

TECHNICAL AUDIT OVERVIEW & THE NUCLEAR INDUSTRY PERSPECTIVE

DOUG FERGUSON

LOWTHER-ROLTON (L-R)

FORMATION

- Construction Technology engineers established in 1987.
- Independent from all equipment suppliers and Contractors.
- Combine mechanical and structural engineering with the practical skills of field engineers and Project managers.

LOWTHER-ROLTON (L-R)

FORMATION

- Formed to improve the Safety of load movement operations – recognition of the hazardous work environment of the era.
- Acknowledgement that incidents are preventable.

LOWTHER-ROLTON

FORMATION



ORIGINAL DESIGN ENGINEERING BY LOWTHER-ROLTON

LOWTHER-ROLTON

PROGRESSION

- Developed the system of Technical Audit in response to a series of high profile oil industry lifting incidents.
- 30 years of service to industry without an incident or accident related to our scope of work.
- Deliver increased safety and efficiency through planning and safe working.
- Significant contribution to industry wide safety performance improvement during the intervening period since formation.

LOWTHER-ROLTON

PROGRESSION



TECHNICAL AUDIT BY LOWTHER-ROLTON

DOUG FERGUSON

INTRODUCTION

Experience:

- Design engineer in heavy lift shipping (7 years)
- Engineering Manager (Baldwins cranes – 3 years)
- Heavy Lift Engineer (Foster Wheeler – 12 years)
- Director - Lowther-Rolton (5 years)
- Specialist in: Modularization

DOUG FERGUSON

INTRODUCTION



DOUG FERGUSON – PAST PROJECTS

SUMMARY

HOW THE NUCLEAR INDUSTRY
PREVENTS DROPS

LOWTHER-ROLTON
PERSPECTIVE 2013 - 2017

NUCLEAR POWER

- NUKE CULTURE and REFINING CULTURE
- SERIOUS INCIDENT
- RESPONSE TO INCIDENT

NUCLEAR POWER - CULTURE

FORMAL TRAINING

- Background checks.
- At least 5 days formal off-site training.
- Additional training on site.
- Formal escorting of visitors.

NUCLEAR POWER - CULTURE

Rapid Risk Assessment system

- Mandated for certain operations (for example cranes over 90% utilization).
- May be called for any reason.
- Require a quorum of Management, field, safety and other Personnel.
- Systematic closeout prior to operations proceeding.

NUCLEAR POWER - CULTURE

OBSERVATION

- Formal observation of activities.
- Observations documented.
- Analysed in detail – more than statistical analysis.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

HUMAN PERFORMANCE TOOLS AND THEIR APPLICATION

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

- Pre-Job Briefing
- Two-Minute Rule
- Three-Way Communication
- Phonetic Alphabet
- Procedure Use and Adherence
- Place Keeping
- Flagging/Operational Barriers
- Self-Checking
- Independent Verification
- Concurrent Verification
- First Check
- STOP when unsure
- Peer Checking
- Post-Job Review

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Pre-Job Briefing:-

- More comprehensive job brief – usually in an office location.
- More focus on plant factors and wider topics.
- High participation by workers – leading and participating.
- Formal presentation of “Operating Experience”.
- Risk Assessment is part of the brief, but not the whole focus.
- Observation of the brief – evaluation of the brief.
- Repetition of certain information for reinforcement daily.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Pre-Job Briefing:-

- ALL of the following tools are promoted daily in the Pre-Job Briefing.
- ALL of the following tools are observed in the field, and observations are documented and analysed.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Two Minute Rule:-

- Initial 2 minute inspection AT THE WORK LOCATION at start of shift.
- “Take a Minute” discussion may be part of it.
- Workers read standard information form cards while it is discussed.
- Similar to 20-20-20 rule in certain refineries.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Three way communication – for all DIRECTIONS:-

- SENDER ensures he has receiver's attention and speaks RECEIVER'S name – then gives instruction.
- RECEIVER repeats the message back to SENDER – RECEIVER paraphrases the instruction (to demonstrate understanding) but uses all equipment tag numbers etc. verbatim.
- SENDER acknowledges that the message has been heard and understood by RECEIVER.
- Checked by observation.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Phonetic Alphabet:-

- Used in communications to ensure clear identification of equipment tag numbers.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Procedure Use and Adherence – prevent workers from having to interpret how to use and apply a SOP:-

1. Procedure Use:-

- has a specific meaning – how often do workers physically refer to the procedure – a formal requirement.
- If Procedure Use is set as “continuous” – document should be in the hands of the worker or supervisor.
- Alternatively it may be set as “reference”.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Procedure Use and Adherence – prevent workers from having to interpret how to use and apply a SOP:-

2. Procedure Adherence:-

- Simply means that procedures should be followed, and provides tools to make this happen.
- Understanding procedure in advance.
- Checking procedure is applicable.
- Identifying critical steps.
- Checked by observation.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Place Keeping:-

- Marking critical steps.
- Understanding each step entirely before commencing.
- Marking each step as complete:
 - Sign-offs
 - Check lists
 - Circle/slash

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Flagging and Operational Barriers:-

- Flagging equipment TO BE WORKED ON.
- Operational Barriers around equipment NOT TO BE WORKED ON.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Self Check:-

- A series of actions a lone worker can take to reduce error.
- Before working on a component, touch it physically.
- Pause and consider next step, consider consequences of actions.
- Double check equipment tag, state the tag number aloud.
- Maintain physical contact and commence action.
- Review results.
- These behaviours to be reinforced in pre-job brief.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Independent Verification:-

- Appropriate when the action to be performed is important, but is without immediate consequence if performed incorrectly.
- Performer remains responsible including for self checks.
- Verifier checks the actions completed by the performer, and that the task was completed correctly.
- Verification NOT in presence of the performer, to avoid influence and repetition of error.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Concurrent Verification:-

- Appropriate when the action to be performed is important and could have immediate consequence if performed incorrectly, or is impossible to verify as correct, once completed.
- Requires two qualified technicians, who must assign role of performer and verifier.
- Both performer and verifier take actions which are similar to the self checks, but they do so independently.
- Verifier directly observes the performer while the action is being performed.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

First Check:-

- A system of verifying the first action in any procedure is being performed in the right location – by checking with the control room or management.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Stop When Unsure:-

- Just what it says!

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Peer check:-

- Similar to self check, augmented by a qualified co-worker.
- Not a formal independent verification.
- Casual check, encouraged at briefings.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Post-Job Review:-

- Just as it sounds!
- More formal system than refining.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Discussion:-

- The refineries extend similar operating procedures across their entire property, and augment them in live areas.
- The Nuclear Industry is intensely focussed on the Protected Area and the equipment within it.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Discussion:-

- The Nuclear Industry is under cost pressure due to inexpensive natural gas prices/competition.
- The Oil and Gas industry has adjusted to lower commodity prices.

NUCLEAR POWER - CULTURE

HUMAN PERFORMANCE TOOLS

Discussion:-

- Nuclear has more layers of personnel checking documentation and observing implementation, heavier documentation requirements and works at a slower pace.
- Should Nuclear be shedding layers, or should Refining be adding them?

NUCLEAR POWER – SERIOUS INCIDENT

ARKANSAS NUCLEAR ONE

Incident on March 31, 2013:-

- Structural failure of a lift system during a Stator lift
- 600t Stator fell resulting in one fatality and 8 injuries.
- The Power Plant's online operating unit tripped.

NUCLEAR POWER – SERIOUS INCIDENT

ARKANSAS NUCLEAR ONE

Incident on March 31, 2013:-

- Root cause was inadequate structural design
- Design was for 100%, not 125% of load.
- Load testing was not carried out.
- Management of change.

RESPONSE TO INCIDENT

ARKANSAS NUCLEAR ONE

Recovery from incident on March 31, 2013:-

- New contractors appointed and given access to the area.
- Damaged (existing) Stator and transporter removed.
- New lift system design was developed from existing equipment.
- Full ***Technical Audit*** carried out on new design and method.
- Load testing carried out.
- Stator installation effected in July 2013.

STATOR SWAP

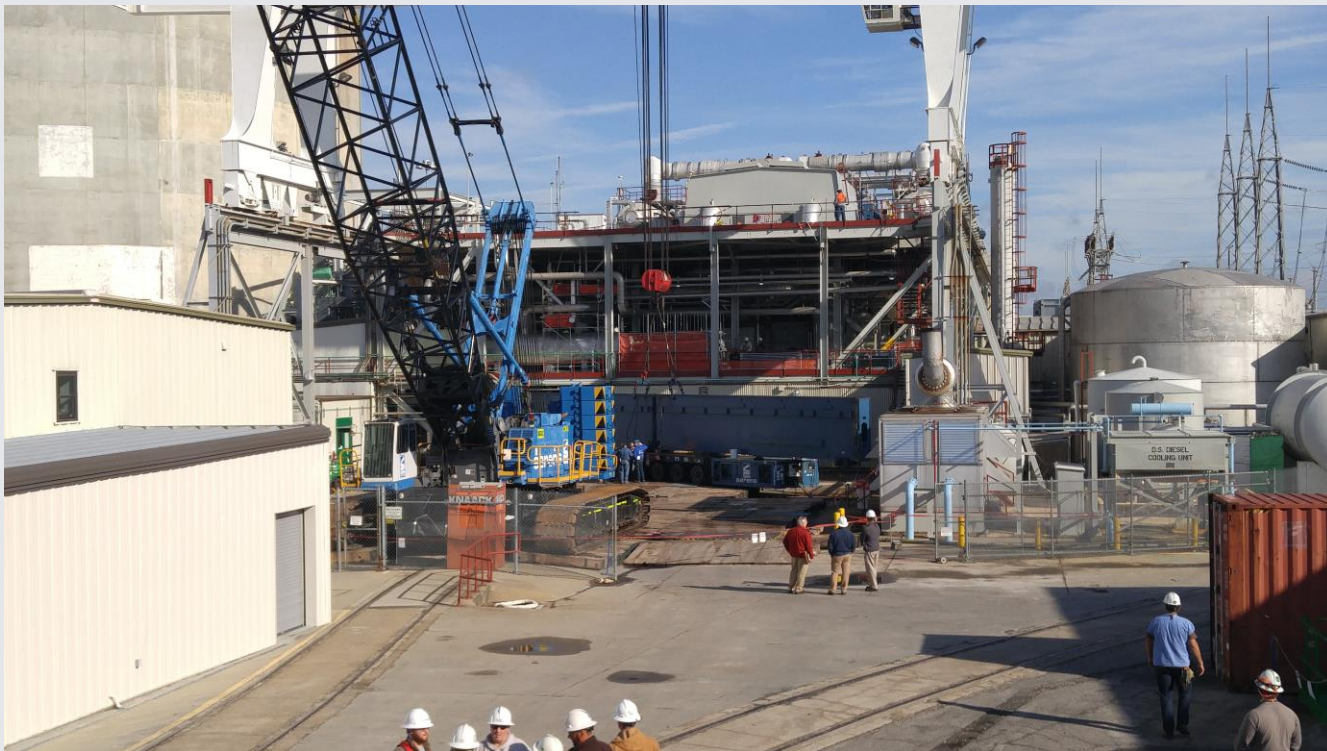
TYPICAL NUCLEAR MOVES



LIFT SYSTEM LOAD TEST

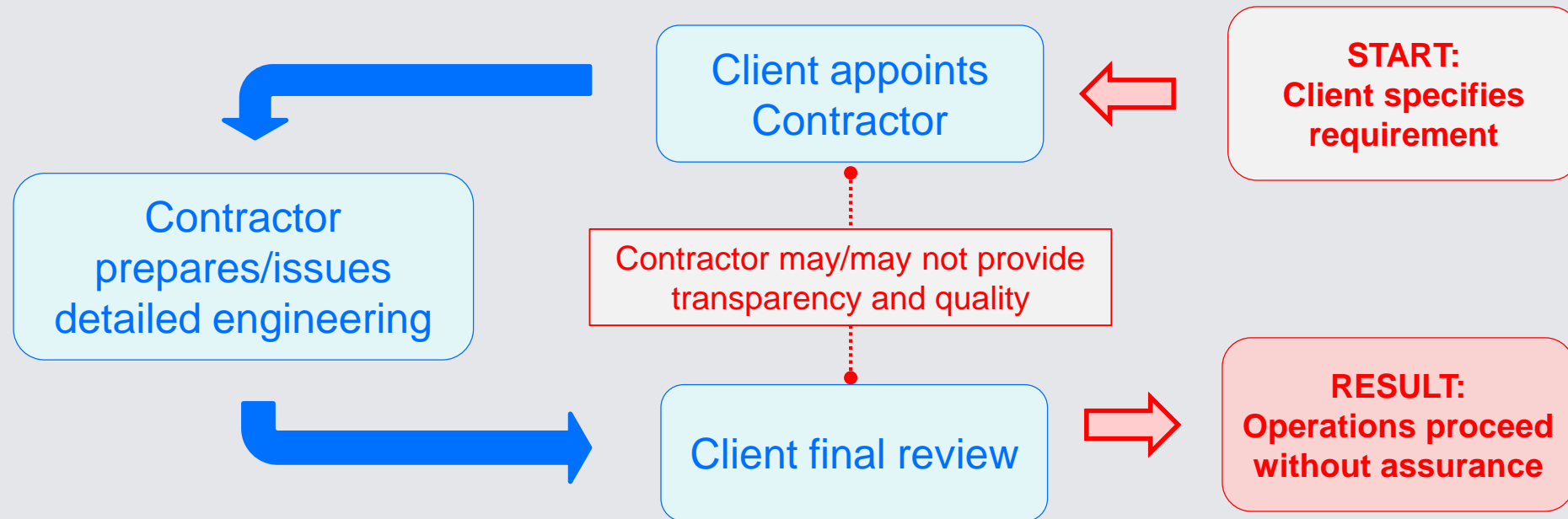
STATOR SWAP

TYPICAL NUCLEAR MOVES



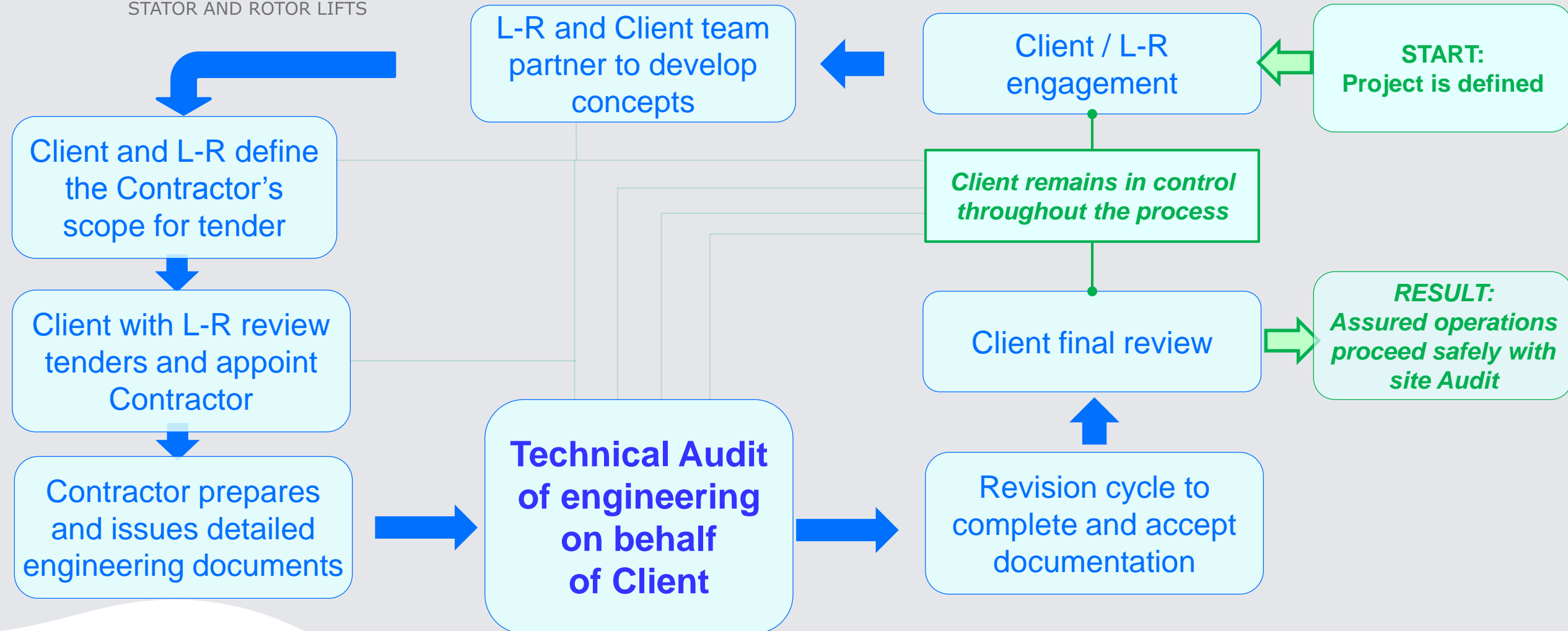
WITHOUT INDEPENDENT TECHNICAL AUDIT

STATOR AND ROTOR LIFTS



WITH INDEPENDENT TECHNICAL AUDIT

STATOR AND ROTOR LIFTS



TECHNICAL AUDIT

TECHNICAL AUDIT

- **PRIMARY PURPOSE:** To ensure planning is complete and accurate such that operations may be completed safely.
- **SECONDARY BENEFIT:** Increased efficiency
- **REQUIREMENTS:** Independent review and verification with no conflict of interest

TECHNICAL AUDIT

TECHNICAL AUDIT

- SCOPE: All heavy load movements
Road transport, ocean shipping, on-Site transport, transfers into and from laydown, installation.

Owner, Engineer, Contractor and Vendor documentation relating to the design, operational and procedural aspects.

Site operational attendance.

TECHNICAL AUDIT

INDEPENDENT DESIGN AUDIT:-

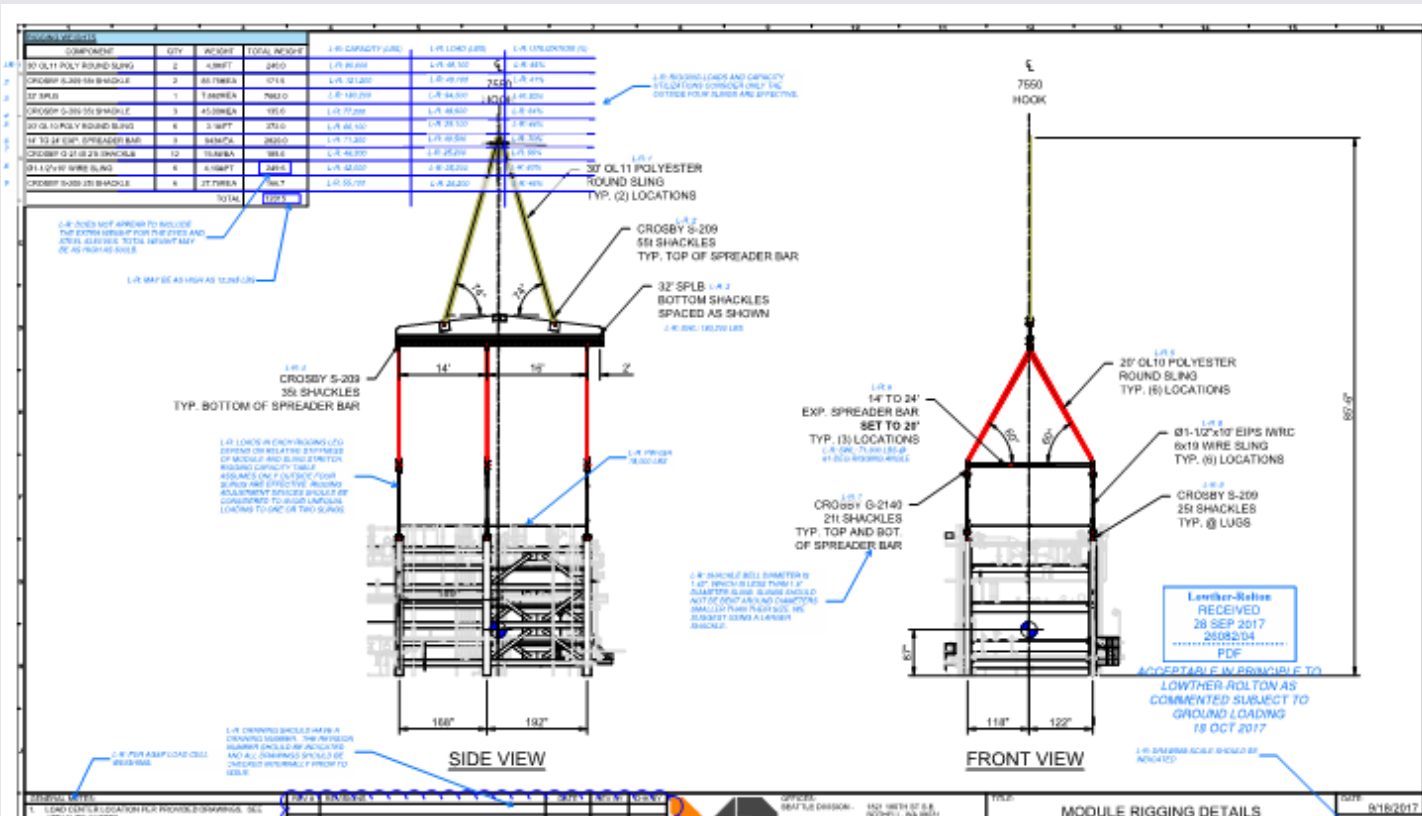
- Structural and mechanical design review - independent of source material.
- Where original and check results diverge – *increased scrutiny*.
- Review includes design of Process Equipment.
- Interface checks (crane/ground, rigging/lift attachments, rigging loads/base ring, temporary supports etc.)
- Ground issues/geotechnical reports.

TECHNICAL AUDIT

OPERATIONAL AUDIT:-

- Dimensional, stability and capacity review for Construction Equipment (cranes and rigging).
- Where original and check results diverge – *increased scrutiny*.
- Review includes design of Process Equipment.
- Weight calculations and weighing reports.
- Interface checks – geometric fit of rigging, datum points, dimensional checks, survey requirements.

TECHNICAL AUDIT



OUR REF: 26912-U-01-RV09-TO
CLEAN PRODUCTS UPGRADE PROJECT
CONTRACT C6227129
PO NUMBER: TBD



INSTALLATION OF MODULES
LOWTHER-ROLTON - ACCEPTANCE IN PRINCIPLE

OCTOBER 26, 2017

1.0 INTRODUCTION

1.1 Further to receipt of documentation during September 28, 2017 regarding the installation of modules for the Andeavor Clean Fuels Project, we have reviewed the operational aspects of certain of the lift plan drawings and associated documentation received from Ness and Campbell, and provide our written review and marked documentation.

1.1.1 The lift plan drawings included in this review are: EQ-07, PW-01C, PW-05A/B, AND EQ-02.

1.2 This should assist Andeavor and Ness & Campbell during the preparation for the Module installation, to ensure compliance with the relevant codes, standards and good practice such that operations are capable of being completed safely. The document sheets reviewed by Lowther-Rolton are initialed in the lower right corner, and blue check marks are used to denote information reviewed and deemed acceptable.

2.0 SUMMARY

2.1 Lowther-Rolton considers the documentation generally to be acceptable as commented, albeit additional documentation should be issued to fully define the operations, as noted.

2.2 We have proposed reduced operational wind speed limits for each crane lift considering the wind sail effects of the Modules (see 5.3).

2.3 Our design comments regarding the ground loading and lifting attachments shall follow this operational review; however, we have included some initial comments regarding the ground loading in advance of our design comments, as the load spreading arrangement appears to require further consideration (see 5.11 and 5.12).

2.4 The rigging arrangements for PW-05A and PW-05B include three rigging legs under each spreader bar, which introduces the possibility for unequal sling loads (see 8.1). We suggest Ness & Campbell should include chainfalls in the rigging arrangement in a manner suitable to allow them to equalize the rigging loadings to avoid higher-than-expected global bending stresses in the Modules or tension in the rigging during lifting.

2.5 We suggest a trial fit of the lower sling DL11 in the shackle bell some time in advance of lifting Module EQ-07 to ensure there will be proper clearance (see 6.2). The slack sling diameter per the included product literature indicates there may be an interference.

2.6 Our reviews of additional Module lift plans shall also follow.

3.0 SCOPE

3.1 The following Project documents are included in this review:

- EQ-07 HOISTING (lift plan and rigging drawings) (3 sheets)
- ISOM PW-01C HOISTING (lift plan and rigging drawings) (3 sheets)
- ISOM PW-05A - PW-05B, EQ-02 HOISTING (lift plan and rigging drawings) (5 sheets)
- Grow GMK7550 capacity charts and supporting information (4 sheets)
- Spreader bar general arrangement drawings (3 sheets)
- Rigging component supporting information (7 sheets)

DATE	BY	DATE	BY
18 OCT 2017	TC	28 SEP 2017	TC
18 OCT 2017	TC	28 SEP 2017	TC

DATE: October 26, 2017 Prepared by: Tom Olson Checked by: Doug Ferguson
www.lowther-rolton.com Page 7 of 8

TECHNICAL AUDIT

PROCEDURAL AUDIT:-

- Verification that Method Statement is accurate and comprehensive, such that operations may be completed safely.
- Ensure Risk Assessment is comprehensive.
- Review equipment test certification, inspection and maintenance records, personnel qualifications.
- Identification of authority to proceed with operations, and sign-off requirements.
- Communications, mitigation plans, contingency planning and Management of Change procedure.c

TECHNICAL AUDIT

SITE AUDIT:-

- Verification that location and Process Equipment aspects are as anticipated.
- Verification that equipment is assembled safely and correctly and in accordance to reviewed, agreed engineering documentation and procedures.
- Pre-operational checks.
- Trouble shooting and enacting controlled Management of Change procedures when necessary.

TECHNICAL AUDIT

BENEFITS – SAFETY, EFFICIENCY AND CLARITY

- Reduced incident rate.
- Improved methods.
- Secondary benefit of increased efficiency.
- Less rework/ errors/ delays.
- Proactive and positive closeout of engineering issues.
- Auditable paper trail – transparency – clarity.

TECHNICAL AUDIT

BENEFITS – SAFETY, EFFICIENCY AND CLARITY

- Client is empowered in their relationship with Contractors.
- Client team gains confidence in the success of operations.
- Client team manages the Project, not technical details of lifting.
- Successful implementation of a highly visible activity lifts overall Project quality expectations.