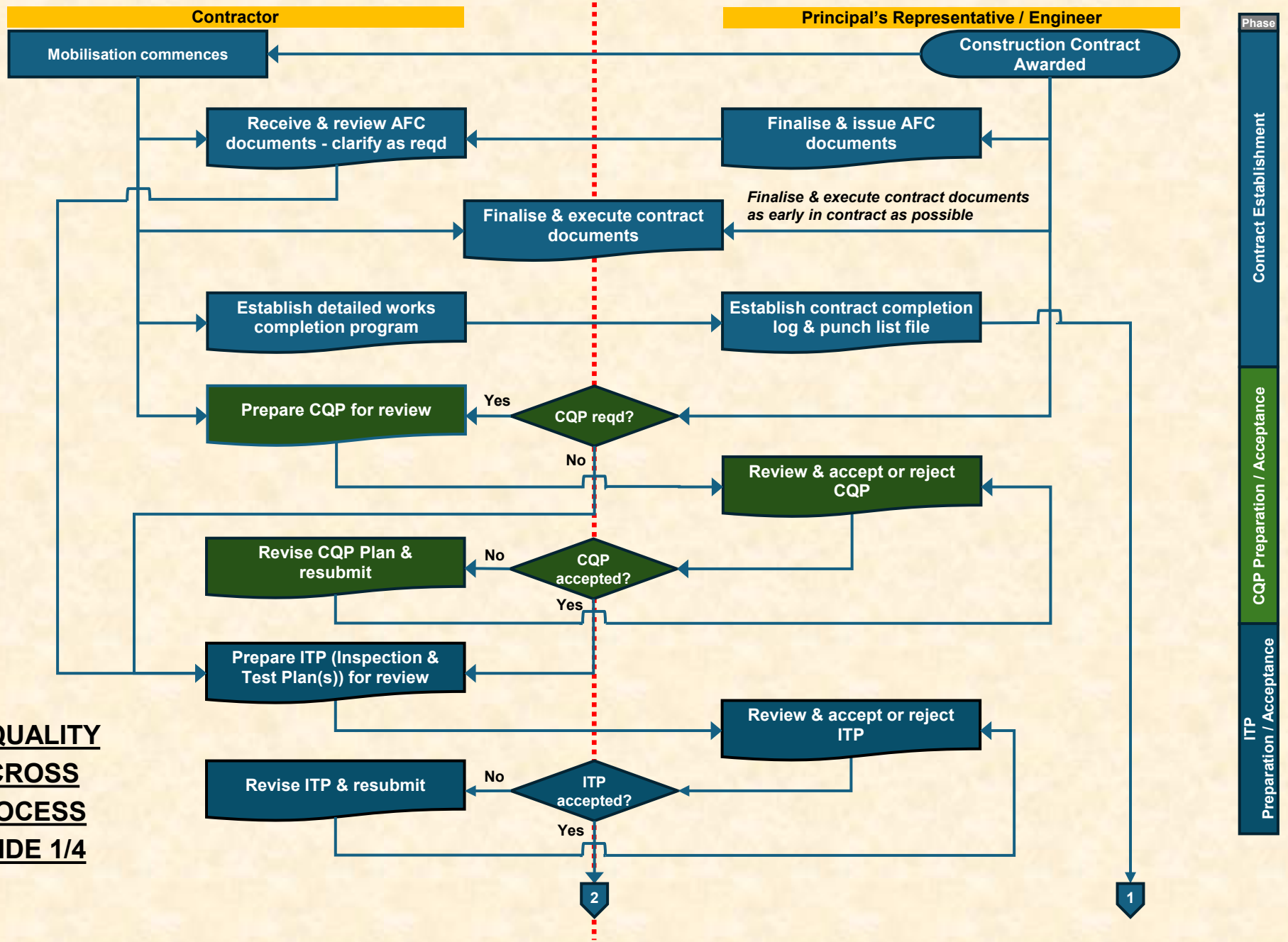
CONSTRUCTION CONTRACT QUALITY MANAGEMENT IN PROCESS PLANTS - PRINCIPAL ELEMENTS

Introduction

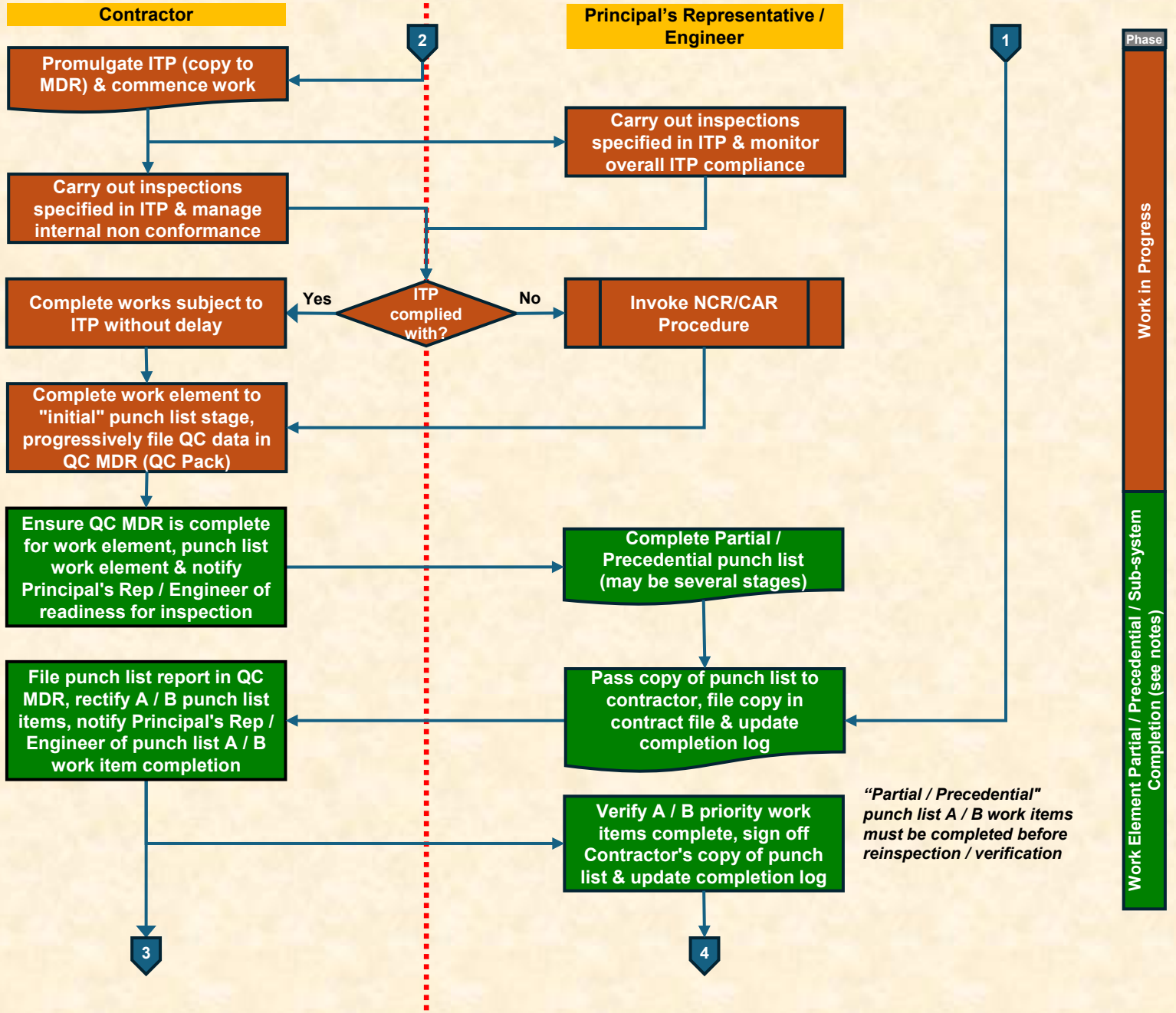
- Presentation outlines the principal elements of construction contract quality management in process plants (from Principals' perspective).
- Slides 2 to 5 comprise a continuous, cross functional flow chart covering all phases of the construction quality management process, namely;
  - Contract establishment
  - Contract Quality Plan (CQP) preparation and acceptance
  - Inspection and Test Plan (ITP) preparation and acceptance
  - Work in progress
  - Partial / Precedential / Sub-system completion
  - System completion
  - Handover
  - Practical completion
  - Contract completion
- Slide 6 outlines construction Contract Quality Plans (CQPs) and their use
- Slide 7 outlines construction Inspection and Test Plans (ITPs) and their use
- Slide 8 outlines Non-conformance Report / Corrective Action Request Process (NCR/CAR Process) and its use
- Slide 9 outlines 'Completion Inspection / Punch Listing', 'Punch Lists' and 'Completion Inspection / Punch List Monitoring'
- Slide 10 outlines 'Completion Inspection / Punch List Categories' and 'Partial / Precedential / Sub-system Punch Lists'
- Slide 11 discusses 'System Punch Lists'
- Slide 12 outlines 'Final Inspection and Handover to Operations'
- Slide 13 outlines 'QC Documentation' requirements for construction in process plants
- Slide 14 & 15 show a sample 'ITP' form and supplementary, explanatory notes
- Slide 16 shows a sample multifunction 'NCR/CAR' form
- Slide 17 shows a sample 'Punch List' form

CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS



CONSTRUCTION QUALITY MANAGEMENT CROSS FUNCTIONAL PROCESS FLOW CHART SLIDE 1/4

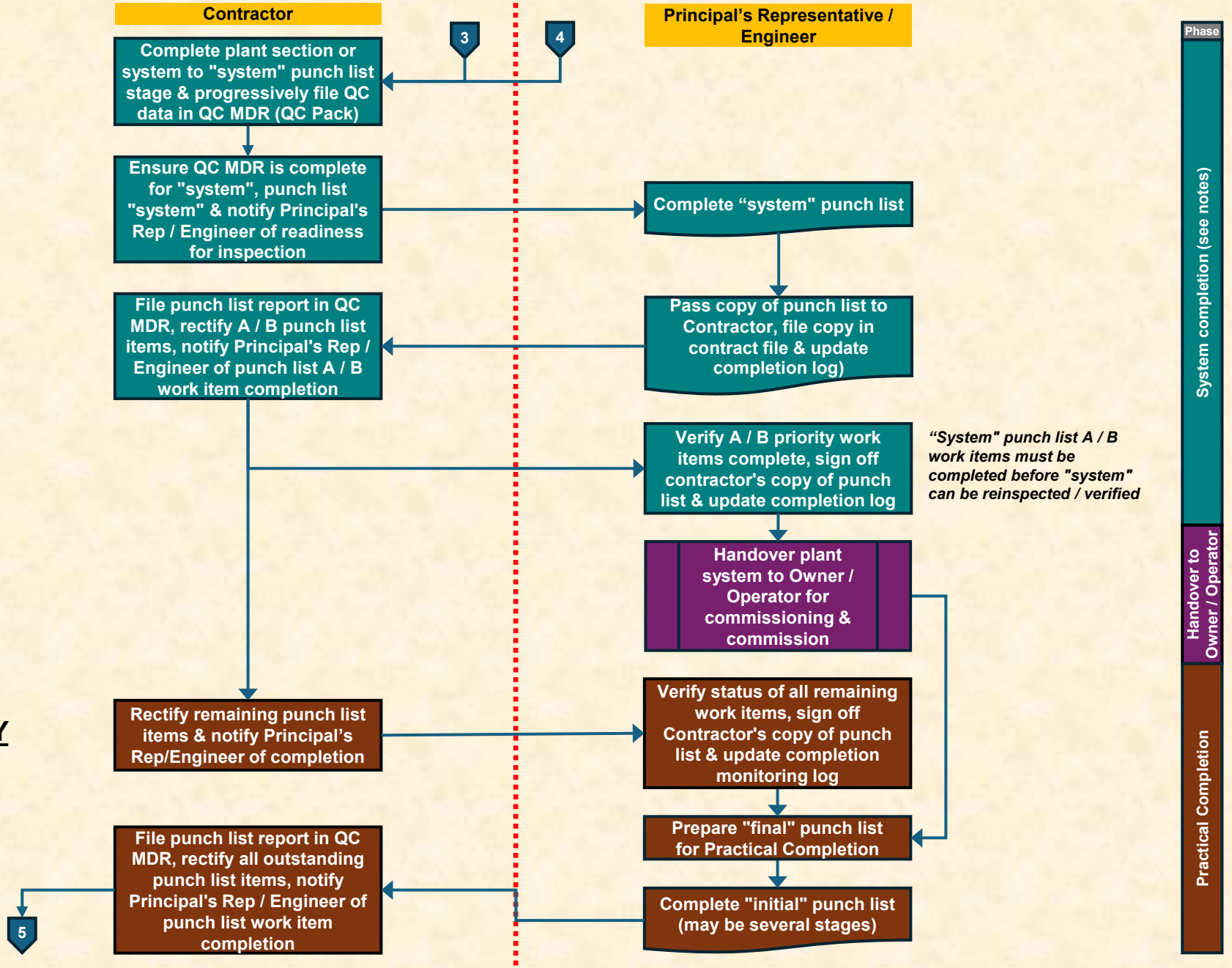
CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS



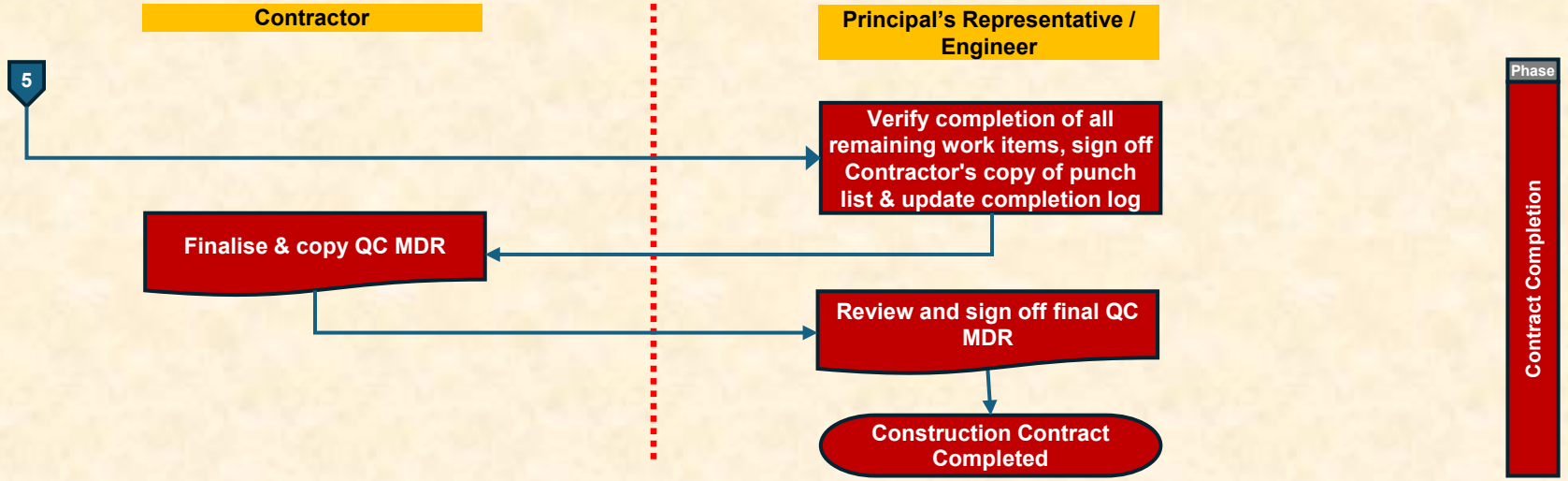
CONSTRUCTION QUALITY MANAGEMENT CROSS FUNCTIONAL PROCESS FLOW CHART SLIDE 2/4

CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS

CONSTRUCTION QUALITY MANAGEMENT CROSS FUNCTIONAL PROCESS FLOW CHART SLIDE 3/4



CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS



CONSTRUCTION QUALITY MANAGEMENT CROSS FUNCTIONAL PROCESS FLOW CHART SLIDE 4/4

Contract Quality Plan (CQP)

- CQPs are prepared by contractors and are contract specific.
- CQPs supplement contractors' quality manuals and procedures.
- CQPs are statements of contractors' intent and commitment regarding quality policies, practices, procedures, organisation and responsibilities etc. for respective contracts.
- Formal CQPs should be called for in tender documents when contract scope is sufficiently extensive to require a CQP and / or when contractors' quality manuals don't cover respective contract requirements adequately.
- CQP contents and scope are somewhat subjective, and format and contents can't be specified definitively. However, CQPs will generally include the following quality related aspects;
  - Corporate quality policy
  - Contract quality policy
  - Contractor's contract organisation, functions and responsibilities
  - A list of all QA / QC procedures relevant to the contract, including company procedures and contract specific procedures, specifications and instructions etc.
  - A list of sub-contracted work and services and the quality management systems to be applied by sub- contractors
  - An appropriate outline of how the Contractor proposes to manage quality and compliance with specification, health, safety and environmental aspects etc. to meet the Principal's expectations during the contract.
  - CQP audit programme
- If a contract requires submission of a CQP, contract works should not commence without an appropriate level of acceptance of the CQP by the Principal's Representative / Engineer.

Contract Inspection & Test Plans (ITPs)

- ITPs are highly interactive documents, which identify inspection, testing and acceptance requirements for each key construction or maintenance activity in the same sequence as the construction or maintenance process.
- ITPs (and their review) ensures contractors have defined and planned the most appropriate series of tests and inspections in a timely manner to achieve design intent and to show where the Principal's personnel will undertake inspection and verification.
- ITP requirements and submission schedule should be clearly defined in contract documents. Submission schedules should enable contractors to submit ITPs in sufficient time for review / acceptance by the Principal's Representative / Engineer and dissemination of accepted ITPs by the Contractor prior to construction or fabrication work commencing. Any special ITP requirements should be included in the tender documents.
- ITPs should be formatted as required by the contract. A typical ITP pro forma with provision for review and acceptance is shown in slide 14 with supplementary explanatory notes in slide 15. Alternative formats which suit a contractor's quality system should be considered and these should be reviewed and accepted by the Principal at the tender stage. Where an alternative ITP format without review and acceptance provision is accepted by Principal, a special stamp should be used to indicate acceptance level.
- ITPs are reviewed by the Principal's Representative / Engineer to verify ITP accuracy and completeness and to ensure that all inspections / verifications have been identified and classified correctly. Depending on complexity of construction or maintenance the Principal's Representative / Engineer should co-opt assistance from more competent personnel as and when required. Unsatisfactory ITPs are returned to the Contractor for revision and resubmission. The panel at the foot of the sample ITP pro forma is used to indicate the level of the Principal's acceptance of the ITP.
- A carefully prepared ITP, including all appropriate process steps, together with appropriate and mutually agreed quality activities for each process step, is a key mechanism in delivering required quality levels and compliance with specification. However, these outcomes will only be achieved if the final ITP is implemented properly and followed closely by both Contractor's and Principal's personnel. The Principal's Representative / Engineer must also determine the necessity for and frequency of audits of the Contractor's quality management systems by the Principal. Such audits are additional to the normal day to day surveillance carried out by the Principal's Representative / Engineer.

Non-conformance Report / Corrective Action Request Process (NCR/CAR) - Principal's Perspective

- Non-conformances may be discovered during Principal's normal surveillance and during internal or external audits or inspections.
- The Principal's formal NCR/CAR process provides a means of formally;
  - reporting non-conformances to the Contractor
  - recording the Contractor's view of such non-conformances and possible corrective actions
  - recording the Principal's disposition and approval of corrective actions
  - recording the Principal's acceptance of completed corrective actions
- The NCR/CAR process is often based on use of a multifunction form that enables Principal and Contractor to formally notify non-conformances, exchange views and opinions about these, determine and request appropriate corrective actions and record implementation of such actions. A sample NCR/CAR multifunction form is shown in slide 16.
- Contractors generally maintain their own NCR/CAR process for internal use as part of their QMS.
- Principals and Contractors should each maintain a non-conformance register to record details of all non-conformances for each contract.
- Principals and Contractors should each file NCR/CARs for each contract according to NCR/CAR completion status.
- Discretion is required in use of NCR/CARs as many simple or routine non-conformances may be resolved with basic site instructions.

Completion Inspection / Punch Listing

- Completion inspection / punch listing is carried out for both quality and contractual purposes.
- Careful, timely punch listing is essential in moving from the advanced stages of field construction to practical completion in a controlled manner with minimum delay.
- Punch listing therefore includes verification of both work completion and satisfactory completion of all 'receiving' and 'in-process' inspection, testing and verification required by the CQP, ITPs and any other documented procedures.

Punch Lists

- Punch lists should be prepared using agreed punch list forms and identified with a unique sequential number relating to contract, system, area work pack or P&ID as appropriate by the Principal's Representative / Engineer. A sample punch list form is shown in slide 17.
- Punch lists must be legible, contain sufficient location detail to enable others to find work items and defect or outstanding work descriptions must be clearly understandable by all concerned.
- Priorities (defined on the sample punch list form) and required completion dates must be specified for all punch list items.
- Punch list originals are sent to the Contractor under transmittal for inclusion in the final QC MDR where they can be progressively signed-off by the Contractor and the Principal's Representative / Engineer as punch list work items are completed. The Principal's Representative / Engineer will retain copies of original punch lists.

Completion Inspection / Punch List Monitoring

- The full completion inspection / punch-listing program should be defined when contract works commence and subsequently monitored to ensure that nothing is overlooked, and facilitation of the completion process is optimised.
- Once QC test packs have been defined and P&IDs marked up, the Principal's Representative / Engineer should compile a **completion log** by setting up a log sheet for each major system and contractor. All test packs and punch lists the Contractor is responsible for are listed in the completion log. As the key steps in the completion inspection / punch listing process are completed, completion dates are noted in the completion log so there is always a clear, up to date record of completion status.

Completion Inspection / Punch List Categories

There are three broad categories of completion inspection / punch list

- Partial / precedential / sub-system / discipline
- System
- Final inspection for practical completion or handover to operations

Partial / Precedential / Sub-system Punch Lists

(I.e., plant area, section, sub-system, discipline, equipment item etc.)

- Partial / precedential / sub-system punch lists are single discipline punch lists for discrete, 'bite sized' sections, subsections or single components of larger more complex systems. E.g., piping test packs form discrete sections of a complete plant process system; steel structures support process vessels and piping etc.
- Punch lists should be divided into the following groups; civil, structural steel, piping, vessels, rotating equipment, electrical, instrumentation, surface protection, insulation etc.
- Partial / precedential / sub-system punch lists should focus on **outstanding work required to enable progression to the next major construction step, system completion or practical completion**. E.g., pre-hydro punch list prior to hydrotesting in the case of piping. Initial/ sub-system punch listing should be undertaken as early as practicable to facilitate earliest practicable completion. Partial / precedential / sub-system punch lists should include the following.
  - Work requiring correction
  - Work requiring completion
  - Work not started

  Listing outstanding work items minimises the need to cover old ground during later checks.

System Punch Lists

(I.e. For a complete plant or system)

- When a plant or system is substantially complete, the complete entity should be punch listed to ensure that all system components have been installed in accordance with P&IDs, instrument diagrams, single line diagrams, loop diagrams and other specifications.
- System punch lists should focus on **safe and complete operability,** which requires adequate working knowledge of system components and familiarity with both process and general operating requirements. System punch listing should be undertaken as late as practicable to take full advantage of partial / precedential / sub-system punch listing.
- System punch lists should include (but not be limited to) the following aspects.
  - Equipment and associated services completed, tested and test blinds removed
  - Piping and valves tight, clean and installed to P&ID
  - Instruments connected, tested and calibrated
  - Electrical equipment tested and operable
  - Personnel safety requirements completed
  - Accessibility requirements completed
  - Plant area tidy with scaffolding and other construction facilities removed
  - Statutory requirements (codes, permits, regulations etc) complete / compliant

Final Inspection and Handover to Operations

- When a system or contract is practically complete (except for minor punch list items from partial / precedential / sub-system or system punch lists), a final inspection will be carried out by the Principal's Representative / Engineer and Contractor jointly. The resulting final punch list will include all outstanding items agreed by the parties to be completed by the Contractor as part of the Certificate of Practical Completion.
- Final punch lists are a consolidation of all outstanding items from earlier partial / precedential / sub-system and system punch lists as well as any new items that fall within the contractual scope of work. Final punch list inspections should be scheduled to enable all relevant parties to be present.
- When all construction or construction testing work has been completed (i.e., all A / B / C punch list items have been completed) and the plant system is ready for hand-over for commissioning, the Principal's Representative / Engineer will submit a construction completion report to the operations manager responsible for commissioning.

QC Documentation

- The systematic grouping of equipment for erection / testing purposes (i.e. sorting into test packs) and the format in which QA / QC records are required to be assembled, maintained, accessed and handed over, should be discussed at contract kick-off and finalised as expeditiously as possible. The preparation of comprehensive construction work packs during the detail design phase may facilitate this requirement to some extent. The Contractor should mark up a set of P&IDs showing boundaries of each process section, system or sub-system.
- The actual contents of contractors' final QC MDR *(Manufacturers Data Report)* packages (QC packs) will vary according to contract discipline, scope and complexity. Generally, contract requirements and relevant in-house procedures should be followed. However, as a guide, QC MDRs should be properly indexed and might typically include (but not be limited to) the following if relevant to contract scope:
  - MDR(s) certificate(s) endorsed by Inspection Body covering design, fabrication, erection examination and testing of pressure equipment as appropriate
  - Design verification certificates for pressure equipment and associated, verified design documents endorsed by the Design Verifier.
  - Design certificates and / or producer statements for **design and construction** of civil, structural and mechanical support infrastructure for pressure equipment
  - Accepted CQP and ITP(s)
  - Test pack schedule with marked-up P&IDs showing test boundaries
  - Approved fabrication / erection / welding / testing procedures and procedure qualifications including verification and test reports e.g., WPS, PQR etc.
  - Personnel qualification records e.g. welder qualification register and WPQs etc.
  - Marked up AFC isometrics for piping fabrication / erection *(mark-ups should include weld numbers, material traceability data and materials test certificate #s)*. Piping isometrics should also show hazard levels according to AS 4343.
  - Fabrication / construction QC verifications, inspection and test records (ITR) and reports including; surveyors reports, concrete certificates, welding control records, equipment installation reports etc.
  - PWHT reports and charts
  - Non-destructive examination reports e.g. RT, UT, MT, PT, etc.
  - Hydro-test / pneumatic test records including; P&IDs showing test boundaries. test procedures, calibration certificates for pressure gauges and chart recorders, hydro-test certificates and recorder charts endorsed by Inspection Body etc.
  - Surface coating inspection records
  - Test equipment certification and calibration records including; hydro test recorders, pressure gauges and instrument & electrical calibration equipment etc.
  - Materials test certificates and traceability data
  - Instrument / loop calibration reports
  - Hazardous Area Dossier
  - Electrical Test Reports
  - Electrical Certificates of Compliance
  - Installation completion checklists.
  - Punch Lists properly executed by each party - e.g. piping pre-hydro, post-hydro (pre-insulation), post insulation, system and final (i.e. for practical completion).
  - ITPs i.e., finals properly executed by each party
  - NCR(s) properly executed by each party
  - Relevant RFI(s), SI(s) and VO(s)

CONTRACT INSPECTION & TEST PLAN (ITP) FORM

INSPECTION & TEST PLAN (ITP)

Inspection & Test Point Legend				
H = Hold Point W = Witness Point R = Document Review S = Surveillance	Contractor:		ITP Type / Scope:	
	Contract No / Descr:		ITP No:	
	Subcontractor:		Revision No:	
	Subcontract No / Descr:		Date:	

Act No.	Manufacturing or Construction Activity Description	By	Inspection & Test Activity Description	Activity Control Procedure	Acceptance Criteria	Verifying Document	Contractor Inspection Point	Contractor's Rep Initials	Principal Inspection Point	Principal Rep Initials	Comments
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

Acceptance of this document does not relieve the Contractor of responsibility for compliance with Contract terms and conditions. Select appropriate acceptance box below.						Principal's Acceptance By:	Date:
ACCEPTED, Work may proceed	☐	ACCEPTED AS NOTED, REVISE & RESUBMIT, Work may proceed	☐	NOT ACCEPTED, REVISE & RESUBMIT, Work may 'not' proceed	☐	.....	...../...../.....

CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS

ITP FORM - COLUMN DESCRIPTION AND USE

Col #	Column Heading	Column Contents Description	Who
1	Activity Number	The manufacturing, construction or maintenance activity number in logical process sequence. (Includes procurement, fabrication, transport, receipt on site, construction, commissioning etc.)	SP or Contractor
2	Manufacturing or Construction Activity Description	Describe the construction, manufacturing or maintenance activity	SP or Contractor
3	By	Identify who performs the work described in column 2.	SP or Contractor
4	Inspection & Test Activity Description i.e. Inspection & Test Point	Describe the quality activities or quality characteristics to be verified associated with the work activity in column 2	SP or Contractor
5	Activity Control Procedure	Identify quality system procedure or instruction reference for conduct of QC activity defined in column 4	SP or Contractor
6	Acceptance Criteria	Identify design specification(s) or code(s) and respective section(s) and clause(s). Also include any critical parameters.	SP or Contractor
7	Verifying Document	Identify the document(s) used to verify acceptance of QC activity performance	SP or Contractor
8	Contractor Inspection Point	Define inspection type i.e. **W** = Witness, **H** = Hold, **R** = Review, **S** = Surveillance.	SP or Contractor
9	Contractor Initials	Leave blank for later verification.	SP or Contractor
10	Principal's Inspection Point	Define inspection type i.e. **W** = Witness, **H** = Hold, **R** = Review, **S** = Surveillance.	Principal's Representative
11	Principal's Representative's Initials	Leave blank for later verification.	Principal's Representative
12	Comments	Additional qualifying data as required.	Both as appropriate

Additional Clarification

- **Inspection and Test Point**
  A point or stage in the fabrication and construction cycle where an inspection or test activity is performed. All inspection and test points in the process should be recorded in the ITP.
- **Principal's Witness Point**
  An inspection and test point on the ITP designated by the Principal as an activity to be observed by the Principal's Representative. If a Principal's Representative is not present at the pre-arranged time and assuming due notice was given, the Service Provider or Contractor may proceed with the activity.
- **Principal's Hold Point**
  An inspection and test point on the ITP designated by the Principal as a point beyond which the Contractor will not proceed without authorisation. The activity will normally be witnessed by the Principal's Representative although in some circumstances, the Contractor may be notified in writing that the activity may proceed without the Principal's Representative.
- **Surveillance (Monitoring)**
  Continuing evaluation by Principal and Contractor of the status and use of procedures, methods, inspection activities and records analysis to ensure quality requirements will be met.
- **Review**
  Examination of documentary evidence related to inspection and test activities to verify that activities have been conducted satisfactorily and that results are acceptable.

CONSTRUCTION NON-CONFORMANCE REPORT / CORRECTIVE ACTION REQUEST FORM

CONSTRUCTION / MAINTENANCE NON-CONFORMANCE REPORT

Contractor:			
Contract:			
Contract No:		NCR No:	
Asset Name / Description:			
Asset No:		Spec / Dwg No:	

A. NON-CONFORMANCE DETAILS *(Attach sketch if necessary)*

Issued By: *(Prncpl's Rep)*		Date:	
Received By: *(Contractor)*		Date:	

B. CONTRACTOR"S RESPONSE / DISPOSITION:

Rework ☐ Repair ☐ Replace ☐ Use As Is ☐

Signed: *(Contractor)*		Date:	

C. PRINCIPAL'S REPRESENTATIVE DISPOSITION / APPROVAL

Signed: *(Prncpl's Rep)*		Date:	

D. PRINCIPAL'S REPRESENTATIVE RE-INSPECTION:

Accepted ☐ Rejected ☐

Signed: *(Prncpl's Rep)*		Date:	

CONSTRUCTION CONTRACT QUALITY MANAGEMENT FOR PROCESS PLANTS - PRINCIPAL ELEMENTS

PUNCH LIST FORM

PUNCH LIST (PL)

Priority Legend				
A = Immediate	Contractor:		Contract No:	
B = Prior to Practical Completion	Plant/System/ P&ID#:		Punch List Type:	
C = Prior to Product Introduction	Area/Section#/ Description:		Discipline:	
D = After Product Introduction				

Item No (1)	Asset No (2)	Asset Description (3)	Date Raised (4)	Priority (5)	Date to Complete (6)	Contractor's Rep Initials (7)	Principal's Rep Initials (8)	RI / TPI Initials As Reqd (9)	Comments (10)	Audit (11)

PL Inspection By:			
This punch list is not to be considered final or complete and may be subject to the results of further inspections and/or tests.	Principal's Representative:	Date: ...../...../.....	Punch List ID: