficiencies contained in change orders, contractor-caused inefficiencies and in some cases, the hours directly associated with executed change orders.

[7] Other contract documents such as the monthly payment requisition lien waiver and release forms must be reviewed carefully for exculpatory language that may seek to limit or bar a contractor's claims.

[8] See: Appeal of Centex Bateson Construction Co., Inc., VABCA-4613 and 5162-5165.

[9] This determination by the board was in

contrast to the appellate decision in the more recent *Bell BCI* matter described at page 9 herein.

[10] Luria Bros. & Co. Inc. v United States, 369 F.2d 701, 712, 177 Cl.Ct 676 (1966).

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