GILKES

HYDROPOWER SYSTEMS

BY APPOINTMENT TO H.M. THE QUEEN
WATER TURBINE ENGINEERS
GILBERT GILKES & GORDON LTD, KENDAL

THE QUEEN'S AWARDS
FOR ENTERPRISE:
INTERNATIONAL TRADE
2010

7.5MW TWIN JET HORIZONTAL PELTON TURBINE

YOUNGS CREEK ,SNOHOMISH COUNTY PUD, MONROE, WA, USA

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AN INTRODUCTION TO GILKES

Gilbert Gilkes & Gordon Ltd (Gilkes) is an internationally established manufacturing company, based in Kendal, UK on the edge of the English Lake District.

Established since 1853, Gilkes is a world leader in small hydropower systems, supplying over 6600 turbines to over 87 countries during its history. With thousands of installations around the world, Gilkes continue to demonstrate the ability to be sensitive to regional differences and requirements and continually design, manufacture and install bespoke engineered solutions for their customers.

The company's head office is in Kendal, UK with dedicated service centres in Scotland. Gilkes also has offices in Vancouver and Tokyo for the North American and Far East Hydropower markets.

Gilkes also acts as the parent company to Gilkes Energy Ltd, which was formed in 2008 as our hydro project development business to help our clients develop and finance hydro projects and focuses on Joint Ventures with landowners.

Other products designed and manufactured by the company include a range of sophisticated pumps for the cooling of diesel engines and plant, supplying many of the world's major diesel engine manufacturers. Gilkes also produce pumping solutions for the lubricating of oil or gas and steam turbines and supply a range of industrial pumps for virtually any application. Gilkes Inc, based in Texas USA is our American facility, which focuses on the repair, remanufacture and sale of engine cooling pumps for our American customers.

GILKES

“GILKES HAS SUPPLIED OVER 6600 TURBINES TO MORE THAN 87 COUNTRIES”


GILKES
“WORLD LEADING SERVICES FOR THE HYDROELECTRIC INDUSTRY”
CARTER LAKE
COLORADO, USA
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
1367 KW
(PER UNIT)

GILKES MANUFACTURE AND SUPPLY HYDROELECTRIC TURBINES AND ANCILLARY EQUIPMENT IN THE OUTPUT POWER RANGE FROM 50kW UP TO 20MW.

ACTIVITIES INCLUDE:

- Design
- Manufacture
- Installation
- Commissioning
- Testing
- Routine service and plant upgrade

GILKES PROCESS:

- Site visit and investigation
- Outline proposal and initial design
- Detailed proposal
- Design
- Project management
- Production
- Installation and commissioning
- After sales and servicing
- Operational support

THE GILKES PACKAGE

In addition to the supply of the turbine, Gilkes can include in the product package:

OUTLINE PROPOSAL AND INITIAL DESIGN

- Advice and consultation during concept phase of project
- Equipment selection
- Annual energy maximisation

EQUIPMENT INERTIA AND SURGE ANALYSIS

For every project Gilkes carry out analysis of the inertia requirements for the turbines and generator. For Francis units this includes a surge analysis on the penstock to keep the pressure rise on a trip from the grid network within the pressure rating of the penstock.

CONTROL EQUIPMENT

All ancillary equipment is specifically designed to be included into a fully integrated package. The control equipment and ancillary equipment such as hydraulic control modules are fully function tested simulating site conditions to minimise commissioning time.

TURBINE ISOLATING VALVES

All turbines are provided with a turbine isolating valve which automatically isolates the turbine / generator unit during normal and emergency shutdown of the unit.

SPEED GOVERNORS

Gilkes can offer a range of speed control devices depending on the specific project requirements:

- Mechanical speed governors
- Digital electronic speed governors
- PLC speed control
- Electronic load governors (load ballast governors)

ELECTRICAL EQUIPMENT PACKAGE

The electrical equipment is designed specifically for each project. We provide solutions to meet the requirements of the surrounding infrastructure and the capabilities of our customers' personnel. With more emphasis on unmanned plants, automation and control is essential. Gilkes offer complete packages ranging from basic manual systems to complex control philosophy for multi-turbine projects. All equipment is fully factory tested, simulating conditions at site to minimise commissioning time.

SYNCHRONOUS GENERATORS

Gilkes have successfully supplied customers with generators from a wide variety of manufacturers. Using our knowledge and experience we can recommend a particular manufacturer for a given application. The synchronous generators are brushless machines, fitted with rotating exciters and solid state AVR's. These features make a significant contribution to the reduction in routine maintenance required on generators. When appropriate, they can be offered with extended shafts. This enables the turbine runner to be directly mounted onto the generator shaft, dispensing with the turbine shaft and bearing, with the resulting reduction in maintenance. Gilkes can also supply induction generators. All generators are manufactured and factory tested fully in accordance with International Standards.

PACKAGING / PACKING AND DELIVERY

Gilkes packing methods are customised to suit the requirements dictated by the project location and access to the project site. Equipment can be packed for long periods of storage.

SITE WORK

Gilkes Engineers provide expert on-site installation and commissioning services. Our engineers provide the expertise to install, commission and start-up all of the components of the equipment package following Operation and Maintenance procedures. Full training on site or at the Gilkes factory can be provided.

AFTER SALES SERVICE

Gilkes' equipment packages are designed to minimise or eliminate unscheduled down time. All critical strategic spares are identified in consultation with our customers. All contract drawings and documentation are archived to provide spare and after sales service through out the life of the project.

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1. Bart Lake 6 Jet Pelton Turbine, Alaska
2. Turbine monitoring
3. Powerhouse at Logan Gill, in the English Lake District

GILKES

“OUR ENGINEERS PROVIDE THE EXPERTISE TO INSTALL, COMMISSION AND START UP ALL OF THE COMPONENTS”

2 X GILKES FRANCIS TURBINES

CARTER LAKE, CO

GILKES

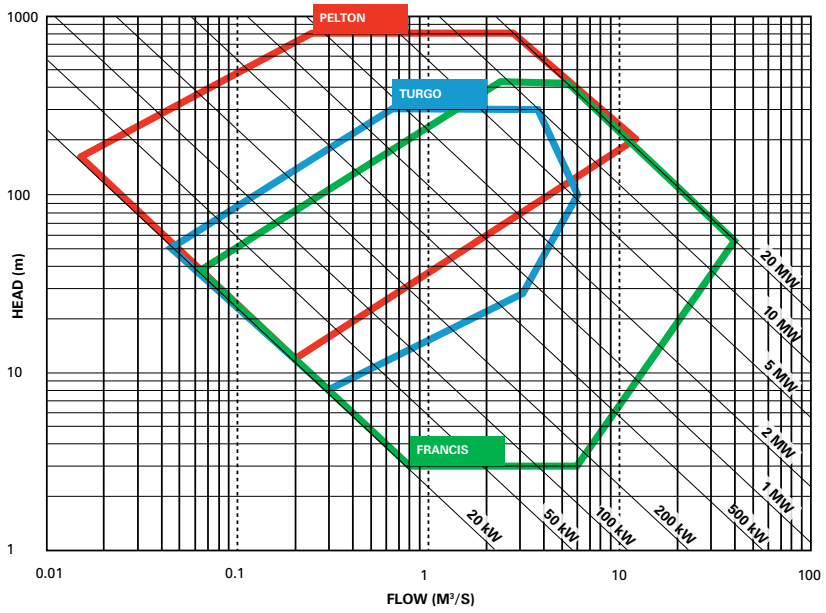
“GILKES HAS BUILT ON ITS EXPERIENCE OVER LITERALLY THOUSANDS OF PROJECTS, WHICH ALLOWS US TO OFFER AN INTEGRATED PACKAGE OF EQUIPMENT”

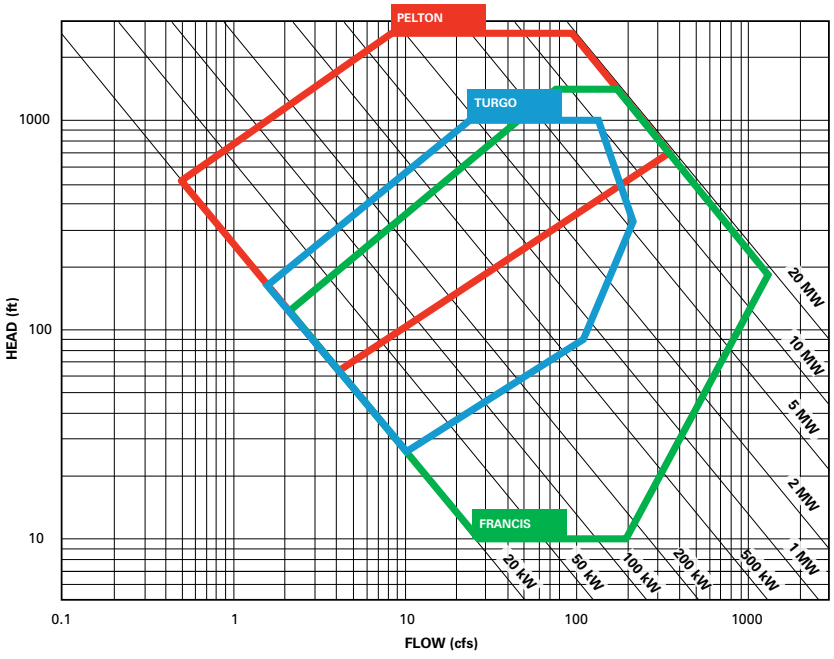
TURBINE SELECTION

The water turbine is the key to any hydro project and requires correct interfacing with the electrical, mechanical, hydraulic and civil aspects of the project.

Gilkes has built on its experience over literally thousands of projects, this allows us to offer a truly integrated package of equipment.

The optimum turbine selection for a given hydraulic duty and site application is dependent on many parameters, however the chart below provides a quick guide to the operating range of the main turbine types. It can be seen that there is a substantial overlap of the duties covered by the different turbine types.





PELTON TURBINES

HEAD RANGE UP TO: 1000m
POWER OUTPUT UP TO: 20MW

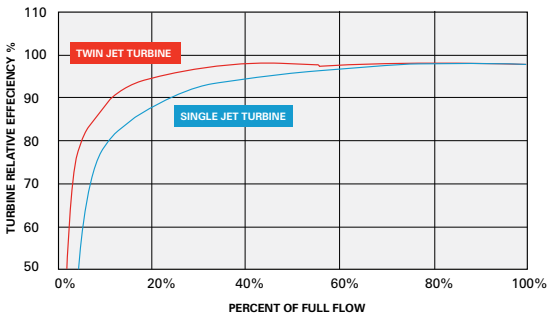
The Pelton Wheel maintains a high efficiency over a wide flow range. Whenever possible two or more jets are specified. This increases the high efficiency flow range. Every Gilkes turbine is designed to optimise your site conditions providing the best annual energy production figures.

Pelton turbines are medium to high head free jet impulse turbines. The jet(s) strike the splitter edge of the double bucket and is turned through an angle of nearly 180% before falling under gravity into the discharge channel or tailrace.

Gilkes' Pelton turbines are supplied as horizontal single and twin jet units or vertical 3, 4 or 6 jet units.

EFFICIENCY

Twin or multi-jet units are specified to increase the flow range over which high turbine efficiencies can be obtained. The efficiency curves given here illustrate this point.



DESIGN FOR PURPOSE:

It is possible to use one size of Pelton bucket on a range of different mean diameters. By this means the turbine can be designed to operate at maximum possible efficiency for any given set of site conditions.

ADVANTAGES OF THE GILKES PELTON TURBINE:

- It can operate on silt-laden water with the minimum of wear. When wear does occur the spear tip, nozzle and deflector plate can be easily repaired and after longer periods, welding can repair the runner. All working parts are easily accessible through a detachable top cover.
- Speed-load control is usually carried out by the deflector, which ensures no pipeline surge even on full load rejection. When water economy is important, the deflector speed control can be augmented by follow-up closure of the spear.
- There is no danger of cavitation damage to the runner or casing.

PELTON CONSTRUCTION:

CASING

The turbine casing is manufactured in two parts and made of fabricated steel. The lower part is specifically designed to allow free discharge of water from the runner and include arrangements for secure grouting into concrete foundations. The upper part is easily removed for access to the runner and maintenance of the unit.

RUNNER

The Pelton runner is machined from solid to improve reliability and efficiency. Materials vary depending on operating conditions but are usually chrome nickel stainless steel. In certain circumstances depending on the head and water quality aluminum bronze runners can be supplied. The runner can be mounted on its own turbine shaft or overhung on the generator shaft.

SHAFT

The turbine shaft of carbon steel is either machined from bar or forged. On larger units the design incorporates a forged half coupling.

BEARINGS

On high power turbines, tilting pad, oil lubricated, thrust or journal type bearings are used, while grease lubricated ball or roller bearings are used for lower power turbines. Where required, lubricating oil and cooling water systems are included.

SPEAR VALVE (NEEDLE VALVE) / BRANCH PIPE

Is manufactured from fabricated steel in a variety of pressure ratings up to PN 100.

SPEAR TIP AND NOZZLE

Are manufactured from stainless steel, both items are easily renewable.

SPEAR ROD

Is manufactured from stainless steel and is supported by a bronze guide which also corrects the flow as it approaches the nozzle, ensuring a clean efficient jet. Operation can be electrical, manual or hydraulic.

JET DEFLECTOR

The deflector plate is of stainless steel and can be easily replaced if worn.

GILKES

“EVERY GILKES TURBINE IS DESIGNED AND OPTIMISED TO PROVIDE THE BEST ANNUAL ENERGY PRODUCTION FIGURES”

GILKES

“FRANCIS TURBINES ARE DEVELOPED FROM LABORATORY-TESTED MODELS AND RETURN EFFICIENCIES OF UP TO 94% AT THE TURBINE SHAFT”

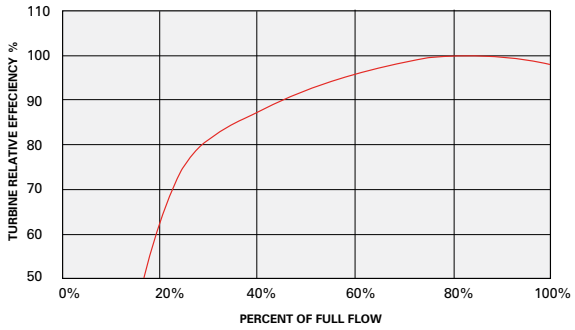
FRANCIS TURBINES

HEAD RANGE UP TO: 400m
POWER OUTPUT UP TO: 20MW

Gilkes Francis turbines are available as either horizontal or vertical units. The water enters the spiral, or scroll case, and is directed by a series of moveable guide vanes, or wicket gates, to the turbine runner. As the water passes through the runner it rotates and the water pressure drops. Water is then discharged through a draft tube into the tailrace. Flow control is affected by opening or closing the guide vanes, which is carried out by an actuator, which, is itself controlled by either a speed governor, for stand-alone duty, or, PLC control for parallel operation with the distribution grid.

EFFICIENCY

Gilkes' Francis turbines are developed from laboratory-tested models and return efficiencies of up to 94% at the turbine shaft. Gilkes use modern Computational Fluid Dynamics (CFD) analysis techniques to continually improve runner design.



DESIGN FOR PURPOSE

Gilkes' Francis model range includes eight different specific speed designs. The Hydro team at Gilkes can advise on the best solution for your project.

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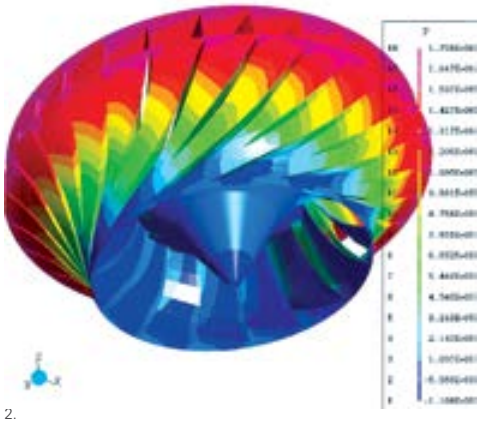

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1. Gilkes hydro installation in Sri Lanka
2. CFD analysis of Francis runner
3. A recent project leaving ready for installation by our team

TURGO TURBINES

HEAD RANGE UP TO: 300m
POWER OUTPUT UP TO: 10MW

Gilkes Turgo Impulse turbine design was developed to provide a simple Impulse type machine with a higher specific speed than a Pelton. The design allows a larger jet of water to be directed at an angle onto the runner.

As a Gilkes patented design, the first ever Turgo turbine was installed in Scotland in 1919. Since then, turbines of Gilkes' originated design have been operating in over 80 countries worldwide and many of the original units are still in operation.

Gilkes are now replacing, completely or in part, copies of our Turgo Impulse turbines with the original Gilkes designed machine and providing the owners and operators with improved output.

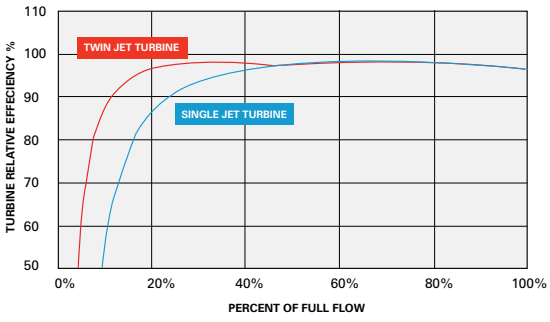
The Turgo range of machines covers the boundary between Pelton and Francis machines and they have been proven to deal extremely well with "dirty" water without any detriment to performance.

The Gilkes Turgo Impulse turbine has the following major advantages relative to other Impulse and Reaction turbines over a wide range of head conditions:

- Being of the Impulse pattern, no fine clearances are involved which means that the turbine can operate on silt laden water over long periods with the minimum of wear. When wear does occur, the speartip and nozzle can be easily repaired, and after longer periods welding can repair the runner. Turgo Impulse turbines are very popular at mining power plants. They are able to provide a long life when operating on mining tailings. The overall efficiency is unaffected by normal wear.
- All working parts, including the deflector are easily accessible through the detachable top cover or through the tailrace pit.
- The jet deflector usually carries out speed load control. This method of speed control ensures that there is no penstock surge even on full load rejection. Where water economy is of paramount importance, the deflector speed control can be augmented by follow up closure of the spear, the rate of closure being designed to be compatible with the penstock design rating. This gives the Turgo Impulse an advantage over medium to high head Francis turbine installations that require higher pressure rated penstocks, surge facilities or relief valves.
- There is no danger of cavitation damage to the runner or the casing.
- The performance curve is flat giving high efficiency over wide flow and load variations. Despite the lower peak efficiency, the Turgo Impulse when compared to a Francis turbine may result in a higher annual energy production. This is particularly important where the turbines are used on run of river sites subject to seasonal flow changes or in conjunction with water supply or irrigation schemes.
- The large jet diameter relative to runner mean effective diameter provides a compact machine capable of passing large quantities of water. This is particularly useful when the turbine is being used as a flow-regulating device in a water supply or irrigation scheme.
- The high specific speed characteristic generally means that a more compact and cheaper generator can be used when compared with multi jet Peltons.
- These features all indicate that the Gilkes Turgo Impulse turbine must be seriously considered when one is looking for a medium to high head machine of proven efficiency, reliability and simple maintenance.

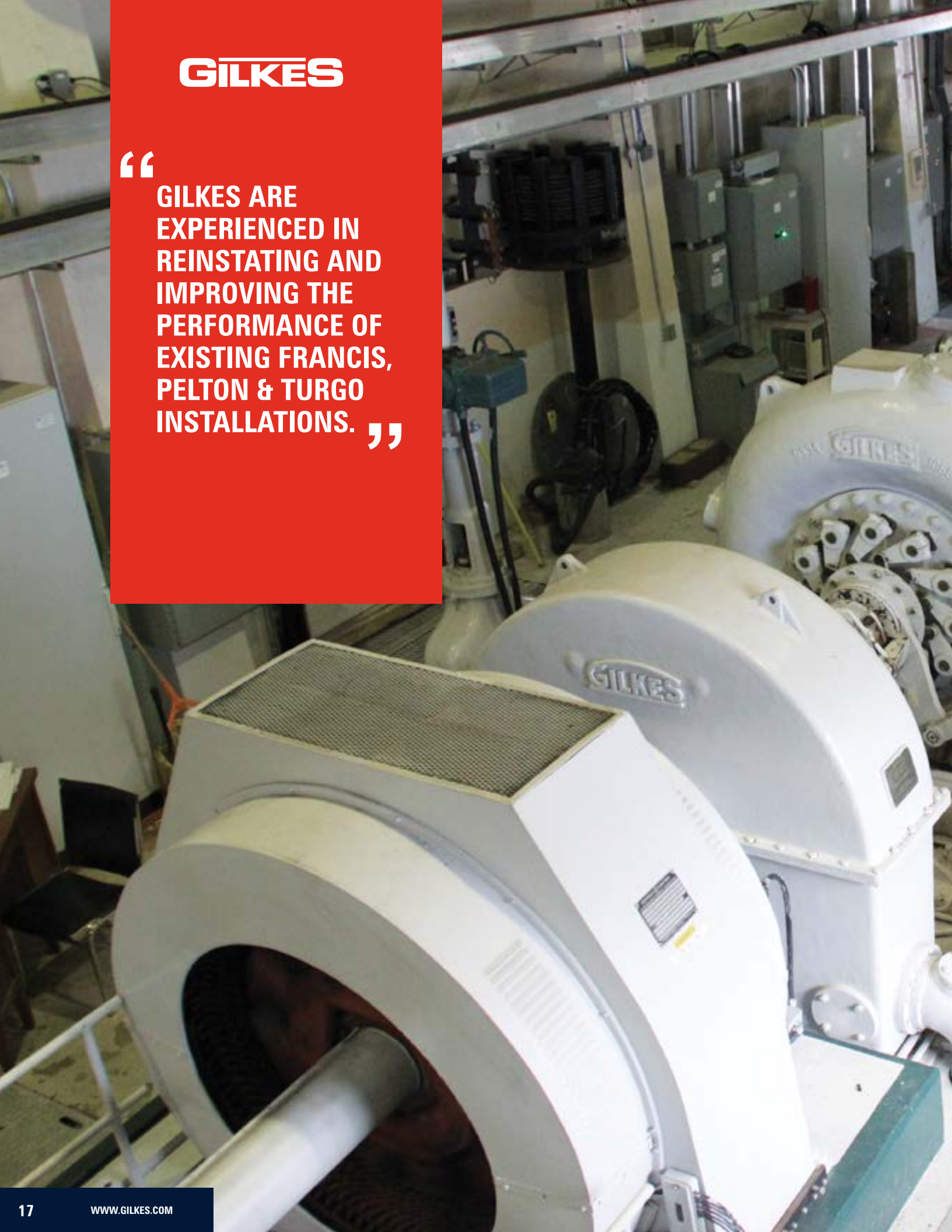
EFFICIENCY

Single or multi-jet units are specified to increase the flow range over which high turbine efficiencies can be obtained. The efficiency curves given here illustrate this point.



GILKES

“TURBINES OF GILKES’ ORIGINATED DESIGN HAVE BEEN OPERATING IN OVER 80 COUNTRIES WORLDWIDE AND MANY OF THE ORIGINAL UNITS ARE STILL IN OPERATION”



GILKES

“GILKES ARE EXPERIENCED IN REINSTATING AND IMPROVING THE PERFORMANCE OF EXISTING FRANCIS, PELTON & TURGO INSTALLATIONS.”

SERVICE AND PLANT MODERNIZATION

Drawing on the experiences gained from over 160 years of designing, manufacturing, installing and commissioning hydro turbines and associated control systems we truly excel when it comes to servicing and plant modernization.

Servicing is a key aspect of any hydro installation to ensure a turbine has a prolonged life whilst performing at optimum efficiencies. For these reasons, Gilkes understand the importance of servicing and offer full on-site servicing of turbines by experienced Gilkes field engineers.

With appropriate servicing Gilkes turbines are built to last for many many decades.

At some point during the life of a turbine, there will undoubtedly come a time where Plant Modernization will be required and certain aspects will have to be replaced, refurbished or upgraded. Gilkes have a great deal of experience of everything from simple part replacement or upgrade to fully rehabilitating whole hydro installations back to their optimum working levels.

One aspect of existing installations which often needs addressing is the control of the turbine. With electrical advances in recent years, Gilkes have designed a Regoverning Package which can be adapted to existing installations to ensure older turbines operate with modern control and reliability.

Plant modernization can essentially give an existing installation another lease of life.

CASE STUDY EXAMPLE

Site: Lockston, NFL, Canada
Turbine Type: Francis (1956)
Main Items in scope of supply: New runner, wicket gates, chamber facings, self-lubricated bushings, main inlet valve.

After over 50 years of operation, time had taken its toll on this Francis turbine and it was in need of rehabilitation. Key components were replaced to ensure the tight tolerances were reinstated around the runner, plus a modern main inlet valve was retrofitted to improve control and general safety.

Main Inlet Valve pit with a Modern Valve solution

Wicket Gate linkage prior to and post rehabilitation

Spiral Case & Discharge Bend upon completion 2013

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