

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Communication networks and systems for power utility automation –
Part 7-410: Hydroelectric power plants – Communication for monitoring and
control**

**Réseaux et systèmes de communication pour l'automatisation des systèmes
électriques –
Partie 7-410: Centrales hydroélectriques – Communication pour contrôle et
commande**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2007 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Communication networks and systems for power utility automation –
Part 7-410: Hydroelectric power plants – Communication for monitoring and
control**

**Réseaux et systèmes de communication pour l'automatisation des systèmes
électriques –
Partie 7-410: Centrales hydroélectriques – Communication pour contrôle et
commande**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

XC

ICS 33.200

ISBN 978-2-88912-589-0

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	10
4 Abbreviations	10
5 Basic concepts for hydropower plant control and supervision	11
5.1 Functionality of a hydropower plant	11
5.2 Principles for water control in a river system	11
5.2.1 General	11
5.2.2 Principles for electrical control of a hydropower plant	12
5.3 Logical structure of a hydropower plant	13
6 Modelling concepts and examples	19
6.1 The concept of Logical Devices	19
6.2 Logical nodes for sensors, transmitters, supervising and monitoring functions.....	19
6.3 Address strings	20
6.4 Naming of logical nodes	21
6.5 Recommended naming structure for automatic control functions	21
6.6 Summary of logical nodes to be used in hydropower plants	22
6.6.1 General	22
6.6.2 Group C – Control functions	23
6.6.3 Group F – Functional blocks	23
6.6.4 Group H – Hydropower specific logical nodes	23
6.6.5 Group I – Interface and archiving	24
6.6.6 Group K – Mechanical and non-electrical primary equipment	25
6.6.7 Group L – Physical devices and common logical nodes	25
6.6.8 Group M – Metering and measurement	25
6.6.9 Group P – Protection functions	25
6.6.10 Group R – Protection related functions	26
6.6.11 Group S – Supervision and monitoring	26
6.6.12 Group T – Transducers and instrument transformers	27
6.6.13 Group X – Switchgear	27
6.6.14 Group Y – Power transformers	27
6.6.15 Group Z – Power system equipment	28
7 Logical Node Classes	28
7.1 Abbreviations and definitions used in Logical Node tables	28
7.1.1 Interpretation of Logical Node tables	28
7.1.2 Abbreviated terms used in Attribute Names	29
7.2 Logical Nodes representing functional blocks LN group F	30
7.2.1 Modelling remarks	30
7.2.2 LN: Counter Name: FCNT	30
7.2.3 LN: Curve shape description Name: FCSD	30
7.2.4 LN: Generic Filter Name: FFIL	31
7.2.5 LN: Control function output limitation Name: FLIM	31
7.2.6 LN: PID regulator Name: FPID	31

7.2.7	LN: Ramp function Name: FRMP	33
7.2.8	LN: Set-point control function Name: FSPT	34
7.2.9	LN: Action at over threshold Name: FXOT	35
7.2.10	LN: Action at under threshold Name: FXUT	35
7.3	Hydropower specific Logical Nodes LN group H	36
7.3.1	Modelling remarks	36
7.3.2	LN: Turbine – generator shaft bearing Name: HBRG	36
7.3.3	LN: Combinator Name: HCOM	36
7.3.4	LN: Hydropower dam Name: HDAM	37
7.3.5	LN: Dam leakage supervision Name: HDLS	37
7.3.6	LN: Gate position indicator Name: HGPI	37
7.3.7	LN: Dam gate Name: HGTE	38
7.3.8	LN: Intake gate Name: HITG	38
7.3.9	LN: Joint control Name: HJCL	39
7.3.10	LN: Leakage supervision Name: HLKG	40
7.3.11	LN: Water level indicator Name: HLVL	40
7.3.12	LN: Mechanical brake Name: HMBR	41
7.3.13	LN: Needle control Name: HNDL	41
7.3.14	LN: Water net head data Name: HNHD	41
7.3.15	LN: Dam over-topping protection Name: HOTP	42
7.3.16	LN: Hydropower/water reservoir Name: HRES	42
7.3.17	LN: Hydropower unit sequencer Name: HSEQ	43
7.3.18	LN: Speed monitoring Name: HSPD	43
7.3.19	LN: Hydropower unit Name: HUNT	44
7.3.20	LN: Water control Name: HWCL	45
7.4	Logical Nodes for interface and archiving LN group I	45
7.4.1	Modelling remarks	45
7.4.2	LN: Safety alarm function Name: ISAF	46
7.5	Logical Nodes for mechanical and non-electric primary equipment LN group K	46
7.5.1	Modelling remarks	46
7.5.2	LN: Fan Name: KFAN	46
7.5.3	LN: Filter Name: KFIL	47
7.5.4	LN: Pump Name: KPMP	47
7.5.5	LN: Tank Name: KTNK	48
7.5.6	LN: Valve control Name: KVLV	48
7.6	Logical Nodes for metering and measurement LN group M	49
7.6.1	Modelling remarks	49
7.6.2	LN: Environmental information Name: MENV	49
7.6.3	LN: Hydrological information Name: MHYD	49
7.6.4	LN: DC measurement Name: MMDC	50
7.6.5	LN: Meteorological information Name: MMET	50
7.7	Logical Nodes for protection functions LN group P	51
7.7.1	Modelling remarks	51
7.7.2	LN: Rotor protection Name: PRTR	52
7.7.3	LN: Thyristor protection Name: PTHF	52
7.8	Logical nodes for protection related functions LN Group R	52
7.8.1	Modelling remarks	52
7.8.2	LN: synchronising or synchro-check device Name: RSYN	52
7.9	Logical Nodes for supervision and monitoring LN group S	52

7.9.1	Modelling remarks	54
7.9.2	LN: temperature supervision Name: STMP	54
7.9.3	LN: vibration supervision Name: SVBR	54
7.10	Logical Nodes for instrument transformers and sensors LN group T	55
7.10.1	Modelling remarks	55
7.10.2	LN: Angle sensor Name: TANG	55
7.10.3	LN: Axial displacement sensor Name: TAXD	55
7.10.4	LN: Distance sensor Name: TDST	56
7.10.5	LN: Flow sensor Name: TFLW	56
7.10.6	LN: Frequency sensor Name: TFRQ	56
7.10.7	LN: Humidity sensor Name: THUM	57
7.10.8	LN: Level sensor Name: TLEV	57
7.10.9	LN: Magnetic field sensor Name: TMGF	57
7.10.10	LN: Movement sensor Name: TMVM	57
7.10.11	LN: Position indicator Name: TPOS	58
7.10.12	LN: Pressure sensor Name: TPRS	58
7.10.13	LN: Rotation transmitter Name: TRTN	58
7.10.14	LN: Sound pressure sensor Name: TSND	59
7.10.15	LN: Temperature sensor Name: TTMP	59
7.10.16	LN: Mechanical tension /stress sensor Name: TFNS	59
7.10.17	LN: Vibration sensor Name: TVBR	60
7.10.18	LN: Water pH sensor Name: TWPH	60
7.11	Logical Nodes for power system equipment LN group Z	60
7.11.1	Modelling remarks	60
7.11.2	LN: Neutral resistor Name: ZRES	60
7.11.3	LN: Semiconductor rectifier controller Name: ZSCR	61
7.11.4	LN: Synchronous machine Name: ZSMC	61
8	Data name semantics	63
9	Common data classes	76
9.1	General	76
9.2	Device ownership and operator (DOO)	76
9.3	Maintenance and operational tag (TAG)	76
9.4	Operational restriction (RST)	77
10	Data attribute semantics	77
Annex A (informative)	Algorithms used in logical nodes for automatic control	80
Bibliography		86
Figure 1	– Structure of a hydropower plant	11
Figure 2	– Principles for the joint control function	13
Figure 3	– Water control functions	14
Figure 4	– Water flow control of a turbine	15
Figure 5	– Typical turbine control system	16
Figure 6	– Excitation system	17
Figure 7	– Electrical protections of a generating unit	18
Figure 8	– Conceptual use of transmitters	19
Figure 9	– Logical Device Name	20

Figure 10 – Example of naming structure, in a pumped storage plant, based on IEC 61346-1	20
Figure A.1 – Example of curve based on an indexed gate position providing water flow	80
Figure A.2 – Example of curve based on an indexed guide vane position (x axis) vs net head (y axis) giving an interpolated Runner Blade position (Z axis)	81
Figure A.3 – Example of a proportional-integral-derivate controller	82
Figure A.4 – Example of a Power stabilisation system	83
Figure A.5 – Example of a ramp generator	83
Figure A.6 – Example of an interface with a set-point algorithm	84
Figure A.7 – Example of a physical connection to a set-point device	85
Table 1 – Example of Logical Device over-current protection	19
Table 2 – recommended LN prefixes	22
Table 3 – Logical nodes for control functions	23
Table 4 – Logical nodes representing functional blocks	23
Table 5 – Hydropower specific logical nodes	23
Table 6 – Logical nodes for interface and archiving	24
Table 7 – Logical nodes for mechanical and non-electric primary equipment	25
Table 8 – Logical nodes for physical devices and common LN	25
Table 9 – Logical nodes for metering and measurement	25
Table 10 – Logical nodes for protections	26
Table 11 – Logical nodes for protection related functions	26
Table 12 – Logical nodes for supervision and monitoring	26
Table 13 – Logical nodes for sensors	27
Table 14 – Logical nodes for switchgear	27
Table 15 – Logical nodes for power transformers	27
Table 16 – Logical nodes for power system equipment	28
Table 17 – Interpretation of Logical Node tables	28
Table 18 – Conditional attributes in FPID	32
Table 19 – Description of data	63
Table 20 – Semantics of data attributes	78

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-410: Hydroelectric power plants – Communication for monitoring and control

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-7-410 has been prepared by IEC technical committee 57: *Power systems management and associated information exchange*.

It has been decided to amend the general title of the IEC 61850 series to *Communication networks and systems for power utility automation*. Henceforth, new editions within the IEC 61850 series will adopt this new general title.

This bilingual version (2013-01) corresponds to the English version, published in 2007-08.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/886/FDIS	57/905/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61850 series, under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The present standard includes all additional logical nodes, not included in IEC 61850-7-4:2003, required to represent the complete control and monitoring system of a hydropower plant.

Most of the Logical Nodes in IEC 61850-7-410 that are of general use, Logical Nodes the names of which do not start with the letter “H”, will be transferred to the future Edition 2 of IEC 61850-7-4. In the same manner, all Common Data Classes specified in IEC 61850-7-410 will be transferred to future Edition 2 of IEC 61850-7-3.

Once future Editions 2 of IEC 61850-7-3 and IEC 61850-7-4 are published, IEC 61850-7-410 will be revised to include only those Logical Nodes that are specific to hydropower use.

Before Edition 2 of IEC 61850-7-410 is published, there will be a period where the Common Data Class (CDC) and Logical Node (LN) specifications will overlap with IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2). During this time, the specifications in IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2) will apply.

Withdrawn

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-410: Hydroelectric power plants – Communication for monitoring and control

1 Scope

IEC 61850-7-410 is part of the IEC 61850 series. This part of IEC 61850 specifies the additional common data classes, logical nodes and data objects required for the use of IEC 61850 in a hydropower plant.

The Logical Nodes and Data Objects (DO) defined in this part of IEC 61850 belong to the following fields of use:

- **Electrical functions.** This group includes LN and DO used for various control functions, essentially related to the excitation of the generator. New LN and DO defined within this group are not specific to hydropower plants; they are more or less general for all types of larger power plants.
- **Mechanical functions.** This group includes functions related to the turbine and associated equipment. The specifications of this document are intended for hydropower plants, modifications might be required for application to other types of generating plants. Some more generic functions are though defined under Logical Node group K.
- **Hydrological functions.** This group of functions includes objects related to water flow, control and management of reservoirs and dams. Although specific for hydropower plants, the LN and DO defined here can also be used for other types of utility water management systems.
- **Sensors.** A power plant will need sensors providing measurements of other than electrical data. With a few exceptions, such sensors are of general nature and not specific for hydropower plants.

NOTE All Logical Nodes with names not starting with the letter "H" will be included in a future edition 2 of IEC 61850-7-4. When that document is published, the Logical Nodes in IEC 61850-7-4 (Edition 2) will take precedence over Logical Nodes with the same name in this part IEC 61850-7-410.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies:

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems in substations – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-7-2:2003, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication services interface (ACSI)*

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4:2003, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61850-2 apply.

4 Abbreviations

In general, the abbreviations defined in IEC 61850-2 apply. The following abbreviations are repeated here for convenience.

ASG	Analogue setting
BSC	Binary controlled step position information
CDC	Common data class
CIM	Common information model (reference to IEC 61970-301)
CMV	Complex measured value
DO	Data object
DPC	Double point control
DPL	Device name-plate
DPS	Double point status information
HMI	Human machine interface
IED	Intelligent electronic device
INC	Controllable integer status
ING	Integer status setting
INS	Integer status
LD	Logical device
LN	Logical node
MV	Measured value
PD	Physical device
PID	Proportional – Integrating – Derivative regulator
SAV	Sampled analogue value
SMV	Sampled measured value
SPC	Single point control
SPS	Single point status

WYE Phase to ground related measured values of a three-phase system

5 Basic concepts for hydropower plant control and supervision

5.1 Functionality of a hydropower plant

Figure 1 is based on the substation structure described in IEC 61850-6. A typical power plant will include a “substation” part that will be identical to what is described in the IEC 61850 series. The generating units with their related equipment are added to the basic structure.

A generating unit does consist of a turbine-generator set with auxiliary equipment and supporting functions. Generator transformers can be referenced as normal substation transformers; there is not always any one-to-one connection between generating units and transformers.

The dam is a different case. There is always one dam associated with a hydropower plant. There are however reservoirs that are not related to any specific power plant as well as there are power plants from which more than one dam are being controlled. While all other objects can be addressed through the power plant, dams might have to be addressed directly.

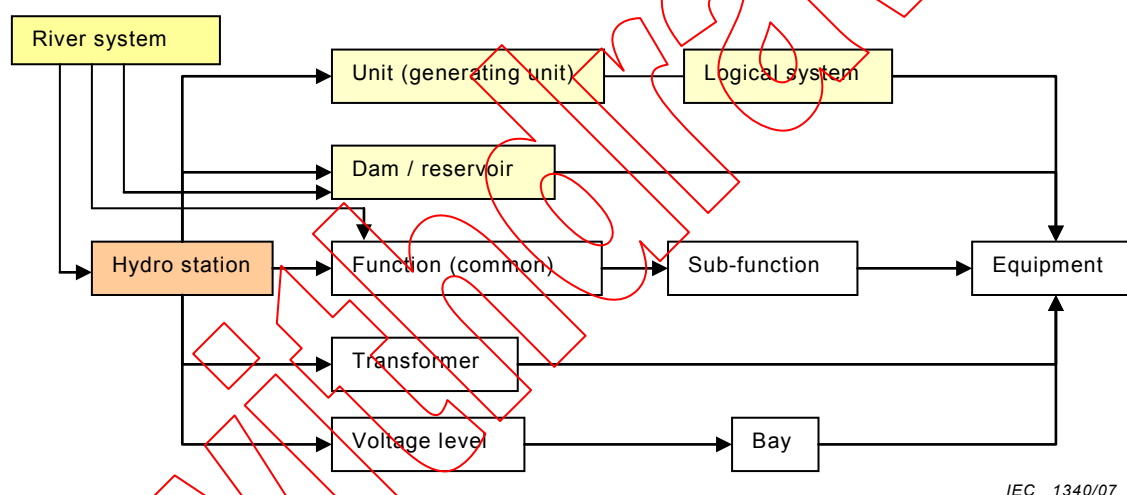


Figure 1 – Structure of a hydropower plant

There is, however, no standardised way of arranging overall control functions. The structure will depend on whether the plant is manned or remote operated, as well as traditions within the utility that owns the plant. In order to cover most arrangements, some of the Logical Nodes defined in this part of IEC 61850 more or less overlap. This will allow the user to arrange Logical Devices by selecting the most appropriate Logical Nodes that suit the actual design and methods of operation of the plant. Other Logical Nodes are very small, in order to provide simple building blocks that will allow as much freedom as possible in arranging the control system.

Some control functions do work more or less autonomously after being started and stopped by the start/stop sequencer. Such functions include the cooling system for the generator and the lubrication oil system for the bearings.

5.2 Principles for water control in a river system

5.2.1 General

The water control of river systems and hydropower plants can follow different strategies, depending on the external requirements put on the operation of the system.

a) Water flow control

In this type of control, the power production is roughly adapted to the water flow that is available at the moment. The rate of flow is the controlled while the water level is allowed to vary between high and low alarm levels in the dams. The dams are classified after the time over which the inflow and outflow shall add up (daily, weekly etc.).

b) Water level control

In some locations, there are strict limits imposed on the allowed variation of the water level of the dam. This might be due to maritime shipping or by other environmental requirements. In this case, the upper water level of the dam is the overriding concern, power production is adjusted by the water level control function to provide correct flow to maintain the water level.

c) Cascade control

In rivers with more than one power plant, the overall water flow in the river is coordinated between plants to ensure an optimal use of the water. Each individual plant can be operated according to the water level model or the water flow model as best suited, depending on the capacity of the local dam and allowed variation in water levels. The coordination is normally done at dispatch centre level, but power plants often have feed-forward functions that will automatically notify the next plant downstream if there is a sudden change of water flow.

Power plants with more than one generating unit and/or more than one dam gate, can be provided with a joint control function that controls the total water flow through the plant as well as the water level control.

5.2.2 Principles for electrical control of a hydropower plant

A power plant can be operated in different modes: active power production mode or condenser mode. The generator can be used as a pure synchronous condenser, without any active power production and with the runner spinning in air.

In a pumped storage plant, there is a motor mode for the generator. A generator in a pumped storage plant can also be used for voltage control in a synchronous condenser mode, in this case, normally with an empty turbine chamber.

The following steady states are defined for the unit:

- a) *Excited, not connected* – Field current is applied and a voltage is generated, the generator is however not connected to any load, there is no significant stator current.
- b) *Synchronised* – The generator is synchronised to an external network. This is the normal status of an operating generator.
- c) *Synchronised in condenser mode* – The generator is synchronised. However it does not primarily produce active power. In condenser mode, it will produce or consume reactive power, in generation- or pump-direction (for pumped storage), it consumes active power.
- d) *Island operation mode* – The external network has been separated and the power plant shall control the frequency.
- e) *Local supply mode* – In the case of a larger disturbance of the external network, one or more generators in a power plant can be set at a minimum production to provide power for local supply only. This type of operation is common in thermal power plants to shorten the start-up time once the network is restored, but can also be used in hydropower plants for practical reasons.

5.3 Logical structure of a hydropower plant

Different devices handle active and reactive power control. The turbine governor provides the active power control by regulating the water flow through the turbine and thus the pole angle between the rotating magnetic flux and the rotor. The excitation system provides the reactive power control by regulating the voltage of the generator. The magnetic flux shall correspond to the shaft torque to keep the generator synchronised to the grid.

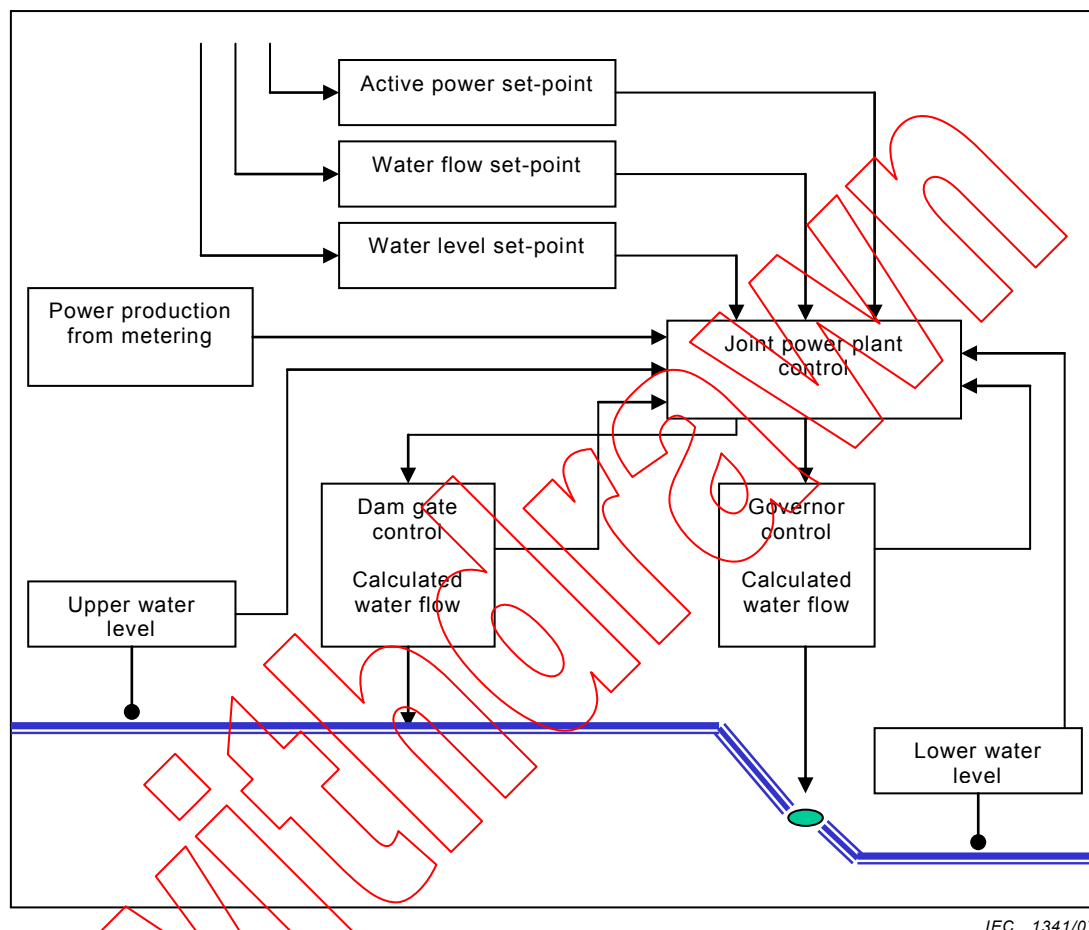


Figure 2 – Principles for the joint control function

Figure 2 shows an example of an arrangement including a joint control function. The set-points will be issued from a dispatch centre and could be one of three optional values. Therefore, the type of set-point that will be used depends on the water control mode that is used for the plant.

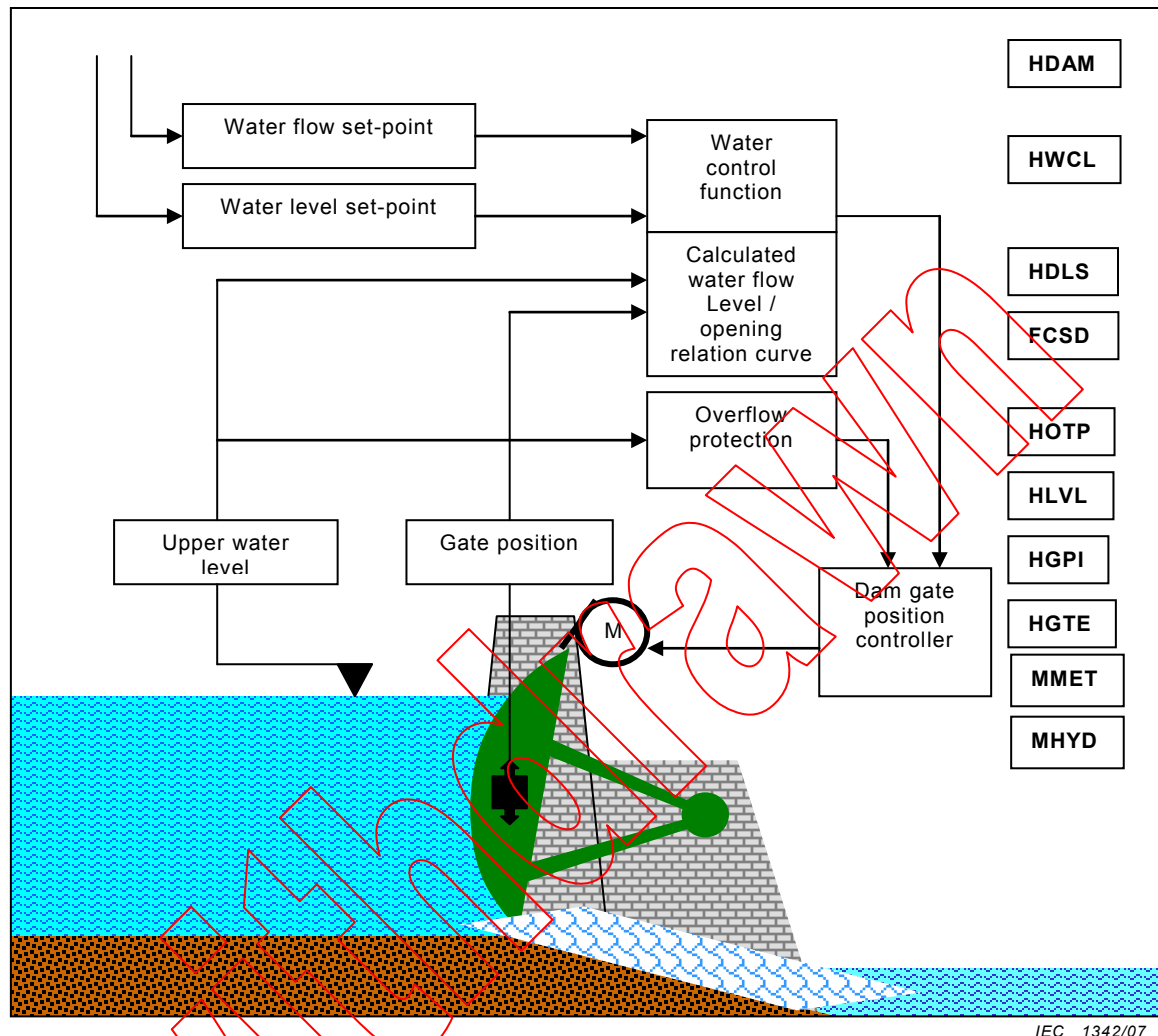


Figure 3 – Water control functions

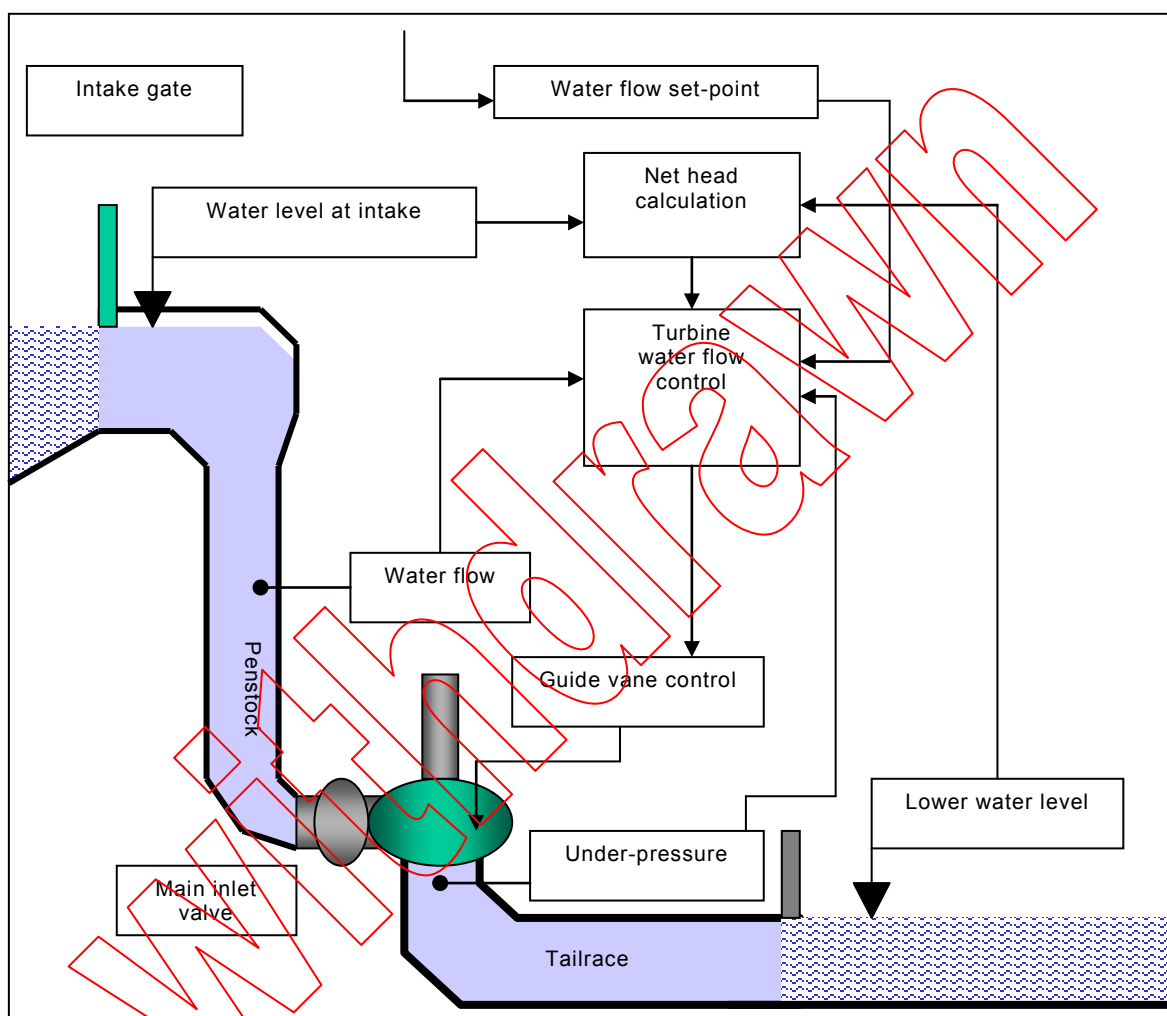
Figure 3 is a typical example of water control functions of a dam. The overall water control of a hydropower plant will also include the water running through turbines. The overtopping protection (HOTP) is a safety function, acting independent of other control functions that will override normal spillway gate controls.

In the case of a reservoir without any power production, this water control function will get the set-points from a dispatch centre; in the case of a power plant it will be normally the joint control function that sets the values. The set-point will be either water level or water flow set-points.

The total water flow is the sum of flows through turbines and gates. The overall flow control shall also consider the flow through turbines. The turbine control system can, due to this, be provided with different set-points for the control:

- Water flow set-point. The control system will base the regulation on the given water flow level and try to optimise the production.
- Active power set-point. The control system will try to meet the active power, the water flow will be reported back to the overall water control system.

- Active power control with speed droop. This is the mode when the unit is contributing to the network frequency control. The active power set-point is balanced over the speed droop setting to obtain the desired power/frequency amplification.
- Frequency set-point. in the case of an islanded system or a power plant in peak load duty, the active power will be controlled to exactly meet the demand. This control mode is also used during start-up of the unit, up to the point when the generator is synchronised. Water flow will be reported.



IEC 1343/07

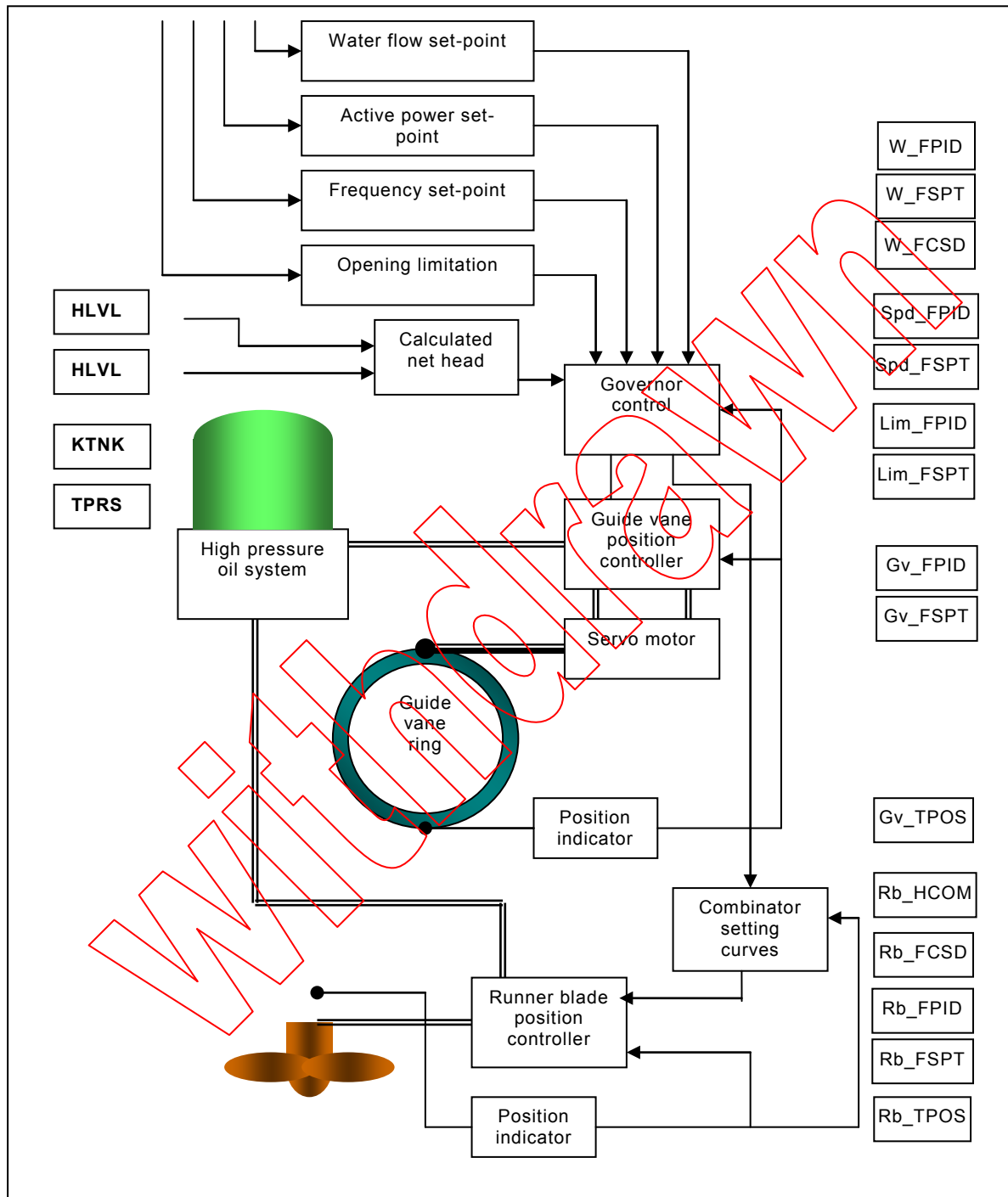
Figure 4 – Water flow control of a turbine

Figure 4 shows an example of water flow control of a turbine. Direct measurement of the water flow, as indicated in the figure, is less common. The flow is normally calculated, using the net head, the opening angle of the guide vanes and a correlation curve.

Main inlet valves to shut off the turbine chamber are used for pumped storage plants and power plants with high penstocks.

It is important to differentiate between the water levels of the dam and at the intake. Due to the intake design or if the turbine is running close to rated power, the water level at the intake might be considerably lower than the average for the dam.

The measurement of under-pressure below the turbine chamber is a safety measure, to ensure that the operation of the guide vanes does not cause any dangerous conditions in the tail-race part.



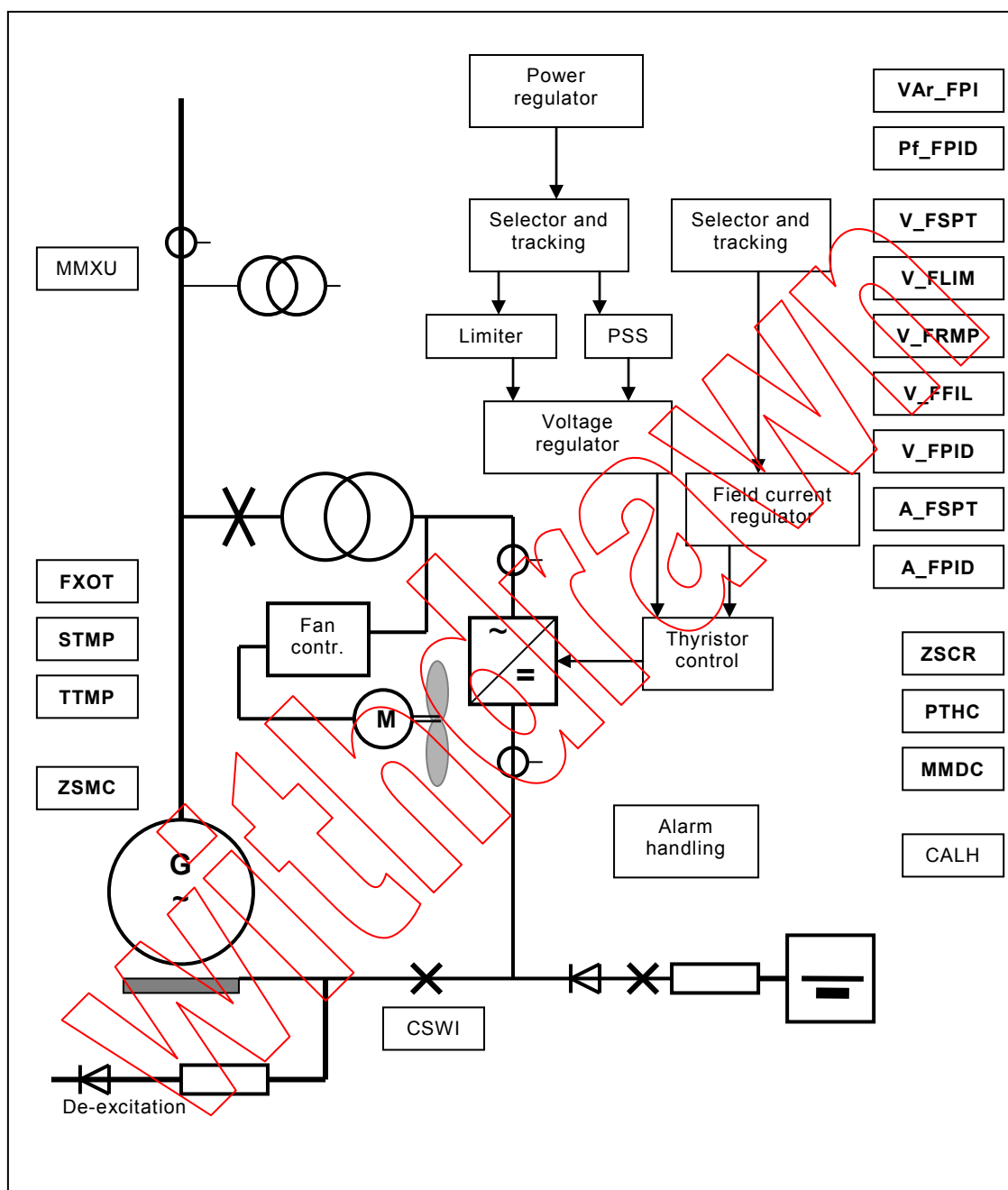
IEC 1344/07

Figure 5 – Typical turbine control system

Figure 5 above shows an example of a turbine control system for a Kaplan turbine with moveable runner blades.

The frequency set-point and any opening (maximum power) limitation set-point are most likely to be given by dispatch centre (or locally).

The active power set-point can be given by dispatch centre, but in the case of overriding water control functions, it is given by the joint control function (HJCL). The water control set-point is almost always provided by the joint control function.



IEC 1345/07

Figure 6 – Excitation system

Figure 6 shows an example of the excitation system for a generator. There are a number of different design principles for excitation systems; the figure does, however, include the most common functions. The synchronisation device can be included in the excitation system, in the turbine governor system, or it can be a separate device not being part of either.

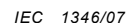


Figure 7 – Electrical protections of a generating unit

Figure 7 shows examples of electrical protections that are commonly used in hydropower applications. There might be other protections beside the ones shown here, such as shaft current protection. Another protection not included in the figure is a protection against unintentional energisation at stand-still; logical node name PZSU.

6 Modelling concepts and examples

6.1 The concept of Logical Devices

A Logical Device is a local definition of an entity that may contain an arbitrary number of Logical Nodes. Logical Devices are used to provide a common address for Logical Nodes that would normally be grouped together. The principle of how Logical Devices are used is described in IEC 61850-7-1. For the formal specification of Logical Devices, see IEC 61850-7-2, Clause 8. As an example, we can look at a simple over-current protection, a standard distribution type protection device. Even if being part of for example an excitation system, this protection will be a separate device, with a possible set-up according to Table 1. All logical nodes in this example are found in IEC 61850-7-4.

Table 1 – Example of Logical Device over-current protection

LOGICAL-DEVICE class		
Attribute name	Attribute type	Value/value range/explanation
SupplyOC	ObjectName	Incoming supply over-current protection
G1ExOCin	ObjectReference	Excitation system for G1, incoming over-current
LPHD	LOGICAL-NODE	Physical device data
LLN0	LOGICAL-NODE	Logical node zero
MMXU	LOGICAL-NODE	Three-phase measurement data
PIOC1	LOGICAL-NODE	First step, instantaneous
PTOC2	LOGICAL-NODE	Second step, time delayed
PTOC3	LOGICAL-NODE	Second step, time delayed *
RDIR1	LOGICAL-NODE	Directional element, linked to first step *
RBRF	LOGICAL-NODE	Breaker-failure function *
* Functions not required in the specific application can be disabled, in which case the corresponding logical nodes will not show in the Logical Device Directory.		

A real world excitation system would most likely be built up of a number of smaller logical (and physical) devices. The excitation system as such will then only be a part of the name reference string that identifies the various logical devices that together constitutes the overall function.

6.2 Logical nodes for sensors, transmitters, supervising and monitoring functions

This group of logical nodes are divided in two groups. Sensors and transmitters are listed within logical node group T. These devices will output a single sampled analogue value at a given sampling rate. Supervising and monitoring functions are grouped under S, these functions may convert the sampled values to measured values and perform checks against limits. Figure 8 shows the concept of how different data classes are used.

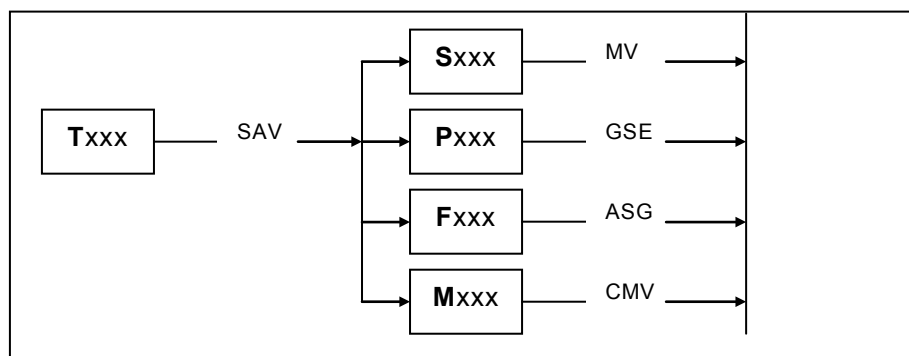


Figure 8 – Conceptual use of transmitters

IEC 1347/07

6.3 Address strings

The utility is expected to provide the address, from top level and down to the Logical Device level. The naming conventions and format shall be as specified in IEC 61850-7-2, Clause 19.

The allowed format is basically as shown in Figure 9.

LD Name	LN Name			Data Name	Data Attribute Name
	LN Prefix	LN Class	LN Instance no		

IEC 1348/07

Figure 9 – Logical Device Name

The Logical Device name (**LDName**) may consist of up to 32 alphanumeric characters.

The Logical Node name (**LNName**) may consist of up to 11 alphanumeric characters, arranged as follows:

Logical Node prefix: m characters

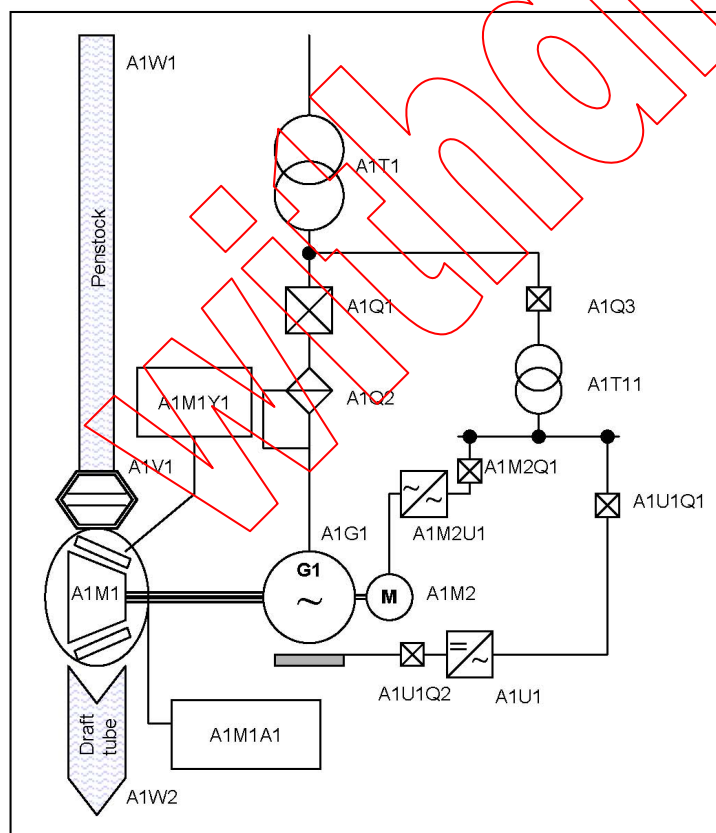
Logical Node Class name: 4 characters (e.g. as specified in IEC 61850-7-4)

Logical Node instance number: n numeric characters

m + n may be up to 7 characters

A Data Name (DataName) may consist of 10 characters (e.g. as specified in IEC 61850-7-4).

Figure 10 shows an example of possible LD name strings, using IEC 61346-1.



IEC 1349/07

Figure 10 – Example of naming structure, in a pumped storage plant, based on IEC 61346-1

A1	Generating unit 1
A1G1	Generator 1
A1M1	Turbine
A1M1Y1	Turbine governor
A1M1A1	Compressed air system for turbine chamber
A1M2	Start motor (pony motor)
A1M2U1	Motor start system
A1M2Q1	Start motor supply circuit-breaker
A1T1	Generator transformer
A1T11	Local services transformer
A1Q1	Generator circuit-breaker
A1Q2	Phase-shift switch
A1Q3	Local services switch
A1U1	Excitation system
A1U1Q1	Excitation supply switch
A1U1Q2	Field circuit-breaker
A1V1	Ball valve

6.4 Naming of logical nodes

Logical Nodes are grouped together with nodes of similar or related functions having the same first letter. The following letters are at present assigned to such groups of functions:

- A Automatic control functions
- C Control functions
- D Functions specific to distributed energy resources (DER)
- F Logical nodes representing functional blocks
- G Generic references
- H Functions specific to hydropower plants
- I Interface and archiving functions
- K Kinetic energy, mechanical devices and equipment
- L Physical devices and common logical nodes
- M Metering and measurement
- P Electrical protections
- R Protection related functions
- S Supervision and monitoring
- T Sensors and transmitters (including instrument transformers)
- W Functions specific to wind power plants
- X Switchgear
- Y Power transformers
- Z Power system equipment

6.5 Recommended naming structure for automatic control functions

In substations, the logical nodes representing functions are named after the purpose of the functions. In most cases, the algorithms used are hidden from the user and there is little point in indicating the type of algorithm of the function.

The design of control functions in power plants is, however, different. Most control structures are assembled from generic control blocks. The logical nodes for automatic control functions included in this document are named on a principle based on the algorithm used within the function, for example PID regulator, ramping control etc.

In order to indicate which logical nodes are used in the same overall control function, or what type of equipment is being controlled, prefixes can be used in a formalised manner. This is recommended for situations where one logical device might include more than one group of control functions. For example, a turbine governor control that includes both frequency and active power control functions, functions for correlating guide vane and runner blade settings as well as position control of operated devices.

As an example, a runner blade control function within the turbine governor, based on a PID regulator algorithm, may be identified as Rb_FPID. If there is more than one logical node of the same type, the instances shall be differentiated by suffix numbers.

Recommended logical node prefixes are listed in Table 2 below:

Table 2 – recommended LN prefixes

Name/description of function	Recommended LN prefix
Active power	W_
Actuator	Act_
Current	A_
Deflector	Dfl_
Droop	Drp_
Flow	Flw_
Frequency	Hz_
Guide vane	Gv_
Level	Lvl_
Limiter	Lim_
Needle	Ndl_
Position	Pos_
Power factor	Pf_
Pressure	Pa_
Reactive power	VAr_
Runner blade	Rb_
Speed	Spd_
Temperature	Tmp_
Voltage	V_

The prefixes in Table 2 are only recommendations, the user may decide on another method to identify the purpose of logical nodes for control functions. If a more specific definition is required, for example if a flow control function is intended for water flow or oil flow, this should be identified by the logical device namestring.

6.6 Summary of logical nodes to be used in hydropower plants

6.6.1 General

This part of IEC 61850 specifies the compatible Logical Node classes to be used in hydropower plants listed in Tables 3 to 16. Logical Node names shown in bold are the LN classes defined in this document. Logical Node names shown in plain text are defined in IEC 61850-7-4:2003, they are included in this list for easier reference.

6.6.2 Group C – Control functions

Table 3 – Logical nodes for control functions

LN Class	Description
CALH	Alarm handling. See IEC 61850-5 for a description of this LN.
CSWI	Switch controller. See IEC 61850-5 for a description of this LN.

6.6.3 Group F – Functional blocks

Table 4 – Logical nodes representing functional blocks

LN Class	Description
FCNT	Counter function. This LN represents a generic counter. It can be a separate physical device or be embedded in a more complex logical device. It basically counts incoming pulses that might represent anything that can be counted.
FCSD	Curve shape description. A logical node to hold a curve shape description used for correlation between measured values and metered values.
FFIL	Filter function. Basic filter function to modify a measured value.
FLIM	Limiter function. The function is used to set restrictions to output signals of other control functions.
FPID	Proportional, integral and derivative regulator function. Basic regulator function used in most controllers.
FRMP	Ramp control function. Ramp function to be used to modify e.g. a set-point value.
FSPT	Setpoint control function. Basic function used to modify inputs to regulators or other control functions.
FXOT	Action at over threshold. This logical node represents a function acting when the measured value increases above a given set value. It can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
FXUT	Action at under threshold. This logical node represents a function acting when the measured value decreases below a given set value. It can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

6.6.4 Group H – Hydropower specific logical nodes

Table 5 – Hydropower specific logical nodes

LN Class	Description
HBRG	Turbine – generator shaft bearing. This LN holds data pertaining to bearings, such as temperatures and lubrication oil flows.
HCOM	Combinator (3D-CAM or 2D-CAM). Optimises the relation between net head, guide vanes and runner blades. It is used in power plants with Kaplan turbines with moveable runner blades. The combinatory function will also use the FCSD LN to hold the relation curves for different net heads.
HDAM	Hydropower dam. A logical node that is used to represent the physical aspects of the dam.
HDLS	Dam leakage supervision. Represents a device that will supervise and give alarm in the case of dam leakage. The actual measurement can be based on water flow.
HGPI	Gate position indicator. A device that provides the position of a dam gate. The position is given either as an angular displacement in the case of sector gates or as distance from fully closed position in the case of straight gates. For aperture gates and valves where the position is given as percent of full opening, either the HVLV or the SPOS logical nodes are recommended.

Table 5 (continued)

LN Class	Description
HGTE	Dam gate. This LN is intended to hold information about the gate. It can also present a calculated water flow through the gate, in which case the FCSD LN shall be included in the same logical device, to provide the relations. Note that in this LN the position set-point is listed under <i>Controls</i> instead of <i>Settings</i> . The normal way to control a gate is to send a position set-point.
HITG	Intake gate. This LN can be used to represent intake gates. The gates will almost never be placed in any other position than fully closed or fully open. However to cater for step-wise or other controls, the gate is normally provided with a number of position switches.
HJCL	Power plant joint control function. In plants with more than one gate or several turbines, this LN will represent the joint control function that is used to supervise the total water flow or to maintain a constant water level. The LN shall be instantiated to provide one instance for each gate and each turbine to be supervised.
HLKG	Leakage supervision. This LN can be used to measure any leakage in the plant, it is more generic than HDLS.
HLVL	Dam water level indicator. The LN represents the water level sensing device. The output is a distance including an offset from a base level (commonly the distance above sea).
HMBR	Mechanical brake for the generator shaft. This is a LN for the brake control. The brake is used for stopping the unit during shut-down and to hold the shaft still, once the unit is stopped.
HNDL	Needle control. A specialised LN that represents the control of Pelton turbines.
HNHD	Net head data. A LN that can be used to present the calculated net head data (difference between upper and lower water levels) in a hydropower plant.
HOTP	Dam overtopping protection. A protection function that will act by opening one or more gates in the case of a risk for overflow. The protection will sometimes include its own water measurement device; hence an optional measured value for water level. Whether the protection shall trip a unit or not depends on the layout of the plant, if there is a risk of flooding if the dam overflows.
HRES	Water reservoir. A logical node that is used to represent the logical function of a reservoir. If the content is to be calculated, the FSCD LN shall be used to provide the relation between water level and content.
HSEQ	Start/stop sequencer. A simple LN that only presents what the sequencer is doing (inactive – starting – stopping) and in case it is active, what step it is presently working on.
HSPD	Speed monitoring. This LN is normally located in a stand-alone logical device, separated from but monitoring the turbine governor. It will also act as a placeholder for various speed limits and set-points used by the start sequencer and other control functions.
HUNT	Hydropower production unit. This LN represents the physical device of the turbine and generator combination in a hydropower plant. It is intended as an extended rating plate that allows temporary settings of data. It also acts as a placeholder for the current operating conditions of the unit.
HWCL	Water control function. This LN will represent one physical device that can modify the water flow through the plant, either a gate or a turbine. In the case of a plant with a joint control function, the HJCL LN will provide the flow set-point to be used by HWCL.

6.6.5 Group I – Interface and archiving

Table 6 – Logical nodes for interface and archiving

LN Class	Description
IARC	Generic archiving function. See IEC 61850-5 for a description of this LN.
IHMI	Generic human – machine interface. See IEC 61850-5 for a description of this LN.
ISAF	Generic safety device. This logical node represents an alarm push-button or other device that will provide an alarm in the case of danger to persons or property.

6.6.6 Group K – Mechanical and non-electrical primary equipment

Table 7 – Logical nodes for mechanical and non-electric primary equipment

LN Class	Description
KFAN	Fan. The LN represents the physical device of a fan.
KFIL	Filter. The LN represents a filter for air, liquid or other media.
KPMP	Pump. The LN represents the physical device of a pump for gaseous or liquid media.
KTNK	Tank. This LN represents tanks of various types used in the plant, e.g. for water, hydraulic oil or pressurised air. It can be used for tanks that are pressurised.
KVLV	Valve or aperture gate. A valve or gate that can be operated between two end positions that can be given as a percentage of full open position. It would normally be assumed that the measured flow can be calculated directly based on the percent of opening.

6.6.7 Group L – Physical devices and common logical nodes

Table 8 – Logical nodes for physical devices and common LN

LN Class	Description
LLN0	Logical Node zero. Shall always be present in a logical device. See IEC 61850-7-4 for a description of this LN.
LPHD	Physical device information. Shall always be present in a physical device. See IEC 61850-7-4 for a description of this LN.

6.6.8 Group M – Metering and measurement

Table 9 – Logical nodes for metering and measurement

LN Class	Description
MDIF	Differential current measurement. See IEC 61850-5 for a description of this LN.
MENV	Environmental data. This LN is used to present various measurements of environmental data, outside what is provided by MHYD and MMET.
MHAI	Harmonics measurement. See IEC 61850-5 for a description of this LN.
MHYD	Hydrological measurement. This LN is used for measurements of hydrological data that is used to supply water level and flow data to various systems such as the power plant controller or to other agencies.
MMDC	DC current and voltage measurement. This LN is used for measurements in DC systems. It provides current (I), voltage (V), active power (P) and resistance (Ω). Since most DC systems in power plants are not connected to earth, the measurements of voltage and resistance is optionally provided between poles as well between each pole and earth.
MMET	Meteorological measurement. This LN is used for measurements of meteorological data elements that contribute to predict level and flow fluctuations in the river system.
MMXN	Single-phase measurement. See IEC 61850-5 for a description of this LN.
MMXU	Three-phase measurement. See IEC 61850-5 for a description of this LN.

6.6.9 Group P – Protection functions

NOTE Most of the logical nodes that represent protective functions are defined in the substation part of the IEC 61850 series.

Table 10 – Logical nodes for protections

LN Class	Description
PDIF	Generator differential, restricted earth-fault. See IEC 61850-5 for a description of this LN.
PDOP	Reverse power. See IEC 61850-5 for a description of this LN.
PDUP	Loss of field (excitation system failure). See IEC 61850-5 for a description of this LN.
PHIZ	Residual over-voltage. See IEC 61850-5 for a description of this LN.
PIOC	Phase over-current. See IEC 61850-5 for a description of this LN.
PPAM	Phase angle, out-of-step. See IEC 61850-5 for a description of this LN.
PRTR	Rotor protection. Field short-circuit protection using the 6 th harmonic (300Hz).
PSDE	Directional earth-fault. See IEC 61850-5 for a description of this LN.
PTHF	Thyristor failure protection. Will provide alarm and tripping in the case of one or more thyristors fails.
PTOC	Time over-current, rotor earth-fault, bearing current, stator earth-fault.
PTOF	Over-frequency. See IEC 61850-5 for a description of this LN.
PTOV	Over-/under-voltage. See IEC 61850-5 for a description of this LN.
PTUF	Under-frequency. See IEC 61850-5 for a description of this LN.
PTTR	Overload. See IEC 61850-5 for a description of this LN.
PVOC	Under impedance. See IEC 61850-5 for a description of this LN.
PVPH	Over-fluxing. See IEC 61850-5 for a description of this LN.
PZSU	Energising at stand-still. See IEC 61850-5 for a description of this LN.

6.6.10 Group R – Protection related functions**Table 11 – Logical nodes for protection related functions**

LN Class	Description
RBRF	Breaker-fail protection. See IEC 61850-5 for a description of this LN.
RPSB	Power swing detection. See IEC 61850-5 for a description of this LN.
RSYN	Synchronizing. Replacement specification of the LN of IEC 61850-7-4:2003. The existing specification in IEC 61850-7-4:2003 is incorrect for use in power generation.

6.6.11 Group S – Supervision and monitoring**Table 12 – Logical nodes for supervision and monitoring**

LN Class	Description
SPDC	Partial discharge sensor. See IEC 61850-5 for a description of this LN.
STMP	Temperature supervision. This logical node represents a generic temperature supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per temperature being measured.
SVBR	Vibration supervision. This logical node represents a generic vibration supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per point being measured. The LN can be used to supervise either vibration or axial displacement or both values.

6.6.12 Group T – Transducers and instrument transformers

Table 13 – Logical nodes for sensors

LN Class	Description
TANG	Angle. This sensor LN returns the angle between two objects (° or rad).
TAXD	Axial displacement. A sensor that returns the axial displacement of a rotating shaft (mm).
TCTR	Current transformer. See IEC 61850-5 for a description of this LN.
TDIS	Distance. This sensor LN provides the distance between two objects (m).
TFLW	Liquid flow. A sensor LN that provides a flow rate value (m ³ /s).
TFRQ	Frequency. This sensor LN provides a frequency value, measuring a non-electric quantity (Hz).
THUM	Humidity. A sensor LN that measures the water content in a media (%).
TLEV	Media level. A sensor LN that provides a level value, given as percentage of maximum content of the device being measured.
TMGF	Magnetic field. A sensor LN that provides a magnetic field value (T) measured at the place where the sensor is located.
TPOS	Position indicator. A sensor LN that provides the position of a mechanical device. The position is given as a percentage of full movement.
TPRS	Pressure. A sensor LN that provides a media pressure value (Pa).
TRTN	Rotation. A sensor LN that provides a value for rotational speed (r/s).
TSND	Sound pressure. This sensor LN returns a sound pressure value (dB).
TTMP	Temperature. A sensor LN that provides a temperature value (K).
TTNS	Mechanical tension/stress. A sensor LN that provides a value for mechanical tension (Pa).
TVBR	Vibration sensor. A sensor LN that provides a vibration value (mm/s).
TVTR	Voltage transformer. See IEC 61850-5 for a description of this LN.
TWPH	Water acidity. A sensor LN that returns the water pH level.

6.6.13 Group X – Switchgear

Table 14 – Logical nodes for switchgear

LN Class	Description
XCBR	Circuit breaker. See IEC 61850-5 for a description of this LN.
XSWI	Switch, disconnect, earth-switch. See IEC 61850-5 for a description of this LN.

6.6.14 Group Y – Power transformers

Table 15 – Logical nodes for power transformers

LN Class	Description
YPSH	Power shunt. See IEC 61850-5 for a description of this LN.
YPTR	Power transformer. See IEC 61850-5 for a description of this LN.

6.6.15 Group Z – Power system equipment

Table 16 – Logical nodes for power system equipment

LN Class	Description
ZAXN	Auxiliary network (power plant supply). See IEC 61850-5 for a description of this LN.
ZBAT	DC battery. See IEC 61850-5 for a description of this LN.
ZMOT	Motor. See IEC 61850-5 for a description of this LN.
ZREA	Reactor. See IEC 61850-5 for a description of this LN.
ZRES	Neutral resistor. This LN is basically a repository for the name-plate data of the neutral resistor; the resistor will normally not have any controllable functionality. A built-in switch shall be referenced by its own XSWI logical node.
ZSCR	Semi-conductor controlled rectifier. In this part of IEC 61850 used for example, to represent the rectifier within an excitation system.
ZSMC	Synchronous machine. LN to represent additional rating data of a synchronous machine.

7 Logical Node Classes

7.1 Abbreviations and definitions used in Logical Node tables

7.1.1 Interpretation of Logical Node tables

NOTE The following text is an extract from IEC 61850-7-4, repeated here for quick reference. See also IEC 61850-7-4:2003, subclause 5.2.

The interpretation of the headings for the logical node tables is presented in Table 17.

Table 17 – Interpretation of Logical Node tables

Column heading	Description
Attribute Name	Name of the Data
Attr. Type	Common Data Class that defines the structure of the data. See IEC 61850-7-3.
Explanation	Short explanation of the data and how it is used.
T	Transient Data – the status of data with this designation is momentary and shall be logged or reported to provide evidence of their momentary state. Some T may be only valid on a modelling level. The TRANSIENT property of DATA only applies to BOOLEAN process data attributes (FC=ST) of that DATA. Transient DATA is identical to normal DATA, except that for the process state change from TRUE to FALSE no event may be generated for reporting and for logging.
M/O	This column defines whether data, data sets, control blocks or services are mandatory (M) or optional (O) for the instantiation of a specific Logical Node. NOTE The attributes for data that are instantiated may also be mandatory or optional based on the CDC (Attribute Type) definition in IEC 61850-7-3. Where the letter C is used for “conditional”, at least one of the items of data labelled with C shall be used from each category where C occurs.

All Attribute Names (Data Names) are listed alphabetically in Clause 8. Despite some overlapping, the data in the Logical Nodes Classes are grouped for the convenience of the reader into some of the following categories.

a) Common Logical Node Information

is information independent of the dedicated function represented by the LN class. Mandatory data (M) are common to all LN classes; optional data (O) are valid for a reasonable subset of LN classes.

b) Status Information

is data which shows either the status of the process or of the function allocated to the LN class. This information is produced locally and cannot be changed remotely unless substitution is applicable. Data such as “start” or “trip” are listed in this category. Most of these data are mandatory.

c) Settings

are data which are needed for the function to operate. Since many settings are dependent on the implementation of the function, only a commonly agreed minimum is standardised. They may be changed remotely, but normally not very often.

d) Measured values

are analogue data measured from the process or calculated in the functions such as currents, voltages, power, etc. This information is produced locally and cannot be changed remotely unless substitution is applicable.

e) Controls

are data which are changed by commands such as switchgear state (ON/OFF), tap changer position or reset-able counters. They are typically changed remotely, and are changed during operation much more often than Settings.

f) Metered values

are analogue data representing quantities measured over time, for example energy. This information is produced locally and cannot be changed remotely unless substitution is applicable.

7.1.2 Abbreviated terms used in Attribute Names

The following terms are used to build concatenated Attribute Names. The list below only includes abbreviations for terms that are defined in this part of IEC 61850. For further abbreviations, see also IEC 61850-7-4 for terms that are reused in this part of IEC 61850.

Term	Description	Term	Description
Act	Action, active	Insol	Insulation
Adj	Adjustment	K	Proportional gain constant
Alg	Algorithm	Lft	Left
Amb	Ambient	Lkg	Leakage
Ax	Axial	Lub	Lubrication
Brg	Bearing	Mag	Magnetic, magnetism
Brk	Brake	Msg	Message
C	Carbon	Mvm	Moving, movement
Cam	Cam	Ndl	Needle (used in Pelton turbines)
Cff	Coefficient	NOX	Nitrogen oxides
Cm	Centimeters	O2	Oxygen
Cmpl	Completed, completion, complete	O3	Ozone
Cndct	Conductivity	Operate	Operate order to a device
CO	Carbon monoxide	P	Proportional
CO2	Carbon dioxide	Pc	Percent
Credit	Credit	PH	Acidity
Crl	Correlation	Pt	Point
Crp	Creeping, creepage	Rad	Radiation, radiants
Cst	Constant	Rb	Runner blade
Cvr	Cover	Rect	Rectifier
D	Derivative	Res	Reservoir
Dam	Dam	Rmp	Ramp
Defl	Deflector (used in Pelton turbines)	Rn	Rain
Dew	Dew, condensation	Rst	Restraint
Dgr	Degrees	Sat	Saturation
DI	Delay, daylight	SInt	Salinity, saline content
Dn	Down, below, downstream, downside	Snd	Sound, audible noise

Term	Description	Term	Description
Dsp	Displacement	Snw	Snow
Dust	Dust, particles suspended in air	SOX	Sulphur oxides
Dvc	Device	Spt	Process set-point
Err	Error	Srfc	Surface
Fil	Filter	Stat	Stator (also statistics)
Fld	Field (e.g. magnetic field)	Stl	Still, not moving
Fll	Fall	Stnd	Stand, standing
Flush	Flush, flushing	Stuck	Cannot move
Green	Green (e.g. green tag)	Tnk	Tank
Gte	Gate, dam gate	Tns	Tension, mechanical stress
Gust	Gust, (e.g. wind gust)	Trade	Trade
Hd	Head	Up	Up, above, upstream, upside
Hmdt	Humidity	Vbr	Vibration
Hor	Horizontal	Ver	Vertical
Hyd	Hydrological, hydro, water	Vlm	Volume
I	Integral	Wd	Wind
Inert	Inertia	Wet	Wet

7.2 Logical Nodes representing functional blocks

LN group F

7.2.1 Modelling remarks

This group of logical nodes represents various types of control function blocks. Logical Node classes of this type do include some form of control algorithm. The LN's will normally be part of a logical device providing overall functionality within the system.

NOTE Logical Nodes specified in 7.2 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.2.

7.2.2 LN: Counter

Name: FCNT

Logical Node FCNT shall be used to count incoming pulses.

FCNT class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		M
Status information				
Up	STS	Last count direction upward		O
Dn	STS	Last count direction downward		O
Measured values				
Out	BCR	Output value		M
Controls				
Blk	SPC	Block operation		O
CntRs	SPC	The counter is reset to 0		O

7.2.3 LN: Curve shape description

Name: FCSD

Logical Node FCSD shall comprise the data classes that represent the curve shaping output positions. The values can be dynamically modified online. The values entered in the table are based on statistical data obtained following a series of index tests.

The Logical Node is used to adapt an incoming value to a specified curve function. For example, it can be used 2-dimensionally to adjust nonlinear transmitters to the correct physical values or, by instantiation, used for 3-dimensional surface mapping.

FCSD class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Measured Values				
Out	MV	Output		M
Settings				
Crv	CSD	Curve shape		M
Controls				
Blk	SPC	Block operation		O

7.2.4 LN: Generic Filter

Name: FFIL

Logical Node FFIL shall be used to filter an incoming value. For a more detailed description of the functionality behind FFIL, see Annex A.

FFIL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Settings				
FiType	ING	Filter type: Low pass High pass Bandpass Bandstop (notch)		
Kp	ASG	Proportional Gain		M
Kld	ASG	K lead		O
Klg	ASG	K lag		O
T1	INT	Time 1 [ms]		O
T1ld	INT	Time 1 (lead) [ms]		O
T2	INT	Time 2 [ms]		O
T2ld	INT	Time 2 (lead) [ms]		O
T3	INT	Time 3 [ms]		O
Measured values				
Out	MV	Output		M
ErrTerm	MV	Error term		O
Control				
Blk	SPC	Block operation		O

7.2.5 LN: Control function output limitation

Name: FLIM

This logical node is used to set temporary or permanent operational limits to an output signal (MV) from a control function. The FLIM Logical Node should not be used to replace FXOT or FXUT.

FLIM class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
HiLim	SPS	High limit reached (input signal equal to or above limit)		O
LoLim	SPS	Low limit reached (input signal equal to or below limit)		O
Measured values				
Out	MV	Output signal		M
Settings				
HiLimSpt	ASG	High limit setpoint		M
LoLimSpt	ASG	Minimum limit setpoint		O
Controls				
Blk	SPC	Block operation		O

7.2.6 LN: PID regulator

Name: FPID

Logical Node FPID shall comprise the data classes that represent proportional, integral and derivative information for a PID controller. For a more detailed description of the functionality behind FPID, see Annex A.

FPID class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
<i>Measured Values</i>				
Out	MV	PID output		M
PAct	MV	Proportional action		C
IAct	MV	Integral action		C
DAct	MV	Derivative action		C
P	MV	P output		O
I	MV	I output		O
D	MV	D output		O
ErrTerm	MV	Error term		O
<i>Settings</i>				
PidAlg	ING	P I D PI PD ID PID		M
Kp	ASG	Proportional gain		C
Ki	ASG	Integral Gain		C
Ti	ING	Integral time (ms)		C
Kd	ASG	Derivative gain		C
Td	ING	Derivative time (ms)		C
Tf	ING	Derivative time filter (ms)		C
Bias	ASG	Bias added to Process variable		O
<i>Controls</i>				
Blk	SPC	Block operation		O

The conditional attributes shown in the first column of Table 18 shall be linked with the corresponding PID algorithm selected.

Table 18 – Conditional attributes in FPID

Attribute Name	PidAlg						
	(M-Mandatory, Blank-Not Used)						
	P	I	D	PI	PD	ID	PID
PAct	M			M	M		M
IAct		M		M		M	M
DAct			M		M	M	M
Kp	M			M	M		M
Ki		M		M		M	M
Ti		M		M		M	M
Kd			M		M	M	M
Td			M		M	M	M
Tf			M		M	M	M

7.2.7 LN: Ramp function**Name: FRMP**

Logical Node FRMP shall be used as a generic ramp. The LN is required due to the fact the data attributes of the ASG common data class does not contain all of the information required to achieved a full ramping function with divergent up and down trends.

FRMP class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Measured Values				
Out	MV	Ramp Output		M
ErrTerm	MV	Error term		O
Status information				
AdjMsg	INS	Adjustment Message		O
		0 Completed		
		1 Cancelled		
		2 New adjustments		
		3 Under way		
Settings				
RmpUp	ASG	Ramping rate on a upward trend		M
RmpDn	ASG	Ramping rate on a downward trend		M
StepPs	ASG	Step size when turning from negative to positive direction		O
StepNg	ASG	Step size when turning from positive to negative direction		O
Controls				
Blk	SPC	Block operation		O

Withhold

7.2.8 LN: Set-point control function**Name: FSPT**

Logical Node FSPT shall be used to provide the common characteristics found in all controller or regulator type Logical Nodes. The LN can be standalone or cascaded with other logical nodes to form a complete controller.

FSPT class																																				
Attribute Name	Attr. Type	Explanation	T	M/O																																
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)																																		
Data																																				
Common Logical Node Information																																				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M																																
Controls																																				
SptR	SPC	Setpoint raise		O																																
SptL	SPC	Setpoint lower		O																																
Measured Values																																				
SptMem	MV	Setpoint in memory		M																																
ErrTerm	MV	Error term		O																																
Output	MV	Output		O																																
Status Information																																				
Auto	SPS	Automatic operation		O																																
SptDvAlm	SPS	Deviation alarm		O																																
SptUp	SPS	Setpoint going up (raising)		O																																
SptDn	SPS	Setpoint going up (Lowering)		O																																
SptDir	SPS	Setpoint direction		O																																
SptMsg	INS	End Message: <table><tr><td>0</td><td>Ended normally</td></tr><tr><td>1</td><td>Ended with overshoot</td></tr><tr><td>2</td><td>Cancelled: measurement was deviating</td></tr><tr><td>3</td><td>Cancelled: loss of communication with dispatch centre</td></tr><tr><td>4</td><td>Cancelled: loss of communication with local area network</td></tr><tr><td>5</td><td>Cancelled: loss of communication with the local interface</td></tr><tr><td>6</td><td>Cancelled: timeout</td></tr><tr><td>7</td><td>Cancelled: voluntarily</td></tr><tr><td>8</td><td>Cancelled: noisy environments</td></tr><tr><td>9</td><td>Cancelled: material failure</td></tr><tr><td>A</td><td>Cancelled: new set-point request</td></tr><tr><td>B</td><td>Cancelled: improper environment (blockage)</td></tr><tr><td>C</td><td>Cancelled: stability time was reached</td></tr><tr><td>D</td><td>Cancelled: immobilisation time was reached</td></tr><tr><td>E</td><td>Cancelled: equipment was in the wrong mode</td></tr><tr><td>F</td><td>Unknown causes</td></tr></table>	0	Ended normally	1	Ended with overshoot	2	Cancelled: measurement was deviating	3	Cancelled: loss of communication with dispatch centre	4	Cancelled: loss of communication with local area network	5	Cancelled: loss of communication with the local interface	6	Cancelled: timeout	7	Cancelled: voluntarily	8	Cancelled: noisy environments	9	Cancelled: material failure	A	Cancelled: new set-point request	B	Cancelled: improper environment (blockage)	C	Cancelled: stability time was reached	D	Cancelled: immobilisation time was reached	E	Cancelled: equipment was in the wrong mode	F	Unknown causes		O
0	Ended normally																																			
1	Ended with overshoot																																			
2	Cancelled: measurement was deviating																																			
3	Cancelled: loss of communication with dispatch centre																																			
4	Cancelled: loss of communication with local area network																																			
5	Cancelled: loss of communication with the local interface																																			
6	Cancelled: timeout																																			
7	Cancelled: voluntarily																																			
8	Cancelled: noisy environments																																			
9	Cancelled: material failure																																			
A	Cancelled: new set-point request																																			
B	Cancelled: improper environment (blockage)																																			
C	Cancelled: stability time was reached																																			
D	Cancelled: immobilisation time was reached																																			
E	Cancelled: equipment was in the wrong mode																																			
F	Unknown causes																																			
AdjMsg	INS	Adjustment Message <table><tr><td>0</td><td>Completed</td></tr><tr><td>1</td><td>Cancelled</td></tr><tr><td>2</td><td>New adjustments</td></tr><tr><td>3</td><td>Under way</td></tr></table>	0	Completed	1	Cancelled	2	New adjustments	3	Under way		O																								
0	Completed																																			
1	Cancelled																																			
2	New adjustments																																			
3	Under way																																			
Settings																																				
MaxRst	RST	Maximum restriction		O																																
MinRst	RST	Minimum restriction		O																																
DvAlm	ASG	Deviation Alarm		O																																
SptVal	APC	Setpoint		O																																
DeadB	ASG	Deadband		O																																
Controls																																				
Blk	SPC	Block operation		O																																

7.2.9 LN: Action at over threshold**Name: FXOT**

Logical Node FXOT shall be used to set a high-level threshold value to be used in control sequences. It optionally provides a second level signal that can be used provide a two-step action.

FXOT class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
Status information				
Op	SPS	Level of action reached	T	M
OpB	SPS	Second level of action reached	T	O
Settings				
StrVal	ASG	Start level set-point		C
StrValB	ASG	Second level of action setpoint		C
OpDITmms	ING	Operate delay time [ms]		O
StrCrv	CSD	Start level curve		C
RsDITmms	ING	Reset operate delay time [ms]		O
Controls				
Blk	SPC	Block operation		O

Condition: Start level shall be given as a singular point or as a curve.

7.2.10 LN: Action at under threshold**Name: FXUT**

Logical Node FXUT shall be used to set a low-level threshold value to be used in control sequences. It optionally provides a second level signal that can be used provide a two step action.

FXUT class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
Status information				
Op	SPS	Level of action reached	T	M
OpB	SPS	Second level of action reached	T	O
Settings				
StrVal	ASG	Start level set-point		C
StrValB	ASG	Second level of action setpoint		O
OpDITmms	ING	Operate delay time [ms]		O
StrCrv	CRV	Start level curve		C
RsDITmms	ING	Reset operate delay time [ms]		O
Controls				
Blk	SPC	Block operation		O

Condition: Start level shall be given as a singular point or as a curve.

7.3 Hydropower specific Logical Nodes

LN group H

7.3.1 Modelling remarks

This group of Logical Nodes covers functions that are specific to hydropower plants. Some may also be used for utility water supply systems or other types of larger reservoirs.

7.3.2 LN: Turbine – generator shaft bearing

Name: HBRG

Logical Node HBRG shall be used to represent the physical device bearing. It can be used to represent both thrust and guide bearings. One instance shall be used per bearing.

HBRG class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
<i>Status information</i>				
BrgTyp	INS	Type of bearing (enumerated list)		M
TmpAlm	SPS	Bearing temperature alarm		M
OilTmpHi	SPS	Lubrication oil temperature alarm		M

7.3.3 LN: Combinator

Name: HCOM

Logical Node HCOM shall be used to represent the function that optimises the relation between net head, guide vane and runner blade positions in order to achieve best possible efficiency. It is normally a part of the governor logical device and the functionality is based on one or more 2-D curves. If more than one curve is defined, one instance shall be used per curve.

HCOM class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
<i>Status information</i>				
CrIAIm	SPS	Correlation deviation alarm		O
RbPos	APC	Runner blade position setting		M
<i>Settings</i>				
CrvNum	ING	Number of setting curves		O
CrvSize	ING	Number of X/Y pairs in each curve		O
<i>Controls</i>				
Auto	SPC	Automatic or manual control		M
Blk	SPC	Block the function from operation		M

7.3.4 LN: Hydropower dam**Name: HDAM**

Logical Node HDAM shall be used to represent the dam of a hydropower plant. It is basically used to provide a reference tag for the dam holding basic design information. In case the functional aspect of the dam shall be represented, the Logical Node HRES shall be used, see 7.3.16.

HDAM class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
DamTyp	INS	Type of dam (construction), enumerated list		O

7.3.5 LN: Dam leakage supervision**Name: HDLS**

Logical Node HDLS shall be used to represent a leakage supervision system for a dam.

HDLS class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
OpCnt	INS	Operation counter		O
Status information				
LkgAlm	SPS	Leakage alarm level reached		M
Settings				
LkgAlmVal	ASG	Alarm level setpoint for leakage		M
Measured values				
Flw	MV	Water flow at point of measurement [m ³ /s]		O
Controls				
Blk	SPC	Block the function from operation		O

7.3.6 LN: Gate position indicator**Name: HGPI**

Logical Node HGPI shall be used to represent a physical device that provides the position of a gate. It shall be used for gates where the full open position (or fully closed position) is dependent on the actual upper water level of the dam. The position is given either as a distance for straight gates or as an angular displacement for sector gates.

HGPI class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status information				
PosUp	SPS	Upper end position reached		M
PosDn	SPS	Lower end position reached		M
Measured values				
GtePos	MV	Gate position given as angular displacement (1/20° or rad)		C
GtePosCm	MV	Gate position given as distance from full closed (cm)		C

7.3.7 LN: Dam gate

Name: HGTE

Logical Node HGTE shall be used to represent a dam gate. It is intended for gates where the full open or full closed position is dependent on the water level of the dam. For gates inserted in a dam in such a way that the upper water level is always above the upper part of the gate, the valve logical node (KVLV) is recommended. For calculation of water flow, a FCSD logical node that holds the relation between water level, opening and flow, should be included in the same logical device.

HGTE class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
PosUp	SPS	Upper end position reached (gate cannot move further)		M
PosDn	SPS	Lower end position reached (gate cannot move further)		M
Mvm	SPS	Gate is moving		O
GteBlk	SPS	Gate is blocked (cannot move from present position)		O
Settings				
GteUpLim	ASG	Upper limit of gate position (temporary restriction)		O
GteLoLim	ASG	Lower limit of gate position (temporary restriction)		O
Incr	ASG	Increment of position change for raise/lower commands		O
Measured values				
Flw	MV	Calculated water flow through the gate [m ³ /s]		O
Controls				
Opn	SPC	Gate to full open position		O
Cls	SPC	Gate to full closed position		O
PosChg	INC	Change gate position (stop, raise, lower)		C
PosChgIncr	INC	Change gate position incrementally (stop, raise, lower)		C
BlkOpn	SPC	Block opening of the gate		O
BlkCls	SPC	Block closing of the gate		O

7.3.8 LN: Intake gate

Name: HITG

Logical Node HITG shall be used to model the intake gates. If operated they will be either raised fully or lowered fully, mid positions are not used during continuous operation. However start sequencers might need to operate the gate at different speeds during different parts of the movement or keep the gate at a certain position for some time, before continuing movement. To cater for this, intake gates are often provided with position switches. In order to not limit the number of switches, the position switches are represented by an integer value (0 representing fully closed, 1 – n indicating steps passed, counting from the closed position).

HITG class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
PosStep	INS	Integer representing the position, counting from lowest position		O
PosUp	SPS	Upper end position reached (gate cannot move further)		M
PosDn	SPS	Lower end position reached (gate cannot move further)		M
Mvm	SPS	Gate is moving		O
GteBlk	SPS	Gate is blocked (cannot move from present position)		O
Controls				
Opn	SPC	Gate to full open position		O
Cls	SPC	Gate to full closed position		O
BlkOpn	SPC	Block opening of the gate		O
BlkCls	SPC	Block closing of the gate		O

7.3.9 LN: Joint control

Name: HJCL

Logical Node HJCL shall be used when a hydropower plant is operated in a constant water flow or a constant upper water level mode. That is, the power production level is subordinated the water control. The joint control logical node is used to co-ordinate the water flow through the plant, through turbines as well as gates. The joint control function will normally try to optimise the power output for a given flow. It can open or close gates that are not blocked from operation, it can increase or decrease the active power from turbines but it cannot start or stop a unit. The LN shall be instantiated to provide one instance per turbine and gate to be included in the joint control. Compare also with the HWCL logical node, which can be used to control a single object.

HJCL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
TotFlwMax	SPS	Total maximum flow reached		O
TotFlwMin	SPS	Total minimum flow reached		O
FlwMax	SPS	Maximum flow through the controlled object (gate or turbine)		O
FlwMin	SPS	Minimum flow through the controlled object		O
FlwLevAlm	SPS	Flow and level control settings in conflict		O
PosChg	BSC	Change position of gate (stop – raise – lower)	T	O
ActPwrR	SPC	Increase active power (open guide vanes)	T	O
ActPwrL	SPC	Decrease active power (close guide vanes)	T	O
Settings				
TotFlwMxLm	ASG	Maximum flow limit (Maximum allowed flow)		O
TotFlwMnLm	ASG	Minimum flow limit (Minimum allowed flow) – can be 0.		O
FlwMaxLim	ASG	Maximum allowed flow through the controlled object		O
FlwMinLim	ASG	Minimum allowed flow through the controlled object		O
Measured values				
Flw	MV	Water flow through the controlled object (gate or turbine)		M
NetHd	MV	Net head (distance between upper and lower water levels)		O
TotFlw	MV	Total water flow through the plant		O
Controls				
HydrCtlMod	INC	The LN to operate in flow control or level control mode		O
FlwSpt	ASG	Total water flow set-point [m ³ /s]		O
LevSpt	ASG	Upper water level set-point [m]		O
Blk	SPC	Block operation		O

7.3.10 LN: Leakage supervision

Name: HLKG

Logical Node HLKG shall be used to represent a leakage supervision system for any purpose.

HLKG class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
<i>Status information</i>				
LkgAlm	SPS	Leakage alarm		M
<i>Settings</i>				
LkgAlmVal	ASG	Alarm level for leakage		M
<i>Measured values</i>				
Flw	MV	Measured water (liquid) flow		O

7.3.11 LN: Water level indicator

Name: HLVL

Logical Node HLVL shall be used to represent a water level indicator. The principles of measurement might vary, but the level will normally be given with an accuracy of 0,01 m. In order to compare different level measurements above and below the plant, an offset from a base level is added to the local measurement. The water level measurement is a typical example of situation where substitution of the measured value is commonly used, the measurement device is often blocked from operation for example by ice.

For a simple level measurement of for example a tank, where the level can be expressed as a percentage of full tank, the TLVL logical node should be used instead of HLVL.

HLVL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
<i>Status information</i>				
Stuck	SPS	Alarm of measurement device not moving (stuck, frozen)		O
<i>Settings</i>				
LevOfs	ASG	Offset from power plant base level		O
<i>Measured values</i>				
LevM	MV	Water level at the point of measuring (including offset if given)		M

7.3.12 LN: Mechanical brake**Name: HMBR**

Logical Node HMBR shall be used to represent the physical device brake. The brake is used to stop the rotation of the shaft during power down of the unit.

HMBR class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
OpCntRs	INS	Reset-able operation counter		O
<i>Status information</i>				
BrkOn	SPS	Brakes are applied (on)		M
BrkOff	SPS	Brakes are disengaged (off)		M
<i>Controls</i>				
Pos	DPC	Change brake position (on/off)		M

7.3.13 LN: Needle control**Name: HNDL**

Logical Node HNDL shall be used to represent the control of turbine needles for Pelton type of turbines.

HNDL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
OpCntRs	INS	Operation counter		O
<i>Status information</i>				
AOfsCam	SPS	A-servo Off CAM function is activated		O
Auto	SPS	Regulator in mode. TRUE = auto		O
DeflOpn	SPS	Pelton using ON /OFF deflector control. TRUE = open command active		O
NdlMan	SPS	Manual selection of number of needles is active		O
NdlErr	INS	Servo loop fault, Pelton turbine needle (needle number returned)		O
<i>Settings</i>				
NdlManNum	ING	Manual number of needles, when in manual needle control		O
<i>Controls</i>				
NdlAutSI	SPC	Auto selection of number of active needles, select		O
NdlManSI	SPC	Manual selection of number of active needles, select		O
OfsCamEna	SPC	Enable runner offset using Asp		O
Operate	SPC	Start command.		O
Stop	SPC	Stop command.		O

7.3.14 LN: Water net head data**Name: HNHD**

Logical Node HNHD shall be used to represent a function that calculates and presents net head data and some related information. The input measured values will, in most cases, be derived from logical nodes of class HLEV.

Separate logical nodes of HNHD class shall be used depending on the purpose of the net head value. The value used for control of a turbine will normally be based on measurements taken inside the intake gate and at the tail-race outlet. If a net head value is to be used for general water control, the measurements are taken at some distance from the power plant, both upstream and downstream.

HNHD class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
Stuck	SPS	Alarm of measurement device not moving (stuck, frozen)		O
Settings				
LevOfs	ASG	Offset from power plant base level		O
Metered values				
NetHd	MV	Calculated Net head		M
DifPres	MV	Calculated Differential water pressure across trashrack		O

7.3.15 LN: Dam over-topping protection

Name: HOTP

Logical Node HOTP shall be used to represent an over-topping protection for the dam. The normal action of the protection, when engaged, is to open one or more gates to full open position. One instance shall be provided for each gate that is to be controlled.

HOTP class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Reset-able operation counter		O
Status information				
OpLev	SPS	Operation level reached	T	M
Settings				
OpSpt	ASG	Operation level set-point		M
RsDITmm	MG	Reset Operate delay time in minutes		O
Controls				
Blk	SPC	Block the function from operation		O

7.3.16 LN: Hydropower/water reservoir

Name: HRES

Logical Node HRSV shall be used to represent the functional aspect of the reservoir in a hydropower plant. Note that the HRES Logical Node does not represent the physical aspect of the dam.

HRES class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Settings				
Area	CSD	Area with respect to elevation		O
VlmCap	CSD	Volume with respect to elevation		O
Measured values				
Vlm	MV	Calculated volumetric content of the dam [m ³]		O

7.3.17 LN: Hydropower unit sequencer**Name: HSEQ**

Logical Node HSEQ shall be used to represent the unit sequencer. It will be part of the unit controller logical device. The LN will keep track of the unit operating status, i.e. what the generator and turbine is doing at the moment. This LN only represents a minimum of information required; in any actual implementation, the sequencer will have to address a large number of devices.

HSEQ class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCntRs	INS	Reset-able operation counter		O
Loc	SPS	Local operation		O
Status information				
SeqStat	INS	Status of the sequencer		M
StepPos	INS	Active step	T	M
StrCmpl	SPS	Start sequence completed (unit synchronised at minimum load)	T	M
StopCmpl	SPS	Stop sequence completed (brakes released, no creeping)	T	M
Controls				
Auto	SPC	Automatic or manual		M
Operate	SPC	Start order to the sequencer		M
Stop	SPC	Stop order to the sequencer		M

7.3.18 LN: Speed monitoring**Name: HSPD**

Logical Node HSPD shall normally be part of a stand-alone logical device. It acts as a protective backup of the governor frequency control and also as a placeholder for various speed limits and set-points used by the start sequencer and other functions.

HSPD class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
StndStl	SPS	Stand still detection		O
SpdCrp	SPS	Creep detection		O
SpdBrk	SPS	Brake operation allowed		O
SpdLub	SPS	Set-point for operation of lubrication system		O
SpdLft	SPS	Set-point for operation of lift pump (high pressure oil system)		O
SpdRB	SPS	Set-point for setting of start angle for rotor blades		O
SpdExt	SPS	Set-point for operation of excitation system breaker		O
SpdSyn	SPS	Set-point for synchronising		O
SpdOvr	SPS	Over-speed detection and alarm		O
DirRot	SPS	Direction of rotation		O
Settings				
SetSpdCrp	ASG	Creep detection setting		O
SetSpdBrk	ASG	Braking allowed setting		O
SetSpdLub	ASG	Lubrication system operation setting		O
SetSpdLft	ASG	Lift pump operation setting		O
SetSpdRb	ASG	Start angle setting setting		O
SetSpdExt	ASG	Excitation breaker operation setting		O
SetSpdSyn	ASG	Synchronisation setting		O
SetSpdOv	ASG	Over-speed detection setting		O
Measured values				
Spd	MV	Rotational speed of the shaft [r/s]		M
Controls				
Blk	SPC	Block the function from operation		O

7.3.19 LN: Hydropower unit

Name: HUNT

Logical Node HUNT shall be used to represent the physical device of a hydropower production unit, that is, a generator and turbine combination. It can be seen as an extended name-plate, which allows temporary settings of data. The logical node holds information about the present operational status of the unit.

HUNT class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
<i>Common Logical Node Information</i>				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
Inert	INS	Inertia of the unit [kgm ²]		O
OpTmh	INS	Operation time		O
<i>Status information</i>				
UntOpSt	INS	Status of the unit 1 = Blocked from operation (disabled) 2 = Stopped (needs control sequence to start) 3 = Starting (start-up in progress) 4 = Generator energised 5 = Synchronised, normal operation 6 = Stopping (shut-down in progress) 7 = Creeping (slow movement) 8 = Standby (stopped but ready for start)		M
UntOpMod	INS	Operating mode of the unit 1 = Generating mode 2 = Synchronous condenser mode 3 = Pumping mode (for pumped storage)		M
GridMod	INS	Grid mode e.g. the actual grid the unit meets when CB synchronises to the grid. 1 = Normal condition (normal frequency and voltage level) 2 = Island (varying frequency and/or voltage level) 3 = Local supply		O
GridOpSt	INS	Grid operational status, i.e. if there is a disturbance or not 1 = Normal conditions (no disturbance) 2 = Disturbed (abnormal frequency and/or voltage level) 3 = PSS control		O
StopVlv	SPS	Stop valve position		M
<i>Settings</i>				
PwrRtgLim	ASG	Temporary limitation of power output		O
VRtgLim	ASG	Temporary limitation of operating voltage		O
FlwRtg	ASG	Rated maximum water flow		O
SpdLim	ASG	Maximum allowed rotational speed		O
<i>Controls</i>				
Blk	SPC	Block the unit from operation		O

7.3.20 LN: Water control**Name: HWCL**

Logical Node HWCL shall be used to represent the control of one physical device, dam gate or turbine, which can modify the water flow through the plant. Compare also with the LN for joint control (HJCL) that can be used for combined control.

HWCL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		M
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
Auto	SPS	Automatic control selected		M
FlwMax	SPS	Maximum flow reached		O
FlwMin	SPS	Minimum flow reached		O
HiLev	SPS	Upper water (dam) high level alarm		O
LoLev	SPS	Upper water (dam) low level alarm		O
HiLevDn	SPS	Lower water (tailrace) high level alarm		O
LoLevDn	SPS	Lower water (tailrace) low level alarm		O
FlwLevAlm	SPS	Flow and level control settings in conflict		O
PosChg	BSC	Change position of gate (stop – raise – lower)	T	C
ActPwrR	SPC	Increase active power (open guide vanes)	T	C
ActPwrL	SPC	Decrease active power (close guide vanes)	T	C
Settings				
FlwMaxLim	ASG	Maximum flow set-point		O
FlwMinLim	ASG	Minimum flow set-point		O
LevHiSet	ASG	Upper water (dam) high level alarm set-point		O
LevLoSet	ASG	Upper water (dam) low level alarm set-point		O
LevDnHiSt	ASG	Lower water (tailrace) high level alarm set-point		O
LevDnLoSt	ASG	Lower water (tailrace) low level alarm set-point		O
Measured values				
Flw	MV	Calculated water flow through the controlled object (m ³ /s)		M
Controls				
HydCtlMod	DPC	The LN to operate in flow control or level control mode		M
FlwSet	APC	Water flow set-point (m ³ /s)		C
LevSet	APC	Upper water level set-point (m)		C

NOTE The Logical Node will control either a gate (gate position) or a turbine (guide vane position).

7.4 Logical Nodes for interface and archiving**LN group I****7.4.1 Modelling remarks**

This group of Logical Nodes represents human interfaces and other generic interfaces towards external entities. IEC 61850-7-4 defines some LN for this purpose (IARC, IHMI, ITCI and ITMI). This document defines one LN for general safety alarm interfaces.

NOTE Logical Nodes specified in 7.4 will be included in Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (Edition 2) shall take precedence over Logical Nodes in 7.4.

7.4.2 LN: Safety alarm function

Name: ISAF

Logical Node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in the case of danger to persons or property

ISAF class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
Alm	SPS	Safety alarm (1=On, 0=Off)	T	M
Controls				
AlmRs	SPC	Alarm signal reset		O

7.5 Logical Nodes for mechanical and non-electric primary equipment LN group K

7.5.1 Modelling remarks

This group of logical nodes represents various devices that can be supervised, controlled or operated but that are not primarily of electrical nature. This group includes devices like tanks, valves, fans etc.

NOTE Logical Nodes specified in 7.5 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.5.

7.5.2 LN: Fan

Name: KFAN

Logical Node KFAN shall be used to represent a fan. It can be seen as an extended nameplate that allows the temporary setting of data.

KFAN class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DRL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAlm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
Blocked	SPS	The fan is blocked from operation		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
Measured values				
Spd	MV	Rotational speed of the fan		O
Controls				
Operate	DPC	Operate fan		M
SpdSpt	APC	Speed set-point (in the case of speed regulated motor)		O

7.5.3 LN: Filter**Name: KFIL**

Logical Node KFIL shall be used to represent a (mechanical) filter. It can be seen as an extended nameplate that allows the temporary setting of data.

KFIL class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAIm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
Flush	SPS	Filter flushing		O
FlushCnt	INC	Filter flushing counter (reset-able)		O
FilAlm	SPS	Filter alarm		O
Settings				
DifPresHi	ASG	Alarm level set-point		O
Measured values				
DifPresHi	MV	Differential pressure over the filter		O
Controls				
Operate	DPC	Operate filter		O

7.5.4 LN: Pump**Name: KPMP**

Logical Node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data.

KPMP class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAIm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
BlkSt	SPS	The pump is blocked from operation		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
Measured values				
Spd	MV	Rotational speed of the pump		O
Controls				
Operate	DPC	Operate pump		M
SpdSpt	APC	Speed set-point (in the case of speed regulated motor)		O

7.5.5 LN: Tank**Name: KTNK**

Logical Node KTNK shall be used to represent the physical device of a tank, such as a hydraulic oil tank. The tank can be pressurised or not. If used to represent a tank for pressurised gas, only the pressure MV will be used. If used for an oil sump, only the level MV will be used. For a simple level sensor, the SLVL logical node can be used instead.

KTNK class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
TnkTyp	INS	Type of tank (pressure only, level only, both pressure and level)		M
Settings				
VlmCap	AsG	Total volume capacity		O
Measured values				
Pres	MV	Pressure in the tank		O
LevPc	MV	Level in the tank (as percentage of full tank level)		O
Vlm	MV	Volume of media in tank		O
Tmp	MV	Temperature of the media in the tank		O

7.5.6 LN: Valve control**Name: KVLV**

Logical Node KVLV shall be used to represent a valve or gate where the position can be given as a percentage of full open position (optionally the angle (0 to 90) ° may be used). In the case of dam gates where either open or closed position depends on the water level of the dam, the HGTE LN should be used.

KVLV class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EENaMe	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
ClsPos	SPS	Closed end position reached (valve cannot move further)		C ¹
OpnPos	SPS	Open end position reached (valve cannot move further)		C ¹
Mvm	SPS	Valve is moving		O
Stuck	SPS	Valve is blocked (cannot move from present position)		O
Settings				
OpnLim	ASG	Opening limit of valve position (temporary restriction)		O
ClsLim	ASG	Closing limit of valve position (temporary restriction)		O
Incr	ASG	Increment of position change for open/close commands		O
Measured values				
PosPc	MV	Valve position given as (0 to 100) %		C ²
PosDeg	MV	Valve position given as (0 to 90) °		C ²
Flw	MV	Calculated liquid flow through the valve [m ³ /s]		O
Controls				
PosSpt	APC	Valve position set-point		O
Opn	DPC	Valve to full open position		O
Cls	DPC	Valve to full closed position		O
PosChg	INC	Change valve position (stop, raise, lower)		C ²
PosChgIncr	INC	Incremental change of position		C ²
BlkOpn	SPC	Block opening of the valve		O
BlkCls	SPC	Block closing of the valve		O