Fluids Environmental Services
A Global Leader

At Baker Hughes we firmly believe that protecting the environment for future generations is paramount to the success of the oil and gas industry. Through dedicated research we have developed innovative, cost effective solutions that uphold the industry’s environmental responsibilities.

The Baker Hughes Drilling Fluids line of Fluids Environmental Services (Fluids Environmental Services (FES)) provides products, equipment, and waste management solutions designed to mitigate the environmental impact of oil and gas exploration and production.

FES consists of four segments that address the complete waste management cycle of the industry:

- Solids Control
- Cuttings Re-Injection and Conveyance
- Cuttings Processing
- Liquids Processing
Solids Control

Solids Control plays a key role in responding to the environmental and economic pressures the drilling industry faces today. From improved drilling fluid properties and lower mud dilution rates to the removal of drier solids from fluid, our solids control equipment delivers quality performance in every project.

FES offers reliable field-proven technology for every drilling application, and specializes in providing high-capacity equipment with small footprint features that are ready for rapid deployment to meet any technical challenge.

FES includes a range of uniquely engineered solids control equipment that enhances rig efficiency, including shale shakers, screens, drying shakers, centrifuges, mud conditioners, desilters, and desanders. Our thorough training program and extensive knowledge base ensure that our FES products and services exceed our customers’ expectations and, more importantly, never compromise quality or productivity in our continuous drive to provide optimal rig efficiency.

Shale Shaker Screens

FES includes a complete portfolio of shale shaker screens for most commercial shakers currently used in the oil industry. Our screen offerings include both pre-tensioned and hook-strip screens with metal or plastic backing.

All our screens are labeled to include the new API designation as well as the traditional nomenclature to facilitate field use and customer ordering. FES screens are built using top quality mesh materials which can be woven in square or rectangular patterns designed to optimize solids removal while preventing screen blinding issues.

FES Centrifuge Technology

Compared to similar models, our FES centrifuge technology is capable of processing larger volumes of solids and liquids, while improving cut points. Fixed and variable speed centrifuge models are also available for multiple uses from barite recovery to high-speed mud separation.
FES 1655M
The high G-force 1655M standard fixed speed centrifuge provides a field-proven design with high industry acceptance. Considered an oilfield workhorse, this centrifuge is a highly reliable unit that can operate under demanding operational conditions. Its simple, rugged, yet efficient design reduces downtime while providing the necessary flexibility to be used in barite recovery, low gravity solids removal, and dewatering applications.

With its streamlined footprint design and fully certified electrical components, the 1655M centrifuge can be easily installed in any onshore or offshore rig, where it complies with all safety requirements and demands fewer resources to operate.

Constructed in 316 stainless steel, the 1655M centrifuge can process up to 200 gpm (757 lpm) of 9.0 ppg (1.08 sg) mud. The design includes state-of-the-art torque and temperature sensors to protect its most critical components in extreme situations.

FES 1854H
Featuring a flexible adjustment of bowl and differential speeds, coupled with high processing capacity, the high-performance FES 1854H centrifuge is the right choice for most oilfield applications.

**Flexibility:** The 1854H centrifuge is equipped with a hydraulic main drive, enabling the operator to easily adjust the bowl speed between zero and 3,500 rpm. This option, combined with variable differential speed, gives complete flexibility in the use of centrifuges for drilling fluids treatment.

Regardless of fluid density, viscosity, or solids particle size, the 1854H centrifuge can be fine tuned to process the maximum volume of solids while achieving the desired separation efficiency and underflow density targets.

**Reliability:** Its rotating assembly is designed to deliver reliable service under any circumstance. The feed chamber of the 1854H reduces turbulence, enhancing wear characteristics. The feed scroll is specifically designed to increase flow rates. The power consumption, relative to flow rates for this model, is extremely low, resulting in longer operating service life. Torque and temperature sensors protect critical components of the centrifuge from unexpected damage.

**Capacity:** A bowl that is 54” (1371 mm) long and 18” (457 mm) in diameter combines with a 2.5” (64 mm) feed tube and a dual port feed chamber to provide enough capacity to process fluids with high solids concentration or to be used to polish large volumes of low density fluid in high ROP environments.

The 1854H centrifuge is also equipped with variable speed back drive. High differential speed can improve solids capture (clarification) and increased solids discharge capacity. The optimum differential speed is customized for each application according to solids loading, required separation efficiency, and required underflow density.
Proper conveyance of drilling waste has become a critical concern for operators. Waste must undergo extensive treatment before it can be disposed of safely. Typically, the waste produced (drilled cuttings and liquids) is transported to a processing site to be treated for disposal. This transportation may simply be to another area of the drill site for injection into a geological subsurface formation or to a facility hundreds of miles away. The volume of waste to be transported and the distance to the processing site determines the handling equipment and the mode of transfer required.

### Bulk Transfer

The FES Bulk Transfer system provides a sound economical solution for waste transfer from the solids control equipment discharge to final disposal. The Bulk Transfer system automated enclosed transfer technology provides a means of storing and transferring drilled cuttings in dense phase where energy consumption is minimized, crane lifts are reduced, and less space is required compared to conventional skip and ship methods. HS&E risks involved with handling multiple cuttings boxes are eliminated, improving offshore safety and providing an environmentally acceptable solution to discharge requirements.

The vessel design is simple; the lower vessel wedge profile is designed with a smooth finish, high angle settings, and a wide discharge port for maximum reduction of drill cuttings friction. This allows for easy extraction of its contents, regardless of the material characteristics. An auger mechanism receives and pulls the material in a controlled manner to ensure that plugging will not occur even after prolonged storage periods. Pressure can be applied to the wedge side ports, assisting movement of the material if necessary.

Each uniquely designed vessel offers 82 bbl of storage for drill cuttings. A flexible vessel configuration enables adequate storage capabilities for even the largest and deepest drilling intervals. The system can transfer material 355 ft. (108 m) horizontally and 150 ft. (46 m) vertically to meet the project’s needs. The optimum transfer rate of the Bulk Transfer System is 20-30 tons per hour depending on distance and material consistency. The FES Bulk Transfer system is designed for transportation at full capacity, enhancing logistics planning and providing significant economic benefits.
Skip and Ship

FES' traditional containment and waste handling equipment is designed to optimize movement of large quantities of drill cuttings and mitigate the customer’s risk of environmental exposure. FES processes are designed to deliver project performance objectives with low maintenance equipment throughout all operations. FES' quality service efforts are focused on optimization and planning of the project life cycle by providing specialized equipment for transporting drill cuttings with purpose-built augers, vacuums, and dense phase blower units.

FES provides traditional 25 bbl drill cuttings boxes designed for backhauling waste to a disposal facility. These containers meet all industry design standards and are sealed to prevent any potential spillage.

Our FES auger systems range from 6” to 24” for conveying the entire cuttings load and are engineered with low power consumption requirements. FES has readily available fixed and variable speed drive systems for rapid callouts. Custom units can also be designed for challenging applications. FES auger systems have a field-proven reliable track record and are fully enclosed and automated with minimum involvement of personnel.

FES offers the most powerful modular vacuum system (150HP) on the market, able to handle high penetration drilling rates in all hole sizes. This modular system can be adapted to fit specific site footprints, transporting high volumes of waste over extended conveyance ranges and challenging layouts. Our reliable vacuum units save customers critical rig time, leading to greater reduction in overall operating costs.

The BHDF FES dense phase blower is a unique air conveyance technology. With only one moving part, it is designed to facilitate maintenance-free operation. This distinctive unit is deployed in applications that are complex and require high elevation cuttings conveyance. The dense phase blower can deliver drill cuttings into any type of waste collection unit and can be used for long conveyance distances to boxes or bulk tanks positioned on a transport vessel.
Cuttings Re-Injection

Handling of drill cuttings by transport vessels can be a costly and logistically challenging endeavor. Harsh weather conditions can result in rough seas, prohibiting the offloading of drill cuttings boxes. Drilling delays can result in excessive cost increases to the operator. In addition, overhead lifting of cuttings boxes onto a supply boat increases the risk of injury and HS&E issues.

The FES group has focused its efforts on using Cuttings Re-Injection (CRI) as a permanent, eco-responsible waste disposal solution. Since 1989, FES has been the global leader in cuttings re-injection technology. Cuttings re-injection is the only technology available capable of full disposal of all E&P drilling waste generated at the rig site into a subsurface geological formation with no future liabilities. This technology, developed by FES, involves breaking down drill cuttings using grinding equipment, mixing them with water to degrade the particles into an acceptable size, and injecting the prepared slurry down a wellbore into the selected formation. A clear understanding of downhole conditions during cuttings injection operations is critical to successfully implement this technology.

Our engineers are trained and experienced in adjusting the rheological slurry properties to maintain continuous injectivity throughout the project.

Our cuttings injection system with the smallest footprint in the industry, is capable of processing 30 tons per hour. The CRI process can be engineered to meet all global standards, including BS 12079, LOLER & PUWER, CE markings, and ATEX certification (mechanical and electrical), all with an ergonomic profile for best practices in repair and maintenance programs.

The FES CRI process is engineered with straight suction and discharge piping runs that reduce wear 40% over competitor models. A "witch’s hat" with hard facing is used as an impingement device for added cuttings degradation and allows for adjustments if debris is captured in the internal piping system. The FES CRI system provides high-pressure triplex pumping units specifically designed to inject the drill cuttings slurry into the predetermined disposal formation. The triplex pumps deliver rates between 3 bpm and 9 bpm (477 lpm and 1430 lpm) at pressures ranging from 1700 psi to 5000 psi to meet most injection project requirements. In extreme applications, FES engineers can custom design our mixing and pumping equipment to meet any technical, environmental or safety requirements.

Cuttings Processing

A major challenge in processing drilling waste is the diverse nature of the waste produced. The methods and technologies used to treat different waste streams are as varied as the waste itself. The treatment method selected for each drilling project is based on the characteristics of the waste material, the local environmental regulations, and the available infrastructure. In most areas of the world, cuttings and drilling fluid discharges offshore are strongly regulated. The restrictions vary from the control of discharges (quality and quantity), to complete zero discharge. Each situation requires a different approach in the treatment of the waste generated during the drilling operation.
The physical state, chemical composition, and any associated hazard also determine the appropriate waste treatment. FES is continuously developing and implementing technologies that minimize the energy or chemicals required to eliminate the environmental hazards associated with the various types of waste materials encountered. FES offers both thermal and mechanical processing methods.

Cuttings Dryers
The BHDF FES cuttings dryers are engineered to provide maximum fluid recovery for recycling expensive drilling fluids at the source and discharging the solids phase overboard to sea or into cuttings boxes.

FES offers both vertical and horizontal units that will meet or exceed fluids separation requirements while using SBM systems. Our dryer units provide a large basket surface area and a high-torque rotating assembly to meet the most challenging processing requirements during drilling operations.

SFHP Dryer
In drilling projects with limited power supply and footprint, FES offers a small footprint, high-performance (SFHP) vertical dryer to fit the most demanding operator requirements. The SFHP dryer provides a compact solution without sacrificing separation performance. The unit is capable of handling 20-30 tons of wet cuttings per hour. It has a split water cone cover that allows easy access to the rotating and separating components during repair and maintenance activities.

Vertical Dryer
For field proven reliability, FES offers our vertical dryer, capable of processing 40-60 tons per hour. This unit has the best field track record in the industry. Back plugging issues are eliminated with the dryer’s patented dual internal discharge auger mechanism which rapidly removes the dried drill solids. The low profile dryer unit sits directly on the deck, offering reduced height benefits that eliminate the need for an additional dryer stand.

Horizontal Dryer
FES’ largest and most powerful dryer is a horizontal unit that processes up to 100 tons per hour. This dryer unit has been engineered specifically for deepwater applications characterized by high cuttings generation rates. It has the highest processing capacity, combined with the largest screen surface area and highest torque capacity, to handle high ROPs in all borehole sizes. It also has a low height profile, eliminating the need for space-consuming stands used to accommodate cuttings transfer equipment for overboard discharge. Variable speed drive systems allow operators to operate the dryer at optimum speed to handle cement, silt, sand, salt, and other challenging formation returns in order to avoid screen out during critical high profile deepwater applications. FES’ revolutionary technology, unmatched in the industry, results in maximum effluent recovery while removing damaging low gravity solids.
Liquids Processing

By taking advantage of existing technology and introducing new and innovative equipment, FES is constantly working to reduce the quantity of spent fluids generated in drilling operations and their associated environmental risk. Our technologies focus on effective reintroduction of valuable components back into the drilling process, and then on the efficient handling of the residue left after the treatment is completed.

Dewatering

With more drilling operations requiring treatment of spent water-based fluids, while facing increased restrictions on the construction of reserve pits in land rigs, efficient dewatering is a key tool in complying with environmental regulations.

FES dewatering units are designed to minimize waste volumes and allow maximum recycling of the water phase back into the drilling operation. Our dewatering system achieves exceptional separation of solids from water-based fluids by combining our FES expertise in fluid centrifugation with the chemistry know-how of our Drilling Fluids product line. The FES dewatering unit is a self-contained, modular, skid-mounted unit that is easily transported to any drilling location on land or offshore.

It includes state-of-the-art mixing and polymer aging tanks, metering and transfer pumps, and static mixers. To ensure real-time control of the process, the unit has a single control panel, quality check points, and a work platform for fluid sampling and equipment maintenance purposes. The acid injection system is separated from the work areas to eliminate the exposure of operators to hazardous environments.

FES uses a variable speed centrifuge that adds flexibility to a process that requires continuous adjustments of its chemical and physical parameters to deal with the wide-ranging properties of WBM fluids.

Closed Loop Mud System

The FES goal for closed loop systems is to reduce overall well costs by removing most drill solids while minimizing fluid loss. However, the needs of every project are different. Multiple factors affect the number and type of equipment required: existing solids control equipment, environmental regulations, well characteristics, solids treatment infrastructure and logistics, etc. The FES closed loop technology is designed with specialized separation equipment to maximize effluent recovery while removing damaging solids. Each system can be configured to facilitate solids separation according to individual well needs using drying shakers, mud cleaners, and centrifuges. For solids handling, the FES closed loop systems provide auger tanks or standard tanks to capture the discarded materials before they are transported to their final disposal site.
Filtration
Formation damage is described as any obstruction or barrier in the near wellbore region which reduces the flow capacity of the rock. Formation damage can be in the form of fines migration, emulsion blockage, water blockage, clay swelling, scale, etc. A producing formation must have good porosity and permeability properties and the near wellbore area must not be damaged during drilling or completion or have a “skin” or radial area that prohibits the free flow of hydrocarbons. Most of the solids in the drilling fluids are very difficult to remove once lost to the formation. Efficient cleaning of the drilling fluid before completion operations begin can have a dramatic effect in reducing formation damage.

Filtration Systems
Our filtration equipment enhances completion operations and minimizes fluid losses to reduce production-damaged wells by optimizing the removal of solids from the system. Our equipment The BHDF filtration process equipment package consists of a filter press, pre-coat slurry tank, powder handling unit, and cartridge filter unit to provide continuous filtering of solids-free completion fluid. The system was designed for operational efficiency and safety using the highest quality components in the industry. The process has a small footprint but offers significant flow characteristics with integrated components, resulting in a safer working environment.

Reduced Water Cleaning System
Our Reduced Water Cleaning system uses specialized equipment for removing the solids on-line from the wash water during tank cleaning operations. The system works by power flushing and re-circulating a detergent and seawater pre-mix made up in a small pill pit, at a pressure of 58-174 psi (4-12 bar) between pits. This directly attacks and breaks down the solids buildup in the tank. This process is repeated until the recycled waste liquid has built viscosity or has spent its cleaning capacity. At this stage it is transferred to either a slurry unit for re-injection or to tanks for containment. If required, a further wash pill can be made up to complete the cleanup operation. Typical volumes generated range from 50 to 150 bbls dependent on pit size and condition.

The Two Stage Power Flush
In stage one, all dead volume residue is removed and recovered back to the active system by the means of a diaphragm pump. A jetting lance is used to attack large buildups of solids in the corners and around pipework. This process does not require any entry into the pits and the FES special adjustable jetting lance can get into some of the hardest to reach places from the existing access hatches with the aid of the swivel head.

Once the recycled waste liquid has built viscosity, it is transferred to either a slurry unit for reinjection or to skips for containment. During stage two, a rotating cleaning machine is lowered into the tank to distribute a detergent or base oil premix. The rotating cleaning machine is automated and provides 360 degree coverage inside the tank. It can easily be positioned at different levels within the tank to achieve optimum cleaning performance. When the tank is clean, the waste fluid is again either transferred to a slurry unit for re-injection or to skips for containment.

Tank Cleaning Services
Most operators experience difficulties with solids drop-out inside mud tanks during and at the end of drilling operations. Once settlement has occurred there is no effective means to re-suspend these solids in the liquid. As a result, over the duration of the well, the level of the sediment will increase; meaning extra time and effort is spent preparing the tank for other types of fluids. The traditional method is to physically enter the tank and dig out this build up, which involves individuals working in a confined space and is very time consuming. Others involve re-circulating seawater through the mix lines and back into the pit which in turn generates large volumes of contaminated sea water. Many methods for reducing this waste water have been developed as a result of zero discharge policies, however most have failed to make a big difference.
TANK SHARK

Operators, rig contractors, refineries, and marine vessel companies are becoming increasingly aware of health & safety risks, intensive manual labor, and the potential for vessel rig downtime while cleaning bulk fluid tanks. While steps are taken to minimize risk exposure, conventional cleaning methods still require prolonged confined space entry and intensive labor.

The TANK SHARK™ Robotic Tank Cleaning system provides a safe, effective, and efficient method of cleaning bulk fluid tanks on supply boats, refineries, and drilling rigs. Unlike other automated systems, TANK SHARK is remotely controlled by a technician from the control cabin positioned on the boat deck or rig floor. The unit uses high pressure water-cannons to move the mud around and a hydraulic submersible pump to extract the solids from the tank. Using cameras and monitors, the technician works from the comfort of a control cabin operating the robotic arm, wash water, chemical injection, and all discharge pumping equipment. TANK SHARK can be maneuvered to “shoot” all parts of the tank including floors, walls, ceilings, and lines. TANK SHARK hits the blind spots that other automated systems often leave behind. TANK SHARK provides an enormous advantage over conventional cleaning methods, especially where high density oil or water-based fluids have been used and large quantities of solids have deposited in the tanks.

The unit conforms to any size tank and can handle water pressures greater than 190 psi (13.1 bar) with a fluid output of over 150 gals/min (568 l/min). High pressure and flow rate easily move high density, packed solids from the bottom of tanks resulting in quicker, effective cleaning with less overall waste produced.

One of the critical components of TANK SHARK is a traversing component that allows the robotic arm to freely move to each end of 20' x 40' tanks on 280 class supply vessels. This ensures that large tanks can be cleaned with a single robotic arm.