



REQUIRED SKILLS AND KNOWLEDGE OF DECISION AND RISK MANAGEMENT

TCM Framework: 7.6 – Risk Management

November 27, 2012

INTRODUCTION

This recommended practice (RP) is intended to serve as a guideline, not a standard. As a recommended practice of AACE International, the intent of the guideline is to define the required skills and knowledge to perform decision and risk management. It serves as the foundation of the skills and knowledge of an AACE certified Decision and Risk Management Professional (DRMP).

Decision and risk management requires knowledge ranging from analytical (e.g., statistics and modeling) to socio/psychological (e.g., risk elicitation and communication) to management (e.g. risk response planning and management). DRM is practiced within the context of all the processes and practices of TCM (they all have elements of uncertainty and the need to make some decisions) and interacts with all the associated disciplines working in a TCM process.

Purpose

The RP highlights the necessary skills and knowledge of a decision and risk management practitioner from a high level viewpoint. It identifies competencies for a risk management practitioner as it relates to their broad business and technical perspectives and senior-level experience in life cycle asset and project management. Detailed skills, knowledge and methodology, are excluded from this recommended practice. These skills and knowledge are applicable to the decision and risk management profession across any industry, portfolio, program, or project in which TCM applies.

This RP is aligned with RP 11R-88, *Required Skills and Knowledge of Cost Engineering* and the *Total Cost Management Framework*.

Background

AACE's skills and knowledge of decision and risk management can be distinguished from other treatments of risk management, by the following:

- Specifically incorporates decision analysis and decision making, not just risk management (all risk assessments result in decisions, and all significant decisions require assessment of risk)
- Focus on the entire asset life cycle (as addressed by TCM), not just projects
- Include a strong quantitative focus (e.g., contingency, modeling, etc.)

Why are Decision and Risk Management Combined?

In the asset and project management arena making decisions and managing risks are largely inseparable topics. While they can and are shown separately in processes such as TCM, in fact, quality decisions of any complexity cannot be made effectively without considering risks, and all risk process steps support decision making (e.g., to treat, price or otherwise deal with risks in plans and actions). The decisions may be of minor or major consequence from deciding on a risk response action to funding a mega-project. The risks considered in any decision may similarly be of minor or major consequence. Research shows that the success or profitability of a project is largely determined by the quality of the sanction decision and the planning and analysis behind it, including risk analysis. Once the asset, portfolio, program, project or activity decision is made, failure to manage risks during execution

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47 can lead to loss of planned value and the diminished success of the specific work or the profitability of the entire
48 enterprise depending on the scope and impact of the risk. So decision making and risk management are entwined
49 in the asset and project management arena and are equally important.

50 *What is Risk Management?*

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52 The *TCM Framework* (Section 7.6) defines risk management as a systematic and iterative process comprising four
53 steps:

54 1. Plan - establish risk management objectives;

55 2. Assess - identify and analyze risk;

56 3. Treat - plan and implement risk responses; and

57 4. Control - monitor, communicate and enhance risk management effectiveness.

58 The goal of risk management is to increase the probability that a planned asset, project or portfolio achieves its
59 objectives. In TCM, potential deviations from plans are all considered potentially adverse to overall performance.
60 In this sense, perceived opportunities may also pose a threat. However, if properly managed, the project or asset
61 management team may be able to capitalize on opportune uncertainties. As discussed in TCM, a key challenge in
62 planning is bringing an awareness of risk and probability concepts to decisions whether they are implemented or
63 not. Traditional deterministic analysis often used in decision making may be somewhat meaningless when there
64 are significant risks.

65 In addition to decision making, the risk management process is applied in conjunction with the other TCM
66 processes. In the context of TCM's strategic asset management process, the term enterprise risk management
67 (ERM) recognizes that the risk management process should be applied to overall enterprise, portfolio and program
68 level objectives, not to just a single business unit, asset or project.

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70 *What is Decision Management?*

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72 According to the *TCM Framework* (Section 3.3), investment decision making is a process to analyze investment
73 alternatives and determine whether, how and when to allocate the enterprise's limited resources to them. In TCM,
74 decision making specifically addresses investment decisions during enterprise planning (e.g., capital planning and
75 budgeting). This general process is applicable to other strategic or tactical decisions that may be made in any
76 process described in the *TCM Framework*. In other words, decision management can be viewed as a systematic
77 way of planning, making, implementing, monitoring and improving major investment decisions; however, the
78 process of decision making and the practices of decision analysis in consideration of risk can be applied to any
79 decision (e.g., to take a corrective action as part of project control) for which an objective methodology is practical.

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81 The most prevalent general methodology for decision making is decision analysis (DA) — a systematic and typically
82 quantitative process for selecting the optimum of two or more alternatives in order to address a problem or
83 opportunity. These alternatives can take the form of two or more actions (i.e., buy vs. don't buy, divest vs. don't
84 divest, etc.) or two or more options (i.e., choice between projects, equipment types, vendors, contractors, etc.). In
85 addition, alternatives can be high profile and strategic such as whether to divest a corporate subsidiary or infuse it
86 with additional capital in an attempt to increase competitiveness and profitability or, conversely, as low-level as
87 the selection between two sources of parts. The purpose of the DA process is making good decisions. A good
88 decision is one that is logical and consistent with the strategy and objectives of the enterprise and is consistent
89 with the information available at the time. In this regard, it is likely to be compatible with the enterprise's decision
90 policy. Owing to inherent uncertainty or risk, a good decision does not guarantee a good outcome but making
91 good decisions over the long term can be expected to maximize the enterprise's progress toward its objectives.

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RECOMMENDED PRACTICE

Basis of Decision and Risk Management Required Skills and Knowledge

This RP outlines those skills and knowledge topics required for a professional to be able to effectively perform the processes and steps outlined in the *Total Cost Management Framework* chapters on *Investment Decision Making* (TCM 3.3) and *Risk Management* (TCM 7.6). As these processes are highly integrated with and sometimes practiced within the other TCM processes, elements of those are also included.

The required skills and knowledge of cost engineering are documented in RP 11R-88, that is a structured outline including performance statements for most topics (e.g., “Be able to define...”). The scope or topic headings for this RP and 11R-88 largely overlap; the difference is primarily in emphasis or the level of required skills. For example, the cost engineer should have application knowledge of schedule model development (e.g., given a schedule network with durations, perform CPM forward and backward pass calculations to determine float) while the DRM practitioner must have comprehension (e.g., understand the concept of logic networks and CPM). On the other hand, the DRM practitioner must have application knowledge of a range of probability distribution functions (PDF) while a cost engineer need only have comprehension.

In summary, this RP looks at the process and steps of TCM 3.3 and TCM 7.6 and summarizes those in a topic outline focused solely on DRM, adding the missing *priority* designations. In some cases, additional detail is added (e.g., typical PDFs) and/or performance statements are modified to address specific DRM requirements.

Skills and Knowledge Priority Designations

When assessing the level or degree of Skills and Knowledge, the following are some generic performance statements that apply:

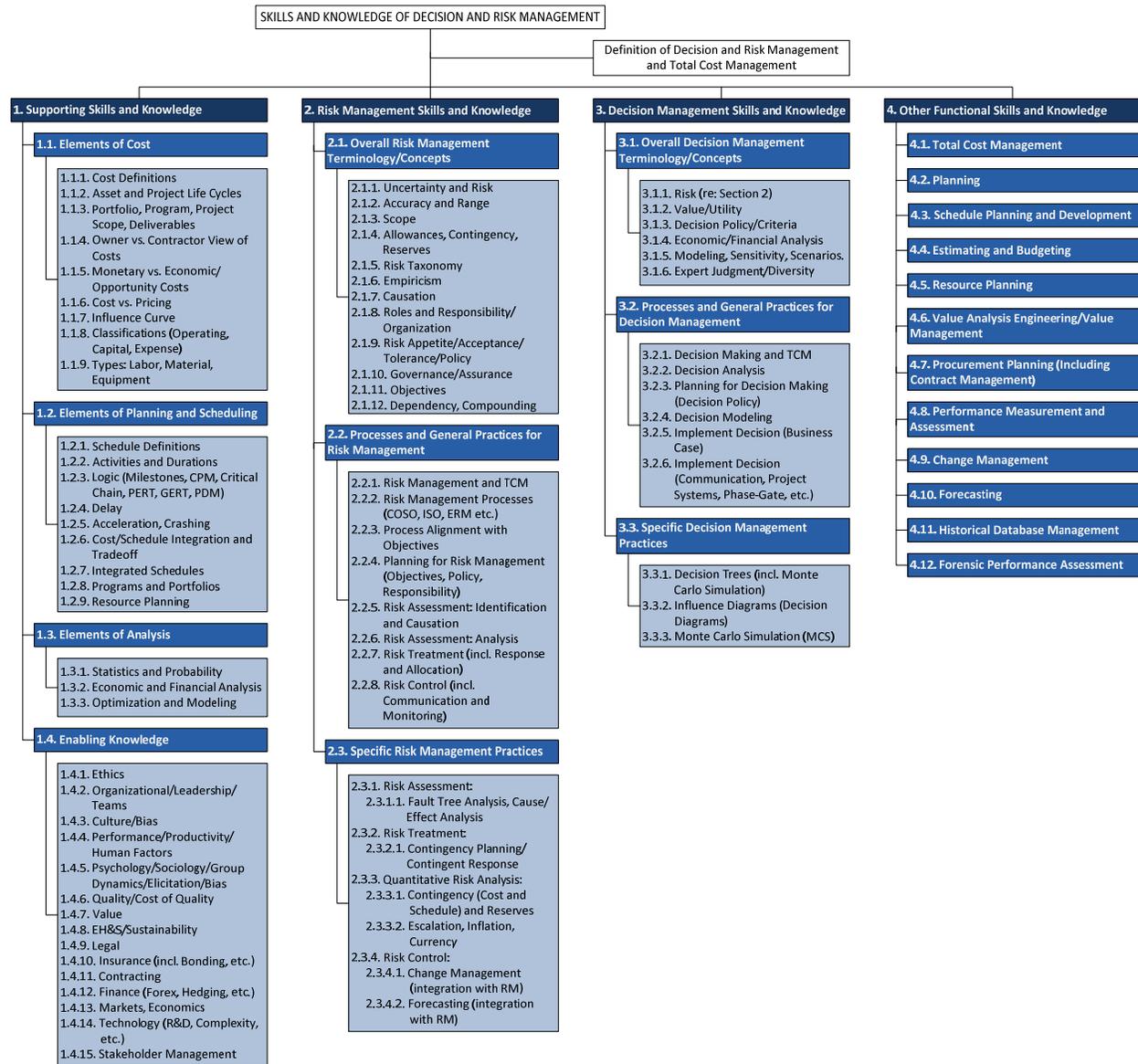
- Knowledge: Recalls facts and information (e.g., define, list, state, identify, label, name)
- Comprehension: Demonstrates understanding of facts and terminology (e.g., explain, predict, interpret, summarize)
- Application: Can use information in concrete situations (e.g., apply, solve, show, make use of, modify)
- Analysis: Can break material down into its parts, identifying both the parts and their relationships to each other (e.g., differentiate, compare/contrast, distinguish)
- Synthesis: Can put the parts together to produce a unique entity, generate a plan, or derive new relationships (e.g., design, construct, develop, formulate)
- Evaluation: Can use evidence and criteria to judge the value of a thing for a given purpose (e.g., appraise, evaluate, justify, judge, recommend)

This RP only has two designations: Primary and Secondary (P or S). A Primary (P) Skills and Knowledge topic will be one that the DRMP should be able to understand and perform at any of the levels in the list above. A Secondary (S) Skills and Knowledge topic will be one where the expected understanding is only knowledge and comprehension.

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Outline of Decision and Risk Management Skills and Knowledge



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Figure 1. High Level Outline of Decision and Risk Management Skills and Knowledge

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150 In the following detailed outline, a “P” in the leftmost column indicates key concepts that form the major emphasis
151 for the AACE International Decision and Risk Management Professional (DRMP) certification examination; while an
152 “S” identifies concepts with less emphasis in the examination (although not necessarily of less importance).
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OUTLINE OF THE SKILLS AND KNOWLEDGE OF DECISION AND RISK MANAGEMENT [P = Primary, S = Secondary]

P/S	1. Supporting Skills and Knowledge
S	1.1. Elements of Cost
S	1.1.1. Cost definitions
S	Resources
S	Time
S	Cost
S	1.1.2. Asset and project life cycles
S	Lifecycle: Be able to describe this term and differentiate the life cycle of an asset and a project.
S	1.1.3. Portfolio, program, project scope, deliverables
S	Process (product vs. project): Be able to describe and differentiate the cost characteristics and types (see cost types below) that make up product and project costs.
S	Be able to distinguish among products, co-products, and byproducts.
S	1.1.4. Owner vs. Contractor view of costs
S	Responsibility: Be able to describe and differentiate the cost perspectives of an owner and a contractor/supplier
S	1.1.5. Monetary vs. Economic/opportunity costs
S	Valuation: Be able to describe and differentiate cost from cash/monetary versus economic/opportunity costs (also see economic analysis) perspectives.
S	1.1.6. Cost vs. pricing
S	Pricing
S	Cost vs. Pricing: Be able to explain the difference
S	Price strategy:
S	Be able to describe how business strategy and market forces may affect pricing.
S	Be able to describe from an owner or buyer perspective concerns about pricing (i.e., risks, competitiveness, cash flow, etc).
S	Be able to describe how profit affects pricing.
S	Be able to describe how profit may be determined how the different types of contracts may influence the amount.
S	1.1.7. Influence curve
S	Influence: Be able to explain the concept of the cost influence curve
S	1.1.8. Classifications (operating, capital, expense)
S	Cost Classifications: For the following classifications, Be able to:
S	Explain the general differences between the ways costs are classified for various cost management purposes.
S	Given a problem with appropriate cost classification inputs (e.g., indirect cost using ABC classification method), Be able to calculate how the cost would be accounted for in a project or product estimate.
S	Operating (Production, Manufacturing, Maintenance, etc.) vs. Capital
S	Capital vs. Expense
S	Depreciation
S	Amortization
S	Accrual
S	Fixed vs. Variable
S	Direct vs. Indirect

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S	Activity-Based Costing (ABC)
S	Job Costing
S	1.1.9. Types: labor, material, equipment
S	Cost Types: for the following cost types, given cost type and classification inputs, Be able to apply them in a project or manufacturing estimating application (i.e., for project or product cost)
S	Materials
S	Materials types: Be able to describe the types and their cost drivers:
S	Raw
S	Bulk
S	Fabricated
S	Engineered or designed
S	Consumables
S	Purchase costs: Be able to describe these terms/concepts and their influence on the cost of materials:
S	Market pricing (pre-negotiated vs. competitively bid, etc.)
S	Order quantity
S	Taxes and duties
S	Carrying charges
S	Cancellation charges
S	Demurrage
S	Hazardous material regulations
S	Warranties, maintenance and service
S	Materials management costs: Be able to describe these terms/concepts and their influence on the cost of materials:
S	Delivery schedule
S	Packing
S	Shipping and freight
S	Freight forwarding
S	Handling
S	Storage and inventory
S	Agent cost
S	Surveillance or inspection
S	Expediting
S	Losses (shrinkage, waste, theft, damage)
S	Spare parts (inventory or start-up)
S	Surplus materials
S	Capital Equipment: (i.e., fabricated or engineered items)
S	Rent vs. lease vs. purchase:
S	Be able to explain the mechanics and cost considerations.
S	Given a problem with useful life, fixed and operating cost, credits, depreciation, taxes, etc., Be able to determine the most economical option
S	Valuation: Be able to explain these concepts:
S	Reproduction costs
S	Replacement costs
S	Fair value
S	Market value
S	Book value
S	Residual or economic value

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S	Operating vs. economic life
S	Temporary Equipment: (expensed items for construction, maintenance, etc) Be able to explain the cost implications of rent, operators, maintenance, scheduling, etc.
S	Labor
S	Labor Wage Rate or Salary:
S	Be able to describe the differences in mechanics of compensation for wage and salaried employees including the meaning of exempt and non-exempt.
S	Be able to calculate an effective wage rate allowing for:
S	Overtime premium
S	Other premium pays
S	Shortened shift time
S	Travel time
S	Show-up pay
S	Benefits and Burdens (mandated and fringe):
S	Be able to describe the basic mechanics of benefits and burdens such as:
S	Retirement (social security)
S	Unemployment insurance
S	Workers compensation
S	Insurance
S	Paid time off (sick, vacation, holiday)
S	Be able to identify typical differences between industrialized and non-industrialized countries and between populated and remote areas.
S	Overhead and profit: Be able to describe the basic mechanics of charging various overhead and profit cost elements to direct labor costs such as:
S	Indirect labor (home office, administrative and similar costs)
S	Small tools
S	Profit
S	Union: Be able to explain the cost differences between union and open shop labor
S	Subcontract: Be able to explain the cost implications of the following issues:
S	Reimbursable vs. non-reimbursable costs
S	Overhead and profit (including contract administration and legal costs)
S	License, fees or royalties
S	Bonds (bid, payment, or performance)
S	Retainage
S	Performance guarantees
S	Liquidated damages
S	Cost of money: Be able to describe these costs:
S	Escalation
S	Inflation
S	Currency exchange rates
S	Risk and Uncertainty: Be able to describe these costs:
S	Contingency
S	Allowance
S	Reserve
P/S	1.2. Elements of Planning and Scheduling
S	1.2.1. Schedule definitions
S	Schedule Planning and Development: Be able to describe the following concepts:
S	Schedule Planning

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OUTLINE OF THE SKILLS AND KNOWLEDGE OF DECISION AND RISK MANAGEMENT [P = Primary, S = Secondary]

S	Activities
S	Activity Logic and Logic Diagramming:
S	Given a series of logic statements, Be able to draw a logic diagram.
S	Given a soft-logic work package with no strict activity interrelationships, Be able to describe ways to do schedule planning for this work.
S	Be able to describe how schedule planning differs between a batch and a continuous process.
S	Be able to describe the concept of linear scheduling.
S	Be able to describe the concept of conditional branching and its potential application in schedule models to support risk analysis
S	Be able to describe the concept of static (fixed) vs. dynamic (conditional) logic in respect to CPM schedule analysis using Monte-Carlo Simulation
S	Activity Duration
S	Critical Path: Be able to define and identify the critical path(s) in a project schedule
S	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality in regards to schedule risk analysis.
S	Float: Be able to describe the relationship and significance of total and free float in the scheduling of an activity.
S	Be able to differentiate between schedule contingency and float.
S	Schedule Models: Using the PDM method, and given a logic diagram and durations for activities, Be able to calculate the early start and finish, late start and finish, and total and free float times for all activities. Identify minimum project completion time.
S	Precedence Diagram Method (PDM): in using this method include at least on each finish-start, finish-finish, start-finish, and start-start relationships with lags and identify critical path(s).
S	Bar chart/Gantt chart:
S	Be able to explain the difference between this and a logic diagram.
S	Given network activity durations, early and late start and finish times, and total float, be able to draw a bar chart based on early start of all activities, and show total float of activities where applicable.
S	Be able to describe the concept of merge bias in probabilistic schedule modeling.
S	Historical Data: Be able to describe the importance of historical, empirical data and databases to schedule planning and schedule development
S	Schedule Development: describe difference from schedule planning
S	Milestones
S	Resource Loading
S	Resource Leveling or Balancing: for a simple PDM network with resource inputs, be able to resource level the network within early and late start limits, and draw a histogram of worker-loading for early start, late start, and resource leveled configurations.
S	Schedule Control Basis
S	Schedule Control Baseline
S	Be able to describe the concept of short interval scheduling (SIS) in relation to an overall project schedule control baseline.
S	Planned Schedule
S	Schedule Basis
S	Other Concepts:
S	Programs and Portfolios: Be able to explain these concepts and how schedule planning and development might be handled for groups of projects.

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S	Operations/Production: Be able to explain how production scheduling differs from project scheduling
S	Schedule strategy
S	Be able to describe the characteristics and risks of a fast track schedule
S	Be able to describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (e.g., crashing).
S	Be able describe the characteristics and risks of just-in-time (JIT) scheduling.
S	Be able to describe the importance of considering cost and schedule tradeoff in schedule Planning.
S	Be able to describe the importance of schedule model (logic) quality to CPM based schedule risk analysis.
S	Be able to describe the concepts of acceleration and crashing as approaches for risk treatment and response.
S	Schedule Development:
S	Be able to describe the concept of development by schedule level.
S	Be able to describe the concept of rolling wave development.
S	Schedule Change Management: Be able to describe how schedule changes might be managed.
S	Critical Chain: Be able to describe the concept.
S	Linear Scheduling: Be able to describe the concept.
S	Schedule Contingency:
S	Be able to define the term including what it is supposed to cover.
S	Be able to describe several typical ways that it can be assessed.
S	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
S	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
S	1.2.2. Activities and durations
S	Activities
S	Activity Duration
P/S	1.2.3. Logic (milestones, CPM, critical chain, PERT, GERT, PDM)
S	Activity Logic and Logic Diagramming:
S	Given a series of logic statements, Be able to draw a logic diagram.
S	Given a soft-logic work package with no strict activity interrelationships, Be able to describe ways to do schedule planning for this work.
S	Be able to describe how schedule planning differs between a batch and a continuous process.
S	Be able to describe the concept of linear scheduling.
P	Be able to describe the concept of conditional branching and its potential application in schedule models to support risk analysis.
P	Be able to describe the concept of static (fixed) vs. dynamic (conditional) logic in respect to CPM schedule analysis using Monte-Carlo Simulation.
S	Critical Path: Be able to define and identify the critical path(s) in a project schedule.
P	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality in regards to schedule risk analysis.
S	Float: Be able to describe the relationship and significance of total and free float in the scheduling of an activity.
P	Be able to differentiate between schedule contingency and float.
S	Schedule Models: Using the PDM method, and given a logic diagram and durations for activities, be able to calculate the early start and finish, late start and finish, and total and free float times for all activities. Identify minimum project completion time.

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S	Precedence Diagram Method (PDM): in using this method include at least on each finish-start, finish-finish, start-finish, and start-start relationships with lags and identify critical path(s).
S	Bar chart/Gantt chart:
S	Be able to explain the difference between this and a logic diagram.
S	Given network activity durations, early and late start and finish times, and total float, be able to draw a bar chart based on early start of all activities, and show total float of activities where applicable.
S	Historical Data: Be able to describe the importance of historical, empirical data and databases to schedule planning and schedule development.
S	Schedule Development: describe difference from schedule planning
S	Milestones
S	Resource Loading
S	Resource Leveling or Balancing: for a simple PDM network with resource inputs, be able to resource level the network within early and late start limits, and draw a histogram of worker-loading for early start, late start, and resource leveled configurations.
S	Schedule Control Basis
S	Schedule Control Baseline
S	Be able to describe the concept of short interval scheduling (SIS) in relation to an overall project schedule control baseline.
S	Planned Schedule
S	Schedule Basis
S	Other Concepts:
S	Programs and Portfolios: Be able to explain these concepts and how schedule planning and development might be handled for groups of projects.
S	Operations/Production: Be able to explain how production scheduling differs from project Scheduling.
S	Schedule strategy.
S	Be able to describe the characteristics and risks of a fast track schedule.
S	Be able to describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (e.g., crashing).
S	Be able describe the characteristics and risks of just-in-time (JIT) scheduling.
P	Be able to describe the importance of schedule model (logic) quality to CPM based schedule risk analysis.
S	Schedule Development:
S	Be able to describe the concept of development by schedule level.
S	Be able to describe the concept of rolling wave development.
S	Schedule Change Management: Be able to describe how schedule changes might be managed.
S	Critical Chain: Be able to describe the concept.
S	Linear Scheduling: Be able to describe the concept.
S	Schedule Contingency:
S	Be able to define the term including what it is supposed to cover.
S	Be able to describe several typical ways that it can be assessed.
P	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
P/S	1.2.4. Delay

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S	Be able to describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (e.g., crashing).
S	Be able to define the term including what it is supposed to cover.
P	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
P/S	1.2.5. Acceleration, Crashing
S	Be able to describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (e.g., crashing).
P	Be able to describe the concepts of acceleration and crashing as approaches for risk treatment and Response.
P/S	1.2.6. Cost/Schedule Integration and Tradeoff
S	Resource Loading.
S	Resource Leveling or Balancing: for a simple PDM network with resource inputs, be able to resource level the network within early and late start limits, and draw a histogram of worker-loading for early start, late start, and resource leveled configurations.
P	Be able to describe the importance of considering cost and schedule tradeoff in schedule planning.
P	1.2.7. Integrated schedules
P	Be able to describe the importance of considering cost and schedule tradeoff in schedule planning.
S	1.2.8. Programs and portfolios
S	Programs and Portfolios: Be able to explain these concepts and how schedule planning and development might be handled for groups of projects.
S	Operations/Production: Be able to explain how production scheduling differs from project scheduling.
S	1.2.9. Resource planning
S	Resource Loading.
S	Resource Leveling or Balancing: for a simple PDM network with resource inputs, be able to resource level the network within early and late start limits, and draw a histogram of worker-loading for early start, late start, and resource leveled configurations.
S	Resource Management: Be able to describe how this process is tied closely to cost estimating (e.g., quantification) and schedule development (e.g., resource allocation). Also see performance / productivity management considerations.
S	Resource availability: Be able to discuss ways to assess availability and potential consequences of not doing so.
S	Be able to describe the types of resources and their appropriateness to analysis.
S	Be able to discuss potential sources for resources.
S	Be able to discuss methods for validation of initial estimates.
S	Resource limits and constraints: Be able to discuss typical limits and constraints that may occur or be imposed.
S	Be able to discuss the role supervision and span of control has on resource limits.
S	Be able to describe how optimal and maximum crew sizing may play a part.
S	Be able to discuss the effects of physical workspace limits.
S	Resource allocation: Be able to describe the mechanics of this step in schedule development.
S	Forward vs. backward allocation: Be able to explain the differences in the methods.
S	Smoothing vs. maximum limits: Be able to explain the difference in the terms.
S	Maximum vs. over-maximum allocation: Be able to explain the differences in the terms.
P/S	1.3. Elements of Analysis
P	1.3.1. Statistics and probability

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P	Statistics and Probability
P	Samples and Populations: Be able to describe the relationship of the mean of a sample to the mean of a population, and the general affect of sample randomness, bias and size on the reliability of the sample statistics .
P	Be able to describe the following additional concepts in respect to samples and populations:
P	Central Limit Theorem; Be able to define this concept.
P	Pareto Principle: Be able to describe this principle.
P	Descriptive Statistics
P	Basic Statistics: given a set of data, Be able to determine the arithmetic mean, median, mode, standard deviation and variance.
P	Normal Distribution: Be able to provide the percent of observations within one and two standard deviations of the mean for a normally distributed variable.
P	Non-Normal Distributions: Be able to describe the following concepts:
P	Skewness (symmetry).
P	Kurtosis (central tendency relative to normal).
P	Be able to describe the following additional concepts in respect to probability distribution functions (PDFs).
P	Bounded vs. Unbounded
P	Discrete vs. Continuous
P	Confidence Levels and Intervals
P	Histograms, Cumulative Frequency: given a tabular distribution for a variable that is other than normal, Be able to draw a histogram and resultant cumulative frequency curve (frequency distribution), and determine the percent probability of the variable not being less than or more than a given number.
P	Inferential Statistics
P	Probability: given a curve of normal distribution and an accompanying table of areas under the curve, be able to determine the probability of a) the variable being between two given numbers, b) not being higher than a given number, or lower than that number, and c) given a confidence interval or range in terms of percentage probability, give the corresponding low and high number of the interval or range.
P	Be able to describe the key attributes/parameters of the following common probability distribution functions (PDFs) and their strengths and weaknesses for use in decision and risk analysis models:
P	Discrete
P	Uniform
P	Triangle
P	Double Triangle
P	Trigen
P	Normal
P	LogNormal
P	Pert or Betapert
P	Binomial
P	Cumulative
P	Regression Analysis: Be able to describe the concept of the methodology as well as diagnostic statistics (R^2 , root mean square error (RMSE), and t).
P	Statistical Significance:
P	Be able to describe the purpose and use of chi-squared and t-tests.
P	Be able to interpret the t-statistic for comparing two sets of normally distributed data.

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P	Be able to interpret of the chi-squared statistic for comparing two sets of data that may not be normally distributed.
P	Be able to describe how a parametric model may explicitly incorporate probabilistic Properties.
P	1.3.2. Economic and financial analysis
P	Economic and Financial Analysis
P	Economic Cost: Be able to define concepts of opportunity cost and assigning monetary value to non-cash values, costs and benefits.
P	Cash Flow Analysis:
P	Be able to calculate simple and compound interest rates and solve interest problems using the basic single payments, uniform series, and gradient formulas.
P	Given a set of cost and revenue forecasts calculate a cash flow for an asset investment option.
P	Internal Rate of Return: Be able to determine discounted rate of return of a cash flow series.
P	Present/Future Value Analysis: Be able to calculate present value, future value, and equivalent uniform annual value of a cash flow series.
P	Net Present Value (NPV): Be able to calculate the NPV of a set of cash flow series representing revenue and cost streams for an asset investment alternative.
P	1.3.3. Optimization and modeling
P	Optimization
P	Model:
P	Be able to describe the concept of a quantitative representational models and parameters.
P	Given an optimization goal involving a result Y which is a function of X, use graphical or incremental methods to determine the optimum value of Y.
P	Be able to describe the general concept of Monte-Carlo Simulation (MCS), its use in decision and risk analysis, and related issues such as random number generation, seeding, Latin hypercube variations, etc.
P	Be able to describe the general concept of parametric modeling and its use in decision and risk analysis and contingency estimation.
S	Linear Programming: Be able to describe the types of problems amenable to this mathematical optimization technique (i.e., find extreme points of a function given a set of constraints).
P	Simulation: Be able to describe the use of a model for analysis of a cost problem.
P	Sensitivity Analysis: Be able to perform a sensitivity analysis of a modeled problem.
P	Boundary definitions and conditions: Be able to describe how the importance of these to model development and application.
P	Be able to describe typical application of sensitivity analysis in investment decision making (e.g., profitability and EMV variables subject to evaluation).
S	Physical Measurements: Be able to convert basic metric and imperial weight and dimensional measurements.
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P/S	1.4. Enabling Knowledge
P/S	1.4.1. Ethics
S	Ethics:
S	Be able to explain the need to judge the means and the ends of a practice or process against personal and societal values and rules of conduct.
S	Be familiar with AACCE International's ethics policy (Canons of Ethics).
P	Be able to describe common ethical issues as potential risks and their impacts.
P/S	1.4.2. Organizational/Leadership/Teams
S	People and Organizations in Enterprises

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S	Leadership: Be able to explain why it is important to obtain team commitment and clearly communicate the purpose of a task or project, and how this might be done.
S	Leadership Roles:
S	Be able to explain why the need for leading, managing, facilitating, and mentoring roles may vary by situation.
S	Discuss the meaning and provide examples of "participative management."
S	Motivation/Incentives (Behavioral Science):
S	Be able to discuss motivator/demotivator affects on labor attitude and performance.
S	Organization Structure
S	Organizational Design: Be able to describe the issues that organizations must address (division of labor, unity of command, unity of directions, and span of control) and how each may affect performance.
S	Basic Structures:
S	Be able to draw and example chart and explain the differences between, and advantages/disadvantages of traditional functional, divisional, and matrix structures.
P	Be able to describe the concept of Enterprise Risk Management and its relationship to an organizational structure.
P	Be able to describe how organizational strategies (e.g., matrices, etc.) may influence the risk management process.
S	Teams:
S	Be able to explain how and why teams are used in enterprises and why they are typically used to manage projects.
S	Be able to describe typical team organization (i.e., matrix) and operation and the roles, responsibilities, and methods for its successful performance.
S	Typical Organizations in TCM: Be able to generally describe the typical roles of capital investment management (business planning), operations management, and project management in TCM (i.e., where cost engineers usually work).
P/S	1.4.3. Culture/Bias
S	Enterprise in Society
S	Societal Values: Be able to generally describe societal concerns and needs that should be considered in asset and project planning.
S	Decision Policy: Be able to describe how to translate societal values to policy so that an enterprise can consistently address societal values in everyday practice.
P	Be able to describe factors of culture, bias, psychology, sociology, and group dynamics as they may impact risk assessment (e.g., identification, elicitation, qualitative risk analysis, etc.)
P	Be able to describe the concept of risk aversion.
S	Be aware of the following types of bias:
S	Confirmation Bias: Gather facts that support certain conclusions; disregard other facts.
S	Premature Termination: Accept the first alternative that looks like it might work.
S	Inertia: Keep thought patterns that we have used in the past despite new circumstances.
S	Selective Perception: Screen-out information that we do not think is important.
S	Optimism Bias: See things in an unjustifiably positive light.
S	Recency: Place more attention on more recent information.
S	Repetition Bias: Believe what we are told most often and by the most different sources.
S	Anchoring: Unduly influenced by initial information; shapes our view of later information.
S	Group Think: Peer pressure to conform to the opinions held by the group.
S	Escalating Commitment: Increase support of a decision over time (over-value sunk costs).
S	Attribution Asymmetry: Attribute success to our abilities; attribute failures to bad luck.

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S	Illusion of Control: Underestimate future uncertainty because we believe we have control.
S	Ascription of Causality: Ascribe causation although evidence only suggests correlation.
P/S	1.4.4. Performance/Productivity/Human Factors
S	Performance/Productivity Management:
S	Be able to describe the concept of productivity (and its difference from the term production).
S	Be able to describe the affect on performance of these factors in terms of motivation and waste/inefficiency, and how performance could be improved and at what cost (e.g., leadership role, work process change, etc.):
P	Be able to describe how the following may contribute to uncertainty:
S	Individual worker skills
S	Crew balance of skills
S	Immediate supervision competence
S	Overall supervision competence
S	Worker and supervision attitudes
S	Work force sociological, cultural and demographic characteristics
S	Absenteeism and turnover
S	Overtime
S	Level of technology used
S	Learning curve
S	Work area environment
S	Weather
S	Geographic location
S	Proximity to other work and contractors
S	Job layout
S	Work rules
S	Safety practices
S	Quality control practices (including quality circles)
S	Materials and tools availability
S	Wages, salaries and benefits.
P/S	1.4.5. Psychology/Sociology/Group Dynamics/Elicitation/Bias
S	Given a list, Be able to describe the basic themes of two or more generally accepted behavioral science theories:
S	McGregor- Theory X and Y
S	Herzberg-Motivation-Hygiene
S	Argyris-Effects of organization like on individuals
S	Likert-Four model systems
S	Mouton-Managerial grid
S	Other current theories
P	Be able to describe factors of culture, bias, psychology, sociology, and group dynamics as they may impact risk assessment (e.g., identification, elicitation, qualitative risk analysis, etc.).
P	Be able to describe the concept of risk aversion.
S	Be aware of the following types of bias:
S	Confirmation Bias: Gather facts that support certain conclusions; disregard other facts.
S	Premature Termination: Accept the first alternative that looks like it might work.
S	Inertia: Keep thought patterns that we have used in the past despite new circumstances.
S	Selective Perception: Screen-out information that we do not think is important.
S	Optimism Bias: See things in an unjustifiably positive light.
S	Recency: Place more attention on more recent information.

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S	Repetition Bias: Believe what we are told most often and by the most different sources.
S	Anchoring: Unduly influenced by initial information; shapes our view of later information.
S	Group Think: Peer pressure to conform to the opinions held by the group.
S	Escalating Commitment: Increase support of a decision over time (over-value sunk costs).
S	Attribution Asymmetry: Attribute success to our abilities; attribute failures to bad luck.
S	Illusion of Control: Underestimate future uncertainty because we believe we have control.
S	Ascription of Causality: Ascribe causation although evidence only suggests correlation.
P/S	1.4.6. Quality/Cost of Quality
S	Quality Management: Be able to explain the following concepts:
S	Quality: Be able to define this as conformance to requirements (which are based on customer needs).
S	Requirements: (see Requirements Elicitation and Analysis practices).
S	Quality Planning: Be able to describe this as an integrated way of planning directed towards satisfying customer needs.
S	Quality Management: Be able to describe this as a process for managing quality and understand that TCM is a quality management process focused on continuous cost performance improvement.
S	Quality Assurance: Be able to describe this as actions that provide confidence that the requirements will be fulfilled.
S	Quality Control: Be able to describe this as actions focused on fulfilling requirements.
S	Continuous Improvement: Be able to describe this as a common goal of quality management processes (the traditional result of the PDCA process).
S	Plan-Do-Check-Assess (PDCA): Be able to describe this as the basis model for TCM and many other management processes.
S	Quality Measurement: Be able to explain that in some views, cost is the best single quality measurement because so many measures can be expressed in cost terms.
S	Quality Policy: Be able to explain that this as an imposed requirement that is assumed guided by accepted quality management principles.
S	Quality Standards: Be able to describe these imposed requirements.
S	ISO 9000 standard quality management series
S	ISO 10006 quality in project management
P	ISO 31000 for Risk Management
S	Quality Focused Practices in TCM: be aware that these key practices (covered in later sections) have particular importance to quality management.
S	Benchmarking
S	Cost of Quality
S	Value Analysis/Engineering
S	Change Management
P/S	1.4.7. Value
S	Valuation: Be able to describe and differentiate cost from cash/monetary versus economic/opportunity costs (also see economic analysis) perspectives.
S	Value Management:
S	Be able to explain the following general concepts (i.e., not in the context of value analysis and engineering practice):
S	Value (i.e., a measure of the worth of a thing in terms of usefulness, desirability, importance, Money.)
S	Value Management (i.e., what an enterprise does to ensure that its assets provide or maintain the usefulness and/or value that the various stakeholders require.)

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S	Value Improving Practices (i.e., practices that have a specific focus and/or significant effect on getting the most value from a process and meet criteria that set the practice apart from “business as usual”.)
P	Considering that risk includes opportunities, Be able to describe how value and risk management processes might be aligned and integrated.
S	Be able to describe the purposes and general approach of these value improving practices (also see the section on Value Analysis and Engineering):
S	Manufacturability Analysis
S	Constructability Analysis
S	Reliability, Availability and Maintainability (RAM) Analysis
P/S	1.4.8. EH&S/Sustainability
S	Environment, Health, Safety, and Security (EHS): Be able to explain the following concepts:
P	Be able to describe the increasing importance of the topics that follow as objectives, their contribution to risk, and their consideration in decision making (e.g., multi-attribute decision making.)
S	Quality Management. Be able to describe why TCM is a quality management process and EHS issues are considered using this process approach (i.e., through establishing EHS requirements and managing to them.)
S	Non-Conformance/Prevention. Be able to explain why it is important, as in quality management, to focus on preventing non-conformance with EHS requirements and improving performance rather than after the fact appraisal, failure and correction.
S	EHS Standards/Compliance. Be able to explain why compliance with minimum standards and regulations should be the minimum expected.
S	ISO 14000: management systems that an organization employs to manage environmental matters.
S	Sustainable Development. Be able to explain why enterprises should not use resources in a manner or degree that compromise the ability of future generations to sustain such development.
P/S	1.4.9. Legal
S	Legal:
S	Be able to explain how cost and schedule analysis practices might differ when applied for forensic versus traditional planning and control purposes.
S	Be able to describe some potential legal consequences that may result from using poor or unethical cost management practices (e.g., anti-trust, claims, Sarbanes-Oxley, etc.)
P	Be able to describe the general concepts of legal requirements (rules, regulations, constraints, duties, etc.) and potential impacts (e.g., penalties, reputation, etc.) and responses/remedies if they are violated.
P	1.4.10. Insurance (incl. bonding, etc.)
P	Be able to describe the general concept of insurance in respect to risk treatment.
P	Be able to describe the various types of insurance that may be required as part of a contract.
P/S	1.4.11. Contracting
P	Be able to describe the general concept of contracting in respect to risk treatment.
S	Procurement Planning and Contract Management.
S	Contract types: Be able to explain the advantage and disadvantages of these types of contracts from the owner and contractor viewpoints:
S	Fixed price (with fixed, incentive, or award fees)
S	Unit price
S	Cost-plus (with fixed, incentive, or award fees)
S	Time and materials (T&M)

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S	Risk Allocation: Be able to explain how each contract type above allocates risks between the contracting parties.
S	Contract Documents:
S	Be able to describe the general contents and purposes of the following elements of bidding and contract documents:
S	Invitation to bid or request for proposal
S	Bid form
S	Agreement
S	General conditions
S	Supplementary or special conditions
S	Technical specifications
S	Drawings
S	Addenda
S	Modifications
S	Bid bond and contract (performance) bond
S	Performance guarantee
S	Warranties
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe the various types of insurance that may be required as part of a contract.
S	Be able to explain the term “retention” and Be able to calculate its effective cost given the terms of the contract and time-value of money.
S	Be able to distinguish between “job (project) overhead” and “general overhead” and provide examples of each.
S	Be able to explain what is meant by a contract payment term such as “2/15 net 30”, and given a payment timing and time value of money scenario, Be able to determine the method of payment that is economically most advantageous under these terms.
S	Be able to explain contract payment terms and how they may expose the parties to risk (e.g., payment not commensurate with work performed, unbalancing, etc.)
S	Be able to describe the risks of various contract types when markets are not competitive.
S	Integrated Project Control:
S	Be able to explain the basic mechanics of how the project control process might be integrated between parties to each type of contract. (e.g., how to measure and report progress, integrate schedules, etc.).
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe how contracting various DRM roles and responsibilities may affect the performance of the DRM process and may lead to systemic risks due to complexity, delay, poor communication, biases, and so on.
S	Changes and Claims: (see Change Management and Forensic Performance Assessment)
P	1.4.12. Finance (Forex, hedging, etc.)
P	Be able to describe the general concepts and roles of finance in respect to risk ownership and actions for assessment and treatment (e.g., forex, hedging, interest, escalation inputs, etc.)
P	1.4.13. Markets, Economics
P	Be able to describe the general concepts of markets in consideration of revenues in decision analysis, impacts on RM and escalation, and so on.
P/S	1.4.14. Technology (R&D, complexity, etc.)

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S	Information Technology (IT) and Systems: Be able to explain that information systems are the mechanisms or tools by which knowledge is delivered to the enterprise and those it interacts with (i.e., includes communication).
S	Enterprise Resource Planning/Management (ERP/ERM): Be able to describe the goal of these types of systems (support efficient business processes, including project management, through shared or common databases.)
S	Be able to describe the concept of Enterprise Risk Management and its relationship to information management.
P	Be able to describe the general concepts of asset and project technology and complexity in respect to risk analysis (e.g., systemic risks.)
P/S	1.4.15. Stakeholder Management
P	Be able to describe the general concepts of stakeholder management in respect to planning for and implementing decision making and risk management.
S	Stakeholders/Customers: Be able to describe how to identify these in relation to various business Problems.
S	Needs, wants, or expectations of stakeholders: Be able describe challenges of eliciting this information from various stakeholders
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Heirarchy Process.
P	Be able to describe how sensitivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).
P/S	2. Risk Management Skills and Knowledge
P/S	2.1. Overall Risk Management Terminology/Concepts
P	2.1.1. Uncertainty and Risk
P	Uncertainty.(also see Risk Management)
P	General Concepts
P	Risk and Uncertainty: Be able to define risk in terms of opportunities and threats
P	2.1.2. Accuracy and Range
P	Estimate Variability
P	Be able to describe the elements, conditions, activities, etc. that may affect estimate variability.
P	Uncertainty.(also see Risk Management)
P	Probability: Be able to describe the probabilistic nature of cost estimates and the concept of ranges and accuracy, and the importance of communicating these to the project team.
P	Accuracy: Be able to describe asset and project characteristics likely to affect the accuracy of cost estimates, and the relationship of estimate classification to accuracy.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
S	2.1.3. Scope
S	Project scope: Be able to describe this as the scope of work to deliver the asset.
S	Project scope breakdown (work decomposition).
S	Work Breakdown Structure (WBS): Be able to diagram a WBS for a basic scope provided in narrative form.
S	Organization Breakdown Structure (OBS): Be able to diagram an OBS for a basic scope provided in narrative form.
S	Work package.
S	Deliverables.
S	Execution strategy.
P	Be aware that stakeholders and teams do not always understand or agree on the meaning of scope and how this may affect risk planning, assessment, treatment and control.

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P	Understand the concept of levels of asset and project scope definition as a systemic risk driver (and the role of cost and schedule classification in that regard).
P	2.1.4. Allowances, Contingency, Reserves
P	Risk and Uncertainty: Be able to describe these costs:
P	Contingency
P	Allowance
P	Reserve
P	Schedule Contingency:
P	Be able to define the term including what it is supposed to cover.
P	Be able to describe several typical ways that it can be assessed.
P	Contingency:
P	Be able to define the term including what cost it is supposed to cover.
P	Be able to describe several typical ways that it can be estimated.
P	Contingency (see cost estimating and schedule development)
P	Be able to describe the appropriate level of authority for managing contingency.
P	Be able to describe typical criteria for its use (i.e., as opposed to a slush fund).
P	2.1.5. Risk Taxonomy
P	ISO 31000 for Risk Management.
P	Taxonomy: Be able to describe the concepts of Risk Taxonomy and Risk Breakdown Structure (RBS) and its utilization and importance in risk assessment analysis and communication.
P	Risk Breakdown: Be able to describe typical breakdown purposes and categories such as determinants of recommended contingency estimating methods (e.g., systemic versus project-specific), categories for estimating and control (e.g., contingency, allowance, etc.) and RM process facilitation (e.g., residual, emergent, etc.).
P	Front-end loading (FEL): Be able to describe this concept and its benefits in terms of risk management and project control planning.
P/S	2.1.6. Empiricism
S	Data, Information, and Knowledge: Be able to explain the difference between these three types of "information".
S	Databases and Database Management. Be able to define and explain the following concepts:
S	History: the importance of historical and empirical information to most cost engineering Practice.
S	Reference Data: the need that specific methods and tools for specific processed data.
S	Lessons Learned: the need for data that is qualitative in nature.
S	Metric: the need that benchmarking or validation methods have for specific processed quantitative data.
S	Validation: the need to assure the reliability and sometimes competitiveness of data.
S	Basis: the need to understand the basis of all data and information in a database.
S	Normalization: Be able to adjust data to a common basis in currency, time, location, etc.
P	Empiricism: Be able to describe the principle of empiricism and its roles and incorporation in the DRM process.
P/S	2.1.7. Causation
P	Risk Factors (or drivers) and Risk Factor Properties.
P	Causation: Be able to describe the concepts of Causation and correlation versus Causation.
S	Be able to describe how forensic performance assessment might interact with the risk management process steps (i.e., causation, lessons learned, impact assessment, etc.).
P	2.1.8. Roles and Responsibility/Organization
P	Be able to describe the appropriate level of authority for managing contingency.

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P	Roles and Responsibilities: Be able to describe the variations in and risks associated with roles, responsibilities and organization for DRM and enterprises and projects in general.
P	Be able to distinguish between risks and opportunities and risks and issues and concerns.
P	2.1.9. Risk Appetite/Acceptance/Tolerance/Policy
P	Risk Perception: Be able to describe the concepts of risk perception and risk aversion (and relation to psychology, culture and bias) and the more formalized concepts to address perception (appetite, tolerance, policy and acceptance criteria).
P/S	2.1.10. Governance/Assurance
S	Be able to describe the concept of Enterprise Risk Management and its relationship to information Management.
P	Governance/Assurance: Be able to describe the assurance process involved in DRM, the role of assurance as a risk treatment, and the risks of its failure.
P	Planning and Risk Maturity Models: Be able to describe the concept and use of Risk Maturity Models.
P	2.1.11. Objectives
P	Objectives and risk: given that risk is "an uncertain event or condition that could affect a project objective" Be able to describe how poorly understood objectives affects decision and risk management effectiveness.
P	Objectives and decisions: Be able to describe the concept of multiple (and sometimes conflicting) objectives and their consideration and trade-off in decision making (e.g., multi-attribute decision models).
P	Be able to describe the following RM process steps at a working level (re: see RPs for each process step).
P	Risk Management Planning: Be able to describe why this step begins with establishing RM objectives considering both strategic asset management requirements as well as tactical requirements for the project, activity or other alternatives being evaluated.
P	Be able to describe the basic practices of risk elicitation and identification (e.g., surveys, brainstorming, delphi, etc.).
P	Be able to describe the concept of the Venn Diagram for assessing risk relationships.
P	Be able to describe the practices of Fault Tree Analysis, Cause/Effect and Root Cause Analysis.
P	Be able to describe the concept and application of Risk Registers.
P	Be able to distinguish between risks and opportunities and risks and issues and concerns.
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to describe the recommended practices for risk analysis and contingency determination.
P	Be able to describe the recommended practices for estimating escalation and related methods for currency risks.
P	Be able to describe the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	Be able to describe the concept of qualitative risk analysis, expected value, and the Risk Matrix (probability vs. impact).
P	Be able to describe the use of Tornado diagrams for communicating risk ranking.
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	Be able to describe the practices of contingency planning (contingent response planning) and workarounds.
P	Be able to describe how RM is integrated with the Change Management process.
P	Be able to describe how RM is integrated with the Forecasting process.
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Hierarchy Process.

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P	Be able to describe how sensitivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).
P	2.1.12. Dependency, Compounding
P	Dependency/Compounding: Be able to describe the concepts of dependency and compounding, and the evolution of new areas of S&K in systems dynamics, chaos and complexity theory.
P	2.2. Processes and General Practices for Risk Management
P	2.2.1. Risk Management and TCM
P	Be able to describe the processes of Investment Decision Making and Risk Management in TCM and their main interactions with other TCM processes. Also be able to describe the concept of ERM.
P	Be able to describe other common industry RM processes (e.g., PMI, ISO, COSO) and variations (e.g., ERM) and differences with TCM in respect to decision making and risk quantification.
P	Be able to describe the following RM process steps at a working level (re: see RPs for each process step)
P	Risk Management Planning: Be able to describe why this step begins with establishing RM objectives considering both strategic asset management requirements as well as tactical requirements for the project, activity or other alternatives being evaluated.
P	Risk Assessment.
P	Be able to describe the basic practices of risk elicitation and identification (e.g., surveys, brainstorming, delphi, etc.).
P	Be able to describe the concept of the Venn Diagram for assessing risk relationships.
P	Be able to describe the practices of Fault Tree Analysis, Cause/Effect and Root Cause Analysis.
P	Be able to describe the concept and application of Risk Registers.
P	Be able to distinguish between risks and opportunities and risks and issues and concerns.
P	Risk Analysis
P	Be able to describe the general principles for risk analysis and contingency estimating Methods.
P	Be able to describe the recommended practices for risk analysis and contingency Determination.
P	Be able to describe the recommended practices for estimating escalation and related methods for currency risks.
P	Be able to describe the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	Risk Factor Screening
P	Be able to describe the concept of qualitative risk analysis, expected value, and the Risk Matrix (probability vs. impact).
P	Be able to describe the use of Tornado diagrams for communicating risk ranking.
P	Risk Mitigation or Acceptance Risk Treatment/Response Planning
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	Be able to describe the practices of contingency planning (contingent response planning) and workarounds.
P	Risk Control
P	Be able to describe how RM is integrated with the Change Management process.
P	Be able to describe how RM is integrated with the Forecasting process.
P	2.2.2. Risk Management Processes
P	Risk Management Planning: Be able to describe why this step begins with establishing RM objectives considering both strategic asset management requirements as well as tactical requirements for the project, activity or other alternatives being evaluated.
P	Planning and Risk Maturity Models: Be able to describe the concept and use of Risk Maturity Models.

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P	Risk Assessment
P	Be able to describe the basic practices of risk elicitation and identification (e.g., surveys, brainstorming, delphi, etc.).
P	Be able to describe the concept of the Venn Diagram for assessing risk relationships.
P	Be able to describe the practices of Fault Tree Analysis, Cause/Effect and Root Cause Analysis.
P	Be able to describe the concept and application of Risk Registers.
P	Be able to distinguish between risks and opportunities and risks and issues and concerns.
P	Risk Analysis
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to describe the the recommended practices for risk analysis and contingency determination.
P	Be able to describe the recommended practices for estimating escalation and related methods for currency risks.
P	Be able to describe the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	Risk Factor Screening
P	Be able to describe the concept of qualitative risk analysis, expected value, and the Risk Matrix (probability vs. impact).
P	Be able to describe the use of Tornado diagrams for communicating risk ranking.
P	Risk Mitigation or Acceptance Risk Treatment/Response Planning
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	Be able to describe the practices of contingency planning (contingent response planning) and workarounds.
P	Risk Control
P	Be able to describe how RM is integrated with the Change Management process
P	Be able to describe how RM is integrated with the Forecasting process
P	2.2.3. Process Alignment with Objectives
P	Risk Management Plan
P	Risk Management Planning: Be able to describe why this step begins with establishing RM objectives considering both strategic asset management requirements as well as tactical requirements for the project, activity or other alternatives being evaluated.
P	Planning and Risk Maturity Models: Be able to describe the concept and use of Risk Maturity Models
P	2.2.4. Planning for Risk Management
P	Risk Management Plan
P	Contingency (see cost estimating and schedule development).
P	Be able to describe the appropriate level of authority for managing contingency.
P	Be able to describe typical criteria for its use (i.e., as opposed to a slush fund).
P	Contingency Action Plans.
P	Risk Management Planning: Be able to describe why this step begins with establishing RM objectives considering both strategic asset management requirements as well as tactical requirements for the project, activity or other alternatives being evaluated.
P	Planning and Risk Maturity Models: Be able to describe the concept and use of Risk Maturity Models.
P	2.2.5. Risk Assessment: Identification and Causation
P	Causation: Be able to describe the concepts of causation and correlation versus causation.
P	Risk Assessment.

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P	Be able to describe the basic practices of risk elicitation and identification (e.g., surveys, brainstorming, delphi, etc.).
P	Be able to describe the concept of the Venn Diagram for assessing risk relationships.
P	Be able to describe the practices of Fault Tree Analysis, Cause/Effect and Root Cause Analysis.
P	Be able to describe the concept and application of Risk Registers.
P	Be able to distinguish between risks and opportunities and risks and issues and concerns.
P	2.2.6. Risk Assessment: Analysis
P	Be able to describe the concept of conditional branching and its potential application in schedule models to support risk analysis.
P	Be able to describe the concept of static (fixed) vs. dynamic (conditional) logic in respect to CPM schedule analysis using Monte-Carlo Simulation.
P	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality in regards to schedule risk analysis.
P	Be able to differentiate between schedule contingency and float.
P	Be able to describe the concept of merge bias in probabilistic schedule modeling.
P	Be able to describe the importance of considering cost and schedule tradeoff in schedule planning.
P	Be able to describe the importance of schedule model (logic) quality to CPM based schedule risk Analysis.
P	Be able to describe the concepts of acceleration and crashing as approaches for risk treatment and Response.
P	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P	Risk Evaluation and Contingency Determination.
P	Be able to describe how to apply risk analysis to an estimate to support contingency Determination.
P	Risk Analysis
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to describe the recommended practices for risk analysis and contingency determination.
P	Be able to describe the recommended practices for estimating escalation and related methods for currency risks.
P	Be able to describe the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	Risk Factor Screening
P	Be able to describe the concept of qualitative risk analysis, expected value, and the Risk Matrix (probability vs. impact).
P	Be able to describe the use of Tornado diagrams for communicating risk ranking.
P	2.2.7. Risk Treatment (Including Response and Allocation)
P	Bonds (bid, payment, or performance)
P	Retainage
P	Performance guarantees
P	Liquidated damages
P	Contingency Action Plans
P	Risk Mitigation or Acceptance Risk Treatment/Response Planning
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	Be able to describe the practices of contingency planning (contingent response planning) and workarounds.

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P	Risk Allocation: Be able to explain how each contract type above allocates risks between the contracting parties.
P	Bid bond and contract (performance) bond.
P	Performance guarantee.
P	Warranties.
P	2.2.8. Risk Control (Including Communication and Monitoring)
P	Be able to describe the appropriate level of authority for managing contingency.
P	Be able to describe typical criteria for its use (i.e., as opposed to a slush fund).
P	Risk Control
P	Be able to describe how RM is integrated with the Change Management process.
P	Be able to describe how RM is integrated with the Forecasting process.
P	Risk: Be able to explain the monitoring and assessment of risk factors in accordance with a risk a management plan.
P	Risk Assessment: Be able to explain the monitoring and assessment of risk factors in accordance with a risk a management plan.
P	Be able to describe how earned value metrics might provide risk control information.
P	Be able to describe how the change management and risk management processes are closely aligned during project execution.
P	2.3. Specific Risk Management Practices
P	2.3.1. Risk Assessment
P	Objectives and risk: given that risk is "an uncertain event or condition that could affect a project objective" Be able to describe how poorly understood objectives affects decision and risk management effectiveness.
P	Risk Factor Screening.
P	2.3.1.1. Fault Tree Analysis, Cause/Effect Analysis.
P	Be able to describe the practices of Fault Tree Analysis, Cause/Effect and Root Cause Analysis.
P	2.3.2. Risk Treatment
P	Risk Mitigation or Acceptance Risk Treatment/Response Planning.
P	Be able to describe the categories of risk treatments for threats and for opportunities.
P	2.3.2.1. Contingency Planning/Contingent Response.
P	Contingency Action Plans.
P	Be able to describe the practices of contingency planning (contingent response planning) and workarounds.
P	2.3.3. Quantitative Risk Analysis
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P	Risk Analysis.
P	2.3.3.1. Contingency (Cost and Schedule) and Reserves.
P	Risk and Uncertainty: Be able to describe these costs:
P	Contingency
P	Allowance
P	Reserve
P	Be able to describe the concept of conditional branching and its potential application in schedule models to support risk analysis.
P	Be able to describe the concept of static (fixed) vs. dynamic (conditional) logic in respect to CPM schedule analysis using Monte-Carlo Simulation.
P	Be able to describe the concepts of near critical path, sensitivity, cruciality, and criticality in regards to schedule risk analysis.
P	Be able to differentiate between schedule contingency and float.

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P	Be able to describe the concept of merge bias in probabilistic schedule modeling.
P	Be able to describe the importance of considering cost and schedule tradeoff in schedule planning.
P	Be able to describe the importance of schedule model (logic) quality to CPM based schedule risk analysis.
P	Be able to describe the concepts of acceleration and crashing as approaches for risk treatment and response.
P	Schedule Contingency:
P	Be able to define the term including what it is supposed to cover.
P	Be able to describe several typical ways that it can be assessed.
P	Be able to describe the concept of delay risk impacts and its implications for schedule planning and development using different modeling methods.
P	Be able to describe the concept of accuracy in statistical terms (i.e., confidence intervals).
P	Contingency:
P	Be able to define the term including what cost it is supposed to cover.
P	Be able to describe several typical ways that it can be estimated.
P	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
P	Risk Evaluation and Contingency Determination
P	Be able to describe how to apply risk analysis to an estimate to support contingency Determination.
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to describe the recommended practices for risk analysis and contingency Determination.
P	Be able to describe the recommended practices for integrated cost and schedule risk analysis and contingency determination.
P	2.3.3.2. Escalation, Inflation, Currency
P	Cost of money: Be able to describe these costs:
P	Escalation
P	Inflation
P	Currency exchange rates
P	Be able to describe the general principles for risk analysis and contingency estimating methods.
P	Be able to describe the recommended practices for estimating escalation and related methods for currency risks.
P	2.3.4. Risk Control
P	Risk Control
P	2.3.4.1. Change Management (Integration with Risk Management)
P	Be able to describe how RM is integrated with the Change Management process.
P	Be able to describe how earned value metrics might provide risk control information .
P	Contingency, Allowances, and Reserves (see Risk Management).
P	Be able to describe how the change management and risk management processes are closely aligned during project execution.
P	Manage contingency and reserves:
P	Draw down: Be able to describe methods for managing contingency.
P	Be able to describe ways to assess the need for contingency for work in progress.
P	2.3.4.2. Forecasting (Integration with Risk Management)
P	Be able to describe how RM is integrated with the Forecasting process.

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P	Be able to describe how Risk Management may be applied context of work in progress, performance assessment findings, change management, and corrective actions.
P/S	3. Decision Management Skills and Knowledge
P/S	3.1. Overall Decision Management Terms/Concepts
P	3.1.1. Risk (re: Section 2)
P	General Concepts:
P	Be able to describe the concept of "decisions under uncertainty or risk".
P	3.1.2. Value/Utility
P	Be able to describe the increasing importance of the topics that follow as objectives, their contribution to risk, and their consideration in decision making (e.g., multi-attribute decision making.)
P	Be able to describe the concept of putting a value (utility) on the stated objectives of the enterprise and/or perceived preferences, wants and needs of stakeholders in order to perform decision analysis.
P	Be able to describe typical methods of valuation using monetary equivalents or expected monetary value (EMV).
P	Be able to describe the concepts and relationships of risk premium, certainty equivalent, and EMV in respect to decision making between alternatives.
P	Be able to describe the concepts of utility and utility functions in respect to decision maker preferences and risk attitudes.
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to describe the mechanics of addressing non-cash value and risk considerations in a monetary decision model.
P	3.1.3. Decision Policy/Criteria
P	Be able to describe what is a decision and what is a "good decision".
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to describe how the decision analysis and making process may differ between major or strategic decisions and minor or tactical one.
P	Be able to describe the role of judgment and expert opinion in decision making, considering bias and other human factors.
P	Decision Policy / Criteria:
P	Be able to describe the role of decision policy in consistent asset investment strategy deployment.
P	Be able to explain why decision policy for most corporations establishes net present value and return on investments (or equivalent) as primary decision criteria.
P	Be able to describe the general topics that a typical decision policy addresses.
P	Balanced Scorecard
P	Key Performance Indicators (KPI)
P	Profitability: see return on investment
P/S	3.1.4. Economic/Financial Analysis
P	Be able explain the concepts and perform the analyses covered previously in the Economic and Financial Analysis section.
P	Be able to evaluate and select the best alternative from several alternatives using these methods.
P	Net Present Value
P	Decision Tree (probability weighted present value):
P	Discounted Rate of Return (breakeven)

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S	Business Decision Basis or Business Case: Be able to describe the information (e.g., objectives, assumptions, constraints, etc.) that should be communicated to the project team.
S	Capital Budgeting. Be able to describe the mechanics of investment decision making in a typical enterprise capital budgeting process.
S	Portfolio Management. Be able to describe the affect of portfolio considerations (multiple and often competing assets and projects) on investment decision making and capital budgeting processes.
P	Profitability: see return on investment
P	3.1.5. Modeling, Sensitivity, Scenarios.
P	Be able to describe the increasing importance of the topics that follow as objectives, their contribution to risk, and their consideration in decision making (e.g., multi-attribute decision making).
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to able to explain the benefits of using a cost-based, quantitative decision model that addresses probabilities.
P	Be able to evaluate and select the best alternative from several alternatives using these methods.
P	Net Present Value
P	Decision Tree (probability weighted present value):
P	Discounted Rate of Return (breakeven)
P	Be able to describe the concept and application of Influence Diagrams in Decision Analysis.
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Heirarchy Process.
P	Sensitivity Analysis and Monte Carlo Simulation: Be able to discuss mechanics of using a decision model to assess probable outcomes.
P	Be able to describe how sensitivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).
P	3.1.6. Expert Judgment/Diversity
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to describe how the decision analysis and making process may differ between major or strategic decisions and minor or tactical one.
P	Be able to describe the role of judgment and expert opinion in decision making, considering bias and other human factors.
P	Be able to describe the concept and application of Influence Diagrams in Decision Analysis.
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Heirarchy Process.
P	Be able to describe how sensititivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).
P	3.2. Processes and General Practices for Decision Management
P	3.2.1. Decision Making and TCM
P	Be able to describe the processes of Investment Decision Making and Risk Management in TCM and their main interactions with other TCM processes. Also Be able to desribe the concept of ERM.
P	Be able to describe other common industry RM processes (e.g., PMI, ISO, COSO) and variations (e.g., ERM) and differences with TCM in respect to decision making and risk quantification.
P	Investment Decision Making
P	General Concepts:
P	Be able to describe the following concepts related to decision making:

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P	Be able to describe the steps in the TCM Investment Decision Making process including the initial planning step.
P	Be able to describe the steps of the Decision Analysis process and how they align with the TCM Asset Planning and Investment Decision Making processes.
P	3.2.2. Decision Analysis
P	Objectives and risk: given that risk is "an uncertain event or condition that could affect a project objective" Be able to describe how poorly understood objectives affects decision and risk management effectiveness.
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to describe how the decision analysis and making process may differ between major or strategic decisions and minor or tactical one.
P	Be able to describe the role of judgment and expert opinion in decision making, considering bias and other human factors.
P	Decision Analysis:
P	Be able to describe the steps of the Decision Analysis process and how they align with the TCM Asset Planning and Investment Decision Making processes.
P	Be able to describe the differences between Decision Analysis and Optimization.
P	Decision Model:
P	Be able to able to explain the benefits of using a cost-based, quantitative decision model that addresses probabilities.
P	Be able to describe the application of MCS to a decision tree model.
P	3.2.3. Planning for Decision Making (Decision Policy)
P	Be able to describe the steps in the TCM Investment Decision Making process including the initial planning step.
P	3.2.4. Decision Modeling
P	Be able to describe the increasing importance of the topics that follow as objectives, their contribution to risk, and their consideration in decision making (e.g., multi-attribute decision making).
P	Be able to describe the role of behavioral psychology, advocacy and bias in decision making and challenges to formalized, structured decision making methods.
P	Be able to able to explain the benefits of using a cost-based, quantitative decision model that addresses probabilities.
P	Be able to describe the mechanics of addressing non-cash value and risk considerations in a monetary decision model.
P	Be able to evaluate and select the best alternative from several alternatives using these methods.
P	Net Present Value
P	Decision Tree (probability weighted present value):
P	Be able to describe the application of MCS to a decision tree model.
P	Discounted Rate of Return (breakeven)
P	Cost/Benefit Ratio
P	Be able to describe the concept and application of Influence Diagrams in Decision Analysis.
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Hierarchy Process.
P	Sensitivity Analysis and Monte Carlo Simulation: Be able to discuss mechanics of using a decision model to assess probable outcomes.
P	Be able to describe how sensitivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).

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P	3.2.5. Implement Decision (Business Case)
P	Business Decision Basis or Business Case: Be able to describe the information (e.g., objectives, assumptions, constraints, etc) that should be communicated to the project team.
P	Capital Budgeting. Be able to describe the mechanics of investment decision making in a typical enterprise capital budgeting process.
P	Portfolio Management. Be able to describe the affect of portfolio considerations (multiple and often competing assets and projects) on investment decision making and capital budgeting processes.
P	3.2.6. Implement Decision
P	Project Implementation: Be able to explain the following concepts:
P	Phases and Gates Process: Be able to describe the typical stages in respect to project planning and funding authorization and the benefits of an established process.
P	Front-end loading (FEL): Be able to describe this concept and its benefits in terms of risk management and project control planning.
P	Project Implementation Basis or Scope Statement: Be able to describe the typical information in this deliverable at project initiation and the importance of business and project team agreement and communicating this information to all stakeholders.
P	Project control plan implementation: Be able to explain the following concepts:
P	Control Accounts: describe this concept and its content in relation to WBS and earned value Application.
P	Project Control Plan and Basis: Be able to describe the typical information in this deliverable at the start of project execution and the importance of integrating, agreeing on and communicating this information to the project team.
P	Validation: Be able to describe how the quality and competitiveness of plans might be assessed before implementation and why the process is important. Also explain the value of historical, empirical information.
P	3.3. Specific Decision Management Practices
P	3.3.1. Decision Trees (including Monte Carlo Simulation)
P	Net Present Value
P	Decision Tree (probability weighted present value):
P	Be able to describe the application of MCS to a decision tree model.
P	3.3.2. Influence Diagrams (Decision Diagrams)
P	Be able to describe the concept and application of Influence Diagrams in Decision Analysis.
P	Be able to describe the concepts and application of Multi-Attribute or Multi-Criteria decision analysis and modeling for complex decisions, including the Analytical Heirarchy Process.
P	Be able to describe how sensitivity analysis may be typically applied in less structured decision making (e.g., the typical variables that may or may not be assessed).
P	3.3.3. Monte Carlo Simulation (MCS)
P	Sensitivity Analysis and Monte Carlo Simulation: Be able to discuss mechanics of using a decision model to assess probable outcomes.
S	4. Other Functional Skills and Knowledge
S	4.1. Total Cost Management
S	Total Cost Management (TCM) Process
S	Overall TCM Process and Terminology
S	Basic Terminology: Be able to explain the following:
S	Plan-Do-Check-Assess (PDCA):
S	Strategic asset
S	Project
S	Portfolios and Programs

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S	TCM Processes: Be able to sketch the TCM, strategic asset management, and project control processes in basic PDCA format and explain the following:
S	The cost management purpose of the overall processes.
S	How the two component subprocesses differ, but are related to each other.
S	The benefits of an integrated, systematic cost management approach over the life cycle of assets and projects.
S	Strategic Asset Management Process
S	Given a representation of the strategic asset management process map (or some portion of it), be able to describe the basic purpose of each step and how it relates to the other steps in the map.
S	Project Control Process
S	Given a representation of the project control process map (or some portion of it), be able to describe the basic purpose of each step and how it relates to the other steps in the map.
S	Be able to describe the Earned Value management process as a specific way of applying the project control process (i.e., in what ways is it specialized).
S	4.2. Planning
S	Planning
S	Requirements Elicitation and Analysis: Be able to describe the following concepts
S	Stakeholders/Customers: Be able to describe how to identify these in relation to various business problems.
S	Needs, wants, or expectations of stakeholders: Be able describe challenges of eliciting this information from various stakeholders.
S	Requirements: Be able to describe the characteristics of a good requirement for use in asset or project control planning.
S	Cost requirements: Be able to describe the following asset planning methodologies for which cost may be a requirement.
S	Target costing (including design-to-cost, and cost as an independent variable).
S	Quality-function deployment.
S	Other Concepts:
S	Asset vs. Project: Be able to explain how requirements for an asset or product might differ from those for a project.
S	Scope and Execution Strategy Development: Be able to describe the following concepts.
S	Asset scope: Be able to describe this as the physical, functional and quality characteristics or design basis of the selected asset investment.
S	Functional decomposition.
S	Project scope: Be able to describe this as the scope of work to deliver the asset.
S	Project scope breakdown (work decomposition).
S	Work Breakdown Structure (WBS): Be able to diagram a WBS for a basic scope provided in narrative form.
S	Organization Breakdown Structure (OBS): Be able to diagram an OBS for a basic scope provided in narrative form.
S	Work package
S	Deliverables
S	Execution strategy
S	4.3. Schedule Planning and Development
S	Schedule Planning and Development: Be able to describe the following concepts:
S	Schedule Planning
S	Activities
S	Activity Logic and Logic Diagramming:

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S	Given a series of logic statements, Be able to draw a logic diagram.
S	Given a soft-logic work package with no strict activity interrelationships, Be able to describe ways to do schedule planning for this work.
S	Be able to describe how schedule planning differs between a batch and a continuous process.
S	Be able to describe the concept of linear scheduling.
S	Activity Duration
S	Critical Path: Be able to define and identify the critical path(s) in a project schedule.
S	Float: Be able to describe the relationship and significance of total and free float in the scheduling of an activity.
S	Schedule Models: Using the PDM method, and given a logic diagram and durations for activities, be able to calculate the early start and finish, late start and finish, and total and free float times for all activities. Identify minimum project completion time.
S	Precedence Diagram Method (PDM): in using this method include at least on each finish-start, finish-finish, start-finish, and start-start relationships with lags and identify critical path(s).
S	Bar chart/Gantt chart:
S	Be able to explain the difference between this and a logic diagram.
S	Given network activity durations, early and late start and finish times, and total float, be able to draw a bar chart based on early start of all activities, and show total float of activities where applicable.
S	Historical Data: Be able to describe the importance of historical, empirical data and databases to schedule planning and schedule development.
S	Schedule Development: describe difference from schedule planning.
S	Milestones
S	Resource Loading
S	Resource Leveling or Balancing: for a simple PDM network with resource inputs, be able to resource level the network within early and late start limits, and draw a histogram of worker-loading for early start, late start, and resource leveled configurations.
S	Schedule Control Basis
S	Schedule Control Baseline
S	Be able to describe the concept of short interval scheduling (SIS) in relation to an overall project schedule control baseline.
S	Planned Schedule
S	Schedule Basis
S	Other Concepts:
S	Programs and Portfolios: Be able to explain these concepts and how schedule planning and development might be handled for groups of projects.
S	Operations/Production: Be able to explain how production scheduling differs from project scheduling.
S	Schedule strategy
S	Be able to describe the characteristics and risks of a fast track schedule.
S	Be able to describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (e.g., crashing).
S	Be able describe the characteristics and risks of just-in-time (JIT) scheduling.
S	Schedule Development:
S	Be able to describe the concept of development by schedule level.
S	Be able to describe the concept of rolling wave development.
S	Schedule Change Management: Be able to describe how schedule changes might be managed.

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S	Critical Chain: Be able to describe the concept.
S	Linear Scheduling: Be able to describe the concept.
S	Schedule Contingency:
S	Be able to define the term including what it is supposed to cover.
S	Be able to describe several typical ways that it can be assessed.
S	4.4. Estimating and Budgeting
S	Cost Estimating Skills and Knowledge: Be able to describe the following concepts:
S	General Concepts (must also understand Elements of Cost and Analysis):
S	Cost Estimating Terminology.
S	Cost Estimate Classification. Be able to describe AACE’s recommended practice and its basis on scope definition (also see project implementation for discussion of scope development phases).
S	Estimate Variability.
S	Be able to describe the elements, conditions, activities, etc. that may affect estimate variability.
S	Uncertainty.(also see Risk Management)
S	Probability: Be able to describe the probabilistic nature of cost estimates and the concept of ranges and accuracy, and the importance of communicating these to the project team.
S	Accuracy: Be able to describe asset and project characteristics likely to affect the accuracy of cost estimates, and the relationship of estimate classification to accuracy.
S	Contingency:
S	Be able to define the term including what cost it is supposed to cover.
S	Be able to describe several typical ways that it can be estimated.
S	Algorithms and Cost Estimating Relationships (CER).
S	Algorithm types: Be able to describe the basic characteristics of these algorithm types:
S	Stochastic or parametric.
S	Given the inputs, Be able to perform a “scale of operations” estimate.
S	Be able to explain why this algorithm type is most often applied in asset planning.
S	Deterministic or definitive: Be able to explain why this algorithm type is most often applied in project control planning.
S	Factors:
S	Be able to describe some typical uses of factors, ratios, and indices in algorithms of various types.
S	Given a set of project characteristics and associated factors, be able to adjust a cost estimate from one time, location, situation, currency, etc. to another.
S	Chart or Code of Accounts: Be able to describe the characteristics of a good code account structure and its benefits for estimating and project control.
S	Historical Data: Be able to describe the importance of historical, empirical data and databases to cost estimating.
S	Processes and Practices: Be able to describe the basic mechanics of these estimating steps.
S	Plan for Estimating and Budgeting
S	Be able to describe practices for assessing estimate requirements.
S	Be able to describe practices for researching, collecting and analyzing information.
S	Be able to describe practices for developing the estimate structure.
S	Estimate Methodologies
S	Be able to describe and apply the estimating methodology using Investment Curves.
S	Be able to describe and apply the estimating methodology using Capacity Factoring.
S	Be able to describe and apply the estimating methodology using Analogy.
S	Be able to describe and apply the estimating methodology using Parametric Models.

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S	Be able to describe how a parametric model may explicitly incorporate probabilistic properties.
S	Be able to describe and apply the estimating methodology using Equipment Factoring.
S	Be able to describe and apply the estimating methodology using Detailed Line-Item Estimating.
S	Quantification and Take-off:
S	Be able to describe how to quantify the project scope in an applicable manner.
S	Be able to describe ways that this step is sometimes automated, and considerations for using the results of automated take-off.
S	Costing:
S	Be able to describe how to apply baseline costs to the scope quantities.
S	Pricing:
S	Be able to describe how to adjust baseline costs for commercial or other considerations.
S	Be able to discuss some business considerations for establishing pricing (risk, competition, desired rate of return, current economic conditions, etc.).
S	Given a basic set of cost inputs and production plans Be able to calculate a break-even product price.
S	Estimate Conditioning:
S	Be able to describe how to apply overall estimating adjustments, such as escalation.
S	Risk Evaluation and Contingency Determination
S	Be able to describe how to apply risk analysis to an estimate to support contingency determination.
S	Estimate Documentation:
S	Be able to describe the typical content of estimate documentation.
S	Be able to describe how to document the Basis of Estimate.
S	Estimate Reconciliation:
S	Be able to explain differences between the current estimate with previous versions; and provide resolutions.
S	Estimate Review and Validation:
S	Be able to effectively review and validate the estimate, including providing estimate Benchmarking.
S	Estimate Reporting:
S	Be able to summarize and communicate the estimate content to stakeholders.
S	Estimate Closeout:
S	Be able to document, analyze, organize and archive estimate information for future use.
S	Other Estimating Issues
S	Bidding
S	Be able to discuss some considerations for using someone else's bid as an input to your cost estimate.
S	Be able to describe the purpose and mechanics of unbalancing or front-end loading a bid.
S	Budgeting: Be able to describe the mechanics of creating a control budget from a cost estimate.
S	Costing and Life Cycle Costing (see algorithms); Be able to explain the concept of project versus life cycle costing.
S	Cash Flow and Forecasting:
S	Be able to discuss the importance of integrating estimating and scheduling practices (incorporating the element of timing in quantification and costing).
S	Be able to discuss the affects on planning and cost estimating when cash flow is restricted.
S	Given a schedule and set of cost inputs, Be able to develop a cost flow curve.

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S	Cost Control Baseline: Be able to describe how cost and schedule control baselines can be integrated.
S	Other Concepts:
S	Product vs. Project costs: Be able to explain how estimating product (i.e., output of manufacturing) cost differs from project cost.
S	4.5. Resource Planning
S	Resource Management: Be able to describe how this process is tied closely to cost estimating (e.g., quantification) and schedule development (e.g., resource allocation).Also see performance / productivity management considerations
S	Resource availability: Be able to discuss ways to assess availability and potential consequences of not doing so.
S	Be able to describe the types of resources and their appropriateness to analysis.
S	Be able to discuss potential sources for resources.
S	Be able to discuss methods for validation of initial estimates.
S	Resource limits and constraints: Be able to discuss typical limits and constraints that may occur or be imposed.
S	Be able to discuss the role supervision and span of control has on resource limits.
S	Be able to describe how optimal and maximum crew sizing may play a part.
S	Be able to discuss the effects of physical workspace limits.
S	Resource allocation: Be able to describe the mechanics of this step in schedule development.
S	Forward vs. backward allocation: Be able to explain the differences in the methods.
S	Smoothing vs. maximum limits: Be able to explain the difference in the terms.
S	Maximum vs. over-maximum allocation: Be able to explain the differences in the terms.
S	4.6. Value Analysis and Eng / Value Management
S	Value Analysis and Engineering: Be able to describe the following concepts:
S	General Concepts:
S	Purpose:
S	Be able define the concept (i.e., “the systematic application of recognized techniques which identify the functions of the product or service, establish the worth of those functions, and provide the necessary functions to meet the required performance at the lowest overall cost.” Where overall cost is usually life-cycle cost).
S	Distinguish among the terms “lowest life-cycle cost”, “best quality”, and “best value”.
S	Be able to describe how value analysis/engineering differs from other cost or scope reduction Exercises.
S	Be able to describe how value analysis and engineering differs from other value improving practices such as manufacturability and constructability.
S	Value: Be able to explain the this general concept as well as the meanings, using examples if desired, of these four kinds of value that may be associated with an item:
S	Use value
S	Esteem value
S	Exchange value
S	Cost value
S	Functions
S	Process/Practices; Be able to describe the purpose and mechanics of these steps:
S	Function Analysis (Value Measurement)
S	Creativity
S	Describe each of the following problem solving techniques:
S	Brainstorming

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S	Checklists
S	Morphological analysis
S	Attribute listing
S	Value Screening
S	4.7. Procurement Planning (Including Contract Management)
S	Overhead and profit: Be able to describe the basic mechanics of charging various overhead and profit cost elements to direct labor costs such as:
S	Indirect labor (home office, administrative and similar costs)
S	Small tools
S	Profit
S	Union: Be able to explain the cost differences between union and open shop labor.
S	Subcontract: Be able to explain the cost implications of the following issues:
S	Reimbursable vs. non-reimbursable costs
S	Overhead and profit (including contract administration and legal costs)
S	License, fees or royalties
S	Bonds (bid, payment, or performance)
S	Retainage
S	Performance guarantees
S	Liquidated damages
S	Cost of money: Be able to describe these costs:
S	Escalation
S	Inflation
S	Currency exchange rates
S	Risk and Uncertainty: Be able to describe these costs:
S	Contingency
S	Allowance
S	Reserve
S	Procurement Planning and Contract Management
S	Contract types: Be able to explain the advantage and disadvantages of these types of contracts from the owner and contractor viewpoints:
S	Fixed price (with fixed, incentive, or award fees)
S	Unit price
S	Cost-plus (with fixed, incentive, or award fees)
S	Time and materials (T&M)
S	Risk Allocation: Be able to explain how each contract type above allocates risks between the contracting parties.
S	Contract Documents:
S	Be able to describe the general contents and purposes of the following elements of bidding and contract documents:
S	Invitation to bid or request for proposal
S	Bid form
S	Agreement
S	General conditions
S	Supplementary or special conditions
S	Technical specifications
S	Drawings
S	Addenda
S	Modifications

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S	Bid bond and contract (performance) bond
S	Performance guarantee
S	Warranties
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe the various types of insurance that may be required as part of a contract
S	Be able to explain the term "retention" and Be able to calculate its effective cost given the terms of the contract and time-value of money.
S	Be able to distinguish between "job (project) overhead" and "general overhead" and provide examples of each.
S	Be able to explain what is meant by a contract payment term such as "2/15 net 30", and given a payment timing and time value of money scenario, Be able to determine the method of payment that is economically most advantageous under these terms.
S	Be able to explain contract payment terms and how they may expose the parties to risk (e.g., payment not commensurate with work performed, unbalancing, etc.).
S	Be able to describe the risks of various contract types when markets are not competitive.
S	Integrated Project Control:
S	Be able to explain the basic mechanics of how the project control process might be integrated between parties to each type of contract. (e.g., how to measure and report progress, integrate schedules, etc.).
S	Be able to explain the role of contract documents in avoiding and resolving disputes, changes and claims (also see Change Management).
S	Be able to describe how contracting various DRM roles and responsibilities may affect the performance of the DRM process and may lead to systemic risks due to complexity, delay, poor communication, biases, and so on.
S	Changes and Claims: (see Change Management and Forensic Performance Assessment)
S	Other Concepts:
S	Supply chain: Be able to explain this concept and how it might affect procurement planning.
S	Supplier relationships: Be able to explain this concept and how it might affect procurement planning (e.g., initial price versus life cycle cost).
S	Schedule of values: Be able to explain this concept in regards to contracts, change management, and project control for contracted work.
S	4.8. Performance Measurement and Assessment
S	Enterprise Resource Planning/Management (ERP/ERM): Be able to describe the goal of these types of systems (support efficient business processes, including project management, through shared or common databases).
S	Performance Measurement
S	Cost Accounting: Be able to describe the interface of the accounting process with cost engineering Practice.
S	Cash and Accrual Accounting. Be able to describe these concepts.
S	Initiation/closure: Be able to discuss the importance of timely management of cost accounts.
S	Review/correct: Be able to discuss ways to deal with and the affects on project control of mischarges.
S	Control and Cost Accounts: Be able to discuss the role of the chart or code of accounts with integrating project control.
S	Classify and account: Be able to explain the role of the cost engineer in assuring that cost accounting information is accounted for so as to align with the control basis. Be able to describe these cost accounting concepts:
S	Expenditures (i.e., cash disbursements)

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S	Incurring Costs (i.e., expended plus cost of work performed but not paid for yet)
S	Commitments (i.e., including expended costs and financial obligations)
S	Cost Allocation
S	Activity-Based Costing (ABC)
S	Capitalization and Depreciation: Be able to explain these concepts and the typical role of the cost engineer in working with the finance function to assure it is done effectively.
S	Asset vs. Project Accounting:
S	Be able to describe how traditional asset operation and finance focused accounting differs from that needed for project control.
S	Be able to describe how legacy or contractor cost accounting system accounts are often not consistent with project control needs, and how the inconsistency may be addressed.
S	Project Performance Measurement
S	General Concepts
S	Earned Value: Be able to explain the general concept and the importance of and reliable control basis and objective, quantitative physical progress measures.
S	Practices
S	Physical Progress: Be able to explain the general concept and the following methods, and, given input information, Be able to calculate percent complete.
S	Units completed
S	Incremental milestone
S	Weighted or equivalent units completed
S	Resource expenditure
S	Judgment
S	Track Resources
S	Labor hours: Be able to explain the advantages and disadvantages of tracking labor hours instead of cost as the basis for earned value.
S	Material management and fabrication: Be able to discuss how material progress/status can be measured.
S	Measure Performance (how work is being done)
S	Be able to discuss why earned value measures alone have limited value in finding ways to improve performance.
S	Be able to discuss the mechanics of the following methods, how they can help find ways to improve performance, and their strengths and weaknesses:
S	Work sampling
S	Time and motion studies
S	Time lapse photography and video monitoring
S	Expediting
S	Inspection
S	Status Schedule: Be able to discuss the mechanics of statusing and updating a schedule.
S	Asset Performance Measurement: Be able to explain how earned value methods do not apply for operations and performance is measured against metrics established by the requirements.
S	Functional Performance: Be able to explain how measures capture what an asset does and how it does it including quality control attributes, cycle time, and so on.
S	Utility measures: Be able to discuss ways to capture user or customer perceptions of how well the asset meets their wants and needs.
S	Measure Activity Factors: Be able to explain how if ABC/M methods are used, cost assignment network tracing ties expenses to activities whose performance must be measured.
S	Track Resources: Be able to explain how ERP systems increasingly handle these measures in operation facilities.

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S	General Concepts
S	Variance: Be able to describe this concept as an empirical difference between actual and planned performance for any aspect of the control plan.
S	Trends: Be able to describe the difference between random and non-random variance and how this might influence subsequent control actions and forecasts.
S	Practices for control assessment: Be able to describe methods for assessing and reporting performance (variances and trends) against the following baseline plans:
S	Cost:
S	Be able to describe basic earned value methods
S	Be able to describe and prepare tabular and cumulative distribution charts (“s-curves”) for reporting.
S	Schedule:
S	Be able to describe methods to identify variance (e.g., calculate slip, earned value methods, etc), assess critical path and remaining float.
S	Be able to describe performance reporting methods (e.g., schedule plot showing the planned and actual schedule activity status), tables showing a percentage or factor that expresses the extent that the schedule is ahead or behind at given points in time, lists of activities sorted by early start date or total float, etc.).
S	Resources
S	Labor
S	Be able to describe basic earned value methods
S	Be able to describe and prepare tabular and cumulative distribution charts (“s-curves”) for reporting
S	Material and fabrication: Be able to describe the use earned value, schedule assessment, material management reports, and so on.
S	Risk: Be able to explain the monitoring and assessment of risk factors in accordance with a risk a management plan.
S	Practices for integrated earned value (Earned Value Management System or EVMS) assessment.
S	Be able to explain and calculate all the basic earned value measures and indices (Planned and/or Budget [was BCWS], Earned [was BCWP], and Actual [was ACWP], SV, CV, SPI, CPI).
S	Be able to describe the advantages and disadvantages of a fully integrated EVMS assessment using costs.
S	Practices for work process and productivity improvement.
S	Productivity assessment.
S	Labor productivity factor: Be able to calculate this using earned value and explain its Significance.
S	Work process improvement.
S	Work sampling: Be able to describe the mechanics of the method and how it can be used to eliminate wasted effort and improve the work process.
S	Be able to describe other methods such as informal sampling, manpower surveys, time card notations, quality circles, inspection observations, etc.
S	Asset Performance Assessment: Be able to explain how for operations, earned value methods do not apply and performance is measured against metrics established by the requirements.
S	Measurement Basis: Be able to describe these concepts for measuring and assessing asset management performance (profitability being the most common metric):
S	Balanced Scorecard
S	Key Performance Indicators (KPI)
S	Practices
S	Profitability: see return on investment

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S	Cost of Quality:
S	Be able to describe the mechanics of the method and costs of prevention, appraisal and failure.
S	Be able to explain how the method can lead to corrective actions.
S	Benchmarking: Be able to describe the purpose and mechanics of a benchmarking study.
S	Lessons Learned. Be able to explain the purpose and mechanics of capturing and evaluating lessons learned.
S	Risk Assessment: Be able to explain the monitoring and assessment of risk factors in accordance with a risk a management plan.
S	4.9. Change Management
S	Project Change Management
S	Basic Terminology: Be able to describe the concepts.
S	Scope: Be able to describe how the meaning of the term “scope” differs in the contexts of owner project funds authorization versus contracting.
S	Deviations
S	Changes: Be able to explain the difference between scope and non-scope changes in an owner funding context.
S	Changes and Contract Types: Be able to explain how the change order process may differ with different contract types.
S	Disputes and Claims
S	Contingency, Allowances, and Reserves (see Risk Management)
S	Practices: Be able to describe the concepts.
S	Variance or trend analysis: Be able to describe the difference between performance variance and a trend.
S	Impact assessment: Be able to describe how the project control planning concepts (e.g., estimating, scheduling, etc.) are applied in change management.
S	Be able to describe the concept of time impact analysis related to schedule change.
S	Make and track disposition.
S	Trends (also see performance assessment):
S	Corrective action (also improvement action): Be able to describe what these are and why they might be needed.
S	Be able to describe ways that change management findings and dispositions (actions) are recorded, reported, and incorporated in the project control plans.
S	Manage contingency and reserves:
S	Draw down: Be able to describe methods for managing contingency.
S	Be able to describe ways to assess the need for contingency for work in progress.
S	Resolve contract disputes and claims: Be able to discuss the concept of changes and change management in respect to contract agreements (also see Forensic Performance Assessment).
S	Asset Change (Configuration) Management
S	Requirements: Be able to explain how managing the scope of the “asset” in respect to its requirements in strategic asset management differs from managing the scope of “work” in project control.
S	Configuration Management: Be able to describe the role of this practice area in managing change in information that defines the asset.
S	4.10. Forecasting
S	Forecasting
S	Forecast and Forecasting.
S	Be able to describe the concepts of forecasts and forecasting.

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S	Be able to describe how the project control planning concepts (e.g., estimating, scheduling, etc.) are applied in the context of work in progress, performance assessment findings, change management, and corrective actions.
S	Earned Value Methods:
S	Be able to explain and calculate the basic earned value concepts related to forecasting (BAC, EAC, labor productivity factor).
S	Be able to explain why earned value measures alone may not be an appropriate basis for a forecast; explain what else must be considered.
S	4.11. Historical Database Management
S	Historical Database Management (see basic concepts in Information Management)
S	Empirical Data: Be able to explain why empirical information is the most fundamental planning resource available (why is it critical for asset and project planning?).
S	Project Closeout: Be able to describe the mechanics and challenges of closing out a project in respect to project control systems, data and information.
S	4.12. Forensic Performance Assessment
S	Forensic Performance Assessment
S	Be able to describe how forensic assessment differs from typical project control performance assessments (i.e., the primary purpose is to relate causation and responsibility (or entitlement) to performance to resolve disputes in a legal context and/or to gain knowledge to support long term performance improvement.
S	Be able to describe the difference between changes and claims (for scope, compensation, relief, damages, delay, or other disagreements).
S	Be able to describe major reasons for contract changes including the role of project scope Definition.
S	Be able to describe various types of schedule delay in respect to contract changes and claims:
S	Excusable
S	Non-excusable
S	Compensatory
S	Concurrent
S	Be able to describe the potential affects of disputes on project performance.
S	Be able to discuss role of these costs (see Elements of Cost) in context of disputes and claims (bonds, retainage, performance guarantees, liquidated damages, demurrage, legal costs, etc.).
S	Be able to discuss means and methods of resolving disputes and claims through negotiation, mediation, arbitration, and/or litigation (or other forms of alternative dispute resolution) including being able to discuss potential good points and bad points of each forum.
S	Be able to describe the terms discovery process, depositions and interrogatory.
S	Be able to describe why it is import to distinguish between supposition and fact.
S	Be able to describe how forensic performance assessment might interact with the risk management process steps (i.e., causation, lessons learned, impact assessment, etc.).

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