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PART IV

PROTECTION AND AUTOMATION

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PART IV

PROTECTION AND AUTOMATION

Chapter IV.1

PROTECTION OF 1KV VOLTAGE POWER GRIDLINE

Scope of application and definition

IV.1.1 This chapter refers to the protection of electric transmission grid up to 1kV voltage, which is installed inside or outside. Other demands of this electric transmission grid are going to remind in other chapters.

IV.1.2 The protective device is the one that automatically switches off the circuit when incident occurs.

Requirements on protective devices

IV.1.3 The protective device's ability to switch off has to be appropriate to the highest short circuit in the protected grid segment.

IV.1.4 In all situation, the nominal current of the fuse wire and adjustable of automatic circuit breaker ,which protect the electric transmission grid, should be chosen after the smallest level of the current counted of the grid or equal to the nominal current of the received power device. However, protective device don't cut off the grid when the received power device is short-term overloaded (such as starting current, so on).

IV.1.5 It's necessary to use automatic circuit breaker or fuse to be protective device. Being sure about the speed, sensitivity, or selectivity is necessary to use protective relays (indirect impact).

IV.1.6 For the device 1kV which connect earth neutrality indirectly in electric transmission grid, to cut off the grid has problem, protective neutral wire and phase conductor should be chosen so that the multiple of the short-circuit current will be smaller no more when touching to the protective neutral wire :

- As three times as the nominal current of the adjacent fuse.
- As three times as the nominal current of the circuit breaker can't adjust or adjustable current of the automatic circuit breaker has electric characteristics- inverse relation time.

When protecting electric transmission grid which has only electromagnetic circuit breaker(over the current impact immediately- cut off quickly), this conductor wire has to be sure that the electric current is not smaller than starting adjustable current multiply to dispersion coefficient (data of the

manufacture) and the reserve factor 1.1. When the manufacturers don't give the data, with the automatic circuit breaker has the nominal current 100A, the multiple of the short-circuit current with the adjustable current is not smaller than 1.4 ; for the automat having the nominal current over 100A is not smaller than 1.25. The conductance of the protective neutral wire is not smaller than 50% of the conductance of phase conductor.

If this is not applied, cutting off short-circuit problem need carrying out by special methods.

IV.1.7 Using automatic circuit breaker and fuse need to be sure so that when demounting them, their skin's screw socket is not on active. If the supply is from one side, power supply cord is connected to the fixed point contact of the protective device.

IV.1.8 Each protective device has label with number of the nominal current following the demand of grid which is protected. These numbers should be printed on the device or diagram near protective device.

Protection Options

IV.1.9 Electric grid has short-circuit protection with the shortest circuit-breaking time and selectivity.

The circuit has to be cut off when there have following short-circuit problems:

- Single phase or multiphase with neutral electric grid connected earth directly.
- Bi-phase and three-phase with insulating neutral electric grid .

If the rate of the minimum short-circuit current counted with the nominal current of fuse or automatic circuit breaker is not smaller than the numbers given in IV.1.6, it's sure that the overloaded grid need cutting off.

IV.1.10. There is only short-circuit protection without counting the number of short-circuit current given in IV.1.6. When comparing the numbers of fixed current in chapter I.3-part I, the protective device has multiple which is not bigger than:

- As three times as the nominal current of fuse.
- As four times and a half as adjustable current of automatic circuit breaker which has rapid circuit breaker.
- As once as the nominal current of automatic circuit breaker having electric characteristics-inverse relation time is not adjustable.(circuit breaker or not).
- As once and a quarter as starting current of the circuit breaker having electric characteristics-inverse relation time is adjustable. If the automatic circuit breaker has rapid circuit breaker, it is

unlimited the numbers of the starting current of rapid circuit breaker. If there is protective device with high number of adjustable or not, don't increase the cross section of the conductor given in chapter I.3- part I.

IV.1.11 It is compulsory to use overload protection with inside electric transmission grid using combustible sheathed conductors, which is covered or uncovered.

Besides, there are overload protections of inside electric transmission grid:

- Grid in house, public places, shops, public house of businesses, changeable device (iron, vacuum machine, fridge, washing machine….), combustible manufacturing rooms…
- Dynamic network in businesses, house, public places when the operating mode of the grid can cause overload in conductors and cables.
- Grids in explosive rooms or areas- not based on the technology process or operating mode of grid.

IV.1.12 In overload protection grids (IV.1.11), the conductors should be chosen after counted electric current, and the conditions with fixed current in Chapter I.3- Part I should be sure, protective device has multiple is not bigger than:

- As 0.8 - with nominal current of fuse or adjustable current of automatic circuit breaker has only rapid circuit breaker with conductors having synthetic resin, rubber sheaths or other insulating materials which has similar thermal behaviours; with the conductors installed in non-explosive places are got 100%.
- As once- for the nominal current of fuse or counted current of automatic circuit breaker having only rapid circuit breaker with cables covered in paper sheath.
- As once- for the nominal current of automatic circuit breaker having electric characteristics- inverse relation time is not adjustable or based on having rapid circuit breaker compared to others conductors.
- As once- for the starting current of automatic circuit breaker having electric characteristics- - inverse relation time is adjustable for conductors having synthetic resin, rubber sheaths or other insulating materials which has similar thermal behaviors.
- As once and a half as the starting current of automatic circuit breaker having electric characteristics inverse relation time is adjustable for conductors having cables which have paper or vulcanized polyester sheaths.

IV.1.13 Fixed current of conductors leading to squirrel cage rotor machine is not smaller than:

- As once as the nominal current of machines in non-explosive areas.

- As once and a half as the nominal current of machines in explosive areas.

The relation between fixed currents of conductors joining on to squirrel cage rotor machine and fixed current of protective device in any situation is not bigger than the numbers in IV.1.10.

IV.1.14 when permitted fixed current determined in IV.1.10 and IV.1.12 is not right to the numbers given in the table about permitted fixed current in Chapter I.3- Part I, conductor with smaller section, but it is not smaller than determined numbers of counted current.

Place to set up protective devices

IV.1.15. The protective device should be placed to operate conveniently, maintain to avoid being ruin. It is sure that when operating, it doesn't cause danger for people and things around it.

Operating and maintaining protective device having uncovered conductor should be done by experienced people.

IV.1.16. The protective device should be placed in grid where conductor's section decrease(to additional charge) or positions which need being sure selectiveness and sensitivities.(IV.1.17 and IV.1.20).

IV.1.17 The protective device should be placed right at node of protected device with conductors. Length of branch between protected devices with conductors can be 6 meters. The section of this can be smaller than the one of conductor (supplying) but the one behind protective device.

For the branch placed in disadvantage area(too much high), the length can be 30m to operate fluently(such as the input of the distribution station, starters-up of electrical devices), the section of the branch is not smaller than the one of current counted, and it's not smaller than 10% of main protected current's loading capacity. Above branch(6m or 30m) has sheaths or placed in fire resistant pipes or boxes; other situation but underground cable constructions, it can be installed on the place that isn't damaged by mechanics.

IV.1.18. When using fuse to protect electric transmission grid, place it on all poles and phase which isn't connect to the earth. Don't place it in neutral wire.

IV.1.19 When using automatic circuit breaker to protect neutral electric transmission grid connecting earth directly, place circuit breaker on all conductor which aren't connected to earth.

When using automatic circuit breaker to protect neutral electric transmission grid insulating three phases three wires or one phase 2 wires or one dimensional flow, place it on 2 phase for the 3 wires grid and on 1 phase for 2 wires. Note: protective device in the same grid should be named the same.

The circuit breaker of the automatic circuit breaker need placing on neutral wire because when there has any affection, all conductors are cut off at the same time.

IV.1.20 Protective device needn't placing in following positions:

- The branch from the bus bar in the cubicle to other device in this. The branch has to chosen after counted current of branch.
- The position which has sections decreasing along with supplying wire if next wire's protective device protect that section, or if decreased section grid, branch having section is not smaller than a half of protected wire.
- The branch from supplying wire to low capacity device if protective device of supplying wire has fixed current is not over 25A.
- The branch from supplying wire for control column boss, signal, measure, if these conductors don't be excessive sphere of machine or cubicle, or placed in resistant pipes or boxes.

IV.1.21 Don't place it at node of supplying with control column boss, signal, measure because it can cause dangerous effect if the circuit is cut off (cutting off firefighting pumper, wind fan against explosive formation, other devices in the auto-system of the plant). In all situations, conductors of this circuit need placing in resistant pipes or sheaths. Those circuit's sections are not smaller than the numbers in IV.4.4.

CHAPTER IV.2

RELAY PROTECTION

Scope of application and definitions

IV.2.1 This chapter is applied to device which is protected by electric relay(Relay Protection) of electrical system's components, industrial electrical installations and other electrical installations which have voltage from 1kV to 500kV.

This chapter is not applied to device over 500kV, the electrical installations of nuclear power stations and loading electric in one dimension.

Demands for protection electric transmission grid having voltage 1kV was given in chapter IV.1

Relay Protection of electrical installations' components is not given in this chapter and other chapters have to perform regulations in this chapter's common requirements.

Main Protection means protecting to the basis and the first step.

Compound protection means major, independence, with the same name, impact at the same time.

Vice protection means impacted protections when main protection doesn't act.

General requirements

IV.2.2 Electric devices need relay protection to:

Cut off automatically damaged components out of the rest of electric system by circuit breaker; if it does not damage directly the system's mode, sealed relay protection is allowed to sign.

React to dangerous working and abnormal modes of electric system's components (such as overload, voltage rise at the hydraulic turbine generator's stator coil); basing on the working mode and operating conditions of electrical installations so that relay protection has to impact to sign or cut off the components which cause problems.

IV.2.3 To decrease the price for the electrical device, fuse or open-link fuse in charge of circuit breaker of automat and relay protection as:

- Can choose fuse to be sure for required data (voltage and nominal current, etc.).
- Supply to demand for selectiveness and sensitivity.
- It won't hamper automatic devices (auto transfer system- ATS, auto switching on and off uninterruptible power supplier-UPS, etc.) necessarily to the working condition of the electrical devices.

When using fuse or open-link fuse, basing on asymmetric levels in unsafe phase mode and characteristics of additional charge, consider the capable of installing protection unsafe phase in electrical substation of each consumer of electricity.

IV.2.4 Relay protection has to cut off short circuit in the shortest time so that other part work in order.(work stably in electrical system and consumer of electricity, to be sure about refresh capability of working through the impact of ATS and UPS), limit the area and failure intensity of the damaged components.

IV.2.5 Relay protection has to cut off selectively so that when there is any problem, only that problem need discarding.

Unselectively protection (then correct by UPS and ATS):

- To be sure to accelerate cutting off short circuit, if it's necessary (IV.2.4).
- When using main electrical diagram, use automatic disconnector in the line or transformer line, automatic disconnector cut damaged components when there is no electric.

IV.2.6 Time Relay protection can be used to be sure about the selectiveness when:

- Cutting off time short circuit, and execute the requirements in IV.2.4.
- Relay protection's task is backup.(review IV.2.14).

IV.2.7 The reliability of relay protection (influencing when there is a condition have to be impacted and failed to operate without that condition)have to be sure by using device which has similar data and structures with the duty and suit for operating these device as well.

If necessary, use special methods to make sure about safety, such as backup diagram, check up working situation continuously or on schedule, etc. It's necessary to count on mistakes of operating staff when they perform necessary manipulations with relay protection.

IV.2.8 If relay protection has voltage circuit, there are following devices:

Automate the relay protections when automatic circuit breaker of voltage circuit is off, fuse is broken or voltage circuit is ruined (if it can cause wrong operations when operating) and report the damages of the circuit.

Damaged voltage circuit signals if it don't lead to wrong operations in common mode but it can cause wrong actions in other conditions(such as there is short circuit out of protected area).

IV.2.9 For time relay protection, whether protect the impacts with primary current's numbers, primary electric resistance or not is based on concrete situation to avoid wrong impacts and refusing to working

of protective device.(because short-circuit current is off gradually, or there are electrical oscillations , arc welding at damaged point, etc).

IV.2.10 Protecting electric transmission grid over 110kV, there are servo equipment to turn off the actions of protective device when there has electrical oscillation, or asynchronous if this electric grid can cause fluctuations or asynchronous which make protective device work in wrong way.

For the voltage line under 110kV which connects to huge supply source, (as it's possible to be electrical oscillations and protective device can work incorrect, servo equipment can be used.

Protective device needn't locking to avoid fluctuation if the protective device is adjusted following to electrical oscillation through time (the persistence time of protective device is about 1.5 ÷ 2 seconds).

IV.2.11 The impacts of relay are done by the indicator which is available in relay, by its own signal relay or by the counter which counts the times protective device impacts and other similar device to analysis, study about the protective device's activities.

IV.2.12 Each protective device's signal relay protection has to have a sign to announce when it intends to cut off. For complex protection, it is compulsory to sign in each part of protection (levels of protection, special compound protection which prevent the grid from various damages….)

IV.2.13 In each components of the system, there are main protection to act when there are problem around protected components which have time being smaller than others placed in that place.

The line which is over 220kV should have 2 protections per component. Connecting these components to current transformer is executed following IV.2.15.

Electric generators over 300MW , duplicate electric generators sets which have total capacity over 300MW, overhead power lines (OPL) 500kV, transformer 500/220kV should be considered being installed compound protection (excluding gas relay).

IV.2.14 In case the protection or breaker of component around refuse to work, far backup protection should be installed.

If the main protection is selective absolutely (for example high-frequency protection, incline or width differential protection), backup protection should be installed which protect not only around components but also its own on that component. It means that it effects when main protection of component refuses to operate or turn off the main protection. For example, if the main short-circuit protection among phases using differential protection, backup protection can be used as distance protection.

If the line's main protection over 110kV which is selective relatively (for example: multi-level protection with late time) then:

- It is allowable that pecial protection needn't installing as long as far backup protection of components around effect definitely when there is any short circuit on the line.
- The methods of near backup protection have to be worked when far backup protection is not reliable.

IV.2.15 Backup protection by special complete plant has to be executed in oder to check separately or repair main protection, special backup protection even protected components are working. If that, main protection and backup protection are supplied from different secondary winding of the breaker.

For the device which has voltage over 220kV, protection is powered up from two different one-way fractionations.

IV.2.16 For lines over 22kV, in order to increase reliable cutting off the problem at the beginning of line, space-time rapid-cutting current protection can be installed to be protection (add to III.2.25).

IV.2.17 If the responsibility of far backup protection makes protection part more complex, or can't be done in term of tech,:

1. Curtail far backup protection (backup protection maybe don't cut short circuit after transformer, there is reactance on line, when near lines have drive voltage, electric current in protection is much smaller than the one in problem)

2. Making far backup protection only with frequent break-downs, excluding hardly working modes and when taking into account action steps of protection.

3. Unselective action protection when there has short circuit in near components (protection is far backup protection) can make some electrical plants power down. Try to make good by using ATS and UPS devices.

IV.2.18 When the breaker refuses to cut off, backup protectors need to be installed in electrical device 110kV-500kV. Backup protectors can cut all components which connect to main bar when one of components'protection has problem : it can start but it can't cut short circuit in condition. Backup protectors needn't installing in electrical device 110kV-500kV when it has :

Ready-to-serve sensitivity and cutting time of far backup protection is in stable condition.

When backup protection impact without additional cut component because cutting breakers which indirectly connected to the one refusing to work (such as no batch breaker, no branch.)

In factories which have power generator refrigerating directly in winding, in order to avoid being ruined power generator when breaker 110kV-500kV refuses to work, BRC should be placed without basing on any condition.

When one of breakers of damaged components (line, transformer (TF),main bar) refuses to work, BRC has to impact near breakers.

If protection connects to current transformer (C.T) which is out of TF, backup protector has to impact when there is short circuit in middle of C.T and breaker

Simple backup protector, cutting can be used when there is short circuit along with refusing to cut breaker which doesn't belong to all components(for example when having short circuit in line); besides, if voltage between 35-220kV, backup protector can be used and it only cuts batch breakers.

When far backup protection is not effective enough, install backup protector to increase reliability of near backup protection.

IV.2.19 To evaluate the sensitivity of different main relay protection, base on the figures of sensitivity. They can be counted:

For protection reacts to added numbers when problem is the rate between counted number (electric line or voltage) when short circuit that connects lines directly in protected area and starting number.

For protection reacts to decreasing numbers when problem is the rate between starting number and counted number (resistance and voltage) when short circuit that connects lines directly in protected area.

Those counted numbers have to be calculated under the worst problem which can happen in fact.

IV.2.20 Evaluating the sensitivity of main protection is based on following assurance of sensitivity figures:

Over-current protection which whether has directional or non-directional pressure tight protection, as well as directional or non-directional primary protection which has negative sequence or zero sequence filter or selector : for current circuit and voltage- about 1.5.

- For directional circuit, negative sequence and zero sequence capacity - about 2 with capacity and 1.5 with electric line and voltage.
- For directional circuit which capacity connect to total electric current and total voltage , capacity and electric current about 1.5 needn't defining
- For overcurrent protection of transformer which has voltage to low voltage 0.23÷ 0.4kV, min sensitivity figure can be 1.5.

Stage protection or electric current protection and directional/indirection voltage protection which inputs in total circuit and total voltage circuit or inputs in zero sequence components : for current circuit and voltage circuit of protection level which is used to impact when there are short circuit at the end of protected portion, sensitivity figure excluding standing impaction about 1.5 ; when there is standing level which impacts selectively, sensitivity figure can be decreased 1.3; when there is bar's protection at the beginning of line, it has matched sensitivity between 1.5 and 1.4 for sequence protection which isn't allowed to impacted by step mode according to stage cutting.

- For directional circuit which has negative sequence/zero sequence capacity- about 2 with capacity and 1.5 with electric current and voltage.

- For directional circuit which has capacity inputted in electric current and total voltage, it needn't regulating after capacity and it is about 1.5 after electric current.

Multiphase short circuit distance protection:

- For starting circuit of any protection and for third distant protection circuit– about 1.5.

- For second distant protection circuit which is used to impact when there are short circuit at the end of protected portion excluding standing impaction- about 1.5 and for the third distance protection, it's about 1.25 ; for those circuit, the sensitivity is about 1.3 when there has problem at that point.

Length differential protection of transformer, power generator, line and other components, total differential protection of main bar as well- about 2.0; for starting circuit after electric current of integral differential protection, distance protection of main bar voltage of power generator, sensitivity figure is about 2.0, for the integral differential protector 's primary of power generator's main bar voltage is cut rapidly- about 1.5 (when there is short circuit at bus bar).

For protecting power generator and transformer, sensitivity is checked when there has short circuit at their outputs. However, for water turbine generator or turbine generator which refrigerates directly conductors of stator winding, it is not based on the sensitivity, effecting current is smaller than nominal current of power generator (IV.2.35). For the autotransformer and power-stage transformer over 63MVA, effecting current is smaller than nominal current because it doesn't include reversing level (for autotransformer, it is smaller than the matched electric current with standard capacity). For the transformer which has capacity over 25MVA and effecting current excluding reversing level, it is not bigger 1.5 than nominal current of transformer.

Sensitivity's figure with differential protection of transformer or power generator set is allowed to decreased – the number of transformer is 1.5 in following situation (in term of technology, ensuring sensitivity's figure bout 2.0 is very difficult):

- When there has short circuit in the output in low voltage of transformer, increase capacity but it has to be smaller than 80MVA (include adjusting voltage).

- When closing transformer under the voltage, being in short term mode of transformer as well. (such as when cutting one of feeding sources of three-winding transformer).

When switching on from one of feeding sources to main bar has problem, decreasing sensitivity figure toward main bar's differential protection is 1.5.

For differential protection of transformer when there has short circuit behind reactor installed in low voltage of transformer and in differential protection area, differential protection is 1.5.

When there are other protections covering the reactor and it satisfies the sensitivity of differential protection of transformer, when there is short circuit at that point, sensitivity needn't regulating.

Directional width differential protection for lines which work in parallel:

For current relay and voltage relay of starting part which belongs to combined short-circuit set between phases and short-circuit ground –about 2.0, when breakers in both end of line has closing fault(short circuit at point has the same sensitivity figure) and they are about 1.5 when breaker in the opposite side of the line which has opening fault.

For directional circuit which has zero sequence capacity- about 4.0 after capacity and about 2.0 after electric current and voltage when the breaker is in the opening opposite end.

For directional circuit which has capacity connects to electric current and total voltage, sensitivity figure after capacity needn't regulating , and after electric current about 2.0 when breaker is in both ends of line which close together and about 1.5 when breaker is in the opening opposite end.

Differential protection with high-frequency interlock:

For directional circuit which has reverse sequence or zero sequence to control cross vein- about 3.0 after capacity, 2.0 after electric current and voltage.

- For start circuit to control break circuit (about 2.0 following current and voltage, about 1.5 following resistance)

7. Protection differential (phase) with high level

For start circuit to control break circuit about 2.0 following current and voltage, about 1.5 following resistance (distance).

8. Current protection are not cut fast time in the power generator set capacity to and located in the transformer, when the circuit breaker protection put in place -about 2.0

9. Earth fault protection on the underground cables in the grid neutral isolation (to signal the impact or cut) for the protection response under the current fundamental frequency - about 1.25; for the protection response applications under high frequency electric current 1.5

10. Protection against touch the ground on the overhead power lines (OPL) in the grid has isolate the impact of neutral signal or cut - about 1.5

IV.2.21 When determining the the run described in this section IV.2.2.0 1, 2.5 and 7 the following needs to be calculated:

1. running level the wattage of the touch relay output oriented monitoring only when It matches the current and voltage and full-order inverse order does not

2. running level of output relays oriented game under diagrams comparing (absolute value or phase), to inspect the current and electric cloths when it the current and voltage total and check the lines and electric power pressure when it matches the current and voltage components and inverse order

IV. 2.22. For power generators connected directly to the bus bar, bus bar sensitivity level of the current protection against short circuits in the stator winding touch ground to cut the impact is determined by the current launch no more than 5A, exceptions allowing increased currents up to 5.5 A boot.

For the power generator batches with transformer's running coefficient of of protection against short circuits include a phase to ground the entire stator winding beam must not be less than 2.0; for voltage protection order does not covering all stator winding, the voltage is not larger boot 15V.

IV.2.23. the sensitivity of protection for AC power operation is done by testing circuit diagram of shunt power cut from the roll, must be the actual test error of current transformer circuit after shunt removal.

IV.2.24. the smallest sensitivity of coefficient for the protection of reserves at the end of the short circuit element at the end of the neighborhood or the most remote part of the serial element in the protection of the reserve must be equal (see IV.2.20)

- With circuit current, voltage and resistance by 1.2

- For the power circuits directed against the order and order does not; by 1.4 by 1.2 by capacity and by electric current and voltage.

Directed circuit for the power line input voltage and full power is not provided for under power lines and electricity by 1.2 When valuating sensitivity of the protection granted reserve near (see Article of IV 2.14) based on the sensitivity of coefficient defined in Article IV of 2.20 for the corresponding protection.

IV.2.25. For the current protection are not cut quickly placed on the timeline duty to protect side, sensitivity of coefficient is about 1.2 where short circuit protection in the most favorable conditions for sensitivity.

IV.2.26. If protection of the element behind the effect that protects the front element does not impact may be due to insufficient sensitivity, the sensitivity of this protection must be coordinated with each other.

Not allowed to coordinate with each other sensitivity for the remote backup protection if the life circuit is not cut short due to insufficient sensitivity of the element of protection following denominations (example: protection order against the machine generators, self dual transformer) can lead to serious damage.

IV.2.27. In the grid directly earthed neutral, due to the requirements of relay protection, must choose a neutral mode of the transformer (example distribution of the number of transformer directly earthed neutral) so that when short touch the ground circuit values of current and voltage to ensure adequate protection of the impact of all elements operating modes of the system.

Increasing pressure for transformer or transformer is offered from two or three sides (or offered significantly from the synchronous motor or synchronous machine booster) that the output windings has insulated neutral descending, right appear to rule out working regime banned for the transformer in neutral mode isolation at the bus bar or the 110-220kWgrid was separated as a single-phase touch the ground occurs.

(the Article 2:26). For this operation a number of transformers and neutral isolated and earthed neutral, expected to ensure the protection insulated neutral transformers cutting measures or automatically earth neutral before cutting of the transformer has high the grounding bus bar to work together or at the the net.

IV.2.28. Current transformers used to supply current circuit of relay protection device against short circuit dissatisfaction to the following requirements:

1. With the aim of preventing wrong action always happens in the outside circuit protection, wrong number (full or bias current) of the current transformer shall not exceed 10%. Allow greater tolerance in the case of a defensive error, but when large, their impact protection guaranteed by the special measures (e.g. bus bar differential protection has brake)

The some compulsory request:

- For more level-while protecting short circuit at the end of the level of impact protection, also for protection as well as instructions on many levels-and short-circuits when
- For the protection of rest - when short-circuits

For current differential protection (bus bar, transformer, generators, etc.) must take into account all errors committed. For the protection of remaining - bias current, while the game under the total current of two or more external current transformer shorted out and when taking into account the total error.

2. To avoid the guards refuse to work in the area during the short circuit protection, current error does not exceed:

- Value permitted under high vibration of the relay contacts oriented power relays or current-value allows for the the selected type relays

- For relay output orientation and relays resistors oriented angle error is 50%

3. Output voltage of the secondary coil of the transformer short-circuit current in the protected areas are not larger than the allowed number of automation and protection.

IV.2.29. Circuit current of the measuring instruments (with meter) and relay protection, usually play on the rolls of different current transformer, allowing them to be fighting them in the secondary coil of current transformer when satisfying the requirements mentioned in Part I and I5.16-

IV.2.28. When the protection circuit can in principle wrong to damage the electrical circuit, just play the instruments for measuring the intermediate current transformer with the main conditions to ensure the requirements stipulated in the Second Circuit's second IV.2.28 when current transformer secondary open space.

IV.2.30. We should use to relay immediate impact (primary or secondary) and protection operation using AC power, if it has the ability to make simple, cost reduction projects while ensuring reliability reliable and selective.

IV.2.31. Conventional current transformer used the element to be protected AC power operation for the protection against short circuits. Also allowed voltage transformer or power used in the transformer itself AC operation.

Depending on the specific conditions must use one of the following diagrams: diagram of the shunt circuit coil removal from the cutter to cut power block diagram has power supply, the device map has loading capacitor.

IV2.32. The relay device to separate from the work required working methods of the grid, under selective conditions or other causes must has their own connection to the device that the operator can separate them Working from the diagram

To ease the inspection and testing, in the protection scheme must having been tested or the box the first wire clamp experiments where necessary.

Generator's Protector directly connected to the voltage bus bar of the generator

IV.2.33. For power generators voltage higher than 1kV, greater than 1MW capacity directly connected to the generator bus bar voltage devices used to relay protection against all types of faults and the working mode is not normal follows:

1. Multi-phase short circuit in the stator winding of power generators and in the first place.

2. Single-phase earth fault in the stator windings

3. Grounding the two points, one point in the stator winding and a point outside the net.

4. Short circuit between the wire loop of a phase in the stator windings

(where the parallel branches of the coil are taken out)

5. The short circuits.

6. Overload currents reverse order (for power generators greater than 30MW capacity).

7. Overload the stator winding symmetry

8. Overloading of the stimulating current rotor

(for power generators cooling directly the coil wire)

9. Touch the ground short-circuit a point or two points in the circuit stimulus

(corresponding to the Article IV.2.48)

10. Asynchronous mode and it is the loss of stimulation

(According to the Article IV.2.48)

11. Electric clothes too stator winding of turbine generator

IV.2.34. For power generators with a capacity higher than 1 kW to 1 MW connected directly to the bus bar voltage power generators should have the relay protection devices correspond to the IV.2.33 1, 2,3, 5 , and 7.

For generator voltage up to 1kW capacity to 1Mwconnected directly to the bus bar voltage power generators to perform simple protection under Article IV.2.49

IV.2.35. For protection against short circuits in the multi-phase stator winding of power generators has higher than 1 kV voltage greater than 1MW capacity that has separate outputs of each phase-in the stator winding neutral need to protect against vertical booster, impact protection must cut away althea power generator's breakers, to put out the word and stop the turbine.

In the protection zone outside power generators itself, it must also include the connection of power generators with the power bus bar (to cut the machine).

Differential protection along with the author made no larger than the 0.6 $I_{current}$ ($I_{current}$ is the nominal current of power generators). For power generators up to 30kW capacity has indirectly cooled to allow the protection with the impact line by (1.3 /1.4) $I_{current}$. Check off the electric current protection circuit should be done when the current impact of greater protection of $I_{current}$.

Longitudinal differential protection must be adjusted according to the value of the non-balanced over-current (example Quality trailers for current transformer saturation).

Protection schemes had implemented in three phases of three relays. For power generators up to 30 MW capacity allows use of two-phase diagram when both relays have protected against touch the ground at two points.

IV.2.36. To protect against short circuits in the multi-phase stator winding of the power generators voltage above 1 kV up to 1MW capacity to work in parallel with a power generators or electrical system to protect the current set fast time at the output output of the power generators connected to the bus bar. If protection is not cutting fast enough to put the sensitivity, the differential protection will along.

For power generators with a capacity greater than zero output respectively in the neutral phase of the stator can quickly cut a defensive replacement for differential protection along.

For power generators work independently higher voltage power 1kW to 1MW, it allows users to protect against short circuits to protect against short circuits in the stator winding phase (the IV.2.43). Impact protection to cut all the machines generators and cut the stamp magnetic.

IV.2.37. To protect against single-phase earth fault in the stator winding of the power generators voltage when current is above 1 kW capacitive touch the ground is naturally at 5Aand larger (not including with or without compensation) to set protection current response under the current ground in full or in part its higher harmonics. When needed, you must use sequence current transformer is not placed directly at the output of power generators. It should also be protected in case of capacitive currents when the ground is less than 5A. Protection must be controlled up to the process of the transition and impact as in Article IV.2.35. or IV. 2.36.

In case do not set earth fault protection (due to capacitive currents when the ground is less than5A, if not enough sensitivity) or protected from impact (example if there are compensating capacitive currents in the grid voltage machines play), use electrical equipment to test the impact on bus bar signal

IV.2.38. When you put the order without current transformer on the power generator to protect against a ground one-phase, expected to connect two point ground protector connected to the current transformer.

To improve the reliability of the current protection relays are large, using current transformer saturation. Protection shall performs on the timeless basis and impacts under Article IV.2.35or IV.2.36

IV.2.39. To protect against short circuits between the wire loop of a one-phase in the stator windings when the coil is parallel branches must be placed across a differential protection system of space-time effects such as protection in Article IV.2.35.

IV.2.40. In order to protect generator with capacity over 30MW against asymmetric out short-circuit as well as protect against reverse sequence current overload, it must be installed the breaking action reverse sequence current protector with two time stages (see Article IV.2.44).

For generator that directly cools the conducting-wire of the coil, protector with multi-stages or dependent time should be used. Therefore, the second-stage time and the time of dependent specialty mustn't be higher than allowable reverse sequence current overload specialty.

For generator that indirectly cools the coil, it needs to use protector having specialty of independent time with effected current not higher than allowable reverse sequence current of this generator in 2 minutes; small time-stage of protector is not higher than allowable time in case of two-phase short-circuit at output of generator.

Reverse sequence current protector must be added sensitive signal element with independent time specialty. Effect current of this element mustn't be higher than reverse sequence current that is allowable long-term for this kind of generator.

IV.2.41. In order to protect generator with capacity over 30MW against symmetric out short-circuit, it needs to install current protector with low voltage start in which one current relay is connected with phase current and one low voltage relay is connected with wire voltage. Impact current of this protector must be approximately $(1.3\div1.5)I_{current}$ and start voltage also must be approximately $(0.5\div0.6)U_{current}$.

For generator that directly cools the conducting-wire of the coil, one-relay space protector can be installed, replacing for the above mentioned protector.

IV.2.42. In order to protect generator with capacity over 1MW up to 30MW against out short-circuit, it needs to install current protector with voltage start, implemented by one low voltage relay connected with wire voltage and one reverse sequence voltage filter relay with the aim of cut off the circuit of low voltage relay.

Start current of protector and start voltage of low voltage circuit are taken following numeric value shown in Article IV.2.41, start voltage of reverse sequence voltage filter relay is $(0.1\div0.12)U_{current}$.

IV.2.43. For generator with voltage over 1KV and capacity up to 1MW, in order to protect it against out short-circuit, overload protector must be connected with transformer at the neutral of generator.

Adjusted numeric value must be chosen following additional charge current with necessary backup level. It is allowed to use simple low voltage protector (without current relay).

IV.2.44. For generator with capacity over 1MW, protector against out short-circuit must carry out these following requirements:

1. Protector must be connected with transformer placed at neutral output of generator.

2. When voltage bus bar of generator having segment, protector must implement following two time stages: first stage – short time – cutting action on the segment breaker; second stage – long time – cutting action on the breaker of generator and magnetic breaker.

IV.2.45. For generator directly cooling the conducting-wire of the coil, there must be rotor overload protector when working with auxiliary or main exciter. Protector implements following independent or dependent time specialty and react in case current or voltage increase highly in rotor coil. Protector carries out cutting action on generator and magnetic breaker. With shorter time stage, it needs to do the rotor offload.

IV.2.46. Symmetric overload protector of generator must use one-phase current of stator for over-current protector having time to effect on signal relay.

In order to offload or automatically switch off generator that directly cools conducting-wire of the coil in case of symmetric overload, it allows to use rotor protector according to Article IV.2.45 and react following rotor overload, leading to generator overload.

IV.2.47. It only needs to install one second-point earth short-circuit protector in the main exciter of generator shared for some generators (but not over 3 generators) with parameters of exciting circuit nearly the same. Protector is only taken into working in case one earth point in exciting circuit is discovered while periodically testing (see Chapter I.6 – Part I). Protector must do the cutting action on circuit breaker of generator, at the same time magnetic breaking of generator that directly cools conducting-wire of the coil and effect on signal relay or cut off the indirect cooling generator.

IV.2.48. For generator that directly cools conducting-wire of the coil, it needs to install protection device against asynchronous regulations with exciting loss. It allows to replace by automatically discovering asynchronous regulations only according to magnetic breaking device's status. At the time that protection device effects or while cut-off the auto magnetic breaker, for generator that is allowed to work in asynchronous regulations, it must effect on signal relay of exciting loss.

For generators that are not allowed to work in asynchronous regulations, please see Article IV.2.85.

IV.2.49. In order to protect generator with voltage up to 1kV and capacity up to 1MW, having neutral point not grounding, against any breakdown as well as abnormal working status, it is allowed to install

automatic circuit breaker which has over-current breaker or circuit breaker that has over-current protector implemented following two-phase diagram. In case there is output at the neutral, if available, that protector should be connected with transformer placed at this neutral output.

For mentioned generators but having direct earth neutral, protector must be installed following three-phase diagram.

Protection of transformer (*) with high-voltage winding from 6kV up and horizontal booster reactor 500kV

(*) If there is not private description for transformer, this term is understood as both normal transformer and random transformer (with voltage and power correlatively).

IV.2.50. Transformer must be installed one part or the whole relay protection devices in order to protect against any following breakdowns and abnormal working status, depended on transformer capacity and voltage level:

1. Multi-phases short-circuit in the coils and on output.
2. Earth one-phase short-circuit in the coils and on output of mains having direct earth neutral.
3. Short-circuit between wire circles in the coils.
4. Over-current in the coils due to out short-circuit.
5. Over-current in the coils due to overload
6. Oil level lowering.
7. Oil pressure highly increasing in transformer.
8. Oil pressure highly increasing in under-load pressure controller (OLTC).
9. Oil temperature highly increasing in transformer.
10. Transformer coil temperature highly increasing.
11. Partial discharge input insulator 500kV.
12. One-phase grounding in mains of 6-10kV with isolating neutral after transformer must be cut off (see Article IV.2.95 and Article IV.2.96) as safety requirement.

In addition, it should be installed one-phase earth protector of 6-35kV for autotransformer with voltage equal and higher than 220kV.

IV.2.51. For horizontal booster reactor 500kV, it must be installed protection devices against following breakdowns and abnormal working statuses:

1. Earth two-phase and one-phase short-circuit in the coils and outputs.
2. Short-circuit between wire circles in the coil.
3. Oil pressure highly increasing.
4. Oil level lowering.
5. Partial discharge at input insulator.

IV.2.52. It needs to install gas protector against breakdown inside machine due to air arising, against oil level lowering and oil pressure highly increasing applied for:

+. Transformer with capacity from 6.3 MVA up

+. Horizontal booster reactor 500kV.

+. Step-down transformer of workshop with capacity from 1MVA up.

For transformer with capacity from 1MVA to below 6.3MVA, gas protector should be also installed.

Gas protector must get effect on signal relay in case of low gas speed as well as oil level lowering, take the cut-off action while high gas speed and oil level continuously lowering.

Buchholz also can be used to avoid breakdown inside transformer with gas making. Protection against oil level lowering also can be done with one private oil level checking relay placed inside oil expansion tank of transformer.

In order to protect the contact underload barostat with arc suppression contact point in the oil, it needs to privately install oil current relay and pressure film.

It should be anticipated the possibility of changing the cut-off action with gas protector into indicating action and separating the signals on signal indicating circuit and signals at cut-off circuit of gas protector (due to different signal property).

Gas protector is allowed to indicate only in these following situations:

+. For transformer placed in earthquake zone

+. For step-down transformer with capacity up to 2.5MVA without circuit breaker at high voltage.

IV.2.53. For avoiding breakdown at output and inside transformer and horizontal booster reactor, below mentioned protectors must be installed:

1. Timeless longitudinal differential protector for transformer with capacity for 6.3MVA up, horizontal booster reactor 500kV as well as for transformer with capacity from 4MVA up while they are working in parallel.

Differential protector can be installed in transformer with smaller capacity but not below 1MVA if:

+. Quickly cut-off current protector is not sensitive enough, and over-current protector has the time higher than 0.5 seconds.

+. Transformer placed on earthquake zone.

2. Timeless quickly cut-off current protector is placed at supply and one part of transformer coil, in case there is not differential protector.

These protectors must get cut-off action on all circuit breakers of transformer.

IV.2.54. Longitudinal differential protector must be implemented by using special current relays that are calibrated in order to avoid electromagnetic current suddenly changing, stabile and transient unbalance current (ex: using saturation current transformer, break coils).

For transformer with capacity up to 25MVA, it allows to be protected by current relay that is calibrated the start current in order to avoid transient electromagnetic current and transient unbalance current in case this protector ensures to be sensitive enough.

Longitudinal differential protector must be implemented so that connection parts of transformer with bus bar are within its protection zone.

Current transformer available inside transformer is allowed to use for differential protector in case there are other protectors that ensure to cut off short-circuit in quick-enough time at connection transformer with bus bar. If reactance coil is installed in low voltage circuit and transformer protector is not sensitive enough in case short-circuit behind reactance coil, current transformer is allowed to placed at transformer low voltage output including reactance coil protection.

IV.2.55. For differential protectors and gas protectors of transformer, horizontal booster reactors is not insisted on sensor with function of starting the fire extinguishing equipments. Fire extinguishing equipments must be implemented by separate fire discover devices.

IV.2.56. Input insulator tester 500kV must get effect on signaling relay in case there is partial discharge at input (no necessary to immediately cut-off) and do the cut-off action in case the input insulator is failed (before insulator is completely broken down).

Interlock needs to be installed in order to prevent input insulating test device from making mistake while breaking the circuit connected between the tester and input.

IV.2.57. In case transformer (excluding workshop transformer) is connected with power line without circuit breaker (ex: following block diagram of power line - transformer), transformer must be cut off by one of below mentioned methods:

1. Install the short-circuit isolator with the aim of making the artificial one-phase grounding (for the mains with direct earth neutral) or making the two-phase short-circuit (for the mains with isolating neutral) and if necessary, install auto switch isolator in order to automatically cut off the power line at the time of no current of the UPS (uninterruptible power supplier). Short-circuit isolator must be placed without differential protection zone of transformer.

2. Install open fuse at high voltage of step-down transformer acted as short-circuit isolator and auto switch isolator in diagram combined with UPS (uninterruptible power supplier) of power line.

3. Transmit switch-off signal to circuit breaker (or circuit breakers) of power line. At that time, if necessary, auto switch isolator is installed. In order to spare for switch-off signal transmitter, short-circuit isolator is allowed to install.

When solving problem by using switch-off signal transmitter replaced for method 1 and 2 shown out above, it needs to consider these following conditions:

+/ The importance of the line and possibility of artificial short-circuit on that line.

+/ Transformer capacity and allowable time for solving the fault in transformer.

+/ Distance from station to the power supply beginning and near short-circuit breaking possibility of circuit breaker.

4. Install the fuse at high voltage of step-down transformer.

Methods shown out from 1-4 are possibly not applied for transformer -line block diagram in case power supply from two sides transformer is protected by general protector of block (high-frequency protector or special differential protector) or transformer capacity up to 25MVA when power supply from one side, if protector of power supply line ensures to strong enough to protect the whole transformer (quick-action protector of the line can protect one part of transformer, and backup protector of the line with time not higher than 1 second can protect the whole transformer); then, gas protector only indicate the signal.

In case of using method 1 or method 3, transformer must install following devices:

+/ At the high voltage of transformer (110kV up), current transformer is available – protectors are installed following Article IV.2.52, IV.2.53, IV.2.58 and 59.

+/ In case current transformer is not available – differential protector (correlatively with IV.2.53) or over-current protector with using transformer outside or magnetic transformer, and gas protector are installed following Article IV.2.52.

Power line protector is allowed to eliminate problem at output of the transformer high voltage.

Especially in case there is not current transformer, roving transformer is allowed to use if current transformer put outside or magnetic transformer don't ensure the protection requirement.

For protector of transformer with high voltage of 35kV, when using method 1, roving transformer must be used; installation of short-circuit isolators and roving transformers must be calculated based on technical-economic foundation.

If open fuse (method 2) is used to increase the sensitivity of gas protector, artificial short-circuit on the fuse can be made by mechanics.

IV.2.58. For transformer with capacity from 1.6MVA up, in order to prevent over-current due to out short-circuit, it needs to use these following switch-off protectors:

1. For step-up transformer with power supply from two sides: use reverse sequence current protector against asymmetric short-circuit and current protector with low-voltage start against symmetric short-circuit or current protector with low-voltage start (see Article IV.2.42).

2. For step-down transformer: use current protector with or without low-voltage condition; for step-down transformer with large capacity, it is also allowed to use reverse sequence current protector against asymmetric short-circuit and current protector with low-voltage start against symmetric short-circuit.

When selecting the start current of current protector, it should be put the eye on overload current that can arise while switch off transformer working in parallel and auto-start current of engine supplied by transformer.

For auto step-down transformer 500kV, space protector should be installed when it is requested to as a precaution or coordinate with protectors of voltage mains nearby; these mentioned protectors should also be installed for autotransformer 220kV.

IV.2.59. For transformer with capacity lower than 1.6MVA, current protector with switch-off action must be used in case there is multi-phases short-circuit outside.

For transformer 35kV downwards, with capacity of 1.6MVA downwards, safety fuse can be used replacing for over-current and quick cutoff current protector following Article IV.2.3.

IV.2.60.Out multi-phases short-circuit protector must be installed as follows:

1. For two-coils transformer – placed at main power supply.

2. For multi-coils transformer with three circuit breakers upwards – placed at every side of transformer, however it is also allowed to not place protector at one of every side, but protector placed at main supply must have two time stages, and shorter time stage is applied for switch-off action on circuit breaker at the side that there is not this protector placed.

3. For two-coil step-down transformer supplied for segments working separately – placed at power supply and at every side of each segment.

Carrying out the out multi-phases short-circuit protection must be following Article IV.2.58, section 2 and also consider the necessity of adding more the quick cutoff current protector in order to switch off short-circuit on bus bar at low-voltage and medium-voltage with shorter time (based on short-circuit current level, separate bus bar protector installed, possibility of coordinating with protector of outputs).

IV.2.61. In case out short-circuit protector of step-up transformer is not sensitive and selective enough, current relays of correlative protector in generator are used to protect the transformer.

IV.2.62. For step-up transformer with capacity from 11MVA upwards and transformer with power supply from two sides and three sides, and autotransformer, it needs earth short-circuit breaking backup at elements nearby. Besides, for autotransformer, due to request that ensures the selectivity of earth protector of mains at different voltages, sequence line protector not against earth short-circuit is installed outside and placed at the coil connected with the main having large earth current.

When the main having transformer with isolator of the coil at neutral output decrease, which is operating with isolated neutral, there must be method of preventing the forbidden operating regulation from neutral of transformer as stated in Article IV.2.27. In order to implement this purpose, at power plant or substation in which isolated neutral and earth neutral transformer are both working with supply at low voltage, protector must ensure to switch off isolated neutral transformer or there must be method of auto neutral earth before switch off transformers with earth neutral working on the same bus bar or at that main.

IV.2.63. For autotransformer and multi-coils transformer, with supply from some sides, out short-circuit protector must implement directionally if due to request of selective condition.

IV.2.64. For autotransformer 220-500kV at substation or for block of generator-transformer 500kV and telecommunication autotransformer 220-500kV of power plant, there must be out short-circuit protector with quick impact acceleration, in case bus bar differential protector is not allowed to work, in order to ensure to cut off the remaining breakdowns without quick impact protector in 0.5 second approximately.

IV.2.65. For step-down transformer and block of transformer – interconnecting line, with voltage at high voltage up to 35kV and the coil at low voltage star connected with earth neutral, there must be earth one-phase short-circuit protector at low voltage main by using as follows:

1. Out short-circuit current protector is placed at high voltage of transformer and if it is requested to ensure the good sensitivity, three-relay diagram can be used.

2. Automatic circuit breaker or fuse is placed at output of low voltage.

3. Non-special sequence protector is placed on neutral line of transformer (when sensitivity of protector following part 1 and 2 is unreliable).

Maybe it doesn't need to install protector as stated in part 3 for industrial electric devices, if low voltage cabinets have protector for output placed near transformer (from 30m downwards) or in case of using three-phase cable connected from transformer to these cabinets.

In case of using protector as stated in part 3, this protector is allowed not to combine with protectors of outputs from low voltage cabinet.

For diagram of line-transformer, in case of using protector as stated in part 3, it only needs to impact on automatic circuit breaker at low voltage and doesn't need to place secondary cable for this protector impact on circuit breaker at high voltage.

In case the fuse is installed at high voltage of this above mentioned transformer, it can be applied as in this part.

IV.2.66. For step-down transformer for voltage at high voltage 6-10kV, low voltage supplied for panel with output that is protected with fuse, overall fuse or automatic circuit breaker should be installed.

In case the fuses at low voltage panel and fuse (or protector) at high voltage are managed by only one operator, overall fuse or automatic circuit breaker at low voltage don't need to be installed.

IV.2.67. One-phase earth protector according to Article IV.2.50 item 12 must be implemented following Article IV.2.95 and Article IV.2.96.

IV.2.68. For transformer with capacity from 0.4 MVA upwards, depending on their frequency and overload capacity, overload over-current protector that take action on signal relay should be installed.

For substation without operator, this protector is allowed to automatically load pull-down or switch off (in case overload can not be cleared by other methods)

IV.2.69. In case auxiliary transformer is installed at neutral of transformer in order to adjust under-load voltage, beside regulations stated in Article IV.2.50 – IV.2.56, IV.2.58, IV.2.62, it needs to install more protectors as follows:

+/ Gas protector for auxiliary transformer.

+/ Current protector with brake while out short-circuit against breakdown at primary coil of auxiliary transformer, except the primary coil of auxiliary transformer is within impact zone of differential protector at low voltage of main transformer.

+/ Differential protector covers the whole primary coil of auxiliary transformer.

IV.2.70. In order to protect auxiliary transformer placed at low voltage of autotransformer, these following protectors must be installed:

+/ Gas protector of auxiliary transformer and gas protector of under-load regulator can be by bunchholz or separate gas relay.

+/ Low voltage circuit differential protector of autotransformer.

Protection for generator-transformer

IV.2.71. For block of generator – transformer with capacity of generator from 10MW upwards, there must be relay protectors against breakdown and abnormal working status as follows:

1. Earth short-circuit at voltage of generator.

2. Multi-phase short-circuit in stator coil of generator and at their outputs.

3. Short-circuit between wire circles of one phase in stator coil of generator (correlatively with Article IV.2.75).

4. Multi-phase in the coils of transformer and on outputs of transformer.

5. Earth one-phase short-circuit in the coil of transformer and on output connected with the mains having large grounding current.

6. Short-circuit between wire circles in the coils of transformer.

7. Out short-circuit.

8. Transformer overload due to reverse sequence current (for block having generator with capacity higher than 30MW).

9. Symmetric overload of stator coil in generator and the coils of transformer.

10. Rotor coil overload of generator due to exciting current (for generator with turbo-generator directly cooling the coil and for water turbine generator).

11. Highly increase voltage on stator coil of generator and transformer of block (for turbo-generator with capacity from 160MW upwards and for all blocks with water turbine generator) (see Article

IV.2.83).

12. One-point earth short-circuit (see Article IV.2.47) and two-point (see Article IV.2.84) in exciting circuit.

13. ASYNC regulation with excite loss (see Article IV.2.85).

14. Lower oil level in transformer.

15. Partial discharge at input insulator 500kV of transformer.

IV.2.72. Regulations of step-up transformer and generator protection while they are working separately are also applied as while they are connected following block diagram of generator – transformer (autotransformer) except some changes stated in Article IV.2.73 – IV.2.89.

IV.2.73. For block of generator with capacity larger than 30MW, there is usually earth protector at voltage circuit of generator covering the whole stator coil.

For generator with capacity up to 30MW, protection device covering 85% of stator coil should be installed.

Protector must take switch-off action in the time of not longer than 0.5 second for all blocks without turnout at generator voltage and with turnout to self-use transformer. At blocks that have electric connection with self-use mains or with consumer supplied by power line from turnout between generator and transformer, if capacitive current while earth short-circuit is 5A upwards, it needs to install earth short-circuit protector with breaking impact on generator stator coil and against two-point earth as while being connected with bus bar (see Article IV.2.37 and Article IV.2.38); if capacitive current while earth short-circuit is smaller than 5A, earth protector can carry out as for blocks without turnout at generator voltage and signal relay.

In case there is circuit breaker at generator circuit, earth signal circuit must be added more at generator voltage of transformer block.

IV.2.74. For protector of indirectly cooling generator block, including one generator and one transformer and without circuit breaker at generator voltage, differential protector is installed shared for the whole block. In case there is circuit breaker at generator voltage, there must be differential protector separately for generator and differential protector separately for transformer.

When using block with two transformers instead of one, also as the case of two generators connected block with one transformer and without circuit breaker at generator voltage (boost block), longitudinal differential protector must be installed separately on each generator and transformer with capacity of

125MVA upwards. In case there is not current transformer available at low voltage of transformer, differential protector is allowed to share for both transformers.

For block with generator directly cooling conducting wire of the coil, longitudinal differential protector should be installed separately for generator. In case there is circuit breaker in voltage circuit of generator, differential protector must be installed separately for transformer (or separately for each transformer if block with generator working with two transformers, without current transformer available on input of low voltage of these transformers, allowed to share differential protector for transformers of block); in case there is not circuit breaker available, in order to protect transformer, it should install either separate differential protector or general differential protector for block (for block including one generator and one transformer, the best way is using general differential protector for the whole block).

At high voltage of transformer, differential protector of transformer (block) can connect with current transformer available in transformer of block. At that time, separate protector must be placed in order to protect bus bar between circuit breaker at high voltage and block of transformer.

Separate differential protector of generator must implement following three-relay three-phase diagram and start current similar to which stated in Article IV.2.35.

In order to provide for those above mentioned differential protectors, in block with generator 160MW upwards directly cooling conducting-wire of the coil, standby differential protector must be installed covering the whole generator, transformer and bus bars at high voltage.

Standby differential protector should be also installed for generator directly cooling conducting-wire of the coil with capacity smaller than 160MW.

When backup differential protector is applied on blocks without circuit breaker in voltage circuit of generator, main differential protectors should be installed separately for generator and transformer.

In case there is circuit breaker in generator's circuit, standby differential protector must finish the impact action in the time from 0.35 to 0.5 second.

IV.2.75. For generator in which stator coil has two or three turnouts in parallel, differential protector must be placed horizontally on one system in order to be against short-circuit between wire circles in one phase with timeless impact.

IV.2.76. For block of generator with capacity from 160MW upwards directly cooling the conducting-wire of the coil, reverse sequence current protector must be installed with specialty of dependable integral combined with specialty of allowable reverse sequence current overload of protected generator. Protector must take switch-off action on circuit breaker of generator, or switch off the whole block if

there is not circuit breaker. In order to protect backup for elements nearby of the block, the above mentioned protector must have independent timeless specialty for switching off the block out of the mains and have two time stages in accordance with Article IV.2.80.

For block that has generator with capacity smaller than 160MW directly cooling the conducting-wire of the coil and for block that has water turbine generator with capacity over 30MW indirectly cooling, reverse sequence current protector must be implemented with time stages or dependable time specialty. Then, there can be one or many impact time stages at every stage of protector (see Article IV.2.80 part 4). Time stage or dependable time specialty must be coordinated with specialty of allowable reverse sequence current overload of generator (see Article IV.2.40).

It is obligatory to do protection for the block which contains the direct cooling electric generator with the capacity larger than 30MW as requested at Article IV.2.40.

Besides the protection on machine turn-off impact, all the blocks containing the electricity generator with capacity over 30 MW must be equipped with countdown signal to warn against the electric overload as in Article IV.2.40.

IV.2.77. As for the block containing the electric generator with capacity larger than 30MW, the symmetrical protector against short external circuit must be applied as stated in Article IV.2.41. As for hydraulic turbine electric generator, the starting voltage of protection is equal to 0.6-0.7 nominal voltage. As for the block containing the backup stimulator, the above protection must be done by the relay connected toward the high pressure part.

As for the block containing the over-60MW generator, the above protector must be replaced by distance protector. As for the block containing the cooling electric generator directly to the wires, it is allowable to replace differential backup protector (consultation to Article IV.2.74) by the two-level distance protector against multi-phase short circuit.

At the first level of this protector, to do close backup, there must be tool to lock against fluctuation and impact as pointed out in Article IV.2.80, section 3 with the time period not longer than 1 second. The first level must ensure to certainly cover the whole block's transformer, whilst ensure the selectivity of the protection for surrounding elements. It is obligatory to apply backup for the first level of the electricity generator's protector if the separate differential protection is placed on the block for the generator and the transformer.

The second level of protection is to do remote backup, as pointed out in Article IV.2.80, section 2.

Even if there is backup differential protector, to increase the efficiency of remote backup, it is advisable to place the two-level distance protector.

IV.2.78. As for the electricity generator with capacity up to 30MW, the protection against short circuit outside must be done according to Article IV.2.42. The protection's parameters of impact on hydraulic turbine generator follow the Article IV.2.41, IV.2.42, and IV.2.77.

IV.2.79. As for the transformer -electricity generator block with breaker machine within the generator circuit, when there is no backup differential protection for the block, the current protector must be placed onward the high pressure side to backup for the transformer's main protectors when the block is working without electricity generator.

IV.2.80. It is necessary to take into account the following requirements for the backup protector for the transformer - electricity generator block:

1. The protector is not placed on the side of the transformer's electric generator's voltage.

2. The remote backup protection has two levels of time: at the first level, isolating the diagram on the block's high pressure part (eg: cutting the intercom bus and segment breaker), at the second level, cutting the block out of the electricity network.

3. The close backup protection must be made cutting through the block (or the power generator) out of the network, stopping the generator's magnetic, and stopping the block as in Article IV.2.88.

4. Each level of protection or backup protection for the block depending on their duty to act as remote backup protection and close backup protection, may be one level, two level or three-level time.

5. The protector's voltage start circuit as in Article IV.2.77 and IV.2.78 should be placed on the power generator's voltage and the network side.

6. As for the main protector(s) and backup protector(s), normally there are separate outlet relay and the DC is provided through different automats.

IV.2.81. As for the blocks containing the stator's symmetrical overload protection for power generator, to do as for the one working on the intercom bus (please see Article IV.2.46)

At the hydraulic turbine power generator without the operator, besides the signaling of stator's circuit symmetrical overload, it is necessary to apply protector whose time feature does not rely on the period longer than the block cutting impact (or power generator) and period shorter than the overload reduction impact. These protectors could also be replaced by the relevant equipments in the system of stimulus adjustment.

IV.2.82. As for the over 160MW wire-coil-cooling power generator, the protection against rotor wire-coil current overload must be done with the depending time integral corresponds to the allowable overload characteristics of the generator caused by the stimulus current.

In case it is impossible to relay the protection into the rotor current circuit (eg, in case of stimulus without carbon brush), it is allowable to use the protector with independent time characteristics, which reacts to the sharp rise of voltage in the stimulus circuit.

The protector must be capable of shortly maintaining time to reduce the stimulus current. When there is overload limitation equipment at the overload reduction impact stimulus regulator, it must be done synchronously at this equipment as well as in rotor. It is possible to use the overload limitation equipment at the stimulus regulator to have impact on overload reduction (with two-period levels) and cutting machine. In this case, it is not necessarily to apply protector with dependable time integral characteristics.

As for the under-160MW capacity direct cooling-wire power generators and over-30MW capacity indirectly cooling-wire hydraulic turbine power generators, it is necessary to apply protector as set in Article IV.2.45.

When there is group stimulus regulator in generators, it is necessary to apply protectors with dependable time characters.

When the generator is working with backup stimulator, the protector against rotor's overload must be set at the working level. In case, it is not capable of using dependable time-characterized protector, it is allowable to place at the backup stimulator the independent time-characterized protector.

IV.2.83. As for the block containing the over-160 MW power generator, to prevent the high-risen voltage when working at the no-load mechanism, it is compulsory to place the high-rise voltage preventive protector. This protector shall automatically lock (when not working) when the power generator is operating in the electricity network. When the protector takes effect, it must guarantee to terminate magnetism of the generator and stimulator.

As for the block containing the hydraulic turbine power generator, in order to prevent against voltage rise when the generator is out of load suddenly, it is necessary to place protector against high-rise voltage. The protection must impact on cutting block (or power generator), and stopping the generator's magnetism. It is allowable for the protector to result in terminating the assembly.

IV.2.84. As for hydraulic turbine power generator, rotor hydraulic wire-coil cooling and all other over 160MW-capacity power generator, it is required to place protector against one-point ground at the simulator circuit. As for hydraulic turbine generator, protection which leaves impact on cutting machine is still in another generator- signaling.

As for the generator with capacity lower than 160MW, it is necessary to place protector against second-point ground in the generator's stimulation circuit correspondingly to Article IV.2.47.

IV.2.85. As for the over 160MW directly wire-cooling power generators and hydraulic turbine generator, the protective equipment against non-synchronous and out of stimulation status must be placed.

The protector should also place at the power generator with capacity lower than 160MW, cooling directly wires. As for these generators, it is allowed to place non-synchronous discovery automats when the magnetism-terminating equipment automat cuts (no need to use non-synchro preventive protector).

When the generator is out of stimulation, turning the non-synchronous mechanism, all the automats and magnetism terminators must impact on signaling the "out of stimulation" status and automatically turning additional charge in the branch of "out of stimulation" to the backup supply.

All the hydraulic turbine power generator and steam turbine as well as other power generators, it is not allowable to work at the non-synchronous regime when the electricity system is lack of quadrature power, all the above equipments must be cut off out of the electric network.

IV.2.86. In case there's breaker in the circuit of the directly wire-coil cooling power generator, there must be backup protector when this breaker fails to cut (Eg: using backup protector).

IV.2.87. The backup protector over 110kV in power station must be applied as follows:

1. To avoid wrongly breaking certain blocks by backup protector(s) in case of non full-phase mode in one of the blocks due to the breaker whose each-phase transmitter fails to work. When cutting the breaker in the power plant with wire-coil cooling power generator, the backup protector start-up accelerator must be placed (eg: by the block's transformer zero-order current protector at the side of the electric network which has the large ground line).

Backup protector is often set to cut off the breakers after 0.3 seconds.

2. As for the power plant whose transformer-power generator – lines has the same breaker (eg: one point and a half network or polygonal network), the remote breaking to cut breaker and lock the UPS (uninterruptible power supplier) at the opposite end when backup protector impacts in case it is started up from the block's protector. Besides, backup protector impacts to stop the frequency transmitter of the high-frequency protector.

IV.2.88. The power generator' stator's protector and the block's transformer against the inner incident and generator's rotor's protector upon effecting must cut the incident factor out of the network, stopping magnetism of the generator and stimulator, starting up backup protector and effecting on the equipment's process of technology protection. (Eg: process of terminating the steam turbine, etc.)

If due to the protector's breaking, leading to self-electricity cut-off connected to the block's branch, the protector should also cut the breaker of the self-working supply to automatically turning to the backup supply by the automatic transfer switch (ATS).

The generator's backup protector and the block's transformer when there is short external circuit must have effect corresponding to Article IV.2.80, section 2 to 4.

In heat power plant that the heat part is working in block diagram, when cutting the block due to the inner incident, the whole block must be terminated. When there is short external circuit as well as protector effects in cases that it could be rapidly restore the block's working, the block should be turned to non-synchronous working mechanism, if the technology allows.

As for hydroelectricity power station, when there is incident inside the block, besides cutting the block, the machine group must be stopped. When cutting the block due to external incident, there must have effect to terminate the machine group.

IV.2.89. As for the generator-transformer-lines block, the main protector for the lines and the backup protector towards the electricity system must be made as required in this chapter on protecting the lines; from the block's side, the lines' backup protection function must be done by the block's backup protector. The block's protector must be made in correspondence to the above-mentioned requirements.

The effect of block's protector on cutting the breaker and starting up backup protector from the electricity system's side must be transmitted via high-frequency channel or communication line to the two the reciprocal remote breakers. Besides, when the block's protector effects, it is necessary to stop the high-frequency protector's transmitter at the same time.

As for the block containing the steam power generator whose heat part follows the block's diagram. The signal effects from the end of electricity system must transmit to the opposite end of bus bar protector's signaling line (in case the double bus bar system is used) or backup protector effect (when using the one and a half diagram or polygonal diagram) to be compatible to turning the block to no-load or magnetism termination and stopping the block by remote breaker. Besides, the remote breaker should be used to accelerate the generator's speed of magnetism termination and cutting the self-circuit when the backup protector from the electricity system effects.

In case the breaker cuts non-whole phase from the big-ground current electricity net, we should accelerate the backup protector start-up as pointed out in Article IV.2.87, section 1.

Protection for overhead power lines (OPL) or cable lines in the neutral isolated electric network 6-15kV

IV.2.90. As for the lines (overhead power line-OPL or cable lines) in the neutral isolated voltage network (even the neutral ground-connecting via the arc-suppression coil), there must be relay protector against multi-phase short circuit and when necessary against one-phase grounding.

IV.2.91. Protection against multi-phase short circuit and in the two same-name phases of the whole electricity network to guarantee to cut only at a breakdown point, in most cases short circuit two phases grounding at two points.

IV.2.92. As for the single line supplying from one side, to prevent against multi-phase short circuit, the two-level current protector must be placed; the first level is under rapid break, and the second level-under the protection of over-current with either dependent or independent time feature.

As for the cable which does not have reactance with the supply from one side originating from the power plant's bus bar, it is mandatory to place the timeless rapidly-cut protector whose effect zone is defined in the condition of cutting short circuit together with residual voltage on the power plant's bus bar lower than (0.5 ÷ 0.6) U current. To implement this, the protector is allowable to non-selective effect in coordination with automatic transfer switch (ATS) or Uninterruptible power supplier (UPS) acting as the adjuster of the whole or a part of the network non-selectively effected by the protector. It is allowed to place the above rapidly-break protector in the lines originating from the electrical substation supplying for huge synchronous motors.

If the cable line does not have one-sided supplied reactance, therefore, it is impossible to place rapid break protector as selective requirements, then to guarantee the rapid break effect, the protector must be placed as in Article IV.2.93, section 2 or 3. It is allowable to use these protectors for self-lines of the power plant.

IV.2.93. As for single line whose supply is from both sides, either round communication or not, as well as for the line within the one-supply closed loop electricity network, the protector must be placed like one-side supplied single line (see Article IV.2.92) but applying directional current protector when necessary.

To simplify protectors and guarantee them to have selective effect, it is allowed to automatically separate the net into the ray-shaped net when incident occurs and subsequently self restore.

To protect the current, with direction or without direction, with time level not guaranteeing sensitivity and rapid effect, it is allowable to use the following protectors:

1. The most simple distant protector

2. The current horizontal differential protector (as for double cables)

3. Longitudinal differential protector for short lines; if we have to set the second cable only used for differential circuit then the cable length is not longer than 3km.

As for protectors pointed out in section 2 and section 3, the current protector acts as the backup protector.

IV.2.94. When doing protection for parallel lines 6 ÷15 kV, we must observe the regulations on parallel lines in the 35kV electricity network. (please see Article IV.2.103.

IV.2.95. The protector against ground one-phase must be done in form of:

- Selective protector (directional) effects on signaling.
- Selective protector (directional) effects on break when necessary upon the requirements on safety; protector must be placed at all elements that have supplies in the whole electricity network.
- Electricity isolation test equipment. The incident factor seeking must be done by professional equipment, which allows to seek incident factor by subsequently breaking the net clues one by one.

IV.2.96. The protection against ground one-phase short circuit in general must be done with zero order current transformer. The protector must effect on the remained ground short circuit, but allows to use the flash-over ground signaling equipment.

The protection against one-phase ground break timeless as the safety requirement (see Article IV.2.95), only cuts the factor that supplies electricity for the incident-occurred net. In this case, in preservation, use timeless order protection around 0.5 second, cut all the electric nets concerning to the bus bar system (segment) or transformer source.

Normally, it is not allowable to increase the current in booster to do effectible protection in the neutral net grounding through arc-suppression coil (eg: by changing levels of the coil).

Protection of overhead power lines (OPL) or cables

in the neutral isolated 22-35kV voltage grid

IV.2.97. As for the overhead power lines (OPL or cables) in the 22-35kV neutral isolated voltage grid, there must be relay protection equipment against multi-phase short circuit and against one-phase ground. The concrete types of protection against one-phase ground shall be done according to Article IV.2.95.

The lines must be equipped with incident parameter recorder.

IV.2.98. In protection against multi-phase short circuit, we must use the two-phase two-relay diagram and place on the same name phases in the whole electric network to guarantee only cut one damaged point in most of two-point ground short circuit cases. In order to increase the sensitivity upon short circuit after transformer star-triangle, it is allowable to use three-relay diagram.

The protector against one-phase short circuit normally effects on signaling. To perform protection, it is advisable to use electric isolated tester.

IV.2.99. When selecting the main protector, we must calculate the requirements the guarantee that the system's working stably and the charger's reliably, similar to the voltage 110kV line protection (see Article IV.2.107).

IV.2.100. As for the single line with one-sided supply, to prevent against multi-phase short circuit, the priority is given to the protection of the level current or the level less-voltage miscellaneous current. If those protectors do not reach the requirement on selectiveness or short-circuit break rapid effect (see Article IV.2.107). Eg: on the ends of the lines, prioritized level distant protector is used to start up along with the electric current. In case the distant protector is used, it is advisable to place the timeless rapid current break protector to be the auxiliary protection.

As for the line which has many consecutive segments, to simplify procedures, it is allowable to use current protector in combination with level less-voltage, non-selective, in coordination with the UPS (uninterruptible power supplier) in order.

IV.2.101. As for the single line with the two-sided or multi-sided supply (the branched lines) with or without round communication circuit, as well as the lines within the one-sided supply closed loop (see Article IV.2.100) but the directional circuit is added, and the distant protector starts up by resistant relay. Then, it is allowable to break non-selectively the surrounding elements upon short circuit in the dead area based on the capacity directional relay voltage, when the current rapid break protector is not placed to be auxiliary protection (see Article IV.2.100), eg: due to not reaching the sensitivity. The protector is only placed where the electricity supply is capable of reaching at.

IV.2.102. As for the two-sided supply short lines, when there is requirement on rapid effect, it is allowable to use vertical differential protector to be the main one. If necessary to place the secondary cable only to be used for the differential circuit, the cable's length could be more than 4 km. To test the secondary cable of the vertical differential protector, there must be specialized equipment. To do backup for the differential protection, we must place one of the protectors specified in Article IV.2.101.

IV.2.103. As for the parallel lines which have the supply from two sides or more, or have the parallel line's supply from one side in its end, we could use protectors like the single lines. (see Article IV.2.100 and IV.2.101).

To speed up the short circuit break, specifically when using the level-current protector or the protector of the current in coordination with low voltage level-one that has the supply from both sides, we could place further the protector that has the capacity direction on the parallel line. This protection could be done either in form of either separately directional current protection or in the form of the available protectors' acceleration circuit (current protector, distant protector) together with the capacity direction tester on the parallel line.

On one end of the parallel line which has the supply from one side, normally we have to place the directional horizontal differential protector.

IV.2.104. If the protection as pointed out in Article IV.2.103 does not reach the requirement on fast impact (see IV.2.107) and the capacity-directional testing protector is not placed, then on the two parallel lines whose supply is from both sides and on the end of the parallel line whose supply from one side, we have to place directional differential protector to be the main protection. (when the two lines' working in parallel).

Thereof, in the one line working status as well as in the backup apparatus when the two lines' working, we should use multi-layer protectors as in Article IV.2.100 and Article IV.2.101. It is allowable to connect this protector or each level according to the total current of both lines' diagram (eg: the backup level to increase the sensitivity in case of short circuit in the surrounding elements). It is allowable to use directional horizontal differential protection in addition to the level current protector to reduce the time of breaking circuit at the protected line. If considering the rapid impact (see Article IV.2.107), it is not mandatory to place this protector.

In particular case, as for the short parallel lines, it is allowable to place the vertical differential protector. (see Article IV.2.102).

Protection over the overhead power lines (OPL) or cables in the effective neutral ground voltage grid 15-500kV

IV.2.105. As for those lines (overhead power lines-OPL or cables) in the effective neutral ground voltage net 15-500kV, there must be protector against multi-phase short circuit and ground short circuit.

The lines should be equipped with incident parameter recorder.

For the lines over 110kV, there should be equipment to allocate the incident point within the line(s).

IV.2.106. The protectors must be equipped with the lock against fluctuation if there is possibility of either fluctuation or non-synchronism in the net leading to malfunction. It is allowable to use the protector without fluctuation lock if it is adjusted to the time of fluctuation about (1.5 ÷2.0) seconds.

IV.2.107. As for the overhead power lines (OPL) 500kV, the main protection is the one that impacts immediately when short circuit in any point on the protected lines.

As for the long OPL 500kV, to avoid the over-voltage when out of load due to a line breaker is cut upon the impact of the protector, if necessary, we have to put the associated breaker to cut others on the line towards the source.

As for the overhead power lines (OPL) 110-220kV, when selecting the main protector, we must use the rapid impact protector when short circuit in any point on the protected line, we should also consider maintaining the stable operation of the electric system. If according to calculations over the system stability, it does not need other harsher requirements, the above mentioned could be satisfactory. When there is three-phase short circuit, the surplus voltage on the bus bar of the power plant and of the electrical substation is lower than 0.6-0.7 $U_{current}$, the protector breaks timelessly. The number of surplus voltage is lower than 0.6 $U_{current,}$ it could be allowable to the 110kV line, and as for the less important 220kV one (in the strong branch electrical net, normally the additional household charge is supplied from various sources), even the important 220kV lines when short circuit, it does not lead to break much over overloading.

The over 110kV cable protection must be done as the overhead power lines'; if the pressure oil cables, we must set the oil spill supervisory and anti-high increased oil spill protection parts.

When protecting the type of protector for the 110-220kV lines, besides the requirements to maintain the stable working mechanism of the electrical systems, the following conditions must be regarded:

1. If breaking over the time incident could lead to damage the working of important additional loading, we have to cut timelessly (eg: incident in which the surplus voltage on the bus bar of the power plant and substation is lower than $0.6U_{current}$, if cut with time period, it could lead to self-dismiss of additional load due to the sudden voltage decrease phenomenon; or the incident with the surplus voltage equal and over $0.6U_{current}$, if cut them with time period, it could lead to damage the technology process.

2. When it is necessary to do ATS's rapid impact, then on the line, we have to place rapid impact protector to ensure break timelessly from both sides of the incident line.

3. When breaking incident with time period, with the current certain times higher than the nominal one, it could lead to the exceeding allowable hot generating lines.

It is allowable to use rapid impact protector in the complex electricity net even when there is no condition as above if it is necessary to guarantee the selectivity.

IV.2.108. When assessing the guarantee of requirements on stability, basing on the surplus voltage number according to Article IV.2.107, we have to follow the below instructions:

1. As for the single communication system among power plant or electricity network, the surplus voltage (as mentioned in Article IV.2.107) must be checked at the bus bar of the station and the power plant in this communication system when short circuit on the line originating from this bus bar, except for the line that forms up the communication system; as for the single communication system a part of which is parallel lines, we have to check further upon short circuit on each of these parallel lines.

2. When the power plants or electrical systems are connected by some communication systems, the surplus voltage number (as in Article IV.2.107) must be checked on the bus bar only in the stations and power plants lying in this communication system when there's short circuit in the communication system, on the lines which are supplied from the bus bar even on the lines supplied from the bus bar of the communication stations.

3. The surplus voltage must be checked when there is short circuit at the end of the impact region of the first-level protection pursuant to the mechanism of breaking incident in sequence like spiral, ie: after breaking the breaker on the opposite side of the line by timeless protector.

IV.2.109. As for the over-110kV single line which has supply from one side, to be against multi-phase short circuit, it is advisable to place level current protector or level low voltage coordinator current protector. If these protectors do not reach the requirements on sensitivity or the level of rapid impact (see Article IV.2.107), eg: on the ends of the lines or in the condition of sound coordination with the surrounding lines, we have to place level distant protector. In this case, we have to use timeless rapid break current protector to be the auxiliary protector.

To be against ground short circuit, normally we place the non-level order current protector, either directional or non-directional. Generally, protectors should be placed on the sides the electricity supply is capable to reach.

As for the lines consisting of consecutive connections, to simplify, it is allowable to use level less-voltage coordinator current protector, non-selective impact (against multi-phase short circuit), and non-level order current protector (against ground short circuit) in coordination with alternate impact UPS (uninterruptible power supplier).

IV.2.110. As for the over 110kV single line which has the supply from two or more sides (the branched lines), either having or not having the loop circuit contact, as well as within the one-supply-source close

loop circuit, to be against multi-phase short circuit, we have to distant protector (priority given to three-level protector) to be the main protector (as for the 110kV-220kV) and to be backup protector when there is differential protector on the line.

The timeless rapid break protector is used as the auxiliary one. Specifically, it is allowable to use the rapid break current protector to impact when there is three-phase short circuit near the place where the protector is put, if the rapid break current protector impacts on another mechanism does not reach the requirement on sensitivity. (see Article IV.2.25).

To be against ground short circuit, normally we have to use the non-level order current protector, either directional or non-directional.

IV.2.111. It is advisable to use directional one-level current protector to be the main one against multi-phase short circuit on the end that inputs electricity of the one-side supply loop circuit net; as for other single lines (mainly the overhead power line 110kV) specially it is allowable to place the level current protector or level less-voltage coordinator current protector, in necessary it could be the directional one. The protector only needs to be placed at the supply part.

IV.2.112. As for the parallel lines whose supply source are from two sides or more as well as the supply source end of the parallel line which has one supply source from one side, we could use the respective protector like the single line's. (see Article IV.2.109 and IV.2.110).

To accelerate the speed of breaking the ground short circuit, especially the short circuit among phases on the line which has two supply sources, we could use supplementary protector with the capacity direction being checked on the parallel lines. This protector could be done in the form of separate horizontal differential protection (relay connected to the zero order current or into the phase currents) or only in the form of accelerated circuit of the placed protectors (zero order current protector, over-current protector, distant protector, …) with the capacity direction being checked on the parallel lines.

To increase the sensitivity of the zero order protector, it is allowable to set the supplementary protector out of status when breaking the breaker of the parallel line.

On the ends that input electricity of the two parallel lines whose supply source is from one side, we could place directional horizontal differential protector.

IV.2.113. If the protector as in Article IV.2.112 does not reach the requirement on rapid impact (see Article IV.2.107), we could place directional horizontal differential protector to be the main one (when the two lines working parallel) on the supply source end of the two 110kV-220kV parallel lines whose supply source from one side and on the 110kV line mainly of the parallel distribution net whose supply source is from two sides.

In the working status of one line as well as the backup working status of the two working lines, we use protector pursuant to Article IV.2.109 and IV.2.110. It is allowable for this protector and its particular level to be connected to the overall diagram of the two lines (eg: the last level of the zero order current protector) to increase its sensitivity when incident occurs in the surrounding elements.

It is allowable to use directional horizontal differential protector to be the supplementary one for the level current protector for the parallel 110kV line to decrease the time of breaking incident on the protected line when on the condition of rapid impact (see Article IV.2.107) it is not mandatory.

IV.2.114. If protectors as in Article IV.2.110 to Article IV.2.112 do not reach requirements on rapid impact (see Article IV.2.107), we have to place high-frequency protector and vertical differential protector to be the main one for the two side supply lines.

As for the 110kV-220kV line, we should use high-frequency lock distant protector and the directional zero order current protector to be the main one, reasonably to the sensitivity condition (eg: on the branched lines) or to simplify protection.

When it is necessary to place the secondary cable for the vertical differential protector, we have to base on the economic-technical calculation results.

To check the secondary circuits of the protector, we must use specialized equipments.

As for the 500kV line, we should add the signal transmitter of the break or settlement to the high-frequency protector to increase the impact of the level-backup protector.

It is allowable to use break-signal transmitter to increase the 110-220kV multi-level protector if there is requirement on rapid impact (see Article IV.2.107) or sensitivity (eg: on the branched lines).

IV.2.115. When applying the main protectors as in Article IV.2.114, we use the followings as the backup protectors:

- To be against multi-phase short circuit, normally we use distant protector, mainly three-levels.
- To be against ground short circuit, we use *level, directional* current protector or *non-directional, zero order* current protector.

In case the main protector needs to stop working in a long period of time, as stated in Article IV.2.114, when this protector is required to break rapidly the incidents (see Article IV.2.107), it is allowable to accelerate the speed of non-selective impact of the backup protector against short circuit among phases (eg: testing the value of multiplying voltage).

IV.2.116.The main protector, the level of rapid impact of the backup protector against multi-phase short circuit and the measurer of the one-phase UPS with the 500kV line must be excellently implemented to

guarantee their normal functions (with the prior given parameters) on the condition of the excessive electromagnetic transitional process and the line's excessive conductance capacity. To do that, the following devices are necessary:

- In the one-phase UPS's measurement and protection loop, there must be measures to limit the impact of excessive electromagnetic process (eg: low frequency filter).
- In the high-frequency differential protection, placed on the line whose length is more than 150 km, there must be booster the line's capacitance.

When connecting rapid impact protector into the overall diagram of the two current transformers or more, in case it is impossible to fulfill the requirements as stated in IV.2.28, it is advisable to use special measures to avoid the wrong impact of protector upon short external circuit or placing a separate current transformer into the line circuit for the protector.

In the protectors on the 500kV lines with vertical booster, measures must be applied against protector's wrong impact when short external circuit due to the affection of the above equipments. Eg: we could use reverse-order capacity-directional or settler-signaling relay.

IV.2.117. In case of using one phase UPS, the protector must be done so as to:

1. When one phase ground short circuit, particularly when two phase short circuit, it is guaranteed to switch off one phase (then UPS' working)

2. UPS fails when there's incident as supposed in section 1, one or three phases will be cut off depending on it is possible or not to exist the long non-integral phase status of the line.

3. When incident of other forms occurs, the protector shall impact on cutting off the whole three phases.

IV.2.118. The lines 15-35kV in the distribution network, if there is no special requirements, could be only equipped with rapid break, excessive current, and ground protectors if the selectivity is ensured.

Horizontal and vertical booster capacitor protection

IV.2.119. Horizontal booster capacitor could be concentrated at the station or dispersed on the overhead power lines (OPL), with all voltage stages.

IV.2.220. When dispersed on the OPL, the horizontal booster could be simply protected by suitable fuse or fuse cut-out. For the selection of fuse for capacitor, please see the regulations on Article IV.2.3.

IV.2.121. When concentrated at the station, the horizontal booster capacitor is normally placed behind the breaker with the following protectors:

- Fuse to protect singly for each single capacitor elements. The fuse could be placed outside or inside the capacitor bottle.
- The over-current protector for each phase.
- Non-balance current protector among branches in one phase and/or non-balance protector among phases.
- Over-voltage protector

Besides the above protectors, the booster capacitors often are set with auto switch on-off (wholly or partly) adjusted in accordance with the system's concrete requirements.

VI.2.122. The vertical booster capacitor could be concentrated at the station or dispersed on the OPL.

The vertical booster capacitor are set with protectors as the horizontal one which has been referred previously in IV.2.121, only different when the protection takes effect, it does not cut off the protected capacitor element out of the electric network, but results in switching off bypass breaker capacitated in all three phases of the capacitated elements.

Once the vertical booster capacitor is started up without effecting on switching off bypass breaker, the interconnection shall cut off breakers on the supplied lines.

Bus bar protector, loop breaker, bus bar communication breaker and segment breaker

IV.2.123. The bus bar system ≥ 110kV of the following power stations and substation must be equipped with separate relay protector:

1. As for the two bus bar system (dual bus bar, one and a half diagram, etc.) and the segmented single bus bar system.

2. As for the non-segmented single bus bar system, if it is unallowable for the switch-off over incident on the bus bar by effecting from the protectors for elements connected to bus bar on the conditions of Article IV.2.108, or if the bus bar provided for the branched lines.

IV.2.124. We have to set separate protector for 35kV voltage bus bar of power plant and substation in the following cases:

- Conditions as in Article IV.2.108

- As for the two bus bar system or segmented bus bar, if using separate protector placed at the bus bar communication breaker (or segment breaker), or protector placed at the factor provided power for this bus bar system is not reliable for household consumers. (the capability of ATS and UPS is taken into account).

- As for bus bar of the close distributor, it is allowable to lower the requirements for bus bar protection (eg: in the net containing strong ground short circuit current, only the ground short circuit protector necessary) due to the probability of incidents lower than the uncovered distributor.

IV.2.125. To protect the bus bar of the power plant and transformer substation with the voltage ≥ 110kV, it is advisable to set timeless current differential protector covering all the factors connected to the bus bar or segments of the bus bar. The protector must use the specialized current relay set to the excessive current and itransformerlanced stable current (eg: relay connected via saturated current transformer, brake relay)

When connecting 500kV transformer through ≥ 2 breakers, it is advisable to use current differential protector for the bus bar.

IV.2.126. As for the dual bus bar system of the power plant and transformer substations ≥ 110kV, at each circuit connected to the bus bar, there must be a breaker and the differential protection is applied. The bus bar protector must be able to meet all the demands of means of operation by switching the connection on the lines upon switching circuits from this bus bar system to another.

IV.2.127. The differential protectors stated in Article IV.2.125 and IV.2.126 must be applied with the tester over the perfection of the current transformer's secondary circuit. This equipment must effect with time period to separate the protectors and signal when the circuit is not perfect.

IV.2.128. As for the bus bar with 6-10kV segments in electric plants, it's a must to use incompletely differential protection in two phases, of which the first phase is done by fast cutting current and potential or distance protection; the second phase is carried out by over-current protection. The protection must cut all the feeding sources and self-used potential transformers.

If the second phase done as mentioned above is not sensitive enough when short-circuit is implemented in the differential protection area of feeder main with reactance (additional charge on the bus bar of the big generator, the breaker of supply line placed behind reactance coil), another protection needs carrying out in the way to protect current with or without potential start placed at reactance circuit. The impact of this protection on cutting supply elements must be controlled by auxiliary apparatus started up when short-circuit happens. In that case, it is necessary to have protection in segment breaker to handle troubles between reactance coil and breaker. This protection is operated on by the time segment breaker

is cut. When supply elements are moved from this segment to another, there must have incompletely differential protection done according to the rule that elements are fixedly distributed.

If the operating condition that splits electric supply elements from this bar to another is regularly driven, individual distance protection can be placed on all electric supply elements, except current generator.

IV.2.129. As for 6-10kV bus bar system with segments of electric plant which has electric generator up to 12MW, no privacy protection can be installed; then in order to handle short-circuit on bus bar, it must be done by protecting the current of electric generator.

IV.2.130. As for single and double 6-10kV bus bar system with segments in depression transformer station, no privacy protection is often installed, but it is necessary to have protection against outside short-circuit of potential transformer placed on segment breaker or communication breaker to handle troubles on the bus bar. To increase sensitivity and action speed of bus bar protection in big transformer stations, a protection can be switched in according to the current diagram of electric supply elements. When there is a reactance coil placed at the line originating from the bus bar of transformer station, bus bar protection is allowed to function as that of electric plant.

IV.2.131. When current transformer is pre-set in breaker, differential protection of bus bar and protection of bus bar united elements, it is compulsory to use current transformer placed at any side of breaker so that the troubles of breaker are in the operating zone of protection.

If there is not current transformer pre-set in breaker, to save money, outside current transformer should be used only in one side of breaker and placed in the way that the breaker is in the area of bus bar differential protection. By then, in double bus bar protection of fixedly distributed elements, it needs to use two current transformers of segment breaker.

To carry out differential protection of bus bar, current transformer can be placed in both sides of 6-10kV segment breaker, if structure condition is admissible, there is no need to have additional drawer. When privacy distance protection functions as bus bar protection, current transformers of this protection in segment breaker circuit must be placed between bus bar segment and reactance coil.

IV.2.132. Bus bar protection needs functioning so that, upon switching on trial with the failure of bus bar or bus bar segment, protection must selectively cut at any time.

IV.2.133. As for ≥110kV detour breaker, when there is bus bar communication breaker (or segment breaker), there must be the following protections (used in case of checking or fixing protection, the breaker and current transformer of any element connected to bus bar):

- Three-grade distance protection and high-speed cutting current protection against multi-phase short-circuit.

- Current protection in order except four-grade one against earth fault short-circuits oriented.

Simultaneously, bus bar communication breaker or segment breaker (used to separate bus bar system or segment bus bar when backup protector doesn't exist, is discarded or used to protect the bus bar in working order, and to increase the efficacy of further backup) must have kinds of protection as follows:

- Two-grade protection against multi phase short-circuits.
- Current protection in order except three-grade one against earth fault short-circuits.

It is possible to place a more complex protection on bus bar communication breaker (or segment breaker) if it is a need to increase the efficacy of further backup)

On ≥110kV bus bar communication breaker (or segment breaker) functioning as a detour, there must be protections like those of detour breaker and of bus bar communication breaker (or segment breaker) when they are in separately running order.

It is advisable to turn the main protections with quick action of ≥110kV line into detour breaker.

On 6-35kV bus bar communication breaker (or segment breaker), it needs placing two-grade current protection against multi phase short-circuit.

IV.2.134. It is better to have a privacy protection cabinet backup for replacement in case the line protection cabinet is repaired, or there is not detour breaker in the diagram (for example quadrangular diagram, 1+1/2 diagram…); This cabinet should be placed for 220kV line without privacy main protection, and 500kV line.

For 110kV line without privacy main protection, it is possible to place privacy protection cabinet backup in the bridge diagram which has breaker at line cir circuit and the polygon diagram if when the check of line protection cabinet is done to overcome break-down on that line without completion by using simple device.

Synchronous booster protector

IV.2.135. The relay protection device of synchronous compensator must work the same as that of current generator with equivalent power, but have the following differences:

1. Current protection against push-pull overload so as to notify signal must be stopped operating when thse compensator starts, if the protection can act upon.

2. Under-voltage protection used to switch off the breaker of synchronous compensator must have the starting voltage of protection of (0.1÷0.2) Udđ and the holding time of about 10 seconds.

3. It is necessary to install action protection when the station is in short interruption (e.g., during the time without electricity of UPS of power supply cord).

The protection needs doing in the form of protecting low frequency and switching off the breaker of synchronous booster or auto electro-magnetic switch-off. It is also allowable for protection to work on a different principle (e.g., reacting at the speed of reducing frequency)

4. As for ≥50MVAr synchronous compensator, it is a need to place protection for cutting synchronous compensator or notifying signal when excitation is out or excitation current is lower than permissible limit. As for synchronous compensator that can run in the condition of negative excitation current, the above mentioned protection can not be used.

5. As for synchronous compensator running in compliance with transformer, it needs to have protection against earth-fault in stator coil placed at the lower potential of transformer.

When earth-fault current is higher than 5A, it is possible not to place arc-suppression coil and to implement over-current protection with two-grade of time: the small grade is to notify signal, the big one is to switch off breaker of compensator.

When earth-fault current is higher than 5A, current protection functions one time grade and notifies signal. As for synchronous compensator with the capacity of ≥50MVAr, it is a must to have protection notified signal or cut.

IV.2.136. As for the station without staff on duty, protection against overload of synchronous compensator must have all of the characteristics as working in independent time, notifying signal and reducing excitation current with low time grade, but cutting synchronous compensator with high time grade (if excitation controlling device can not stop overload for a long time)

IV.2.137. The same protection against earth-fault in excitation circuit must be done as that of hydroelectric generator. (Refer to Article IV.2.84)

Chapter IV.3

AUTOMATION AND REMOTE CONTROL

Scope of Application and General Requirements

IV.3.1. This chapter is applied to automatic device and remote control of electric power system, electric plants, grid, supply network for industrial enterprises and other electric installation so as to:

1. Automatically switch off 3-phase or 1-phase current of line, bus bar and other elements after being automatically cut.

2. Automatically switch off current backup.

3. Synchronization, switch synchronous generator and synchronous compensator to put them into synchronous running condition.

4. Control excitation, potential and quadrature power between synchronous electric machines and electric plants to restore the potential in and after short-circuit cutting time.

5. Control frequency and active power.

6. Prevent stable breakdown.

7. End asynchronous condition.

8. Limit reduction frequency.

9. Limit incremental frequency.

10. Limit reduction potential.

11. Limit incremental potential.

12. Prevent the overload of electric device.

13. Moderate and control.

The functions of the devices from Item 4 to 11 can be done completely or partly subject to the working condition of electric grid.

As for electric grids and electric plants, it is possible to install controlling automatic device not belonging to the regulations in this chapter, but of those in other documents. The action of those devices must be in reciprocal association, and with that of the system and devices mentioned in this chapter.

In electric consumption business grid, it is advisable to use automatic devices with option of not disrupting important production processes upon ending short-term electric supply caused by the action of protection and automation in and out of power line.

Uninterruptible Power Supplier (UPS)

IV.3.2. UPS devices are used to quickly restore electric supply for consumers or communication among electric grids or in in-house electric grid by automatic re-closing breakers when they are cut because of relay protection.

It is a must to place automatic re-closing devices at:

1. Overhead power line (OPL) and cable line combination and OPL of over 1kV potential. When UPS is not used, it is obligatory to base on thoroughly analyzing each case. As for up to 35kV cable line, it is better to use UPS in the cases which there is effect because of open arc (e.g., there are too many nodes as one cable line supplies current to some stations simultaneously), also for revision of random action protection. The application of UPS on ≥110kV cable line must be analyzed in designing different cases to adapt to specific condition.

2. Bus bars in electric plants and transformer stations. (Refer to Article IV.3.24 and 25)

3. Transformers (Refer to Article IV.3.26)

4. Important engines cut in order to ensure the auto-start of other engines (Refer to Article IV.3.38)

For applying UPS according to Item 1 to 3, UPS device must be placed at detour breaker, bus bar communication breaker and segment breaker.

In order to save money, it is possible to gather UPS on lines, preferably cable lines, and other 6-10kV routes. However, it is necessary to take the drawback of gathered UPS into consideration such as non-driving possibility is any after cutting the breaker of one route; the breaker of other route is also cut before UPS returns to initial state.

IV.3.3. It is a must to apply UPS so that it doesn't have an effect when:

1. Breaker drivers cut by hands on the spot or by remote control.

2. Breakers automatically cut due to the action of relay protection right after drivers switch on breakers by hands or remote control.

3. Breakers are cut because of relay protection against inside transformer and electric rotating machinery breakdown, the action of breakdown protector as well as in other cases upon cutting breakers but UPS is

not allowed to act. After the action of additional charge discard subject to automatic switch-off to the frequency (freq. UPS), the application must be done in accordance with Article IV.3.80.

IV.3.4. UPS devices must be executed so that there is no possibility of making breakers repeatedly switch upon the existence of short-circuit or break-down in UPS diagram.

UPS devices must be executed for automation to return original state.

IV.3.5. Normally, upon using UPS, it is a must to accelerate the action of relay protection after UPS execution is not successful. It is better to use this acceleration device after switching breakers and the breakers affected by other actions (control lock, remote control or automatic transfer switch-ATS) to function as acceleration device after UPS execution is not successful. When the action of protection is accelerated after switching breakers, it is obligatory to have a measure of preventing breakers from being cut by protection due to the action of sudden rise in surge current because the phases of breakers are not switched simultaneously.

It is not necessary to accelerate protection after switching breakers when lines are supplied by other breakers (i.e. when there is symmetric potential on lines)

If protection becomes too complex and the action time of protection upon the time between direct short-circuit and the position of protection is not over 1.5 seconds, it is allowable not to use protection acceleration behind UPS for ≤35kV lines when the current of that protection is alternating current.

IV.3.6. Three-phase UPS devices (UPS 3P) must be started by virtue of the incompatibility between the position of control lock and the virtual one of breakers or by relay protection.

IV.3.7. It is possible to use UPS 3P to act on once or twice if the running condition of breakers is allowable. It would be better to use the double action of UPS 3P for overhead power lines - OPL, especially single lines with unilateral feeding source. As for up to 35kV electric network, the double action of UPS 3P is often preferentially placed at OPL without standby power source.

In the network with insulated neutral or earth default booster often does the second switch of UPS upon the earth default after the first time of UPS (such as with zero sequence potential). Time for 2^{nd} UPS 3P must be more than 15÷20 seconds.

IV.3.8. In order to speed up the restoration of normal operating condition of OPL, time for UPS 3P (especially the first time of UPS double acting on at the line with one-sided feeding source) must be equal to the lowest number, accounting for time on arc extinction, deionization at the breakdown and ready switch of breakers.

As for lines with two-sided feeding source, upon choosing time for UPS 3P, it is necessary to take the possibility of un-synchronously cutting at two sides into consideration; by then it needn't account for

action time of distant backup protection as well as time on non-concurrently switching off breakers at both sides due to the action of high frequency protection.

To increase the effect of one time action UPS 3P, it is possible to lengthen dead time depending on bearing capacity of additional charge.

IV.3.9. As for the lines upon cutting not to disrupt electric communication among sources (such as for parallel lines with one-sided feeding source), it is advisable to place UPS 3P in non-synchronous checking condition.

IV.3.10. For single lines with two-sided UPS 3Ps, it is a must to place one of the following UPS 3Ps or put them in combination as follows:

1. Quick acting UPS 3P.
2. Non-synchronous UPS 3P.
3. Synchronous UPS 3P.

Besides, it is possible to combine UPS 1P and dissimilar UPS 3Ps if breakers have their own phase-by-phase control and don't disrupt the current regulation of parallel operation upon the action of UPS 1P.

Choosing the class and quality of UPS must base on specific condition of the system and electrical installations in accordance with the provisions specified in Article IV.3.11, 15.

IV.3.11. Normally, quick-acting UPS 3P is placed (simultaneous two –sided witching in the lowest time) on lines according to Item 1 Article IV.3.10 when the angle among electromotive force vectors of the combined systems is small. Quick-acting UPS 3P can be used when breakers allow quick-acting UPS 3P, provided that after switching, it is possible to keep the synchronism of parallel operation system and the maximum electromagnetic moment of synchronous generator and synchronous booster generator is smaller than electromagnetic moment upon the output 3-phase short circuit (accounting for necessary backup).

The number of electromagnetic moment is calculated on the basis of the ultimate angle of deflection (angle of the two driving forces during quick-acting UPS 3P time). Correspondently, quick-acting UPS 3P must be started when quick-acting protection has an effect and protection zone of this type must cover all the line.

It is a must to lock quick-acting UPS 3P when protection backup acts, lock or slow down the action upon the operation of action-proof device of breakers. If using quick-acting UPS 3P to guarantee the stability of the system is not successful resulting in the mass action of auto-anti-breakdown devices, it shouldn't be used.

IV.3.12. It is possible to use non-synchronous UPS with the lines mentioned in Item 2 Article IV.3.10 (particularly 110-220kV) if:

1. Electromagnetic moment of generator and synchrony-compensator comes out upon non-synchronous switching (with necessary backup) smaller than that when 3-phase short-circuit is implemented on the output, the factual standard of estimating if non-synchronous UPS can be used is initial estimated value of cycle elements of stator circuit upon switching angle of 180^0.

2. Maximum flow through transformers (including autotransformers) with switching angle of 180^0 is smaller than that of short-circuit on the output when they are supplied with electromagnetic bus bar of super high capacity.

3. After UPS guarantees quick resynchronization; if long-lasting non-synchronous regime exists due to non-synchronous UPS, it is obligatory to have prevention or termination measure.

If all the above mentioned conditions are responsive, it is allowable to use non-synchronous UPS upon repairing one of the two parallel lines.

While implementing non-synchronous UPS, it is a must to have prevention measure to protect unnecessary action. With that aim, it is advisable to switch on breakers in a certain sequence upon implementing asynchronous UPS, for example, from one side of the line together with checking if there is potential in lines after successfully implementing UPS 3P at the other end of line.

IV.3.13. It is possible to use synchronous UPS on lines mentioned in Item 3 Article IV.3.10 for a line switching when there is quite a high sliding velocity (about up to 4%) and permission rephrasing angle.

It is possible to implement UPS as follows: at one end of the line that switch-off must be carried out first, placing UPS 3P with accelerating (defining action of quick action protection when its protection zone covers the whole line) but without checking potential available on lines or UPS 3P with checking potential unavailable on lines at the other end of sync UPS 3P. Therefore, synchronous UPS can be implemented provided that switching the other end of line is successful.

To do synchronization, it could use the equipment according to the principle of the synchronous connecting pole with the unmodified angle of deflection

The UPS should be done so that there is capability of changing in order switching on the breaker for them in two the ends of line

Upon performing synchro-UPS, it is obligatory to ensure capability to effect with the high frequency deviation for the UPS mechanism

Upon using sync-UPS, the allowed maximum co-phase difference must be applied as stated in Article IV.3.12. It should let the operators operating semi-automatic synchronous connection.

IV.3.14. As for the lines containing the voltage transformers to control without voltage and to control with voltage in the line of types UPS 3P, it should use the reactive equipments according to the line voltage or the phase voltage, the negative sequence voltage and the zero sequence voltage. In some cases, example in the OPL (overhead power lines) equipments without the shunt compensative reactance, it could no use the zero sequence voltage.

IV.3.15. UPS 1P could only use in the gird with the large earth-fault current. UPS 1P must not automatically change the line into the operating mode of the permanent non full-phase when there is the steady phase deviation for the following cases:

1. As for the high-load carried single-line communicating between the electric power systems or as for the transmission line in the internal electric power system

2. As for the high-load carried line communicating between the electric power systems with the over 220V voltage, there are two the roundabout communicative systems and more on the condition upon cutting off one of them, it could cause instability of the electric power system.

3. As for the communicative lines between the electric power systems or in the internal electric power system with the different voltage, if when cutting off three-phase of the line with the high voltage, it could cause the unpermitted overload of the low-voltage line and could cause instability of the electric power system.

4. As for the communicative lines between the power- station's system containing the large blocks, which there is little the local additional charge.

5. As for the transmission lines which it do UPS 3P causing the high sudden load loss due to the voltage fall

It is obligatory to ensure for the equipment UPS 1P upon bringing out the working or upon losing the power supply it must automatically change the protector of the effecting line to cut off all of three-phase without passing the equipment UPS

Determining the faulty phase when the earth fault short circuit, it must be executed by the selectors, this selector could also use as the fast effecting ancillary protector of the line in the cycle UPS 1P, when UPS 3P, UPS 3PN or when the operators switch on the breaker from a side of the line.

The time of UPS 1P must be set by the time of arc extinction and deoxidizing ion of the environment at the position of the one-phase short circuit in the non-full- phase mode on condition the protectors in two terminals not effect simultaneously as well as effecting by stair of the selector

IV.3.16. As for the lines as in Article IV.3.15, UPS 1P must be done combining with the types of different UPS 3P. When there must be the locking ability of UPS 3P in the cases UPS 1P or only if UPS 1P fails. Depending on the specific condition it allow to do UPS 3P after UPS 1P is fails. In this case, before performing UPS 3P in one terminal of the line it must check voltage-free in the line with the level of increased holding time.

IV.3.17.As for the single-line containing the power supply from two the directions contacting with the system containing the power stations with low capacity, it could use UPS 3P with auto synchronizer with the water turbin generators to the hydroelectric plants, UPS 3P contain the different equipments depending on the hydroelectric plant or the heat power station.

IV.3.18. It is obligatory to do for the line which contains the power supply from two directions when there are some the roundabout communication systems:

1. When there are two or three the communication systems if the capability of long simultaneous cutting off two in that systems (eg: the double circuit line) :

- Non-sync UPS (principally with the lines 110-220KV and upon satisfying the conditions as in Article IV.3.12, except as for the case cut off all of the communication systems)

- Sync-UPS (when not applying Non-sync UPS because of the given reasons in Article IV.3.12, except as for the case cut off all of the communication systems)

As for the important lines containing two the communication systems as well as with three systems, two of in which (the two-circuit line) could not be done non-sync UPS because of the given reasons in Article IV.3.12, allowing to carry out UPS 1P, UPS 3P N or non-sync UPS(see Article IV.3.11,13,15). When it must be necessary to add the equipment sync-UPS for the equipments UPS 1P and UPS 3P N.

2.When there are four of the communication systems and over as well as when there are three systems, if among three these systems cutting off simultaneously two within the systems with the small probability (difficulty in happening) (example if all must be the one circuit lines), it must perform sync-UPS.

IV.3.19.The sync-UPS must perform in the line terminal with checking voltage-free on the line and checking synchronism, in the other terminal of the line only checking synchronism. The diagrams of the equipment sync-UPS of the line must be performed similar in two the line terminals and take account of the ability changing in order switching on the interruption machine when switching off.

It should use the sync-UPS when the operator connect synchronous the line joining two of the systems.

IV.3.20. Allowing to use combinative some of the three-phase Automation types in

the line, example UPS 3PN and sync-UPS 3P. Also allowing to use the different UPS types in every the line terminal, example UPS 3P with the voltage-free controller (see Article IV.3.13) in a terminal and UPS 3P with the positive bias controller and the synchronous controller in the other terminal.

IV.3.21. Allowing to combine UPS 3P with the unselected fast effecting protector to readjust this non-selection. It should use UPS effecting in turn; it also may use UPS with the accelerating protector before UPS or effecting several times (not over three times) increasingly toward the power supply

IV.3.22. Upon using the UPS 3P effect once in the line, transformer containing the power supply toward the high voltage side with setting the short-circuit knife-switch and the automatic isolating knife, to cut off the automatic isolating knife at the non-electric cycle of UPS, it must set by the total of the switching on time of the short-circute creating knife and the cutting off time of automatic isolating knife. Upon using the twice effecting three-phase UPS (see Article IV.3.7),the effecting time of UPS at the first cycle on the given condition must be not increased, if cutting off the automatic isolating knife it shall be done at the non-electric time of the second cycle of UPS.

As for the line which the automatic isolating knife replace the breaker, cutting off the automatic isolating knife in the case of unsuccessful UPS must execute at the non-electric time of the second cycle of UPS.

IV.3.23. If because of the UPS effect, it could switch on asynchronous the synchronous booster or the synchronous motor and if it not allow them to switch on and also to prevent not supplying power from these electric machines to the place of breakdown, it must cut off automatic these synchronous machines upon losing the power supply or changing them into the asynchronous operating mode by cutting off auto electro-magnetic termination and following that as it automatically switch on or re-synchronization after restoring the voltage due to the UPS is successful.

As for the stations containing the sync-booster or the sync-motor there must be measure to prevent the wrong effect of switch-off (self-discharge) when UPS effect.

IV.3.24. The main bar UPS of the power station or the electric stop when there is the private protector's the main bar and the breaker allow UPS, it must do according to one of two the following projects:

1. Automatic switching on trying the main bar (passing voltage into the main bar by the breaker from UPS of one of source- routes)

2. Automatic selecting the electric diagram: first the breaker must be switched on from UPS of one of source- routes (example the line, transformer) after this element must be switched on successful, following it may automative restore completely the electric diagram before breakdown by switching on

the remaining routes. At the first, according to this project the main bar UPS should set in the stops without the watchman.

There must be the eliminative measure switching on asynchronous for the main bar UPS when it do, if it not allow.

It must ensure enough for sensitivity of the main bar's protector in the case UPS is unsuccessfully

IV.3.25. As for the stop containing two depression- transformer operating separately, normally the main bar UPS must be installed in the medium-voltage side and the low voltage side combining with ATS ; when there is breakdown inside ATS transformer must effect, when there is other breakdown, UPS must effect (see Aticle IV.3.42)

In the stops containing two transformers operating parallel in the main bar, it allow to install additional the ATS device in the UPS device to work when one transformer is at the standby mode

IV.3.26. The UPS should be installed in the decompression transformer station's the power system containing a transformer with capacity lager than 1MVA and containing the breaker and the current protector toward the power supply in which upon cutting off transformer, electricity shall be cut off to customers. In certain case, according to the particular specific process, it allows the UPS effecting upon cutting off transformer by the protector against short circuit inside the machine.

IV.3.27.When the UPS effect on switching on the first breaker's the element containing two the breakers or more it is unsuccessful , UPS's the remain breakers must usual be locked, not to effect

IV.3.28. When in the electric station or the power plant in which the breaker containing the electromagnetic drive units, if UPS have capability to switch on simultaneous two the breakers or more, to ensure the voltage level of battery while swiching on and to reduce the section of source cable's the drive unit of the breaker, usually UPS have be done not to switch on simultaneous the breakers (example by using the UPSs with the different effecting time). Particularly, allowing the cases (it is mainly as for 110kV and there are many routes with equipping UPS) it must be simultaneously switched on two the breakers from UPS

IV.3.29. Effect of the equipment UPS must be recorded by the directive device setting in the effecting directive relay, by the counter of effect numbers or by the equipments with the similar functions

Automatic Transfer Switch System-ATS

IV.3.30. The equipment ATS must be used to restore the power supply to the consumers by auto switching off the standby power source when the source have been working, it is cut off losing

electricity of the electrical equipments' the consumers. The equipment ATS must also be used to switch on automation of the stand-by units when the main units have been operating, it is cut off the power cause breaking through the technological process.

The equipment ATS could also be applied if that simplify the relay protective section, reducing the short circuit current and lowering the prices of the project due to the closed loop is replaced with the segmental radial network, etc…

The equipment ATS could be installed in transformer, in the lines, at the electric motor, the main bar breaker, and the batch machine, etc..

IV.3.31. It is obligatory to ensure the effecting capability for the equipment ATS when loss of voltage in the main bar which supply the power to the elements with the standby power source, irrespective of any causes, including short circuit in the main bar (in the case of the main bar without UPS, see Article IV. 3.42)

IV.3.32. When the breaker's the power supply source effect on cutting off, the equipment ATS must switch on immediately the breaker's the standby power source(see Article IV. 3.41). Then, it must ensure the device effecting once. Besides, if it not demand additional the complicated devices, ATS must check all the cutting off the state's breaker in the operating elements.

IV.3.33. To ensure ATS effecting when the supply routes lose power due to loss of voltage from the power supply source or effecting when the breaker is in the power receivable side to cut off (example, as the case, the relay protector of the working elements only cut off the breaker towards the power supply source) , the voltage starter must be added in the diagram ATS as in Article IV.3.32. This starter when loss of voltage in the supply element and there is voltage in the standby elements, must effect on cutting off the breaker from the power receivable side. There must be no need to set the voltage starter to ATS if the operating elements and the standby elements have in common the supply source.

IV.3.34. As for the transformer and the line not long, to speed up the effect of ATS, it should do the effecting relay protection to cut off not only the breaker toward the supply source but also in the breaker of the power receivable side. Also with that purpose, as for the important case (for example: as for the auxiliary electric system 's the power station), upon cutting off the breaker's the supply source due to any causes, it must also cut off immediately the breaker in the power receivable side by the interlock circuit

IV.3.35. The low voltage elements of the starter 's ATS react according to loss of voltage of source, it must be set on the self starting mode of the motors and the phenomenon of voltage loss when there is short circuit in far. The effecting voltage of the voltage checking elements on the main bar of the standby power source of the starter in the ATS must be selected by the self starting condition of the

motors. The effecting time of the starter in the ATS must be larger than the cutting off time of the short external circuit and usually larger than the ATS effecting time towards the source. The short external circuit phenomenon, which reduces voltage, causes impact on the low voltage elements of the starter.

Usually there must be capability to eliminate wrong-effecting for the low voltage elements of the starter, when one of the fuses in the high voltage side and low voltage side of the voltage transformer is blown out. In the case using the circuit breaker to protect the low-voltage winding, it must lock the starter by interlock. It allow not to execute the above demand upon using ATS for the electric distribution network 6 -10 kV if there must be installed additional the voltage transformer for this purpose.

IV.3.36. In case when using the voltage starter of ATS that its effecting time could be large over the allowed level (for example in the case of the additional charge containing many the synchronous motors), apart from the voltage starter of ATS it should use additional the other starters (for example: eliminating reaction when loss of power current, reducing frequency, changing the direction of capacity etc, etc…)

In the case using the starter according to the frequency, when the frequency of the supply source reduce to the given value and the frequency of the standby source is at the normal level, the starter must effect on cutting off the breaker of the supply source according to time.

When there is demand of technology, ATS could be started by the different sensors (pressure, level, etc,…)

IV.3.37. The ATS equipment diagram of the auxiliary electric supply source in the power station- after switching on the standby source to replace one of the working sources has cut off- must have the capability to effect on cutting off the other working supply sources.

IV.3.38. Upon performing ATS it must check the overload capability in the standby supply source and checking the self starting of motors, if there is the overload phenomenon not allowing and the motor could not self start, it must lay off the additional charge when ATS effect (for example, cutting off the unimportant motors, and sometimes, a part of the important motors; as for the back case must use UPS)

IV.3.39. Upon performing ATS it is necessary to pay attention to eliminate the capability for switching on the additional charges which has been cut off by the additional charge laying off automation in frequency (switch off/self-discharge). To achieve the above purpose it must apply the special measures (example, using the interlock in frequency). In the particular case, allowing not to do this measure as for ATS, but there must be close calculation.

IV.3.40. It could switch on the breaker by effecting ATS when the short circuit is still maintained, usually the protector of this breaker have the accelerator (see Article IV.3.5). When there must be the

measures to avoid cutting off the stanby supply source cause the accelerator of the protector, because of this case, " the close current" increase suddenly.

To perform this aim, at the breaker of the standby supply source for the auxiliary power factory, it only is obligatory to do protection for speeding up if its time exceed (1-1,2) second; when it must be set time in about 0,5 second in the accelerator. As for the other electric equipments, the time shall be selected basing on every the specific condition.

IV.3.41. In case if ATS could switch on asynchronous the synchronous compensator or the synchronous motor, and if that is not allowed, this synchronous machine must be cut off automatic or changed to work in the asynchronous mode by cutting off DDT and following it is switched on or resynchronizing after voltage is restored by the successful ATS. Besides, to avoid the current phenomenon running from the generative compensator to the place of short circuit in the case losing the supply source, it also must be applied the above measure.

To avoid switching on the standby source before cutting off the synchronous electric machines, it must be allowed to use the slow effecting ATS. If that is not allowed for the remaining additional charges, and if it is calculated exactly, it must be allowed to cut off the starter ATS of the line joining the main bar of the operating source with the additional charges which contain the synchronous electric machines.

As for the electric plants containing the synchronous compensator or the synchronous motor there must be the measure to avoid wrongly-operating Switch-off (self-discharge UPS) when ATS takes effect(see Article IV.3.79).

IV.3.42. To prevent switching on the standby source when short circuit happen in the unclear standby mode, at the same time, to prevent overload, to lighten self starting as well as to restore the normal electric diagram by the simple means after cutting off breakdown or because effect of the automatic equipments, it should use combinative the equipment ATS and UPS. The ATS must effect when there is breakdown in the internal working source, UPS shall effect when there is other breakdown.

After UPS or ATS effect successful, it must ensure to restore automatic the diagram as before breakdown (for example as for the electric plants containing the simple electric diagram towards high voltage - after UPS has switched on the supply line, the circuit must cut off automatic the breaker which has been switched on by effect of ATS in the sectional breaker toward low voltage)

Switching off the power generator

IV.3.43. It is obligatory for switching on the current generator to work parallel in one of the following measures : exact synchronous connection (by hand, semi-automation, automation) and self-synchronous connection (by hand, semi-automation, automation)

IV.3.44. The exact synchronous connecting measure with automatic type or semi-automatic type is the main measure to pass the generator in working parallel as for:

- The turbine generator containing the indirect cooling type coil of wire, capacity large than 3MW and operating directly on the voltage main bar of the current generator, the cycle component numerical value of the transient current must be larger than $3,5I_{max}$.
- The turbine generator containing the direct cooling type coil of wire
- The water turbine generator with capacity 50MW and over

When there is the breakdown in the electric power system, switching on the current generator to work parallel- not depending on the cooling system and capacity- all must be performed by the self-synchronous connecting measure.

IV.3.45. The synchronization must be the main measure to pass the generator in working parallel as for:

- The turbine generator with capacity up to 3MW
- The indirect cooling turbine generator, capacity large than 3MW, operating directly on the voltage main bar of the current generator, and if the cycle component numerical value of the transient current upon switching on the gird by the self-synchronous measure is not larger than $3,5I_{current}$
- The indirect cooling turbine generator, operating according to the block transformer
- The water turbine generator with capacity up to 50MW
- The water turbine generators must be connected rigid on electricity together and operating through a general breaker with total of capacity up to 50MW

The above case may not use the exact synchronous connecting equipment with automatic type or semi-automatic type.

IV.3.46. When the exact synchronous connection is used as the main measure to pass the current generator in working parallel, the exact synchronous connecting equipment should be installed in the water turbine generators, the synchronous connecting equipment by hand or semi-automatic should be installed in the steam turbine generators.

IV.3.47. When the exact synchronous connection is used as the main mearure to pass the current generator in working parallel, it should use the exact synchronous connecting equipment with automatic type or semi-automatic. As for the current generator with capacity up to 15MW, it must be allowed to use the exact synchronous connection by hand combining with the asynchronous switching on prevention device.

IV.3.48. According to the above raised stipulation, all the current generators must be equipped the synchronous connecting equipment correlatively setting in the central control compartment or the local control chest (as for the water turbine generator) or setting at the main control room or the block control compartment (as for the turbine generator).

Not depending on the synchronizing measures, all the power generators must be equipped with suitable equipments so that when it is necessary, it could be possible to synchronize manually accurately in combination with the asynchronous prevention lock

IV.3.49. Upon using the accurate synchronization to connect to the electric grid from ≥ 2 electric generators through a generic circuit-breaker, at the first time it must be connected them together by the auto- synchronization, after synchronize them to the grid by the accurate synchronization.

IV.3.50. At the relaying station between the electric main and the power station - where must need carry out to synchronize between the circuit elements of electrical system- it must be equipped the devices that serve the accurate synchronization half-automatically or manually.

Automatic adjuster of stimulus, voltage, and reactive power (sVRP)

IV.3.51. Automatic adjuster of stimulus, voltage, and reactive power (sVRP)

must be used for:

- Maintaining the voltage in the electrical system and on the electrical equipment according to determined characteristics before the electrical system work normally
- Apportioning the reactive load between in the quadrature powers according to the determined rule
- Reinforcing the steady state stability and the rough state of the electrical system and the damping of fluctuation shall be occur in the transient state

IV.3.52. Synchronous generators (current generator, compensator, electric engine) must be equipped with SVRP adjuster. Sets of field control must be suitable with the requirement of current standards for the excitation system and they must be according to the equipment's technical condition of the excitation system

For the current generator and the synchronous compensator with lower capacity of 2,5 MW, except the current generator must independent operate in the power –stations or in the electrical systems with not above capacity, it must be only use the equipment of constrained stimulus relay type. For the synchronous motor must be equip the SVRP adjuster correlatively with the stipulated clause (e.g: the

synchronous motor must have constrained stimulus or compound excitation, the synchronous motor use in some especial cases, it must have ATS vv..)

IV.3.53. It must be ensured high reliability for the SVRP and the other devices of the excitation system, which must be supplied power from the voltage transformer as well as it must be ensured high reliability for the correlative circuit.

Upon switching SVRP adjuster in the voltage transformer which has the fuse in the primary-side, it shall be warned:

- For the SVRP adjuster and the other equipments of the excitation system during loss of the power supply it shall be overloaded or reduced stimulus of the machine that does not allow, it must connect them with the secondary circuit of the voltage transformer that must be not through the fuse or automat
- The equipment of constrained stimulus relay type must be carried out so that it must avoid operating wrong upon one of the fuses in the primary-side of the voltage transformer may be broke.

Upon switching SVRP adjuster in the voltage transformer which no have the fuse in the primary-side, it shall be carried out:

- SVRP adjuster and the other equipments of the excitation system must be switched in the secondary circuit of them through automat
- There must be means using the auxiliary contact of automat to eliminate the overload or reduced stimulus that shall do not allow whenever action automat.

In principle, it must be not switch the equipment and the measuring instrument on the voltage transformer which switched on the equipment SVRP adjuster and the other equipments of the excitation system. In the particular, it may be allowed switching on but it shall be through the automat or the private fuse.

IV.3.54. The equipment SVRP adjuster of turbine must be carried out so that upon losing overload suddenly, in the condition of the governor must fully accurate operate, the protector shall be not acted on. Upon being necessary, it may be connect SVRP adjuster with the excitative reducible equipment of fast action.

IV.3.55. The diagram of the equipment of constrained stimulus relay type must have capacity to move the its action to the standby exciter upon this exciter must replaced the main exciter.

IV.3.56. The equipment of compound excitation shall be connected up to the transformer in the outlet side of the current generator or the synchronous compensator (the side of main bar)

IV.3.57. In the power-station or electrical plant there must be not a regular watchman, for the synchronous generator with more capacity of 15 MW or the synchronous compensator with capacity of 15 MVAr or more, direct cooling, in the control board there must be the self-limiting device that must have action time, depend on the overload factor.

The self-limiting device shall be not allowed to prevent the constrained stimulus during the allowed time for the type of correlative equipment.

IV.3.58. For the electric generator with capacity of 100 MW or more and for the synchronous compensator with capacity of 100 MVAr or more , it shall be installed the excitation system of quick-acting there must be SVRP adjuster of strong-acting

Particularly, depending on the role of the power-station with the electric power system, it shall be allowed using SVRP adjuster of other type as well as the stimulative system of slow-acting.

IV.3.59. The stimulative system and the equipment of SVRP adjuster must be ensured adjusting the exciting current from the allowed min number to the allowed max number stably. For the synchronous compensator with the excitation system of noninverting trigger gate, it must be ensured starting from the rôto number appromixately the zero, for the synchronous compensator with the excitation system of inverting trigger gate it must be ensured starting from the maximum negative number of the exciting current.

For the block transformer-work exciting current there must be the current compensating capacity cause losing the electric pressure in transformer.

IV.3.60. The current generator with capacity of 2,5 MW in the barrage power station and the heat power station with four of the machine assembly or more that must have equipped the automatic system controlling the general procedure of the plant. If there must be not the above system, it shall be installed the group stimulator control system. This system of the current generator in the heat power station must be carried out depending on the diagram, the operating condition, and capacity of the current generator.

IV.3.61. The transformers with the controller of under-load voltage in the switchgear and in the auxiliary electric system of the power-station, as well as the linear regulation controller in the switchgear to maintain or change the voltage at the predetermined level, must be equipped the controlled automation system of voltage change coefficient of transformer. Upon necessity, the controlled automation equipment must ensure controlling the voltage counterpart.

As for the electrical substation with transformer (or autoconnected transformer), with the controlled automation system of voltage change ratio parallel operating , must equip the controlled automation

system of general procedure for all of station, or the control system of group to except appearance of out-of-balance current between the transformer s

IV.3.62. The compensating capacitors shall be equipped the controlled automation equipment suitably.

Auto controller of frequency and effective power

IV.3.63. The system of auto frequency and effective power controller must be used for:

- Maintaining frequency of the integrated electric system (the national electric system, the associate electric system) and the self-contained electric system in the normal mode according to the requirement of the current standards on power quality
- Adjusting the capacity exchange between the integrated electric power systems and limiting the capacity overcurrent through the check communication systems interiorly and exteriorly of the integrated electric power system and the electric power system
- Distribution of power (including distribution of the economic one) among the controllers at in all of administrative harmonizers (between the integrated system, the electric power systems in the integrated system, the power-stations in the electric power system and the machine assembly or the blocks in the power-station)

IV.3.64. The system of auto frequency and effective power controller (when is the determinant scope of control) in the power-station, in the state of the normal operating electric power system, must ensure maintaining the average deviation of frequency vis-à-vis the determinant frequency within limit ±0,1Hz in a period of 10 minute and limiting the capacity overcurrent through the check communication systems with the controlled degree not less than 70% the capacity overcurrent oscillation amplitude with periods of 2 minutes and over.

IV.3.65. In the auto frequency and effective power controller system, there must be:

- The auto-controller of frequency, power exchange, and over-current power limitation placed at the control central.
- The controllable signal distributing equipment between the controlled power-stations with the of capacity over-current limit equipments through the interior check communication systems of the system must install in the control centre of the electric system. This signals must be received from the auto frequency and effective power controller of the higher control level
- The equipment which use for controlling the active power in the power-station must take part in the process of auto power control.

- The active capacity over-current sensors and the remote control means.

IV.3.66. The auto frequency and effective power controller in the control centrals must ensure detecting the actual deviation vis-à-vis the predetermined condition, establishing and communicating the control actions to the control center of junior level and the power-stations which must take part in the process of capacity controlled automation

IV.3.67. The equipment of capacity controlled automation of the power-station must ensure:

- Receiving and re-establishing the control-actions which must be delivered from the higher controller and forming the signal of control-action of the station-level
- Establishing the control-actions for every the block.
- Maintaining the capacity of the block according to the received control-actions.

IV.3.68. Controlling the capacity of the power-station must execute with the steady frequency, changing in range of 3-6%.

IV.3.69. As for the hydraulic plant, the capacity control system must be equipped with automatic device s to ensure the start-up and termination of the assembly, when it is necessary to could switch over the synchronous condition or switch over the generated mode depending on the condition and the work-mode of the station and the electric power system, there must be taken into account the limitations of the machine assembly.

At the hydraulic plants, their capacity must determine according to the current regime, it is too necessary to have the equipment of the capacity controlled automation by flow.

IV.3.70. The auto frequency and effective power controller must have the capability to change the set-factors upon changing the operating condition of controlled object and must be equipped the signal-elements, the interlock and protecting to prevent the error-actions when the usual operating mode of controlled object must have change or when there is fail in itself equipment. The above elements must also eliminate the actions which could prevent the anti-breakdown devices executing their function.

In the heat power station, the auto frequency and effective power controller must be equipped the elements to prevent the change in the technological parameters greater than the acceptable level cause the action of the equipments in the machine assembly or the block.

IV.3.71. The remote controlled means must ensure giving the information about the capacity over-current to the communication branches inside the system and the communication branches between the systems, transmitting the controlled actions and signal from the auto frequency and effective power

controller to the controlled objects as well as transmitting the necessary information to the superior administrative office.

Auto controller of instability

IV.3.72. The auto controller of instability in the electric power system must be equipped depending on every the concrete condition, in the places where it is reasonable consideration in economic and technical, to maintain the best dynamical stability and ensuring the statistical stability backup in the fail-after mode.

The instable preventable automatic equipment could be applied in the following cases:

a. Cutting off the normal line as well as the faulted line due to the single-phase short circuit when the main protector and single-phase switchgear operate. This could occur in the mode of the large-load carried line or during repairing the grid. Allowing to use the automatic equipments in the diagrams of the fault-grid and in the diagrams and the normal work- mode of the system, if the instability is due to the automatic equipments refusing to work cause the most of additional charges of the system must not be cut off (e.g: due to the effect of auto dismiss)

b. Cutting off the lines cause the polyphase short-circuit when the main protection must work in the normal work- mode and the fault-grid mode; allowing not mention in the case of the large-load carried line

c. The circuit-breaker must refuse cutting off by the action of the backup protector equipment when the short-circuit in the normal work-mode of the electric power system and in the normal diagram of the grid

d. Separating the asynchronous work-lines from the electric power system in the normal work-mode

e. Lacking seriously the capacity or being supernumerary the capacity in the one of the joint parts with the unified system

f. There must be the fast closed automatic equipments (rapid UPS) or UPS must work in the diagram and the normal mode

IV.3.73. The asynchronism preventable automatic equipment could be used in the following purposes:

a. Cutting off a part of the current generators of the barrage power station – and sometimes – cutting off the current generator or several blocks of the heat power station

b. Reducing or increasing quickly the additional charge of the steam turbine in the possible limit of the heating equipment (following that not restore automatically the additional charge as before)

c. In the particular case, could use to cut off a part of the additional charge of the consumers which could accept short interruption (automatic cutting off separately the additional charge)

d. Partitioning the electric power system (if the above measure is not enough)

e. Fast and short-term reducing the additional charge in the steam turbine (following that, not restore automatically the additional charge as before)

The instable preventable automatic equipment could change the work-mode of the series compensative equipment and shunt compensative equipment and the other equipment of the transmission line., example the shunt compensative reactance, the exciter automatic controller of the electric generator, ect…Reducing the active power capacity of the power-station when there is the break-down according to VI.3.72 Article, item a and b, it should limit the quantity of the power cause auto-dismiss effect in the system or cause the other undesirable consequences.

IV.3.74. The controlled signal intensity of the instable preventable automatic equipment (for example: the capacity of the current generator must be cut off or the depth of turbine load-pulldown) must be determined by the power cause effect (example the quantity of the transmitted capacity must reduce abruptly when the short circuit and the long time of the short circuit) or by the intensity of the transient process recorded automatically as well as by the onerous status of the initial mode. This status must be recorded in the automatic measurer or must be written by the operating personnel.

Auto termination of asynchronous mode

IV.3.75. To terminate the asynchronous mode if it appears, it must be depended on automats. This equipments must have the action differentiating the asynchronous mode from the synchronic vibrations, the short circuit or the other unusual work-mode.

In the possible range, the above equipments shall be first executed the measures according to the direction lightening the condition of resynchronization, example as:

- Increasing promptly the additional charge of turbine or cutting off a part of the additional charge of the consumers (in part of the system being short of the load capacity)
- Reducing the power output by effecting on the turbine governor or cutting off a part of the current generators (in part of the system being the load capacity in excess)

Delimitative automation of the system at the predetermined points must only be carried out after appearing the asynchronism, if the above measures must not be pulled into synchronism after passing number of the predetermined vibration cycles, or when the asynchronism exceeding the given limit.

In the case, not allowing to work at the asynchronism, the hazardous resynchronization or less effect, to terminate the non-synchronization, we must use the time partition equipment with the minimum time that still ensuring stably in accordance with the other connections and the select effect of the automatic equipments.

Auto limitation of reduced frequency

IV.3.76. Limit automation of the reductive frequency must be executed according to the calculation so that when there must be any the capacity deficiency in the aggregate current system, in the electric power system or in the button of the electric power system, the frequency ability must drop below 45Hz being eliminated completely. The time in which the frequency is below 47Hx must not be in excess of 20 seconds, the frequency is below 48,5Hx- must not be excess of 60 seconds.

IV.3.77. The system of limit automation of the reduced frequency must execute :

. Automatic closing the standby power source according to the frequency

. Automatic laying off the additional charge according to the frequency (auto dismiss/switchgear)

. Additive dismiss the additional charge

. Closing the released additional charges when the frequency is recovered (frequency switchgear).

. Separating the power stations or the current generators to equilibrate the additional charge, separating the current generators must separate supply for the auxiliary power station.

IV.3.78. Upon the frequency reducing, the first must automatic closed the standby power source to reduce the mass cutting-off the additional charge or the time stop supplying the electricity for the consumers, including the following measures:

. Mobilizing the Hot Stand By in the heat power stations.

. Automatic starting the water turbine current generators being in the backup mode.

. Automatic changing the water turbine current generators working from the compensative mode into the generative mode

. Automatic starting the air turbines

IV.3.79. The auto dismiss of the additional charge according to the frequency must execute by cutting off the small mass of the additional charges on level of the frequency reduction (auto-dismiss/switchgear 1) or the long level of the frequency reduced time (auto-dismiss/switchgear 2)

The switchgear must install in the stations of the system. Letting them is installed directly in the consumer but administrated by the electronic engineering.

The mass cutting off the additional charges must be determined basing on ensuring effect when there must be any the capacity shortages; the position cutting off must be selected so that causing minimum damage by cutting the power off. Sometimes, it must use many switchgears and many the effect degrees of auto-dismiss. The important additional charges must usually last cut off.

The effect of auto-dismiss must combine with the effect of the UPS and ATS equipments. Not allowing to reduce the mass auto-dismiss by the effect of ATS or by the operating personnel.

IV.3.80. The additional laying-off the additional charges must be applied in the electric power systems or in a part of the electric power system in which there must be the great ability of the capacity shortage and the auto-dismiss effecting less effect , reviewing of the level well as the speed of dismiss.

The management hierarchy of the electric power system determining the necessity must carry out dismiss additional, the mass of dismiss and the factors need effecting (cutting off the supply factors, reducing fast the active capacity, etc…)

IV.3.81. The AC inverter must use for reducing the time turning the power off to the consumers when the frequency must restore cause closing the power sources, resynchronizing, synchronizing by the released lines.

Upon setting the equipments and apportioning the additional charges in order, (amplitude cycle) AC inverter should be taken into account the important level of the additional charge, the ability cutting off their by ATS, the complication and the dead time of the restoration of the lines not equipping automation (basing on the operating technology of the object). Commonly, the closing sequence of the additional charges in AC inverter must be opposite to the lay-off sequence by ATS.

IV.3.82. Separating the power stations, electric generator to balance the additional charges or separating the auxiliary supply generator of the power station must be executed for the following purposes:

. To maintain the auxiliary supply for the power station

. To prevent the loss of power in the all of power station when the frequency reduction restricting device must refuse to work or working ineffectively according to the Article IV.3.79 and IV.3.81

. To ensure supplied the electricity for the importantly special consumers

. To replace the additional laying-off the additional charge, when the technical and economic calculations approving is reasonable

IV.3.83. It must be necessary to use the additional laying-off measure of the additional charge, the mass cutting the load off (when switch off the UPS) and closing the load (on AC auto-transfer switch), the setting-degree of time, frequency, and the other inspection parameters as for the frequency reduction restricting device must be determined in the condition of the operating system according to the current norms and the other relevant regulations.

Auto limitation of increased frequency

IV.3.84. With the aim of preventing the frequency increasing in excess of allowed level of the head power plants having the capability operating parallel with the hydraulic plants being very large capacity in the case of losing the load suddenly, must use the effecting automatic device when the frequency must exceed 52-53Hz. At the first, these equipments must effect to cut off some the current generators of the hydraulic plant. It is also possible to use the effecting device separating the head power plant from the hydraulic plant, but still keeping an additional charge for the head power plant, which must be as close its capacity as possible.

Beside, as for the part of the electric power system with only including entirely the hydraulic plants must be set the equipments to aim limiting the frequency phenomenon up to 60 Hz due to the break-down, by cutting off some the current generators to ensure the additional charges of the electric engine operating normally. Also as for the part of the system with only including entirely the head power plants must be set the time limitative device of frequency long increasing to the value in which the additional charges of the block must not exceed the their controlled range limit.

Auto limitation of reduced voltage

IV.3.85. The automatic device for limitation of reduced voltage must be installed to aim at eliminating the stability disruption of the additional charge and the chain voltage reduction reaction in the mode after break-down of the electric system.

These devices must monitor separately not only the voltage indicators but also could check the other parameters, including the voltage change rate. Besides, there is still the function enhancing the constrained excitation of the synchronous machines, the constrained compensating device, cutting off the impedance coils and – in the compulsory case when the technical calculations show the grid without enough ability for repairing, - must cut off the additional charge

Auto limitation of increased voltage

IV.3.86. With the aim of limiting the increased voltage time on the high-voltage equipments of the transmission line, the power station and the electrical plant by cutting off the phases of the one-sided line, must use the automatic effecting equipment when voltage exceed 110-130% the rated voltage, when it is necessary to check numerical value and direction of the quadrature power in the transmission lines

This device must effect with the maintaining time, including the allowed overvoltage time, and has been set by the switching overvoltage time, atmospheric over-voltage and fluctuation, the first work must switch on the shunt booster reactances (if they are fitted in the power station and the electrical plant which record with increasing voltage). If the power station and the electrical plant without the shunt booster reactances with the breaker, or switching on the impedance coils not reduce voltage as requirement, the device must effect to cut off the line causing voltage increase.

Auto controller of overload

IV.3.87. The auto controller of overload must be used to limit the long time of overloaded current on the line, in the transformer, in the series capacitor, if this time exceed the allowed level.

This device must effect to reduce load of the power station, they could effect to cut off the additional charge and partitioning system and- at the final level- cutting off the overloaded devices. When there must be preventable measure of stability disruption and the other undesired consequences.

Remote control

IV.3.88. Remote control (including remote control, remote signal, remote data collection, remote measure, and remote adjustment), in there containing the system SCADA, must be used to manage the dispersive power facilities with connecting together in the general operating mode, and controlling them. The obligatory condition upon using remote control must be reasonableness on technical economy, improving the control effect (to make the operating mode and production process better, dealing with the breakdowns fast, raising economy and the working realibility of electric devices, increasing power quality , reducing amount of the operators, no need the watchman frequently, reducing the ground plans for production, etc,…)

The means of remote control could also use to transmit the far signals of the frequency automatic controlled system, the breakdown automatic prevention device and the systems of the other controlled device and other controls.

IV.3.89. Remote controlled mass of the electrical equipment must be determined according to the branch standard or the other guide-stipulations in accordance with mass of automation. The means of remote control firstly use to collect the information about the working mode, the active state of the main switchgear, about changes when appearing the mode or the state of breakdown, and to check performing the switch information (according to the production plan, repairing, operating). Besides, the means of remote control create advantageous conditions for the operators applying the suitable modes on the technological process.

Upon determining the remote controlled mass of the power facilities without the regular watchman, the first it must examine capability to use the simple signaling device (using the warning signal of remote breakdown with two signals and more)

IV.3.90. There must be enough the necessary devices for the system of remote control to concentrate solving the problem of working mode establishment of the power facilities in the complex gird trustingly and economically, if the problems has not been solved by the automatic means.

As for the power facilities containing remote control, the controlled operations as well as effect of the protective device and automation must not be imperative to add the auxiliary operations in place (by the watchman or calling man arrive)

If the spending and the technical economic indexs of remote control and automation are equally, using automation should be a priority.

IV.3.91. Remote signal must be used for:

- Reflecting to the control panel on the state and the situation of the switchgear of the power facilities belong among the direct administrative office or reflecting to the superior control panel with the decisive signification to the working mode of the power supply system
- Charging the information in the computer or in the information processing device
- Transmitting the breakdown signals and the warning signals

Remote signal from the power facilities under the management of some the controlled stations must usually transmit the signals to the superior controls by forwarding or moving the selective signals from the junior controlled stations. The information communication system must usually perform no more than one level of transition

To communicate the remote signals on the situation or the state of the electric device in the power facilities must usually use an auxiliary contact of the device or the contact of repeated relay

IV.3.92. Remote measure must ensure communicating the main parameter in electricity or in technology (parameters specific to the working mode of every facility), these parameters are necessary to set up and check the optimal working mode of all the power supply systems as well as preventing or rejecting the breakdown process could happen. Remote measure of the most parameters – as well as the necessary parameters to forward, to save, or to record- must be performed continuously.

Remote measurement transmitting system on upper level distribution centers are often implemented no more than one transition level.

For parameters that are not required to check regularly, remote measuring work must be carried out periodically or following request.

When implementing the remote measurement, it is needed to consider the request of reading data on the spot (right at the controlling panel). Following the rules, converters (remote measuring sensor) used for measuring parameters on the spot must be put right on meter panel, if exactly measurement level is kept intact (see Chapter I.6 – Part I).

IV.3.93. Remote controlling quantity of electric equipments, requirements of remote controlling equipment and communication channels in remote controlling system are determined by accuracy, reliability and late time of information while design automatically modify frequency and capacity in united electric system. Remote measurement of necessary parameters for automatically capacity and frequency modifying system must be continuously carried out.

Remote transmitting channel (communication channel) used for measuring capacity current and transmitting remote controlling signals to main power-station or group of modifying power-stations often has double remote controlling channel including two independent channels.

In remote controlling equipments, there must be protector impacting on automatically modifying system in case there is breakdown of equipment or in remote controlling channels.

IV.3.94. In each specific situation, it is needed to be consider properly all problems of remote controlling (especially when carry out the communication channels and distribution stations), check and control the production process in system of electricity, gas and heat supplying, ventilation and public lighting.

IV.3.95. For large-scale electric substation and power-station with many generators in a long distance from generator's place, transformer station and other works to controlling centre, in order to make it suitable in technique, it should be installed remote controlling equipments in internal plant. Quantity of

these remote controlling equipments must be in compliance with technology requirements of plant, as well as strictly in accordance with technical economic targets of each specific project.

IV.3.96. When combined using different remote controlling systems together in one distribution station, as the rules, all operations of distribution employees must be the same.

IV.3.97. In case of using remote controlling equipments, it must be able to cut off on the spot in some following situations:

- Cut off simultaneously all remote controlling circuits and remote signals with equipment, and can see clearly the spot of cut-off circuit.

- Cut off the remote controlling circuit and remote signal of each object with special safety clips, testing box and other equipments which have design that clearly show out the spot of cut-off circuit.

IV.3.98. Other related items apart from remote controlling equipment must be implemented following requirement stated in Chapter IV.4

IV.3.99. Sensor-measuring equipments (remote measuring sensor) are fixed electricity measuring equipments which are installed following Chapter I.6 – Part I.

IV.3.100. Channels for other purposes or just conducting-wire channels can be used as remote controlling channel (underground cable or in-the-air wire, optical cable…), high-frequency channel of electric wire and distribution net, broadcasting channel, telecommunication channel.

Choosing remote controlling channel by using previous channel or new one must be based on the reasonableness of technical-economic as well as requirement of reliability.

IV.3.101. Using reasonably remote controlling equipment and communication channels (when reliability and transmitting quality ensure technical requirements) allows to:

1. Measure the capacity some parallel electric lines and voltage with full capacity measuring equipment.

2. Measure with the mode of calling to station checking through one general equipment in order to meter identical objects- and use a meter to measure the parameters transmitted from other checking substations; at that time, possibility of simultaneous transmittance or reception those metered parameters must be excluded.

3. In order to reduce the remote measuring quantity, it needs to be replaced with remote signals which reflect the limited numeric value of controlled parameters, or with signal warning equipment and record the difference between those parameters and standard numeric value.

4. In order to ensure the simultaneous transmittance of continuous signals when remote measuring, it is

needed to use complex remote control equipment.

5. Use the same remote control receive-transmit equipment applied for many distribution stations, as well as use the remote control equipment of one distribution station applied for some checking points.

IV.3.102. Supply of remote control equipment (main supply as well as spare one) in distribution stations and checking points are shared for appliances of remote control and communication channel.

At the checking point which use alternating current and spare supply is available, it is still needed to have spare one used only for remote control equipment (different sections of main bar, spare input or batteries of appliances in communication channel, transformer …). Following the principle, if there is no spare supply in electric system, it doesn't need to install spare one in remote control. At checking point used battery, spare supply for remote control must be carried out through converter. Supplying spare electricity for remote control equipment at distribution station of united electric system must be by separate supply (battery and converter, roving generator…) used for appliances of both communication channel and remote control.

In case of arising the break-down in the main supply, it must be transmitted automatically into spare one. Demand of spare supply at distribution substation of industrial enterprise depend on requirement of ensuring to supply the reliable electricity.

IV.3.103. All appliances and remote control boxes must be marked and placed for convenient operation.

Chapter IV.4

SECONDARY CIRCUIT

Scope of application

IV.4.1. This chapter is applied for secondary circuits (circuit of control, measurement, signal, checking, automation and protection) of electric equipments.

Requirements on secondary circuit

IV.4.2. Working voltage of secondary circuit mustn't be over 500V. In case the secondary circuit is not connected with another secondary circuit and appliances of that circuit are arranged separately, working voltage is allowed up to 1kV.

Connecting the secondary circuit must be suitable with surroundings and safety requirements.

IV.4.3. In power-station, electric station and industrial enterprise, it needs to use secondary circuit with bronze core.

IV.4.4. According to conditions of mechanic durability:

1. Secondary cable core connected with clips of electric box, equipment and/or with screws must have section that is not smaller than 1.5mm^2 (in 5A electric circuit – 2.5mm^2; with secondary circuit that is not important, conducting-wires of checking circuit and signal circuit allow the section is 1mm^2).

2. At secondary circuit with working voltage from 100V up, section of cable core connected by tin welding mustn't be smaller than 0.5mm^2.

3. At circuit with working voltage up to 60V, diameter of cable connected by tin welding mustn't be smaller than 0.5mm (section of 0.197mm^2). Equipments for communication, remote control and similar circuits should be connected with twisted screws. Connecting one-fiber cable core (by twisted screw or tin welding) is only used in static elements of appliance. Connecting cable core into elements of roving equipment by plugging in (plug, connection boxes…) as well as connecting into boxes and appliances put at having-vibration place must use flexible fiber core cable.

IV.4.5. Section of cable core and conducting-wire must meet the protection requirement against timeless short-circuit, meet the allowable long-term additional charge current according to Chapter I.3 – Part I, stand the heat impact (for circuit coming from current transformer), as well as ensure the equipment working with allowable exactly range. At that time, it must ensure these following requirements:

1. Current transformer with electric circuit must be working in exact range:

+/ Following Chapter I.5 Part I – for payment meter

+/ For capacity measuring and converting equipment – following Chapter I.5, as technical meter.

+/ Exact level no smaller than 3.0 – for meter at electric panel and capacity and electric current measuring-converting equipment used in metering circuits.

+/ Commonly, in error limit of 10% - for protection circuit (see Chapter IV.2)

2. For voltage circuit, voltage loss from transformer (when all protectors and metering tools that are working, the largest additional charge of transformer) to:

+/ Payment meter and capacity measuring and converting equipment in order to record information into computer – no higher than 0.5%.

+/ Payment meter on the connection wire between electric systems – no higher than 0.25%.

+/ Technical meter – no higher than 1.5%.

+/ Meter at electric panel and capacity sensor used for measurement circuit – no higher than 1.5%.

+/ Automatic protection box – no higher than 3% (see Chapter IV.2)

In case of combinative supply for above mentioned elements with general cable core, their sections must be chosen following numeric value of smallest voltage loss.

3. For control circuit, voltage loss from supply:

+/ To electric box or electromagnetic control coil without current intensity – no higher than 10% in case of the largest additional charge current.

+/ To electromagnetic control coil with operating current intensity no higher than 20% of current.

4. For voltage circuit of automatic excited adjusting equipment, voltage loss from transformer to measuring element is not higher than 1%.

IV.4.6. It is allowed to use the same multi-core secondary cable for circuits of control, measurement, protection and direct & alternative current signal as well as supply circuit for additional charges with small capacity (ex: motor of valves).

In order to avoid increasing reactance of cable core, it needs to divide the secondary circuit of current transformer and voltage transformer so that total current of these circuits in each cable is zero in any working regulations.

The same cable is allowed to use for different circuits except spare circuits.

IV.4.7. Secondary cable is as usual connected with gathered clip line. It should not connect two secondary conducting wires with one screw.

Cable is allowed to join with output of measuring transformer. Cable joined with clip must be correlative with section of cable core.

IV.4.8.Making secondary cable longer by connecting more is only allowed if the length of cable line is longer than the length of cable roll of manufacturer. Secondary cable with metal cover is connected with hermetic connection box or specialized clip line.

Cable with non-metal cover must be connected with intermediary clip line or specialized connection box.

Cable of secondary circuit mustn’t be connected by twisting but no welding.

IV.4.9. Cable cores and conducting wires of secondary circuit connected with clip line or appliances must have sign number.

IV.4.10. The work of choosing conducting wire and cable used in secondary circuit, method of installation and protection must consider the relative requirements stated in Chapter II.1' II.3 – Part II and Chapter IV.1.

Cables and conducting wires going through hot place, oil or poisonous chemicals must be special cables and wires. (see Chapter II.1 – Part II).

In case conducting wires and cable core with insulated cover that can not stand the sunlight impact must be suitably protected

IV.4.11. Cable of secondary circuit of transformer 110kV up connected from transformer to electric panels must have metal cover and connect to ground at two ends. Cable in main coil and auxiliary one of the same transformer 110kV up must be placed together on the whole channel. For circuit of meters and appliances that are sensitive with electromagnetic field of others or nearby electric circuit, it needs to use conducting wires or cables with the same diaphragm or core with diaphragm.

IV.4.12. According to condition of mechanical durability, installation of electric circuit in internal box, panel, control table, box … as well as in motor control cabinet of breaker, insolated knife and other equipments must use conducting wire or cable with section no smaller than:

+/ 1.5mm^2 for one-fiber core if connecting with screw.

+/ 0.5mm^2 for one-fiber core if connecting by welding

+/ 0.35mm^2 for multi-fiber core connected by welding or with screw if its core has terminal lugs; connected by welding multi-fiber cable core with section of lower than 0.35mm^2 but not lower than 0.2mm^2 if there is basis of operation safety.

0.197mm^2 for cable core connected by welding in voltage circuit of no higher than 60V (electric panel, control table, remote control equipments …).

One-core cable connected with fixing elements of equipment must be by twisting the screw or by welding. Cable core connected with roving or removable elements (plug or connection box…) should use multi-fiber soft-core cable.

When connecting cables by welding, it must ensure there is not mechanical force right at connection point.

In case of being through the door, it needs to use multi-fiber soft wire with section not smaller than 0.5mm^2; it allows to use one-fiber wire with section not smaller than 1.5mm^2 in case the wires must be twisted at transferring place.

Sections of conducting wires on equipment panel and beforehand manufactured parts are determined following request of protection against timeless short-circuit, ensure the requirement of allowable long-term current according to Chapter I.3 – Part I, moreover, for circuit going from current transformer, it needs to ensure the heat-resistance requirement. Conducting wires and using cables need to have fire-resistant insulated cover.

IV.4.13. Joining up equipments in the same cabinet, electric panel can be implemented directly between terminal lugs or through intermediary clip line.

For circuits that can join up with equipment or testing tools when needed, terminal lugs must be taken to clip line or testing box.

IV.4.14. Intermediary clips are needed when:

+/ Joining up conducting wires with cable

+/ Gathering circuits having same name (gathering up the wire ends of voltage circuit…)

+/ Need to connect with portable or roving measurement, testing equipments without testing box or similar equipments.

IV.4.15. Clips joining up with wires of circuit or with different appliances must be divided up into separate clip line.

On clip line, wire ends mustn't be placed close together due to operation mistake or break-down if they touch each other.

When arranging different protection equipments or other appliances of the same circuit in electric cabinet, electric supply from the pole of on-off circuit through gathering clip line as well as dividing circuits into other electric cabinets must be carried out separately for each kind of protection or appliance. If there is not connecter in off circuit of private protector, the connection of these circuits with output relay of protector or off circuit of breaker must be implemented through separate ending clips; then the connecting in cabinet of above mentioned circuits is not depended on kind of protector.

IV.4.16. In order to do the checking and testing work in automation and protection circuit, testing box or measurement ending clips (except the case stated in Article IV.4.7) must be installed, ensure that it doesn't need to separate conducting wires or cable from on-off circuit, transformer and current transformer.

In case automation and relay protection equipments stop working periodically as working regulations of grid, condition of selection or other reasons, it needs to arrange specialized means for operators take it out of working regime.

IV.4.17. Clip lines, auxiliary contacts of breaker, isolated knife and other equipments, as well as grounding wires must be arranged carefully in order to ensure the safety while operators are working without cut off the primary circuit with voltage of higher than 1kV.

IV.4.18. Insolating of appliances in secondary circuit must comply with standard, determined by working voltage of supply (or isolated transformer) supplied for this circuit.

Insulating of alternating and direct current circuit needs to be checked separately for each supply (including isolated transformer also) without earth connection.

Equipment for checking insulation must ensure to warn signal in case insulation is lower than allowable numeric value; measure the insulating resistance numeric value of each pole in direct circuit. It doesn't need to check insulating for circuit without branch.

IV.4.19. On-off current supply for secondary circuit of each circuit must be through separate breaker or fuse (use breaker as a priority).

On-off current supply for relay protection circuit and breaker control circuit of each circuit must be implemented through separate breaker or fuse, not related to other circuits (signal circuit, electromagnetic interlock circuit...). The same supply circuit is shared for circuit of breaker control and signals warning breaker position.

For circuit of 220kV up, generator (or generator block) with capacity from 60MW up must be supplied the separate on-off current (through separate breaker or fuse) for main protection and spare protection circuit.

Fuse must be connected before breaker counted from power supply in series connection of breaker with fuse.

IV.4.20. Working status of on-off current supply circuit used for equipment of relay protection, automation and control the important elements must be checked continuously by separate relay, light or use equipment to check broken circuit after each time the on-off equipment operating due to remote control.

For less important elements, on-off current supply circuit for their protection equipments can be checked by transmitting the cutting position signal of breaker in on-off circuit switched off.

After each time on-off equipment operates, broken circuit must be checked if there are auxiliary contacts in that circuit. Then broken circuit of off circuit must be checked for all cases; broken circuit of switch-on circuit is only checked at circuit breaker of important element, at short-circuit toggle-switch and at equipments switched off due to impact of automatic switching-off or by remote control.

IV.4.21. In electric equipments, there are usually automatic signal warning system in case the system operates unusually and/or break-down occurs.

These signal systems must be periodically checked by testing.

In case there are not regularly be-on-duty worker at these electric equipments, these signal should be transmitted to place having on-duty worker.

IV.4.22. On-off circuit must have protector, avoiding the wrong operation of other appliances due to over-voltage when switch off electromagnetic coil or other instruments or touching-ground short-circuit occurs.

IV.4.23. Ground connection in secondary circuit of current transformer should be done at one point near current transformer on clip line or on the poles of current transformer.

For protection system , it only needs to connect to ground at one point when some current transformers connect with each other; in this case, it allows to earth through over-voltage protector with voltage not over 1kV and resistance of 100Ω with circuit distributed for releasing electrostatic electricity.

Secondary coil of transformer must be earthed at neutral point or at one of coil outputs having request of grounding.

Secondary coil of transformer must be earthed at the point near transformer, on clip line or poles of transformer.

Secondary circuit of some transformers in the same distributed equipment is allowed to connect to ground by one shared earth bar. If this earth bar related with other equipments and be at different place (ex: relay boxes of distributed equipments with different voltages), these bars needn't to be connected with each other.

For transformer acting as supply of alternating current, if grounding is not requested in one of the poles of operating circuit, grounding for secondary coil's protection must be done through over-voltage protector.

IV.4.25. Transformer must be protected against short-circuit at secondary circuit with breaker. Breakers are placed at all no-grounding wires and behind clip line, except sequence circuit (open triangle) of transformer with high touching-ground current.

It is allowed not to install breakers in circuits without branch.

In secondary circuit of transformer, circuit breaker must be revealed (breaker, connector…).

It is not allowed to install equipment that is able to break the circuit between transformer and grounding place of secondary circuit.

IV.4.26. On transformer at grid with small touching-ground current, without capacitive current booster (ex: grid from generator-transformer, self-use grid of power station and substation), protection against over-voltage must be implemented if necessary when neutral point automatically move. Protection can be done by installing one pure resistor into delta open.

IV.4.27. Secondary circuit of transformer for 220kV up must have spare one from another transformer.

It allows wire voltage transformers to provide for each other if their capacities are enough for additional charge of secondary circuit.

IV.4.28. Transformer must have tester for broken circuit.

Voltage transformer supplied for relay protector must be equipped the devices stated in Article IV.2.8.

Regardless of having the above mentioned equipments or not, circuit must have signals:

- When cutting automatic circuit breaker – based on their auxiliary contacts.

- When repeated relay of main bar isolating breaker is not working – based on equipment for checking the control circuit break and repeated relay circuit.

- When the fuse placed at high-tension circuit of transformer is damaged – based on central equipments.

IV.4.29. In position that is impacted by vibration and knock, there must be method against damage at the connection of conducting wires, against relay faulty action, as well as anti-wear with the time of devices and meter.

IV.4.30. On electric box, at the side of operation record, it needs to show out clearly which circuit they belong to, their task, electric box number; and on instruments placed in the box, there must be label that is suitable with diagram.

Appendix

Symbol of automation and protection functions

(Details are requested to refer to standard IEC 617; IEEE C37.2-1991; IEEE C37.2-1979)

According to current international standard, automation and protection functions are signed with codes and letters as the following list:

1. Start control element
2. Time relay (start or close control)
3. Test or interlock relay
4. Main contactor
5. Stopper
6. Start circuit breaker
7. Ratio relay
8. Supply isolator
9. Recovery device
10. On-off coordinator
11. Multi-functions device
12. Over-speed avoider
13. Synchronic speed impact
14. Speed reducing function
15. Frequency or speed follower
16. Spare for future
17. On-off switch over shunt circuit or discharge
18. Off speed reducer or accelerator
19. Transitional start contactor (equipment starts through increasing levels)
20. Electric valve
21. Space relay
22. Balance control circuit breaker

23. Temperature controller
24. V/Hz ratio relay (voltage/frequency)
25. Synchronic test function
26. Protection function
27. Low voltage protection function
28. Flame supervisor (with turbo-compressor or boiler)
29. Isolating contactor
30. Signal relay (without self-clearing)
31. Isolating existor
32. Power orienting function
33. Location lock
34. Schedule maker
35. Carbon brush slip-ring
36. Polarization relay
37. Protection function for low voltage or low power
38. Temperature metering function for bearing or bearing housing
39. Vibration measuring function
40. Function as protection against exciter malfunction
41. Magnetic circuit breaker
42. Equipment or motor start breaker
43. Manual or auto selection switch
44. Start relay for succeeding function block
45. Monitoring relay for air pressure (smoke, fire, explosive …)
46. Sequence reverse current relay or direct sequence current filter
47. Sequence reverse voltage relay or direct sequence voltage filter
48. Order protection relay
49. Thermal relay (protection against over-heating)

50. High current protection

50N. High earth current protection

51. Time (alternating) over-current protection

51N. Holding time earth over-current protection

52. Alternating current switch gear

53. Electric exciting force relay for direct current generator

54. Mechanic number transferor with electric control

55. Power-factor relay

56. Exciting electric control relay for alternating motor

57. Short-circuit or grounding unit

58. Relay for preventing rectifier from broken

59. Over-voltage relay

60. Current or voltage balance relay

61. Sensor or on-off switch at vacuum sensor

62. Time relay for normal open and close

63. Pressure relay (Buchholz)

64. Ground detector relay

64R. Ground protector for rotor

64G. Ground protector for stator

65. Speed governor

66. Counting function for start per hour

67. Direct over-current protection relay

67N. Direct earth fault relay

68. Interlock relay

69. Control device

70. Resistor

71. Oil level relay

72. DC circuit breaker

73. Resistor contactor

74. Signal relay

75. Position device

76. DC over-current relay

77. Tele-metering device

78. Protection relay for angle of phase difference

79. Re-closing relay (AC)

80. Converter

81. Frequency relay

82. DC loading level re-closing relay

83. Auto control select or change-over relay

84. On load tap changer (LTC)

85. Carrier or pilot-wire receiver relay

86. Output re-closing relay

87. Differential protection relay

87B. Differential bus bar protection relay

87G. Differential generator protection relay

87L. Differential line protection relay

87M. Differential motor protection relay

87T. Differential transformer protection relay

87TG. Differential earth transformer protection relay (only for the grounding star-connection coil)

88. Auxiliary motor or motor generator

89. Switch off

90. Regulating relay (voltage, current, power, speed, frequency, temp.)

91. Voltage directional relay

92. Voltage and power directional relay

93. Exciter changing contactor

94. Cut-out relay

95. Synchronic function (for synchronic motor with small load and inertia) under momentum effect

96. Auto loading function

For example: F21