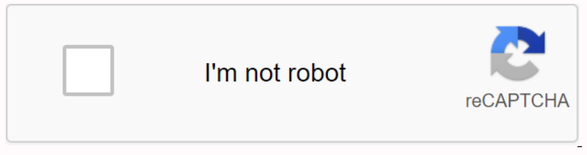

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Switchgear design calculation pdf

When identifying and planning medium voltage switches for a substation, functions and influencing factors must be combined and an economically efficient solution must be found among the manufacturer's services. Things you must know for the design and installation of medium voltage switches (photo credit: RJ Power Group)For this there is no simple formula with a clear solution for engineers, simply because: The tasks of a switchgear substation can vary a lot of factors affecting each otherThe same influencing factors and requirements have can be weighted differently by different manufacturers. Generally, a switchgear substation MUST provide a high level of safety so that both operator protection and error-free network operation are guaranteed. It must meet ind touch protection requirements and exclude maloperation capabilities. However, if an error occurs, its impact on the error location should be limited and not cause personal injury. Content: 1. Distribution level of MV switches Similar to distribution grid, switchgear can be assigned to primary or sub-distribution level: Main distribution - What is characteristic for the main distribution level is high load and short circuit current and high-end extra features of the switch related to protection , measurement and control (remote). At the main distribution level (Figure 1), you will find the main substation, where energy is inserted with higher voltage and switched to medium voltage. The switchgear is almost completely equipped with circuit breakers. They convert large consumers, mostly in industrial plants, or cable rings that switchgear feed at the level of sub-distribution. Acute distribution - At the level of acute distribution, the switch is equipped with switches or a mixture of switches and circuit breakers, where the proportion of switches clearly prevails. The lower current, short circuit protection is usually guaranteed by the circuit breaker indicated at the main distribution level. Requests placed on extra features are usually lower. Figure 1 – The structure of voltage supply and power distribution In general, typical substation forms are: Consumer Substation Consumer Substation from which energy is distributed at line voltage (medium voltage). A conveyor switch (coupling) in the substation can form the asset border between the supply company and the customer if the customer wants to develop his switch department independently. In that case, the measuring and counting equipment for payment will also be available. Figure 2 – Substation consumption Substation, also known as secondary unit substation, where energy is transferred from medium to low voltage and distributed as such. In industrial plants, substations are often installed in production centers which are also load centers. Therefore, these substations are called load center substations. For very Substations that are not accessible, the designing of 'small' or 'compact substations' has become popular. Figure 3 – Compact Substation (photo: New gas insulated medium voltage switch, Compact 8DJH, for secondary distribution systems up to 24 kV; credit: Siemens) Return to content ↑ 2. MV Switchgear Design and Installation Standards distinguish between two main groups of medium-sized switches: Assembly plant, plant test type with: Metal casing in accordance with IEC 62271-200 (VDE 0671-200) Molded plastic casing in accordance with IEC 62271-201 (VDE 0671-201)On-site switches or construction workshops in accordance with IEC 61936-1 (VDE 0101-1), as it is rarely built today. In the following section, we will describe the attached metals, the type of test medium-class switches suitable for IEC 62271-200 (VDE 0671-200), since both plastic castings are attached and built on site, i.e. factory construction plants are produced significantly less often. High production and testing costs are usually depreciated only if high quantities produced and manufactured are standardized accordingly. Technical data must be verified by type tests. Production quality is monitored by regular tests. Back to content ↑ 3. Configuration parametersThe selection parameters for the configuration of the switch can be distinguished as follows: Pre-definedFor connection to earth, grid voltage, grid frequency, neutral point connection, ambient conditions, short-circuit peak current. Conditional selectionFor insulation level for example, neutral point connection, over-pressure protection, short circuit time, type of operation area, factory design. Any optionFor example switchgear type, switches and their mechanism of operation, busbar circuits, compartments and partitions, available operations, accidentally qualificationTable 1 for an overview of configuration parameters and characteristics that can play a part in the planning. The most important aspects are presented in more detail below. Table: - Overview of the rated values and selection parameters for the configuration of the medium-voltage switchTprimary evaluates the value Of the number of optionsSodent - Insudentation rated: Ud - Short-time power frequency withstands voltageUp - Lightning pulse withstands voltageCulation voltage coordination: Medium point connection calculate / over-high netting critical consumersOvervoltage protectionAltitudeEnvironmental influences (pollution)Rated withstand capacity:Ip - Peak currentIK - Short-time currenttK - Short-circuit durationRated switching capacity:Ima - Short-circuit making currentIsc - Short-circuit breaking currentGrid characteristicsGrid characteristicsSyers and power qualityGrid protection, response timeSelect selects selectir criteria - Load-rated operating line (feeder circuit), distributed capacity (busbar)Ambient temperatureReserves /service continuity Busbar circuitSelection / Double busbarBus sectionalizer / busbar coupler, vertical (BCL)Switch-over (BCL) using switch or circuit-breakerBusbar coupler, transversal (double busbar)System confgurationGrid protection, response times, selectivity criteriaReserves/service continuity, switch-over timesOperational proceduresEmbedded or in-plant power generation, emergency power supplyThe emergency power supply (unstable load)The operating processThe bus is doubled with the general connection Two single busbar systemsThe switch-overInterlockings busbar system, error protection switchInstillation (space) Device conversionThe system of choiceThe busbar switch-overInterlockings, conversion protection error Installation (space) Device conversionThe system selects The public formulaDeterming capacitySwitchContactorHV HRC fuseOperating current and switching taskSwitching capacity (fault currents)Switching frequencyGrid protection, requires selective Design and control panel typeSelection parameterDeterminantsCircuit breaker panelSwitch panelSwitch panelType of construction :Extendable panelsBlock typePrimary rated valuesSwitching devicesOperating current, switching capacityGrid protectionNumerical ratio of switch panels to circuit-breaker panelsWork processes and handlingThe conditions of installationThe media and installationThe correction, power reserve / mechanical insulation Means of shock of the mindThe processes of humidity shock, pollution, salt, positive gasesType of operating sitePlace of installation (spatial requirements)Fire protection requirements (fire load)AltitudeSwitching frequency and switch lifetime DisconnectorSelection parameterDeterminantsWithdrawable unit/truckDisconnector (fixed mounted)Switching frequencyService life of componentsOperational EncapsulationSelection parameterDeterminantsDegree of protection (IP in accordance with IEC 60529, VDE 0470-1)Environmental conditionsThe personal safety operation site type Internal arc classification (IAC): A or B (accessibility type)F/L/R (classification party)IA , tA (current and time arc error) Pressure relief tube compartment and partition Select parametersThe service continuity item (LSC compartment partition – continuous loss of service) Operating process: workingMaintenance requirements Maintenance (service life of components)Operating company instructionsPersonnel qualificationShock-hazard protection during work in progresSwitchgear space requirementsAccessibility and access control using:InterlockingWork instruction + lockingToolsNon-accessible switchgear compartmentPartition class:PM (metal partition)PI (insuffered material partition) Go feeder componentsSelection parameterDeterminantsCable connection:Termination: conventional / plugNumber of cablesConductor cross sectionsOperating and short-circuit currentSwitch task:Cable / overhead lineAltitudeVoltage transformer:Earth fault winding (if required)Current transformerNumber and data of coresSummation current transformer (cable-type current transformer)Grid protectionMetering, countingControlNeutral Switch: Busbar componentsSelection parameterDeterminantsMeasuring transducerEarthing switchSurge arresterGrid protection and measurementOperational procedures Secondary equipmentSelection parameterDeterminantsProtection relaysEquipment for control, nested, and error protection switchIngMing measuring equipment, counting, measuring the detector value Monitoring and communication EquipmentControll the motor test systemDamping the anti-voltage (for voltage voltage voltage machine)Grid parameters , power grid operation protection equipment, integrated into (industrial) processes and operational processesTho all electrolyc compatibilitySelect back content ↑ 4. DesignGas medium-voltage insovenous switches should be used for medium voltage consumer substations. The advantages of air insulation switches are: Requires less space (save up to about 70% with 30 kV) than air insulation switches Smaller transport size and therefore easier transport Increase operational reliability due to closed main switches (detrimental impact as from pollution , small animals, contact, condensation is excluded due to packaging) The main part that does not require maintenance (without lubrication and adjustment) Ecological balance is better than the air insulation switches mentioned the entire system life cycle Return content ↑ 4.1. Operator protectionThe gas-safe instuation switches to touch thanks to grounded metal HRC fuse and cable termination are only accessible if the branch circuits are groundedThe operation is only possible if the casing is fully sealed (and any door closes)A pressure absorption system without maintenance , is in place that the special cooling system reduces the impact related to the pressure and heat of a arc error so that employees and buildings will be safe (Figure 4). Figure 4 – Room layout for switches with pressure reduction to the bottom (left) and with pressure absorber tube (click to expand) Return to content ↑ 4.2. ScalabilityThe switches must be extended at minimal time cost. A modular system with ordering options for busbar extensions on the right, left, or both sides provides the best prerequisites for this: Individual control panel and panel blocks can be mounted side by side and expanded as desired - no gas work required on siteLow-voltage compartment (compartment) available at two heights , wired with switchgear panel with plug connectors All panels can be replaced at any timeGo back content ↑ 4.3. Installation siteThe medium-life switches can be used as indoor installation in accordance with IEC 61936-1 (VDE 0101-1). One difference is made between: Switchgear type in locations with no access from the public, outside closed electrical operating areas. Switchgear shells can only be removed with the help of tools and the operation of ordinary people must be prevented. closed electrical operation area: A closed electrical operating area is a room or location that is only used the operation of the electrical switch and is kept locked. Access is granted only to people with electrical skills and those guided by electricity. Ordinary people are allowed to be accompanied only by people with electrical skills or instructions. Figure 5 - Installation of switches according to IEC 61936-1 (VDE 0101-1) Back to content ↑ 4.4. Operating and maintenance areas These are corridors, connecting walkways, access areas, traffic and exit routes. Corridors and approaches must be full size for work, operation and transportation of components and must be at least 800 mm in width. The width of the corridor must not be hindered by devices protruding from the corridor, such as permanently installed drives or switch trucks in disconnected positions. The width of the exit must be at least 500 mm, even if the parts are removable or the door is fully open protruding into the exit. Switchgear boards or cabinet doors should be closed in the direction of exit. To install and maintain the work behind the attached unit (independently) the width of the 500 mm segment is sufficient. A minimum height of 2,000 mm under the ceiling, casing or enclosure, except for the cable basement is required. The exit must be arranged in such a way that the length of the exit inside the room does not exceed 20 m in case the edo voltage is up to 52 kV. This requirement does not apply to walking in busbars or cable ducts or cond ducts. For works with a ediline voltage of up to 52 kV, the length of the exit inside the room should not exceed 20 m (40 m for installations over 52 kV). Fixed ladders or similar facilities are allowed as emergency exits in exits. Back to content ↑ 4.5. Accessibility of the IEC 62271-200 standard compartment (VDE 0671-200) for metal closed switches distinguishes between support level A for authorized personnel and level B accessibility for unlimited access (also to the public). In addition, the openness of a compartment is distinguished, affecting accessibility, and therefore availability, of a switchgear. A gas insulation switch is also available as a type with: Insidable compartmentIt is not opened. Opening such a compartment can destroy it and weaken the function of the switch. The medium-generation switch is further distinguished by 3 types of opening: The accessible compartment is controlled by an inter-dynamic lockM an inter-lock in the control panel that allows access when the direct parts are isolated and grounded. Opening the cutting equipment under normal operating conditions or for maintenance, for example to replace HV HRC fuse, is possible. Access pane depends on theAccess process described through the operating company's instructions and the lock must ensure safety when accessed during normal operation and maintenance. The tool depends on the tool being able to access the Tool and the correct working instructions are necessary to open the compartment, for example a safety note. Full. Accessibility type will not be usable during normal operation or maintenanceGo back content ↑ 4.6. Continuous service during work in progressIEC 62271-200 (VDE 0671-200) determines the type of operational availability (LSC, continuous loss of service) of the functional unit of a switchgear. They describe which parts must be removed from operation during the opening of an accessible switch compartment. Accessibility of switches and terminals is classified according to Table 2 below: Continuous service categoryWhen an accessible compartment of switchgear is opened ... ConstructionLSC type 1The busbar and therefore the complete switchgear must be isolatedNo partition plates in the panel, no panel partition so that the adjacent panelsLSC 2LSC 2AOnly cable supply must be isolated. Busbar and adjacent plates can remain in operationPanel partitioning and separation distance with compartmentalization to busbarLSC 2BThe cable supply, busbar, and adjacent plates can remain in operationPanel partition and separation distance with compartmentalization to busbar and cable Figure 6 (below) shows several examples for different types of continuous service : Figure 6 - Example of service continuity (LSC) of the medium voltage switch Back to content ↑ 4.7. Busbar systemThe following aspects play a part when choosing a single or double busbar: Number of loaders going in and outThe separate operation of the installation parts requires the operational capabilities of certain installation parts required during maintenance during the processSwitch-over of the consumer for different feed partsNon-interruptible switch-over requiredGo return internally ↑ BusbarA single busbarA content is enough for most tasks provided, even if this supply task consists of two destination feeds. It is simple and easy to handle, reducing the likelihood of error conversion. When switching operations are affected by an error, the circuit breaker must only be operated. If the wrong breaker should be operated accidentally, this will not have any safety-related consequences in switchgear, since circuit breakers are capable of carrying and breaking all loads and short-circuit currents, even in earth-buggy and other faulty conditions. In the case of more intense branching (rule of thumb: more than five feeders), the single busbar can be divided once or more times, with its own feed in each section. Disconnectors or switch disconnectors at breaking points create bus sectionalizers, while circuit breakers create vertical busbar couplers (BCL). A BCL makes sense if the busbar sections are acted as alternate splits or combinations. Return content ↑ Double Busbars Reasons to use a double busbar can be, for example: Two or more feed points in must always be operated separately (for example because there are other providers or embedded power generators used separately from the public grid). Consumers Disturbing disturbances on the grid are separated from consumers who place high demands on the quality of electricity supply. Consumers are classified by importance and assigned to the ongoing service requirements placed on the grid. The limited short circuit strength of the installed device requires a sub-division into two sub-systems with switch-overs to balance the load in case of different energy needsScler section from the first example, for example 2-4 allows the use of a transversal busbar coupler (BCT), which allows to change busbars without interrupting the energy flow (Figure 7). Figure 7a - Duplicate busbar with bus sectionalizer and busbar coupler, transversal (BCT)Figure 7b - Gas-insuver switchgear NXPLUS C (double-busbar) Back content ↑ 4.8. Internal arc classification (IAC)A successful classification test of medium voltage switches also requires an internal IAC arc error classification in accordance with IEC 62271-200 (VDE 0671-200). Distinguishing classifications are as follows: Accessibility: A - access for onlyB qualified employees - public access (i.e. a test in tightening conditions)Eligibility, Accessable side of switchgear: F - FrontL - LateralR - Current RearTest and Time Example: - Internal arc classification: IAC AR BFL 25 kA 1 sThe specification means that the rear can only be accessed by a skilled employee, while the front and side can be accessed by anyone Inner arc test is carried out with test line 25 kA in 1 s.Note time : Medium voltage switches are often tested for accessibility of Type A. Complete only, factory assembly stations (substations / load center substations) are tested for normal type B.Testing switchgear to suit type B does not make sense, as they will always be built into an additional station housing in public spaces. Considering the dangers associated with the appearance of an arcing bug, The following aspects should be noted when configuring on the basis of IEC 61936-1 (VDE 0101-1) standard: Protection against operating errors, for example guaranteed by the following measures:DisconnectorsMake-proof switchesLocking devicesNambiguous key locksKeep operating aisles as short, high and wide as possible. Use sealed or inclusive packaging instead of packing with holes or wire mesh. Installation deployments are arcing-error testing instead of installing in open design (e.g. installations in accordance with IEC 62271-200; VDE 0671-200). Bleed the arc gas into a direction away from the operator, and if necessary, out of the building. Use the current limited device. Ensure very short tripping times from fast-impact relays or devices that respond to pressure, light or heat. Operate the installation from a safe distance. Prevents the regeneration of energy using devices that cannot reset the device error detection inside, combines pressure reduction and provides an external instructions. Under Operating room must always be included in the safeguards taken against the effects of an arcing error: A calculation of dynamic pressure loads on the operating room, from which an architect or structural engineer can recognize the stress on the construction structure, is recommended. The operating room must be equipped with pressure-reducing holes of the cross section sufficiently or with a pressure reduction tube. Siemens provides two calculation methods as a service to establish raw guide values for calculating room size and/or pressure loss during the planning phase. Back to content ↑ 4.9. Simple pressure effect estimate PiglerA provides estimates according to F. Pigler for rooms up to 50 m³. Data on room volume, area of free relief cross-section and short-circuit current are checked into the matrix. This provides a simple curve process for overload pressure (see Figure 8). Figure 8 – Example of a fixed excess pressure due to an internal arc error Return to content ↑ 4.10. Limited-factor simulates pressure load in arcing conditionsAlth whether the incidence of internal faults (arc errors) is highly unlikely in this type of air test or switchgear insulate gas, the consequences of such an arcing error can be serious for the operator as much as possible for the room itself. For this reason, appropriate measures regarding the room situation must be provided to reduce pressure, such as downsy shops, ducts, soers or coolers. It is possible that this was considered during the installation and planning phase of the room. With the help of extremely modern methods of limited elements, pressure calculations can be performed in the entire three-dimensionally mapped space for the entire combustion time of the random supply. Some MV switch manufacturers, such as Siemens - provide a digital calculation service on the basis of a 3D volume model, where the actual installation of the cutting closure device, pressure development, reflection and arrangement of pressure loss holes is taken into account. Figure 9 - Drawing the contour of a simulation at 0.1 sVarious pressure load scenarios can be calculated for specific types of switches, short-circuit currents and installation sites. Therefore, customers benefit from extensive planning security and cost optimization solutions. Flow conditions are defined as boundary conditions. Firstly, these are switchgear steel plates and secondly, the absorbing plates are penetrated. Finally, the pressure drop holes in the switchgear room are identified. But the model also allows to calculate a completely closed room, or factor in pressure loss holes with pre-determined reaction pressure. As a result, the model brings an increase in pressure and flow conditions at any point of the grid of limited elements over time. In addition, the pressure distribution on the walls can be displayed as contours at a certain time (Figure 9). Note: Typically, too high pressure is caused by a arc error, which, when assumptions of the same room volume, is significantly higher for air insulation switches than metal insulation switches. Return to content ↑Reference // Power Distribution Plan - Siemens Siemens Technical Principles

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