



IEC/TC OR SC:	SECRETARIAT:	DATE:
4	Canada	December 2018

Please ensure this form is annexed to the Report to the Standardization Management Board if it has been prepared during a meeting, or sent to the Central Office promptly after its contents have been agreed by the committee.

**A. HYDRAULIC TURBINES**

TC 4 is responsible for the preparation, periodic review and updating of standards and technical reports covering the design, manufacturing and rehabilitation, commissioning, installation, testing, operation and maintenance of hydraulic machines including turbines, storage pumps and pump turbines as well as related equipment associated with hydropower development. Equipment not part of dam installations and tidal barrage are covered by TC 114 Marine Energy – Wave, tidal and other water current converters.

Continually increasing interest is the use of hydroelectric pump-storage, whose benefits greatly facilitate compensating the large daily variations of power production from other forms of energy including renewables like wind and solar.

**B. MANAGEMENT STRUCTURE OF THE TC**

TC 4 with some 178 registered experts at the time of the Milano Plenary responsible for twenty-eight (28) main Standards and Guides (some are additionally available in several languages), either published or being developed. Thirteen (13) different Working Groups and Maintenance Teams are currently active in the development of new standards and maintenance of existing standards. TC4 maintains liaisons with other TC's, ISO, ASME and IEEE regarding Vibrations, Large Flow Measurement, Monitoring & Control and Marine Energies, Smart Hydro and monitors activities with other Renewable Energy groups. Fifteen (15) of the seventeen (17) "P" countries participated in the Milano Plenary Meeting held September 2016, mobilizing the efforts of some 84 active members present from around the world, who collaborated in the update of this business plan. Please note that an additional eighteen (18) Observer countries are formally registered for TC 4 activities.

In September 2018 we have 13 different expert groups spread out between working groups, maintenance teams and project leaders. We are presently finishing a JWG document with ISO and have formal ongoing joint work with IEEE/PES, IEEE Entity, IEC/TC57 and informal exchanges through some members who are also members of other Standard Writing Organizations. Of special interest are harmonizing efforts between IEC and IEEE in the area of digitalization and controls.

During the coming year we will review TC 4 structures and processes, available training for new members (IEC Academy and others), requirement for approvals of circulating documents, review of available facilitating tools, typical delays for voting and French versions, implications of abstentions and negative vote, identify if/who other than regular TC4 members have access to our documentation storage.

### C. BUSINESS ENVIRONMENT

According to the IHA (International Hydropower Association) during 2017, an additional 21.9 gigawatts (GW) of installed hydropower capacity was added worldwide, including pumped storage, with China once again making up for the largest share of newly commissioned projects. The five countries with the largest individual increases were China (9.1 GW), Brazil (3.4 GW), India (1.9 GW) and Portugal (1.1 GW) and Angola (1.0 GW). Total installed capacity worldwide has now reached 1,267 GW, producing an estimated 4,185 terawatt hours (TWh) in clean electricity – two-thirds of all renewable electricity generation. This will continue to improve with growing carbon credits increasing prices.

Hydropower development is integral to the growth strategies of many fast-growing economies around the world and is present in more than 100 countries, contributing approximately 16.4% of the global electricity production. And hydropower accounts for more than 95 per cent of worldwide energy storage capacity. By absorbing surplus electricity and supplying it when needed, hydropower is seen as an enabler of variable renewable energy sources such as wind and solar power. Throughout 2017, 3.2 GW of pumped storage hydropower capacity was added worldwide, bringing global pumped storage capacity to 153 GW. More than 100 pumped storage hydropower projects totaling some 75 GW of new capacity are in the pipeline. These projects will increase existing global storage capacity by 50 per cent to almost 225 GW by 2030.

Studies by IHA, UNESCO with others provided findings of the greenhouse gas (GHG) footprint of 500 reservoirs worldwide, published for the first time indicating that hydropower is one of the cleanest sources of electricity generation. Renewable energy targets assume that hydropower will make a significant contribution to carbon reduction for decades, if not centuries, into the future. Such projections rely on prolonging the life of hydropower assets and optimizing performance using new technologies. The revolution in digitalization which has swept through computing to encompass algorithmic trading, artificial intelligence and blockchain technology, has not left hydropower untouched. In the sector, enhanced digital systems are part of a growing trend towards improving the performance of turbines, plants and equipment, by reducing costs, adding flexibility and enhancing asset management. A challenge for the global hydropower sector today is the establishment of benchmarking metrics to allow hydropower companies to evaluate their current Operations & Maintenance practices against best in class utilities.

### D. MARKET DEMAND

Since electric energy demand is still growing, the market is active and will support the existing hydroelectric industry for many decades, either for new projects or rehabilitation and upgrades.

While the capacity added last year was lower than the 31.5 GW recorded the previous year, importantly, USD 48 billion of final investment decisions were committed to hydropower projects in 2017 – nearly double the amount recorded in 2016. This indicates that there is a strong pipeline of projects in development.

At this time TC 4 experts estimate that 75% of Industry efforts will continue towards Rehabilitation projects versus 25% for New installations.

Industry concentration can be considered completed and the world financial crisis should not compromise the trends for a better cleaner world. Electrification of domestic and public transportation is part of this trend and will require flexible and predictable sources of energy.

In their Hydropower status report, IHA states that financial instruments are making hydropower investments more attractive through the involvement of more multi-lateral agency, like the World Bank or IFCC. The marketing of green bonds and carbon credits contributes also to render hydropower financially more attractive, as does the growth of the need for ancillary services, like frequency response, reactive power, inertia and fast response. Hydropower is well placed to provide these services for good revenues and is the only commercially viable and dispatchable renewable.

However, cheap oil and gas, mainly shale gas, may hamper somehow the development of large hydropower as might do the development of large storage other than pump-storage (High capacity battery or compressed air storage).

**E. TRENDS IN TECHNOLOGY AND IN THE MARKET**

The development of computational tools during the last fifteen years has brought hydraulic turbines to a level of quality and reliability which might seem difficult to improve, most new units being able to extract 95% of the hydraulic energy they receive in their most frequent operating zones. The challenge is to still improve the tools in order to calculate dynamic load for example and find ways to predict the remaining life expectancy.

As mentioned before, because of its flexibility, hydro is particularly well suited to be a major contributor to this increase of demand for grid and power regulation, as well as ancillary service like black start capability, frequency stabilization through the machine's inertia, reactive power control, voltage control, balancing power, frequent starts and stops, part load operation, spinning reserve, faster response. Black start capability, frequency stabilization through the machine's inertia, reactive power control, voltage control, balancing power. frequent starts and stops, part load operation spinning reserve, faster response,

In addition to the hydraulic aspects, turbine mechanical aspects become more and more important, in relationship with much greater numbers of starts/stops, their greater range of operation, and the more frequent large load variations due to the provision of reserves for the grid frequency control.

Materials and fabrication tools will continue to evolve, including increased used of industrial robots. Erosion remains a concern in many areas and research on better materials and coatings is constant.

Fatigue computations and sophisticated commissioning tests can aim to space out major overhauls. Planned and unplanned outages are expected to remain in the region of one per cent, in spite of daily starts and stops made necessary to accommodate the growing fluctuations of the grids.

Promote and include in standard new technologies such as variable speed (doubly fed asynchronous machines and full frequency converters with synchronous machines) as well as hydraulic short circuit operation of ternary units enabling hydropower plants to provide high quality control services for primary and secondary control (and also for ternary control) needed for a better integration of new renewable energies.

Surprisingly, both these extreme performances and reliability can always be improved by tenths of a percent, precisely because of the exceptional longevity of hydropower installations, high specific energy and the excellent return on investment they authorize. Research and development is needed even more for the megaprojects being now developed or planned.

Extension of plant life time remain a major issue with the aging of a large part of the installed hydro generating plants. Better monitoring and diagnosis equipment and tools, integrating with Smart-Grid all contributing to help optimize operations and timely maintenance. And continued efforts to continually maintain optimal Energy versus Environmental balance.

**F. SYSTEMS APPROACH ASPECTS (REFERENCE - AC/33/2013)**

Increasing role of TC8 (Systems aspects for electrical energy supply) in the Renewable Energy sectors, recommending TC4 to have a Liaison with both TC8 and TC88 (Wind energy generation systems)

Ongoing work within Smart Hydro will favor additional integration of hydro plant production and stabilization in combination with controls of other energy generation and control systems on the grid.

The hydroelectric science is already supported by a century of research, publications and tests. The future will combine this valuable know-how with new technologies.

Industries are moving towards the major markets, mainly the Asia-Pacific area, and the tradition of excellence and reliability of the hydroelectric industry has to survive such reorganizations.

TC 4 has accumulated important experience providing harmonizing efforts and publishing Double-Logo documents with ISO and IEEE, this is ongoing. It is also monitoring work from other Standards Writing Organizations to assure systematic approaches while avoiding overlapping. International standards, based on the best practices, are the answer to this necessity of preserving and improving the traditional reliability of equipment, some of which are still in as-new condition in spite of being nearly a century old.

**G. CONFORMITY ASSESSMENT**

TC 4 has always followed the general intent of conformity assessment, with information on the various specific test specifications and required test methods, as defined by the very knowledgeable technical experts reviewing documents under their specific responsibility and followed with the typical voting approval process of the stakeholders in National Committee circulations.

**H. HORIZONTAL ISSUES**

Horizontal issues such as energy efficiency, environmental aspects, safety, security are reviewed as part of standard practice and identified if need for further action. Potential problem areas would be discussed with the IEC Technical Officer and identify the potential need to interact with the SMB Advisory Committees, if applicable.

**I. 3-5 YEAR PROJECTED STRATEGIC OBJECTIVES, ACTIONS, TARGET DATES**

STRATEGIC OBJECTIVES 3-5 YEARS	ACTIONS TO SUPPORT THE STRATEGIC OBJECTIVES	TARGET DATE(S) TO COMPLETE THE ACTIONS
Training new members by identifying required processes with documents with existing and new tools.	TC 4 Secretariat to provide additional list of available information and working group expectations of members	Ongoing and documented by end of 2019
Importance of maintaining translation copies of documents, for its known clarifications of working texts.	Continue support and exchanges with various stakeholders	Ongoing
Great interest identified for information of IEC TC4 papers in the different Hydro professional journals and/or conferences, with presentation of the results of our works,	In order to provide adequate information to the different customers, consultants and manufacturers around the world. Ongoing discussions in 2019	Also include in CAGs with working group Convenors/Leaders and discussions with IEC Marketing Ongoing discussions in 2019

Note: The progress on the actions should be reported in the RSMB.