XPS Consulting & Testwork Services

Materials Selection and Quality Assurance in Capital Projects

Materials Technology

Presented by Wilson Pascheto

Wilson.Pascheto@xps.ca

Presented at CMP, Sudbury, ON November 2015

A GLENCORE COMPANY

Introduction - History

XPS Consulting & Testwork Services

Risk Management / 2002

- Mining companies often lack project management skills due to infrequency of projects
- Mining projects often located in remote areas of extreme weather and altitude

Introduction - History

XPS Consulting & Testwork Services

Risk Management / 2002

- The Chemical and Oil and Gas Industries are the leaders in Risk Management and we should adopt their Risk Management Techniques
- Resources for Risk Management are finite (scarce)

Introduction - History

XPS Consulting & Testwork Services

Risk Management / 2002

- The mining industry has done a poor job managing project risks
  - refer to list of causes of Falconbridge losses

Introduction - History

XPS Consulting & Testwork Services

Risk Management / 2002 Falconbridge Losses

Wedge Oct'97
BI - Ground Movement

Kitchen Fire May'97
DD - Contractor gross negligence, inadequate monitoring of contractors

Conveyor Oct'96
DD - Contractor gross negligence, inadequate monitoring of contractors

Crane Oct'97
DD - Inadequate controls on operation of crane during construction

Fan Failure Feb'98
Supplier design and construction errors, inadequate quality control

Ice Dam Jun'97
DD - Contractor failure to comply with construction parameters

Microscope Aug'98
DD - Inadequate Design Change Procedures

Conc. Fire Sept'98
DD - PHA did not identify required fire suppression systems

Hoist Gear Sept'98
DD - Inadequate Procurement Procedures

Dome Dec'98
EE - PHA did not identify required fire suppression systems

Furnace Feb'99
BI - Furnace Design

Ball Mill Nov'98
DD - Inadequate Maintenance Procedures

Falcondo Furnace Runout Mar'00
BI - Undetermined

Falcondo Loader Feb'00
DD - Inadequate Fire Suppression Systems

Conc. Silo Jan'99
BI - Improper Design

Construction Cause: Yes
No

Introduction - History

XPS Consulting & Testwork Services

Major losses:

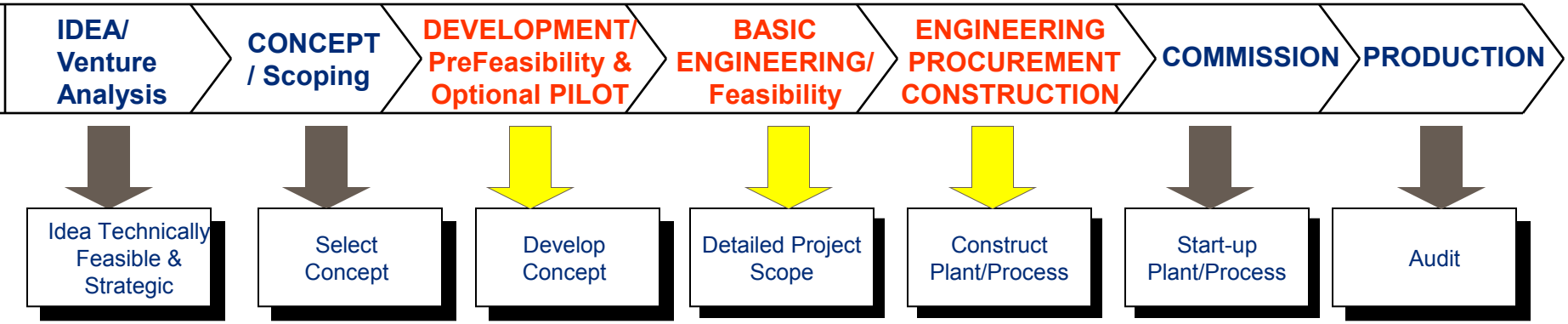
- Sulfuric acid drying tower $ 28 million
- Concrete (buildings) $ 10 million
- Conveyor gallery $ 6 million
- Acid-plant converter $ 5.8 million
- Concentrate dryer fan $ 5.2 million
- Skip hoist $ 3.5 million
- Reverb furnace $ 1 million
- Conveyor fire $ 1.7 million
- Magnola…

Major cause = faulty workmanship and design

Presentation Summary

- Introduction to QA
- QA in Development and Basic Engineering
- QA in Engineering and Design
- QA in Procurement, Fabrication and Construction
- Opportunities and Challenges
- Summary

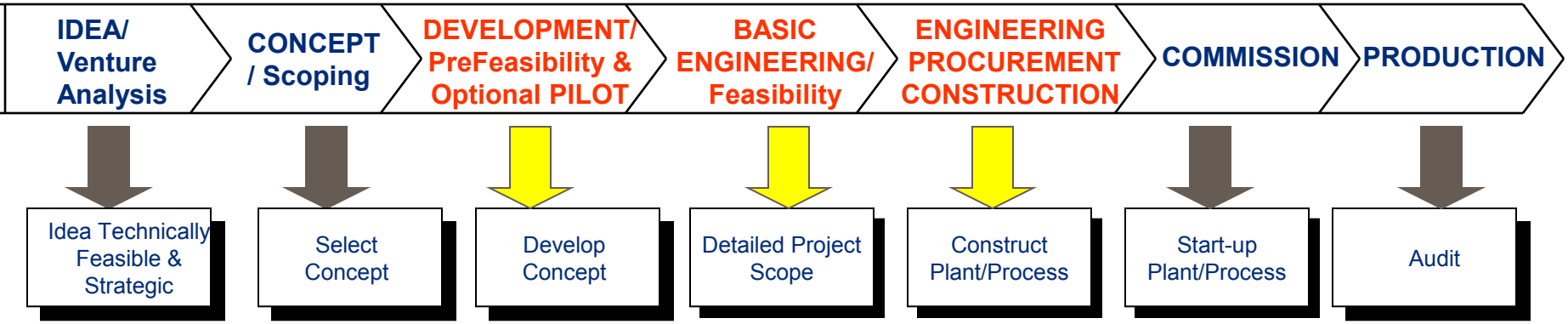
Introduction to QA



Comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service.

Comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component, or system to predetermined requirements.

Introduction to QA



QA covers all activities from development, design, fabrication, installation, servicing and documentation.

QA builds on the sayings "fit for purpose" and "do it right the first time".

Introduction to QA

XPS Consulting & Testwork Services

Why Quality Assurance?

To obtain the required design, materials, fabrication and construction quality for new equipment to:

- Improve safety
- Reduce loss of assets
- Limit downtime
- Improve plant reliability
- Improve operation stability

Introduction to QA

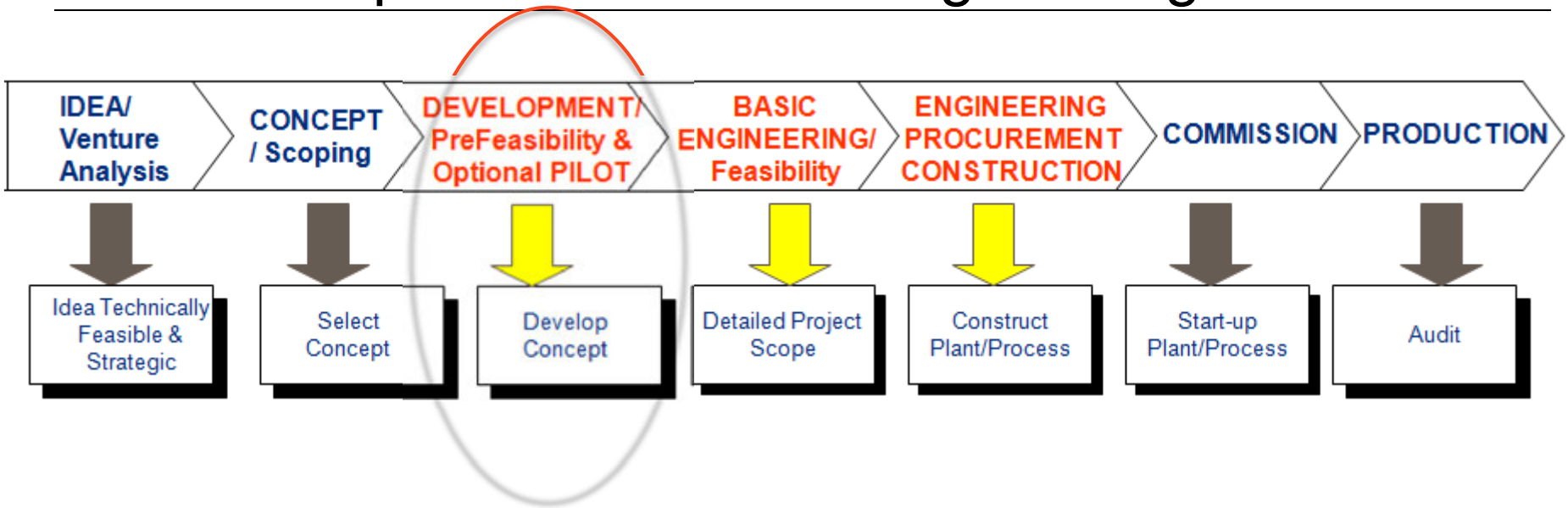
XPS Consulting & Testwork Services

What is required?

- Proper decision making (Ex: Stage Gate Process)
  - Ensure that a quality assurance program is in place
  - Proper quality-assurance methods
  - Involve all disciplines (engineers, operation, maintenance)
- Define critical equipment based on impact to
  - Safety
  - Property
  - Production
  - Based on Hazops, FMEA, risk and consequence of failure
- Adequate funding (Include cost of QA in AR estimate)
- Qualified and experienced personnel

QA in Development and Basic Engineering

XPS Consulting & Testwork Services



QA in Development

XPS Consulting & Testwork Services

- Can the process be contained?
- Will process parameters change with time?
- Upset conditions?
- Preliminary review/considerations of process parameters, design, equipment selection, materials of construction, etc
- Pilot testing (process & materials)

Case 1 – Materials Selection, development stage

XPS Consulting & Testwork Services

High pressure acid leaching plant

- Testing to support materials selection during the development stage
- Testing of acid resistant masonry, mortars and membrane materials
- Design review, life estimate of ancillary equipment
- Plant ramp-up was within target timeline

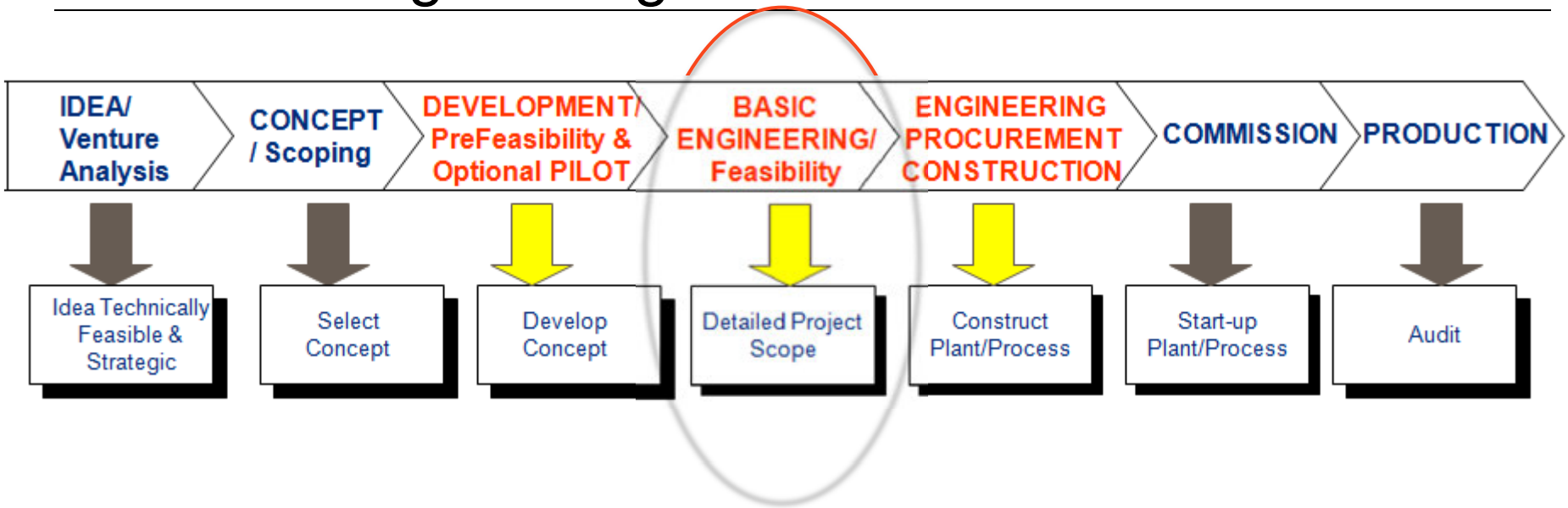
Case 2 – Materials Selection

Nickel Sulphide Concentrator

- Original structural steel and plant equipment coating not suitable for the application
- Process conditions changed over time aggravating corrosion of structural steel and plant equipment
- Re-coating and replacement of structural steel and equipment was required
- New coating system, application methods and inspection was implement during plant rehabilitation

XPS Consulting & Testwork Services

QA Basic Engineering



QA in Basic Engineering

XPS Consulting & Testwork Services

- Develop overall project QA strategy
- Estimate cost of:
  - Owners team QA
  - Third party quality surveillance
    (1-3% of equipment cost)
- Include cost of QA in AR estimate
- Review of process parameters, design, equipment selection, materials of construction, benchmark, etc
- Preliminary procurement specifications

Case 3 – Design and Materials Selection

XPS Consulting & Testwork Services

Back fill tank erosion

- Bolted, flanged design
- Carbon steel tank coated with ceramic filled organic coating
- Severe erosion of baffles, tank wall and floor, bolts
- Tank design not suitable for coating and rubber lining

Case 4 – Design and Materials Selection

Corrosion & mechanical failure of agitator shaft

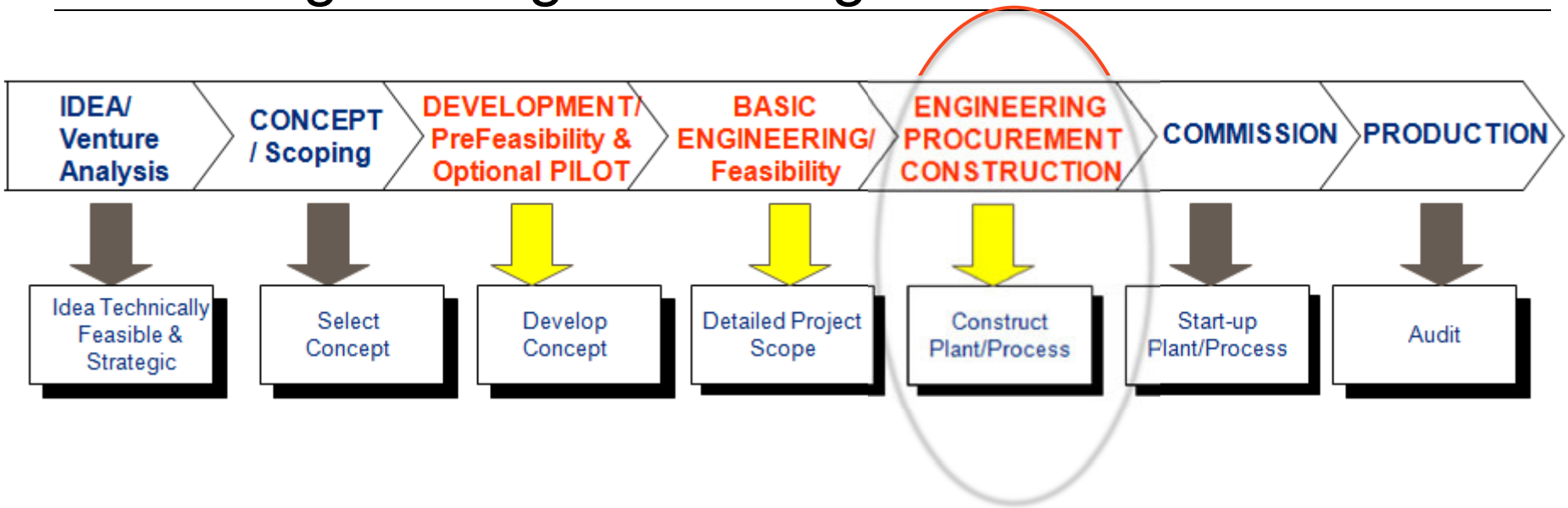
Agitator shaft of copper leaching reactor

- Leaching solution at high T and low pH
- Shaft made of rubber lined carbon steel
- Breach in rubber lining led to corrosion of carbon steel substrate and shaft failure
- Replacement was made of super duplex SS

Agitator shaft

XPS Consulting & Testwork Services

QA in Engineering and Design



QA in Engineering and Design

XPS Consulting & Testwork Services

- Review and finalize technical specifications
- Review drawings / design, including equipment selection
- Selection of materials of construction (may require testing prior to final selection)
- fabrication and inspection requirements, acceptance parameters
- Qualification and selection of potential suppliers, review of tenders, pre-award meetings, inspection during fabrication and construction, review of vendor documents
- Review and approval of inspection and testing plans (ITP)

QA in Procurement, Fabrication and Construction

XPS Consulting & Testwork Services

Develop a Plan

- Quality surveillance including inspection levels

Inspection Levels

1. Final verification and inspection
2. Limited surveillance
3. Full surveillance
4. Continuous surveillance

QA in Procurement, Fabrication and Construction

XPS Consulting & Testwork Services

Inspection level is a function of

- Equipment cost
- Material of construction and complexity
- Degree of custom fabrication involved
- Importance of fabrication defects
- Consequences of failure
- Supplier reputation

Case 5 - QA/QC in fabrication

XPS Consulting & Testwork Services

Hood – Peirce Smith Converter

- Material: 2 ½ Cr-1 Mo plate + CS stiffeners
- Deficiencies in welding procedures and ITP identified during pre-fabrication meeting
  - No NDT after Post weld Heat Treatment (PWHT)
  - Choice of filler metal prone to weld cracking
- Implementation of NDT after PWHT and change in welding procedures prevent fabrication delays and failures in service

Case 6 - QA/QC in fabrication

Boiler Tube Bundle Failure

- Material: 9Cr-1Mo + 347HSS
- Deficiencies in welding procedures and ITP led to cracking and their detection in the fabrication shop
- Weld cracks were only discovered after the bundles had been installed
- The extent of cracks made the tube bundles unrepairable

Case 7 –Inspection during fabrication

Hoist Bull Gear

- Pitting due to dimensional errors
- Gear was re-cut at suppliers cost
- Incomplete technical specification and inspection
- Procurement specifications and inspection have been introduced since this failure

Opportunities and Challenges

XPS Consulting & Testwork Services

Opportunities

- Improve safety, reduce capital and operating costs by proper implementation of good QA practices

Challenges

- Awareness of the contribution of various disciplines in all phases of capital projects, particularly materials technology

- Develop experienced personnel to attend the needs of Owners and Contractors

Summary

XPS Consulting & Testwork Services

Key Messages

- Implement QA from development to construction
- Development a QA strategy
- Estimate the cost realistically and include in AR
- Prepare appropriate equipment specifications
- Ensure qualified inspection & surveillance personnel are available.

Questions?