Lifting Operations Incident Case Study

Vattenfall BA Wind

What happened & why?

Incident summary

1. An offshore main component (Wind turbine generator main bearing) exchange was planned.
2. The exchange required removal of the complete rotor assembly (3 blades and the hub) via JUV to gain access to the main bearing.
3. To remove the Rotor assembly a specialist lifting tool, a Rotor yoke would be required between the rotor hub and the crane hook attachment.
4. The Rotor was removed from the WTG in vertical position and then rotated to a horizontal plane via a secondary crane and then manoeuvred to the JUV deck where it could be stored. During the change in orientation from vertical to horizontal the yoke assembly failed.
5. The yoke, hub and blades fell, striking the jack-up-vessel before falling into the sea.
6. Damage occurred to the vessel deck, lifting accessories, lifting tools and a secondary crane that was involved in the re-orientation.
7. There were no physical injuries to personnel as the lifting area had been cleared prior to the lift.

What happened & why?

Incident Root Causes

The investigations identified that the lifting system failed at the bolted connection of the yoke due to forces above its design and build specification.

These forces were applied due to the blade clamp attached to the 6 O'clock blade via the secondary crane being off-centre due to the curvature of the blade, and as the rotation of the load was ongoing this caused the rotor assembly to tilt.

The yoke had a max tolerance for side loading of 6˚.

The conclusion is that execution of the lifting operation exceeded the limitations of the lifting equipment.

Communication between all parties involved in the planning and management of the lifting operations was insufficient to ensure information about design limitations was incorporated into the lifting system.

The planned lifting system was not reviewed sufficiently and incorporated back into the design, development and testing process of the Rotor Yoke.

Had the testing and details of the design limits been better understood and communicated adequately to all, the planning and execution could have been adapted to ensure a safe operation.

How G+ Good Practice Guidance (GPG) content could help

Tool design, review, and information sharing

Where did this go wrong in the incident?

When this tool was designed the risks introduced by load tilt were not communicated, this means that additional tilt control required for the entire lifting system was not implemented. During the review phase this was also not identified or addressed as a potential risk, and the designer/manufacturer who would have been aware of this restriction did not communicate it as a limitation when considering the task that it would be used for, and the method.

What does the G+ GPG say on this subject?

The GPG describes the processes that should be followed when a new item of lifting equipment or accessory is being developed to enable the designer to have all the information to determine a best solution. Involving key operational personnel during design and testing could have identified the potential risk for load tilt and this could have been addressed with a higher side loading tolerance or emphasising the importance of correct connections for control to the 6 0'Clock blade, depending on certain blade types.

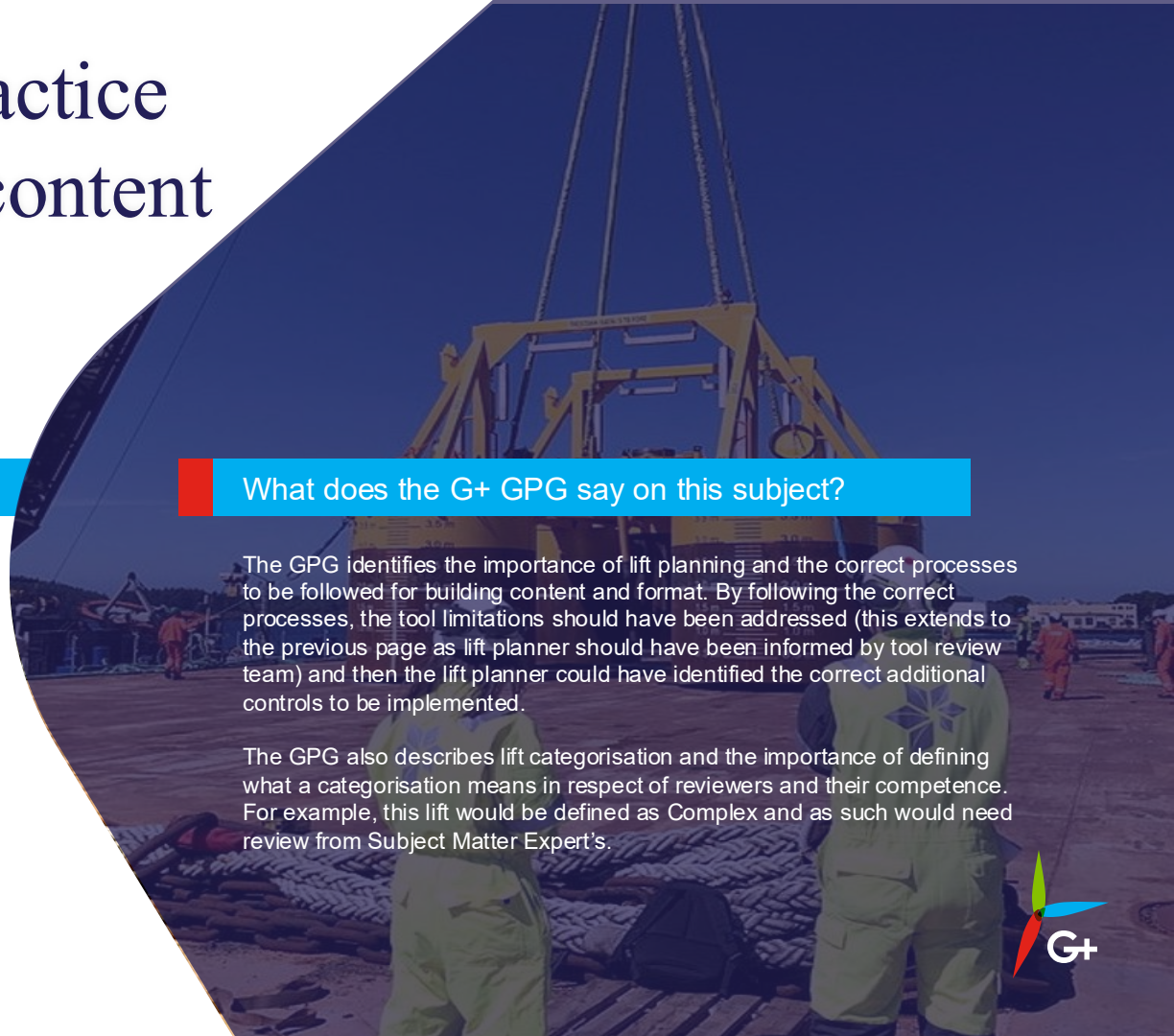
There is a section within the GPG dedicated to 'safe by design', and the correct design reviews that should be performed on new tools and equipment. By performing this review with the correct stakeholders, and the correct SME's & engineers as it is defined within the document, the potential risks associated with the tool misuse would have been identified and the correct additional controls determined. The GPG encourages good information sharing between differing organisations and stakeholders. With better communications between manufacturer, contractors, and operators this risk may have been identified and mitigated against.

How G+ Good Practice Guidance (GPG) content could help

Lift Planning & Review

Where did this go wrong in the incident?

The lifting plan that was developed did not specify sufficient controls that were required to mitigate against load tilt (additional taglines, monitoring system), or the criticality of attaching the lower clamp (for load rotation) into the correct position (use of different tool, identification of blade curve etc). This indicates unfamiliarity with the tool and component during lift planning. The review of the document pack via the client organisation also failed to identify this hazard, due to insufficient review by technical and operationally competent personnel.



What does the G+ GPG say on this subject?

The GPG identifies the importance of lift planning and the correct processes to be followed for building content and format. By following the correct processes, the tool limitations should have been addressed (this extends to the previous page as lift planner should have been informed by tool review team) and then the lift planner could have identified the correct additional controls to be implemented.

The GPG also describes lift categorisation and the importance of defining what a categorisation means in respect of reviewers and their competence. For example, this lift would be defined as Complex and as such would need review from Subject Matter Expert's.

How G+ GPG content could help

Competence

Where did this go wrong in the incident?

There was doubt around the specialized competence required, or insufficient involvement of the correctly competent personnel during the following Key stages.

Design of the tool
Competent personnel in execution should have fed into design of tool

Review of the tool
The correct SME's & Engineers from contractor & Client organisations were not involved with testing, review & acceptance of tool

Creation of lifting plan
Although Lifting plan authors may have been trained and certified for creating lifting plans, they were not fully informed regarding tool limitations. Due to the way this lift was performed load tilt was inevitable so this should have been discussed and controlled.

Lift plan review
Lift plan reviewers from client site organisation did not specialize in complex lifting operations so were not sufficiently competent to review this complex activity which would have provided an additional layer of protection.

What does the G+ GPG say on this subject?

The GPG offers guidance for key stages through various lifting operations where specialized skills / competence are required, including lift plan reviews. Also within the guidance is detail on what competence means for differing job roles, giving examples of qualifications supporting competence, as well as experience, skillsets, and attitudes. By adopting this guidance and including persons with the recommended competence into this work scope, the risk of the incident occurring could be avoided.

Conclusion

Can we be assured that adopting the G+ guidance would prevent this incident from happening?

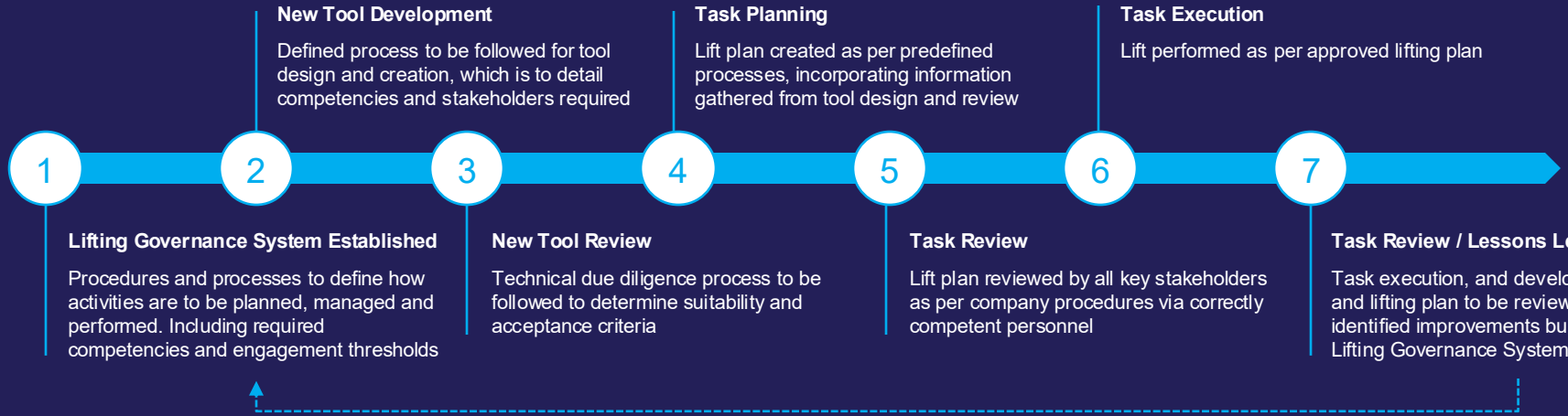
Root causes for this incident were identified and investigated. There were several opportunities for improvement, missing or insufficient barriers, and they can all be corrected by the implementation of a robust lifting management system. With robust processes, procedures and policies that outline how certain activities are to be performed, and who is to perform them, there is a much higher degree of assurance that safety critical steps are being correctly completed.

The G+ Lifting Governance GPG outlines the importance of establishing a lifting management system, that integrates into an organisations wider management system, and the key components that it should contain.

If all the aspects of the G+ guidance had been adopted in the incident discussed in this case study, we can be relatively assured that the hazards could have been identified early in the planning phase, and suitable control measures investigated and incorporated in lift planning and execution.

Since the incident the operator organisation have updated their lifting management system to align with the G+ GPG and now have a more robust process, set of procedures, and competence.

This has proven to identify areas of improvement at key stages and has increased control during lift planning and execution.



Shown in the image is the sequence followed to develop and implement the Lifting Management/Governance system from conception through to task evaluation. This can also highlight where process steps defined within the G+ GPG document could have acted as barriers if incorporated correctly