

IET Wiring Regulations (BS 7671:2008+A3:2015) - SECTION 710 MEDICAL LOCATIONS

710.1 Scope

This section applies to electrical installations in medical locations to ensure the safety of patients and medical staff. These requirements, in the main, refer to hospitals, private clinics, medical and dental practices, healthcare centres and dedicated medical rooms in the workplace.

The requirements of this section do not apply to medical electrical (ME) equipment.

This section also applies to electrical installations in locations designed for medical research.

NOTE 1: It may be necessary to modify the existing electrical installation, in accordance with this Standard, when a change of utilization of the location occurs. Special care should be taken where intracardiac procedures are performed in existing installations.

NOTE 2: Where applicable, this Standard can also be used in veterinary clinics.

NOTE 3: For ME equipment and ME systems, refer to the BS EN 60601 series.

NOTE 4: Care should be taken so that other installations do not compromise the level of safety provided by installations meeting the requirements of this section.

NOTE 5: Supporting information on the electrical installations of medical locations can be found in Health Technical Memorandum (HTM) 06-01 (Part A), published by the Department of Health.

710.3 Assessment of general characteristics

In order to determine the classification and Group number of a medical location, it is necessary that the relevant medical staff indicate which medical procedures will take place within the location. Based on the intended use, the appropriate classification for the location shall be determined.

NOTE 1: Classification of a medical location is related to the type of contact between applied parts and the patient, the threat to the safety of the patient owing to a discontinuity (failure) of the electrical supply, as well as the purpose for which the location is used. (Guidance on the allocation of a Group number and classification of safety services for medical locations is shown in Annex A710.)

NOTE 2: To ensure protection of patients from possible electrical hazards, additional protective measures are applied in medical locations. The type and description of these hazards can vary according to the treatment being administered. The purpose for which a location is to be used may justify areas with different classifications (Group 0, 1 or 2) for different medical procedures.

NOTE 3: Applied parts are defined by the particular standards for ME equipment.

NOTE 4: Where a medical location may be used for different medical procedures the requirements of the higher Group classification should be applied; refer to Annex A710.

710.31 Purpose, supplies and structure

710.312.2 Types of system earthing

PEN conductors shall not be used in medical locations and medical buildings downstream of the main distribution board.

NOTE : In Great Britain, Regulation 8(4) of the Electricity Safety, Quality and Continuity Regulations 2002 prohibits the use of PEN conductors in consumers' installations.

710.313 Supplies

710.313.1 General

In medical locations, the distribution system shall be designed and installed to facilitate the automatic changeover from the main distribution network to the electrical safety source feeding essential loads, as required by Regulation 560.5.

710.4 Protection for safety

710.41 Protection against electric shock

710.410.3 General requirements

710.410.3.5 The protective measures of obstacles and placing out of reach (Section 417) are not permitted.

710.410.3.6 The protective measures of non-conducting location (Regulation 418.1), earth-free local equipotential bonding (Regulation 418.2) and electrical separation for the supply to more than one item of current-using equipment (Regulation 418.3) are not permitted.

NOTE :A medical IT system does not use electrical separation as the sole means of protection against electric shock.

710.411.3 Requirements for fault protection (protection against indirect contact)

710.411.3.2 Automatic disconnection in case of a fault

710.411.3.2.1 Care shall be taken to ensure that simultaneous use of many items of equipment connected to the same circuit cannot cause unwanted tripping of the residual current protective device (RCD).

In medical locations of Group 1 and Group 2, where RCDs are required, only type A according to BS EN 61008 and BS EN 61009 or type B according to BS EN 62423 shall be selected, depending on the possible fault current arising. Type AC RCDs shall not be used.

710.411.3.2.5 In medical locations of Group 1 and Group 2, the following shall apply:

- (i) For TN, TT and IT systems, the voltage presented between simultaneously accessible exposed-conductive-parts and/or extraneous-conductive-parts shall not exceed 25 V a.c. or 60 V d.c.
- (ii) For TN and TT systems, the requirements of Table 710 shall apply.

TABLE 710– Maximum disconnection times

System	25 V < U ₀ ≤ 50 V		50 V < U ₀ ≤ 120 V		120 V < U ₀ ≤ 230 V		230 V < U ₀ ≤ 400 V		U ₀ > 400 V	
	Seconds									
	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.	d.c.
TN	5	5	0.3	2	0.3	0.5	0.05	0.06	0.02	0.02
TT	5	5	0.15	0.2	0.05	0.1	0.02	0.06	0.02	0.02

NOTE :In TN systems, 25 V a.c. or 60 V d.c. may be met with protective equipotential bonding, by complying with the disconnection time in accordance with Table 710.

710.411.3.3 Additional protection

Where a medical IT system is used, additional protection by means of an RCD shall not be used.

710.411.4 TN system

In final circuits of Group 1 rated up to 63 A, RCDs having the characteristics specified in Regulation 415.1.1 shall be used.

In final circuits of Group 2 (except for the medical IT system), RCDs having the characteristics specified in Regulation 415.1.1 shall be used in circuits for:

- (i) the supply of movements of fixed operating tables
- (ii) X-ray units
- (iii) large equipment with rated power greater than 5 kVA.

NOTE 1: The list of circuits in (i) to (iii) above is not exhaustive.

NOTE 2: The requirement in (ii) above is mainly applicable to mobile X-ray units brought into Group 2 locations.

710.411.5 TT system

In medical locations of Group 1 and Group 2, RCDs shall be used as protective devices and the requirements of Regulation 710.411.4 apply.

710.411.6 IT system

710.411.6.3.1 In Group 2 medical locations, an IT system shall be used for final circuits supplying ME equipment and systems intended for life support, surgical applications and other electrical equipment located or that may be moved into the “patient environment”, excluding equipment listed in Regulation 710.411.4.

For each group of rooms serving the same function, at least one IT system is necessary. The IT system shall be equipped with an insulation monitoring device (IMD) in accordance with BS EN 61557-8, with the following additional specific requirements:

- (i) Internal a.c. impedance shall be $\geq 100 \text{ k}\Omega$
- (ii) Internal resistance shall be $\geq 250 \text{ k}\Omega$
- (iii) Test voltage shall be $\leq 25 \text{ V d.c.}$
- (iv) Injected current, even under fault conditions, shall be $\leq 1 \text{ mA peak}$
- (v) Indication shall take place when the insulation resistance has decreased to $50 \text{ k}\Omega$. If the response value is adjustable, the lowest possible setpoint value shall be $\geq 50 \text{ k}\Omega$. A test device shall be provided
- (vi) Response and alarm-off time shall be $\leq 5 \text{ s.}$

NOTE 1: An indication is recommended if the protective earth (PE) or wiring connection of the IMD is lost.

For each medical IT system, an audible and visual alarm system, incorporating the following components, shall be provided so that it can be permanently monitored by the medical staff and any alarm reported to technical staff:

- (vii) A green signal lamp to indicate normal operation
 - (viii) A yellow signal lamp which lights when the minimum value set for the insulation resistance is reached. It shall not be possible for this light to be cancelled or disconnected
 - (ix) An audible alarm which sounds when the minimum value set for the insulation resistance is reached. This audible alarm may be silenced
 - (x) The yellow signal shall extinguish on removal of the fault and when the normal condition is restored.
- Documentation shall be easily readable in the medical location and it shall include:
- (xi) the meaning of each type of signal, and
 - (xii) the procedure to be followed in case of an alarm at first fault.

NOTE 2: For illustration of a typical theatre layout refer to Figure 710.2.

NOTE 3: A system constructed to the requirements of Regulation 710.411.6.3.1 is known as a medical IT system.

710.411.6.3.2 Monitoring of overload and high temperature for the IT transformer is required.

710.411.6.3.3 In addition to an insulation monitoring device, consideration shall be given to the installation of fault location systems which localize insulation faults in any part of the medical IT system.

The insulation fault location system shall be in accordance with BS EN 61557-9.

710.411.7 Functional extra-low voltage (FELV)

In medical locations, functional extra-low voltage (FELV) is not permitted as a method of protection against electric shock.

710.414 Protective measure: Extra-low voltage provided by SELV or PELV

710.414.1 General

When using SELV and/or PELV circuits in medical locations of Group 1 and Group 2, the nominal voltage applied to current-using equipment shall not exceed 25 V a.c. rms or $60 \text{ V ripple-free d.c.}$ Protection by basic insulation of live parts as required by Regulation 416.1 or by barriers or enclosures as required by Regulation 416.2, shall be provided.

710.414.4.1 In medical locations of Group 2, where PELV is used, exposed-conductive-parts of equipment, e.g. operating theatre luminaires, shall be connected to the circuit protective conductor.

710.415.2 Additional protection: Supplementary equipotential bonding

710.415.2.1 In each medical location of Group 1 and Group 2, supplementary equipotential bonding shall be installed and the supplementary bonding conductors shall be connected to the equipotential bonding busbar for the purpose of equalizing potential differences between the following parts, which are located or that may be moved into the “patient environment”:

- (i) Protective conductors

- (ii) Extraneous-conductive-parts
- (iii) Screening against electrical interference fields, if installed
- (iv) Connection to conductive floor grids, if installed
- (v) Metal screens of isolating transformers, via the shortest route to the earthing conductor.

Supplementary equipotential bonding connection points for the connection of ME equipment shall be provided in each medical location, as follows:

- (vi) Group 1: a minimum of one per patient location
- (vii) Group 2: a minimum of four but not less than 25% of the number of medical IT socket-outlets provided per patient location.

NOTE :Fixed conductive non-electrical patient supports such as operating theatre tables, physiotherapy couches and dental chairs, should be connected to the equipotential bonding conductor unless they are intended to be isolated from earth.

710.415.2.2 In medical locations of Group 1:

- (i) the resistance of the protective conductors between the earth terminal of any socket-outlet (or fixed equipment) and any exposed-conductive-part and/or extraneous-conductive-part shall be such that the voltages given in 710.411.3.2.5(i) are not exceeded, and
- (ii) the measured resistance between the earth terminal of any socket-outlet (or fixed equipment) and any extraneous-conductive-part shall not exceed 0.7 Ω .

In medical locations of Group 2, the measured resistance of the protective conductor between the earth terminal of any socket-outlet (or fixed equipment) and any extraneous-conductive-part shall not exceed 0.2 Ω .

NOTE :In TN and TT systems, a value of 25 V a.c. or 60 V d.c. may be obtained by the provision of protective equipotential bonding in conjunction with circuit protective conductors for the particular circuit. In the case of TT systems a satisfactory value of R_A will also be required.

710.415.2.3 The equipotential bonding busbar shall be located in or near the medical location. Connections shall be so arranged that they are accessible, labelled, clearly visible and can easily be disconnected individually.

NOTE 1:In medical locations the equipotential bonding busbar (EBB) is also referred to as the earth reference bar (ERB).

NOTE 2:It is recommended that radial wiring patterns are used to avoid "earth loops" that may exacerbate electromagnetic disturbances.

710.444 Measures against electromagnetic disturbances

Special considerations have to be made concerning electromagnetic interference (EMI) and electromagnetic compatibility (EMC).

710.5 Selection and erection of equipment

710.51 Common rules

710.511.1 Distribution boards

Distribution boards shall meet the requirements of BS EN 60439 series.

Distribution boards for Group 2 locations shall be installed in close proximity to the areas they serve and be clearly labelled.

710.512 Operational conditions and external influences

710.512.1 Operational conditions

710.512.1.1 Transformers for IT systems

Transformers shall be in accordance with BS EN 61558-2-15, installed in close proximity to the medical location and with the following additional requirements:

- (i) The leakage current of the output winding to earth and the leakage current of the enclosure, when measured in no-load condition and with the transformer supplied at rated voltage and rated frequency, shall not exceed 0.5 mA

(ii) At least one single-phase transformer per room or functional group of rooms shall be used to form the IT systems for mobile and fixed equipment. The rated output shall be not less than 0.5 kVA and shall not exceed 10 kVA. Where several transformers are needed to supply equipment in one room, they shall not be connected in parallel

(iii) If the supply of three-phase loads via an IT system is also required, a separate three-phase transformer shall be provided for this purpose.

For monitoring see Regulation 710.411.6.3.1.

Capacitors shall not be used in transformers for medical IT systems.

710.512.1.2 Power supply for medical locations of Group 2

In the event of a first fault to earth, a total loss of supply in Group 2 locations shall be prevented.

710.512.2.1 Explosion risk

Electrical devices, e.g. socket-outlets and switches, installed below any medical-gas outlets for oxidizing or flammable gases shall be located at a distance of at least 0.2 m from the outlet (centre to centre), so as to minimize the risk of ignition of flammable gases.

NOTE :Requirements for ME equipment for use in conjunction with flammable gases and vapours are contained in BS EN 60601.

710.514.9 Diagrams and documentation

710.514.9.1 Plans of the electrical installation together with records, drawings, wiring diagrams and modifications relating to the medical location, shall be provided.

Information provided shall include but not be limited to:

- (i) single-line overview diagrams showing the distribution system of the normal power supply and power supply for safety services in a single-line representation
- (ii) distribution board block diagrams showing switchgear and controlgear and distribution boards in a single-line representation
- (iii) schematic diagrams of controls
- (iv) the verification of compliance with the requirements of standards
- (v) functional description for the operation of the safety power supply services and of the safety power supply system.

710.52 Selection and erection of wiring systems

Any wiring system within Group 2 medical locations shall be exclusively for the use of equipment and accessories within those locations.

710.53 Protection, isolation, switching, control and monitoring

710.531.1 Overcurrent protective devices - protection of wiring systems in medical locations of Group 2

Overload current protection shall not be used in either the primary or secondary circuit of the transformer of a medical IT system.

Overcurrent protection against overload and short-circuit currents is required for each final circuit.

NOTE 1:Overcurrent protective devices (e.g. fuses) may be used in the primary circuit of the transformer for short-circuit protection only.

NOTE 2:Fig 710.3 shows a typical medical IT system arrangement.

710.531.2 RCDs

710.531.2.4 Socket-outlets protected by RCDs

For each circuit protected by an RCD having the characteristics specified in Regulation 415.1.1, consideration shall be given to reduce the possibility of unwanted tripping of the RCD due to excessive protective conductor currents produced by equipment during normal operation.

710.537 Isolation and switching

710.537.1 General

Automatic changeover devices shall comply with BS EN 60947-6-1 and shall be arranged so that safe separation between supply lines is maintained.

710.55 Other equipment

710.553.1 Socket-outlet circuits in the medical IT system for medical locations of Group 2

Socket-outlets intended to supply ME equipment shall be unswitched.

At each patient's place of treatment, e.g. bedheads, the configuration of socket-outlets shall be as follows:

- (i) Each socket-outlet supplied by an individually protected circuit, or
- (ii) several socket-outlets separately supplied by a minimum of two circuits.

Socket-outlets used on medical IT systems shall be coloured blue and be clearly and permanently marked "Medical Equipment Only".

NOTE :Guidance is given in Health Technical Memorandum (HTM) 06-01 (Part A).

710.559 Luminaires and lighting installations

In medical locations of Group 1 and Group 2, at least two different sources of supply shall be provided. One of the sources shall be connected to the electrical supply system for safety services.

710.56 Safety services

A power supply for safety services is required which will maintain the supply for continuous operation for a defined period within a pre-set changeover time.

The safety power supply system shall automatically take over if the voltage of one or more incoming live conductors, at the main distribution board of the building, has dropped for more than 0.5 s and by more than 10 % in regard to the nominal voltage; refer to Annex A710, Table A710– List of examples.

710.560.4 Classification

Classification of safety services is given in Regulation 560.4.1.

NOTE :Safety services provided for locations having differing classifications should meet that classification which gives the highest security of supply.

710.560.5.5 General requirements for safety power supply sources of Group 1 and Group 2

Primary cells are not allowed as safety power sources.

An additional main incoming power supply, from the general power supply, is not regarded as a source of the safety power supply.

The availability (readiness for service) of safety power sources shall be monitored and indicated at a suitable location.

710.560.5.6 In case of a failure of the general power supply source, the power supply for safety services shall be energized to feed the equipment stated in Regulations 710.560.6.1.1 to 3 with electrical energy for a defined period of time and within a predetermined changeover period.

710.560.5.7 Where socket-outlets are supplied from the safety power supply source they shall be readily identifiable according to their safety services classification.

710.560.6 Electrical sources for safety services

710.560.6.1 Detailed requirements for safety power supply services

NOTE :Also refer to Regulation 710.560.5.5.

710.560.6.1.1 Power supply sources with a changeover period less than or equal to 0.5 s

In the event of a voltage failure on one or more line conductors at the distribution board, a safety power supply source shall be used and be capable of providing power for a period of at least 3 h for the following:

- (i) Luminaires of operating theatre tables
- (ii) ME equipment containing light sources being essential for the application of the equipment, e.g. endoscopes, including associated essential equipment, e.g. monitors
- (iii) Life-supporting ME equipment.

The duration of 3 h may be reduced to 1 h for items (ii) and (iii) if a power source meeting the requirements of Regulation 710.560.6.1.2 is installed.

The normal power supply shall be restored within a changeover period not exceeding 0.5 s.

NOTE :Guidance relating to the autonomy of battery inverter units for theatre luminaires is provided in HTM 06-01 (Part A).

710.560.6.1.2 Power supply sources with a changeover period less than or equal to 15 s

Equipment meeting the requirements of Regulations 710.560.9.1 and 710.560.11 shall be connected within 15 s to a safety power supply source capable of maintaining it for a minimum period of 24 h, when the voltage of one or more live conductors at the main distribution board for the safety services has decreased by more than 10 % of the nominal value of supply voltage and for a duration greater than 3 s.

710.560.6.1.3 Power supply sources with a changeover period greater than 15 s

Equipment, other than that covered by Regulations 710.560.6.1.1 and 710.560.6.1.2, which is required for the maintenance of hospital services, shall be connected either automatically or manually to a safety power supply source capable of maintaining it for a minimum period of 24 h. This equipment may include, for example:

- (i) Sterilization equipment
- (ii) Technical building installations, in particular air conditioning, heating and ventilation systems, building services and waste disposal systems
- (iii) Cooling equipment
- (iv) Catering equipment
- (v) Storage battery chargers.

710.560.7 Circuits of safety services

The circuit which connects the power supply source for safety services to the main distribution board shall be considered a safety circuit.

710.560.9 Emergency lighting systems

710.560.9.1 Safety lighting

In the event of mains power failure, the changeover period to the safety services source shall not exceed 15 s. The necessary minimum illuminance shall be provided for the following:

- (i) Emergency lighting and exit signs
- (ii) Locations for switchgear and controlgear for emergency generating sets, for main distribution boards of the normal power supply and for power supply for safety services
- (iii) Rooms in which essential services are intended. In each such room at least one luminaire shall be supplied from the power source for safety services
- (iv) Locations of central fire alarm and monitoring systems

(v) Rooms of Group 1 medical locations; in each such room at least one luminaire shall be supplied from the power supply source for safety services

(vi) Rooms of Group 2 medical locations; a minimum of 90 % of the lighting shall be supplied from the power source for safety services.

The luminaires of the escape routes shall be arranged on alternate circuits.

710.560.11 Other services

Other services which may require a safety service supply with a changeover period not exceeding 15 s include, for example, the following:

- (i) Selected lifts for firefighters
- (ii) Ventilation systems for smoke extraction
- (iii) Paging/communication systems
- (iv) ME equipment used in Group 2 medical locations which serves for surgical or other procedures of vital importance. Such equipment will be defined by responsible staff
- (v) Electrical equipment of medical gas supply including compressed air, vacuum supply and narcosis (anaesthetics) exhaustion as well as their monitoring devices
- (vi) Fire detection and fire alarms
- (vii) Fire extinguishing systems.

710.6 Inspection and testing

NOTE : The testing of equipment connected to the electrical installation is outside the scope of this document. For ME equipment refer to BS EN 62353.

710.61 Initial verification

The dates and results of each verification shall be recorded.

The tests specified below under items (i) to (iii), in addition to the requirements of Chapter 61, shall be carried out, both prior to commissioning and after alteration or repairs and before re-commissioning:

- (i) Complete functional tests of the insulation monitoring devices (IMDs) associated with the medical IT system including insulation failure, transformer high temperature, overload, discontinuity and the audible and/or visual alarms linked to them
- (ii) Measurements of leakage current of the output circuit and of the enclosure of the medical IT transformers in no-load condition, as specified by Regulation 710.512.1.1(i)
- (iii) Measurements to verify that the resistance of the supplementary equipotential bonding is within the limits stipulated by Regulation 710.415.2.2.

NOTE 1: The tests specified within HTM 06-01 (Part A) may also be required as part of client requirements.

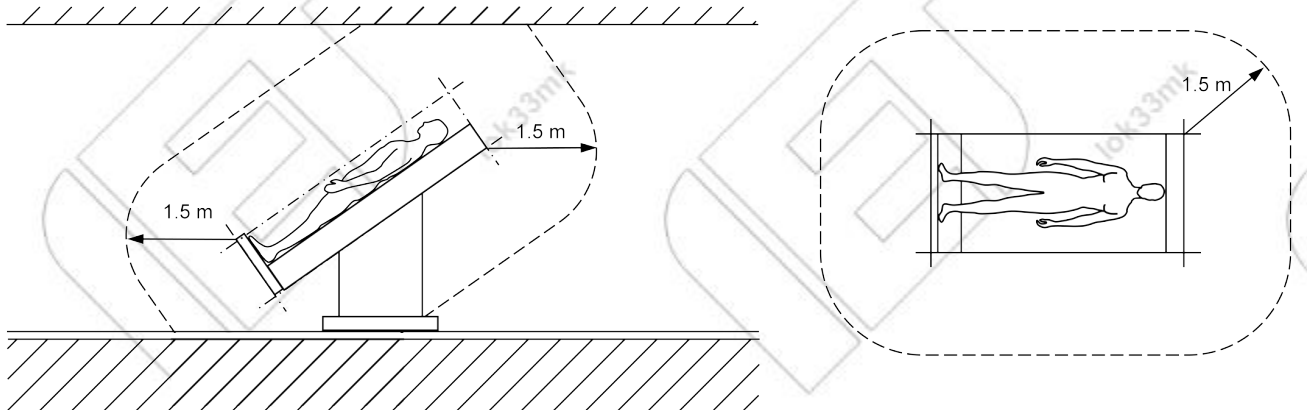
710.62 Periodic inspection and testing

NOTE 1: In addition to the requirements of Chapter 62, the following procedures are recommended at the given intervals:

- (i) Annually - Complete functional tests of the insulation monitoring devices (IMDs) associated with the medical IT system including insulation failure, transformer high temperature, overload, discontinuity and the audible/visual alarms linked to them
- (ii) Annually - Measurements to verify that the resistance of the supplementary equipotential bonding is within the limits stipulated by Regulation 710.415.2.2.
- (iii) Every 3 years - Measurements of leakage current of the output circuit and of the enclosure of the medical IT transformers in no-load condition, as specified by Regulation 710.512.1.1(i)

NOTE 2: Guidance on periodic inspection and testing is given in HTM 06-01 (Part B). Client or local Health Authority requirements, if any, may apply.

Fig 710.1– Example of patient environment (BS EN 60601)



NOTE : The dimensions in the figure show the minimum extent of the patient environment in a free surrounding. This applies where the patient's position is predetermined; if not, all possible patient positions should be considered (see Patient environment, Part 2, Definitions).

Fig 710.2– Typical theatre layout

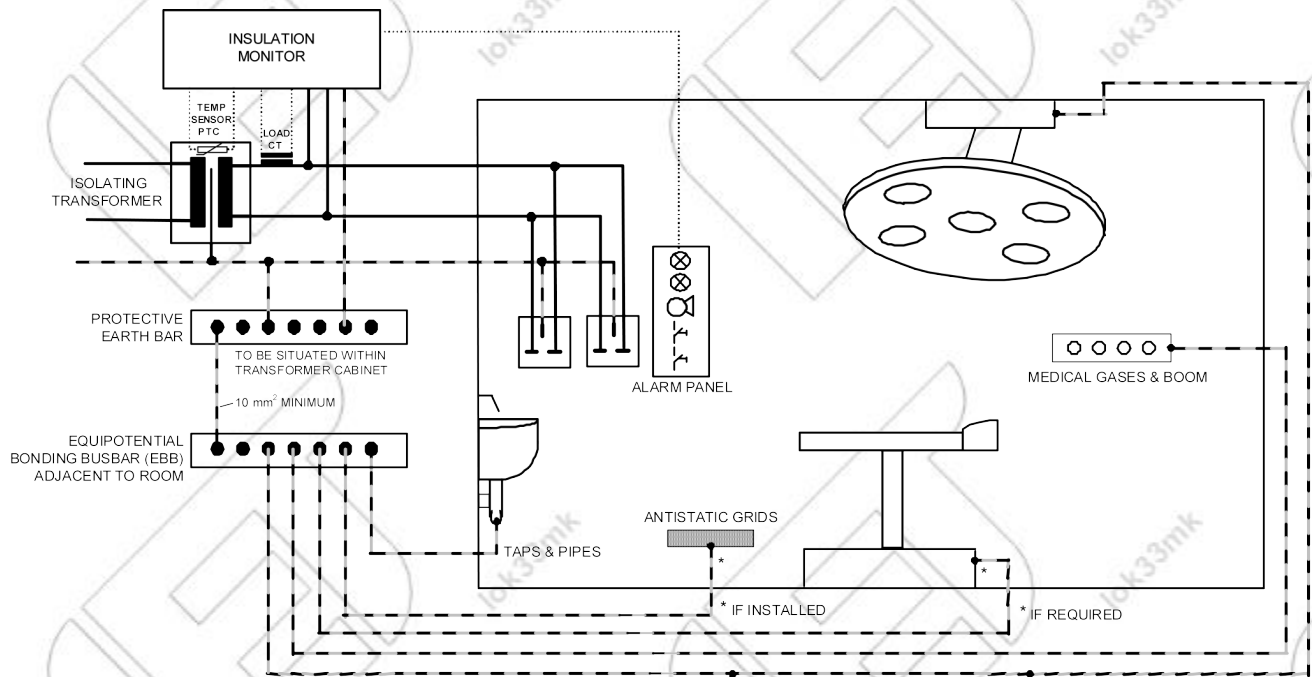


Fig 710.3– Typical medical IT system arrangement

