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the newsletter from KGAL **Spring/Summer 2021**

You can rely on KGAL

In addition to our structural, hydraulic, electrical and mechanical engineering services, we also offer system engineering and consultancy services addressing risk and reliability.

Our reliability assessments identify potential hazards and explore the probability of more than one event occurring simultaneously generating a hazard, and our deep industry knowledge and expertise play a crucial role in helping to recognise design and system vulnerabilities that others might miss.

For clients in our core markets of hydropower, water control and moving structures, we provide professional advice on risk management and subsequent mitigation through reliability engineering. Our capability in reliability assessment continues to expand and here we highlight three of of these recent projects.

Analysing reliability at Strathcona Dam in British Columbia

KGAL has been appointed by BC Hydro in Canada to carry out a reliability analysis of the proposed new low-level outlet (LLO) gates and associated gate operating systems at Strathcona Dam.

Located at the southern end of the Upper Campbell Lake Reservoir, Strathcona Dam was constructed between 1955 and 1958 by the British Columbia Power Commission, a predecessor of BC Hydro. Along with the Ladore and John Hart dams further downstream, Strathcona Dam is part of the Campbell River hydroelectric system and the three dams produce around 11% of Vancouver Island's power demand by harnessing a watershed of more than 1,400 sq km. Strathcona Dam is unique, however, because it is an earth-filled dam with an extremely wide base.

In order to improve the capability of the dam to discharge large inflows to the reservoir, the new LLO gates will replace the existing vertical lift gates, which are installed at the dam crest.

The objective of the commission was to ensure that a very high level of confidence in the reliability of the proposed new LLO design is built into the overall design as part of the design process itself. It will also serve to ensure that reliability of the LLO is considered continuously throughout the lifecycle of the equipment.

The reliability analysis consisted of a Hazardous Operations (HAZOP) workshop, a Failure Mode and Effects Analysis (FMEA) and a Fault Tree Analysis (FTA).

The HAZOP workshop was used to identify the potential hazards that could arise based on the preliminary mechanical and electrical design of the LLO gates prepared by Klohn Crippen Berger and Hatch on behalf of BC Hydro.

An extensive FMEA followed on from the HAZOP. This is a qualitative process used to identify all of the potential failure modes that could arise whilst using the new LLO gates. The FMEA considers equipment down to component level and uses a "bottom up" approach to analyse all possible failure modes.

Having identified the individual failure modes, each one of these modes was then represented in a quantitative FTA. The fault tree approach identifies a single top level event (in this case "fail to open on demand" was chosen) and then all subordinate failure events (e.g. mains power failure) that could contribute to the overall top level event were included. For each individual event, a numerical "probability of failure on demand" (PFD) was then assigned, culminating in an overall PFD for the top level event. This PFD was then compared with the target PFD value, which had been established at the outset of the analysis, independently of the FTA.

KGAL has now completed the reliability analysis up to the end of the preliminary design phase and provided their findings to BC Hydro. This has enabled the gate system designer to take account of any recommended changes required to improve the overall design reliability.

It is envisaged that further work will be instructed to refine the analyses for the detailed design phase.

The spillway gates at Strathcona Dam that the proposed new LLO gates will replace

Improved floodgate control at SSE Dam Sites

Between 2004 and 2016, KGAL carried out a fundamental review of SSE's floodgate control philosophy at various dam sites in Scotland.

The first phase consisted of a hazard analysis of the floodgate operation on each individual site, along with Failure Modes Effects and Criticality Analyses. The results were reviewed and recommendations made to improve the floodgate control systems in terms of both reliability and availability. We also recommended compliance with the appropriate standard for safety critical software and hardware (IEC 61508).

The second phase involved project managing several Flood Gate Controller (FGC) design and build contracts at hydroelectric plants throughout the Scottish Highlands. The objective was to replace the existing systems with new FGCs to strike an appropriate balance between the various hazards that can arise in the event of equipment failure.

The new FGCs were designed to improve gate availability by adding several layers of redundancy to the system. SIL 2 safety related functions were also incorporated to monitor safety critical operations and react safely to system failures.

Downstream of Pitlochry

Breydon Bridge FMECA

Built in 1985, Breydon Bridge carries the A47 in Great Yarmouth across the River Yare, close to Breydon Water. KGAL was retained by Qualter Hall & Co Ltd (QHCL) earlier this year to undertake a Failure Modes Effects and Criticality Analysis (FMECA) on the new hydraulic and electrical systems being designed by QHCL. This work forms part of the overall refurbishment project for the bascule bridge being carried out by John Graham Construction under their Highways England Framework.

Our reliability engineering team worked closely with the client design team to review all the existing QHCL hydraulic and electrical design documentation, including the tender specification, drawings, AIP and technical reviews and responses. We also facilitated the FMECA virtual meetings and prepared all relevant documentation, including the formal FMECA analysis report.

The results of the FMECA have now enabled QHCL to address any possible design issues that might impact adversely on the overall system reliability in a timely and efficient manner.

The KGAL Reliability Team:

Combining a wealth of experience and expertise, our Reliability team plays a critical risk management role, identifying design and system vulnerabilities that could lead to potential hazards.

Russ Digby, **Regional Managing Director**

Paul Jones, **Associate Director**

Shaun Richardson, **Senior Electrical Engineer**

Yue He, **Engineer**

George Stacey, **Graduate Engineer**

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Project Updates

Playing a part in meeting flood protection targets at Keadby

The re-planting of the original Keadby Pumping Station, located on the convergence of the Three Rivers with the River Trent, has continued throughout the last twelve months of the pandemic. This has been challenging and at times frustrating, but the constant has been the whole project team's determination not to let COVID win or frustrate progress with the project.

The pandemic has taken the project team on a new journey that nobody could have possibly anticipated when the final touches to the full business case were being made back in 2019. Factory testing of the new pumps and valves has been carried out online - nobody had realised this form of communication would take over our lives quite as much as it has - and working arrangements on site have been adapted, but progress has continued to the point where the Environment Agency achieved the required OM2 in March. This essentially records that government targets for protecting houses from floods have been achieved across the country, and Keadby has played an important part in meeting those targets.

Keadby was built during the 1930s when construction practices were quite different to those employed on modern sites today. We wonder what our predecessors on site would make of us masked up and keeping two metres apart.

Keadby Pumping Station under construction in the 1930s

Aerial view of Keadby today

Inisde the pumping station

The original facility at Keadby comprised six diesel driven pumps that have successfully drained the Isle of Axeholme catchment for the last 80 years or so. Their successors are six 330kW variable speed driven pumps with completely new control systems, pipework, isolation valves and a re-engineered outfall structure. A new electrical supply has been connected and is backed-up by a standby diesel generator that can pick up the full operational load in the event of a grid supply failure, ensuring resilience is underwritten even during extreme conditions.

KGAL is proud to be involved in this project having been technical advisor to the Environment Agency from the early pre-contract optioneering phases through to operational acceptance testing at site. There is a way to go yet before we are complete but new pumps are operational and the whole project team has demonstrated resilience and resourcefulness to overcome whatever has been thrown at them so far.

Hydraulic cylinder replaced at the Padstow tidal gate

After many months of investigation, design and planning, replacement of the hydraulic cylinder on the Padstow tidal gate has been successfully completed by A&T Services Ltd.

The hydraulic cylinder spends much of its life in the inter-tidal zone, giving a very arduous duty, particularly for the spherical bearing of the rod end connection to the gate structure. To limit any operational problems with the hydraulic cylinder, the complete unit is regularly swapped with a running spare, which is refurbished after removal to be available for planned, or unplanned, replacement of the operational unit.

The current rod end pin arrangement had proven to be difficult to remove to facilitate the hydraulic cylinder replacement, so KGAL was appointed by A&T Services Ltd to design a new pin and bearing arrangement that will permit easy disassembly for future hydraulic cylinder removal.
Environment Agency MEICA Advsior, Michael Adams, gave a glowing review of the project, saying "Really great design and investigation work carried out by KGAL Consulting Engineers Ltd. Yet another professional removal and installation by A & T Services Ltd and excellent lifting operations by Ash Bruton. The Principal designer for this project was Anthony Evans . It has been challenging but a great project where we have all pulled together, learned along the way and introduced a more resilient component into an important asset".

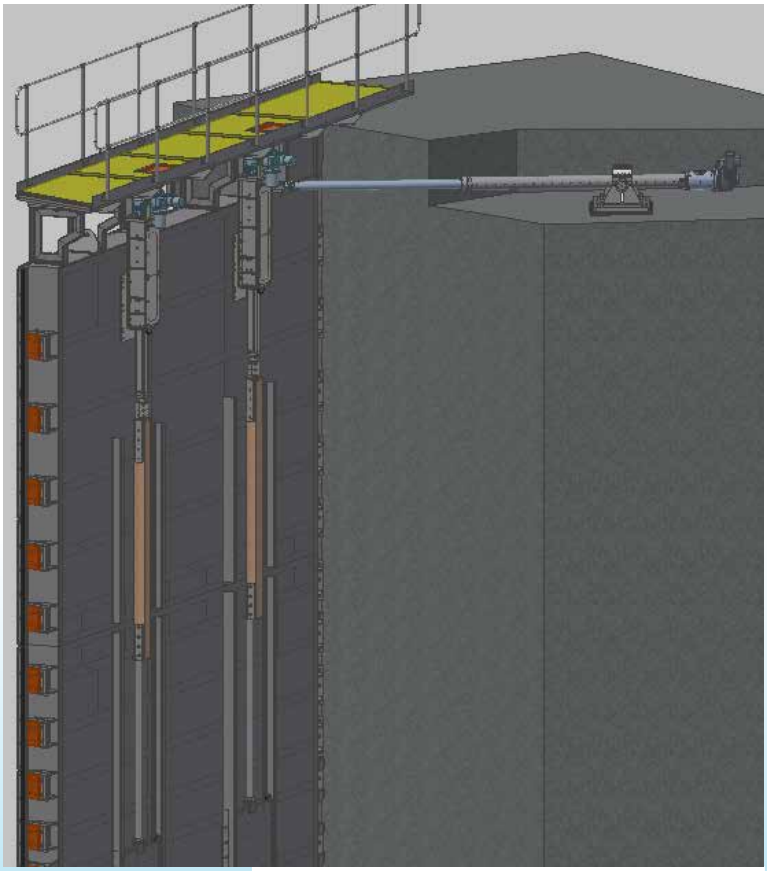
The Padstow tidal gate

Infrastructure Upgrade for the Caledonian Canal

Improvements being made on the Caledonian Canal by Scottish Canals involve upgrading the infrastructure, including replacing the hydraulic actuating systems for the lock mitre gates and their integral sluice gates with electrically powered actuators on the four pairs of gates at the Kytra and Cullochy locks.

KGAL has been retained by ECS Engineering Services Ltd to provide the design for the main mitre gate actuators housed within the dockside civil structure, along with the sluice gate actuators mounted directly onto the mitre gates. The new system design incorporates ADE-Werk GmbH linear actuators for the main mire gate drives and Auma multi-turn rotary actuators for the sluice gate drives.

We have worked closely with both ECS and Scottish Canals to provide a solution that fulfils the design brief but is also sympathetic to the heritage of the Caledonian Canal.



Caledonian Canal mitre gate with KGAL designed electric main gate actuator and sluice gate actuators

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NEWS in brief.....

New KGAL-Arup Partnership

We are very pleased to welcome an old friend back to our client list now that we've started work on a number of schemes in support of Arup, under their EA NGSA Framework Contract. After a hiatus lasting a few years, we have re-established our working relationship, starting with a few schemes in the Environment Agency Midlands hub, on the River Trent and River Nene at Beckingham and Northampton respectively. Our initial scope includes the assessment and specification of refurbishment and/or replacement work on a number of sluice gates. Further works in the Midlands and North East hubs are anticipated on both flood control gates and pumping stations.

Joint Paper for the Power of Water Canada conference

Our Regional MD, Russ Digby, is looking forward to co-presenting a joint Paper with Karl Pirik and Oriel Mendelovitz of Canadian renewable power and mining consulting engineering firm BBA Consultants about the use, deployment and, maintenance of stoplogs at the virtual **Power of Water Canada** conference later this month.

In support of mind for better mental health | Dorset

KGAL is proud to be supporting Dorset Mind, a mental health charity that supports adults, children and young people to get the help they need when experiencing a mental health problem. Dorset Mind Your Head (DMYH) helps children and young people in Dorset to be as mentally healthy as possible.

"This amazing donation from KGAL Consulting Engineering Ltd will go directly to the Children and Young People Counselling Service which is completely funded by donations like this" said the charity's CYP Lead Practitioner/Co-ordinator, Tracey Digby. "It is such a vital service, particularly now as children and young people are struggling to come to terms with the events of the past year and how the covid pandemic has affected them, their families and the world. With donations like this we can continue to help the children and young people that need it."

Visit **www.dorsetmindyourhead.co.uk** to learn more about their vital services.

DMYH Young Ambassadors

Expanding Team KGAL...

Joining us.....

We were very pleased to welcome Project Manager, **James Bentley**, to the KGAL team in February. A chartered Engineer, James has a great deal of project management and site experience in both the UK and overseas (in the photo he is busy at his desk in Malaysia). When he's not working, James likes walking, travel, badminton, tap dancing and loud shirts. A number of our engineers have worked extensively with James in his previous role at Kvaerner, so it's great to welcome him to the KGAL team.

James Bentley

Continuing the expansion of our team of specialists, we also welcomed Senior Electrical Engineer, **Shaun Richardson**, in February. A chartered engineer, Shaun is very experienced and knowledgable with a track record spanning 30 years. And when he's not working or spending time with his family (including twins and a dog), he's a keen cyclist and Barnsley FC fan. Shaun will complement our skills on the controls and electrical side of KGAL's wide range of expertise and we're delighted to have him on board.

Shaun Richardson

The newest member of our team is CAD Engineer, **Paul Harris**. Paul has been a mechanical design contractor working for a number of engineering companies over the years, but he's now enjoying creating 3D models and drawings for us and, when not working, designing and building electronic control systems.

Paul Harris

...and a sad Goodbye

After six years of dedicated service, we wish to announce the retirement of **Eric Grant**, our Senior Electrical Engineer based in Scotland. Since joining KGAL in 2015, Eric has been instrumental in developing clear and precise operating and maintenance documentation, proof testing procedures and flood control manuals for a major Scottish client. We are very grateful for his professional and diligent contribution to our organisation and wish him a long and happy retirement.

Thank you Eric!

Eric Grant

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