VSL HEAVY LIFTING

HANDLING OF EXCEPTIONAL LOADS

SPECIAL EQUIPMENT

CUSTOMISED SOLUTIONS

VSL - YOUR PARTNER FOR DESIGN, CONSTRU

VSL INTERNATIONAL

The VSL organisation has grown from being a small Swiss post-tensioning subcontractor to an acknowledged world leader in special construction methods since its first commercial application of the VSL Post-Tensioning system in 1956.

WORLDWIDE NETWORK

VSL operates through 60 locations as a worldwide network, which includes technical centres located in Switzerland and Singapore as well as production facilities in Spain, Thailand and China. The group's 4,600 employees – including 900 engineers and technicians – provide a full range of construction services, from project planning and consultancy through to the execution of the work on site including construction engineering and technical support.

VSL – A COMMITMENT TO QUALITY, SAFETY AND SUSTAINABLE DEVELOPMENT

VSL has put in place rigorous policies for quality, safety and sustainable development in keeping with its position as a leading specialist contractor. Proactive management systems have been established to address local needs while ensuring uniform high standards throughout the company's network.

VSL recognises that its employees are the key to competitiveness, efficiency and safe working practices. The company is committed to "Safety first" and strives for "Zero Accident" operations by motivating and empowering its employees to act responsibly in order to achieve these goals.

SUSTAINABLE DEVELOPMENT

For VSL, sustainable development means striking a balance in its activities between the economic profitability of its business operations and their social and environmental impacts.

Better Life

VSL HEAVY LIFTING

VSL Heavy Lifting has carried out hundreds of challenging projects all over the world – involving an incredible variety of different applications – and has set many new records in the process.

Its unrivalled specialist experience has been gained on projects where it has lifted, lowered, slid and tilted loads for everything from bridges to skyscrapers, offshore platforms to sports stadiums. The business started successfully in 1970 with the lifting of two silo roofs at Portoscuso in Sardinia, Italy. A further milestone soon followed in 1971 with the lifting and tensioning of the roof structure of Munich's world-famous Olympic Stadium.

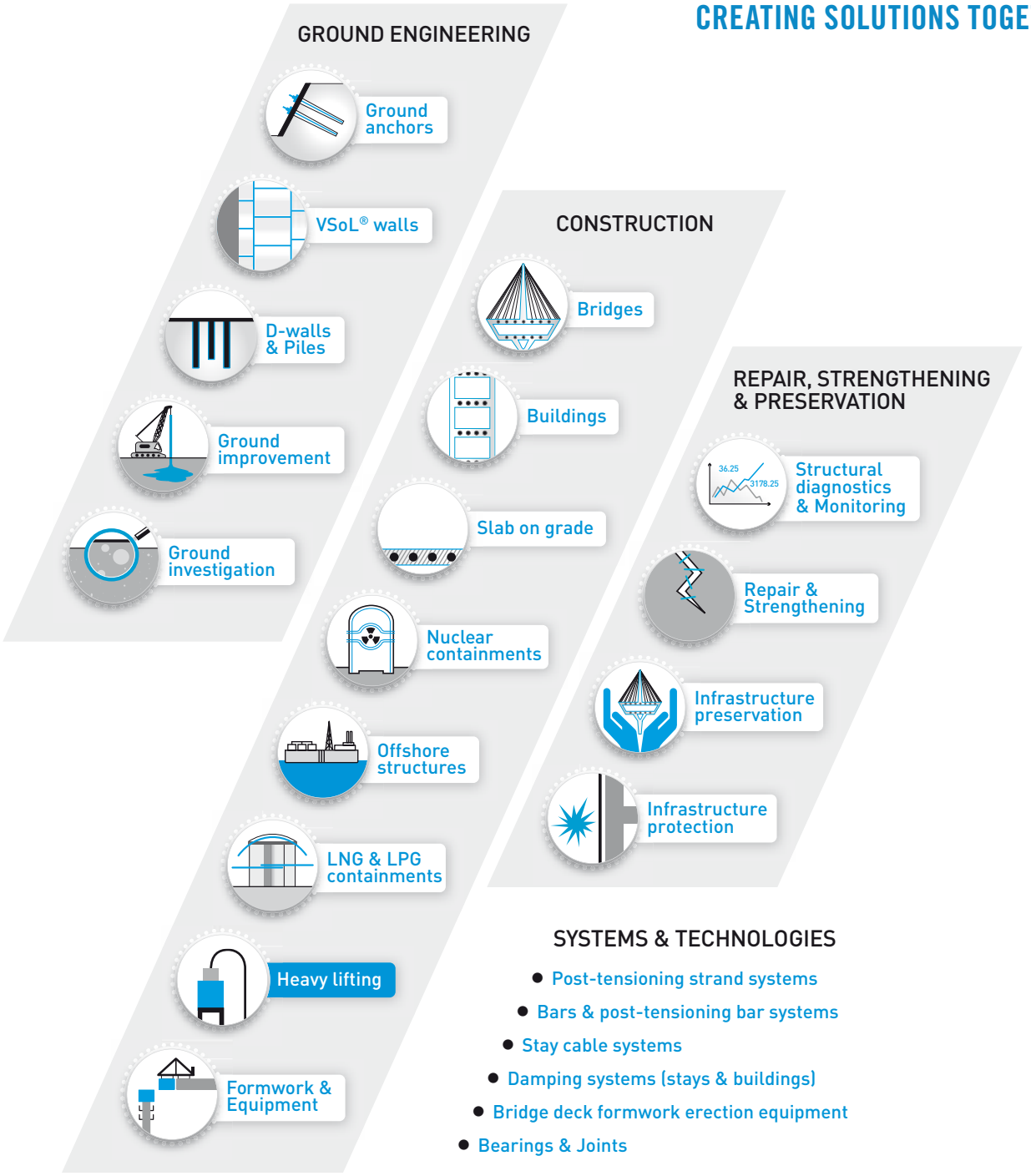
The VSL strand lifting system is at the heart of all heavy lift operations and, in an ever-more eco-conscious world, contributes to delivering sustainable solutions as it has only minimal environmental impact. A strand lifting unit has the capacity to move 300 to 500 times its own weight – in comparison the ratio for a crane might be as low as one, depending on the situation. As a result, the resources required to mobilise the VSL equipment on site are substantially lower, which makes heavy lifting a far more environmentally friendly solution.

VSL designed and built a 1.3km-long six-lane cable-stayed bridge, connecting the western coastline of Abu Dhabi with Hodariyat Island.
Hodariyat Bridge, Abu Dhabi - UAE (2009-2012)

CREATING SOLU

CTION AND RELATED SERVICES WORLDWIDE

CREATING SOLUTIONS TOGETHER



SYSTEMS & TECHNOLOGIES

- Post-tensioning strand systems
- Bars & post-tensioning bar systems
- Stay cable systems
- Damping systems (stays & buildings)
- Bridge deck formwork erection equipment
- Bearings & Joints

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HEAVY LOADS – POSITIONED WITH SKILL

CUSTOM-ENGINEERED SOLUTIONS FOR MOVING LARGE STRUCTURES

TAILORED SERVICES

VSL offers a complete range of services from initial concept through to the engineering, planning, equipment supply and execution of any kind of heavy lifting project.

The approach is flexible and the scope of the services provided by VSL is tailored to specific project requirements. VSL operates worldwide, delivering the most appropriate solutions for each project.

- Feasibility studies and preliminary consultation for lifting, lowering, sliding, skidding, tilting and jacking operations
- Project design and planning, equipment specification, scheduling and budgeting
- Design, manufacture and supply of specialist equipment and temporary structures
- Rental and operation of VSL equipment
- Execution of the heavy lifting operation

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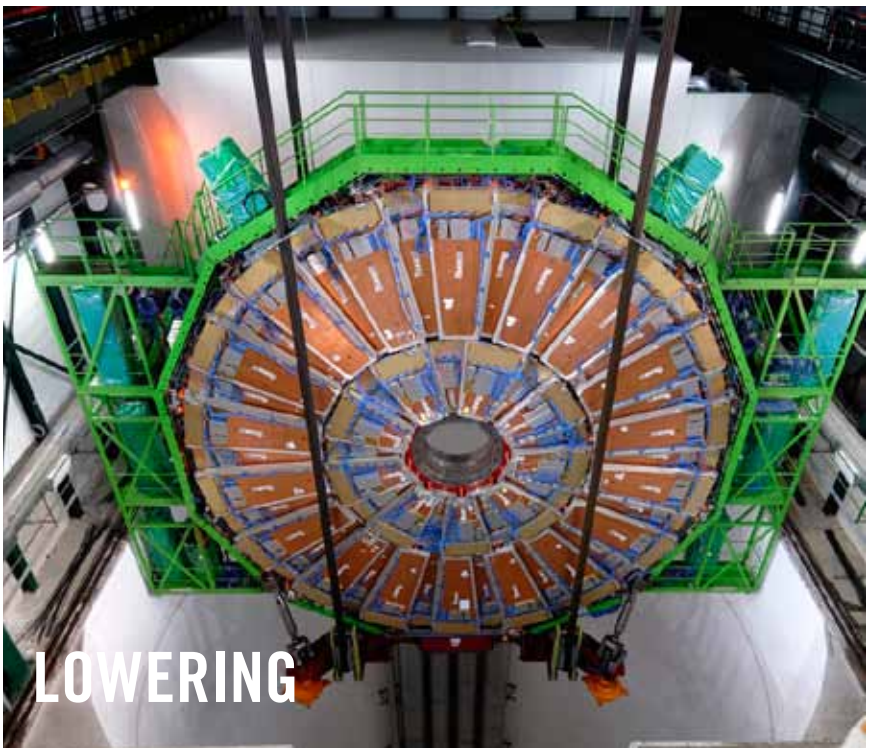


BENEFITS TO CLIENTS

ECONOMY

- Cost-effective and practical methods for carrying out complex operations
- Considerable time-savings
- Decreased usage of cranes
- Reduced need for temporary supports and falsework

SAFETY

- Increased safety through the use of customised methods
- Controlled and well-managed working procedures
- Reduced need for working at heights thanks to ground-level assembly of large structural elements
- Controlled handling of loads
- Fail-safe methods using a strand jacking system that keeps the load mechanically secured even in the unlikely event of an electrical or hydraulic fault

QUALITY

- Collaboration at every step from early design onwards
- Soundly engineered systems and methods
- Reliable operations drawing on long experience
- Non-invasive operations with minimum impact on the load being handled

ENVIRONMENT

- Minimum environmental impact
- Use of biodegradable fluids
- Low energy consumption

RELIABLE SUPPORT

- Nearly 50 years of experience in heavy lifting works, including design and execution together with equipment provision and operation
- Operations backed by a worldwide network and the complete range of VSL products and services

ALL OPERATIONS CARRIED OUT TO RECOGNISED INTERNATIONAL STANDARDS

ISO 9001: 2008 Quality Management System

ISO 14001: 2004 Environmental Management

OHSAS 18001: 2007 Occupational health and safety management systems.

T I O N S T O G E T H E R

THE VSL'S HEAVY LIFTING SYSTEMS

THE VSL STRAND JACKING SYSTEM

VSL's hydraulic strand jacking system is designed for the lifting, lowering, sliding and tilting of loads.

The system's main components are a motive unit, a tension member (made up of strands and an anchorage for the load), a hydraulic pump and a monitoring and control system.

MOTIVE UNIT

The motive unit consists of a hydraulic center-hole jack together with upper and lower anchorages.

The upper anchorage is attached to the jack's piston. When the hydraulic jack extends, the strands are gripped by the wedges in the upper anchorage and move upwards.

When the piston starts its downward movement ready for the next stroke, strands are gripped by the wedges in the bottom anchorage. The upper anchorage opens at the same time.

This sequence is repeated to move the load in a step-by-step process. For lowering operations, VSL motive units are equipped with a device that automatically controls the opening and closing of the anchorages.

TENSION MEMBER

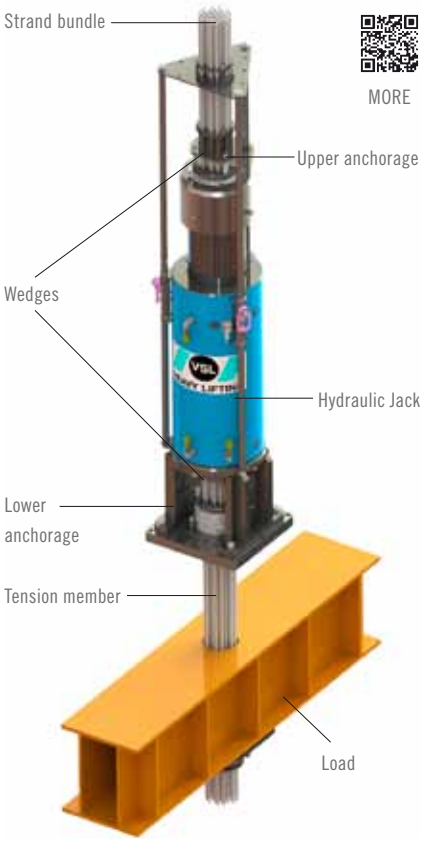
The tension member consists of 7-wire steel prestressing strands of 15.24 mm nominal diameter. It is anchored to the load by a specially designed end anchorage.

HYDRAULIC PUMP

The oil flow for the motive units is provided by electro-hydraulic pumps with either single or multiple outlets.

The characteristics of these pumps guarantee synchronised jacking, even under variable loads. Built-in pressure gauges or remote pressure control devices allow monitoring at all times.

The size of the pump is chosen to suit the load being moved. The movement speed depends on the project requirements and can exceed 20 m/hour, if required.



To lift the cable-net roof of a major stadium, two strand jacking units were installed at each lifting point on the compression ring. Each pump served up to seven lifting points.
Maracanã Stadium, Rio de Janeiro - Brazil (2013)

MORE

CREATING SOLU

CONTROL AND MONITORING

The VSL jacking system enables precision-controlled movement to within millimetres, whether operated manually or by remote control.

This precise coordination of all movements across every part of the system is achieved by using specially designed, computer-based multi-point monitoring systems.

SPECIAL FEATURES

- The VSL strand jacking system is lightweight and easy to handle
- The load is secured at every step of the operation
- The efficient, compact modular system is easily adaptable to client and project requirements

KEY DATA FOR VSL STRAND LIFTING UNITS

TYPE	CAPACITY [1]	MAX. NUMBERS OF STRANDS	CABLE DIAMETER	BODY DIMENSIONS		WEIGHT [2]
	kN		mm	Height mm	Width/Depth mm	kg
SLU-10 SMU-10	104	1	16	1536	270/270	95
SLU-40 SMU-40	416	4	67	1952	360/360	280
SLU-70 SMU-70	728	7	82	2517	460/460	530
SLU-120 SMU-120	1248	12	117	2657	520/520	750
SLU-220 SMU-220	2288	22	167	3064	520/520	1790
SLU-330 SMU-330	3224	31	191	3074	650/650	2080
SLU-580 SMU-580	5720	55	254	3280	790/790	4500

All technical data are based on VSL standard equipment.

Piston strokes vary between 160 mm and 550 mm, depending on the type of unit.

[1] Capacity is based on Y1860S7.15.2 strands in accordance with the requirements of EN 10138:2009; or grade 1860 [270] -15 strands meeting ASTM A416/416M-10 with a safety factor of s=2,5 with respect to the minimum breaking force of the strands.

[2] Body dimensions and weight listed are for the basic version of the SLU lifting units with the maximum piston stroke.

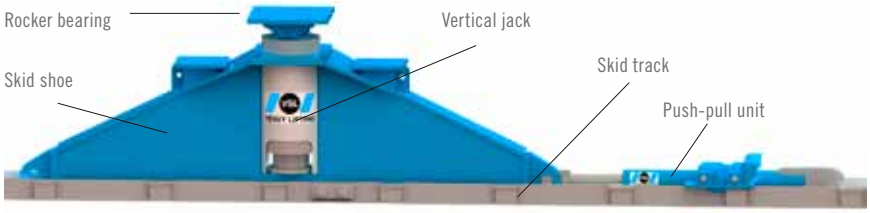
THE VSL SKIDDING SYSTEM

The VSL hydraulic skidding system (VSS) is designed for moving heavy loads along the ground in any direction, even over long distances. The system's main components are skid shoes, push-pull units, skid tracks, hydraulic pumps and a monitoring and control system.

SKID SHOES

Each skid shoe consists of a triangular steel housing with an integrated vertical jack and a rocker bearing. Ground pressure is kept to a minimum by spreading the load over the length of the skid shoe. Options for further spreading of the load are available if required.

A simplified version called a skid beam can be used if the load does not need to be raised in the vertical direction



TYPE	SKID SHOE				PUSH-PULL UNIT	
	Capacity kN	Min. height mm	Stroke mm	Weight kg	Capacity kN	Stroke mm
VSS-90	880	645	150	585	200/120	600
VSS-150	1480	905	250	1000	200/120	600
VSS-300	2950	1355	400	3211	560/320	1250
VSS-500	4900	1485	600	4761	560/320	1250
VSS-750	7400	1542	600	8000	560/320	1250
VSS-1000	9900	1462	600	11600	560/320	1250

PUSH-PULL UNITS

Push-pull units are horizontal double-acting hydraulic jacks that supply the motive force needed to propel the complete system in either direction. They are connected to the tracks and the edges of the skid shoe.

SKID TRACKS

The skid shoes slide on the pads of a skid track. The skid tracks are U-shaped steel channels, which are connected together by a simple pin arrangement and contain integrated PTFE pads. A lubricant further reduces the friction.

HYDRAULIC PUMPS

VSS is operated using standard VSL electro-hydraulic pumps. The size of the pump is chosen to suit the load being moved.

MONITORING AND CONTROL SYSTEM

The VSS enables precision-controlled movement to within millimetres, whether operated manually or by remote control. This precise coordination of all movements across every part of the system is achieved by using specially designed, computer-based multi-point monitoring systems, customised to the project's requirements.

SPECIAL FEATURES

Skidding tracks can be laid out on even ground without any fixings, including in situations with large-radius curves. Special skid tracks are available for use when moving loads along sharp curves.

A 2,500 t tunnel boring machine was skidded 625 m overland. **TBM, Bienne - Switzerland (2010 and 2011)**

CREATING SOLU

Massive concrete caissons were skidded in their casting yard so that they could then be lowered into the sea by a VSL gantry.
Each caisson weighed 3,400 t, measured 28 m by 28 m in plan view and was 10 m high.
MORE **Tangiers Med 2 container port - Morocco (2011 - 2013)**

FLEXIBILITY

VSL Heavy Lifting's wide range of equipment allows even exceptional loads to be moved. The range includes a large selection of hydraulic jacks, pumps, skidding equipment, control units, monitoring systems and modular lifting/jacking frames such as lifting towers, lifting gantries and turntables.

Together they provide VSL Heavy Lifting with the capability and flexibility to carry out virtually any project that requires lifting, lowering, sliding, skidding, tilting or jacking.

Two 900 t container cranes were moved 160 m using VSS.
Tilbury Container Cranes, London - UK (2014)

T I O N S T O G E T H E R

CREATING CONNECTIONS – BRIDGES

Erection of arch segments for a striking 843 m-long bridge wouldn't have been possible without the expertise of the VSL Heavy Lifting team. The bridge's curved design symbolises sand dunes in the desert. **Sheik Zayed Bridge, Abu Dhabi - UAE (2006-2010)**

Space restrictions led to the development of a totally new method for launching the steel structures of two main viaducts.
Cadagua Viaduct, Bilbao - Spain (2009 - 2010)

MORE

CREATING SOLU

A complete 740 m-long bridge was slid laterally following an earlier operation to lift the two middle spans from pontoons. **Milton-Madison Bridge, linking Indiana and Kentucky - USA (2012 and 2014)**

MORE

A 1,600 t centre span with a length of 55 m was lifted into place. **Tseung Kwan O Bridge, Hong Kong - China (2012)**

VSL was brought in to recover a 128 m-long steel bridge that had fallen into the river. The 550 t bridge was then launched 36 m into position. **Omo Bridge - Ethiopia (2013)**

Launching and lateral sliding operations were carried out for a 606 m-long replacement railway bridge. **Rheinvorland Bridge, Worms - Germany (2010 - 2012)**

MORE

T I O N S T O G E T H E R

The roof structure of Warsaw's new stadium features a stunning central spire, two tension rings and 144 radial cables. The cable-net roof was lifted by 144 strand lifting jacks. **Narod Stadium, Warsaw - Poland (2010-2011)**

HIGH-LEVEL LIFTS – BUILDINGS

Building the world's highest 'sky bridge' involved lifting 750 t segments by 230 m. **Gate District Towers, Abu Dhabi - UAE (2011)**

The roof of a massive aircraft hangar was lifted in two parts, weighing 970 t and 770 t. **A380 Hangar, Toulouse - France (2013)**

MORE

CREATING SOLU

The new stadium in Durban has a remarkable roof structure: a giant Y-shaped arch representing the South African flag. Its construction required the special installation of 'flying' - or self-climbing - strand jacking units. **Moses Mabhida Stadium, Durban - South Africa (2008-2009)**

AND STADIUMS

MORE

The last pin: one of the largest cable-net roofs in the world was raised into place using 60 lifting points. **Maracanã Stadium, Rio de Janeiro - Brazil (2012-2013)**

MORE

VSL carried out a complex operation to lift a 340 t steel roof, transfer the load onto the permanent bearings and install a lighting ring. **SSE Hydro Arena, Glasgow - Scotland (2012-2013)**

With a lifting distance of 335 m VSL Heavy Lifting broke a new record when it raised three roof trusses on top of the ADNOC's new headquarters building. The trusses were then slid into their final positions. **ADNOC Building, Abu Dhabi - UAE (2013)**

MORE

T I O N S T O G E T H E R

MORE

Installation of the core element of a wind farm by involved lifting the 5,500 t hull and lowering the 3,500 t substructure.
Global Tech I Platform, German North Sea - Germany (2012-2013)

Offshore installation of a self-elevating leg barge required VSL to lift a 2,300 t hull and lower four support legs, each weighing 145 t.
Sanaga Leg Barge - Cameroon (2001-2012)

MORE

Cooling towers for a power plant were built in a dry dock before being transported by sea and then lowered into the water onto their foundations. **Electrabel Power Plant, Wilhelmshaven - Germany (2013)**

CREATING SOLU

FLEXIBLE OPERATIONS – OFFSHORE

More than 100 caissons were skidded and then towed into position to create new breakwaters. **Tangiers Med 2 container port - Morocco (2011-2013)**

Two 2,000 t concrete caissons were lowered about 100 m onto the ground of a reservoir. **Dam Reservoir, Emosson - Switzerland (2011 and 2012)**

Risers and umbilical cables were lifted from a depth greater than 100 m onto a floating production storage and off-loading unit. The coilers for the operation were custom-made for the project. **USAN Deepwater Development Project - Nigeria (2011)**

T I O N S T O G E T H E R

PRECISE INSTALLATION – INDUSTRY AND

A 2,700 t storage tank was lifted by 35 m. **Abidjan Water Tower - Ivory Coast (2008)**

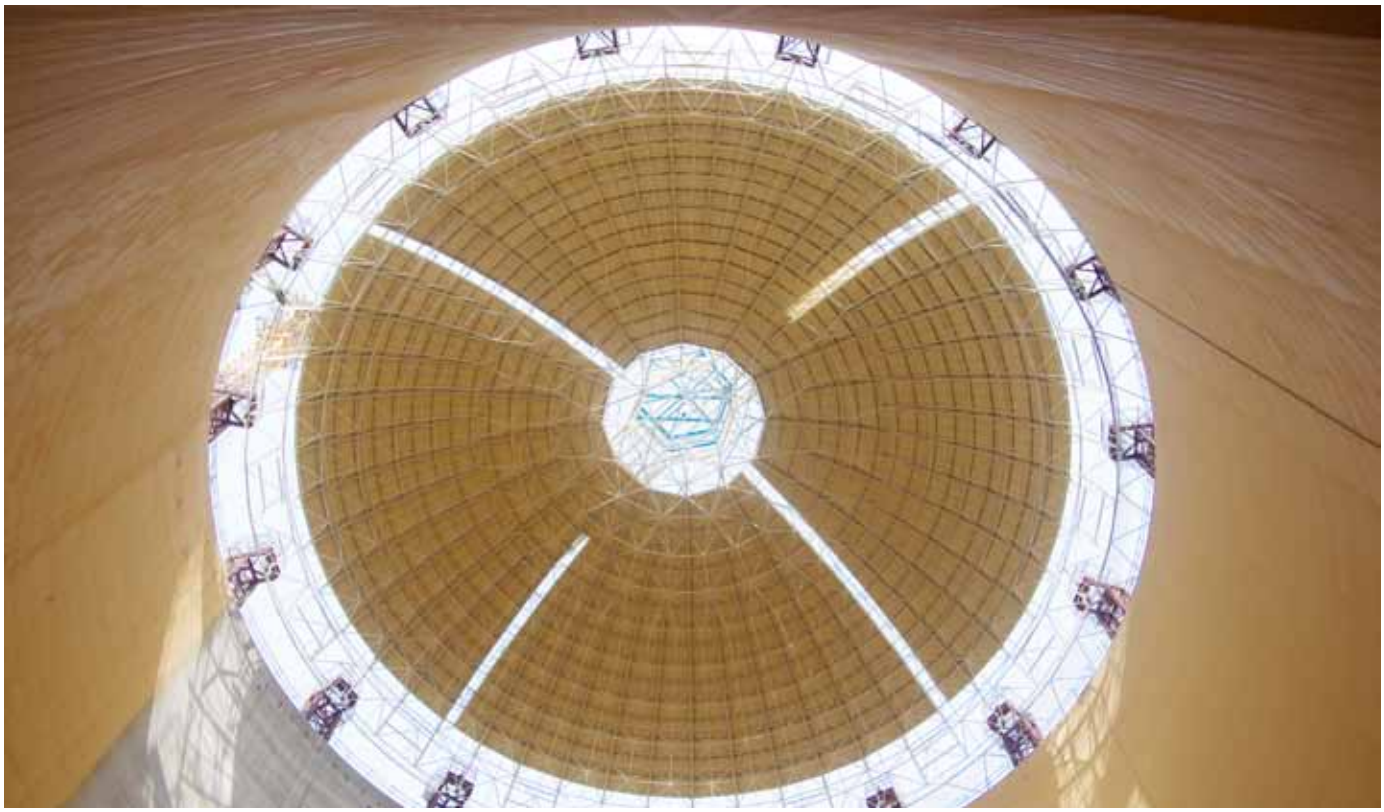
VSL lifted a power plant's steel boiler components and some of the pipework. **Power Plant Walsum Block 10 - Germany (2007-2008)**

A machine-house gantry crane was replaced with a larger one. **Power Plant, Gösgen - Switzerland (2012)**

CREATING SOLU

ENERGY

Three 180 t dome-shaped roofs were raised about 70 m into their final positions using 16 lifting points. **Al Khaleej Sugar Silo, Dubai - UAE (2011)**



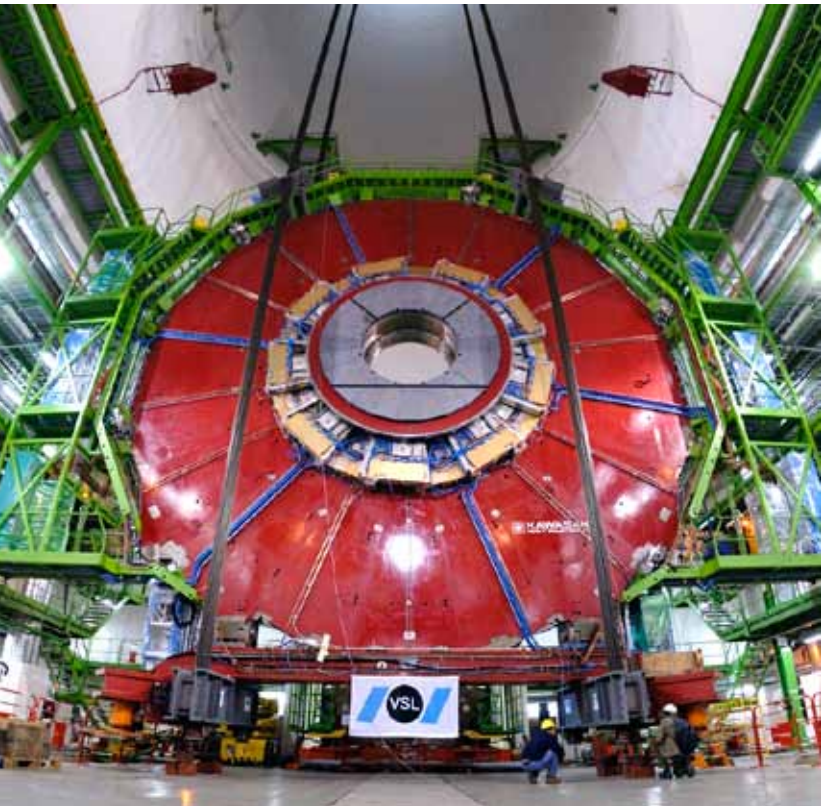
For the lifting and lowering operations at Europe's largest pumped storage plant, VSL Heavy Lifting developed a new tandem lifting/lowering system that allowed speeds of up to 40 m/h to be achieved. **La Muela Hydroelectric Power Station - Spain (2009-2010)**

Four Aalborg boilers were lifted at the energy recovery plant of one of the most energy-efficient ferrosilicon producers. **Finnfjord energy recovery plant, Finnsnes - Norway (2011 and 2012)**

CUSTOMISED SOLUTIONS – SPECIAL PROJECTS

MORE

VSL carried out 1,400,000 test cycles over a six-month period to assess the performance of wind turbine foundations. Simulating the repeated wind and wave effects on the gravity foundation required the loading to be increased from 1,000 kN to 11,000 kN within just a few seconds. Wind turbine foundation testing, **Cuxhaven - Germany (2010-2011)**



Record-breaking box-jacking was carried out to install two adjacent 65 m-long concrete tunnel modules underneath six live Queensland Rail lines. It is believed to be the world's largest single box-jack ever undertaken and required a design force of 360,000 kN on the largest box. **Airport link, Brisbane - Australia (2011)**

A 450 t pinnacle was lifted 89 m onto the top of the world's tallest building. **Burj Khalifa, Dubai - UAE (2009)**

VSL lowered into place 15 segments weighing between 250 t and 1,920 t for CERN's CMS detector, 97 m below ground. **CERN, Geneva - Switzerland (2004)**

CREATING SOLU

RELIABILITY BASED ON PROVEN EXPERIENCE

1970

OLYMPIC STADIUM, MUNICH - GERMANY
First large-scale application of the VSL strand jacking technique, for the lifting and tensioning of the world-famous roof

1980

SIA HANGAR, CHANGI AIRPORT - SINGAPORE
Lifting by 27 m of a stell roof structure weighing 3,600 t

1985

NUCLEAR POWER PLANT, BEZNAU - SWITZERLAND
Multiple operations carried out between 1985 and the present day, including the exchange of major components such as steam generators

1995

PETRONAS TWIN TOWERS, KUALA LUMPUR - MALAYSIA
Lifting of a 325 t 'sky bridge' to link the twin towers at a height of 170 m

2007

STONECUTTERS BRIDGE, HONG KONG - CHINA
Lifting of bridge segments for one of the world's longest cable-stayed bridges

T I O N S T O G E T H E R

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