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Management of Project Risks and Uncertainties

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**Prepared by
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Cost/Schedule Controls Task Force**

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INTRODUCTION

“The only sure things in life are death and taxes.” While not questioning those two, it would seem that another factor is equally sure—uncertainty. Whether speaking of human or business life, each is subject to uncertainties, many of which involve risks which continually challenge it. Risks threaten both physical and economic well-being. Daily newspaper and television reports are filled with accounts of accidents and disasters, criminal and terrorist activity, political upheavals and economic collapses. The occurrence of a tragedy means that an everyday risk has been converted from threat to event in some location with injury, death, property loss and economic hardship befalling the victims. We also know that next week those or other tragedies could hit any of us so we buy insurance, establish savings programs, dig a tornado shelter or otherwise protect ourselves should such tragedy strike. And, for a life to survive and prosper, it must continually face and manage these uncertainties.

Uncertainties that have only a loss potential tend to command most of our attention. Yet some uncertainties have the potential for gain. For example, we know that investing in the stock market has the potential for gains as well as loss. Management of uncertainty must consider the potential in both directions.

This report is an introduction to risk management and dealing with uncertainty, particularly as it applies to construction contractors. Specifically it will:

- Provide a basic introduction to risk management.
- Introduce typical methods of identifying risks.
- Identify common risk measurement methods.
- Provide guidance for risk control.
- Provide guidance for contingency account management.

This report is based in part upon “Risk Management in Capital Projects,” a CII source document. That report deals with management of risk as applied to owners, construction managers and constructors involved in the total engineering, procurement and construction of a capital construction project. This report focuses more on management of risk for a construction contractor; however, most of the recommendations presented here are equally applicable to owners, designers and subcontractors.

The term “risk management” often is applied to the duties of the staff section within a company that handles insurance matters for the company. As will be emphasized in subsequent chapters of this document, however, risk management includes considerably more than insurance. Thus, as used in this document, the term “risk management” encompasses the full spectrum of activities associated with identification, measurement and control of risk.

RISK BASICS

Risk Definitions and Classifications

Various authorities define risk in different ways. Webster speaks of it in terms of a potential for loss or injury—in other words, if there is a risk, the best one can hope for is no loss or injury. Risk obviously involves uncertainty. If the outcome were totally predictable, there would be no risk. Risk usually involves variability in both frequency and severity—the outcome can occur within a range.

Most experts define risk in terms of its parent—uncertainty. Uncertainty is simply the set of all potential outcomes, both favorable (if any) and unfavorable (if any). Those outcomes which are unfavorable represent risk, whereas those which are favorable represent opportunity. Thus, uncertainty can give birth to either, or both, risk and opportunity.

Risk is also defined as the probability that an unfavorable outcome will occur. Similarly, opportunity is defined as the probability that a favorable outcome will occur.

A popular way to catalog uncertainties (and thus risks and opportunities) is in terms of *known*, *known unknown*, and *unknown unknown* situations or conditions. Using examples in our personal lives, an individual playing the stock market (which has both risk and opportunity) or operating a power saw (which has only risk) is aware of a range of potential outcomes inherent in both activities—these situations are *knowns*. A *known unknown* is an acknowledged situation that could affect the activity, but its potential for occurrence is not immediate nor would one normally expect it in the course of the activity. A disease such as cancer is an example—you know it exists in our society and could strike you, but you do not see a direct threat to your life until it is diagnosed. You see the potential for loss of your job, a serious auto accident or a lawsuit by someone injured on your property as other known unknowns. The *unknown unknowns* are the situations we have not even heard about or can not imagine; yet, we realize that some unforeseen risk can materialize to threaten us. AIDS was an *unknown unknown* risk until recently.

Uncertainties, and therefore risks and opportunities, can also be cataloged by source. *Technical uncertainties* relate to the technological aspects of the project. An owner building a facility that incorporates a new process must balance the potential risks against the potential opportunities. The same applies to a contractor attempting an innovative construction procedure. *Contractual risks* are found in any contractual agreement. The contract language is not always clear, some key issues may not be covered in the contract and the all-too-common adversarial situation between owner and contractor can lead to many problems. *Financial risk* is the third source. This risk is primarily with

the owner on a cost-reimbursable project and primarily with the contractor on a fixed-price project.

Uncertainty and the Project Cost Estimate

In estimating the total cost of a project, a phenomenal number of potential outcomes exists, ranging from the best potential underrun to the worst potential overrun. All potential outcomes which are unfavorable (i.e., cost overruns) represent risk, whereas those which are favorable (i.e., cost underruns) represent opportunity. In this same context, if there is a 60 percent chance that a cost overrun will occur, then the probability of 60 percent is referred to as the risk. Conversely, the probability of 40 percent that a cost underrun will occur is referred to as the opportunity.

If, as is often the case, all the potential outcomes are numerical, they can be depicted as a range. For example, consider a project in which the target estimate for excavation is \$100,000. This target estimate is one of a large number of potential excavation cost outcomes. One of those potential outcomes relates to everything going right—the best weather along with the best soil conditions and the best labor productivity (a highly unlikely scenario to be sure, but one which must be considered). The cost associated with this potential outcome might be \$80,000. Another potential outcome relates to everything going wrong—the worst weather along with the worst soil conditions and the worst labor productivity. The cost associated with that potential outcome might be \$130,000. Thus, the set of all potential outcomes is captured in a range with a lowest estimate of \$80,000 and highest estimate of \$130,000. Considering only whole dollar figures, the uncertainty related to excavation cost is a set of 50,001 potential outcomes (30,000 unfavorable and 20,001 favorable).

The target estimate separates the range into two segments. The segment above the target contains those potential outcomes which are unfavorable (i.e., cost overruns of increasing magnitude from the target to the highest estimate). This segment of the range is the risk. The segment below the target estimate contains those potential outcomes which are favorable (i.e., cost underruns of increasing magnitude from the target to the lowest estimate). This segment of the range is opportunity.

Degree of Risk

What are the characteristics of any risk element that determine its importance to the decision maker? These are some:

- The potential frequency of loss

- The amount of information available to define its potential

- The potential severity of loss

- The manageability of the risk

The vividness of the consequences

The potential publicity should the loss occur

The ability to measure the consequences of loss

One more element might be added to the above list—whose money is it? individuals probably tend to be more reckless in managing assets belonging to other parties than they would their own.

It appears that severity of potential loss is the one factor that attracts the attention of decisionmakers more than any other. Individuals are willing to accept small (even frequent) losses, but are averse to a risk which has high stakes. That is why catastrophic loss insurance and deductible insurance policies are so popular.

Risk Management

A total risk management program has three stages. In this chapter they are introduced as they apply to an individual. In subsequent chapters they will be applied to a construction project.

Risk *identification* is the first stage. This is simply the cataloging of risks that may befall the individual in question. This is compiled based on general knowledge and experience combined with a “what can happen” analysis of the future.

The second stage is *measurement* or evaluation of identified risks in terms of potential cost should the risk become an event. When dealing with personal assets, such as a home or car, it is easy to establish a potential loss figure based on replacement value. An infinite number of loss scenarios exists, however, for a vehicle and its occupants and the probability of each is a function of many factors.

Risk control, the third stage, is achieved in various ways, one of the better known actions being the purchase of *insurance*. Risk avoidance is another technique; for example, you can avoid the liability risks of car ownership by not owning one. If you own a car, you can reduce risks by less frequent use of the car or *share* risks by carpooling. You can *transfer* those risks by traveling on public transportation only. Again, if you own a car, you can insure yourself totally or you can *accept risk* by not insuring at all or accept part of the risk by buying only partial coverage or deductible insurance. You can save for that “rainy day” by establishing a savings program (*contingency funds*). Finally, you can *contain risk* by careful driving, wearing seat belts and having regular safety inspections. In summary, risk control includes risk avoidance, risk reduction, risk sharing, risk transfer, insurance, risk acceptance by establishment of contingency accounts, risk acceptance without any contingency and risk containment.

RISK IDENTIFICATION FOR CONSTRUCTION

Overview

Certainly all in the construction profession will agree that risks are found in every project. Safety risks are inherent in construction activity; business risks are associated with any venture involving contracts, multiple agencies, time and money; performance risks are associated with producing goods and services with a constantly changing human work force operating under variable weather conditions and the uncertainties of materials and equipment deliveries; and liability risks threaten every business in our litigious society. We also are painfully aware of examples where failure to manage those risks has resulted in significant losses to the contractor.

If we are to manage the risks inherent in a project, we must first identify those risks. We will find that construction projects, like individuals, are subject to risks which can result from *known*, *known unknown*, and *unknown unknown* conditions.

Identification Responsibility

Too often the risk identification function is performed by one or more project personnel. Risk identification is the responsibility of the entire project team. Competent risk identification relies on historical information, formalized checklists of risks and the collective experience of the project personnel. The project team should have several opportunities to brainstorm the entire project and discuss the risk items identified by the individual participants. This will help insure that all risks have been identified, defined and interrelated.

Risks from Known Conditions or Situations

The most common risks in the project to identify are those which come from known conditions (knowns). These risks are typically those which must be explicitly or implicitly accounted for in the estimate. In general they involve a continuous range of outcome, have a relatively high frequency and are individually of relatively low severity (at least not catastrophic).

The contract documents themselves are one of the first places to look for these. They define the products and services to be provided, the time requirements and the payment provisions, and establish a variety of administrative requirements that the contractor must accept if the contract is awarded. These contract terms must be reviewed by a battery of specialists. The legal or contracting personnel will check to insure that the contract terms are generally fair and equitable, that vital protective clauses are present, that no burdensome clauses exist and that no risks have been assigned that properly belong to

others. Project management personnel must check all time requirements and determine that they are achievable. Of course, they must also identify unusual risks associated with the type of work involved. Project controls, materials management, quality management and other specialists must check all requirements in their respective areas—are they clear or are they vague, or are they subject to interpretation and a potential source of disagreement between owner and contractor? Estimators must identify quantities of work. Their work is always subject to error. If the plans are incomplete or of poor quality, there can be considerable error. On a fixed-price project, an unfavorable quantity variance will be a loss. Subsurface conditions must always be considered. Are subsurface data complete and reliable? Who has responsibility for unforeseen subsurface conditions? The results of these reviews provide a catalog of requirements and risk conditions which must be evaluated.

The area survey conducted as part of preconstruction planning will identify other risks coming from knowns. Perhaps the site is congested, transportation access may be limited, the nearby communities may be too small to absorb and support the anticipated project population or competing projects in the area may limit labor availability. Detailed checklists should be used during these surveys to minimize the potential for overlooking some risk item.

Labor productivity is always a *known* derived risk on a project. Using a combination of historical experience and information generated during the area survey, productivity judgments must be made for all work. The probability of these judgments being correct is essentially zero; at best, estimators can reasonably predict that productivities will occur within a range.

Finally the project team as a group should brainstorm the entire project and list risk items identified by the individual participants in their review of the project. This will help insure that all risks have been identified, defined and interrelated.

Risks from Known-Unknown Situations or Conditions

Known-unknown conditions (*known-unknowns*) which include risk exposure are neither explicit nor normally expected, but are foreseeable and possible. In general, they tend to be discrete events, yet have a low frequency of occurrence and a high severity of impact when they do occur. They are best identified through review of historical reports on comparable past projects. Extreme bad weather (e.g., tornado, hurricane, floods), unusual difficulty with a client, extreme adverse labor activity, sudden labor shortages due to new and competing work activity in the project area, commodity shortages due to embargos and regulatory interventions are representative known-unknowns that have affected other projects. A checklist of potential known-unknowns will assist greatly in developing the list for the project at hand.

Risks from Unknown-Unknown Situations or Conditions

Unknown-unknown situations cannot be identified in advance; their potential can only be acknowledged. Again, historical records may provide some guidance on the extent that *unknown-unknowns* have had on past projects. Essentially, these must be grouped together as a single risk line item that has potential catastrophic effects, but a low probability of occurrence. If the project team has done a thorough job of identifying the *knowns* and the *known-unknowns*, there will be few *unknown-unknowns* left to plague the project.

The Risk Checklist

In the identification of risks, a checklist will always prove helpful. Obviously, the checklist for an owner will differ from that of a contractor or engineer. For the sake of providing an example, the listing below is for a contractor.

- Reputation—potential for unfavorable exposure

- Project Execution Strategy Employed

 - General contract

 - Construction Management—multiple prime

 - Owner—multiple prime

- Project Size

 - Physical area

 - Population—total and individual craft

- Type Contract

 - Lump-sum

 - Unit-price

 - Guaranteed maximum

 - Reimbursable

- Unfavorable Contract Clauses

 - Differing site conditions

 - Hold-harmless

 - No damage for delay

 - No relief for *force majeure* losses

 - Not responsible for quantity variations

- Area Factors

 - Geography/geology/altitude

 - Area economic conditions

 - Government stability & sophistication

 - Police, fire and medical support

 - Local population attitude and stability

 - Transportation network

 - Communications

 - Other support infrastructure (housing, etc.)

Site Factors

- Topography/drainage/trafficability
- Access/egress
- Congestion
- Adjacent operations
- Hazards—safety and health
- Location and adequacy of construction support facilities/areas
- Availability of utilities
- Security

Weather

- Normal weather patterns
- Potential for extremes

Monetary

- Bidding costs vs. potential for award
- Escalation
- Exchange rates
- Area cost indices
- Payment floats
- Retention
- Unbudgeted premium time
- Overhead costs
- Contractual penalties (liquidated damages, etc.)
- Regulatory penalties (OSHA, EPA, etc.)
- Bonuses & shared savings

Ability to Perform

- Familiarity with type work
- Availability and qualifications of key personnel
- Knowledge of area
- Completeness of design
- Quality of design
- Timeliness of design
- Complexity, constructability of design
- Requirements for new technology
- Competing activity on site
- Availability of access to work when required
- Need for work or fire permits

Time Factors

- Deadlines and milestones
- Available normal work days
- Potential for stoppages by other parties or situations

Regulatory Factors

- Permits—potential for delays or rejection
- Environmental—potential for spills, emission, other violations

Labor Factors

- Availability
- Skill levels
- Work ethic/area productivity standards
- Wage scales
- Potential for adverse activity
- Substance abuse in labor population

Client Factors

- Financial stability
- Construction management sophistication
- Interferences
- Quality expectations
- Interpretation of contract
- Ability/willingness to meet obligations
- Change management policies

Contractor-Furnished Materials Factors

- Quantity variations
- Quality
- Price
- Availability
- Delivery uncertainties
- Contract-imposed procurement limitations
- Potential for waste in use
- Potential for loss (theft, vandalism, damage)

Construction Equipment Factors

- Availability
- Cost
- Loss or damage

Subcontractor/Vendor Factors

- Technical qualifications
- Financial stability
- Timeliness/reliability
- Bondability
- Minority, women, disadvantaged business and small business enterprise requirements

Care and Custody Exposure

- Constructed facilities
- Storage of materials/equipment furnished by others

Special Exposures

- Insurance deductibles
- Client claims
- Third party litigation
- Warranties & guaranties
- Permitting requirements