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A Contractor's Guide to Managing Design Risk

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Introduction

In its forty-seven year history, Revay has produced a number of articles regarding best practices for contractors on construction projects. Some of these previous issues of the *Revay Report* include "Best Practices for Managing Construction Projects in Good Times and Bad" (Volume 28, Number 1, 2009) and "The Pitfalls of Incomplete Contract Documents" (Volume 29, Number 1, 2010).

Design problems continue to be a major cause of claims and disputes on construction projects. In this *Revay Report*, we specifically look at how contractors can mitigate the risks arising from design issues on their projects. The *Report* examines contracts where the owner is responsible for design (Design-Bid-Build) as well as those where the contractor is responsible for design (Design-Build). Under either project delivery method, the contractor can incur additional costs due to unforeseen problems arising from design.

Where used in this *Report*, the term "design risk" is limited to a contractor's exposure to delays and increased costs (direct and indirect) resulting from design issues on infrastructure and building projects.

By implementing best practices in the management of design risk as described in

this *Report*, contractors can take measures to mitigate their exposure to it.

Unless noted otherwise, the *Report* considers design risk from the perspective of general contractors and large trade contractors.

1. Design Risk Defined

Design risk is inherent to all construction projects. In the context of this paper, design risk is the risk of delays and increased project costs to the contractor. Design risk manifests itself through poor coordination, unclear specifications and requirements, omissions, insufficient predesign investigations and technical errors. The impact of design risk (delays and extra costs) varies throughout the life of a project. Design risk has a low impact during the early development phase of a project, when funding, financing and construction contracts have not been finalized and few financial commitments have been made. However, design risk has a high impact after the award of construction contracts, when the parties involved have committed to funding, financing and their contractual responsibilities.

By definition, design risk can only be zero when design is 100% complete and no more design changes are possible. This situation exists *only* when all of the owner's project requirements are defined by a complete and fully coordinated design (whether such a design is produced by the

owner in a Design-Bid-Build contract or by the contractor in a Design-Build contract) and when it has been confirmed that there are no unknown project conditions that could impact the design. Owners' project requirements are generally extensive on all types of projects. They typically include ensuring that the project simultaneously meets budgetary targets, construction schedule targets, specific environmental requirements, specific stakeholder requirements, statutory permit requirements and core project technical (i.e. functional) requirements. The design must address all of these parameters.

On Design-Bid-Build projects, owners usually arrange financing and commence the construction procurement process before they have a completed, fully coordinated design. Design risk therefore already exists on the project at this stage and, in theory, the owner is solely liable for it¹. As the contractor is not liable for this design risk and must competitively price its bid to have the best chance of being awarded the contract, it generally does not consider design risk in its pricing. In reality, however, the contractor often incurs costs during construction through no fault of its own, as these are caused by the owner's design requiring amendments during the construction period.

Similarly, on Design-Build projects, owners usually arrange financing and commence the

construction procurement process *before* they have a completed and coordinated design. This time however, the design risk is formally passed on to the contractor under the contract. The contractor's pricing now *must* consider and price these design risks as the contractor is now responsible for them. In Design-Build, it is extremely difficult for contractors to pass increased costs resulting from the design risk back to the owner, except in cases where the owner's functional requirements or performance specifications were not clearly defined at the outset, or were changed after the contract award. Having said that, the situation is different as the contractor *is* entitled to keep any savings it makes as a result of innovative design.

Whether in Design-Bid-Build or Design-Build, Revay's experience in construction claims is that poor-quality design, poorly coordinated design and design document deficiencies are often the main causes of delays and increased project costs. These need to be either avoided or recovered by the contractor.

2. Design-Bid-Build – Overview

Under a traditional Design-Bid-Build project, an owner engages a designer to prepare the design and then tenders the work to contractors. The budget and schedule for the project are prepared by the owner before the contractor is engaged and usually include contingencies for additional time and money. However, these budgets and contingencies are usually not disclosed to the contractor². The construction contract gives the contractor a fixed time to complete the work for a fixed dollar amount (with some margin for increased quantities on a unit-rate contract). The contractor's costs often increase due to the impacts from late design, poorly coordinated design or technically faulty design. However, the contractor can generally only recover such additional costs if it can prove that they are compensable under the contract.

The contractor's goal with respect to design risk is to (i) avoid assuming design responsibility that it does not carry under the contract and (ii) ensure that no design changes are necessary during construction due to coordination/construction failures on site for which the contractor might later be held responsible. An example of this would be using a construction sequence in a building that is different to that assumed by the designer, which results in a revised design due to a new build-up of structural loadings not previously contemplated. The owner relies on the contractor bringing practical aspects of construction to the implementation of the design, but the risk to the contractor in this process is

usually unclear. Although technical design risk is not taken on by the contractor in its contract, the contractor is often exposed to residual design risk if it is unable to effectively coordinate and resolve the practical design issues on site. As an example, mechanical contractors on building and industrial projects are often assigned responsibility for producing a significant number of coordination drawings. Ensuring that owner direction or approval is always in place prior to any deviation from the owner's plans, specifications, construction sequences, permit requirements or special conditions is always the contractor's best defence against accepting design risk on a project.

Design Risk and the Decision to Bid

In reality, contractors must decide to bid on contracts that are somewhere on a sliding scale of "very desirable" to "too risky to bid on". Because of the high level of competition in the construction market, the "too-risky-to-bid-on" decision is rarely made. Poor-quality design is often the biggest single cause of increased project costs. The reason for this is that many changes occur after a contractor has been selected with poor-quality design. Therefore, in making a Go/No Go bid decision, a contractor should carefully evaluate whether significant design risk will be directly or indirectly "laid at its door", and if so, whether it can manage it. In this context, "manage" means avoiding acceptance of risk due to deficiencies in the owner's design. Critically, however, poor design and uncoordinated drawings are not always evident at the bid stage (which is usually a rushed undertaking) and this makes the contractors' assessment of design risk very difficult. Questions the contractor must examine in assessing if design risk should be a material consideration in its Go/No Go decision (and dollar risk allowance in its bid) include:

- Does the contract contain language that can be interpreted as requiring design coordination between the different trade disciplines to be the responsibility of the contractor? (This coordination responsibility is particularly often passed on to mechanical contractors).
- Is the project design completed or not (i.e. are the drawings and specifications stamped and Issued for Construction)? If the bid drawings are only at 90% complete, then, by definition, significant coordination risk could still exist within the design. (The reality is that drawings labelled as 90%, or even 100% complete, do not necessarily have all of the design issues properly resolved!)
- Does the contract clearly identify contractor submittals and reasonably limit the amount of

time the owner has to accept such submittals (such as shop drawings)? Contractors should be wary of agreeing to unrealistic timescales that they have little chance of achieving.

- Do the project specifications appear to be well thought-out, or are they just "cut and paste" from similar projects, with parts of the specifications clearly not directly applicable to some of the works on the drawings? "Cut-and-paste" specifications usually contain many errors.
- Does the contract unreasonably oblige the contractor to build in compliance with a long list of applicable codes as a substitute to detailed and coordinated plans and specifications?
- Does the contract language (usually in the supplementary conditions) attempt to limit the owner's responsibility for errors or inconsistencies within the plans and specifications?
- Does the contract contain unreasonable requests for the contractor to investigate unresolved project design constraints (to determine that the design intent and/or the planned construction methodology can be implemented) prior to proceeding with some of the works?
- Does the contract give unreasonable time for the contractor to price change orders?

This is not an exhaustive list of design-related questions. However, such questions should be considered by the contractor at the bidding stage, along with the other queries it may have. The answers to these questions will allow the contractor to sensibly conclude whether it can adequately manage the direct or indirect design risk to which it will be exposed. Wherever possible, a contractor should attempt to negotiate with the owner to reduce or eliminate its exposure to unreasonable design risk, and if this cannot be done, it should add contingency dollars to its price or rigorously pursue compensation for disruption during the contract.

Note that all contracts contemplate that owner changes will occur and, often, most of these changes are design related. So by implication, all contractors accept some *implied* responsibility for managing changes caused by design. The question is always whether what they are required to do on site is reasonable or not.

Mitigating Design Risk – Managing the Impact of Design Changes

Effective management of owner-initiated design changes is the contractor's primary defence against having to absorb additional costs due to design revisions. The owner is responsible for both the technical adequacy of the design and coordination between all of the design

disciplines. However, the owner's inter-trade coordination is often very poor. Contractors are builders and they inevitably get "drawn into" helping solve coordination issues on site. The key issue is for the contractor to have a "line in the sand" beyond which excessive effort in resolving coordination issues or accepting revised designs is documented as evidence for compensation entitlement.

Contractors have an implied (and often an expressly defined) duty to inform the owner as soon as possible of any errors, omissions or coordination problems they discover. It is important for the contractor to formally notify the owner of these discoveries in strict accordance with the notice provisions set out in the contract, if any, to maintain a record of all such notifications and to quantify time and cost impacts as soon as possible. If an owner inadequately addresses such notifications with respect to timeliness and substance, then the ability to demonstrate the requests and when they were made and properly answered will help the contractor to subsequently demonstrate entitlement to additional time-extension costs.

As already discussed, in the heat of delivering a construction project a contractor will usually feel compelled by circumstances to assume some level of design coordination responsibility, as stopping work partway through an activity to seek owner direction is often unfeasible. Such scenarios include work during temporary weekend closures of pedestrian and vehicle commuter routes, night work required to maintain building safety systems and maintenance work during planned outages. In such instances, the contractor should ensure that its coordination efforts are documented (via photographs and site diaries, etc.), that the required notices are sent to the owner and that what occurred, and why, is recorded at the next owner meeting (if it is materially significant). This provides a) the owner with the earliest possible opportunity to object, or not, to the contractor's actions before further construction costs on site are incurred, and b) records that can be used for future contractor compensation claims.

Contractors often have to produce extensive coordination drawings for approval by the owner. Insufficient coordination by the designer equates to significant coordination efforts required on site by the contractor. Where such site coordination is onerous, use of a regularly tracked and updated coordination drawing schedule is strongly advised.

The contractor needs to be vigilant with respect to constructive changes by the owner, particularly those which are not formally

acknowledged as such. These can be generated by the owner's revisions to shop drawings or comments on other submittals for approval. If they have a potential to, or if they do, result in extra costs for the contractor, they should be formally challenged (and priced) at the time of their occurrence.

Owner changes, either individually or collectively, can have a significant impact upon a contractor's productivity and, therefore, its costs. When pricing the cost of changes, the contractor should generally not agree to a final value for impact costs unless the full extent of these costs is known. Best practice is to reserve the right to claim impact costs at a later date (in writing) as part of the change order dialogue with the owner. This is because accurate impact cost calculations can usually only be produced *after* the event. If an owner refuses to allow inclusion of impact costs in the cases where they are known at the time of the change, or refuses a contractor's right to claim for them later, a formal letter of objection should be submitted to the owner thereby putting the contractor's disagreement "on record". In the rare circumstances when all of the impact and extended duration costs can be calculated at the time of the change, the contractor should of course then quantify these costs alongside the direct costs at the same time, and include them in its price for the change.

Mitigating Design Risk – Having a Robust Schedule

A contractor's best defence against liability for delay and extra costs caused by design risk is to ensure that its bid's key assumptions about the issue of design information and the interface thereof with its work sequences are clearly reflected on a critical path method (CPM) schedule. It then becomes much easier to prove compensable delay and extra costs due to design issues that have impacted the contractor. Ideally, the schedule should identify all areas where the contractor's performance depends upon receipt of design information from the owner, such as the transmittal of Issued for Construction (IFC) drawings, owner's review of shop drawings, and any construction "hold" points requiring inspection by the owner's designer within a limited time window. The schedule should also identify when the contractor receives access to work areas, especially when staged access handovers are involved.

The Canadian Construction Documents Committee ("CCDC") suite of contracts and many standard municipal contract forms for design-bid-build projects often contain standard clauses requiring a contractor to produce and

regularly update a detailed schedule, regardless of whether a project schedule has already or not been produced by the owner. In rebutting delay claims, owners often state that a contractor's failure to produce and update such schedules is proof that it was never in a position to properly manage its work. Such accusations by an owner, whether true or not, can potentially undermine any genuine claims made by a contractor; this, in itself, is a strong enough reason why the contractor should always produce its own schedule. It should do this *regardless* of whether the contract requires it to produce one or not.

If the owner has provided a schedule as part of the bid package, the contractor should use it as a starting point for producing its own detailed work schedule. Ideally, the contractor should submit its work schedule with its bid. This can then be revised as necessary during the contract period. Even if the schedule produced is not a CPM, it can still serve to clearly identify the owner's deliverables that the contractor needs.

If the owner has produced no schedule at all for the project (which is quite common), this is a warning sign that the project may not have been adequately planned by the owner. Any project with no owner's schedule at bid stage should be treated as a potentially high-risk project. For example, the schedule consequences of dealing with stakeholders and other impacted parties might have been completely ignored and left for the contractor to "sort out", but the contractor might have no idea of the real risk implications at bid stage. In this situation, the contractor should *always* prepare its own schedule from first principles (preferably a CPM schedule) to submit with its bid. As a minimum, this schedule should show when the contractor expects to get a) all of its accesses, b) all of the design and c) all of the approvals to its submittals. If the contractor elects not to submit a schedule, either at bid or soon after award, it may be very difficult to demonstrate entitlement for design-related delay at a later date, basically because the cause and effect relationship between design change and construction change will not be clear. The contractor must have done enough analysis at bid stage to ensure that its part of the overall project schedule is achievable.

Contractors (and particularly trade contractors) do not regularly utilize professional construction schedulers during their bid proposal stage, either because they see no need for it, or because they feel it is an unnecessary additional cost. However, a professionally prepared construction schedule showing where the contractor will be waiting for design, design reviews, design inspection and key non-design items such as ac-

cess to work areas is a good investment and an effective insurance policy. Even if the contractor has no professional construction scheduler on staff, these services can be engaged quickly and inexpensively if they are planned ahead. All sizes of general and trade contracts gain a management benefit from utilizing an accurate baseline schedule from which change can be accurately measured.

Proving Design Change Impact – Keeping Accurate Records

Proving productivity loss and impact costs caused by design changes can be challenging. The better the records a contractor has, the more easily convincing calculations can be produced in order to demonstrate its additional costs. Therefore, for all design-related changes, the contractor should ensure that sufficient resources are in place to record all of the associated impacts. These may include loss of access to other work, productivity loss due to trade stacking, being forced into winter working, additional safety or environmental requirements, additional management requirements, the need for additional coordination activities, negative impact to other ongoing projects, inefficient use of materials and plant, being forced into night and/or weekend working and the hiring of additional equipment and manpower, etc. Such records should of course also be kept for all other relevant project changes that are not necessarily design related.

Keeping accurate records of project events, but particularly those related to impacts caused by design changes, is essential if a contractor ever needs to pursue a design-change claim against the owner, or to rebut such a claim. Referencing accurate project records is critical. The necessary records in relation to the owner's design change impacts include:

- Date of issue of all IFC drawings and their revisions. Were they produced in a coordinated manner before the start of the contractor's activity?
- Date of issue of all IFC specifications and their revisions. Were they produced in a coordinated manner before the start of the contractor's activity?
- Date of approval of all contractor submittals (i.e. shop drawings) for review and their revisions. Were they approved (or were relevant comments made) within the time provided for by the contract or allocated on the schedule?
- Date of responses to contractor Requests for Information (RFIs). Were the owner's

responses received within the time provided for by the contract or in a reasonable time period, and was the number of RFIs issued "industry norm" for the size of the project?

- Accurate minutes of meetings in relation to significant design issues. Whether or not such issues are captured in the regular meeting minutes, the contractor should always strictly comply with the notice provisions stated out in the contract.

It is essential for the contractor to keep a log of all mitigating actions performed "in good faith" to keep its work progressing despite changes or other problems in the owner's design, and the contractor should consider communicating these formally to the owner on an item-by-item basis. This is essential as the contractor has a duty to mitigate its damages under the law and it is very important in a claim situation that it can prove that it has actually done so.

The extent of all of this accurate record keeping may be perceived as onerous. However, without it the contractor is at a major disadvantage in making a claim against the owner, or in rebutting a claim against itself from the owner. Strategies for making this record keeping as painless as possible (subject to the project being able to afford them) include:

- Using email in lieu of formal letters for speed and convenience (but with the *discipline* of clearly referencing all emails against the correct parts of the contract and addressing contractual issues to the party named in the contract). This, however, does not dispense the contractor from strict compliance with the notice provisions stipulated in the contract.
- Having a formalized document management process with a dedicated document controller.
- Taking date-marked daily or weekly photographs of the contractor's work sites. This is inexpensive to do and very useful to help justify claims at the end of a project.
- Verifying the accuracy of the minutes of meetings (a contractor must never rely on owner-produced minutes until it has verified them itself).
- Keeping monthly project reports.
- Enforcing the discipline of producing accurate and detailed daily site diaries (and ensuring periodical review of these by the project management team).
- Keeping accurate logs of the issue and owner responses to RFIs, change order requests and notifications of mitigation actions performed by the contractor.
- Promoting independent monitoring of progress (such as the Independent Certifier concept used on P3s) such that the owner and

contractor always have a trusted independent third-party record of what key change events occurred and when, etc.

3. Design-Build Projects – Overview

This section of the report applies to both traditional Design-Build projects and to Design-Build teams contracted by P3 project sponsors via bespoke P3 contract agreements. It also partly applies to major trade contractors who may have design responsibility within their scope on larger projects.

Under Design-Build contracts, the contractor generally "inherits" a preliminary design produced by the owner, which, in reality, may vary from conceptual to an almost completed detailed design. The contractor is then responsible for adopting and completing the design in accordance with the performance specifications. All existing errors, incorrect assumptions and mistakes in the inherited design become the responsibility of the contractor. The owner's performance criteria may be at many different levels, ranging from extremely prescriptive to expressing only the very basic functional requirements. The contractor completes the outline design by hiring its own designer³, which is the situation for most Design-Build contracts in Canada. However, for the industrial sector, the designer may also be a joint venture partner with the lead contractor.

During the bid⁴ period, the contractor and its designer must develop the design to a stage where they can generate a construction schedule and quantities suitable for pricing. However, the contractor has limited time and money during the bid period, and so by necessity its bid design will contain significant risk as it will *never* be complete at the time of submission. By implication, risk money must be added to the bid for design and can often form a substantial amount of the overall project risk contingency. Contractors often *underestimate* the amount of risk transfer that has actually occurred from the owner to themselves under a Design-Build contract. All the extra costs caused by design issues that could normally have been claimed from the owner on a Design-Bid-Build project are now almost wholly the responsibility of the contractor. This is a huge pricing challenge.

In addition to pricing construction from quantities based on an incomplete design, the contractor must allow sufficient contingency for all the other design issues which could cause an increase to schedule and cost (such as scope-

creep and adverse impacts upon other project areas like stakeholders and the environment). Successfully managing design risk in the execution of Design-Build projects requires a level of management from the contractor that is *significantly greater* than that needed for a Design-Bid-Build project. This can only be achieved by employing the right designer and experienced contracting staff to manage and direct the designer and manage the design/construction interface. On Design-Bid-Build projects, the contractor's design risk occurs almost entirely during the construction period as it has no technical design risk to price in its bid. This is completely different from Design-Build projects, where the contractor's design risk occurs in *both* the bid and the construction periods. In fact, more design risk is actually carried during the bid stage, when a fixed price is given against an incomplete design. In the construction period, the contractor must try to "force" the design not to exceed the key quantities that its bid is based upon. This can be very challenging and wherever possible the contractor should consider using pain-gain mechanisms to incentivize its designer accordingly.

3.1 Design-Build Projects – Pre-Award or Bid Stage

The key to winning Design-Build bids at a profitable margin is teamwork. The combined expertise of both the designer and the contractor is required to find the most cost-effective design and execution strategy that meet the owner's requirements. To properly optimize the design, ideally the *entire* bid team should be involved in developing a bid strategy from the start of the bid period, before any bid drawings, quantities or specifications are produced for pricing.

Time Constraints – The Benefit of Clearly Understood Procedures

Time constraints place considerable pressure on both the designer and the contractor's estimator during the bid period⁵. For this reason, a bid program that allocates appropriate time for both design and pricing activities should be developed. It must be noted, however, that not all quantities will be based upon tender design; many will have to be based upon benchmarking previous projects and the use of industry ratios, etc. Bid design should be managed tightly via agreement of a production schedule with the designer, as late bid design reduces the contractor's (and its trades') time for pricing. In particular, it is unfeasible to obtain commercial

subcontract quotations from trades without allowing adequate time for their production. The contractor should ideally produce bid procedures that clearly and unambiguously identify what bid design deliverables are required, when they are required and the procedures by which they are generated. For large projects, the contractor should consider having its own staff, such as experienced superintendents or a design manager, based in the designer's main production office.

Bid Production Schedule – Designer's Deliverables

The contractor should agree to a detailed bid production schedule with its designer. Ideally, it should allocate time for design review by the contractor, securing subcontract quotations, estimating quantities or ratios for pricing and producing bid submission documents. It is essential that the designer formally *accepts and agrees* to a bid production schedule – there is no room for misunderstanding the contractor's requirements in a time-limited bid period. To this end, it is recommended that the designer and contractor agree to a schedule of deliverables (i.e. the documents the designer must produce for pricing) from the designer at the earliest possible opportunity. The headings for these deliverables are typically: (i) drawings, (ii) quantities, (iii) specifications and (iv) any other specific owner's requirements. For some types of projects, however, the pricing may have to be based more on previous similar contracts than on priced tender design.

Conforming and Alternative Submissions

Owners will usually indicate the extent to which they are open (or not) to receiving submissions that vary from their base concept. Generally, contractors should only consider an alternative if they believe it will give them a significant competitive advantage and that the owner will consider it fairly and seriously.

When preparing a bid, the designer should highlight for resolution any potential ambiguities or queries in the owner's requirements. These queries should be addressed either via questions and answers with the owner, or by the designer and contractor making decisions together as required. These queries should focus particularly on ensuring that the contractor has a clear understanding of the performance requirements in the bid package. As the bid design, schedule and price are generally based upon performance requirements, *it is essential that the contractor knows that it is correctly*

*interpreting the owner's requirements*⁶. Some owners address this concern by mandating that contractors provide a separate technical submission which must be acceptable to the owner before permission to submit a financial submission is granted. By definition, under this arrangement contractors know that they conform with the owner's understanding of the performance requirements before the entire bid is submitted. This system is beneficial to both parties as it eliminates the time and the cost of preparing non-conforming technical bids.

Establishing Design Constraints

One of the most important initial tasks in preparing a bid is to establish the constraints on the design: physical, engineering, stakeholders, environmental, planning, and, very importantly, the *minimum* requirements which will satisfy the owner. The contractor's bid documents are usually prepared by its designer and are thus the designer's interpretation of the owner's requirements. It is critically important that the designer and contractor have an in-depth and thorough understanding of these core owner requirements. If the requirements are scattered throughout the bid documentation, it is usually worth summarizing them in a single document for the bid team. The owner's design will need to satisfy many requirements including statutory legislation, promises to stakeholders, permits and environmental obligations, etc. The contractor should be satisfied that the designer is incorporating everything materially significant into the bid design, or, if not, the contractor needs to include an allowance.

Design Rationale Statements

Once the design concept for each major element is finalized, the designer should be *required* to produce short, high-level Design Rationale Statements that briefly summarize the driving assumptions behind each chosen design solution. These documents should primarily address the questions (i) why use this solution and these design criteria? and (ii) which cost-driving design parameters are optional? Where applicable, key safety and environmental considerations should also be stated. The Design Rationale Statements allow the party commercially responsible for the design, i.e. the contractor, to grasp what is driving the main construction costs and give the designer "course corrections" as necessary. This minimizes abortive design work on the project. The Design Rationale Statements can be used to catch both unbuildable designs and mistakes in the interpretation of performance requirements.

Design Freeze

It is good practice to have a design freeze meeting identified in the bid schedule in order to record an agreement between the designer and contractor on *how* far the design of all of the main project elements will be developed for pricing and, where there is a choice, which are the preferred design solutions. Ideally, this process involves review and acceptance of the Design Rationale Statements. In practice, it is not always possible to freeze the concepts for all key designs by the target date. In such cases, the contractor should set revised dates for those items that could not be frozen on their initial planned dates. Either way, every major element of design should be subject to a *formal design freeze*. The agreed design principles should *never* be changed by the designer after the design freeze.

Quantities for Estimating

The quantities produced from the designer's documents are the fundamental driver of the bid, as they have the largest influence in determining the construction schedule, cost and risk. It is therefore very important that the designer's documents are subject to quality checking *before* the contractor receives them for pricing, particularly for completeness of coverage and correctness of the quantities. This quality checking of design deliverables in a time-limited bid situation will not usually happen unless the contractor forces the designer to undertake it. Uncertainties in quantities should be quantified as far as possible, for example by a range of quantities and their associated probabilities, for review under a separate risk assessment. The contractor should *require* the designer's bid deliverables to be reviewed by a senior principal from the design company using the 80:20 rule, *i.e.* that 80% of the value lies within 20% of the items.

Specifications

Specifications may be required for two different reasons: the first is to enable the contractor to seek prices for materials and from subcontractors; and the second is to be part of the owner's required documentation for the bid. Generally, specifications should always be as flexible as possible but used with "locked-in" definitions of the actual work involved. Performance specifications will offer the most flexibility to the contractor and should be used *wherever possible*. Conversely, prescriptive specifications should be avoided wherever possible. This is because prescriptive specifications restrict the contractor's available

choices during construction, which is often the only time at which the optimum choice can be made for many products and materials.

Most owner specifications are written on the assumption that the quality level required to meet the minimum performance criteria will not be met without a high degree of over-specification. To bid competitively under Design-Build, the contractor should assume it can ensure that the required quality standards can be met. Hence, the contractor should make sure that its designer is using the *minimum compliant standards* to meet the requirements. Not following this approach will make the contractor's bid higher and hence less competitive.

Bid Submission Documentation

The owner's requirements specify the documentation to be submitted with the bid. In compiling the documents, two key principles should be observed to the greatest extent possible: first, submit the minimum information to avoid disqualification of the bid and second, be very careful not to "over-fix" the bid design technically (*i.e.*, dimensions, form, finishes, specifications, work methodologies, etc.).

The first principle is important because the owner inevitably asks for far more information, and to a far higher presentation standard, than is reasonable in the context of a Design-Build bid. Full compliance often renders such bids uneconomic for the contractor to produce on large projects. In most cases, contractors should be confident in focusing on the owner's "needs" rather than on its "wants" (as long as the "wants" are not contractual obligations!). The lowest bid is unlikely to be disqualified because of "average" rather than "excellent" documentation quality. This principle should be spelled out clearly to the design team so that the designer accurately understands what should be produced and to what level, allowing it to properly price the work for the contractor.

The second principle is relevant in that many public owners have difficulty accepting one of the fundamental principles of Design-Build: that the contractor should be free to amend the design during the design-development stage, *after* contract award. If the contractor defines too much, too rigidly in its bid, the owner may insist on that specific design's incorporation or seek a credit if the design is later amended. These issues can reduce the contractor's ability to deliver the project within budget by eliminating design optimization options.

None of the above lowers the quality of the finished product, but rather allows maximum flexibility in the way that the contractor achieves

it. *This is the only way both the owner and the contractor can derive the maximum benefit from Design-Build.*

Design Risk Analysis

It is good practice for the designer to produce the leanest credible design given the information available. An assessment of possible risks, quantitative wherever possible, with their associated probabilities should then be undertaken by the designer. This risk analysis should not be left until the last minute, as proper assessment of design risk is critical to the success of a Design-Build bid. Ideally, a live listing of risk items should be maintained jointly by the designer and contractor. All members of the bid team should contribute to this list on an ongoing basis. Risks should be reviewed regularly at design review meetings during the bid. In some cases, design risks can be minimized or removed by adopting a different design approach, but wherever this is done, input from the entire bid team should be sought prior to making the design change. Design risks can cover a huge number of issues including material and product procurement, environmental impact, constructability, safety, stakeholders and the owner's own political constraints (such as limits on local road closures, for example).

3.2 Design-Build Projects – Construction Period

On all but the smallest of Design-Build projects, the contractor should actively manage the designer throughout the project for the obvious reason that under the head contract, the contractor is commercially responsible for the design and its impacts upon the project, *not* the designer!

Using a Dedicated Design Manager

On any significantly sized project, the contractor will achieve substantial design-related risk reduction by employing a dedicated contractor's design manager for both the bid and execution phases. This person (or persons) should focus on managing all the technical and commercial aspects of the Design Agreement, *i.e.*, the contract executed between the designer and the contractor to provide the detailed design. Ideally, the design manager will be a seasoned professional experienced in the challenges faced by both designer and contractor in the delivery of Design-Build projects, usually warranting a full-time role on large projects. The design manager should be responsible for ensuring that constructability and value-

engineering input from superintendents and trades is integrated with the technical design as appropriate.

Producing a Design Schedule

The contractor should ensure that it has established with the designer a design schedule that is fully integrated with: subcontract enquiries and bid packages; any required additional investigations; procurement; temporary works requirements; and the construction schedule. The designer's provision of an adequate design schedule (to a defined standard) should be an *explicit* condition within the Design Agreement.

The contractor should verify that the designer has developed the design schedule to enough detail for each package to permit adequate planning and resourcing of the work. In the absence of a well-thought-out design schedule, work is most likely not being adequately planned and the contractor then has little basis for believing that the design dates will be met.

It is critical for the contractor to allow sufficient time for mobilization of the design team at the start of a project. *Design teams need mobilization time in exactly the same way that construction teams do, for planning, organization and establishing communication protocols.*

The contractor should also recognize that determining the project's document flow procedure for design is a prerequisite for producing a design schedule, as reviews and approvals should be "built in".

The contractor should ensure that the designer has established what, if any, information is required from other parties in order to complete the design for each package. Examples are performance criteria for key materials and products, etc. and inputs from trade contractors on constructability. These requirements should be clearly communicated and these inputs to design should be actively managed by the designer and contractor working together. Particularly, if the contractor has long-lead items, it should ensure that these are identified early to the designer so that they can be scheduled appropriately in the design schedule.

It is critical for the contractor to ensure that its designer has produced a schedule of deliverables list. Without such a list supplementing the design schedule, there is no guarantee that the design activities encompass all scopes of work. Such a list helps align each of the parties' understanding of the scope represented by each activity. Without it, there will usually be missing design documents and missed deadlines, since there is otherwise no *precise* definition of what has to be produced at the individual drawing/document

level, as design schedules rarely drop down to the level of individual drawings, etc.

Managing the Design Product

The designer and the contractor should fully understand the owner's requirements, the bid design and all of the constraints on the design.

Before any post-award design work commences, the contractor and the designer should immediately reconcile the scope of the designer's work as described in the owner's requirements and the Design Agreement.

The Design Rationale Statements used during the bid design should be "refreshed" and expanded as necessary for the detailed design production. It is tempting for both the designer and the contractor to avoid this step. However, it is one of the most effective things a contractor can do to reduce its design risk exposure.

As previously mentioned, design freezes should be rigorously used and both the designer and the contractor should adhere to them. The designer's obligation is to produce draft designs for construction review at the scheduled time. The contractor's obligation is to control and expedite the comments on the design made by the construction team. Comments from the construction team add value to a project *only* if they are delivered early enough for the designer to address them within the time scheduled for the design.

Stakeholder Coordination

The contractor should be fully involved in the decisions made regarding design interfaces between the designer and design-supply-install subcontractors. Neither the designer nor the subcontractors should have the authority to dictate *the* best decision at such interfaces. For example, it is common for mechanical plant contractors to specify excessively tight settlement criteria for some items of plant. The cost consequences of applying such stringent design criteria should be weighed against the alternative of buying a more expensive plant with less onerous settlement requirements, etc.

The designer should coordinate with, and integrate into the design, the requirements of third parties as stipulated under the main contract. Ideally, this interfacing should be controlled by the contractor as it carries the financial burden of any decisions made. As previously stated, subcontractor submittals should be reviewed to ensure that contractual obligations are met without superfluous and costly additions. Additionally, designers are often poor at ensuring that their designs seamlessly accommodate the major subcontractors' work methods. The contractor must make time for ensuring that its

subcontractors' "needs" are accommodated by the designer, as far as practicable.

Managing Design Changes

A clear, formal system of design change control should be established by the contractor at the start of the project, covering the many potential sources of design changes (owner, designer, contractor, subcontractor, other third parties, etc.). This system should clearly identify the source of the change and the party responsible for its implementation. All potential design changes should be reviewed by the contractor in conjunction with other members of the site team as appropriate for potential impacts on schedule, cost, subcontractor schedules and risk. Note that construction team preferences are often a cause of disruptive design changes. Such changes should be allowed only *if* it can be demonstrated that (i) the saving from the change is worth the disruption to the design, (ii) other designs will not fall behind due to the loss of design resources required by the change, and (iii) the design change introduces no new significant risks to the project⁷. Contractors' site staff naturally have many good ideas to improve the design during the construction period. However, such changes must be "filtered" by senior contractor staff who can properly "rationalize" the disruption, cost savings, risk and schedule impact involved in change decisions.

Temporary Works Interfaces

The contractor should be mindful of the interface between permanent works and temporary works. Careful integration of the design of temporary and permanent works is critical to ensure the constructability and optimization of the design. In many instances, the temporary works solutions chosen may have non-technical constraints due to safety, stakeholders or environmental considerations. In some projects, such as large bridge projects, for example, the temporary works actually drive the permanent works' design.

Design Communication

A review of previous projects confirms that major design problems on Design-Build projects are frequently due to a lack of communication, rather than to the technical design ability of the designer.

For a successful Design-Build design, the designer should be fully integrated into the contractor's team. Ideally, this means that a senior representative (such as a contractor's design manager or superintendent) is colocated in the designer's office for much of the design period.

The designer should not be treated like a subcontractor to be unduly pressured into producing what the contractor wants. Every member of the design team must be an enthusiastic and committed project team member, extending themselves to produce the most economic design. The contractor's "soft skills" are very important here, as the designer needs to be motivated to make good design decisions that are economically advantageous to the contractor.

The designer should *never* be threatened with claims against its insurance during the design production phase. This has been shown to be hugely counterproductive. The contractor should also not assume that all members of the designer's team understand the challenging design process on Design-Build projects, or that the design team intuitively knows what the contractor requires. The contractor's mantra needs to be "tell the designer what you want and then tell him again and again".

Document Control

On a Design-Build project, the contractor will have to manage somewhere in the order of five to ten times the amount of documentation it manages on an equivalent Design-Bid-Build project. Managing design generates huge additional communication and recording requirements. The importance of appointing an experienced professional on the contractor's team to set up and manage document control and information flow should never be underestimated. Best practice includes the use of cloud-based database systems that can be customized for any given project. Robust systems for exchanging and storing information are imperative and should be well thought-out in advance to ensure that consistent coding,

numbering and filing occurs from project inception to conclusion.

4. Conclusion

Design issues can result in significant cost increases for a contractor, whether the project delivery method is Design-Bid-Build or Design-Build.

Design-Bid-Build

In order to mitigate the risk of increased costs and schedule delays associated with design, the contractor should first determine if a project is too risky to bid on. If a contractor moves forward with a bid and is awarded the contract, knowing the contract requirements is paramount. Key aspects other than scope of work are the contract requirements regarding notification, schedules and entitlement to compensation for changes, including delays. The contractor must be rigorous and timely with respect to changes and notification. In order to improve the chances of remuneration, detailed documentation is key. And finally, frequent communication amongst the parties can help ensure that everyone's interpretations, concerns and changes regarding the design (and the project in general) are addressed promptly. While this will not eliminate all design-related issues, it will go a long way towards mitigating the impacts caused by design changes and inadequacies.

Design-Build

In order to mitigate the risk of increased costs and schedule delays associated with design, the contractor should *actively* manage the designer throughout the project. This can only be achieved by employing experienced staff dedicated to managing the designer and

by having suitable procedures in place for managing the design/procurement/construction interface. These include producing well-thought-out design schedules, clarifying the owner's requirements and the scope of the designer's work, managing design changes and, last but not least, effective communication between the design team, construction team and all third-party suppliers and subcontractors.

** Any views expressed in this article are those of the author and may not necessarily reflect the views of the company.*

- 1 In the context of its contract with the contractor.
- 2 Note that this is not the case for Early Contractor Involvement or Progressive Design Build projects where a contractor is brought on board at the development phase.
- 3 Note that some larger contractors have their own in-house design team which can be used.
- 4 The term "bid" is used herein but represents bids and/or proposals.
- 5 For large P3 projects however, the bid period can be lengthy, often up to 6 months.
- 6 An interpretation of the owner's performance requirements that is different from the owner's engineer's view is a common cause of disputes on Design-Build and P3 projects in Canada.
- 7 The author's experience is that it can be useful for the project to require any design change to have a minimum total project saving, such as more than five times the cost of implementing the existing design.

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