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Field-Level Enhancement Practices For Change Orders

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Abstract–Changes from as-bid work scope are common in construction and therefore construction contracts typically have provisions for handling change orders. There is a significant amount of published information concerning change orders, but this information fails to focus on field-level enhancements in this area. Both from experience and discussions with other industry professionals have found that failures in handling change orders at the field level are a key reason for the erosion of projected profits on projects.

Therefore, field personnel need enhanced procedures for recognizing changes and then dealing with these changes. There are times when design-drawing changes seem to be purposely not called out, but these same changes significantly increase line-item work scope. Field personnel can take advantage of technology such as electronic document analysis to spot changes that otherwise would have been missed in plans. An approach to improvement should also look at pricing of change orders on a lump-sum basis unless unit-pricing is in place. Daily time cards and time card automation can both help with the calculation of labor costs. Field-first-line supervisors, often, are ill-suited to the paperwork involved in change order management and require training. Corrections for these above issues and others are essential and the focus of this discussion.

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Introduction

Change orders are an inevitable fact of life in the construction industry. Change orders result from owner decisions, A/E design decisions, field conflicts, changed conditions on the jobsite, or combinations of the above reasons. There are, of course, numerous published articles and papers on construction claims and general discussions on change orders including court cases related to the legal aspects of change orders including issues as to within or outside the scope of the contract. In this paper, the assumption is that any change-order discussion falls within the bounds of the contract documents. The target here is actionable information that successful contractors are practicing in the field in order to improve their profits. This paper grows out of the experience of the author as an employee of contractors and owners plus later as a consultant for the same entities concerning change-order issues plus numerous discussions with industry professionals over the years.

The goal with field improvement on change order practices is twofold:

- to ensure that valid change-order work is recognized in a timely fashion in compliance with contract requirements and not missed in the field until it is too late to receive compensation under the agreed-upon contract terms
- to ensure that change-order work is taken care of initially and does not become a construction claim

The first line of defense regarding many change orders is the field foreman on the typical construction project. Yet often the foreman is not viewed when it comes to change orders as an essential member of the management team. Overlaying the change order process must first and foremost be an emphasis on accurate analysis and concomitant paperwork. An inevitable part of the change-orders process is paperwork. One of the reasons why people often take occupations involving field roles on construction jobsites is that they prefer to avoid doing paperwork.

Due to the prevalence of change orders in the construction industry, standard construction contracts typically have provisions for handling change orders. The detail and requirements within these change-order clauses can vary substantially as well as do the legal ramifications for missing certain change-order requirements.

AACE International defines a change order as:
“CHANGE ORDER – A document requesting and/or authorizing a scope and/or baseline change or correction. 1) From the owner’s perspective, it is an agreement between the project team and higher authority approving a change in the project control baseline. 2) From a contractor’s perspective, it is an agreement between the owner and the contractor to compensate for a change in scope or other conditions of a contract. It must be approved by both the client and the contractor before it becomes a legal change to the contract.” [1]

Therefore, change orders are changes to the original construction contract. In addition, there is often no such animal as “no-charge” change. Certainly, at the inception of a project, the client may not have decided on certain aesthetic issues such as paint colors which would not increase or change costs on the same paint or other similar decisions as examples. However, often the act of determining whether a change will require additional cost takes time and effort on the part of the contractor and necessarily distracts contractor personnel from other duties on the project. There are four basic types of change orders with (1) additions to the contract, (2) deletions from the contract, (3) relocation of items with no quantity change within the contract work, or (4) those with no cost- or schedule-impact changes.

How Significant is the Change-Order Problem In the Field?

Although contract changes are an inevitable reality on construction projects, the phrase “change-order problem” refers to the issues with change orders that make many construction-process participants wary any time changes take place. Contractors are wary as often they have performed change-order work without being fairly compensated for this work. In addition, contractors may find out too late after the work is already done that their field forces performed changed work without recognizing it as such. Owners, if not the ones to initiate the changes, are often annoyed or upset with designers for inadequate design plans/specifications that now require change orders as a problem remedy. Designers can be upset with owners that make changes because of failures to understand what the design plans would look like once constructed as an example. Designers also express frustration with owners that constantly change designs during construction. If the designer is being paid on a percentage of construction cost, this percentage amount on small changes does not fairly compensate them for their time because there are no economies of scale. Both owners and designers balk at the legitimate cost of change orders as they often do not understand the true cost of these items.

The significance of the change-order problem in construction is difficult to ascertain as there is a lack of research or other information in this area. There are litigated cases that involve change orders but often contractors and owners either settle out of court concerning change orders or involve other forums such as arbitration and dispute review boards, which do not publish recorded results.

Contractor surveys taken in the past by this writer have typically shown change order costs versus original contract amount ranging from a low of 2% - 5% to multiples of this and in extreme cases exceeding 50%. A typical general contractor might be marking up their field direct costs by 15% with as much as ten points out of these fifteen points taken up by general conditions at the jobsite (field superintendent, trailers, clean-up, and other indirect costs). As an example, with the remaining five points split out as three points for home-office overhead [office rent, office salaries (estimating, purchasing, accounting)] with the final two points representing the contractor’s net profit before taxes (NPBT). This means that the general contractor is only making $20,000 NPBT per $1 million of construction. Thereby, if actual physically-completed change-order work was 15% of the original contract amount and the

contractor misses change orders over the course of construction that amounted to 1% of the original contract amount, the contractor has now given away 50% of their NPBT.

This writer's experience is that unfortunately, for a variety of reasons, contractors miss change orders in the field. This is due to their own management issues or the fault of other parties to the process such as designers.

Change-Order Issues with Designers

Unless the job is of a design-build nature, designers are, of course, direct-hired by owners to design the project. If changes to the design occur prior to contractors submitting bids or pricing for a project, these changes are, of course, handled by addenda to the design documents in the plans and specifications. After a contractor is selected, then design changes are handled by change orders. Unless there is a deletion of work to the contract or a lesser-cost type of work is specified, the typical impact of these change orders is to increase project costs. Owners obviously have budgets for every construction project. In the typical owner organization, capital is allocated between a variety of capital project alternatives. No owner is pleased or understanding when a project starts to exceed their budget even when the owner themselves or their staff may be the largest reason for this cost issue. Designers are hired by the owner under the traditional design-bid-build contracting method. Unless this is the rare owner that will only build a single project, the underlying hope of designers is to be retained by the same owner in the future for additional projects.Designers also want to protect their reputation in the industry. No designer wants to look bad in the owner's eyes and a large volume of change orders on a project leading to substantial extra costs is upsetting to the owner. Combined with this is the fact that many popular construction contract forms in common use are authored by designer-led professional associations. Given the designer's influence over these contract forms, and that a designer will choose the form and then effectively administer provisions of the form during construction, the contractor is at a distinct disadvantage.

Avoid Change Orders Where Possible with Lower-Cost Details

Often the contractor performing the work needs clarification on drawings as to necessary detail information before the work can proceed. It is rare that any set of plans for a project is perfect or that 100% of the necessary details are shown on the plans. Therefore, a unit heater may be shown suspended from a ceiling on a mechanical contractor's plans but the detail attachment for the four 25-millimeter hangar rods that will suspend the heater are not shown in the detail itself. Obviously, the unit heater is shown on the plan locations suspended from the ceiling. The standard approach is for the contractor to submit an RFI (request for information) to the designer and then have the designer supply the necessary detail. However, this standard RFI process means that the designer will then have to find time to supply a design detail if they don't have a standard detail in their CAD library. In the case of an ~~or perhaps an~~ inexperienced designer, they may not be able to find this detail and then must create the attachment detail

from scratch. Given this, the design answer to the RFI delays the work plus can be an expensive detail since the contractor's estimator had envisioned a standard connection. It is both time and cost efficient for the contractor to supply a standard detail that they may have used with the same or similar unit heaters on other projects with its RFI submittal.

Another example would be with its BIM constructability analysis, the contractor sees that an elevated 10-inch diameter pipe will clash with a building column. If not found prior to installation of the pipe, an expensive workaround with pipe fittings to turn to bypass the building column would be necessary. However, if the clash is detected early on, a fundamental solution could be given to the designer to simply add a couple of feet of straight pipe in one direction and then eliminate the requirement for multiple fittings and associated welding to detour at the column.

Therefore, providing standard details with RFI submittals in order to suggest ways to avoid the need for more expensive changes can both save time and money on the project. There, as an example, may be ten ways to accomplish a given attachment ranging from low cost to high cost. It is to the designers', the contractors' and the owners' benefit to build with lower-cost details that still accomplish the design intent and preserve project quality.

Know the Contract Requirements

Field personnel need to know the contract requirements for their project. Commonly, contract documents contain requirements for change orders to be in written format and notice/timing requirements concerning change orders as to recognition issues. The contractor who comes in with a change order six months after the work has been accomplished will typically not be successful in getting paid. If the contractor is to be successful, they must follow these requirements which as noted above include prior written authorization to perform change-order work. In addition, field personnel must clearly understand the scope of the requisite work and avoid unknowingly exceeding that scope. Ignorance when it comes to scope can be expensive, therefore, the contractor must understand the scope boundaries. An example of a scope boundary could be with two contractors on a jobsite involved in the same type of work such as control wiring. An electrical contractor may be responsible for certain control wiring whereas the HVAC contractor on the HVAC equipment might also be responsible for the associated control wiring. Just because an owner, designer or managing contractor states, for example to a subcontractor, that this is necessary because "it is in the contract or required in the specifications," field personnel must verify these statements to be correct. The adage for field personnel should be the timeworn phrase "trust but verify." By the same token, field management personnel with a general contractor must also not ignore change orders from subcontractors or third-tier subcontractors as laws in some states hold that if not responded to within the requisite time, a change order becomes accepted as valid. An example of this is Nevada State Law. [3]

Confronting "Minor-Changes" Contract Clauses

Owners and designers, bedeviled by change orders, have incorporated into some contracts a clause that states to the effect that minor changes to the work are considered to be ordinary and not the proper subject for a change order. When a contractor brings up a change-order issue, the owners' representative at the job site will point to this as why a change-order request is not valid. These clauses that state "minor changes" shall be done with no additional cost to the owner bring up two key questions:

- What is a "minor change?" Does the contractor need to ream out one bolt hole in a structural steel column to concrete foundation anchor-bolt connection? This could be a one-time event. As a hypothetical, say that this added work takes two iron workers twenty minutes plus two other ironworkers have to wait plus a crane operator and crane. The actual cost for five workers at $60 each per hour yields $5 per minute for the five-member crew plus the crane at $2.50 per minute totals $7.50 per minute times 20 minutes equals $150. Ten instances of this then totals to $1500 (Ten bolt holes x $150 each).
- What about 500 bolt holes for reaming work? At $150/hole and this number of 500 over the course of the job yields $75,000.
- What about numerous minor changes that add up over the course of the project?

Again, the contractor is attempting to protect their razor-thin profit margin on the project. Just as the contractor's own field personnel in many cases do not understand the true contractor profit margins in the industry, the same can often be said for both owner and designer personnel. The contractor earning a 2% net profit for every $1 million of contract volume is getting a $20,000 profit margin. The case of one bolt hole being off may delay setting the steel column by twenty minutes. If the contractor "gives" this away in just ten cases totaling $1500, that is 7.5% of their net profit. More of these minor changes involving the same crew/equipment cost structure could quickly become 25% of the contractors' net profit on the work. The contractor cannot afford to lose one quarter of their net profit for the work. For someone not acquainted with the contractor's cost structure, the anchor-bolt-hole issue may seem trivial and therefore categorized as a "minor change." But the costs involved are not trivial. The experience from conversations with numerous industry professionals over the years is that when field personnel for the owner/designer are confronted with this reality, change orders are more likely to gain approval.

Change-Order Approach with Negotiated Work Versus Hard-Bid Work

The situation for contractor field personnel can vary on negotiated work versus hard-bid work. On negotiated work the contractor's margins should be higher due to less competition and the contractor has been selected on the basis of a number of factors that includes price but not price as the sole determinant. There are more opportunities in this situation to incorporate contingencies into the price. As one contractor stated, negotiated work is "love" and hard-bid

work is “war.” With a higher margin on negotiated work, the contractor’s strategy may include not “sharp-penciling” the owner on every single change. Still the contractor needs to track this and ensure that their markup structure with a higher margin is sufficient so that they are not losing money allowing certain changes to not be billed out.

Hard-bid work on the other hand has the owner solely accepting contractors on the basis of which contractor has the lowest price and bidding is an “arms-length relationship” which is particularly true on governmental work. Due to this price competition, contractors have to get paid on all change orders unless a change is truly a “minor change” as per the prior discussion. In addition, with a hard-bid environment with the lowest-bid selected it is expected that change-order practices will be aggressive.

Field Supervisory Training/Education

Shockingly over the years surveys of craft personnel on jobsites have found a high degree of ignorance when it comes to the true situation of contractor profitability. Workers and supervisors are in an environment with millions of dollars in material and labor expenditures, and millions of dollars in equipment required to complete certain work classes. An example of this might be a $20 million excavation project where the dollar value of the contractor’s equipment assets to complete this work actually exceeds the contract amount. Therefore, the contractor might be using $25 million of construction equipment to complete a $20-million contract. Notably this equipment is utilized over a number of years and a number of projects but the costs of these deployed assets on a per-job basis such as hourly depreciation charges is still substantial. As an example, in the past, surveys have found first-line field supervisors’ estimation of contractor profitability ranging from 10% to 40% of contract price. The truer picture is that contractors on larger-volume projects are experiencing profitability rates of 2% to 5%. First-line field supervision seeing the magnitude of costs involved for labor, materials, and equipment have indicated that due to these amounts, that contractors have to be making substantial profits. At a 2% net profit this means the contractor is only actually making $20,000 on every million dollars of work. Moreover, contractor management surveys over the years have found that they can achieve planned profits on ten jobs and then encounter a sour job which consumes all the profit from the ten previous projects.

Construction is at the zenith along with a handful of other industries in high-volume, low-profit work. The true picture of this low-profitability environment needs to be brought home to all construction-firm employees. Since the field foreman is the first line of defense regarding identifying changes and initiating the change order process, they need to understand the economics and their crucial importance in defending the contractor’s margins on a project. Some foremen look at multi-million dollar projects with millions of dollars of equipment out on a project with no conception of project economics. Exposed to these construction-industry realities encourages foremen and others to be more conscious regarding the impact of missed change orders and missed hours on change orders.

In addition, the construction foreman is busy so how can contractor management make their job easier? Moreover, construction foremen feel a lack of support from upper management. As one foreman noted, “I’m fed-up and frustrated in the land of the forgotten.” The foreman needs to be trained to recognize changes. Would a three-day training class pay for itself if the foreman was able to pick up $15,000 of extra changes/year. Three days away from a project given that the foreman is billed out at $75/hour x 8 hrs x 3 days = $1,800 in salary plus $1,000 per person for the class = $2,800 total. If this foreman in the next year was able to recognize $15,000 in changes, most would agree that this is a solid investment. This investment not only provides benefits in the current year but also in future years. The added benefit of the training investment is to make the foreman feel more a part of the construction team.

Check Cost Reports for Potential Early Warning of Changed Work

Trending analysis by the field on cost reports can also help to pinpoint changed work. A minor detail change on a plan might create higher concrete formwork costs. The cost report information seen below in Table 1 for some simple concrete formwork shows a negative cost variance of $1.68 per SMCA (square meter contact area) with a projected loss of $10,080. The estimate was based on standard historical production rates. However, it may be that due to a more complicated design detail or an informal field change, excessive costs are being incurred. Therefore, field management needs to analyze cost reports particularly on high-volume work to spot potential areas requiring change orders.

Estimated labor cost to date	$ 7,707.00
Actual Labor cost to date	$ 9,150.00
Variance	**-$ 1443.00**
Estimated Quantity to date	1,200 SMCA
Actual Quantity to date	1,200 SMCA
Variance	**-0-**
Estimated Material cost to date	$ 3,150.00
Actual Material cost to date	$ 3,750.00
Variance	**-$ 600.00**
Estimated Unit Price	$ 9.06/SMCA
Current Actual Unit Price	$ 10.74/SMCA
Variance	**-$ 1.68/SMCA**
Amount remaining to complete	4800 SMCA
Projected loss at this rate	**-$ 10,080.00**

Table 1–Projected Loss on Simple Concrete Formwork Activity

Field Documentation Essential for Receiving Payment

While time-and-material change orders are easier for the field to manage, still documentation is an important requirement in order to receive payment. [4] Time-and-material changes must have adequate documentation that describes the work. As an example, an invoice for a T&M change that reads "Labor and material to install extra 12" gate valves……..$29,700" will not be accepted by most owners. As a guide to substantiating change orders AACE Recommended Practice 100R-19 illustrates recommended practices in this area. [2]

Similarly, an invoice with a total of $29,700 reading as below in Table 2 still requires proof of all these expenses. Was 52 labor hours actually expended and did that type of 12-inch gate valve actually cost $5775 per unit?

Item Description	Total Cost
52 hours of labor @ $75 per hour	$ 3,900
4-12-inch gate valves @ $5775	$23,100
RT crane assist to install valves in place	$2,700
Change Order Total Cost	**$29,700**

Table 2–Sample Itemized Time and Material Change Order

Avoid Cost Stacking on Existing Change Orders

Field personnel, on average, do not like doing paperwork. Their dislike of paperwork is often a key reason why they are working in the field rather than in an office position. There can be a tendency with time-and-material change orders to "stack" costs onto an existing change order due to a key factor in avoiding the creation of more paperwork. The term "stack" refers to costs that are placed into an approved change order for other work that do not relate to the scope of the change order. Therefore, a change order being performed on a time-and-material basis must ensure that only those costs associated with the actual changed work are accumulated. Project management from both the owner's side and contractor's side, from foreman on up, can become lazy on a project such that "we'll just charge this to that still-open change order." This makes it easy for the owner's rep and the field personnel until an estimated $25,000 change order becomes $75,000 or multiples of this on larger projects. Combined with poor records and the inevitable turnover of personnel on projects, or simply forgotten details means that eventually, someone will have to explain why change-order billings are at a multiple of an original estimate. Personnel, higher in the management hierarchy, on the owner's staff or designer's staff will have bases to be skeptical that the work could have cost as much as being claimed. The bases for the claimed cost for the overly priced change order would be unreasonable since that one change order may have accumulated costs that should have been part of perhaps four or five other change orders.

Avoid Cost Spreading to Change Orders

There can be a tendency for field supervision to engage in cost spreading. Cost spreading, a common construction-industry issue, is when costs are running over on one line item so they get slotted instead with another line item. An example would be that the costs of forming concrete beams are exceeding the cost budget but the costs for elevated concrete slab forms are less than budget. Therefore, field supervision spreads costs from the beam formwork to the elevated slab formwork.

Unfortunately, with some contractors, cost reports are used as a "club" to beat field supervision over the head when they are not "making budget." Therefore, to avoid trouble, field supervisors will spread costs from an item that is trending towards an over-budget position to areas that are in an under-budget position. On a lump-sum contract with similar lump-sum line items, the only victim is the contractor and the firm's cost-estimating system as inaccurate historical costs obviously result from this practice. So, a concrete contractor, may have underestimated time required on installation of beam formwork and overestimated time required on slab formwork. Once field construction is taking place, a field supervisor sees this with one line item over-running estimated/budgeted time and a companion item under-running estimated/budgeted time. Therefore, work hours are then allocated when time is being recorded from the overrun item to the underrun item.

In the case of a newly-issued change order, field supervision is starting with a "clean" budget or "blank" slate. What better area to dump costs from other work to than this change order particularly if it is on a time-and-material basis? This practice has to be discouraged and unfortunately when left unchecked can give the contractor a false sense of confidence with other work being estimated on a hard-bid basis.

Avoid "Horse-Trading" Concerning Change Orders

Since field personnel tend to dislike more paperwork, there can be a tendency towards "horse-trading" or bartering on extra work. The owner or designer requests something in the field that would involve extra work. Meanwhile, often near or at the same time, the contractor's field personnel see a particular detail on the other in-contract work that is particularly cost-intensive and doe not make sense to them based on their past experience. So, field personnel have an idea to substitute one detail for another. A field representative for the owner such as an owner's representative/inspector sees the extra work and this "non-essential" (at least to those in the field) and decide to "horse-trade" the extra work for eliminating the "non-essential" detail in favor of an easier-to-build detail. What could go wrong? The overarching problem with horse-trading in this environment is a lack of review by higher-up owner/design personnel who may have requested/created the detail to service a particular requirement.

As a case-study example, an industrial construction project included a multi-story coal materials processing building as part of a larger development. The structural steel package consisted of numerous floors of structural steel including heavy grating for the floors. The contractor's estimator estimated welding the grating during the estimating process but the plans, in amongst the details, actually showed a time-consuming bolt/clip arrangement for the grating. Around the same time, handrail was added to the plans around numerous openings. The owner's representative said to the contractor, "let's make a trade and weld the grating in return for the handrail install." The contractor agreed believing it was a great "trade" based on having to work less hours. The multiple floors of structural gratings were welded down instead of bolted and the extra handrail was installed. However, during the final punch list process, the owner's operating staff walked through and they noticed on final inspection that the grating

was not bolted/clipped. They were not aware of this variance with the plans, and furthermore, they had requested this feature for maintenance shutdowns to allow easier and better access to equipment units. The contractor was confronted with the logical question by the owner's staff of why attaching grating via welding when bolts/clips were shown clearly on the plans? The owner's representative had left some months before and was on a job overseas and could not be contacted. The contractor's PM was apprised on the non-conformance to the plans. Questioning of the foreman and general foreman revealed that they had made this "great deal" with the owner's representative. The PM, confronted with the sad news that the contractor had to remove the grating and reattach it with bolts/clips as shown on the plans. As some small consolation, the contractor did get paid for the extra handrail. If the owner and contractor had, at least, authorized this substitution in writing, the problem would have been the owner's and not that of the contractor.

Unit-Price Change-Order Work and Potential Pitfalls

If a change order takes place under a unit-price contract, determining the cost of the change order is a basic process since the extra quantities incurred are simply multiplied by the unit price. In addition, if the contract allows, when quantities vary substantially from the original-specified quantities, these unit prices can be adjusted through negotiation for this event. An example of this would be where, due to a large amount of anticipated quantities identified in the tender documents, the contractor priced out the units based upon larger equipment to perform the work. If the resulting actual quantity amounts are significantly reduced, this larger equipment may no longer be an economical choice. The typical reason for unit-price contracts in the first place is that exact quantities are unknown; e.g. common-excavation quantities compared to rock-excavation quantities. The owner on a unit-price contract typically has furnished quantity estimates on a line-item basis to the contractors bidding the work, and therefore, has an overall estimate of project costs from the summation of these line items. Unless there is a dispute on quantities such as "is over break on rock excavation for foundations paid for or not," the standardized process eliminates disputes. The phrase "over break" refers to the fact that in blasting of rock, exact lines cannot be followed and therefore quantities can increase over what is anticipated from standard excavation work. Pipeline projects involving many miles of trench excavation for the pipe to be placed, as an example, will typically be on a unit-price basis. While soil borings are conducted at intervals along the pipeline route, these intervals cannot possibly include a complete representation of actual field conditions encountered along the route. Therefore, an unidentified rock outcropping required ripping or blasting will then be paid at the rock-excavation unit price rather than the common-excavation unit price. Unit-price basis projects, as a general rule, encounter fewer disputes as to change orders due to this allowance for variability.

Potential pitfalls can still arise with unit prices, however. On heavy/highway construction projects, the unit price developed in the estimating process is based on an estimated quantity. The contractor has therefore taken this estimated quantity into account in setting up crew/equipment in order to accomplish the work. The secondary basis for the unit-price

determination is that the contractor is mobilized in the area where the work is going to take place. But what happens if the quantity substantially underruns the designer estimated quantities? Contractors where quantities substantially underrun can find themselves mobilized on the jobsite with an uneconomic equipment fleet. There are two recommended practices here:

- Knowing that at times, quantities can underrun substantially, contract provisions should include language to the effect that additional compensation will be required if these underruns take place and that a percentage such as 25% is the action trigger in this event. If the contract language doesn't include this, the contractor needs to include this as a qualifier to their bid proposal to eliminate potential field-cost busts on the project
- Contractors need to identify these quantity underruns as soon as they take place and the location particularly on a far-flung job such as a pipeline or highway project in order to avoid disputes

The next pitfall with unit prices takes place where owners/designers plagued with change orders and cost disputes on non-unit price work decide to implement unit prices as a supplement for lump-sum contracts. Therefore, contractors bidding standard building construction projects such as office buildings are expected to deliver both a lump-sum hard bid and fill out what sometimes amounts to pages of unit-price quotations. The problem for the piping contractor, as an example, in filling out these unit-price categories is that the demand for unit-prices includes items that were not part of the building construction project as defined by the contract tendering documents. Therefore, on the project to be bid, the largest pipe size on the project is 16 cm and there are unit-price requests for 24 cm and 32 cm sizes. Unlike the standard heavy construction unit-price contracts, there is also no quantity information. The overarching issue as well concerning unit pricing on this possible work is the timing and job conditions for the subject change-order work. If 16 cm pipe is added to the work scope while the contractor is mobilized in the area with scaffolding and a crane, a standard unit price to add 10 m of straight 16 cm pipe in a section would not be an issue. However, what happens, if, in the field, the same 10 m of 16 cm pipe is added after the contractor has demobilized in perhaps one area with dismantling of scaffolding and the crane is off the jobsite? What happens if the contractor estimated the unit price of this work for standard conditions at standard heights of 3 meters accomplished with standard scaffolding and the new work height is 10 meters?

The common practice of many contractors is to take standard unit prices from their estimating data base and simply apply them to their respective blanks when filling out the unit-price requests. However, in the second scenario, the contractor now has to bring back scaffolding and bring back the crane to add this 10 m of 16 cm pipe. Absent other information, the contractor is advised to estimate these unit costs as if the contractor had to mobilize in the area for the first time and to estimate for extreme conditions such as at maximum possible heights and poor working conditions. Potentially the contractor could add qualifiers to their unit-price submissions stating that the contractor must be mobilized in the area doing the same type of work at the same time with scaffolding and equipment for these unit prices to be applied to change-order work.

Lump-Sum Change Orders Versus Time-and-Material Change Orders

Aside from unit pricing on change orders, the two most common methods for change-order pricing are time-and-material (T&M) pricing and lump-sum pricing. In the rush to accomplish change-order work, the advantage of T&M work is that no estimate is required to start the work. Contractor field personnel, already under time pressures, welcome this aspect of T&M work. Owners and designers approve the work to be done by signing a change order that states "You are herewith directed to proceed with the following changes, subject to an equitable adjustment in the contract amount and/or performance time." However, typically, the owner and designer have no idea for how costly the change order work will be. In numerous areas in the U.S., rates of $60 per hour or higher, including fringes/overhead, for one worker on a jobsite are common. If a change order with a five-member crew takes one week to accomplish, at an average wage-fringe-overhead rate of $60 per hour, this is $12,000 (5 workers @ $60/hour x 8 hours x 5 days = $12,000.) For an owner that thought the labor cost of this change might be $2,000, the $12,000 labor bill is factors of magnitude more than was thought possible. Presented up front with this cost of $12,000, owners thinking that the cost would be much less, in a number of cases, would probably decline to have the change-order work done. The other problem with T&M change orders is the "stacking" of these change orders such that twenty of these change-orders at an average of $12,000 each where the owner was budgeting $40,000 ($2,000 x 20 = $40,000) and now the owner is staring at a bill of $240,000 instead. Depending on the situation, the owner may simply not have the ability to pay nearly a quarter of a million dollars for the requested work. Surprised at the magnitude of a $240,000 amount, the owner may think that the contractor has simply cheated them and there is no way that the cost can be this high. The contractor on T&M work has to document the costs in adequate detail to substantiate all the changed work performed was reasonable. All relevant time-card hours, material receipts, and equipment hours should be accumulated on a daily basis to assist in this documentation. The contractor also has to understand the owner's perspective in that just because a contractor states that there is a $240,000 bill does not make it so.

There are essentially two methods for getting around the surprise-cost issues:

1. Set a guaranteed-maximum price for the change order with T&M requirements
2. Enact lump-sum change orders instead of T&M to avoid potential surprises at the outset [3]

With Method 1, this should be approached by including daily time sheets that are submitted with sign-off requirements done by a designated person representing the owner's staff. The guaranteed-maximum price (GMP) must be realistic from the standpoint of including all elements necessary to perform the work with labor, material, and equipment items. With Method 1 encompassing GMP-change-order work, there is essentially no difference between this and T&M work except that the GMP, of course, sets the upper limit. If unexpected work develops as a result of the change order work itself such as unknown buried utilities then the GMP price requires upward adjustment.

In order to accomplish Method 2 for performing lump-sum changes, this method requires accurate estimating up front on the part of the contractor. Method 2 has strong advantages in that fewer disputes result since the price is agreed upon before the work is done. In addition, since the contractor is taking on more risk with a lump-sum price, the profit margins here should, by necessity, be higher than for Method 1. However, Method 2 requires competent estimating work for this to be effective. Method 2 also requires adequate time and available information to produce an estimate which in select cases may not be practical

Experienced Personnel Necessary for Change Order-Cost Estimates

There is obviously more leeway in giving an estimate to a client on a time-and-material (T&M) change order versus a lump-sum change order. The estimate on a T&M basis should yield a target price of what the change order should cost. Neither designers nor owners appreciate cost surprises but if a T&M change order exceeds a given estimate by a reasonable margin, the contractor still will typically be paid since it was on a T&M basis. However, T&M costs have to be backed up with requisite documentation with time-card information and material receipts as examples.

This changes with lump-sum change orders and the acceptance of the lump-sum number by the owner means that the lump-sum amount will not be exceeded unless it arises that a change to the scope of a change order is necessary. Therefore, estimating accuracy for lump-sum change orders require experienced estimating personnel. Estimators with most contractors are typically busy during both slow economic conditions and busy economic conditions. The mantra of estimators is to get the next job and not leave “too much money on the table”; meaning that substantially low estimates often indicate mistakes. For an estimator bidding multi-million dollar projects, change-order estimates often fall in the low-priority category. However, with change orders unless there are multiple contractors such as two or more mechanical contractors or electrical contractors on a job, there is no competition except for not doing the work. This “not-doing-the-work” phrase means that if the owner does not find the proposed price acceptable, the alternative is to forego the changed work unless it is essential such as a code change to comply with a building code or safety/environmental regulations. Since the average contractor does not welcome change orders, if they get them, they need to be performed at a fair price meaning the contractor is compensated for all costs plus overhead and profit.

For lump-sum change orders, the contractor must consider potential risks. The contractor must ensure that a submitted estimate includes not only all costs but also a risk factor. The risk factor is included to cover for potential issues with the work as to issues such as inefficiencies with the work itself or impacts on other work due to the change-order work taking place. In addition, unless project specifications are available to cover the intended work, the estimator has to tie their price to a target specification. This means that change orders on a lump-sum basis require experienced estimators either in the home office or those at the project site to develop accurate estimates.

Failure to Include Both Time and Cost or Other Impacts Resulting from Change Orders

Unfortunately, too often contractors estimate a price on a change order but fail to consider the impact costs related to the added time within the project schedule for completing this additional work or acquisition time to get the materials for the work itself. As an example, the actual changed work may take a week but the delivery of material could add months depending on the items involved with the additional work. Based on industry experience, the most-common overlooked aspect of change orders is time. Often contractors will expend significant efforts to develop an accurate costing for a change order but on industry-standard change-order forms is usually a space for additional time. The space line item may simply state: This change order adds _____ days to the project completion time. Too often contractors will simply leave this blank, sign the change order and send it through. At the end of the project, many contractors facing delays and liquidated damages for the failure to meet the original schedule can only now recognize that additional time should have been requested for any number of change orders. Obviously, if it is a situation where a change order that adds a few days is on a schedule path for the project wherein there happens to be weeks or months of float time, the common approach is to not adjust the current schedule. However, if the change order is on a critical or near-critical path, the contractor should request a time extension.

Moreover, some change orders, due to the duration necessary to accomplish the changed work, may shift certain warm-weather activities into adverse weather months. This can significantly impact productivity. An example is where foundation-related change orders prevented masonry work from taking place in the fall which then slipped the same masonry work to the colder winter months. This meant lower productivity plus additional costs for temporary heat and activity tarps/screens. These impacts were seen on the schedule and based on historical winter costs, these impacts were then included in the change-order request and ultimately accepted by the owner.

Adequate Overhead Structure Necessary for Fair Compensation

Here, the assumption is that the change-order will include the necessary direct costs of the work plus associated indirect/overhead costs and profit. AACE defines direct costs are defined as the labor, material, and equipment directly associated with the changed work [1]. Overhead costs are often allowed per the contract at a set percentage such as 10% or 15%. Either within the contract itself or through other means, cost breakdowns between direct and indirect/overhead costs require definition and AACE provides well-recognized definitions for these terms [1].

The question here is that certain overhead costs perhaps should be, instead, considered part of the direct cost structure. In addition, a subcontractors' cost submittal on a line item to a another upper-tier subcontractor or the general contractor will include all costs in the subject submittal whether direct or indirect. An example was a change order as part of a plant construction project inside an existing facility. Where a new structure was to be installed

including the construction of a foundation was a pit full of grease and oil. Before the work could proceed, a time-and-material change order was issued to the contractor with a 10% add-on for overhead. Considered part of overhead was any item not part of direct costs and overhead included consumables. Consumables defined here included paper coveralls, solvent, and rags. In addition, any tool less than US$1,000 was considered as part of the overhead cost structure. When the pit had been cleaned of all oil and grease, the contractor found out that due to an inadequate overhead structure, they had actually lost money on this T-&-M change order since paper coveralls, rags, and solvent were extensively utilized yet the 10% overhead rate failed to cover this.

During the nuclear-power-plant building boom in the U.S. in the late 1970s, a study by a management consulting firm found that fully 50% of contractors on cost-plus contracts were losing money on this work because standard overhead markups failed to cover all their costs. These overhead costs included extensive management time to obtain mill certs on involved materials and inspector time/management time that were not considered as direct costs.

Contractors on change-order work must ensure that any percentage number for overhead be reasonable and well-thought out before agreeing to these terms. There should be an upfront agreement in the original contract between parties that spells out in detail as to classifications for what is an indirect cost and direct cost to help avoid later disputes.

Employee Participation in Change-Order Proceeds

Some contractors will award employees a bonus for their diligence in spotting change orders and, therefore, award these employees additional money, which corresponded with the overall dollar amount of change orders at the end of the job. While these types of incentive programs are based on well-meaning intentions, they unfortunately can encourage bad behavior. Construction industry history is littered with incentive programs that one way or another became corrupted in some fashion. In cases often seen in construction, field personnel, in order to achieve extra bonus funds, might submit change-order requests on in-scope baseline contract work. These fraudulent practices can cause owners and designers to then view legitimate requests with skepticism.

Daily Time Cards Versus Weekly Time Cards

In order to capture actual hours being charged to a change order, underreporting of labor hours incurred on the change-order work has to be avoided in all cases. In order to accomplish the capture of all spent hours on change-order work, contractors, if not already using daily time cards (paper or electronic), need to implement daily timekeeping as opposed to weekly timekeeping. [5] The cost of missing hours on change-order work is too important to leave this to the vagaries of a foreman’s memory. If the foreman is filling out a weekly time card on Friday, can the foreman really remember what took place on Monday or Tuesday? For change-

order work that started on a Tuesday, the foreman may misremember this fact on a Friday and start the change order work on the following Wednesday. Another example is a foreman forgetting to add a worker that worked on change-order work and should be charged as the same. Typical margins in the construction industry are too thin to allow this type of haphazard practice.

Therefore, time cards must be completed on a daily basis and turned in daily as well. Ideally, this can be shortly before the shift ends as again, if the requirement is after the shift is completed, in the rush to get home, foremen may sacrifice detail and accuracy for speed in these situations. On an eight-hour shift basis, typically having time cards filled out and turned in during the last hour of the workday will still ensure necessary accuracy as worker re-allocation is uncommon near shift-end work.

Time Card Automation

Time cards in the construction industry have traditionally been of the paper-and-pencil variety where, commonly, a foreman will manually fill out the time cards with workers' names, hours taken on a particular line item, and then forward the time card up the management chain. The foreman may or may not include cost codes with the time card such as with concrete formwork for spread footings, retaining walls, and so forth. In numerous cases, contractors may have someone else apply cost codes to the raw time-card information either in a field office or home-office environment. Manual time cards are a labor-intensive endeavor and fraught with error for those that have to interpret what was filled in by the first-line supervisor. As aforementioned, time cards should be accurate and filled out on a daily basis.

Technology has come to the construction industry via numerous software packages that allow for the automation of time cards. This automation has meant that the foreman on a cell phone or tablet can simply call up the time card template and fill it out. Standard programs allow time cards from the prior day to act as a template. Therefore, with an eight-member crew, the names of all eight workers automatically pop up on the screen along with the prior day's activity list/description and allocated time such as two hours, three hours, eight hours, etc. along with equipment such as support items with welding-machine time, crane time or forklift time as examples. This would, of course, include change-order activities. The foreman then edits and changes/adds/deletes entries as appropriate.

The advantage for the foreman is that this eliminates repetition in creating time cards and therefore saves time. Typing in information electronically is faster than printing by hand. In addition, certain programs allow change orders to be highlighted so that these activities are not overlooked. Moreover, capturing time card data for those processing this information in the field office or home office environment is much faster and more accurate. No longer does a data entry clerk have to guess or interpret handwriting and potentially miss accurately accumulating change-order labor hours.

Many contractors have found that the return-on-investment or payback period from implementing automated time cards is measured in months and not years. This ROI or payback period is measured on the basis of less time required on the part of both field supervision as well as costing/accounting personnel plus enhanced accuracy and process speed.

Technology for Change-Order Recognition

It is beyond the bounds of this paper to recommend or evaluate specific software packages or other branded-technology for recognizing changes to the contract documents as they are received by the contractor. Historically changes to contract documents should be flagged by the designer to attract the contractor's attention without having to "dig" to find the changes. On drawings or specifications, these changes should be flagged such as by "clouds" around a particular change in details along with perhaps notes or cross-outs. Therefore, if a spread-footing size on a structural drawing is changed from 2 meters by 2 meters in size to 2.5 meters by 2.5 meters in size, the footing detail would reflect this change with a "cloud" around the subject detail. In the register section of the next revision of the drawing, ideally, this change would be noted as a change in footing size.

But what happens if, for whatever reason, the designer just sends out the new structural drawing revision with a general note such as "clarified foundation details"? If the work identified on the drawing is some time away from building the foundation based on this detail in the field, no one from field supervision on up may notice the change. The above example expanded, if the spread footings are 0.5 meters in depth means that the concrete quantity has now increased by 1.125 cubic meters (2.5 m x 2.5 m x 0.5 m = 3.125 m versus 2 m x 2 m x 0.5 m = 2 m). If just the cost of purchased ready-mix concrete at the jobsite is $130/cubic meter, the raw concrete costs have increased by $146.25 per spread footing and for 50 spread footings the cost impact is $7312.50. If the foundation concrete package was $1 million and the contractor's net profit was 2% on this work, the profit is $20,000. With not recognizing this scope change of $7,312.50, the contractor has just "given away" 36 percent of their profit ($7,312.50 / $20,000 x 100 percent = 37 percent).

The practice of some contractors is to immediately pull the existing drawing in favor of the new revised drawing so that the field is building from the most-current set of plans. The discarded drawing then goes out of the plan set into the discard pile to be looked at "later" for any changes. In the pressures of a busy job site, this task of drawing comparison can be overlooked until it is too late in the process for if the work in the field with the new footing size has already been installed, then after-the-fact change orders may find little support in both the contract documents and from the designer and owner. The "bust" in the footings' estimate may simply be blamed by the field personnel as an estimating mistake.

Besides visually scanning and comparison of a revised drawing with the existing drawing on a manual basis, an early improvement was the utilization of a light table to spot drawing changes between the previous drawing and the current revised drawing. The light table was often a job-

created invention wherein a glass top was substituted for the wood top of a drafting table. Then fluorescent tubes were placed under the glass top and then a new drawing was overlaid with the existing drawing to identify changes. A size-change in floor plan given the two same-scale drawings with the new drawing on top of the old drawing would show up as a difference. As an improvement from simple visual comparison between drawings, the light table was a significant benefit for spotting these changes. Therefore, if the size of an element changed on a drawing, the comparison on the light table between the new and old drawing could be seen and the cost implications included in a change order.

However, it is common with construction plans that many construction details are drawn with the notation, "N.T.S." meaning not-to-scale. Therefore, a person utilizing a light table would not be able to identify the difference if the footing size was changed on the detail with a simple written notation that stated 2-1/2 meters square versus the previous 2 meters square. Another situation might be if a footing schedule was utilized for the project where footings were called out with letters such as A, B, C, and D, etc. wherein these footing sizes were simply then denoted in a footing schedule.

It is not the intent here to recommend specific brands of software but simply to point out that electronic technology packages used to take off digital versions of plans or other packages that are used in the field to access digital plan images can be used to spot plan changes. Therefore, if areas are changed, while the old methods of light-table use could spot this, the electronic methods can readily find the changed area. A manual calculation on a flooring change from carpet to tile for an area that goes from 10 meters square to 15 meters square is simple but irregular areas can create time issues and inaccuracy issues. Electronic technology first starting years ago with digitizers on paper-based plans and for the past several years with digital plan takeoffs has significantly changed and improved estimating accuracy. An enhanced element in many software packages is when details such as N.T.S. details don't change in size on a plan but the work scope still is increased driving up contractor costs such as the footing size increases via a simple drawing note. Another example would be wherein a specification note is added to a plan or wording is revised that also increases costs. An example would be wherein sawed concrete-control joint spacing is changed from three-meter spacing to two-meter spacing on a plan note thereby increasing the contractors work by one-third for this item.

In addition, while the trend in construction-industry specific software is that software firms are making this technology easier and easier to use, such packages as electronic takeoff software still have a learning curve and the need for some experience.

Conclusion

While there is a vast amount of information that has been published regarding change orders in construction, unfortunately, they mostly focus on contract issues and legal issues in this area. Therefore, the topics covered in this paper have dealt with field-level techniques to enhance the change-order process. Based on decades of construction industry experience, often this

ignoring of field-level issues leads to significant profit erosion on projects for contractors. Field personnel such as foremen require education/training concerning change orders and the change-management process. An adage in estimating is that while costs for an item can be inaccurate to the point of 10% or more, for every item missed the inaccuracy is 100%. This adage also applies to change orders. Field personnel first need to recognize change orders that may not be apparent as designer changes are often not highlighted in the plans. Field personnel must also avoid "horse trading" wherein an owner's representative in the field may want extra work done and in return agrees to a change in contracted work scope as a tradeoff. The problem with "horse trading" on change orders is the lack of documentation, higher-up approvals, and then with personnel changes and fading memories, a contractor can find themselves still liable for not completing items as per the original plans and specifications.

Based on experience, while it is relatively simple to conduct change orders on a time-and-material basis, change orders priced out beforehand on a lump-sum basis provide two key benefits. First, a lump-sum price avoids "sticker shock" on the part of the owner which can discourage the change in the first place and secondly help to ensure that with no surprises, the contractor will be paid for the work. While pricing out changes on a lump-sum basis is the preferred course unless unit pricing has already been established, the lump-sum method requires estimation by experienced professionals whether this takes place in the field or with the estimating staff back at the home office. Since design changes are not always flagged by designers, technical advances for the construction industry can help to spot these such as changes in dimensions that add work to the originally-estimated work scope. Even when a change is properly noticed, contractors often fail to capture all costs, particularly labor, with change orders because of sloppy practices. Daily time cards instead of weekly time cards can help to avoid forgetting to charge labor hours to time cards. Time card automation with templates, which reduce recording time, are a significant benefit for the foreman. In addition, time card automation reduces mistakes and time for gathering data that go into the contractor's job costing/accounting systems. Properly-approved change orders should not be a dumpsite to drop off labor and other costs for other changed work, but each change order should be processed on its own. At the same time, cost-spreading practices where labor hours and other costs from contract work in scope are spread to change orders to make budgets on line items must be avoided in the field.

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