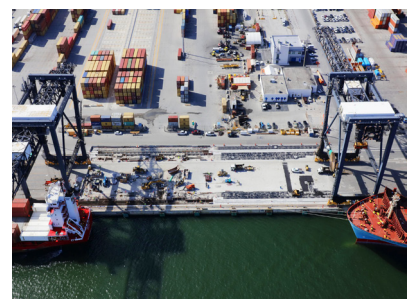
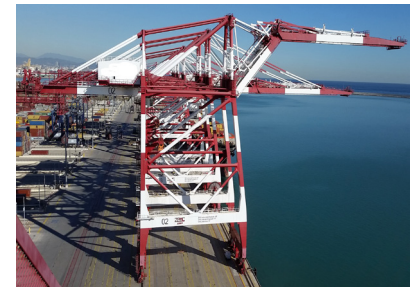


BULK EQUIPMENT SERVICES

Liftech Consultants Inc.



Liftech
LIFTECH CONSULTANTS INC.

Liftech Consultants Inc. is a consulting engineering firm, founded in 1964, with special expertise in the design of dockside container handling cranes and other complex equipment and structures. Our experience includes design for container and material handling equipment, wharves and wharf structures, heavy lift equipment and structures, buildings, and container yard equipment and structures. We provide structural, mechanical, and electrical engineering services. Our national and international clients include owners, engineers, operators, manufacturers, and riggers.

Design Philosophy

We design functional, environmentally sound equipment and structures for the most economical investment. We believe in converting natural resources and labor into usable facilities that are a blend of aesthetic and functional considerations. We work well with owners, engineers, contractors, and architects.

Material Handling Equipment

We provide design and analysis services for a variety of material handling equipment including loaders, unloaders, stacker reclaimers, and hydraulic excavators. Our services include procurement assistance, project management and construction management, design and design review, condition assessment, design for repair, refurbishment, and upgrades, oversight of manufacturing, testing, and repairs, fatigue cracking analysis and reliability studies, and seismic analysis and advice.

Crane Design

We design crane structures and machinery for most of the world's container crane manufacturers. For Paceco, we developed the original standard A-frame, modified A-frame, low profile quay cranes, and RTG and RMG frame structures that have become the industry standard. For Mitsubishi, we provided structural design for the first machinery-on-trolley cranes to meet the strict stiffness criteria of the Port of Singapore Authority. For Paceco, Italimpianti, and Samsung, we designed the then largest low profile cranes and provided designs of articulated boom cranes worldwide. Most recently, we helped design the largest quay crane for ZPMC with a 100-ton capacity and reviewed many of the manufactured DHT40 (dual-hoist-tandem-40) cranes. We have designed many of the now standard features on container cranes throughout the world including hydraulic snag protection, trim-list-skew systems, hydraulic anti-sway, articulating booms, and dual-hoist-tandem headblocks and hoist machinery. We have also designed many innovative crane concepts such as interleaved cranes working both sides of a ship-in-a-slip, elevating girder cranes, and the APMT FastNet concept allowing working of adjacent bays on the biggest vessels.

Heavy Lift Design and Review

We have provided design and review of heavy lift and crane structures and machinery for nuclear power plants, offshore platforms, and other special structures since the 1970s. Our expertise includes design and review of floating cranes of capacity up to 12,000 t. We also have experience with jack-strand and other heavy lift and heavy translation systems.

Equipment Transportation

We provide engineering for the transportation of cranes, oil processing modules, offshore oil structure components, and miscellaneous equipment on barges and ships. Our services include checking the structures and the vessels for voyage forces, designing any required reinforcing for the structure and/or vessel, and designing the attachments to the vessel.

Seismic Design

Our experience with seismic design includes evaluation and design of buildings, container cranes, unloaders, and wharf structures. After the Loma Prieta earthquake, we provided structural evaluation of several buildings. After the Guam and Kobe earthquakes, we evaluated crane and wharf structures and helped owners determine the future of their structures. We provided the design reconstruction of a portion of the wharf at Guam. For new cranes, buildings, and other structures, we provide innovative and economical earthquake-sound designs using the latest technology. We have performed seismic studies using finite element time history analysis to evaluate the performance of several container crane and unloader structures.

Controls and Automation

We work with a wide variety of control system vendors on cranes and heavy equipment around the world. We are very familiar with the structural, mechanical, and electrical needs of highly automated heavy equipment and have helped specify, procure, and review the automated equipment for most of the domestic automated terminals and many international terminals.

Manufacturing Oversight, Quality Assurance, and Startup

We have extensive experience with many manufacturers and inspection firms around the world and are often retained to help ensure custom heavy equipment is manufactured to the requirements of the project specifications and approved design drawings. We work closely with the manufacturer's QC department and on-site third-party inspection agencies to track progress, monitor construction quality, identify non-conformance problems early on when they can still be quickly corrected, provide meaningful and timely progress reporting, and witness startup, commissioning, and acceptance testing.

More Information

For more information, please visit the Liftech website: www.Liftech.net

Client & Location			Year			Manufacturer & Equip. Type			Services Provided						
									Design or Review	Engineering Support	Condition Survey	Seismic Study	Concept Study	Inspection Program	Life Assessment
Confidential	2021	Unloader acquisition study, various types					✓								
Confidential	2021	Bauxite unloader	✓	✓						✓			✓		
Confidential	2021	Bauxite reclaimers		✓						✓		✓			
Confidential	2018	Bauxite unloader		✓						✓		✓			
Rio Tinto Alcan Quebec, Canada	2012	Heyl & Patterson, Inc. unloader			✓				✓						
Confidential	2011	Bauxite unloader			✓				✓	✓					
Confidential	2010	Bauxite unloader	✓	✓	✓			✓				✓			
Confidential	2009	Grab unloaders & stacker reclaimers			✓			✓		✓		✓			
MacGregor Sacramento, California	2009	MacGregor bulk AB unloader				✓									
Hoist & Crane Service Group Point Comfort, Texas	2009	Wellmann unloader				✓			✓			✓			
Confidential	2007	800 t cement unloader			✓	✓									
Robert Reid & Associates Darwin Port, Australia	2007	Techint loader	✓									✓			
Robert Reid & Associates Esperance Port, Australia	2007	ZPMC hybrid grab unloader	✓									✓			
Price Systems, Inc. Various Locations	2003	Alliant log handling crane	✓												
Bickerton Iron Works Port of Los Angeles, California	2003	Krupp coal loader		✓	✓					✓			✓		

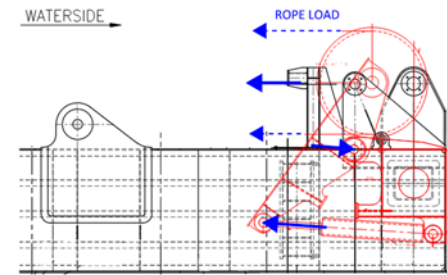


Bauxite Reclaimer Bridge Chord Repair

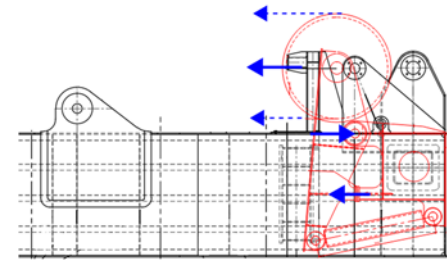
The client has a reclaimer that has been operating for over ten years at its facility in South America. This equipment experienced chronic fatigue cracking in the truss beam upper chord. After making in-house crack repairs and performing a modification that resulted in further fatigue cracking, the client retained Liftech to evaluate the cracking and to design repairs.

Client:
Confidential

Liftech performed analyses that determined the cause of cracking and developed a simple repair detail that improves fatigue performance by a factor of 20 to 400 depending on the loading condition. Liftech provided a report summarizing our review, the cause of cracking, and our recommendations, repair design drawings, and procedure.



NORMAL, CYLINDER EXTENDED



OVERLOAD, CYLINDER RELEASED

Fuse System (in Red), Between Girders at Boom End

Bauxite Unloader Boom Repair

The client operates two bulk unloaders at its facility in South America. The boom on one unloader buckled due to a snag event, when the grab bucket struck the edge of the vessel opening during operation.

Liftech provided engineering services for temporarily securing the damaged unloader, structural concepts and design for boom stabilization, and structural concepts for boom removal and repair. Other engineering services included a boom failure investigation, snag time history analysis to evaluate multiple modification concepts, structural design for a new snag protection system, and basis of design, specifications, and design review for procuring the snag protection system.

Snag mitigation methods considered included modifying the bucket geometry, integrating a mechanical or structural fuse in the hoist system, and integrating a fast-acting braking system.

Liftech developed concepts for modifying the bucket geometry and integrating a fuse into the hoist system. The recommended fuse consists of rocking beams and hydraulic cylinders. The system detects rope loads, and for loads above a preset value, the cylinders release, allowing the rocker beams to rotate a fixed amount. This results in a decrease in rope stretch, which provides time for the brakes to set and the machinery to stop rotation prior to overloading the structure and other components.

We provided concept drawings and a comprehensive report describing the hoist system response, including required characteristics and resulting improvements from the recommended hydraulic fuse system.

Client: Confidential



Furnace Crane Bridge Girder Repair

The client has furnace cranes that were in operation from 1984 to 2015 at its facility in South America. This equipment experienced significant chronic fatigue cracking in the crane bridge girder.

Client:
Confidential

The client retained Liftech to provide engineering services for repairing the fatigue cracks and improving the structural details to help reduce the likelihood of future cracking.

Liftech developed a practical repair design, contributing to a significant improvement to the fatigue life, and provided repair design drawings and procedure.



Business Case Study—Ship Unloader Acquisition

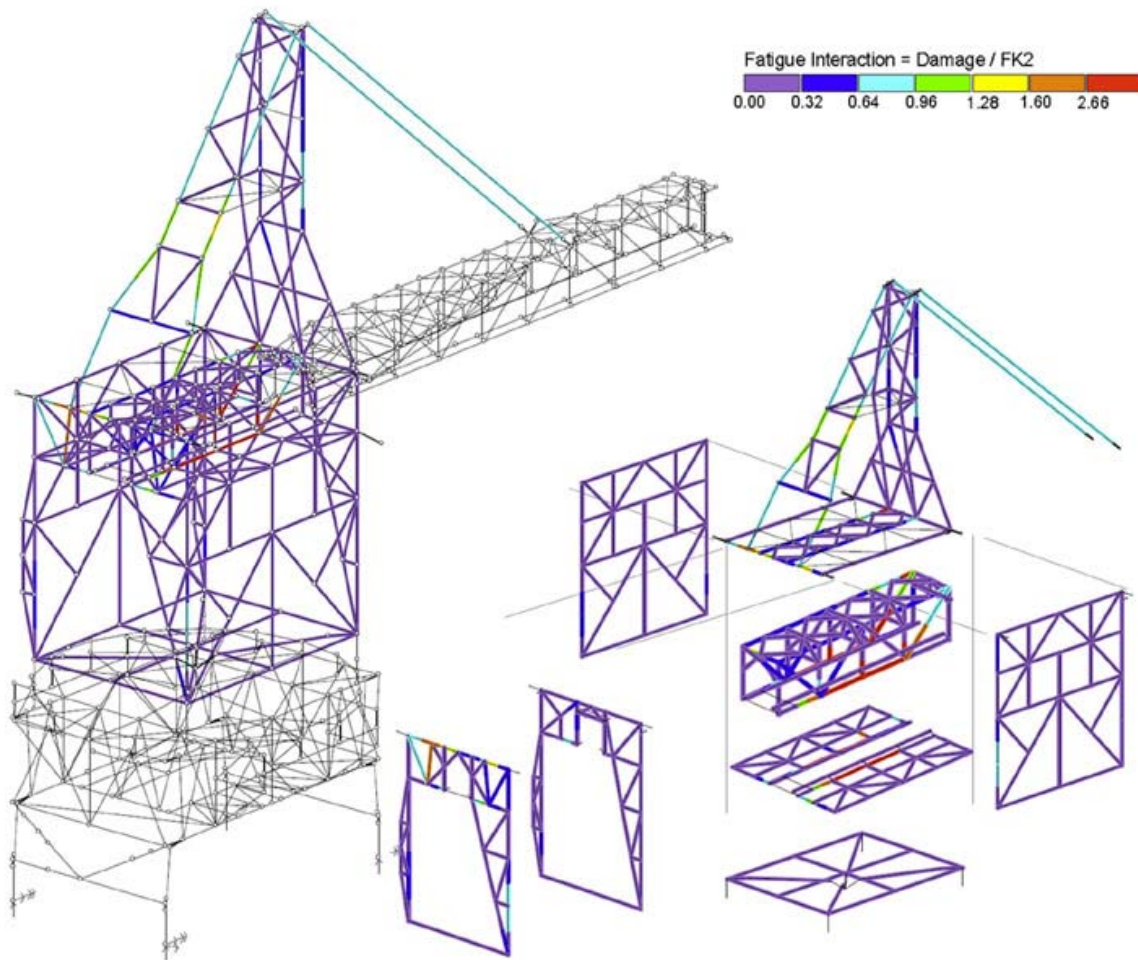
Liftech provided a business case study acquiring a ship unloader for a bulk handling facility in South America.

Client:
Confidential

The study included investigating three types of ship unloaders (land-based continuous bucket and grab bucket, and ship-based types), preparing a basis of design document to invite proposals from unloader manufacturers, and providing order-of-magnitude cost estimates.

Liftech also provided a technical report describing the study approach, alternatives and options assessments, a trade-off study, and recommendations for the preferred solution.

The trade-off study provided a comparison of the three alternatives, summarizing the advantages and disadvantages of each option, with scores based on evaluation criteria discussed with the client.



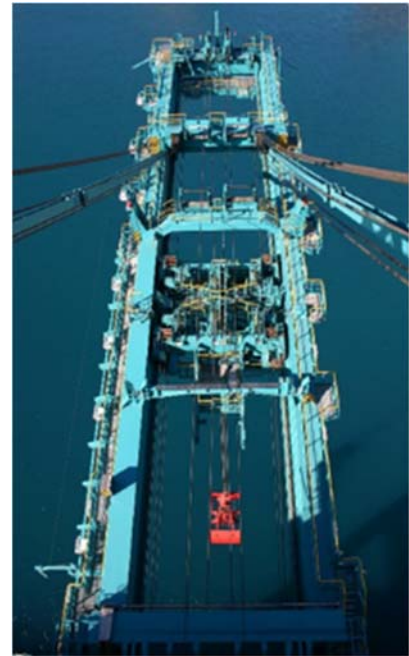
Future Fatigue in Rotor Structure

Bauxite Unloader Study

Two bauxite unloaders of identical design have been operating for over 50 years. The operator wished to continue operations for another 15 years.

Liftech analyzed the crane structure to assess the fatigue life for continued operations. The study showed that the crane structure can perform reliably for another 15 years with repair and strengthening of some members and implementation of a structural maintenance program.

Reference:
Hoist & Crane Service Group
Charlotte, North Carolina, USA



Esperance Port Authority Hybrid Crane Review Esperance, Australia

Esperance Port Authority purchased a hybrid crane from ZPMC to handle containers and bulk material. Robert Reid & Associates and Liftech Consultants Inc. provided procurement services.

Liftech reviewed the structure design, helped resolve design issues, and audited the structural fabrication in China. Liftech also reviewed the crane wheel loads and helped coordinate the crane interface issues with Esperance Port Authority.

Reference:
Robert Reid & Associates
Port Melbourne
Victoria, Australia



Unloader Structure Assessment Montreal, Quebec, Canada

Rio Tinto Alcan (RTA) in Quebec, Canada, was evaluating whether to continue operating, to upgrade, or to replace their two existing 40-year-old bauxite unloaders. As part of the feasibility study, RTA required a condition assessment of the unloaders by an independent consultant.

Reference:
Rio Tinto Alcan
Montreal, Quebec, Canada

Liftech was retained by RTA to perform an on-site visual assessment of the structural and mechanical condition of the unloaders. Our report included suggestions to improve the structural and mechanical reliability and extend the service life of the structure and the components. Various modification options for future productivity demand were studied and evaluated for RTA implementation.



Bauxite Unloader Structural Condition Survey

A bauxite unloader has been operating at a bauxite refinery facility in South America since it was built in 1983.

Liftech performed a structural condition survey of the unloader structure and presented significant findings and recommendations in the structural assessment report.

Liftech identified cracks in the boom and other critical members during the observations and assisted with emergency repairs of the boom so the unloader could resume operation.

Client:
McKay International Engineers
Benicia, California, USA

Owner:
Confidential



Bauxite Unloader Structural Design Review

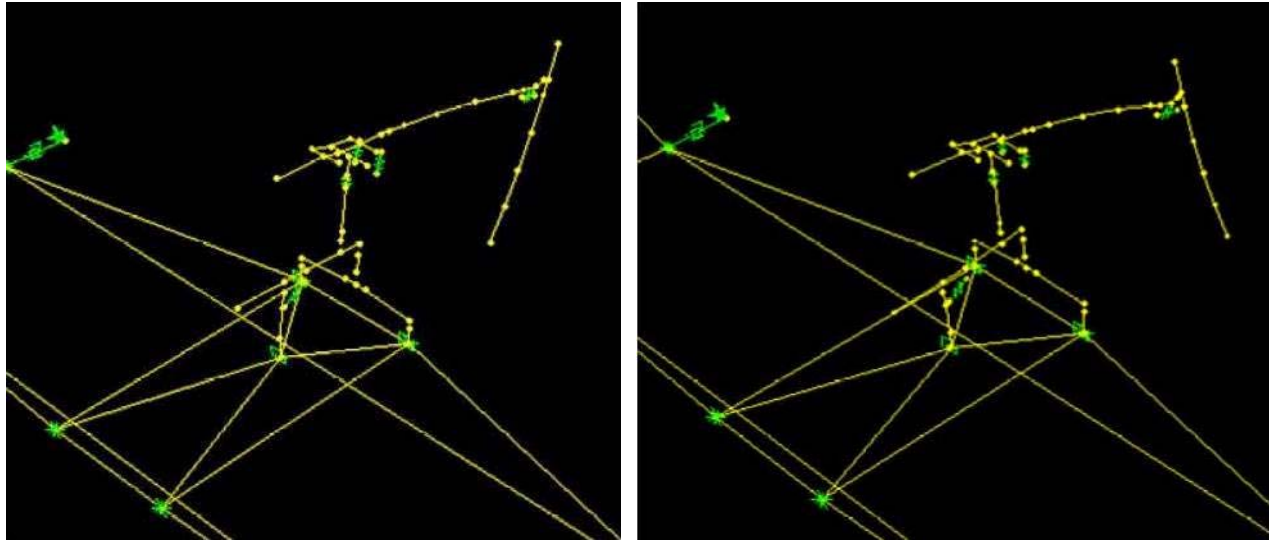
Liftech provided structural design review of a bauxite unloader in South America.

We reviewed the workmanship of the primary structure, performed finite element analyses, reviewed design drawings, and provided wheel load and stability calculations.

Liftech provided a report of the significant findings of our review and recommendations for improvements. We also provided a comprehensive structural maintenance program based on cumulative fatigue damage analysis.

Client:
McKay International Engineers
Benicia, California, USA

Owner:
Confidential



Calculated Unloader Deformations

Unloader Seismic Study Sacramento, California

Liftech performed a seismic response study of a ship unloader on a stiff wharf structure and a flexible wharf structure.

The study included a finite element time history analysis and a pushover analysis for three design Operating Level Earthquakes and three Contingency Level Earthquakes used for design by a port on the West Coast of the United States.

The study provided an understanding of the seismic response of the structure including displacements, dynamic characteristics, stability, and forces and moments within the structure. Time history results included maximum forces and moments and their concurrent forces and moments at key locations on the structure.

Liftech also provided recommendations to improve the structure's seismic performance.



Repair of Fire Damaged Coal Loader Berth 301, Port of Los Angeles, California

Repair of damage from September 2000 fire, February 2001 fire, and April 2001 ship collision.

The coal loader built by Krupp was severely damaged in two fires and suffered significant damage during a ship collision.

After each incident, Liftech provided on-site engineering to assist with repairs. Repairs consisted of replacement or stiffening of buckled sections, restoring the geometry of the boom and shuttle structures to mitigate operational problems, and development of a structural maintenance program to ensure long-term reliability of the repaired structure.

The loader was returned to operation within five weeks of the first fire, within four weeks of the second fire, and within days of the ship collision.

Reference:
Bickerton Iron Works
Torrance, California, USA



Log Boom Cranes Various Locations

Liftech provided structural analysis and design for various rotating log boom cranes. The latest was for a 170-foot, 45-ton crane in Valliant, Oklahoma. Liftech also designed and prepared drawings for cranes with radii of 125 feet and 155 feet and capacities ranging from 25 tons to 60 tons. The grapples are either at a fixed radius or mounted on a moving trolley.

Reference:
Price Systems, Inc.
Malvern, Arkansas, USA

Erik Soderberg**President, Structural Engineer**

Mr. Soderberg is a skilled designer and project manager. He is experienced in the design, review, repair, and modification of a variety of structural and crane related systems including wharves, container cranes, and bulk loader structures. Other structures include crane lift and transfer systems and concrete and steel floats. He oversees the technical and contractual aspects of Liftech's projects in addition to his design work.

**Jonathan Hsieh****Vice President, Structural Engineer**

Mr. Hsieh is experienced in design, review, analysis, and modification of container cranes, bulk handling cranes, and special structures. His expertise includes crane procurement, fatigue failure investigation and repair, and computer modeling and analysis. He has also worked on structural maintenance programs, seismic design of container cranes, crane instrumentation, and voyage bracing.

**Arun Bhimani****Founding Principal, Past President, Structural Engineer**

Mr. Bhimani is an expert in all phases of container crane and wharf design. He has developed innovative solutions to container crane design problems, including a technique for combining analysis with heat straightening for repairing damaged container crane booms, the first seafastening design for transporting fully erected container cranes on barges, and a structural maintenance program used to periodically inspect cranes.

**Catherine Morris****Vice President, Structural Engineer**

Ms. Morris has a wide range of experience in the design of container cranes, buildings, and miscellaneous special structures. She has worked on all facets of container crane design including designing new cranes, reviewing crane designs, designing modifications, and voyage bracing. She has also reviewed and designed reinforcing for barge structures for transport of various equipment, designed chassis storage racks, and analyzed and designed equipment to lift and replace steam generators in nuclear power plants.



Nicholas Grebe**Principal, Mechanical Engineer**

Mr. Grebe has extensive experience performing conceptual and detailed designs of mechanisms and systems, analyzing dynamic mechanical systems, and developing designs and detailed drawings suitable for manufacture. He is responsible for developing purchase specifications and reviewing contractors' mechanical, hydraulic, and electrical designs for feasibility and contract compliance. He is experienced in reviewing heavy machinery and container crane controls including logic, interlocks, system architecture, and automation features. He provides project management, condition assessment, commissioning, troubleshooting, and acceptance testing of material handling equipment including container cranes and bulk loaders.

**Sugiarto Loni****Principal, Structural Engineer**

Mr. Loni has extensive management experience and design expertise with marine terminal structures including crane-wharf interface, container and intermodal yard structures, building facilities, and marine structures. He is responsible for contract negotiations, technical oversight, and quality assurance of project deliverables. His work includes managing a variety of engineering projects ranging from small projects with short duration to large projects with multi-discipline coordination. As project engineer, he performs civil and structural design of marine terminal facilities, seismic retrofit design of existing building structures, and civil and structural design of wharves and marine structures.

**Kenton Lee****Principal, Structural Engineer**

Mr. Lee is experienced in design, analysis, and project management of container cranes, floating cranes, rigging, and special structures. He specializes in container and floating crane procurement projects and crane modification projects. He is also involved in preparing structural maintenance programs. Some of the technical aspects of his work that are of special interest to him are steel connection design, wind effects on structures, wind tunnel testing, and structural fatigue of steel structures.

**Patrick McCarthy****Principal, Professional Engineer**

Mr. McCarthy is experienced in ship-to-shore and port yard container crane procurement, modification, reliability, and repairs. His work includes project management, condition assessment, and developing structural maintenance programs and repair procedures. He is Liftech's manager for developing crane technical specifications and helps clients with various aspects of the crane procurement process, including pre-bid assistance, post-award design and fabrication review, and post-delivery structural assessment. He also has expertise in wind provisions, has been involved in wind tunnel and other wind studies, and is an associate member of the Wind Load Subcommittee of ASCE 7.



Derrick Lind**Principal, Structural Engineer**

Mr. Lind is experienced with project management, design, review, analysis, and modification of many types of structures, including container cranes, unique industrial equipment, buildings, wharves, and bridges. He specializes in all facets of crane modification, including crane raises, boom extensions, capacity upgrades, and wheel load feasibility studies. His work has included crane procurement, structural analysis and design, checking shop drawings, developing construction documents, and managing design teams and project budgets and schedules.

**Simo Hoite****Principal, Professional Engineer**

Mr. Hoite is a registered professional engineer with extensive experience in container crane design, modifications, specifications, and procurement, as well as container and rail terminal operations. His experience includes development of innovative RTG and STS crane designs for container terminals. He is also experienced in the heavy rigging industry and has managed substantial design projects including wharf design.

**Anna Dix****Principal, Structural Engineer**

Ms. Dix is a registered structural engineer in California with experience in the design and analysis of various steel and concrete structures. Her focus is on ship-to-shore cranes and other structures that reside next to, in, or on top of the water, such as heavy lift and container handling equipment, wharves, and floating cranes. She likes earthquake and fatigue engineering topics and working with clients.

**Leah Olson****Principal, Professional Engineer**

Ms. Olson has managed multiple wharf and float projects, and has participated in the design, analysis, and modification of wharf and float structures, container cranes, steel barges, and other rigging structures. She has evaluated the behavior of various concrete and steel structures using finite element analysis (FEA) computer software. Her work includes project management, structural analysis and design, and site inspection and reporting.

**Di Liu****Principal, Professional Engineer**

Mr. Liu is an experienced designer and project manager. His work includes structural analysis, design review, modification review, and feasibility studies of container cranes, wharves, and other structures.

