استراتژی پیاده‌سازی سیستم کنترل پروژه

برنامه‌ریزی + اجرا + اندازه‌گیری + ارزیابی

(بر اساس اسنادی از AACE و CII)

ارائه دهنده:

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What we will learn?

AACE and CII DOCUMENTS

Comprehensive Guideline

- Introduction
  - Purpose
  - Background
  - Using the project controls plan with a phased project process
  - Continuous improvement during the project life cycle
- Recommended practice
- The body of the project controls plan
  1. Project Controls Plan General Requirements
  2. Functional Applications of Project Controls (as per TCM Framework)
  3. Systems and Data Integrity Plan
  4. Communications Plan
  5. Project Controls Deliverables
  6. Project Controls Plan Implementation
- Supporting information for development and implementation

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What we will learn?

CII DOCUMENT

Model planning and controlling system for EPC of industrial projects

- Introduction
- Phases and their characteristics
  - Characteristics of the Conceptual Engineering Phase
  - Characteristics of the Detailed Engineering Phase
  - Characteristics of the Procurement Phase
  - Characteristics of the Construction Phase
  - Characteristics of the Start-Up Phase
- The control structure
  - The schedule
  - The budget
  - Breakdown structures
  - reporting

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What we will learn?

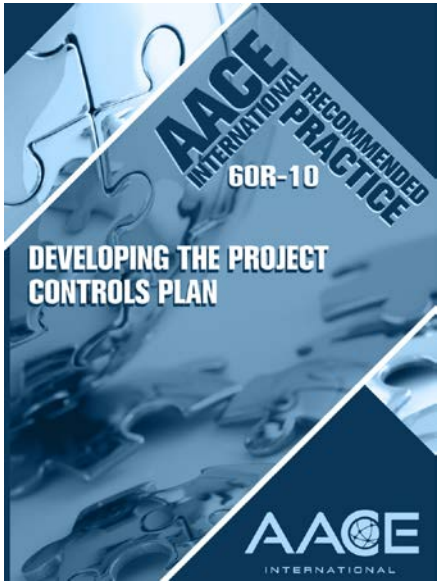
CII DOCUMENT

Model planning and controlling system for EPC of industrial projects

- Project control within phases
  - Approach
  - Start-Up Control
  - Construction Control
  - Procurement control
  - Detailed engineering control
  - Conceptual control
  - General logic diagram

Reference

Primary reference



IMPROVING PROJECT PROGRESS AND PERFORMANCE ASSESSMENT BY USING CORE PROJECT CONTROL METRICS

by

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A Report to
Construction Industry Institute
The University of Texas at Austin

Under the Guidance of
CII Research Team 322
Improving Project Progress and Performance

CII Research Report 322-11
November 2016

CONSTRUCTION INDUSTRY INSTITUTE

MODEL PLANNING AND CONTROLLING SYSTEM FOR EPC OF INDUSTRIAL PROJECTS

Bureau of Engineering Research
The University of Texas at Austin

Publication 6-3
April 1987

Introduction

RP intention

- This **recommended practice** is intended to serve as a guideline, not a standard.
- As a recommended practice of AACE International, the intent of the guideline is to

  improve the communication among stakeholders involved with

  1. Preparing,
  2. Evaluating, and
  3. Using

  project controls information.

- This recommended practice (RP) of AACE International defines

  1. Overall development,
  2. Implementation and
  3. Management

  of a project controls plan.

What this deliverable could do?

RP intention

- This **deliverable** can be
  1. Included as part of an overall project execution plan (PEP) or
  2. Considered a standalone document

     that describes **specific approaches** that each functional entity will use (engineering, procurement, construction, safety, quality, etc.).

What project controls plan describes?

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RP intention

- The project controls plan **describes** specific

  processes,

  procedures,

  tools and

  systems

  that guide and support effective project control.

What does it mean when we say plan?

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RP intention

- The **plan** is a narrative or qualitative representation of the project control process, while the estimate, budget, schedule, etc. represent the **quantitative aspects.**

How this RP helps organizations?

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RP intention

- **Organizations** may use this RP to develop a fit-for-use template

  as a **model document**,

  which is further customized for each specific project.

How this RP helps practitioners?

Purpose

- This RP is **intended** to

  provide guidelines (i.e., not a standard) for the development of a project control plan

  that **most practitioners** would consider to be good practices

  that can be relied on and that they would recommend for use where applicable.

What are the purposes of project controls plan?

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Purpose

- The **purpose** of the project controls plan should include, in part:
  - A **plan** to **implement** an integrated set of work processes, procedures and applications to plan, monitor, execute and control the work.
  - A **plan** to **implement** an integrated suite of applications (systems).
  - A **plan** to **identify** roles, responsibilities, and accountabilities for the project controls team members.
  - A **plan** to **produce** the project control deliverables, expectations and scope of work

What elements this RP describes?

Background

- This recommended practice (RP) describes the **important elements** of defining
  1. Project controls plan and
  2. Requirements

  for **communicating** project information to the project team and its stakeholders.

Does this RP coincides with another document?

Background

- This recommended practice coincides with the **TCM Framework**.
  - As **part of the TCM Framework**, the project controls plan should provide the project team and its stakeholders the process model

    based upon the

    1. PDCA management or
    2. Control cycle.

What does this mean when we say PDCA and control cycle?

From PDCA perspective

- The **PDCA steps** of the project control process cycle include:
  1. Project Planning
  2. Project Implementation
  3. Project Performance Measurement
  4. Project Performance Assessment

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From project control perspective

- **Project control** is a process for **controlling the investment** of resources in an asset.

- The **project controls plan** is considered the communication tool for **instituting** the **project control process**.

What is the relationship between project management and project control?

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Background

- **Project control** may be considered the quantitative resource control subset of the **project management process**, and

  therefore, the **project controls plan** should be considered a **subset or compliment** to the overall project execution plan.

What should be done prior to developing the project controls plan?

Background

- **Prior to developing** the project controls plan
  1. Requirements elicitation and
  2. Analysis process

  should be completed.

Background

- The **requirements elicitation** and **analysis process** will assist the team in
  1. **Identifying** stakeholders (decision-makers and those who interface with project controls)

     needs, wants, and expectations; and
  2. **Documenting** them in a form that **supports** planning, communication, implementation, measurement, and assessment.

- Figure 1 represents the project controls process of the **Total Cost Management Framework.**

Background

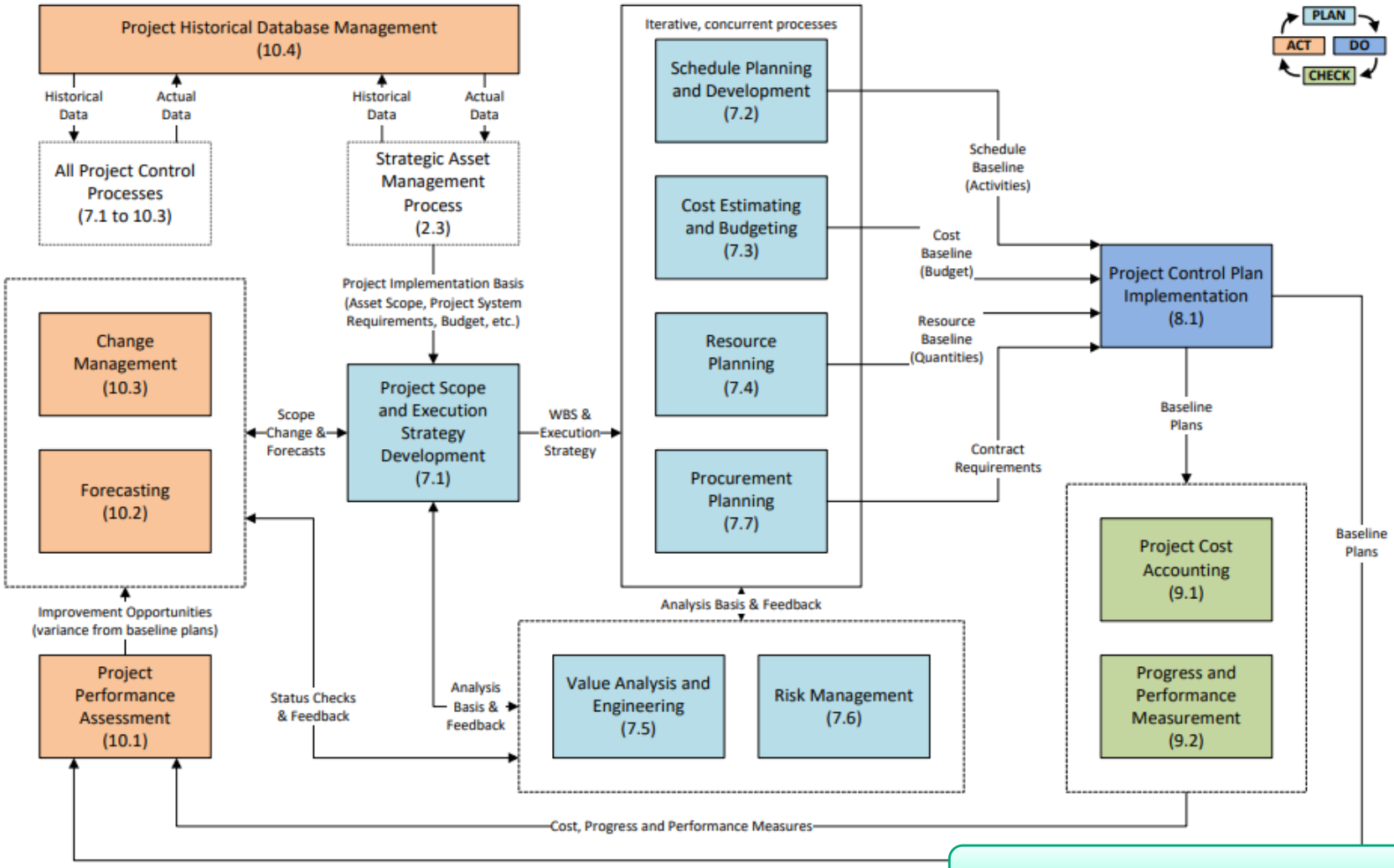

Figure 1 – Project Controls Process - *Total Cost Management Framework*

How this RP helps experts?

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Background

- Also, the application of the project controls process provides our membership and others in exercising due diligence in the stewardship of the **six elements of project controls**, which are:
  1. Know what has to be done
  2. Know what has been done
  3. Know how actual performance compares with baseline
  4. Know what remains to be done
  5. Identify and implement corrective actions to bring performance in line with expectations
  6. Check results of corrective action

What does phased project process mean and how it helps in project control?

Using the project controls plan with a phased project process

- A phased project process, often known as a **stage-gate process** is

  a **conceptual** and **operational** road map

  for moving **new projects** from proposal to closure.

- Stage-gate divides the effort into **distinct stages**

  separated by **management decision gates** (gate keeping).

- Project teams must **successfully complete** a prescribed set of related activities in each stage prior to

  obtaining **management approval** to proceed to the next stage of project delivery.

Using the project controls plan with a phased project process

- In its simplest terms, the stages of a phased project process can be:
  1. Ideation
  2. Planning
  3. Execution
  4. Closure

Implementation of project **control cannot wait until** the start of execution phase.

Should we update project controls plan?

Continuous improvement during the project life cycle

- It is expected that the **project controls plan**

  continuously be updated during the life of the project

  in order for the project team and its stakeholders to be **kept current**

  of the requirements and expectations of the project controls team.

Recommended Practice

Project controls plan and SOW

- The **project controls plan** is considered the scope of work (SOW) for the project controls team that will support the overall project team and its stakeholders.

What are the primary sections of project control plans?

Sections of project controls plan

- To further assist in understanding the **requirements of project controls**, the project controls plan is divided into five (5) sections,

  with each section defining the recommended requirements for the development of the **project controls plan.**

- The major steps or sub-processes are organized by the **PDCA model**, as described earlier.

Project controls process

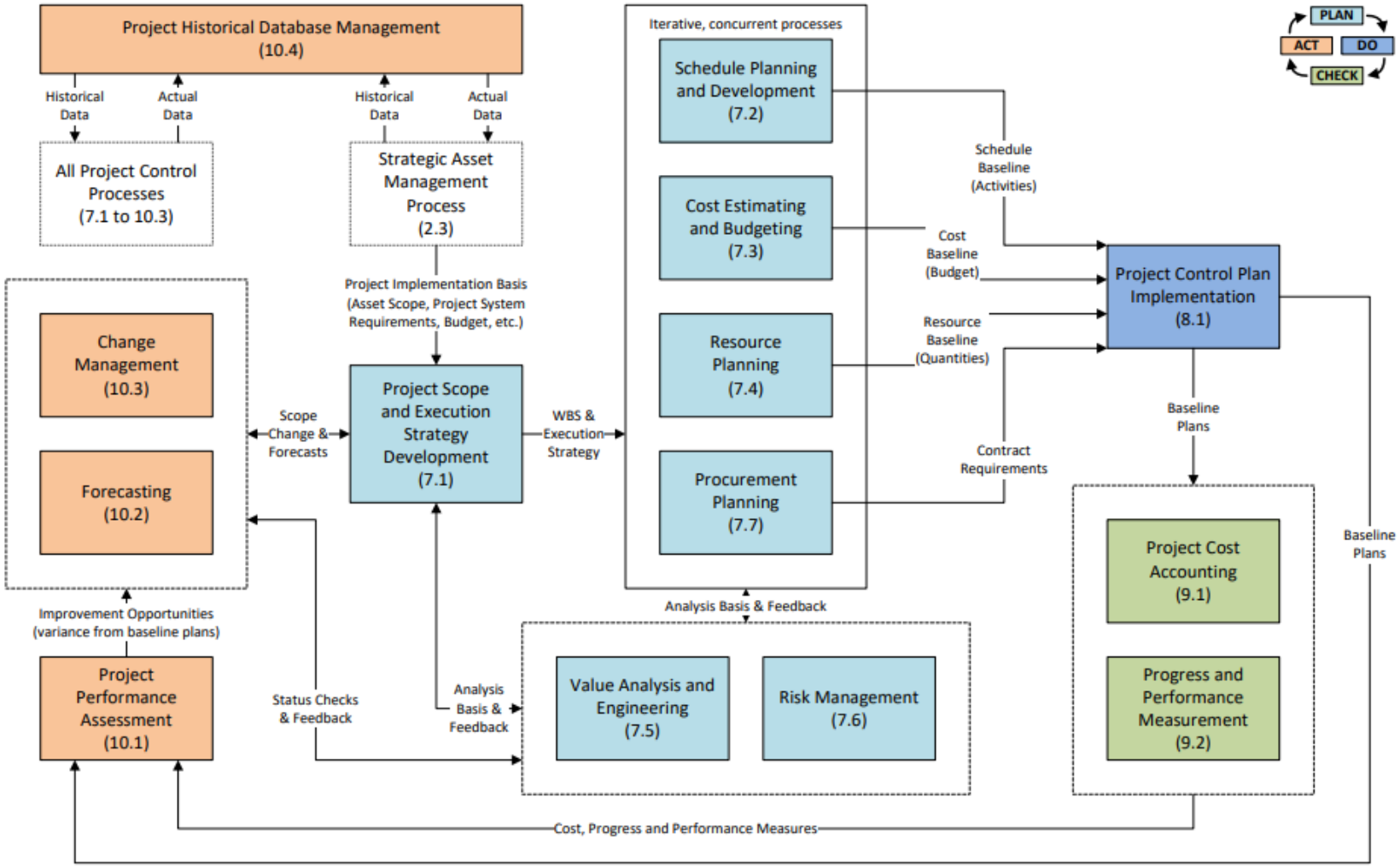

Figure 1 – Project Controls Process - *Total Cost Management Framework*

Sections of project controls plan

- The following can be considered the **table of contents** of the project controls plan:

1. **Project Control Plan General Requirements**
   a. Mission Statement
   b. Delegation of Authority Guideline
   c. Compliance
   d. Revision Control
   e. Organization for Project Control
      i. Organization Chart
      ii. Organizational Breakdown Structure (OBS) Development
      iii. iii. RACI (Responsible, Accountable, Consulted, and Informed) Charts iv. Transition Planning

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

2. Functional Applications of Project Controls (as per TCM Framework)

a. Project Planning

i. Project Scope and Execution Strategy Development

ii. Control Account Development

iii. Schedule and Cost Planning: Iterative and Concurrent Processes

1. Schedule Planning Development
2. Cost Estimating and Budgeting
3. Resource Planning
4. Procurement Planning

iv. Value Analysis and Engineering

v. Risk Management

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

2. Functional Applications of Project Controls (as per TCM Framework)

b. Project Performance Measurement

i. Project Cost Accounting

ii. Progress and Performance Measurement

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

2. Functional Applications of Project Controls (as per TCM Framework)

c. Project Performance Assessment

i. Project Performance Assessment

ii. Forecasting

iii. Change Management

iv. Project Historical Database Management

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

3. Systems and Data Integrity Plan

a. Systems

b. Data Integrity and Backup

c. Electronic File Transfer

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

4. Communications Plan

a. Meeting Requirements

b. Reporting and Frequencies

c. File Structures

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

5. Project Controls Deliverables

Sections of project controls plan

- The following can be considered the table of contents of the project controls plan:

6. Project Controls Plan Implementation

a. Review and Validation

b. Communicating the Project Controls Plan

c. Training

d. Audits

The Body of the Project Controls Plan

Introduction

- The following provides the **user of this recommended practice** with an understanding of the requirements in order to develop an **appropriate plan** for a specific project.
    1. Project Controls Plan General Requirements
    2. Functional Applications of Project Controls (as per TCM Framework)
    3. Systems and Data Integrity Plan
    4. Communications Plan
    5. Project Controls Deliverables
    6. Project Controls Plan Implementation

The Body of the Project Controls Plan

(1. Project Controls Plan General Requirements)

Mission statement

- The purpose of the **mission statement** is to assist in providing the **appropriate guidance** of the actions of
  1. Project controls organization and
  2. Project controls team.

- The mission statement will provide the framework or context within which project strategies are **formulated**

What questions are answered as examples?

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Mission statement

- Do we encourage limited reporting or introduce analysis and recovery strategies?

- Do we include **causal measurement** such as work sampling or only lagging metrics assessment (EV)?

  Is speed paramount or accounting perfection?

- Do we prefer actionable intelligence or data

The mission statement will provide justification for the actions that the project controls team will undertake.

How to achieve this mission?

Delegation of authority guideline

- In order to **ensure compliance** that the project controls plan is being developed and instituted as the official document,
  1. Governing body and
  2. Governance support

  needs to be **assigned**.

Members of governing body?

Delegation of authority guideline

- This **governing body** may be
  1. Subject matter expert,
  2. Corporate governance officer,
  3. Project sponsor,
  4. Executive director, or
  5. Even the project manager.

- In accordance with the project controls plan, **administration and compliance** to the document is assigned to the appropriate authority level.

What does compliance mean?

Compliance

- Once the **project controls plan** has been developed and implemented,

  the **project team** will be required to comply with all associated sections of the project controls plan.

Why compliance?

- Compliance of the requirements of project controls **provides** the necessary
  1. Project stewardship and
  2. Reporting deliverables

  so that the project team can **maintain the execution** of the approved scope of work.

Primary requirements for compliance?

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Compliance

- A **brief description** should be **written** in the project controls plan identifying
  1. Compliance requirements,
  2. Responsibilities, and
  3. Corrective actions.

Revisions needed?

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Revision control

- Since the project controls plan is considered a **dynamic document** (continuously updated during the life of the project),

  a **management of change policy** should be introduced to allow for any **editing or the addition / deletion** to the body of the document.

What are requirements?

Revision control

- **Any changes** can only be made by re-issuing the project controls plan with new, approved **revision number.**

- Since this is considered a controlled document, you may want to **use your document control department** for the **release** of project controls plan.

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Revision control

- A **revision log** identifying
  1. Revision and
  2. Brief description

  should be **available** for all stakeholders of the project.
- The **management of change policy** should also determine
  1. Who approved the changes,
  2. Who distributes the changes, and
  3. How copies (obsolete or new) will be managed.

New and revised project controls plans should be issued as per the delegation of authority document.

What documents needed to support revision control?

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Revision control

- To **support revision control**, a consolidated list of all supporting documents
  1. Procedures,
  2. Processes,
  3. Roles & responsibilities,
  4. Estimates,
  5. Baseline schedule, and
  6. Key performance indicators,

  should be included as **part of the attachments** to the project controls plan.

What should be identified in each of these documents?

Revision control

- The consolidated list should **identify** the
  1. Document name,
  2. Document ID,
  3. Revision number, and
  4. Revision date.

What is the organization for project control?

Organization for project control

- The **risk or size** of the project, or a **combination of both**,

  will determine the **requirements** for the development and dimensioning of the project controls organization.

  - For smaller projects,

    the **project control process** may be managed by

    project leader, or

    designate.

  - For larger projects,

    discrete personnel may be required to carry out functional aspects of the project controls responsibilities, such as

    planners/schedulers, cost engineers, estimators, etc.

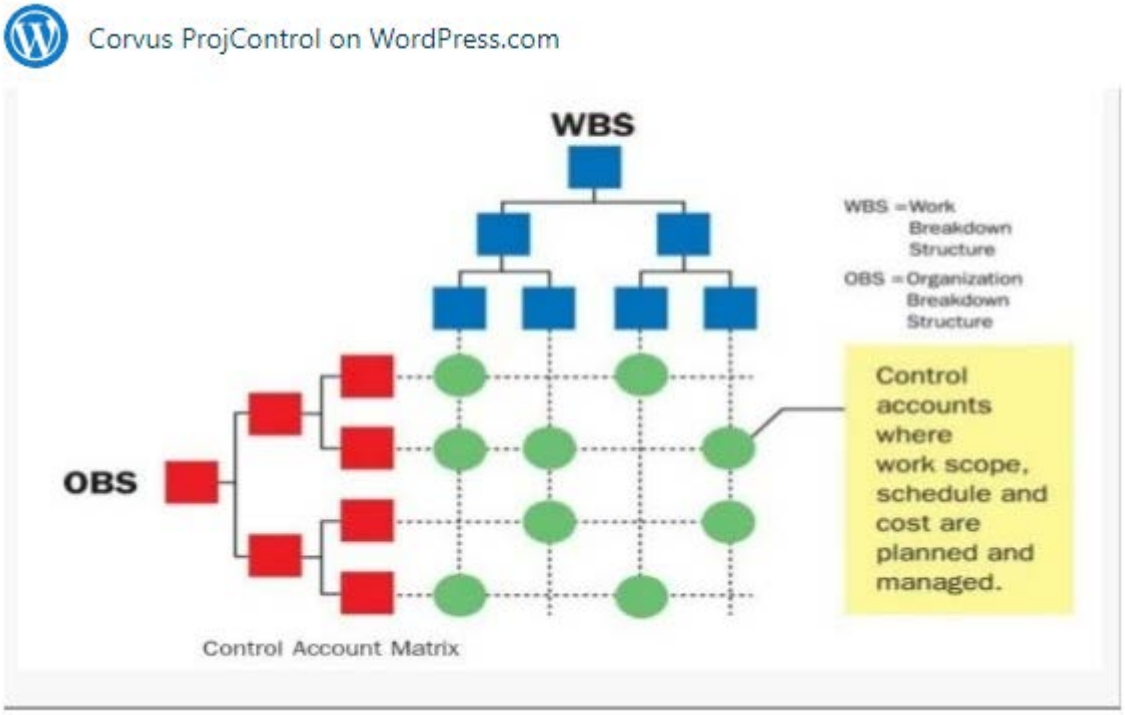
Organization for project control: Organization chart

- As part of the project controls plan, please provide a **brief understanding** of the project controls resource requirements.
- The project controls plan should **identify**
  1. Various key team members and
  2. Their responsibilities.
     - This should include the **roles and functions** of each team member.
- An organization chart should be developed and submitted as **part of the project controls plan.**

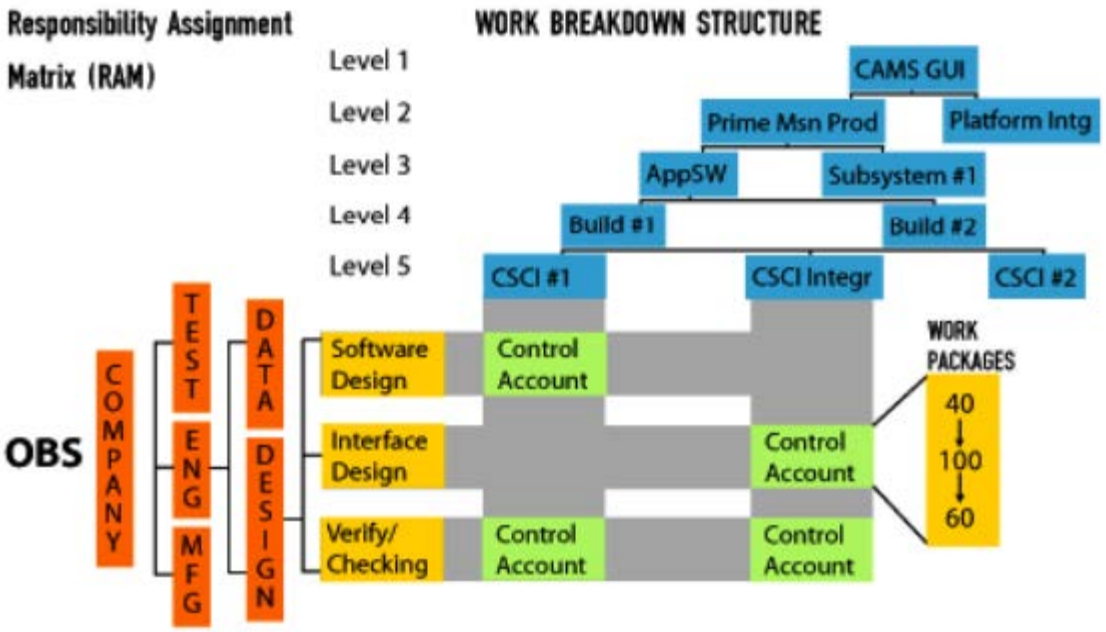
Organization for project control: Organization breakdown structure (OBS)

- Organizational breakdown is focused on **translating resource provisions** into general approaches for
  1. What work is to be performed, and
  2. By whom.
- **Similar to the WBS**, organizational responsibilities can be broken down in logical, hierarchical manner resulting in an **organization breakdown structure (OBS).**
- Depending on the integration / interface requirements of a project, the project team may want to assign **organizations responsibilities** to specific scope elements, specifically, an OBS / WBS Relationship Chart.

Organization for project control: Organization breakdown structure (OBS)



Organization for project control: Organization breakdown structure (OBS)



Organization for project control: Organization breakdown structure (OBS)

- The **OBS / WBS Relationship chart** is a matrix table that identifies the WBS Elements on the vertical axis (left-hand column) and the organizations responsible for delivering the **WBS elements** on the horizontal axis (top row).
- Organizations may include owner, engineering/architectural firms, equipment vendors and constructors.

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Organization for project control: RACI (Responsible, Accountable, Consulted, and Informed) Charts

- Again, please consider
  - Risk and size of the project
  - Agreed-to deliverables

  to ensure that your project has the **appropriate coverage** to manage and execute the work.

- A RACI chart should be developed for <u>each project</u>,

  regardless of size or complexity.

Should we prepare for transition?

Organization for project control: Transition planning

- Transition planning is a **partnership** involving
  - Project controls specialist,
  - Their expectations and deliverables,
  - Project team,
  - Stakeholders and
  - Other key people involved with the project.

What important factors should be considered here?

Organization for project control: Transition planning

- The **project controls plan** should
  1. **Identify** requirements for replacing project personnel and
  2. **Transitioning** new project members in an expeditious effort to **minimize** learning curve and possible delays.

- **Part** of the transition planning is **preparing** for individuals that **leave** the project due to **unforeseen circumstances**.

The Body of the Project Controls Plan

(2. Functional Applications of Project Controls (as per TCM Framework))

Project controls process

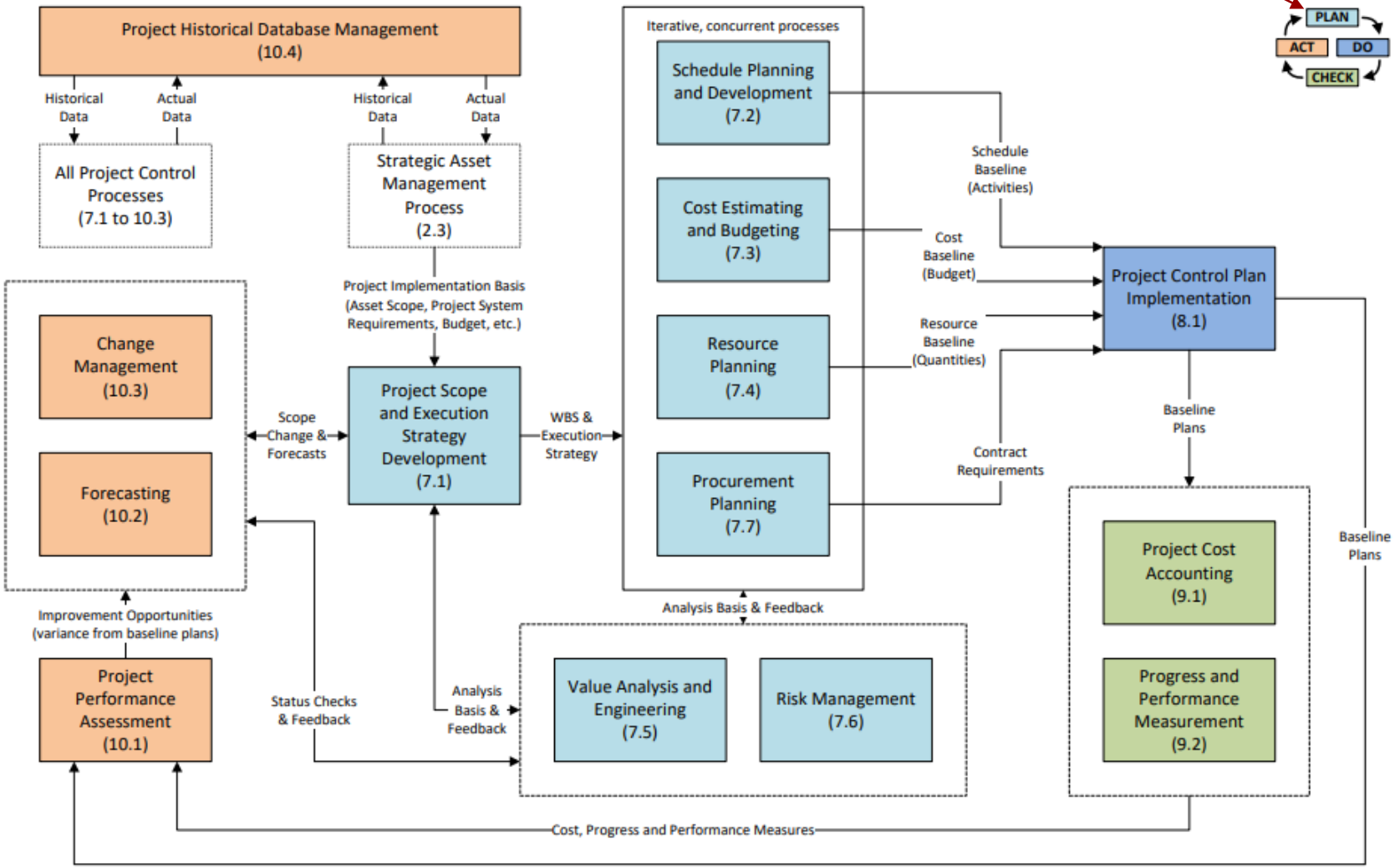


Figure 1 – Project Controls Process - *Total Cost Management Framework*

Project controls process

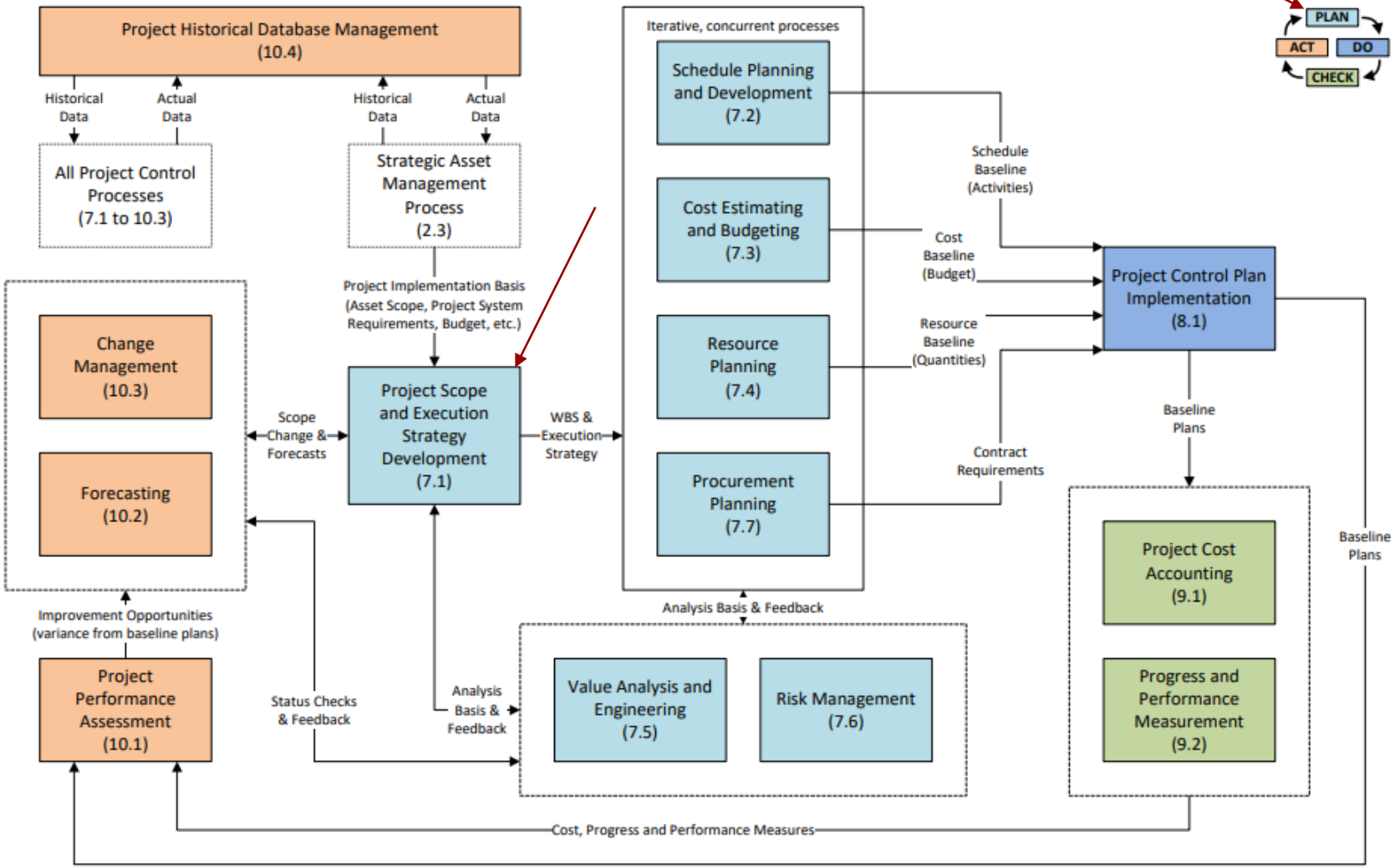


Figure 1 – Project Controls Process - *Total Cost Management Framework*

Project planning: Project scope and execution strategy development

- The
  1. Project scope,
  2. Contract requirements,
  3. Internal corporate requirements, and
  4. Execution strategy

  provide the project team with the **basis** for the **development** of the project controls plan.

Project planning: Project scope and execution strategy development

- The project scope should be **supported** by the following documents.
  - Ensure that all documents and their revision numbers are documented as the **"control source"** for the project.

Project planning: Project scope and execution strategy development

- The following documents may be included as a **separate attachment** to the project controls plan:
  1. Contract, complete with addenda, omissions and exclusions
  2. General and particular conditions
  3. Project specifications
  4. Scope of work (included and excluded)
  5. Work breakdown structure
  6. Project control accounts
  7. Drawings
  8. Bid price (estimate), estimate basis, risk / event log, assumptions
  9. Tender schedule, schedule basis, risk / event log, assumptions
  10. Execution plan

What 3 items should be described by execution plan?

Project planning: Project scope and execution strategy development

- The execution strategy should **describe** and **identify** three (3) items.

1. **Briefly describe the type of work**

(new project, addition or expansion, revamp, relocation).

Project planning: Project scope and execution strategy development

- The execution strategy should **describe** and **identify** three (3) items.

2. **Briefly describe the execution strategy, specifically whether the project is considered one of the following:**

   a) Standard execution (standard workweek, spot overtime, non-shutdown)

   b) An **aggressive execution approach** (non-standard workweek, high overtime)

   c) Fast-track approach (engineering incomplete at the start of construction plus aggressive execution)

   d) Shut-down (planned shut-down, non-standard workweek, high overtime)

Project planning: Project scope and execution strategy development

- The execution strategy should **describe** and **identify** three (3) items.

3. Briefly describe the contracting strategy.

a. Self-perform, prime contractor, multiple contracts, alliance, joint venture.

When **entering into** an alliance, joint venture or multiple contract environment,

the project team must **consider how** coding structures, systems, accounting practices, etc.

will be **integrated** (or mapped) within the environment.

Project planning: Control account development

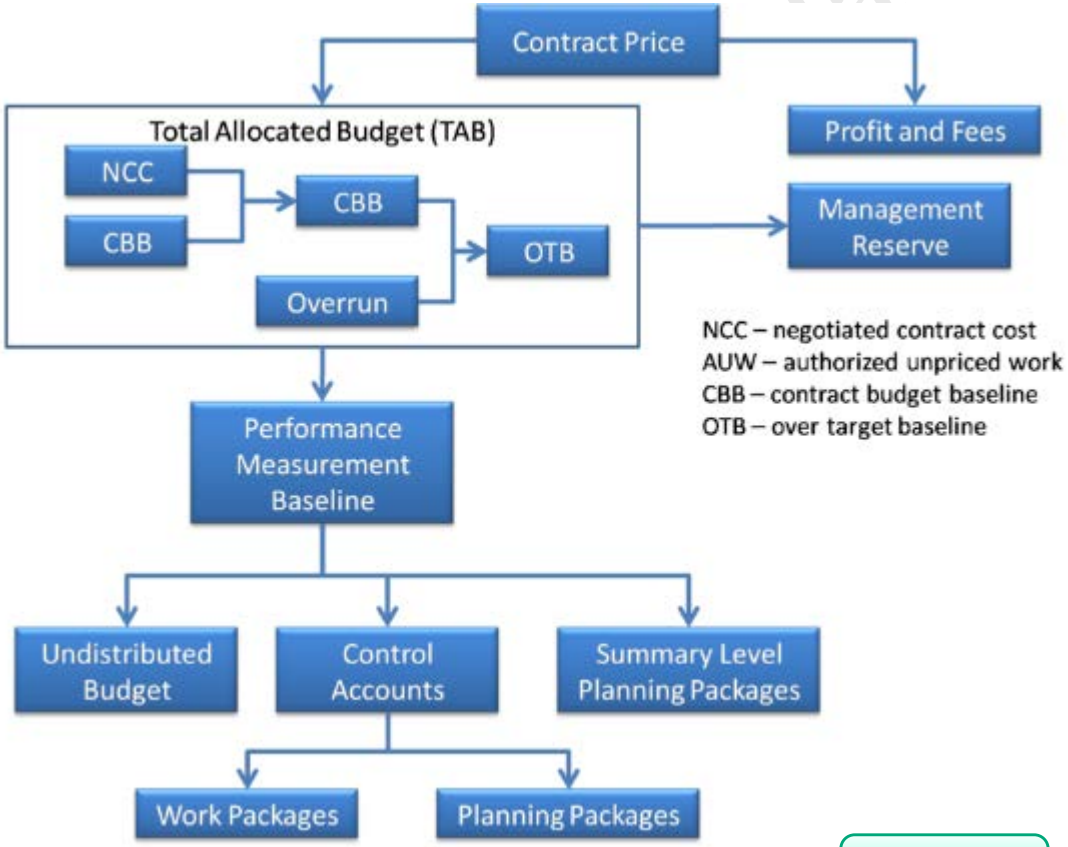
- A **key concept** for project control plan implementation is that the **control account integrates** all the project control plan components (i.e., cost, schedule, resources, risk, and procurement).

The control account directly relates to …

Project planning: Control account development

- The control account relates directly to

  a **work package component** from the work breakdown structure (WBS)



Why?

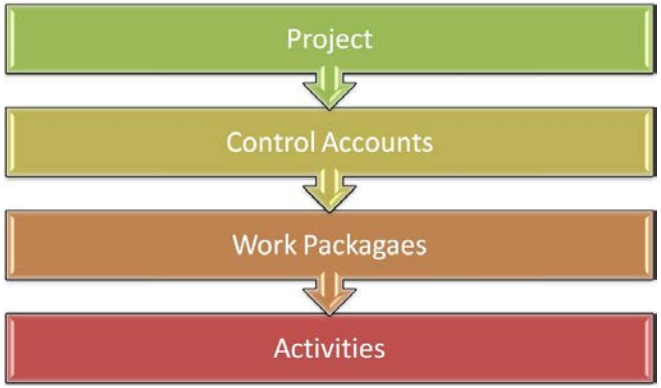
Project planning: Control account development

- The control account relates directly to

  a **work package component** from the work breakdown structure (WBS) for which

  1. **Responsibility** has been **assigned**

     (in accordance with the organizational breakdown structure (OBS) and the procurement plan), and
  2. **Cost budgets and resources** have been **assigned**, and
  3. **Activities** scheduled.



When and who should develop?

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Project planning: Control account development

- At the **start of the planning process**, the control accounts are developed by the **project control person or team**.

What are typical control account characteristics?

Project planning: Control account development

- The following is an example of **typical control account characteristics**:
  - WBS
  - OBS
  - Work package: scope description
  - Responsibility: contractor, discipline, lead person, etc.
  - Budget: costs and revenue
  - Resources: labor hours, material quantities, etc.
  - Schedule: network activities
  - Code of accounts: cost category, type or element

Project controls process

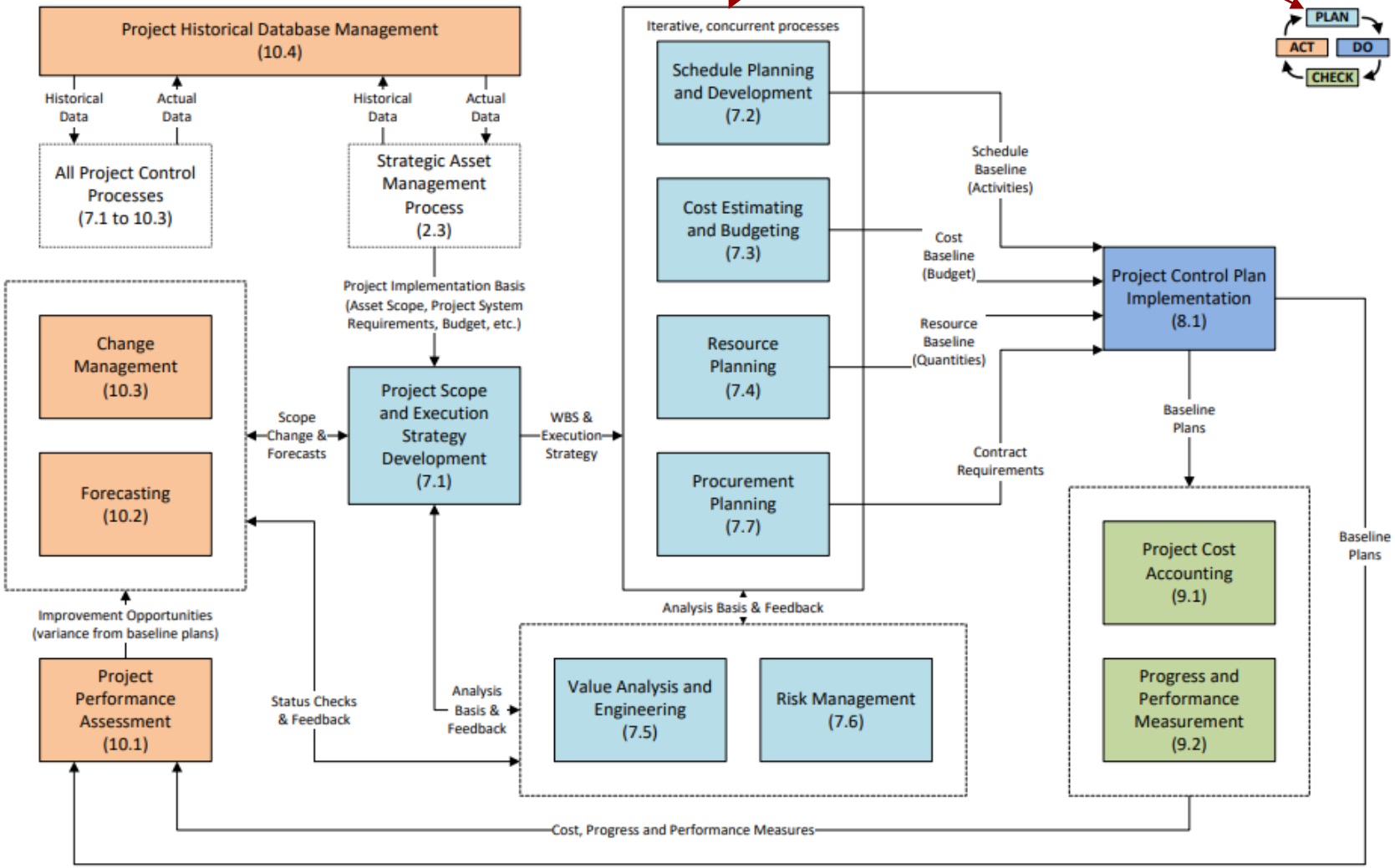

Figure 1 – Project Controls Process - *Total Cost Management Framework*

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Project planning: Schedule and cost planning – Iterative and concurrent processes

- The **following section** describes the iterative and concurrent processes
  that are required to develop and communicate the integrated performance measurement baseline documents,
  such as the estimate, schedule, resource histograms, etc.
- Therefore, **close and iterative integration** of
  cost and schedule elements is essential to
  development of the performance measurement baseline
  in order to ensure the **successful execution** of the project.

Project planning: Schedule and cost planning – Iterative and concurrent processes

1. Schedule Planning Development

- For the development of the schedule to be **complete**, the planning and scheduling **requirements**

  must be established and **integrated** with estimate development.

- This will include
  - ✓ Internal (developer / owner) conditions and requirements and
  - ✓ External (contract) conditions and requirements,
  - ✓ Common WBS,
  - ✓ Resources,
  - ✓ Codes,
  - ✓ Etc.

What 3 items should be integrated here?

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Project planning: Schedule and cost planning – Iterative and concurrent processes

1. Schedule Planning Development

- The project controls plan will address the integration of
  1. Schedule development,
  2. Basis of schedule and
  3. Schedule validation process.

What is basis of schedule?

Project planning: Schedule and cost planning – Iterative and concurrent processes

1. Schedule Planning Development

The schedule basis memorandum is broadly defined as a written document that describes, explains, and details how a CPM schedule was developed at a specific point in time. It is usually included or referenced within the schedule management portion of a Project Execution Plan (PEP) by the contractor or by the owner. Depending on a project's size, scope, and complexity, a schedule basis document could be presented in a simple one-page bullet format or a small number of presentation slides. For large and complex EPC projects, the schedule basis is usually detailed in a multi-section report along with supporting tables, attachments, and exhibits. A key purpose of the schedule basis memorandum is to document detailed assumptions, exclusions, and/or qualifications known at the time that the project schedule is developed.

When to prepare?

The schedule basis memorandum is typically prepared during the baseline schedule development phase, but the schedule basis documentation should be considered as a living document to be updated periodically throughout a project's lifecycle when conditions are warranted (*e.g.*, re-baseline schedule or recovery schedule development). In general, it is recommended to include sufficient detail in the schedule basis memorandum. Greater detail documenting what is known and what is not known at the time the schedule basis is developed provides better visibility of potential schedule issues or risks. A detailed schedule basis memorandum provides crucial information to key stakeholders and project participants, especially if changes substantially alter the original schedule basis plan or the original project baseline schedule becomes delayed.

Sample Table of Contents for a Schedule Basis Memorandum

Section Number	Section Title
1.0	INTRODUCTION
2.0	EXECUTIVE SUMMARY
3.0	CURRENT PROJECT STATUS
4.0	BASIS OF SCHEDULE
5.0	RISK ANALYSIS
6.0	SUPPORTING APPENDICES, ATTACHMENTS AND EXHIBITS

For more info
see Planning and Scheduling Course!

Project planning: Schedule and cost planning – Iterative and concurrent processes

1. Schedule Planning Development

- The **plan** will **identify** the level of detail required for the various schedules that are **prepared** during the **project**, including resource loading and leveling

  (i.e.

  *the schedule must be **detailed enough** to*

  1. *Show the **effect** of a **changed condition** to an activity sequence*
  2. *Accrue **costs associated** with scheduled work activities based on the estimate and/or budget).*

2. Cost Estimating and Budgeting

- The **project controls plan** must outline the methodology for establishing the effort to
  1. **Perform** the scope of work and the associated project budget, and
  2. **Address** the **integration** of the budgeting process with the schedule to ensure a **performance measurement baseline** is properly established.

What 3 items should be integrated here?

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Project planning: Schedule and cost planning – Iterative and concurrent processes

2. Cost Estimating and Budgeting

- Like the **Schedule Planning Development Section**,

  the project controls plan will address the integration of

  1. Estimate development,
  2. Basis of estimate and
  3. Estimate validation process.

- The project estimate should be delivered in a **standard hierarchy**, for example.

Project planning: Schedule and cost planning – Iterative and concurrent processes

2. Cost Estimating and Budgeting

- Cost Estimate Hierarchy
  - ✓ Direct Costs
    - o Labor
    - o Material
    - o Equipment
    - o Subcontract
  - ✓ Indirect Cost
    - o Taxes
    - o Risk
    - o Profit
    - o Contingency
    - o Overhead
    - o Escalation

2. Cost Estimating and Budgeting

- One **final thought** to consider is for the project team to provide an **understanding** as to

  how **revenue (price)** versus the cost of the project will be **managed and communicated.**

- Based on contract type (lump sum, cost plus, or unit pricing),

  clients or other parties may want to **communicate or have communicated** the profits (price minus cost) of the project.

3. Resource Planning

- The project team is required to **understand**

  how the appropriate resource requirements were determined to support the execution of the project.

- The **resource management section** may want to specifically outline the requirements for
  1. Labor resources and
  2. Site equipment.

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Project planning: Schedule and cost planning – Iterative and concurrent processes

3. Resource Planning

❖ Labor Management Planning

✓ Labor management planning is designed to

1. **Facilitate** the collection and
2. **Reporting** of the project labor (home office, field office, engineering disciplines, and field trades).

✓ Time-phased usage profiles and histograms based on the project schedule and estimate should be developed as an **output for measuring**

actual hours / costs against the planned hours / costs

to support the **evaluation** of

performance and

prediction

of final forecast hours / costs.

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Project planning: Schedule and cost planning – Iterative and concurrent processes

3. Resource Planning

❖ **Equipment Management Planning**

✓ **Like labor management**, equipment management planning is designed to facilitate the collection and reporting of the site equipment.

✓ **Usage profiles** will be developed as an **output for measuring** actual costs against the planned costs to support the evaluation of performance and prediction of final forecast costs.

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Project planning: Schedule and cost planning – Iterative and concurrent processes

4. Procurement Planning

❖ Procurement planning is the part of the project control planning process that **ensures information** about resources (e.g., labor, material, etc.) as required for project control is

1. Identified for,
2. Incorporated in, and
3. Obtained

through the procurement process.

Should we include procurement process in controls plan?

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Project planning: Schedule and cost planning – Iterative and concurrent processes

4. Procurement Planning

- The project controls plan does **not explicitly** include the procurement **process**.
  - ✓ The project controls plan **only addresses** the project control interface with procurement.

What information must be included?

4. Procurement Planning

- Procurement planning is crucial to the success of the project.
- The project team is required to determine and communicate the **procurement plan**, which must include **information** on
  1. Both equipment and bulk purchasing, and
  2. Subcontracting

  as identified by the scope of work.
- Procurement planning should identify the **relationship** of the scope of work to
  1. Work breakdown structure (WBS) and
  2. Organization breakdown structure (OBS).

4. Procurement Planning

❖ Equipment and Bulk Purchasing Plan

- ✓ This section provides the project team with the opportunity to communicate the requirements on

  how permanent materials and equipment will be

  1. Purchased,
  2. Delivered.

- ✓ The procurement plan requirements should also **indicate** on site material management and logistics for **transporting materials**.
- ✓ The equipment and bulk purchasing plan should include for
  1. Imported goods and services,
  2. Freight and logistics considerations.
- ✓ Finally, the plan should **identify** site material storage and management requirements.

Does contractor prepare its own documents?

4. Procurement Planning

❖ Contractor Plan

- ✓ **Contractors** generally **prepare** their own control plans and control accounting.
  - o However, these must be **consistent** with the overall control plans and accounting to the extent **required by the contract**.
- ✓ A complete list of **contractors and subcontractors** should be provided.
- ✓ The list should **outline** their
  - o Scope of work,
  - o Start and completion dates, and
  - o Original budget.

Project planning: Value Analysis and Engineering

- The **objective** of value engineering is to improve the value for the intended asset or project objectives.
- **Improvement techniques** could either be
  1. Improving the function or
  2. Reducing the cost or both.

What information needs to be included in this section?

Project planning: Value Analysis and Engineering

- This section of the project controls plan should **communicate how**
  - Value engineering will be **introduced** and
  - **Supported** throughout the life of the project, and
  - **Identify** the decisions and outputs **derived** from the VA/VE process.

- The project controls plan does **not explicitly include** the value analysis and engineering process.

- The project controls plan only addresses the project control interface with VA/VE.

Project planning: Value Analysis and Engineering

- Further to **understanding value analysis**,

  also known as value enhancing practices (VEP's),

  certain industries have identified **two main categories** to

  recognize and improve the value analysis process.

- The two categories are:

  1. Value improving practices (VIPs)
  2. Project execution best practices

Project planning: Risk management

- Risk management is the **process of**
  1. Identifying risk factors **(risk assessment),**
  2. Analyzing and quantifying the properties of those factors **(risk analysis),**
  3. Mitigating the impact of the factors on planned asset or project performance and developing a risk management plan **(risk mitigation)**, and
  4. Implementing the risk management plan **(risk control)**.

Project planning: Risk management

- This section of the project controls plan should **communicate** how risk management will be

  introduced and supported throughout the life of the project.

- The project team should further describe both qualitative and quantitative aspects of risk.

Project controls process

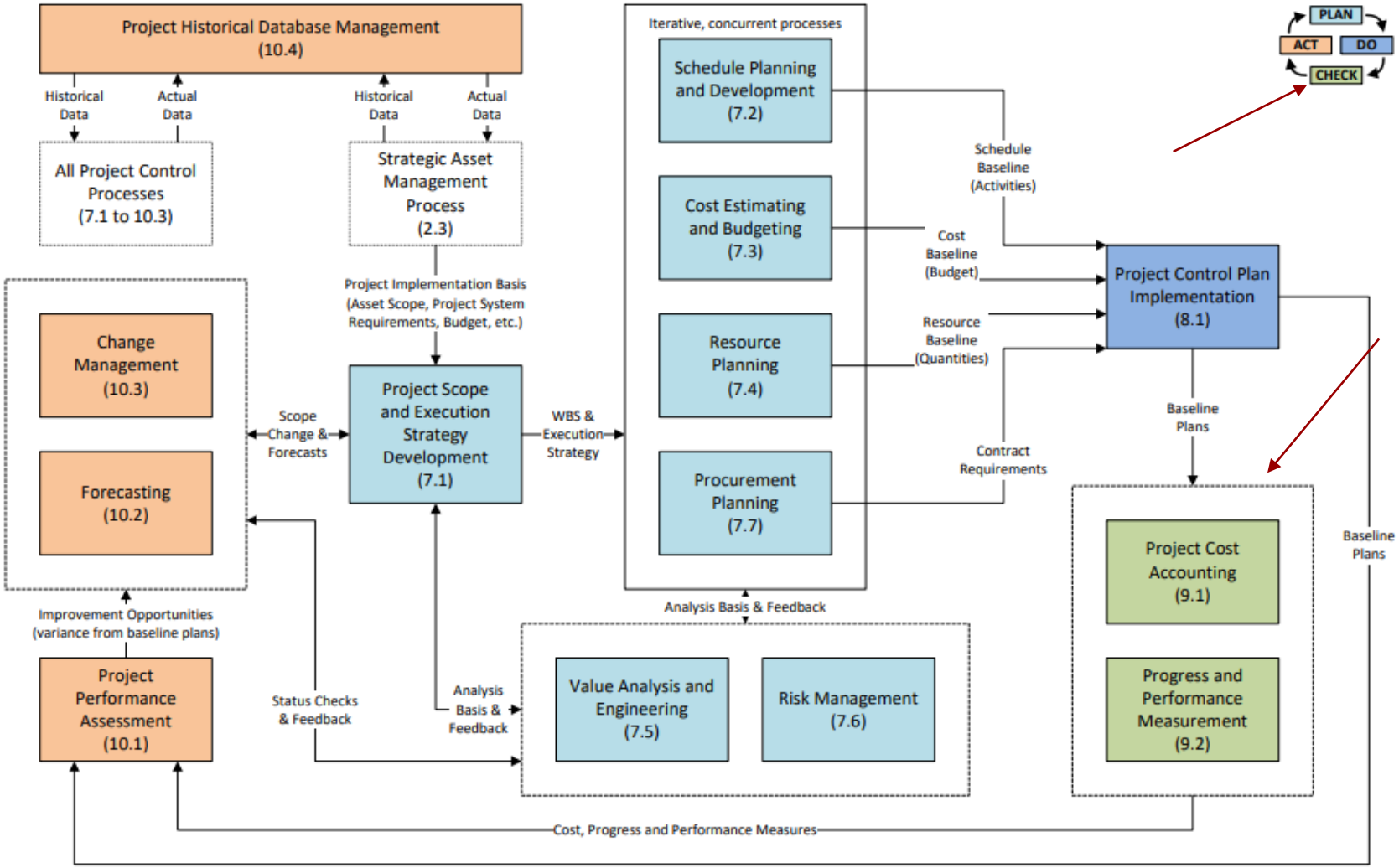

Figure 1 – Project Controls Process - *Total Cost Management Framework*

Project performance measurement: Project cost accounting

- The project controls plan will **address** the interface requirements with cost accounting to develop the **methods** for the collection of
  1. Cost commitments and
  2. Expenditures.
- The **project cost accountant** will support the **administration** of cost collection, analysis, and forecasting.
- It is **not only important** to have a cost accounting structure that supports the development of the estimate and budget;
  it is equally important for the project team to **ensure** that all actual values are **coded correctly**.

What other systems import data from financial system?

Project performance measurement: Project cost accounting

- **Other systems** may import data from the **financial system** to **support reporting** for
  1. Control accounts,
  2. Work breakdown structures,
  3. Schedule of pay values, etc.

What other factors project team and accountants need to be aware?

Project performance measurement: Project cost accounting

- The following identifies **other aspects** the **project team and the accountants** need to **be aware of**:
  - Work In Progress (WIP), Accruals
  - Cost of Money (Financing)
  - Invoicing
  - Cash Flow
  - Cost vs. Revenue
  - Taxation & Depreciation
  - Etc.

Project performance measurement: Progress and performance measurement

- The **progress and performance measurement** section **identifies** process and methodology necessary to perform progress and performance measurement and reporting.
- The progress and performance measurement process will **allow** the project team to
  1. **Review** the **current performance** of the work from inception to completion through periodic updates, and
  2. **Facilitate** the **adjustment** of their efforts to meet the changing circumstances.

Project performance measurement: Progress and performance measurement

- In order to ensure that **proper earned value management** is applied and understood, the project team should describe the methodologies to be used for **capturing work accomplished**.
- **Different** industries and companies may apply **different methodologies** when communicating work accomplished.
- The following **identify** the **methodologies** used in progress measurement.

Project performance measurement: Progress and performance measurement

❑ Units Completed

❖ This measurement method can be used when **work package scope**

1. **Can** be further decomposed into **fairly homogenous units of work** (e.g., Units of material, drawings, lines of code, function points, etc.)
2. That each require **approximately the same level of effort** to produce, and
3. For which work is usually completed, and
4. Can be **measured**, for some units while **work continues** on others.

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Project performance measurement: Progress and performance measurement

❑ Incremental Milestone

❖ This measurement method can be used when **work package scope** is

1. One deliverable (i.e., not many units as described above) or
2. A set of deliverables done together,
   - ✓ For which **multiple activities** must be performed in sequence and
   - ✓ For which the **completion of incremental tasks** can be observed.

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Project performance measurement: Progress and performance measurement

❑ Judgment or Supervisor Opinion

- ❖ This measurement method is the most subjective and is used when more objective methods are **not reasonable**.
- ❖ In this method, the **person responsible** for the **work package** **estimates** the percent complete based on his or her **informed judgment**.

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Project performance measurement: Progress and performance measurement

❑ Resource Expenditure (Level of Effort) or Cost Ratio

- ❖ This measurement method is generally used when the **work package scope**
  1. Does **not include** discrete deliverables or milestones and
  2. For which the **activities** are of long duration and of a relatively constant level of effort.
- ❖ These **most often** include management and support labor cost accounts (e.g., project management, project control, quality assurance, etc.).

Project performance measurement: Progress and performance measurement

❑ Weighted or Equivalent Units

- ❖ This measurement method is a **hybrid** of units completed and incremental milestones.
- ❖ It is used when the **work package scope**

includes

Non-homogenous units of work and/or work tasks

that **overlap**

such that the **other methods** don't work well.

What is the next step after measurement?

Project controls process

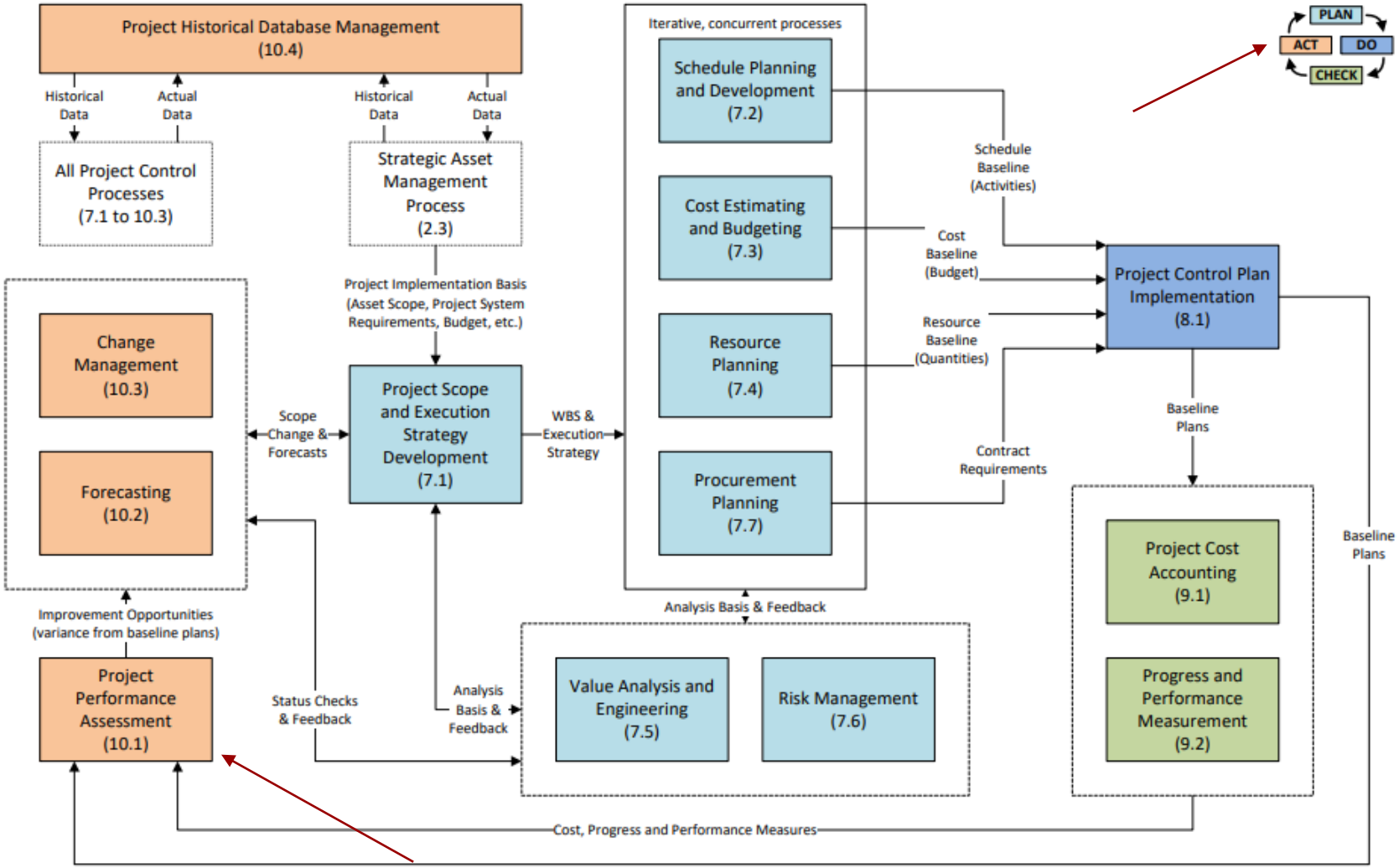

Figure 1 – Project Controls Process - *Total Cost Management Framework*

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Project performance assessment: Assessment

- The project performance **assessment section** of the project controls plan **identifies** the process and methodology necessary to

  perform performance

  assessments and reporting.

- The use of each assessment method (e.g., earned value, work sampling, etc.) should be planned in a way that **optimizes** the **identification** of

  1. Variances, and
  2. Opportunities and risks

  for all aspects of the project.

  Optimally, the assessment should provide the team with an **understanding** of work accomplished.

Is there another aspect to be considered?

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Project performance assessment: Assessment

- Another aspect is to ensure that the **interfaces** (i.e., data transfer) between
  1. Measurement systems (e.g., Payroll systems, material management systems, etc.) and
  2. Systems used for assessment (e.g., Scheduling software, cost processors)

  is complete and understood.
- Also, the **interaction/interface** with any owner, supplier, and contractor should **support** the reporting systems in order to **address** the performance measurement and assessment responsibilities

When the use of assessment methods begin?

Project performance assessment: Assessment

- **After**

1. Project performance measurement and assessment have been **planned**, and
2. Measurement processes and systems have been **initiated**,

the **use** of **assessment methods** can begin.

What areas require assessment?

Project performance assessment: Assessment

- The **areas** that require assessment are:
  - Cost Performance
  - Schedule Performance
  - Resource Performance
  - Work Process & Productivity
  - Risk Factors

What to do when completed?

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Project performance assessment: Assessment

- **Once completed**,

  the project team needs to **report the assessment** that has **been completed**.

- These **observations**—along with schedule, resource, productivity, and work process and performance assessments—

  will be used in the **forecasting process.**

Let's see the forecasting process!

Project controls process

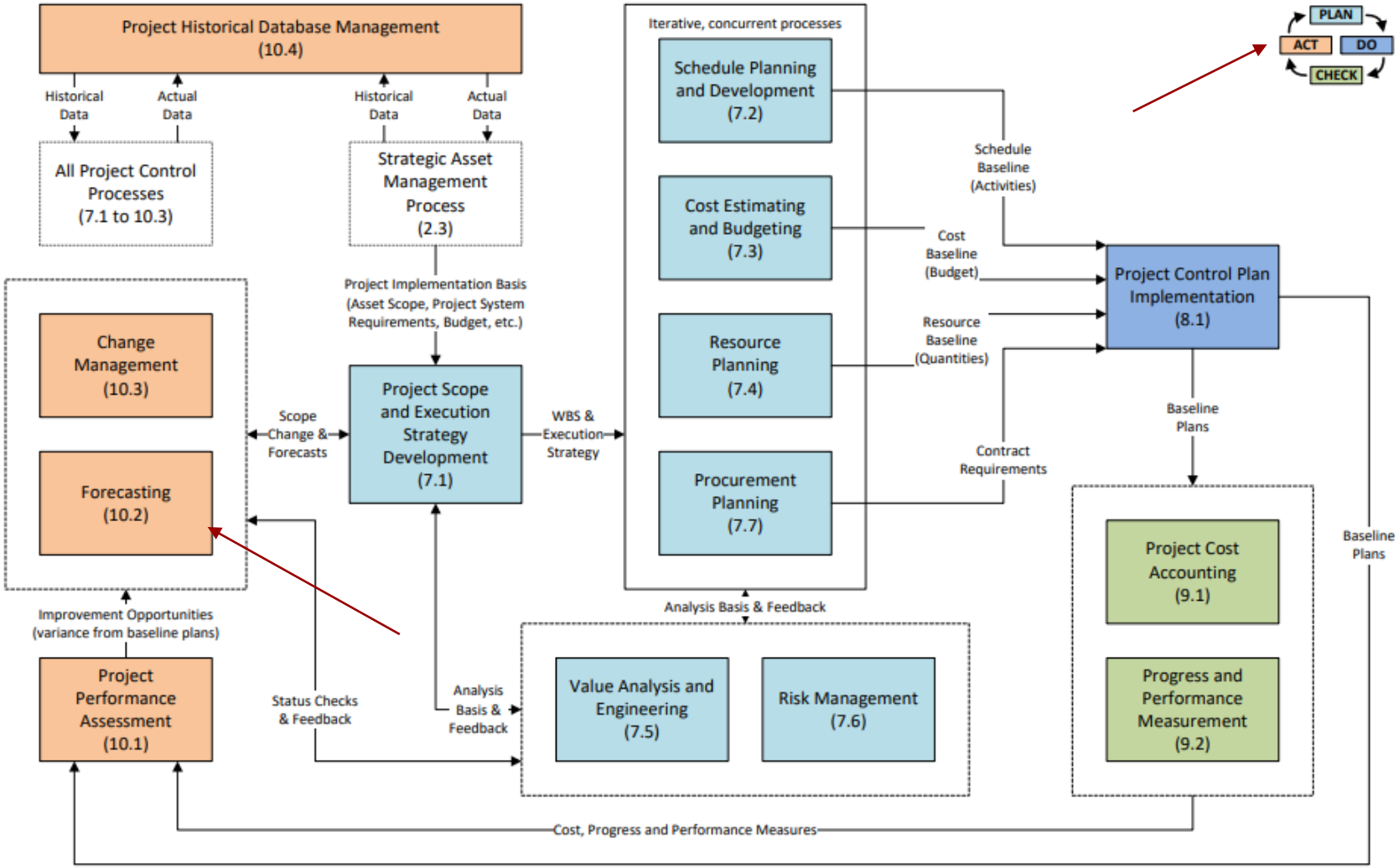

Figure 1 – Project Controls Process - *Total Cost Management Framework*

Project performance assessment: Forecasting

- Forecasting is the process of evaluating project control baselines in consideration of **assessments** of ongoing project **performance**.

- The **forecasting process** should be performed in a **proactive**, **systematic approach** based on an established update frequency, rather than being performed **in reaction** to performance problems.

What is the purpose of this section?

Project performance assessment: Forecasting

- For the purposes of this section in the project controls plan, the project team will

  define the forecasting process to be used to

  assess each applicable element of the project, which may include

  1. Scope,
  2. Schedule,
  3. Budget,
  4. Resources, and
  5. Risks.

What inputs needed to the process?

Project performance assessment: Forecasting

- The **inputs** to the process include
  1. Plans,
  2. Performance and progress assessments (which include project cost accounting, and progress & performance measurement),
  3. Values analysis,
  4. Risk management and
  5. Change management information.
- These forecasts should be reported in a way that **highlights** performance variances and issues that need project management **attention**.

*This section of the project controls plan should address **quantitative forecasting** for both **cost** and **schedule** values.*

Project performance assessment: Forecasting

Cost Forecasting

- There are **three basic forecasting approaches**, as identified below.
  - ✓ *Estimate At Completion = Actual Cost + Estimate To Complete*
  - ✓ *Estimate At Completion = Actual Cost + Budget At Completion – Earned Value*
  - ✓ *Estimate At Completion = Budget At Completion ÷ Cost Performance Index*

What the team should focus on at this stage?

Project performance assessment: Cost forecasting

Cost Forecasting

- The project team must determine the **best possible solution** that
  1. **Identifies** an accurate EAC, and
  2. **Supports** the **mitigation** of cost and schedule overruns that may surface.
- **Caution** must be used as the project team may be **ignoring** the **warning signs** necessary for project recovery.

Project performance assessment: Cost forecasting

❑ Schedule Forecasting

- ❖ When **forecasting** schedule completions dates, the project team must be **aware of** the project's define critical path.
- ❖ The **main purpose** of **defining** the critical path is to determine which **activities** are considered **critical**.

Project performance assessment: Cost forecasting

❑ Schedule Forecasting

❖ The following is an example of a basic forecasting approach for schedules:

- ✓ *Schedule At Completion = Actual Duration + Remaining Duration*
- ✓ *Schedule At Completion = Project Duration ÷ Schedule Performance Index*

What to consider when forecasting remaining duration?

Project performance assessment: Cost forecasting

❑ Schedule Forecasting

❖ When **forecasting remaining duration**, the project team will need to be aware of (to name a few):

- ✓ Past performance
- ✓ Remaining hours to complete versus available resources
- ✓ Material and equipment delivery and support
- ✓ Start and finish dates based on activity to activity relationships

Project controls process

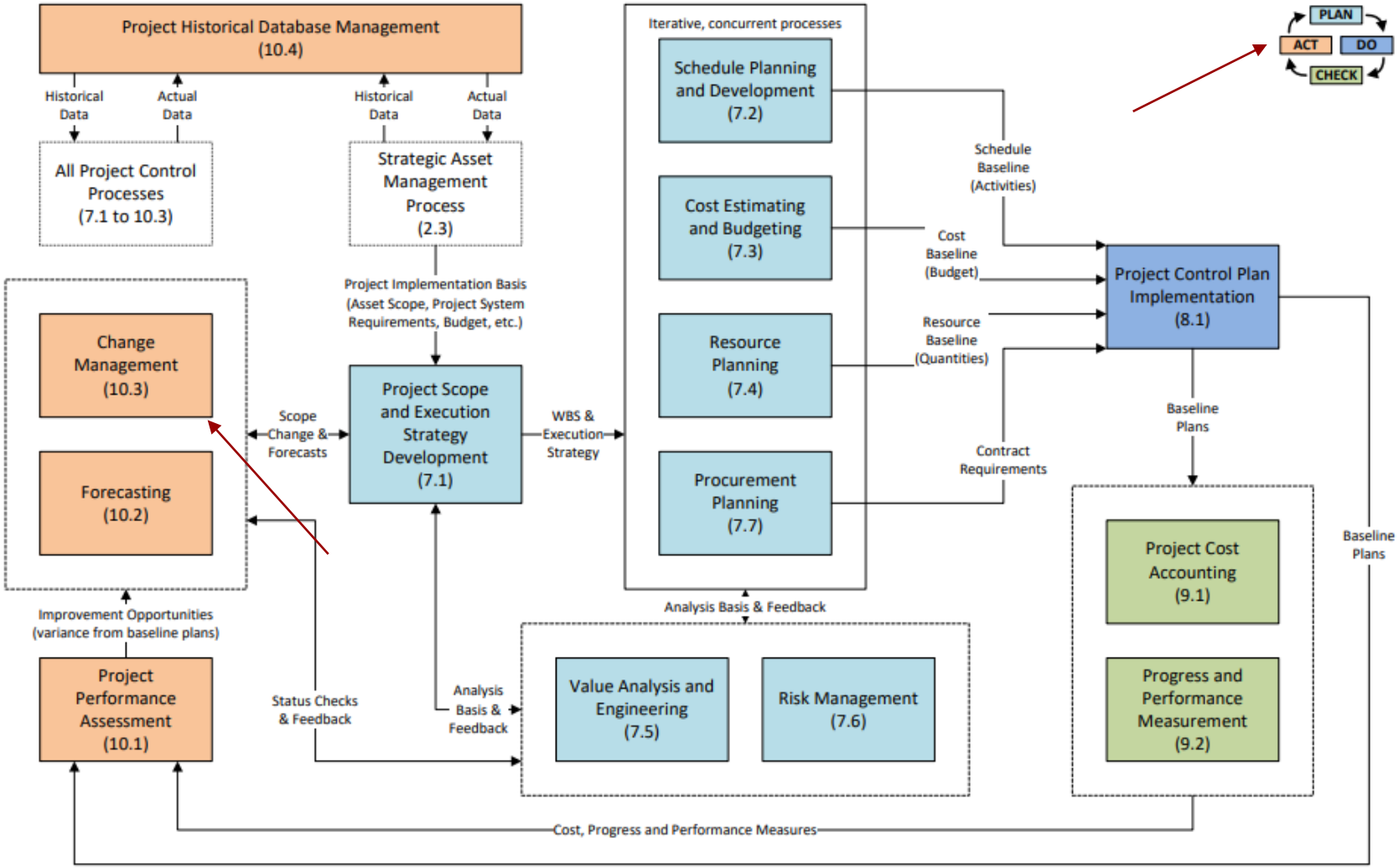

Figure 1 – Project Controls Process - *Total Cost Management Framework*

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Project performance assessment: Change management

- **Change management** imposes the **required structure and discipline** in the project control process by

  protecting the integrity of the control basis (performance measurement baseline) as a valid baseline (i.e., it represents a project plan in alignment with project objectives and requirements)

  for performance measurement.

- The **process objective** is not to limit or promote change, but to
  1. Manage (identify and mitigate) and
  2. Report it.

What should be addressed by change management?

Project performance assessment: Change management

- The project control plan should address the **methodology and processes**

  for managing changes (whether internal and/or external to the business plan, project or contract)

  throughout the project **regarding** scope, quality, cost and time.

- The plan will address both the

  1. Various types of changes and/or trends,
  2. **Desired approval** process.

Relations with claims and disputes?

Project performance assessment: Change management

- **Change** can be positive or negative, and should always be **carefully evaluated**.
- Upon approval, the change should be **methodically incorporated** into the revised performance measurement baseline.
- Also, **change increases** the risk that there will be disputes and legal claims; these are generally **detrimental** to project **performance**.
- Therefore, **developing plans and applying methods** for **resolving** disputes and claims are part of the change management process.

Project performance assessment: Change management

- Due to the importance of **managing change** within a project,

  it would be best that a **separate procedure** be developed or incorporated

  to **identify** the process for supporting the specific project.

What minimum explanations should be provided?

Project performance assessment: Change management

- At a **minimum**, the process should provide **explanation** on the following items:
  - Identify deviations, variances, and change
  - Analyze variance
  - Define deviation or change in scope
  - Assess impact
  - Record and track status
  - Manage contingency and reserves
  - Resolve disputes and claims
  - Revise control basis (PMB)

Project controls process

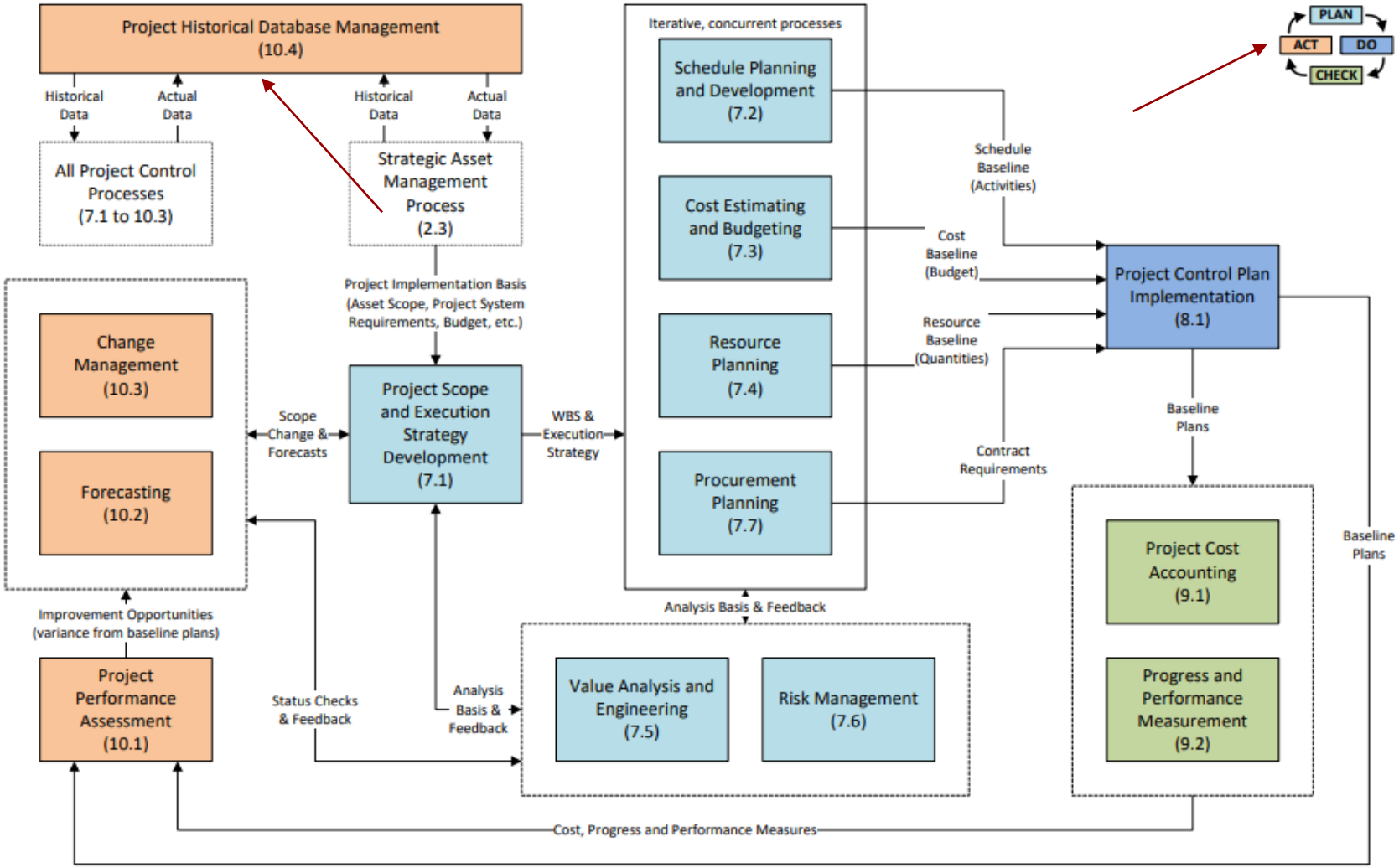

Figure 1 – Project Controls Process - *Total Cost Management Framework*

Project performance assessment: Project historical database management

- A very important aspect of any project is to **ensure**

  that the project team prepares the appropriate **close out reports** at project completion.

- This section of the project controls plan should **identify**

  how and who will be collecting the **project information**.

What are typical requirements need to be collected?

Project performance assessment: Project historical database management

- The following is a **list of typical requirements** that should be collected:
  - Lessons learned, historical from past projects and previous phases / stages (action plans and continuous improvement strategies)
  - Budget and estimate, estimate basis
  - Final cost report
  - Baseline schedule, schedule basis
  - Final schedule
  - Final executive project report
  - Resource histogram(s), cash curves, progress charts
  - Final change order log, complete with costs, hours, and quantities
  - Final progress and performance report
  - Qualitative and quantitative metrics & analysis (i.e. questionnaires, installed quantities per discipline or commodity ID, etc.)
  - Contractor evaluation report

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CII Document

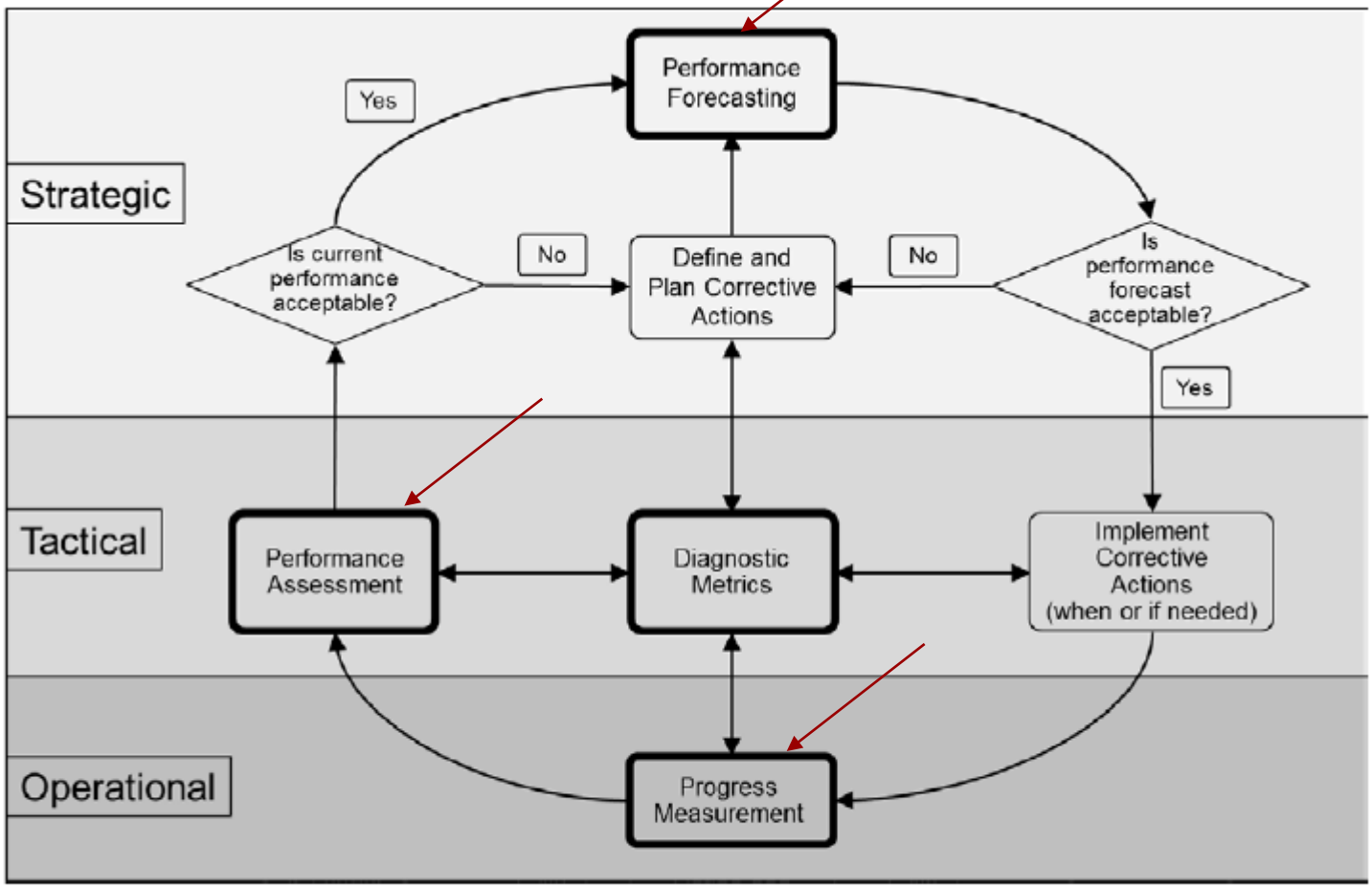

Figure 2-2. Framework of the current practice for Project Control.

Progress measurement: Progress measurement metrics

- The major methods for progress measurement include,

1) Units completed,
2) Incremental milestones,
3) Weighted or equivalent units completed,
4) Resource expenditure, and
5) Judgment (supervisor opinion)

(CII, 1987a; CII, 2012c; AACE International, 2012).

Table 2-2 provides definitions, applicable conditions, and implementation examples for each method.

Progress measurement: Progress measurement metrics

Table 2-2. Commonly used progress measurement methods

(CII, 1987a; CII, 2012c; AACE International, 2012).

Method	Definition	Application Conditions	Implementation Example
Units completed	Quantity surveys or physical measurement of work items	Homogenous units of work	Linear-feet of wire pulling, cubic-yard of concrete placed
Incremental milestone	A percent completion be credited for completion of key incremental tasks	One deliverable with multiple activities performed in sequence; output for each subtask cannot be easily measured	Equipment installation, alignment and testing (e.g., 50, 70, and 100 percent of completion, respectively)
Weighted or equivalent units completed	A hybrid of units completed and incremental milestones	A major effort involving a long period of time; composed of two or more overlapping subtasks, each with a different unit of work measurement	Subtasks in structural steel erection with different units of measure are converted to equivalent tons and then the weighted percent complete is calculated
Resource expenditure	The percent of the total planned or forecast duration hours, or cost spent for the control account	No discrete deliverables or milestones in the work package; a relatively constant level of effort	Measurement for tasks such as project management, quality assurance, contract administration, and project controls
Judgment	The person responsible for the work package estimates the percent complete based on his or her informed judgment	Only for relatively minor tasks where development of a more discrete method cannot be used	Measurement for tasks such as painting, dewatering, constructing support facilities, installing architectural trim, and landscaping

Progress measurement: Strength and weaknesses of progress measurement metrics

- **Each progress measurement** method has its **own strengths and weaknesses**.
  - For example, the Units Completed method provides the **most detailed** and **accurate progress** information.
    - ✓ However, it is applicable only to homogenous units of work.
    - ✓ Also, this method may require a **significant amount of time** for data collection.

Progress measurement: Strength and weaknesses of progress measurement metrics

- **Each progress measurement** method has its **own strengths and weaknesses**.
  - On the other hand, the Judgment method takes the **least amount of time** and effort.
    - ✓ However, this **subjective** approach is highly dependent on the **experience of the supervisor**, and can be inaccurate and misleading.
    - ✓ In general, there is a **trade-off relationship** between ac**curacy/consistency and efficiency** in progress measurement (Chin et al., 2004).

Table 2-3 summarizes the strengths and weaknesses of these progress measurement methods.

Progress measurement: Strength and weaknesses of progress measurement metrics

Table 2-3. Strengths and weaknesses of existing progress measurement methods

(Thomas, 2000).

Method	Strengths	Weaknesses
Units completed	• Most detailed and accurate • Does not rely on subjective opinions or evaluations • Claimed output can be readily verified	• Time for data collection might be lengthy, especially if not applied correctly
Incremental milestone	• Easy to use • Simple to understand	• Long periods may elapse before an intermediate milestone is reached
Weighted or equivalent units completed	• Detailed and objective • Provides ability to compare and summarize several different subtasks and activity groups	• May be inaccurate, especially if there are few items and the activity durations are lengthy • Weighing or equivalency conversions and calculations might be complex, as well as requiring attention
Resource expenditure	• Greater detail and objectivity than simply estimating how much work was done • Less expensive than counting or measuring the units completed of subtasks	• Requires much more effort than simply estimating the percent complete
Judgment	• Simple, inexpensive, quick	• Can be very inaccurate and misleading

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Progress measurement: Strength and weaknesses of progress measurement metrics

- Since one complete project usually includes different types of tasks, **multiple progress measurement** methods are often used.

- One limitation in the existing body of knowledge is the l**ack of an integrated framework** to facilitate applying various progress measurement methods systematically in the project.

- The **implementation of different progress measuremen**t methods is usually based on the project manager's experience instead of objective criteria.

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Progress assessment metrics

- There are several metrics and indicators used to **assess performance of construction projects** based on **different approaches**.
- The **most commonly used** performance assessment method in the construction industry is **Earned Value Management (EVM).**
- In the early 1960s, the Department of Defense lead efforts for a standardized performance assessment and project control system, which eventually **popularized the use of EVM** in construction projects (Morris, 1982b).
- Performance assessment requires an **established baseline** of cost and schedule as a **benchmark for comparing** actual progress to planned work so that the progress and performance can be measured, assessed and, eventually, controlled (Oberlander, 1993; CII, 2012c).

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Progress assessment metrics

- Over time, due to certain **shortcomings of EVM**,

  other innovative methods were offered as viable alternatives, including

  - Earned Schedule Method (ESM),
  - Earned Duration Management (EDM) and
  - Critical Chain Project Management (CCPM).

Table 2-4 defines these commonly used methods and their related performance assessment metrics.

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Progress assessment metrics

Table 2-4. Performance assessment methods and related metrics.

Methods	Metrics	Definitions
Earned Value Management (EVM)	Cost Variance (CV)	The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost.
	Cost Performance Index (CPI)	A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost.
	Schedule Variance (SV)	A measure of schedule performance expressed as the difference between the earned value and the planned value.
	Schedule Performance Index (SPI)	A measure of schedule efficiency expressed as the ratio of earned value to planned value.

I completely covered this section in two courses:

1. ***Construction accounting and financial management***
2. ***Strategic scheduling during the life cycle of the project***

Progress assessment metrics

Earned Schedule Management (ESM)	Earned Schedule (ES)	The amount of time that was originally planned to take to reach the current level of earned value.
	Earned Schedule Variance (SV(t))	A measure of schedule performance expressed as the difference between the earned schedule and the actual time.
	Earned Schedule Performance Index (SPI(t))	A measure of schedule performance expressed as the ratio of earned schedule to the actual time.
Earned Duration Management (EDM)	Earned Duration (ED)	A calculation of activity duration using baseline planned duration of an activity and the rate of activity progress.
	Earned Duration Index (EDI)	A measure of progress expressed as the ratio of total earned duration to total planned duration of an activity.
Critical Chain Project Management (CCPM)	Critical Chain Completed (CCC)	A measure of the completed work tasks on the critical chain.
	Buffer Consumption Rate (BCR)	A measure of the overall rate at which the project buffer is being consumed for the project to date.

I completely covered this section in two courses:

1. ***Construction accounting and financial management***
2. ***Strategic scheduling during the life cycle of the project***

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Performance forecasting – Performance forecasting metrics

- Performance forecasting can be defined in **three basic ways**:
  (1) The remaining work will be completed at planned rates;
  (2) Current performance rates will be sustained for the remainder of the project; and
  (3) An extrapolation of the trends to date will help project the rest of the work (CII, 1987a).

Most performance forecasting metrics utilize current knowledge to project future performance outcomes.

Table 2-5 lists and defines performance forecasting metrics for both cost and schedule estimations.

Performance forecasting – Performance forecasting metrics

Table 2-5. Performance forecasting methods and related metrics.

Methods	Metrics	Definitions	Cost/Schedule
Earned Value Management (EVM)	Estimate at Completion (EAC)	A projection of total cost using the performance to date to project overall performance. It represents an independent second opinion of the final program costs.	Cost
	Estimate to Completion (ETC)	The expected cost to finish all the remaining project work.	Cost
	Variance at Completion (VAC)	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	Cost
	To Complete Performance Index (TCPI)	A measure of the cost performance that is achieved with the remaining resources in order to achieve a specified management target BAC (budget at complete) or EAC (estimate at complete).	Cost
	Independent Estimate at Completion (IEAC)	A projection of total cost using the performance to date to project overall performance.	Cost
Earned Schedule Management (ESM)	Estimate at Completion (time) [EAC(t)]	A projection of total duration of the project at the end of the project.	Schedule
	Estimate to Completion (time) [ETC(t)]	An estimation of time required to complete the remainder of the project.	Schedule

I completely covered this section in the construction accounting and financial management course.

Performance forecasting – Performance forecasting metrics

	Variance at Completion (time) [VAC(t)]	The predicted variance on the total schedule at the end of the project.	Schedule
	To Complete Schedule Performance Index (TSPI)	A measure of the cost performance achieved with the remaining resources to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.	Schedule
	Independent Estimate at Completion (time) [IEAC(t)]	An independent second opinion of the final project duration.	Schedule

Performance forecasting – Core forecasting metrics

Classification	Category	Name	Definition	Equation	Indicator	Use and Interpretation	Reference	Aditional Sources
Core Metrics	Performance Forecasting	**Variance at Completion** | VAC	A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.	VAC = BAC - EAC(CPI)	VAC>0 The project is under budget; VAC=0 The project is on budget; VAC<0 The project is over budget	VAC could be used in trending analysis for forecasting purposes. It can be used to communicate cost status of the project to senior management.	PMI Lexicon of Project Management Terms Version 3.0	
		Estimate at Completion | EAC(CPI)	EAC(CPI) is a metric to project total cost using the cost performance to date.	EAC(CPI) = AC + (BAC-EV) / CPI	Cost performance can be tracked over time using EAC(CPI).	This is one of the five variations of calculating EAC. This metric can be compared to the EAC, which is the manager's projection. It is an easy to calculate metric.	A Guide to Managing Programs Using Predictive Measures (NDIA, 2014)	PMI Lexicon of Project Management Terms Version 3.0 DCMA-EA PAM 200.1
		Estimate to Completion | ETC(CPI)	The expected cost to finish all the remaining project work.	ETC(CPI) = (BAC - EV) / CPI		This is one of the five variations of calculating ETC. A common practice is to use ETC periocally during the life of project. ETC may be compared to project manager's estimate.	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		To Complete Performance Index | TCPI(EAC(CPI))	A measure of the cost performance that is achieved with the remaining resources in order to meet a specified management goal, expressed as the ratio of the cost to finish the outstanding work to the remaining budget.	(TCPI_EAC(CPI)) = (BAC-EV) / (EAC(CPI)-AC)	TCPI_EAC(CPI) ≤ 1: Cost objective achievable; TCPI_EAC(CPI) > 1: It becomes more difficult to achieve the EAC	TCPI is the future cost performance required to finish the project within EAC. TCPI is a check index for ETC which is used to validate whether or not the estimate to complete can be achieved. Once ETC and EAC are calculated, calculate TCPI to determine whether the EAC is reasonably achievable.	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
	Performance Assessment	**Cost Performance Index** | CPI	A measure of the cost efficiency of budgeted resources expresssed as a ratio of earned value to actual cost	Cost Performance Index (CPI) CPI = EV / AC	CPI > 1: Project cost performance favorable; CPI = 1: Project cost performance on track; CPI < 1: Project cost performance unfavorable	CPI is an indicator of cost performance. However, CPI can be calculated either based on cost or manhours.	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		Schedule Performance Index | SPI	A measure of schedule efficiency expressed as the ratio of earned vlaue to planned value.	Schedule Performance Index (SPI) SPI = EV / PV	SPI > 1: Project schedule performance favorable; SPI = 1: Project schedule performance on track; SPI < 1: Project schedule performance unfavorable;	SPI is an indicator of schedule performance. However, SPI can be calculated either based on cost or manhours. A drawback to the use of SPI is that approximately halfway through the project SPI begins to converge to 1 regardless of the actual schedule performance. Using SPI(t) is a better alternative for assessing schedule performance.	PMI Lexicon of Project Management Terms Version 3.0	DCMA-EA PAM 200.1
		Earned Value | EV	The measure of work performed expressed in terms of the budget authorized for that work.	EV = BAC x Physical % Complete	EV > PV: Project cost performance favorable; EV = PV: Project cost performance on track; EV < PV: Project cost performance unfavorable	Accurately measuring physical progress is critical in calculating EV. However, earned value makes no distinction between a critical quantity and a non-critical quantity. Therefore, EV may not be closely tied to achievement of critical path.	PMI Lexicon of Project Management Terms Version 3.0	
	Progress Measurement/Data	**Physical Percent Complete** | PPC	Represents the amount of work performed as a percent of the total physical work required.		PPC ≥ Planned percent complete: Project component is on track; PPC < Planned percent complete: Project component is lagging	Physical percent complete is based on Quantity Based Measurements, Milestones, or Other methods (e.g., Rules of Credit and Level of Effort). Accurately measuring physical progress is critical in calculating EV.	CII RT-322	
		Budget at Completion | BAC	The sum of all budgets established for the work to be performed.			BAC must incorporate all approved changes.	PMI Lexicon of Project Management Terms Version 3.0	
		Planned Value | PV	The authorized budget assigned to scheduled work.			PV is also reffered to as Budgeted Cost of Work Performed which is the sum of the performance budgets for all work scheduled to be accomplished in a given time period. This includes detailed work packages, Level of Effort (LOE) packages, apportioned effort, and planning packages. Typically represents cumulative to date values, unless some other time period is specified.	PMI Lexicon of Project Management Terms Version 3.0	A Guide to Managing Programs Using Predictive Measures (NDIA, 2014)
		Actual Cost | AC	The actual cost of the work determined by the paid costs to date and accurals.	AC = Paid Costs (PC) + Accruals		The actual cost reported by the project control group may be more current and complete than that reported by accounting.	PMI Lexicon of Project Management Terms Version 3.0	

The Body of the Project Controls Plan

(3. Systems and Data Integrity Plan)

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

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