Moffatt & Nichol has, for decades, been an industry-leading consultancy addressing the specific offshore and near-shore marine terminal needs of the oil & gas industry. Today, this practice has spread globally and involves projects ranging from piers and wharves to deep foundations, offshore floating facilities, liquid bulk, and LNG terminals, and offshore mooring systems.

Our capabilities include a full suite of services from planning and conceptual design to final design, and construction management. Our comprehensive marine engineering services include navigation studies, vessel maneuvering, regulatory compliance and permitting support. In addition, our services include coastal, civil, and structural engineering for substructure design and mechanical, electrical, and piping engineering services for terminal topsides design. Our engineers use the latest, sophisticated modeling techniques and state-of-the-art software to analyze marine transportation systems and operations systems for the design of marine facilities.
SERVICES

Marine Facilities Planning

Mooring/Berthing/Fender Systems

Coastal & Hydraulic Engineering

Waterfront Structures Design

Vessel Maneuvering

Dredging & Reclamation

Marine Oil Terminal Assessments/Upgrades

Marine Equipment Specifications

Electrical/Mechanical/Piping/Fire Protection

Single & Multi-Point Moorings

Floating Facilities

Submarine Pipelines

Construction Logistics / Offshore Production Support Facilities

Vessel Emissions Mitigation

Above Water & Underwater Inspection

Service Life Engineering
Marine Facilities Planning

Moffatt & Nichol routinely assists our clients in the planning process for oil & gas-related marine facilities. These services typically include:

- **Front-End Engineering Design (FEED) Studies**
- **Throughput Analysis & Component Sizing**
  - Probabilistic simulations and risk analysis
  - Evaluation of operational scenarios
  - Evaluation of trade-offs between terminal downtime vs. infrastructure improvements
- **Economic Feasibility & Funding Analysis**
- **Berth Optimization Studies - Number, Type, Size**
- **Site Screening & Proximity Evaluation**
- **Navigation Studies**
- **Site Data Acquisition & Characterization**
  - Bathymetry and topographic survey data
  - Geotechnical and seismic investigation
  - Metocean data
  - Ice data
- **Berth Orientation Optimization**
- **Berth Layout**
  - Platform and dolphin spacing/configuration
  - Support craft facilities
  - Service and maintenance vehicle requirements
  - Access and traffic flow
  - Secondary egress considerations
- **Equipment Requirements**
- **Support Services Evaluation**
  - Fire response capability
  - Fire water sourcing
  - Tug and service vessel availability
- **Berth Availability Evaluation**
  - Considering metocean conditions
  - Marine traffic
  - O&M considerations
- **Design Life or Service Life Extension Goals**
- **Project Delivery Planning**
  - Comparison of delivery options – Design-Build, Design-Bid-Build, EPC, CM at Risk, etc.
  - Construction bid package development
- **Basis of Design Preparation**
- **Security Risk Planning**
- **Conceptual Design Development**
- **Cost Estimating & Scheduling**
- **PhotoSim & Animated Video Flyover Creation**

Planning of Pacific LA Marine Terminal, Port of Los Angeles, CA

Planning of Kitimat LNG Terminal, Kitimat, BC, Canada

Dynamic Output During an LNG Storage Simulation, LNG Regasification Facility in Gulf of Mexico
Moffatt & Nichol employs the latest technology and industry experience to solve complex ship mooring and berthing problems and to produce state-of-the-art designs. These services routinely include:

- **Mooring Systems for Piers & Offshore Moorings**
  - Jetty terminal mooring design
  - Conventional/spread buoy mooring design
  - FPSO mooring evaluation
  - Single point mooring evaluation
  - Static mooring analysis
  - Frequency and time-domain dynamic analysis
  - Downtime analysis
  - Fatigue analysis
  - Mooring arrangement optimization
  - Passing vessel analysis
  - Vessel manifold motions at berth
  - Environmental operating limit determination
  - Mooring hardware selection
  - Anchor design
  - Alternative vacuum mooring system design

- **Berthing Analysis**
  - Geometric evaluations
  - Fast-time maneuvering simulation

- **Fender System Design**
  - Berthing impact energy analysis
  - Type selection and design
  - Structural system component design
Coastal & riverine infrastructure development, from conceptual layouts to detailed design, optimization and environmental impact assessment requires a thorough understanding of coastal processes and challenges. Moffatt & Nichol utilizes state-of-the-art numerical models and experience to provide a full range of coastal engineering services including:

- **Coastal Processes & Modeling**
  - Hydrodynamics
  - Wave refraction/shoaling/reflection
  - Harbor resonance
  - Tsunami modeling
  - Eddy simulation
  - Sediment transport
  - Water quality
  - Sediment quality

- **Meteocean Data Collection & Analysis**
  - Wave climate assessment
  - Extremal analysis of winds and waves
  - Wave and current meter deployment

- **Estuarine/Riverine Processes & Modeling**

- **Coastal Structures Design**
  - Breakwaters
  - Jetties
  - Revetments
  - Shoreline Revetment
  - Intake & Outfall Structures
Moffatt & Nichol provides cutting-edge structural analysis and design services to our global oil & gas clients utilizing performance-based analysis and design approaches for piers/jetties, wharves/quaywalls, dolphins, trestles and ancillary components. These services routinely include:

- **Analysis & Design of Structural Systems**
  - Pile-supported structures
  - Bulkhead structures
  - Gravity-based systems
  - Caissons
  - Jackets
  - Wave screens
  - Combination systems

- **Performance-based Seismic Design**
  - Displacement-based design
  - Response spectrum analysis
  - Push-over analysis
  - Nonlinear time-history analysis

- **Fender & Mooring Systems Design**
  - Vessel berthing and breasting
  - Vessel mooring

- **Hydraulics & Scour Protection Design**

- **Structural Materials Capacity Analysis**
  - Reinforced concrete
  - Prestressed concrete
  - Steel
  - Timber
  - Composites

- **Upgrade & Strengthening Design**

- **Constructability Evaluation**

- **Phasing & Construction Planning Studies**
Moffatt & Nichol utilizes state-of-the-art numerical models and experience to provide comprehensive navigation and vessel simulation services including:

- **Navigation**
  - Channel analysis and design
  - Berthing and turning basin layout
  - Suitability analysis
  - Channel capacity analysis and modeling
  - Dredging studies and specifications

- **Ship Maneuvering**
  - Statistical and flow modeling of ship traffic
  - Fast-time simulation
  - Full mission bridge simulation management

- **Navigation Aids**
  - Evaluation of existing ATON systems
  - Design of new ATON systems
  - Leading line (range) analysis & design
  - Floating aid (buoy) specifications
  - Fixed aid design
  - Permitting

Full Mission Bridge Simulation for Real-time LNG Carrier Berthing

Offshore Navigation Range Design for U.S. Coast Guard, Upper Chesapeake Bay, MD

Vessel Navigation at Tangguh LNG Export Terminal, Papua, Indonesia

Tanker Turning and Departure Simulation, Fraser River, BC, Canada
Moffatt & Nichol has successfully completed many dredging and reclamation projects around the world and provides world class services for dredge material management including:

- **Design Services in Support of**
  - Maintenance dredging
  - Channel/berth deepening
  - Contaminated sediment remediation
  - Beneficial re-use
  - Reclamation design

- **Sediment Assessment, Modeling & Management**
  - Site characterization
  - Sediment/contaminant resuspension and transport
  - Sediment loss at the dredge
  - Chemical fate and effects
  - Remediation technologies
  - Geochemistry and toxicology
  - Dredged material management plans (DMMP)
  - Risk assessment and management
  - Monitoring and regulatory agency coordination

- **Dredging Engineering**
  - Plans and specifications
  - Cost estimating/cost management
  - Contractor selection
  - Contract management

- **Environmental Support**
  - Permitting alternatives analysis
  - Environmental documentation
  - Permit acquisition

- **Beneficial Re-Use**
  - Habitat creation and restoration
  - Land creation
  - Beach restoration
  - Capping and confined aquatic disposal (CAD)
The Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), promulgated by the State of California, require periodic audits of terminals to ensure compliance with the MOTEMS requirements. To date, Moffatt & Nichol has provided audit services on over a dozen California terminals.

Typical services include:

- Above Water Structural Inspection Services
- In-House Underwater Structural Inspection Services
- Mooring & Berthing Analysis
- Structural & Seismic Analysis
- Pipe Stress Analysis
- Inspection & Audit of Mechanical Systems
- Inspection & Audit of Electrical Systems
- Inspection & Audit of E/M Equipment
- Hazard Analysis & Fire Plan Preparation
Marine Equipment Specifications

Moffatt & Nichol provides detailed specifications for marine equipment to ensure project requirements are met, to ensure code compliance, and to allow the client to purchase equipment from reputable vendors.

Typically specifications are provided for the following materials and equipment:

- **Marine Equipment Specifications**
  - Marine arms (oil & LNG)
  - Fender systems
  - Quick release hooks and capstans
  - Docking aid systems
  - Mooring line load monitoring systems
  - Bollards
  - Gangways
  - Elevated fire monitor towers
  - Aids to navigation

- **Problem Evaluation**
- **Factory Acceptance Testing & Surveillance**
Moffatt & Nichol provides complete Electrical, Mechanical, Piping and Fire Protection Services for Marine Oil Terminals Topsides, including:

- **Electrical Equipment & Systems Design**
  - Electrical area classification
  - Electrical isolation
  - Power supply and distribution
  - Emergency shutdown systems
  - Emergency power supply
  - Shore Power/Cold Ironing/AMP
  - Lighting
  - Lightning protection
  - Communications
  - Instrumentation
  - Security and access control
  - Grounding and bonding
  - Cathodic protection
  - Electrical equipment specifications
  - Navigation lighting

- **Mechanical Equipment & Systems Design**
  - Ballast water handling
  - Potable and firewater supply
  - Sanitary sewer system
  - Sumps and waste handling
  - Vapor dispersion
  - Mechanical equipment specifications

- **Mechanical Equipment Specification & Integration**
  - Pumps
  - Marine arms
  - Hoses and hose handling
  - Loading equipment purging system
  - Gangways
  - Mooring hooks and load monitoring systems
  - Docking aid systems
  - Fire monitors, pumps, connection points
  - Service cranes

- **Piping System Design**
  - Pipe stress analysis
  - Piping layout and pipe support design
  - Pig and pig launcher

- **Fire Protection System Design**
  - Hazard analysis
  - Fire prevention plan development
  - Fire detection system design
  - Fire response plan and equipment design
  - Foam system design
  - Fire protection equipment and system specifications

Design of Electrical, Mechanical and Piping Systems for Portland Pipe Line Pier 2, South Portland, ME

Evaluation of Existing Terminal Equipment and Piping, Chevron, El Segundo, CA

Pipe Stress Analysis Model on Existing Marine Oil Terminal, Using Caesar II
Moffatt & Nichol provides comprehensive evaluation, planning, engineering and design services for conventional buoy mooring (CBM) and single point mooring (SPM) marine terminals globally. These services cover a range of expertise, from site evaluation / characterization to construction support, and include both the mooring system and subsea mechanical (piping) design. Typical services include:

- **Evaluation of Existing Terminals**
  - Condition surveys (above and below water) of buoys, anchoring system and subsea pipelines
  - Analysis required for upgrades
  - Recommendations for improvements to existing operations
  - Development of operational limitations and criteria
  - Specifications for load testing existing anchor systems

- **Site Evaluation & Selection**
  - Metocean characterization – wind, wave current, water depth
  - Downtime analysis
  - Trade-off studies

- **Terminal Layout & Design**
  - Optimal anchor spread and buoy placement
  - Subsea pipeline routing and pipeline end manifold (PLEM) location

- **Vessel Mooring Analysis**

- **Mooring System Design**
  - Anchor and buoy design and specifications
  - Performance specifications for single point moorings
  - Subsea pipelines and PLEM’s
  - Cost estimates

- **Construction and Post Construction Services**
  - Support during tendering and procurement
  - Review of vendor submittals
  - Inspection of mooring equipment prior to installation
  - Development of maintenance & operations manuals
Moffatt & Nichol performs a diverse range of studies for offshore oil and gas floating production and storage facilities, including:

- **Collecting and Evaluating Site Specific Conditions**
  - Wind
  - Waves & Currents
  - Visibility
  - Temperature
  - Humidity
  - Ice Flow
  - Tropical Storms

- **Typical Studies Include:**
  - Side-by-side lightering
  - Ship-to-ship product transfer operations
  - Relative cargo manifold motions
  - Mooring line loads

- **Weathervaning of Tankers on Offshore Buoys**
  - Field layout
  - Transfer system availability

- **Operational Simulations**
  - Vessel movements
  - Operational data developed to determine operational downtime
  - Storage and vessel requirements
  - Monte Carlo simulation techniques

- **Vessel Motion Analysis**
  - Effects of shallow water
  - Effects of shadowing

Moffatt & Nichol was a key member of the Shallow Water Initiative Joint Industry Project to further the study of shallow water effects on LNG tankers.
Moffatt & Nichol provides comprehensive design services for submarine pipelines associated with offshore liquid bulk cargo transfer and mooring system installations, including:

- **Pipeline System Design**
  - Route selection and layout
  - On-bottom stability and stress analysis
  - Shore-approach and onshore piping tie-in
  - Pipeline systems [pig launcher/receiver, PLEM]
  - Offshore mooring and cargo transfer systems [SPM, CALM, MBM]
  - Horizontal directional drill shore crossings
  - Micro-tunnel shore crossings

- **Pipeline Coastal Impacts & Protection**
  - Coastal process modeling
  - Metocean data collection, analysis and transformation
“Greenfield” petrochemical facilities are often developed in remote areas, inaccessible by roads and far from large metropolitan areas. Therefore, most equipment and materials for these projects have to be brought in using marine transport. Large prefabricated process modules are often the preferred method of construction for plant facilities in remote areas.

These port facilities require structures that are designed for very heavy loads and can accommodate specialized heavy-lift vessels and multi-wheeled transporters. These port facilities are also sometimes used to support offshore Oil & Gas exploration and production operations.

Moffatt & Nichol understands the unique requirements of these specialized port facilities and provides planning and design services that typically include:

- Site Evaluation and Selection
- Construction Harbor Master Planning
- Drilling Support Facilities Master Planning
- “Pioneer Dock” Planning and Design
- Crew Boat & Tug Berthing Facilities
- Dock Facilities for Heavy Lift Vessels & Barges
- Transport and Construction Logistics
  - Assisting during early project planning phases
As emissions from the stacks of ships become more of a focus for regulators, Moffatt & Nichol has been a leader in the design of support infrastructure for emissions mitigation systems, including shore power, also known as Cold Ironing, as well as Advanced Marine Emissions Capture Systems (AMECS). Typical design services include:

- **Shore Power/Cold Ironing/Alternative Marine Power (AMP)**
  - System planning and layout
  - Power supply and substation design
  - Electrical systems design
  - Cable management design
  - Lifting appliance specifications
  - Receptacle and connector design and specification
  - Equipment specifications
  - Vault design in wharves
  - Design of support structures

- **Advanced Marine Emissions Capture System**
  - System planning and layout
  - Vessel motion analysis
  - Equipment specifications
  - Power supply and distribution design
  - Ductwork layout and support system design
  - Crane support structure design
  - Processing equipment support structure design

Design of Rail-Mounted AMP System at Pacific LA Marine Oil Terminal, Port of Los Angeles, CA

Design of Infrastructure for Emissions Capture System at Pier G, Port of Long Beach, CA

Design of Shore Power Electrical System & Vaults at Berth G232, Port of Long Beach, CA
Moffatt & Nichol has over 50 commercially-trained, professional engineer-divers on staff. These individuals routinely provide above water and underwater inspection services in support of projects worldwide. Services typically include:

- **Above Water & Underwater Inspection Types**
  - Routine Condition Assessment Inspections
  - Motems-Compliant Condition Assessment Inspections
  - Baseline Inspections
  - Due Diligence Inspections
  - Repair Design Inspections
  - Special Inspections
  - Post-Event Inspections
  - New Construction Inspections
  - Repair Construction Inspections

- **Non-Destructive Testing Services**
  - Ultrasonic thickness testing
  - Concrete and timber coring
  - Magnetic particle and radiographic
  - Schmidt Hammer and Windsor Probe
  - Reinforcing steel cover, location and size determination
  - Steel coupon removal and testing
  - Teredo, bankia and limnoria infestation

- **Corrosion Engineering Services**
  - Chloride ion profiling evaluation
  - Corrosion rate and potential measurement
  - Impressed current and passive cathodic protection system evaluation and design
  - Durability modeling

- **Underwater Documentation**
  - High quality digital and film photography and video
  - Clear water box capability for low visibility conditions
  - Video production and editing

- **Professional Engineering Services**
  - Drawings and reports
  - Service life engineering and preservation studies
  - Repair and preservation recommendations
  - Cost estimating
  - Life cycle cost estimates
  - Repair design
  - Construction inspection and support
  - Waterfront maintenance management program development
  - Training manuals and seminars
Moffatt & Nichol has been a pioneer in the field of Durability Modeling and Service Life Extension, having worked with the US Navy to develop new techniques to advance the state-of-the-art in concrete modeling. We are leading the industry with new and innovative ways to help our clients design durable new structures as well as extend the service life of their existing critical infrastructure. Services typically include:

- **Design of Durable New Structures**
  - Concrete mix modeling
  - Performance specifications for durability
  - Fair comparison of durability strategies

- **Field Sampling and Testing**
  - Visual and tactile inspection
  - Concrete coring
  - Reinforcing steel corrosion rate and potential testing
  - Chloride ion sampling
  - Concrete cover measurements

- **Laboratory Testing/Analysis – Specs & Oversight**
  - Chloride ion depth profiling
  - Petrographic analysis
  - Concrete transport property testing

- **Desktop Analysis**
  - STADIUM® modeling
  - Estimating of remaining useful life
  - Evaluation and optimization of rehabilitation and preservation alternatives