

## **Multi Storied Buildings** **having height more than 15 m.**

The literary meaning of multi storied building is nothing but the building with multiple floors. Height of the building has predominant role with the safety measures. Electrical Inspectorate has statutory role with the multi storied buildings having height more than 15 m as per regulation 36 under Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010. NEC-2011 part-3 section-7 explain the statutory requirements of the electrical installations belonging to this category of buildings. This section of the code insists to obey with the safety provisions of NBC-2016 for the buildings. When we refer to NBC-2016, for fire safety a category of building is defined as High Rise Buildings, which are the multi storied buildings having height 15 m and above. NEC-2011 Part-3 Section-7 clause 5.7 & NBC-2016 Part-8, Section-5 clause 3.5 are unanimously insisting to obey with state/local fire laws. Hence high rise buildings will be defined with different heights for different states/area depending upon the vertical height reachability of the respective fire departments. In Kerala this height is defined as 16 m and above, while in Mumbai it is 24 m. Since, the whole electrical design parameters those explained with NBC-2016 Part-4 are defined to apply for buildings having height 15 m & above, it is understood that they are explicitly applicable to the multi storied buildings having height more than 15 m, which are coming under the jurisdiction of Electrical Inspectorate. This means, the way of high rise building height definition is for fire safety only, but not for the electrical design standards.

Collecting the whole data from NEC-2011 & NBC-2016, the following parameters are concluded for the multi storied buildings having height more than 15 m which are coming under the jurisdiction of Electrical Inspectorate.

### **1. General**

1. The wiring and cabling are with flame retardant property. (NBC-16 P-4 3.4.6.1)
2. High, medium and low voltage wiring running in shaft and in false ceiling shall run in separate shaft/metal conduits. (NBC-16 P-4 3.4.6.1)
3. Any 230 V wiring for lighting or other services, above false ceiling, shall have 660 V grade insulation. (NBC-16 P-4 3.4.6.1)
4. The electric distribution cables/wiring shall be laid in a separate shaft. (NBC-16 P-4 3.4.6.1)
5. The shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor. (NBC-16 P-4 3.4.6.1)
6. Water mains, gas pipes, telephone lines, intercom lines or any other service line shall not be laid in the duct for electrical cables; use of bus ducts/solid rising mains instead of cables is preferred. (NBC-16 P-4 3.4.6.1)
7. All metallic items like steel structural members, etc, shall be bonded properly to the earthing system. (NBC-16 P-4 3.4.6.1)
8. The minimum height of substation room/HV switch room/MV switch room shall be arrived at considering 1.2 m clearance requirement from top of the equipment to the below of the soffit of the beam. In case cable entry/exit is from above the equipment (transformer, HV switchgear, MV switchgear), height of substation room/HV switch room/MV switch room shall also take into account requirement of space for turning radius of cable above the equipment height. (NBC-16 P-8 S-2 4.2.1.26)
9. All the rooms (substation/HV switch/MV switch) shall be provided with partitions up to the ceiling and shall have proper ventilation. Special care should be taken to dissipate transformer heat and

where necessary fresh air louvers at lower level and exhaust fans at higher level shall be provided at suitable locations.(NBC-16 P-8 S-2 4.2.1.27)

10. In case of cable trench in substation/HV switch room/MV switch room, the same shall be adequately drained to ensure no water is stagnated at any time with live cables.(NBC-16 P-8 S-2 4.2.1.28)
11. All door openings from substation, electrical rooms, etc, should open outwards. (NBC-16 P-8 S-2 4.2.1.7)
12. Vertical shutters (like fire rated rolling shutters) may also be acceptable provided they are combined with a single leaf door opening outwards for exit in case of emergency. For large substation room/electrical room having multiple equipment, two or more doors shall be provided which shall be remotely located from each other.(NBC-16 P-8 S-2 4.2.1.7)
13. If substation is located at a height 1000 m above MSL, then adequate derating of equipment shall be considered.(NBC-16 P-8 S-2 4.2.1.8)
14. The power supply to the panel/distribution board of the fire and life safety systems shall be through fire proof enclosures or circuit integrity cables or through alternate route in the adjoining fire compartment to ensure supply of power is reliable to these systems and equipment. (NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
15. It shall be ensured that the cabling from the adjoining fire compartment is protected within the compartment of vulnerability. (NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
16. The location of the panel/distribution board feeding the fire and life safety system shall be in fire safe zone ensuring supply of power to these systems.(NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
17. Circuits of fire & life safety system shall be protected at origin by an automatic circuit breaker with its no-volt coil removed. (NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
18. Master switches controlling essential service circuits shall be clearly labelled.(NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
19. Cables for fire alarm and PA system (signal cables) shall be laid in metal conduits or armoured to provide physical segregation from the power cables.(NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
20. In multi storied buildings where large number of people gather (for example office buildings), there shall be at least two rising mains located in separate shafts. Each floor shall have a changeover switch for connection to either of the two mains. (NEC-11 P-3 S-7 7.2.1)
21. It is essential to provide independent feeders for installations such as fire lift, fire alarm, fire pumps, etc. (NEC-11 P-3 S-7 7.2.3)
22. In the case of residential buildings, submain wiring to the flats/apartments shall be independent for each flat/apartment. (NEC-11 P-3 S-7 7.2.4)
23. Twin earthing leads of adequate size shall be provided along the vertical runs of rising mains. . (NEC-11 P-3 S-7 7.2.5)

## **2. MV/LV Panel / Room**

24. The MV panel room shall be provided with access from outside (or through exit passageway accessible from outside). (NBC-16 P-4 3.4.6.3)
25. The MV panel room shall be provided with fire resistant walls and doors of fire resistance of not less than 2 hr rating.(NBC-16 P-4 3.4.6.3)
26. If the licensees agree to provide meters on upper floors, the licensees cables shall be segregated from consumers cables by providing a partition in the shaft.(NBC-16 P-4 3.4.6.3)
27. Meter rooms on upper floors shall not open into staircase enclosures and should be ventilated directly to open air outside or in electrical room of 2 hour fire resistant walls.(NBC-16 P-4 3.4.6.3)

28. Electrical MV main distribution panel and lift panels shall be provided with CO<sub>2</sub>/inert gas flooding system for all panel compartments with a cylinder located beside the panel.(NBC-16 P-4 3.4.6.3)
29. In case transformer and main MV/LV panel room are located at different floors or are at a distance more than 20 m, MV/LV isolator shall be provided at transformer end. (NBC-16 P-8 S-2 4.2.1.10)
30. In case transformer and main MV/LV panel room are located at different floors, an additional isolator or an emergency push button in the vicinity to trip the supply shall be provided.(NBC-16 P-8 S-2 4.2.1.10)
31. Layout of equipment should take care of the need that any one piece of equipment or sub-assembly can be taken out of service and out of the installed location, while keeping the remaining system in service. Working space for access for maintenance of equipment, while keeping an adjoining section of the substation live to maintain power supply to essential loads, may require additional space between such sections of equipment.(NBC-16 P-8 S-2 4.2.1.19)
32. An independent, ventilated or air conditioned MV panel room shall be provided on the ground level or first basement. (NBC-16 P-4 3.4.6.3)
33. A clear space of not less than 1 m in width shall be provided in front of the switchboard.(NBC-16 P-8 S-2 5.3.6.8.a)
34. If there are any attachments or bare connections at the back of the switchboard, the space, if any, behind the switchboard shall be either less than 200 mm or more than 750 mm in width, measured from the farthest protruding part of any attachment or conductor.(NBC-16 P-8 S-2 5.3.6.8.b)
35. If the space behind the switchboard exceeds 750 mm in width, there shall be a passageway from either end of the switchboard, clear to a height of 1.8 m.(NBC-16 P-8 S-2 5.3.6.8.c)
36. If two switchboards are facing each other, a minimum distance of 2.0 m shall be maintained between them. (NBC-16 P-8 S-2 5.3.6.8.d)

### **3. Emergency backup/Generator**

37. Power supply to the fire & life safety systems and equipments shall be from normal and emergency (standby generator) power sources with changeover facility. (NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
38. If power supply, is from HV source and HV generation, the transformer should be planned in standby capacity to ensure continuity of power to such systems. (NBC-16 P-4 3.4.6.2 &NBC-16 P-8 S-2 4.2.1.29)
39. Wherever transformers are installed at higher levels in buildings and backup DG sets are of higher voltage rating, then dual redundant cables shall be taken to all transformers.(NBC-16 P-4 3.4.6.2&NBC-16 P-8 S-2 4.2.1.29)
40. The generator shall be capable of taking starting current of all the fire and life safety systems and equipments.(NBC-16 P-4 3.4.6.2 &NBC-16 P-8 S-2 4.2.1.29)
41. Where parallel HV/LV supply from a separate substation fed from different grid is provided with appropriate transformer for emergency, the provision of generator may be waived in consultation with the Authority.(NBC-16 P-4 3.4.6.2 & NBC-16 P-8 S-2 4.2.1.29)
42. Diesel generators shall not be installed at any floor other than ground/first basement. (NBC-16 P-4 3.4.6.4)
43. If the diesel generators are installed indoors, proper ventilation and exhaust shall be planned. (NBC-16 P-4 3.4.6.4)
44. The DG set room shall be separated by 2 hour fire resistance rated walls and doors.(NBC-16 P-4 3.4.6.4)

45. The oil tank for the DG sets (if not in the base of the DG) shall be provided with a dyked enclosure having a volumetric capacity of at least 10 percent more than the volume of the oil tank. The enclosure shall be filled with sand for a height of 300 mm.(NBC-16 P-4 3.4.6.4)
46. It is preferable to install the standby generator in utility building. (NBC-16 P-8 S-2 4.3)
47. If installed in the enclosed space, facilities for forced ventilation shall be provided such that there is minimum derating of the equipment. (NBC-16 P-8 S-2 4.3)
48. The DG set should preferably be housed adjacent to MV switchgear in the substation building to enable transfer of electrical load efficiently and also to avoid transfer of vibration and noise to the main building. (NBC-16 P-8 S-2 4.3)
49. There shall be provision of separate direct escape and entry from outside so that in case of fire, electrical supplies can be disconnected to avoid additional losses which may be caused due to electrical supply, present at the time of fire. (NBC-16 P-8 S-2 4.3)
50. When it is located at a place, other than the ground level with direct equipment access, a hatch or ramp shall be provided. (NBC-16 P-8 S-2 4.3)
51. The height of DG set rooms shall however be not more than 3.0m above the DG set height, unless required due to DG room ventilation requirements. (NBC-16 P-8 S-2 4.3)

#### **4. Substation**

52. Areas in substation shall not be used as storage/dump areas or for other utility purposes other than those required for the functioning of the substation.(NBC-16 P-4 3.4.6.3)
53. The substation area should be adequately ventilated.(NBC-16 P-4 3.4.6.3)
54. The utility/substation building shall be at least 6 m away from the adjoining building(s) to allow passage of fire tender between the utility/substation building and adjoining building/main building. (NBC-16 P-4 3.4.6.3.1 & NBC-16 P-8 S-2 4.2.1.12)
55. Access to the substation shall be provided from the nearest fire exit/exit staircase for the purpose of electrical isolation.(NBC-16 P-4 3.4.6.3.2)
56. The substation should preferably be located in a separate utility building and may be adjacent to the generator room, if any. (NBC-16 P-8 S-2 4.2.1.2)
57. Location of substation in the basement should be avoided, as far as possible.(NBC-16 P-8 S-2 4.2.1.2)
58. In case there is only one basement in a building, the substation/switch room shall not be provided in the basement. (NBC-16 P-8 S-2 4.2.1.3)
59. Also, the floor level of the substation shall not be lowest point of the basement.(NBC-16 P-8 S-2 4.2.1.3)
60. Ideal location for an electrical substation for a group of buildings will be at the electrical load centre.(NBC-16 P-8 S-2 4.2.1.4)
61. In order to prevent storm water entering the transformer and switch rooms through the soak-pits, the floor level of the substation/ switch room shall be at least 300 mm above the highest flood water level that may be anticipated in the locality. Also, facility shall be provided for automatic removal of water. (NBC-16 P-8 S-2 4.2.1.5)
62. Substation shall not be located immediately above or below plumbing water tanks or sewage treatment plant (STP) water tanks at the same location.(NBC-16 P-8 S-2 4.2.1.6)
63. All transformers where capacity exceeds 10 MVA shall be protected by high velocity water spray systems or nitrogen injection system. (NEC-11 P-3 S-7 7.1.3 & NBC-16 P-4 3.4.6.3.1)
64. The power supply HV cables voltage shall not be more than 12 kV and a separate dedicated and fire compartmented shaft should be provided for carrying such high voltage cables to upper floors in a building. These shall not be mixed with any other shaft and suitable fire detection and suppression measures shall be provided throughout the length of the cable on each floor.(NBC-16 P-8 S-2 4.2.1.14)

65. The provision for installation and removal of substation equipment should be provided from inside or outside the building without disturbing the associated major equipment in the substation.(NBC-16 P-8 S-2 4.2.1.15)
66. In case of compact substation design and location of the substation shall ensure safety of the people around the compact substation installed along walkways, playgrounds, etc. Compact substation with incomer voltage of 12 kV or less, when located in open areas shall have fencing or barrier (of any metal based protection, such as wire mesh or chain link, which is duly earthed) against unauthorised contact possibility around it at a minimum distance of 750 mm around it with access for maintenance from all four sides. For incomer voltage more than 12 kV and less than 24 kV the fencing distance from substation may be 1000 mm minimum. In case of more than 24 kV incomer, the distance may be further increased accordingly. The fencing design should take care of the servicing and maintenance requirements of the substation equipment.(NBC-16 P-8 S-2 4.2.1.16)
67. In case of two transformers (dry type or transformers with oil quantity less than 2000 litre) located next to each other without intermittent wall, the distance between the two shall be minimum 1 500 mm for 11 kV, minimum 2000 mm for 22 kV and minimum 2500 mm for 33 kV. Beyond 33 kV, two transformers shall be separated by baffle wall of 4 h fire rating.(NBC-16 P-8 S-2 4.2.1.17)
68. Horizontal routing of HT cable through functional/occupied areas should be avoided in view of safety. (NBC-16 P-8 S-2 4.2.1.18).
69. If dry type transformer is used, it may be located adjacent to medium voltage switchgear in the form of unit type substation. In such a case, no separate room or fire barrier for the transformer is required either between transformers or between transformer and the switchgear, thereby decreasing the room space requirement; however, minimum distances as specified in this code shall be maintained between the apparatus depending upon voltage ratings.(NBC-16 P-8 S-2 4.2.1.19)
70. In case of HV panel and transformers located at different floors or at a distance more than 20 m, HV isolator shall be provided at transformer end.(NBC-16 P-8 S-2 4.2.1.9)
71. In case of single point supply with two or more transformers, the number of switch required will be one for incoming supply and one for each transformer.(NBC-16 P-8 S-2 4.2.1.23)
72. In places where flooding can occur and water level may go above 1000 mm, the base substation may be located on one level above the ground level of a utility building. In such cases, one feeder should feed ground level and levels below with automatic tripping of the feeder to avoid electrocution in case of live electricity coming in contact with water. (NBC-16 P-8 S-2 4.2.1.20)
73. No services or ventilation shafts shall open into substation or switch room unless specific to substation or switch room. (NBC-16 P-8 S-2 4.2.1.11)
74. In case the transformers are housed in the basements, totally segregated from other areas of the basements by 4-h fire-resisting wall/walls with an access directly from outside, they may be protected by carbon dioxide or BCF (bromochloro difluoromethane) or BTM (bromotrifluoro methane) fixed installation system. (NEC-11 P-3 S-7 7.1.4)
75. Oil-filled transformers shall not be housed on any floor above the ground floor. (NEC-11 P-3 S-7 7.1.6)
76. Only dry type of transformers should be used for installation inside the residential/commercial buildings.(NEC-11 P-3 S-7 7.1.8)
77. In the cases of certain high rise buildings, provision of substation at intermediate floors may be necessary for case of distribution. In such cases, non-inflammable cooling medium shall be used for substation equipment from the point of view of fire safety. (NEC-11 P-3 S-7 7.3.1.g)
78. The fault level at the point of commencement of supply should be obtained from the licensee and fault

levels at salient points in the distribution system assessed. Distribution system component should be selected to satisfy the same. (NEC-11 P-3 S-7 7.0.3)

79. Easy access for purpose of movement of equipment in and out of the substation including fire fighting vehicles. (NEC-11 P-3 S-7 7.3.1.a)

**a.Oil filled type substation**

80. Substations with oil-filled equipment/apparatus [transformers and high voltage panels] shall be either located in open or in a utility building. (NBC-16 P-4 3.4.6.3.1 &NBC-16 P-8 S-2 4.2.1.12.i)
81. Substations with oil-filled equipment/apparatus [transformers and high voltage panels] shall not be located in any floor other than the ground floor or the first basement of a utility building. (NEC-11 P-3 S-7 7.1.2 &NBC-16 P-8 S-2 4.2.1.12.i)
82. Substations with oil-filled equipment/apparatus [transformers and high voltage panels] shall not be located below first basement slab of utility building.(NBC-16 P-8 S-2 4.2.1.12.i)
83. Substations with oil-filled equipment/apparatus [transformers and high voltage panels] shall have direct access from outside the building for operation and maintenance of the equipment.(NBC-16 P-8 S-2 4.2.1.12.i)
84. There shall be no interconnecting basement with the main building underneath the oil-filled transformers.(NBC-16 P-8 S-2 4.2.1.12.iii)
85. Provisions for oil drainage to a point at a lower level and separated by adequate fire barrier shall be provided. (NBC-16 P-8 S-2 4.2.1.12.iv)
86. If there is a floor directly below the ground floor level or first basement where the oil-filled transformers and oil-filled circuit breakers are placed, then they shall be separated by a 4 hour rated fire barrier.(NBC-16 P-8 S-2 4.2.1.12.iv)
87. Proper oil drainage system shall be provided to avoid possible leakage of oil into the lower floor.(NBC-16 P-8 S-2 4.2.1.12.iv)
88. Substation equipment (exceeding oil capacity of 2000 litre) in utility building shall have fire rated baffle walls of 4hour rating constructed between such equipment, raised to at least 600 mm above the height of the equipment (including height of oil conservators) and exceeding 300 mm on each side of the equipment. (NEC-11 P-3 S-7 7.1.2, NBC-16 P-4 3.4.6.3.1 &NBC-16 P-8 S-2 4.2.1.12.v)
89. Provisions shall be made for suitable oil soak-pit, and where use of more than 9000 litre of oil in any one oil tank, receptacle or chamber is involved, provision shall be made for the draining away or removal of any oil which may leak or escape from the tank, receptacle or chamber containing the same. Special precautions shall be taken to prevent the spread of any fire resulting from the ignition of the oil from any cause and adequate provision shall be made for extinguishing any fire which may occur. (NBC-16 P-8 S-2 4.2.1.12.vi)
90. In respect of all oil type transformers located at basement, a kerb (sill) of a suitable height shall be provided at the entrance in order to prevent the flow of oil from a ruptured transformer into other parts of the basement in the event of the possibility of oil spillage from the transformer on its failure. (NEC-11 P-3 S-7 7.1.2 &NBC-16 P-8 S-24.2.1.12.vii)
91. Adequate fire barriers or deflectors shall be provided to avoid flames from the substation reaching or affecting the upper floors.(NBC-16 P-8 S-2 4.2.1.12.viii)
92. Soak pit of approved design shall be provided where the aggregate oil capacity of the apparatus does not exceed 2 000 litres. Where the oil capacity exceeds 2000 litre, a tank of RCC construction of capacitycapable of accommodating entire oil of the transformers shall be provided at a lower level to collect the oil from the catch-pit in case of emergency. The pipe connecting the catch-pit to the tank shall be of non-combustible construction and shall be provided with a flame-arrester. (NEC-11 P-3 S-7 7.1.7)

**b.Dry type substation**

93. Transformers located inside a building shall be of dry type and all substation/switch room walls, ceiling, floor, opening including doors shall have a fire resistance rating of 2 hour rating. (NBC-16 P-4 3.4.6.3.2)
94. Dry type substations shall be located on the ground level or on first basement, and shall have direct access from the outside of the building for operation and maintenance of the equipment.(NBC-16 P-8 S-2 4.2.1.13)
95. In case of functional buildings, such as air traffic control towers, data centres and buildings of height more than 100 m having high electrical load requirement, dry-type installations/substations may also be provided at upper level. In such cases, a base substation shall be located at ground floor/first basement to cater to the main MV/LV panel which feeds life and safety services loads. The base substation shall be located in such a way to provide direct access to the firemen in case of any emergency. (NBC-16 P-8 S-2 4.2.1.13)
96. The power supply control to any substation or transformer located at upper floors shall be from the base substation so that in case of fire, the electrical supply can be easily disconnected to avoid additional losses.(NBC-16 P-8 S-2 4.2.1.13)

\*\*\*