

# GREEN HOSPITALS

## CONCEPT MANUAL FOR

### IMPROVING INFRASTRUCTURE

#### SECTION 2

## Best Practice:

# Building and Building Services Maintenance

Additional sections available - go to EPOS' Green Hospitals page to view all:

Section 1: Best Practice – Basic Planning Principles

Section 2: Best Practice – Building and Building Services Maintenance

Section 3: Best Practice – Water Supply and Wastewater for Health Facilities

Section 4: Best Practice – Healthcare Waste Services

Section 5: Best Practice – Environmental Cleaning Services

[www.epos.de](http://www.epos.de)



[www.etlog-health.com](http://www.etlog-health.com)



[www.giz.de](http://www.giz.de)



Developed as part of the 'Greening Hospitals Integrated Infrastructure Competence Project' in Tajikistan, co-funded by EPOS, ETLog and GIZ • December 2013 - October 2015

For further information contact:

EPOS Health Management • [eposhq@epos.de](mailto:eposhq@epos.de) • +49 (0)6172-930-370



This Concept Manual has been prepared in five sections within the framework of the 'Greening Hospitals — Integrated Infrastructure Competence Project' in Tajikistan, by the development partnership of EPOS Health Management and ETLog Health GmbH, as part of the part of the develoPPP.de programme that Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is implementing on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ).

The five sections are as follows:

- SECTION 1 — Best Practice: Basic Planning Principles
- SECTION 2 — Best Practice: Building & Building Services Maintenance
- SECTION 3 — Best Practice: Water Supply and Wastewater in Health Facilities
- SECTION 4 — Best Practice: Healthcare Waste Services
- SECTION 5 — Best Practice: Environmental Cleaning Services



## Table of Contents

<b>Introduction—Importance of Maintenance Service</b> .....	4
<b>General Building Maintenance</b> .....	6
<b>Maintenance of Electrical Services</b> .....	45
<b>Maintenance of Ventilation &amp; Air Conditioning Systems</b> .....	75
<b>Maintenance of Heating Systems</b> .....	94
<b>Maintenance of Medical Gas Supply</b> .....	100
<b>Further Reading</b> .....	105

## List of Tables

Table 1 Maintenance Checklist: Lighting Fixtures .....	46
Table 2 Maintenance Checklist: Power Outlets .....	49
Table 3 Maintenance Checklist: Communication/Data Outlets .....	51
Table 4 Maintenance Checklist: PVC Conduits/ Conduits .....	53
Table 5 Template for Recording Electrical Testing Results .....	57
Table 6 Template for Recording Electrical Testing Results .....	58
Table 7 Maintenance Checklist: Split ACU.....	76
Table 8 Maintenance Checklist: Package ACU .....	79
Table 9 Maintenance Checklist: Supply Air Fan .....	81
Table 10 Maintenance Checklist: Exhaust Air Fan.....	83

Table 11 Maintenance Checklist: Vent. Duct Air Filter Units.....	84
Table 12 Maintenance Checklist: Supply Air Diffusers/Return Air Grilles	85
Table 13 Maintenance Checklist: Exhaust Fume Hood—Kitchen .....	87
Table 14 Maintenance Checklist: Outdoor Air Intake Ventilation Ducted System.....	89
Table 15 Maintenance Checklist: Thermostat .....	90
Table 16 Maintenance Checklist: Ductwork .....	91

## **Introduction—Importance of Maintenance**

A crucial contribution to sustainability in healthcare infrastructure is safeguarding the life of the facilities and ensuring they remain fit for purpose for as long as possible. A key component of this contribution is achieved through effective maintenance—planned, preventative and corrective.

As much as sustainability considers energy use and the application of appropriate materials and technologies, the value of any investment measures are soon depleted if comprehensive and adequately funded building maintenance is not carried out.

In particular, if investment in the latest energy efficient technology and equipment is not an option, safeguarding what is already in existence is the key to sustainable operation. Even where investments and improvements have been made, without appropriate maintenance, these will have reduced effectiveness. An effective building maintenance programme can help a hospital or health facility reduce energy consumption and operating costs, as well as prolong the life of the facility.



# **Organization & Management of Maintenance Services**

## Roles & Responsibilities

Roles and responsibilities to be considered when ensuring maintenance is carried out in the healthcare facility and its compound:

### **The Director**

The Director of the healthcare facility will be responsible to ensure an appropriate maintenance plan is in place and is upheld, as well as ensuring that budget is available to carry out maintenance tasks. He/she will also need to consider what the overall strategy for maintenance should be, whether carried out entirely by in-house staff, entirely contracted out or a combination of both, to optimum efficiency and quality of repairs.

### **Facility Manager**

The Facility Manager will be responsible to oversee the daily operation of the maintenance plan. He/she will be responsible to communicate with external service providers and ensure in-house maintenance staff are carrying out the agreed maintenance activities. The Facility Manager should raise awareness on the importance of recording faults and damage amongst the healthcare facility staff.

**Maintenance Person:** The Maintenance Person is designated to carry out the planned, preventive and corrective maintenance activities as agreed in the maintenance plan,

### **Other Healthcare Workers/Operational Staff**

The tasks of other staff in the healthcare facility will include reporting of faults or damage to building infrastructure and installations.

## Budgeting

To ensure the health facility infrastructure is maintained to an appropriate standard and repairs are carried out in a timely manner, an appropriate budget needs to be made available. This budget should be available either to finance in-house staff to carry out repairs or for contracting out repair activities. The facility manager will be responsible to estimate the needed annual budget.

For capital costs, the following items must be considered:

- \* Tools and equipment for carrying out minor repairs;
- \* Staff training and capacity building.

For recurring costs, the following items must be considered:

- \* Spare parts and repair materials— such as for electrical, plumbing, heating and ventilation installations.



# **General Building Maintenance**

## Building Maintenance /Flooring — Ceiling — Walls

### FLOORING

QUARTERLY: Check tile work. Ensure that all tiles are filled with grout. Use only black grout. If tiles are missing, install new tiles. If tiles are broken, remove segment and replace with a complete tile. Fitted tiles should be plain non-skid rating.

DAILY: General cleaning on corners, ensure that dirt is removed and cleaned with approved disinfectant solution.

### CEILING

QUARTERLY: Check for cobwebs, insect nests. Remove immediately and clean. Repair all ceiling spalling, paint after.

### WALLS

DAILY: Check for dirty walls, clean as where necessary.

QUARTERLY: Repair as/where necessary for broken tiles. If paint work are peeled off, scrape 20% over affected surrounding areas and polish with rough sand paper. Damp wash down and leave it to dry prior to new paint. If necessary, patch holes then paint. Never use plastic paint for exterior walls. Use only washable paint on the interior walls. Ensure that first 1.2m has a layer of oil paint followed by water based paint to the ceiling. Use a chalk line to mark out the horizontal separation line and carry out works professionally.

## Maintenance of Door Assembly

MONTHLY: Check **door leaf**. Ensure that door leaf can open as within 135 Degrees without buckling. Use a measuring chalk to check this in closed and open position. Align door as/where necessary. If fails to align, then check door hinges, replace or repair if necessary.

MONTHLY: Check **door hinges**. Ensure that all screws are affixed and there are no stress on pivot components, door not tweaked, no audible sounds of “sweak” and all hinges are lubricated with dry silicone lubricant. Ensure that all screws / fasteners for the door hinges are installed. Replace damaged fasteners with correct size. If fastener holes are loose and cannot adapt new screw, fill hole with 2 chemical epoxy and screw new fastener after it has dried (see manufacturer’s specification for drying time). Drill a pilot hole of 1mm for 1/4" deep prior to engaging new fastener. This will ensure that the new fastener has a positive engagement into the hole.

BI-ANNUALLY: Check all **door jambs** and ensure that they are properly fastened against the wall. Any cracks in plaster around the jambs are to be repaired immediately by using flexible concrete/cement based components. Ensure that the undercut along the jambs have a longitudinal undercut for about 2mm deep, separating the wall and the jamb, apply white silicon after to seal this induced crack joint.

BI-ANNUALLY: Check **door seals**. Ensure that all elastomer door seals are intact. If peeled off, apply clear silicon into grooves and reinstall. Ensure that silicone has about 7 hours or curing prior to closing the door. Failure to do this will cause the seals to stick with the door, leading to reworks.

BI-ANNUALLY: Check **Bottom jamb undercut**. Ensure that there is at least 3cm of undercut to ensure that water does not absorb into the wood from the bottom. Check and ensure that 2 coats of oil paint is painted at the bottom for waterproofing. If possible for best practice and sustainability of the hospital, install a 3cm marble strip at the bottom of this undercut. Install with clear silicone as adhesive, seal all surrounding areas properly.

MONTHLY: Check **door closers**. Check that all screws are affixed and the components are intact. Any missing hinge bolts are to be replaced to ensure that the function of closing is met. Check piston settings, ensure that the closing mechanism operates gracefully and meets its closing force at remaining 15-20cm towards closure at jambs.

MONTHLY: Check **door hardware**. Ensure that door handle, lockset, strikers and striker plates are installed correctly. Strikers on the door jamb are sometimes integrated, if so, then check for alignment. Door should close without any indirect force asserted, leading to a complete latch into the striker plate assembly. When lockset keys are rotated into locking or unlocking position, the locking mechanism should engage into the striker plate without any interference. If this is not the case, then adjust the striker plate until it is operating properly. Ensure that door bumpers are installed and serviceable.

MONTHLY: Check **classroom hardware**. Ensure that all class room hardware are operating properly and cannot be locked from the inside. This is to ensure that in an emergency, person(s) inside the room can exit without hindrances.

DAILY: Check **Emergency exit doors**. Ensure that all emergency exit doors are operating properly and are not obstructed. On a monthly basis, if door is fixed by solenoid release function, then check if all accessories and alarms are operating correctly. Ensure that all levers and push bars are lubricated.

Check all functions as stated in the above component paragraphs.

MONTHLY: Check **PVC plastic doors**. Ensure that wing retaining pins are installed. Check all functions as stated in the above component paragraphs.

MONTHLY: Check **door ventilation grilles**. Ensure that all grills are removed and cleaned properly. Check if insect mesh for damage, replace if necessary.

BI-ANNUALLY: Check **Door Kick plates**. Ensure that door kick plates are securely fastened and are not loose, all edges are not exposed, causing hazard. Clean as/where necessary.

MONTHLY: Check **door push levers**. Ensure that all levers are fastened properly and not loose. Tighten as necessary. Clean as/where necessary.

MONTHLY: Check **fly mesh door**. Ensure that fly-mesh doors are serviceable, closes properly with all jamb face sealing against the main door jamb face. Check rubber seals, replace or repair if needed. Ensure that rubber or spring door closer operates properly and does not create a slamming sound when closed – if so, check bumper, adjust as necessary. Check wire mesh grille are free from corrosion, paint as necessary, use diluted oil based white paint only. If Lubrication on hinges are necessary, use only dry silicone lubricant.

## Maintenance of Window Assembly

MONTHLY: Check **window wing**. Ensure that leaf can open as within 90 Degrees without buckling. Align wing as/where necessary. If fails to align, then check hinges, replace or repair if necessary. Ensure that double glazing leaf are operating correctly, and all latches are installed (**Specifically for GOST Wooden windows**). Clean regularly in-between the wings. Ensure that wind does not enter the room, if necessary, use clear silicone to edges of glass.

MONTHLY: Check **Window hinges**. Ensure that all screws are affixed and there are no stress on pivot components, door not tweaked, no audible sounds of “sweak” and all hinges are lubricated with dry silicone lubricant. Ensure that all screws / fasteners for the hinges are installed. Replace damaged fasteners with correct size. If fastener holes are loose and cannot adapt new screw, fill hole with 2 chemical epoxy and screw new fastener after it has dried (see manufacturer’s specification for drying time). Drill a pilot hole of 1mm for 1/4" deep prior to engaging new fastener. This will ensure that the new fastener has a positive engagement into the hole.

MONTHLY: Check all **Window jambs** and ensure that they are properly fastened against the wall. Any cracks in plaster around the jambs are to be repaired immediately by using flexible concrete/cement based components. Ensure that the undercut along the jambs have a longitudinal undercut for about 2mm deep, separating the wall and the jamb, apply white silicon after to seal this induced crack joint.

BI-ANNUALLY: Check **Window seals**. Ensure that all elastomer seals are intact. If peeled off, apply clear silicon into grooves and reinstall. Ensure that silicone has about 7 hours or curing prior to closing the door. Failure to do

this will cause the seals to stick with the window, leading to reworks.

ANNUALLY: Check **Bottom air Grooves**. Ensure that the air grooves are clear from dirt and dust. Undercut is to ensure that condensed water does not absorb into the wood from the bottom. Check and ensure that 2 coats of oil paint is painted at the bottom for waterproofing against water droplets forming during pressure differences.

MONTHLY: Check **window hardware**. Ensure that handle, lockset, Top/Bottom latches strikers and striker plates are installed correctly. Strikers on the window jamb are sometimes integrated, if so, then check for alignment. Window should close without any indirect force asserted, leading to a complete latch into the striker plate assembly. When lockset keys (if installed) are rotated into locking or unlocking position, the locking mechanism should engage into the striker plate without any interference. If this is not the case, then adjust the striker plate until it is operating properly.

MONTHLY: Check **Emergency escape windows**. Ensure that all hardware are operating properly. Check and verify that the glass hammer is installed or available near such dedicated windows. This is to ensure that in an emergency, person(s) inside the room can exit without hindrances. Ensure that these windows are not installed with outside security protection grills.

ANNUALLY: Check **window security protection grilles**. Ensure that security protection grills in rooms that require such protection are secured, fastened correctly and do not dislodge with human force. Ensure that corrosion is not present and if required, provide oil painting as where necessary.

WEEKLY: Check **PVC plastic windows**. Ensure that wing retaining pins are installed. Check all functions as stated in the above component paragraphs.

WEEKLY: Check **window ventilation fans**. Ensure that all such fans are in-

stalled with its exterior fly mesh, on/off pull cords, sound electrical installation and are cleaned regularly. If necessary, remove power and disassemble fan for lubrication. Only apply Dry silicone lubrication at axle areas. Reinstall and test for serviceability. If found damaged, replace unit.

WEEKLY: Check **fly mesh door**. Ensure that fly-mesh doors are serviceable, closes properly with all jamb face sealing against the main window jamb face. Check rubber seals, replace or repair if needed. Check wire mesh grille are free from corrosion, paint as necessary, use diluted oil based white paint only. If Lubrication on hinges are necessary, use only dry silicone lubricant. If fixed plastic frames are installed, check to ensure that the frame is secured against the window jamb face, apply white silicone (sun resistant) around the inner face of the fly mesh jamb to protect insects from ingestion into the area. If plastic mesh is damaged, repair by sewing new material around damaged area or if necessary, replace.

QUARTERLY: Check **exterior window parapet**. Ensure that area is clean and free from bird droppings. If necessary, install nail plate on the exterior. Do this by simply measuring the exterior parapet area, cut 2mm plywood to area, hammer flat faced thumb tacks at 5cm centre to centre, paint both faces white, install invert face with silicone glue against parapet surface with sharp edges facing upwards. This will naturally prevent birds from landing on the exterior parapet. Make sure to seal all bottom runs along the parapet for water entry protection, use clear sun-resistant silicone.

QUARTERLY: Check **interior window sill**. Ensure that interior sills are clean. Check for water seals at bottom runs, if necessary install clear silicone to seal.

## Maintenance of Roofing System

### CAUTION

DANGEROUS SPIDERS, SCORPIONS, SNAKES, RATS OR OTHER ANIMALS MAY EXIST INSIDE THE ROOF AREA

NO SMOKING INSIDE ROOF AREA DURING MAINTENANCE OPERATION

ANNUALLY: Check **Roofing GI sheets**. Ensure that roofing sheets are affixed securely onto roof frame. Check all fasteners are intact, covered with water proofing silicone (sun resistant) over the screws. All holes unused are to be sealed.

ANNUALLY: Check **structural integrity**. Ensure that structure is rigid and members are properly secured. Affix bonding plate if necessary to repair and strengthen, paint after.

ANNUALLY: Check **roof insulation**. Ensure that roof insulation are not broken or deteriorated. Replace if necessary by using an approved roofing contractor.

BI-ANNUALLY: Check for **termites** on roof members. If necessary, carryout anti termite treatment. Check roof ventilation. Ensure that all ventilation eaves are secured with insect and bird wire mesh. Secure and ensure that the roof is sealed and isolated from rat, bird and insect ingress. Check all areas and make sure that there are no entry point. Paint wire mesh with diluted oil paint for corrosion protection, use 50% oil paint & 50% thinner, apply 3 coats. Ensure that paint works are carried out on ground and completely dried, prior to installation and paint work does not cover the openings. Use 3mm x 3mm mesh.

BI-ANNUALLY: Check **lighting under roof**. If exists, then ensure that cables

are installed inside a metal conduit, sealed and do not have any spark hazard. All switches are to be maintained at the hatch entry point of the roof and not inside the roof. All cables are to be sealed inside junction box and lighting should be IP54 Rated. Ensure that independent circuit breaker (1P3A/3kA) is dedicated for roof lighting (Flourescent Tube Fixtures Only). It is possible to use the circuit breaker as a switch. Never use open incandescent bulbs. No power points are to be installed under the roof, if needed then operator should acquire the use of extension plug and cord, connected from a room at the bottom floor.

WEEKLY: Check **roof smoke detectors and horn**. Ensure that these fire prevention components are working. Check and ensure that detector heads are clean and free from dirt. Clean as/where necessary. All detectors and horns should be in a single line system and non-addressable are accepted, if maintenance is done on a weekly basis and proper diagrams are available.

ANNUALLY: Check **snow guard**. Ensure that snow guards are affixed on all roof where snow load exceeds 90kg/m<sup>2</sup>. This is to ensure that gutters and sprouts are not choked during snow thaw, which leads to icicles. Icicles are a major killer in CIS and therefore without the use of snow guards, this poses a great danger.

ANNUALLY: Check **gutters & sprouts**. Ensure that all gutters and spouts are installed with debris cages, cleared regularly and are installed with nylon pull-push ropes. This will ensure that all cloaks are clearable from ground level. Secure all components with proper clamps and fasteners. Ensure that gutters are properly fastened and do not dislodge under snow load, if necessary affix a galvanised steel strip and fasten onto horizontal roof beams.

WEEKLY: Check **fire extinguishers**. Ensure that all extinguishers are fully charged, wrapped with plastic at the nozzle and secured with rubber band (prevents insects from nesting at nozzle area causing jams during opera-

tions), dust plastic (clear) fitted over extinguishers and bottom plastic skirt secured loosely with paper masking tape. Must be covered as part of OSHA standards. Extinguishers are to be securely wall mounted next to the roof entrance hatch area. Check for correct firefighting class, rating type and quantity required for 25% area coverage. If floor mounted, then it should be placed on a 10cm wooden block to prevent rusting at the bottom. Ensure that the next servicing date is stencilled on the body, clearly visible, schedule servicing recorded in the maintenance log book and visual inspection done daily.

**MONTHLY:** Check **Hatch Entrance Door**. Ensure that entry point is locked at all times and an emergency key is kept next to the hatch door, inside a red box with plastic glass and a pull handle to open this box. This is needed during an emergency to access the roof. This box should be mounted at a height of minimum 1.8 meters to prevent children from accessing it. One key should also be maintained with the following people or location:

Security Guard house / Guard on duty (24 hrs station)

Hospital director's office

Hospital Administration department (24hr station)

Maintenance team (24 hrs station)

**DAILY:** Visual inspection and verification should be done on a daily basis to ensure that the key box is not tampered. If such device is fitted with an electronic alarm, then testing should be done once a month.

**ANNUALLY:** Check **diagonal bracing**. Ensure that all diagonal bracing are installed and provided for flexible counter moment movement during an earthquake. Diagonal steel strip bracing (4cm x 0.5cm) can be used.

**ANNUALLY:** Check **vent pipes**. Ensure that all vent pipes are sealed against the GI roofing sheet by properly welding around the orifice. If welding cannot be achieved, use a flexible GI sheet to secure the bottom root and affix/

seal with heat resistant silicone. Test for water leaks. All vent pipes opening are to have a top crown cap and wire mesh wrapped around the opening to ensure that debris, insects or birds do not enter the pipe. Crown should be GI material and properly secured against the pipe (This will ensure that snow does not fill the pipe and jam the vent pipes). All pipe exposed to the environment should be of GI material and extend no shorter than 25cm from GI roof sheet (This is to ensure snow does not enter the pipe) and no taller than 15cm from head of pipe to crown (This is to ensure that wind load does not bend the pipe) If vent pipe extends more than 50cm, then the pipe should be supported by steel strip, holding the pipe in 3 equidistance proportion and fastened to the GI roof sheet at 60 degrees inclined angle. Seal all fasteners with sun resistant silicone.

**BI-ANNUALLY:** Check **maintenance support restraint cable**. Check and ensure that all maintenance support restraint cable on the roof are installed correctly, secured and are properly connected to main frame members. Any personnel carrying out maintenance on the roof are to use PPE (Personal protective equipment), specifically body harness (NOT waist harness), proper slings that can engage the restraint cable supports. This will ensure that in case a personnel slips, he/she does not fall off the building leading to death or serious injuries. Ensure that all body harness are made available to personnel entering the roof, are serviceable and all servicing and inspection of such PPE are registered as part of the maintenance log book. PPE for roof works are as following:

- a. Non slip rubber boots
- b. Leather gloves
- c. Reflexive vests
- d. Hard Hat with chin strap
- e. Safety goggles with head strap
- f. Full long pants, length no lower than ankle
- g. Torch light

- h. Safety body harness with dual sling and lockable latches (one for engaging, other for disengaging)
  - i. Sealed tool case/bag
- Long sleeve shirt

4 Man team required for this job at any time, with **2-men on roof, 1-man to assist men on roof. 1-man on emergency or duty runner.**

**Additional safety notes:** Ensure that Maintenance support restraint cables are installed from point to point, meaning, overlap areas would require continuation of body harness latches. If person needs to extend to another area for servicing, then the restraint cable should allow for disengage of one latch and engagement of the 2<sup>nd</sup> latch, like this at any time, personnel has at least 1 latch engaged to the restraint cable when changing location.

## Maintenance of Diesel Generator Room

MONTHLY Check **entrance doors**. Ensure that doors are fitted with ventilation grills, wire mesh are painted with red oil paint. This room must be locked at all times and an emergency key is kept next to the door entrance, inside a red box with plastic glass and a pull handle to open this box. This is needed during an emergency to access the roof. This box should be mounted at a height of minimum 1.8 meters to prevent children from accessing it. One key should also be maintained with the following people or location:

Security Guard house / Guard on duty (24 hrs station)

Hospital director's office

Hospital Administration department (24hr station)

Maintenance team (24 hrs station)

BI-ANNUALLY: Check **door leaf**. Ensure that door leaf can open as within 160 Degrees without buckling. Use a measuring chalk to check this in closed and open position. Align door as/where necessary. If fails to align, then check door hinges, replace or repair if necessary.

BI-ANNUALLY: Check **door hinges**. Ensure that all screws are affixed and there are no stress on pivot components, door not tweaked, no audible sounds of "sweak" and all hinges are lubricated with dry silicone lubricant. Ensure that all screws / fasteners for the door hinges are installed. Replace damaged fasteners with correct size.

ANNUALLY: Check all **door jambs** and ensure that they are properly fastened against the wall. Any cracks in plaster around the jambs are to be repaired immediately by using flexible concrete/cement based components. Ensure that the undercut along the jambs have a longitudinal undercut for

about 2mm deep, separating the wall and the jamb, apply white silicon after to seal this induced crack joint.

BI-ANNUALLY: Check **door seals**. Ensure that all elastomer door seals are intact. If peeled off, apply clear silicon into grooves and reinstall. Ensure that silicone has about 7 hours of curing prior to closing the door. Failure to do this will cause the seals to stick with the door, leading to reworks.

YEARLY: Check **Bottom Jamb Riser**. Ensure that there is at least 3cm of riser to ensure that water does not enter into the building from the bottom. Check and ensure that 2 coats of oil paint is painted at the bottom for corrosion resistance. If possible for best practice and sustainability of the hospital, install a 3cm marble strip at the bottom. Install with clear silicone as adhesive, seal all surrounding areas properly.

BI-ANNUALLY: Check **Door Closers**. Check that all screws are affixed and the components are intact. Any missing hinge bolts are to be replaced to ensure that the function of closing is met. Check piston settings, ensure that the closing mechanism operates gracefully and meets its closing force at remaining 15-20cm towards closure at jambs.

BI-ANNUALLY: Check **Door Hardware**. Ensure that door handle, lockset, strikers and striker plates are installed correctly. Strikers on the door jamb are sometimes integrated, if so, then check for alignment. Door should close without any indirect force asserted, leading to a complete latch into the striker plate assembly. When lockset keys are rotated into locking or unlocking position, the locking mechanism should engage into the striker plate without any interference. If this is not the case, then adjust the striker plate until it is operating properly. Ensure that door bumpers are installed and serviceable.

BI-ANNUALLY: Check **Classroom Hardware**. Ensure that all class room hard-

ware are operating properly and cannot be locked from the inside. This is to ensure that in an emergency, person(s) inside the room can exit without hindrances. All push bars are lubricated.

QUARTERLY: Check **Ventilation Grilles**. Ensure that all grills are removed and cleaned properly. Check insect fly-mesh for damage, replace if necessary. Ensure that oil based coat is present for corrosion protection

ANNUALLY: Check **Door Kick plates**. Ensure that door kick plates are securely fastened and are not loose, all edges are not exposed, causing hazard. Clean as/where necessary.

BI-ANNUALLY: Check **door push levers**. Ensure that all levers are fastened properly and not loose. Tighten as necessary. Clean as/where necessary.

DAILY: Check **fire extinguishers**. Ensure that all extinguishers are fully charged, wrapped with plastic at the nozzle and secured with rubber band (prevents insects from nesting at nozzle area causing jams during operations), dust plastic (clear) fitted over extinguishers and bottom plastic skirt secured loosely with paper masking tape. Must be covered as part of OSHA standards. Extinguishers are to be securely wall mounted next to the entrance and inside the room. Check for correct firefighting class, rating type and quantity required for 100% equipment coverage. If floor mounted, then it should be placed on a 10cm wooden block to prevent rusting at the bottom. Ensure that the next servicing date is stencilled on the body, clearly visible, schedule servicing recorded in the maintenance log book and visual inspection done daily.

QUARTERLY: Check **Emergency Hatch Escape Entrance Door**. Ensure that exit point has class room fitted hardware, well lubricated, sealed and unobstructed inside and outside at all times. This hatch to be at strategic locations, so that if a fire or explosion happens at the entrance door area and

personnel inside cannot exit thru the main door, he/she can escape thru these hatches from another location within the room to safety. This door hatch should not have any key from the inside or outside, but operate by a lever or dead bolt action.

ANNUALLY: Check **Roofing** : See roofing section and adapt servicing where applicable

MONTHLY: Check **Flooring**. Ensure that flooring is not cracked, concrete sealant are non-skid. Cleaning required every weekly.

MONTHLY: Check **Walls**: clean as necessary

QUARTERLY: Check Windows: If available, then see Window section and adapt servicing where applicable.

BI-ANNUALLY: Check **Generator mounting bolts** on concrete pad. Ensure that bolts are secured tight and rust free

SIGNAGE: Ensure that signage is placed on 4 corners of the building, with words (white) stating, "NO SMOKING WITHIN 15 FEET" on a red background, in Russian and English and local language. Signage should be sized at 70cm x 50cm.

## **Maintenance of Data, Communication, Security Surveillance Rooms**

WEEKLY: checks. Ensure that all floors, windows, doors, door hardware, walls, ceiling, electrical and HVAC are inspected and maintained in all aspects. Refer to above paragraphs for maintenance guidelines.

## **Maintenance of Operating Theatre & ICU, Laboratory, CSSD, Medical Supplies Room, Hazardous Materials Storage Room, Chemical Storage facility Room**

DAILY: Checks. Ensure Floor, walls and ceiling are clean with disinfectants. Carry out repairs as necessary with clearance from Director of hospital to ensure that the rooms are not dysfunctional for emergency operations. Approval must be given for repair works to commence. Clean all debris immediately after each works completed.

WEEKLY: Checks. Ensure all electrical outlets, lighting fixtures and power sources are maintained properly and its safety factors are met. Refer to above paragraphs for maintenance guidelines.

WEEKLY: Checks. Ensure all exhaust fans, air conditions, HVAC are cleaned, maintained in operating function in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY: Checks. Ensure that all door & window hardware are cleaned, maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

MONTHLY: Checks. Ensure that all fire alarm systems, fire extinguishers are maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY: Checks. Ensure that all storage containers for chemicals and HAZMAT materials are stored and placed on secondary bunds, to ensure that if any leaks, it is contained. If any cleaning required, use proper PPE prior to handling such chemicals.

NOTE: Disposal of such chemicals are to be directed with Hospital director and government municipal, to allocate approved area of disposal. Do not allow such chemicals to enter the atmosphere (by burning), sewer or waste water system without being processed, as this may lead to an Environmental problem. Approval should be attained prior to any kind of disposal action.

SIGNAGE: Ensure that signage is placed on 4 corners of the fencing, with words (white) stating, “NO SMOKING, SPARKING, OPEN FLAMES WITHIN 4.5 METRES” on a red background, in Russian and English and local language. Signage should be sized at 70cm x 50cm.

## Maintenance of Kitchen, Dining, Oil Water Separator

DAILY Checks: Ensure Floor, walls and ceiling are clean with detergent. Carry out repairs as necessary with clearance from Director of hospital to ensure that the facility is not dysfunctional for operations. Approval must be given for repair works to commence. Clean all debris immediately after each works completed.

DAILY Checks: Ensure all electrical outlets, lighting fixtures and power sources are maintained properly and its safety factors are met. Refer to above paragraphs for maintenance guidelines.

DAILY Checks: Ensure all exhaust fans, air conditions, HVAC are cleaned, maintained in operating function in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY Checks: Ensure that all door & window hardware are cleaned, maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY Checks: Ensure that all fire alarm systems, fire extinguishers are maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

WEEKLY Checks: Ensure that all storage containers for waste bulk oil materials are stored properly. Containers should be marked as "USED OIL – FOR DISPOSAL". REMOVE from kitchen daily and store in waste shed. Waste oil can be used for secondary heating fuel in winter, hence creating sustainable energy solutions. Store oil in an open ventilated sheltered area with drain-

age bunds.

DAILY checks: Ensure that oil water separator are cleaned daily, remove top oil from separator. DO NOT Reuse this oil. Ensure that all inlet and outlet are flowing correctly. Unit should be sealed properly to ensure that water from the outside cannot get in and oil from inside does not leak out. Check all cleanouts, covers and accessories are sealed and functional.

DAILY: Ensure that all dining area chairs, tables and floor is cleaned with approved cleaning solution after every meal time, or 4 times a day. Sinks are to be clean, dry and liquid soap available. Handles are to be dis-infected.

## Maintenance of Fuel Storage Room—For Diesel Generator Fuel

### FOR DIESEL GENERATOR FUEL

WEEKLY Checks: Ensure that fuel storage facility are clean, secured with perimeter fence, locked and keys with authorised personnel as stated in the above paragraphs.

WEEKLY Checks: Ensure that floor is clean and free from oil. There should be no cracks on the floor, if necessary fill with concrete floor sealants during Quarterly maintenance.

DAILY Checks: Ensure that all fire alarm systems, fire extinguishers, sawdusts and sand buckets are present and maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

MONTHLY Checks: Ensure that all storage containers are stored and placed on secondary bunds and on wooden blocks, to ensure that if any leaks, fuel is contained and bottom base is not in contact with water. If any cleaning required, use proper PPE prior to handling fuel.

BI-ANNUAL Checks: Ensure that all door hardware are serviced. Refer to above paragraphs for maintenance guidelines

#### NOTE:

Disposal of fuel are to be directed with Hospital director and government municipal, to allocate approved area of disposal. Do not allow fuel to enter the atmosphere (by burning), sewer or waste water system, as this may lead to an Environmental problem. Approval should be attained prior to any kind

of disposal action.

**CONSTRUCTION:**

Ensure that storage facility is mounted on the 250mm high slab, installed with fenced wall and ceiling, properly grounded, well ventilated (natural), gate locked with chain and padlock (3 No.)

**SIGNAGE:**

Ensure that signage is placed on 4 corners of the fencing, with words (white) stating, “NO SMOKING, SPARKING, OPEN FLAMES WITHIN 50 FEET” on a red background, in Russian and English and local language. Signage should be sized at 70cm x 50cm.

**PROTECTION:**

Ensure that if necessary, bollards are placed around the storage areas to prevent cars from parking nearby.

**FOR WOOD HEATING FUEL**

**MONTHLY Checks:** Ensure that fuel storage facility are clean, secured with perimeter fence, locked and keys with authorised personnel as stated in the above paragraphs.

**DAILY Checks:** Ensure that all fire alarm systems, fire extinguishers, water hose reel are present and maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

**BI-ANNUAL Checks:** Ensure that all door hardware are serviced. Refer to above paragraphs for maintenance guidelines

**CONSTRUCTION:**

Ensure that storage facility is mounted on the 150mm high slab, installed

with fenced wall and ceiling, properly grounded, well ventilated (natural), gate locked with chain and padlock (3 No.)

SIGNAGE:

Ensure that signage is placed on 4 corners of the fencing, with words (white) stating, "NO SMOKING, OPEN FLAMES WITHIN 3 METRES" on a red background, in Russian and English and local language. Signage should be sized at 70cm x 50cm.

## **Maintenance of Patient Room, Offices and Admin. Rooms, General Waiting Areas, Corridors, Toilets and Bathrooms, Laundry, Balconies, Stairs and Ramps**

WEEKLY checks: Ensure that all floors, windows, doors, door hardware, walls, ceiling, electrical and HVAC are inspected and maintained in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY GENERAL CLEANING: Cleaning should be carried out with disinfectant solution approved by the hospital as stated:

Patient rooms and wards : 3 times a day

Offices and admin room : 1 time a day

Corridor area : 3 times a day

Toilets and Bathrooms : 4 times a day

Balcony Area : 1 times day

Stairs and Ramp : 1 time a day

General waiting area : 3 times a day

Stairs handrails : 3 times a day

DAILY: Firefighting equipment should be inspected and maintained in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY: All rubbish bins and replacement of rubbish bags are to be cleaned on a daily basis and moved to segregated waste disposal area. Container to be washed down with disinfectant solution once a week.

DAILY: All laundry clothes baskets are to be clean, disinfected with approved solution and segregated, meaning, dirty laundry and clean laundry bags. They should be in different rooms or storage racks, baskets should be of different colour and visible. PPE should be used in this area, like, Face mask and gloves.

Clean laundry racks should be covered with plastic sheet to prevent ingestion of dust and dirt.

WEEKLY. Laundry machines are to be maintained and cleaned on a weekly basis. Water entry hose usually has a filter. This filter must be removed and cleaned to ensure the filter is free from dirt and debris. Waste water filter, usually located at the bottom of the machine should be removed and cleaned. Washing drum should be washed with water and disinfection solution, and this must be done with no load. Flushing should be done with 30minutes cycle and at 70°C hot water – select temperature to highest possible on machine.

Ensure that floor is dry at all times.

## Maintenance of Boiler Room

WEEKLY: Check and ensure that all floors, windows, doors, door hardware, walls, ceiling, electrical and HVAC are inspected and maintained in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY: Check for fuel leaks, clean as necessary. Refer to above paragraphs for maintenance guidelines.

DAILY Checks: Ensure that all fire alarm systems, fire extinguishers, water hose reel are present and maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

BI-ANNUALLY: Check all retaining and mounting bolts to floor. Ensure that the bolts are secured and tight.

### CONSTRUCTION:

Ensure that boilers mounted on the 250mm high slab, installed with fenced wall and ceiling, properly grounded, well ventilated (natural), gate locked with chain and padlock (1 No.). Fence should be covered with wire mesh to ensure that insects and other possible small animals do not try to enter the boiler unit, but general ventilation still possible.

### SIGNAGE:

Ensure that signage is placed on 4 corners of the fencing, with words (white) stating, "NO SMOKING, OPEN FLAMES" on a red background, in Russian and English and local language. Signage should be sized at 70cm x 50cm.

## Maintenance of Warehouse and Technical Workshops

MONTHLY: Check and ensure that all floors, windows, doors, door hardware, walls, ceiling, electrical and HVAC are inspected and maintained in all aspects. Refer to above paragraphs for maintenance guidelines.

MONTHLY: Check all tools rack, storage racks are secured and properly coated with anti-corrosion paint.

DAILY: Ensure that floor is free from oil and other slippery materials.

DAILY: Ensure that all fire alarm systems, fire extinguishers, water hose reel are present and maintained in operating functions in all aspects. Refer to above paragraphs for maintenance guidelines.

DAILY: Ensure that eye wash stations are working properly and can be used immediately for an emergency. Check all first aid kits are current and stocks are available.

DAILY: Ensure that tools are accounted for daily, before and after work. Tools are stored in a shadow board, securely fastened onto walls.

WEEKLY: Check oil/water separator are cleaned, oil removed and placed in allocated storage location. No contaminants are permitted to enter the ecosystem. Refer to above paragraphs for maintenance guidelines.

## Maintenance of Entrance Gates, Roads, Parking & Gardens

DAILY: Ensure that entrance gates are free from obstruction, boom is properly working and locks are in place.

MONTHLY: Check entrance gates are structural sound and corrosion protection in place. If paint works are required, then paint with white and yellow stripes, spaced at 200mm width. Boom block should be Bright red and properly caged to prevent foot injury. Ropes or chain controlling the boom arm should be secured with hammerlock and lubricated. All pivot pins are to be greased.

MONTHLY: Check all road curbs, ensure that all curbs are clean, free from rubbish stacked in-between, painted with black and white paint per block or 30cm intervals. All sign boards are clear and visible for direction. All road speed bumps are painted with white and black diagonal stripes. Parking areas are well designated for public and does not obstruct ambulance movement routes. All public walkways are properly designated so that people do not walk on the roads.

WEEKLY: Check all garden area for rat holes and other animals. If necessary, request for pound to remove stray dogs and cats.

BI-ANNUALLY: All trees are to be painted with anti-termite paint at the bottom base for at least 1.2m. This will lead to eco-sustainability. Check for broken or loose branches, remove accordingly in a safe manner. REMOVE dead trees, ensure that eco-system is not damaged.

MONTHLY: Inspect for bee hives. Remove bees hives at night only when

bees are in hibernation. This is to be done by approved municipal authorised pest controller. Do not use fire as this may cause a fire hazard to perimeter building and facilities.

**DAILY**: Ensure that plants are watered daily using well water and NOT water from the tank. Ensure that sufficient water is applied and the after works do not leave pools of water which can induce flies and mosquitoes to breed. USE spray nozzles to ensure water conservation.

**BI-ANNUALLY**: Trim excess grass to ensure that snakes do not breed in tall grass areas. Plant grass in areas where are soiled. Ensure that all gradients are flat or sloped correctly and do not lead soil erosion. Ensure that in high sloped areas, erosion mats are placed, to prevent soil erosion.

**SNOW & ICE: DAILY**: Ensure that snow and ice is removed from walkways, this will prevent fall injuries and vehicle accidents.

**SPEED LIMITS**: Speed limit signs should be clearly visible and indicate 5 km/h (Rain/Snow/Ice periods) & 8km/h (all other times). Ensure that speed bumps are installed and maintained at 5m prior to every turn and not on the turning point, this will lead to vehicles not being able to overcome the bump during snow or ice surfaces. Limit entry of vehicles into hospital area if necessary. Maintain bumps daily in winter months and bi-yearly for signage.

**SNOW WHEEL TRACKS**: Ensure that snow friction tracks are available to assist vehicles which are stuck during snow months and causing a blockage for other traffic. Maintain a 2 Ton tow-cable strap for emergency. Check equipment yearly.



# **Maintenance of Electrical Services**

## Lighting Fixtures

- a. Check Ballast, Starters and Lamps. Replace if necessary. This will ensure that all parts are operational and working correctly without arcing. Parts contribute to power loss, surge and energy losses.
- b. Check and ensure that florescent lamps are operating at 80% of the ballast rated power, i.e. if Ballast rating is 40W, lamp should be 32w Max. This will in the long run enable longer life for the lamps and sustain energy and lower costs. Lamps selected should be Day Light rated.
- c. Clean Lamps, Cowling cases and reflectors to ensure light refraction and LUX meet sufficient levels. This will lead to allowing lesser fixtures to be turned on (energy and cost savings), due to requirements of LUX/ Lumens being met with minimum light fixtures turned on. Cleaning should be with damp and dry cloth
- d. Check Exterior lighting Fixtures/Perimeter Lighting Fixtures, if Automatic timer or photocell operates at correct timing for “on” and “off” operations. Ensure adjustments are carried out for winter and summer setting. Clean photocell lens sensors. This will enable energy and cost savings.
- e. Check all connections are secured and properly sliced. This will lead to lower energy cost.
- f. Check Light Switches are operational, secured onto wall back-boxes and cleaned with damp cloth and Windex solution. Ensure that no acid or other degrading solution is used, which may lead to defacing of switch finishing surface.

- g. Ensure that PIR are cleaned, secured, pointed at the correct direction and operational. PIR may be installed to detect movement, leading to automatically light being turned on. During non-operational hours, light fixtures are in off position. This leads to energy and cost savings, as unnecessary lights left on are automatically turned off when the PIR does not detect any human within its wide range scope.
- h. Check if Emergency light Fixtures with back up battery are operational. Ensure that if power is removed, the light should turn on. In some cases, these fixtures may have a test button.

Table 1 - Maintenance Checklist: Lighting Fixtures

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
	Check Ballast, Starters, Lamps for correct operations			X <sub>1</sub>		X
Clean lamps, reflectors, covers – All interior		X <sub>1</sub>		X		
Clean lamps, reflectors, covers – All Exterior			X <sub>1</sub>	X		
Check Exterior Lighting Timer/Photocell (On/Off)		X <sub>1</sub>				
Check connections on all lighting fixtures				X		
Check Light Switches, general cleaning			X			
Check Light Fixture electrical terminals for burns				X		
Check PIR operations			X			
General Visual Exterior Inspection and Checks	X					
X <sub>1</sub> : Dusty Conditions						

## Power Outlets

### **Δ WARNING**

#### **LOW VOLTAGE ELECTRICAL SHOCK RISK**

**QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO ELECTRICAL SHOCK OR/AND DEATH**

- a. Check power outlets are operational, loose fitting. Secured onto wall back-boxes and cleaned with damp cloth and Windex solution. Ensure that no acid or other degrading solution is used, which may lead to de-facing of finishing surface.
- b. Check if power outlet has circuit tags correctly and corresponds to its own group circuit breaker
- c. Check power outlets if they are serviceable and are operating correctly.
- d. Replace Soviet GOST Standard power outlets with Schuko EU Type, as where / If necessary.
- e. Check interior wiring – Remove front socket cover, and inspect if wiring to the pins are correctly positioned. Right – LIVE & Left – NEUTRAL. Re-configure pins as necessary to meet a standard wiring polarity connection to reduce float voltage. Ensure MCB is turned off before disconnecting.
- f. Check if terminal lug is burn. If burn, then change immediately. Burn or deteriorated terminals may cause a fire hazard. Use crimp lug to terminate into terminal lug, if possible.
- g. Check cable size is at least 2.5mm<sup>2</sup> for general power outlets and 1.5mm<sup>2</sup> for lighting. This may vary if group load is larger. Report into maintenance book if cables found under-sized.

- h. Check if power outlets are grouped correctly to its associated circuit breaker (MCB), a group of no more than 5 outlets should be grouped to a 20A circuit breaker, having an Interrupting capacity (Isc) of 6kA. If found that more than 5 outlets are connected to a single circuit breaker, ensure that calculation is established for Isc and Voltage Drop. Rate circuit breakers lower than installed cable size/carry current. This will ensure that the circuit breaker trips before the wire burns during an overload. If necessary install a smaller Isc rate circuit breaker, i.e. 3kA in such mentioned cases, so that the circuit breaker releases upon short circuit. Report into maintenance book if found under-sized. These calculations are to be assessed by an Electrical Engineer.

**Table 2—Maintenance Checklist: Power Outlets**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	<b>Daily</b>	<b>Week</b>	<b>1m</b>	<b>3m</b>	<b>6m</b>	<b>12m</b>
Check Power Outlets, Notes: (a) (b) (c) (d)			<b>X</b>			
Check Interior Wiring, Terminal Lugs, Notes: (e) (f) (g)					<b>X</b>	
Check Power Grouping, Overload Prevention, Notes (h)						<b>X</b>
General Visual Exterior Inspection and Checks	<b>X</b>					

## **Communication/Data Outlets**

- a. Check Communication/Data Outlets are operational, loose fitting. Secured onto wall back-boxes and cleaned with damp cloth and Windex solution. Ensure that no acid or other degrading solution is used, which may lead to defacing of finishing surface.
- b. Replace damaged outlets, wiring and shuttering covers, if necessary/ where necessary.

**Table 3 — Maintenance Checklist: Communication/Data Outlets**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	Daily	Week	1m	3m	6m	12m
Check Communication/Data Outlets, Notes: (a)			<b>X</b>			
Check for damages, Notes: (b)						
General Visual Exterior Inspection and Checks	<b>X</b>					

## PVC Conduits/ Conduits

### Δ CAUTION

### FALL HAZARD & ELECTRICAL HAZARD

QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO DAMAGE, FIRE HAZARD, FALL FROM  
HEIGHTS

- a. Check if conduit cover are secured and held within its integrated conduit structure. All necessary shuttering, i.e. corner fitting, T Fitting, Junction boxes, etc are installed.
- b. Check and ensure that after cables are installed inside the conduit, 40% breathing space is available. DO NOT fill wires without space, as this may lead to heat build-up, power loss and risk of fire. This contributes to loss, wastage of energy, increased operating costs and FIRE HAZARD.
- c. Check if conduit is secure in a rigid manner against the wall (Overhead, Vertical, horizontal Runs) and does not buckle under its own weight, if necessary, secure with additional concrete nails.

**Table 4—Maintenance Checklist: PVC Conduits/Conduits**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	<b>Daily</b>	<b>Week</b>	<b>1m</b>	<b>3m</b>	<b>6m</b>	<b>12m</b>
Check Conduit Integrity, Notes: (a)				<b>X</b>		
Check for Overloaded conduit, Notes: (b)						<b>X</b>
Check Conduit Static Integrity, Note (c)				<b>X</b>		
General Visual Exterior Inspection and Checks	<b>X</b>					

**Main Power Distribution Panel (MDP) – Primary Controls  
Distribution Boards (DB) – Secondary Controls  
MONTHLY INSPECTION**

**Δ DANGER**

**MAIN ELECTRICAL DISTRIBUTION CONTAINMENT SYSTEM**

FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO ARC FLASH, FIRE  
HAZARD, HEALTH HAZARD

PRIMARY AND SECONDARY ELECTRICAL SHOCK HAZARD & STATIC DIS-  
CHARGE

RISK OF DAMAGE TO EQUIPMENT, SERIOUS INJURY, PERMANENT DAM-  
AGE OR/AND DEATH

PERSONNEL SHOULD BE 72 HOUR ALCOHOL FREE, DRUG FREE, 8 HOURS  
SLEEP REQUIRED PRIOR TO TESTS

ELECTRICAL SYSTEMS QUALIFIED PERSONNEL REQUIRED FOR THIS TEST –  
2 MAN TEAM

- a. Check exterior for panel tagging information, corrosion, circuit diagram, water tight sealed (if available), secured to wall in a rigid manner, dust free.
- b. Check Phase Lamp Indicators are working properly, replace lamp if not laminated/faulty.
- c. Check if wing hinges and face panel cover are working properly. Able to open, close and lock properly. If necessary, use Silicone Dry Lubricant **ONLY**. Do not attempt to use oil or other fluids.
- d. Check all wire entry points into panel orifice, ensure that glands are used to prevent cable from chaffing against entry orifice. At no time should cables be exposed to open metal. If necessary, use silicone to secure edges, if gland is unavailable.

e. PANEL WITH EARTH BUSBAR

- Check and ensure that Grounding wire is affixed from Earth Bus bar to panel cover and panel wing with insulated 6mm<sup>2</sup> single core stranded cable. Ensure that security nut and bolt is assembled with spring washer and any contact with metal surface has paint removed prior. Spray silicone dry lubricant after. Paint removal at nut assembly contact face against panel is important to ensure that the metal panel is positively grounded. Ensure that danger sign is visible on the front cover. Failure may lead to serious injury or Death. Electrical panel must only be operated by a qualified technician trained and certified in Electrical systems

f. PANEL WITHOUT EARTH BUSBAR

- DO NOT CONNECT Grounding wire from earth bus bar to panel body.
  - Ensure that panel is installed with a lock, only exposure should be the main breaker switches used for emergency off. Panel should be painted with anti-static paint coat and opening knob should be plastic or non-conductive material. Ensure that danger sign is visible on the front cover. Failure may lead to serious injury or death. Electrical panel must only be operated by a qualified technician trained and certified in Electrical systems
- g. Check Grounding Mat are installed on the floor, under the panel and is at least 1m<sup>2</sup> per panel.
- h. Check if Phase Bus Bars are correctly sized and of pure copper material (>97%). All connections on the bus bar are with correctly rated lugs, affixed and secured with isolators and are NOT in contact with any panel body parts. Check if bus bar is 1.5x larger in current carrying capacity than main incoming service power cable rating. This will ensure that the bus bar can sustain current surges, momentary overload and does not dissipate too much heat inside the panel. Failure to ensure these

measures may lead to bus bar deteriorating and causing electrical failure.

- i. Extension Termination Cables are correctly rated from bus bars to MCCB are to be 1.25x MCCB current rating. Cables should be neatly identified with color code and secured with cable ties in parallel manner. **Bundling not allowed.** All cable end terminals should be continuous and terminated with Terminal Lugs properly crimped at both ends, followed by color code PVC electrical tape to clearly identify the phases (L1, L2, L3, N).
- j. MCCB should be rated to protect the cable. Ensure that at all times, cable carry current is rated and sized by 1.25x larger than MCCB. **NOTE:** Cable sizes may vary from MCCB to MCCB. Failure to check and rectify this may lead to heat gain, power loss, voltage-drop and possibly pose a **Fire Hazard, causing serious injury, Death and Equipment failure.**
- k. Check if Existing panels are overloaded. If growth factor exceed the design load conditions, the panel must be paralleled by installing another panel to distribute the load. Failure to intervene at an early stage may lead to equipment damage and costly remediation, causing interruption to power service and failure in building.
- l. Check, measure and record electrical test, using a CAT III (600-1000v) Digital Multi-meter and Digital Cable Clamp measuring tool as mentioned in the bottom table.

### **Δ DANGER**

#### **ELECTRICAL LIVE VOLTAGE SYSTEM**

**FAILURE TO COMPLY WILL LEAD TO SERIOUS INJURY, DEATH OR/AND DAMAGE TO TEST EQUIPMENT. PERSONNEL SHOULD BE 72 HOUR ALCOHOL**

**FREE, DRUG FREE, 8 HOURS SLEEP REQUIRED PRIOR TO TESTS**

**ELECTRICAL SYSTEMS QUALIFIED PERSONNEL REQUIRED FOR THIS TEST – 2**

**MAN TEAM**

Table 5—Template for Recording Electrical Testing Results

<b>⚠ DANGER! TESTING PROCEDURE WITH MAINS INCOMING LIVE POWER ON AND HOT</b>					
Phase	Volts	Amps	Test Notes and Objective	Date	Sign
L1 - L2			Test/Determine for Phase Balance (Phase to Phase) ①		
L2 - L3			Test/Determine for Phase Balance (Phase to Phase) ①		
L1 - L3			Test/Determine for Phase Balance (Phase to Phase) ①		
L1 - N			Test/Determine for Phase Balance (Phase to Neutral) ①		
L2 - N			Test/Determine for Phase Balance (Phase to Neutral) ①		
L3 - N			Test/Determine for Phase Balance (Phase to Neutral) ①		
L1 - E			Test/Determine for Phase Leakage (Phase to Earth) ②		
L2 - E			Test/Determine for Phase Leakage (Phase to Earth) ②		
L3 - E			Test/Determine for Phase Leakage (Phase to Earth) ②		

① Readings for Voltage should be within  $\pm 10\%$

② Reading Should Be ZERO if no grounding system is installed. If Grounding system is installed, a reading can be registered. Here Grounding term is with reference to via a physical Grounding Rod installed.

Table 6—Template for Recording Electrical Testing Results

<b>⚠ WARNING! TESTING PROCEDURE WITH MAINS INCOMING LIVE POWER OFF AND COLD</b>					
<b>Phase</b>	<b>Mohm</b>	<b>Contin.</b>	<b>Test Notes and Objective</b>	<b>Date</b>	<b>Sign</b>
L1 - L2			Mega ohm reading and continuity check ③		
L2 - L3			Mega ohm reading and continuity check ③		
L1 - L3			Mega ohm reading and continuity check ③		
L1 - N			Mega ohm reading and continuity check ③		
L2 - N			Mega ohm reading and continuity check ③		
L3 - N			Mega ohm reading and continuity check ③		
L1 - E			Must be open circuit Δ READ FOOT NOTE ① ②		
L2 - E			Must be open circuit Δ READ FOOT NOTE ① ②		
L3 - E			Must be open circuit Δ READ FOOT NOTE ① ②		
N-E			Must be open circuit Δ READ FOOT NOTE ① ②		

① **Phase to Earth (E)** and **Neutral (N) to Earth (E)** should have no continuity and Open circuit. If reading exists, then isolation test should be done to ensure that any circuit that has leakage into these systems are identified and rectified. This must be carried out to ensure that energy sustainability is achieved by having no leakage and loss of power within the electrical system.

② **DANGER:** Existence of Leakage between any Voltage Phases L1 or L2 or L3 to E & Earth to Neutral should be identified and rectified immediately. THIS MAY CAUSE SERIOUS INJURY, DEATH OR/AND DAMAGE TO EQUIPMENT.

③ **WARNING:** Existence of Leakage between Voltage Phases L1 or L2 or L3 and/or to Neutral should be identified and rectified immediately. This may cause voltage drop, loss of power, existence of short circuits in the system. May cause circuit breakers intermittent trip, equipment malfunctioning, damages.

## Moulded Case Circuit Breaker (MCCB)

### MONTHLY INSPECTION

#### **Δ DANGER**

#### **MAIN ELECTRICAL PROTECTIVE DISCONNECT DEVICE**

**FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO ARCING FIRE HAZARD**

**PRIMARY AND SECONDARY ELECTRICAL HAZARD**

**RISK OF DAMAGE TO EQUIPMENT, SERIOUS INJURY, PERMANENT DAMAGE OR/AND DEATH**

- a. Check if 4P-3PN (4 Pole {3 Pole + N}) MCCB are used for 3 Phase + Neutral systems, this will ensure that the system gets totally disconnected completely in a short circuit condition.
- b. Check if MCCB is correctly rated for the panel's load. MCCB should protect its associated cables and should be rated lower than cable carry current. Engineers Calculation Required.
- c. Check if MCCB is original, from a legit manufacturer. To ensure this, check manufacturer's specification, where here, reference to weight ratio will be treated as a primitive test. Non- authentic MCCB would have a lower weight than that specified. If weight found to be different, consult with an Electrical Engineer to remove, carry out further test (voltage breakdown test) or/and replace with an authentic protection device.
- d. Check if Trip Setting is set according to the correct interrupting capacity (Isc) as per Electrical engineers calculations. If not available, pre-set to  $I_{sc}=10kA$ . Monitor closely for intermittent trips, adjust accordingly until trip stops, this should usually not exceed  $I_{sc}=15kA$  with 65-70% load application. If within this criteria, trip still exists, then check and trace

for faulty equipment installed on phase lines. Conditions may vary from case to case, therefore consult with a qualified Electrical Engineer to determine the problem. Do not exceed recommended settings as this may fail to disconnect in a serious short circuit.

**Δ WARNING**

**PROTECTIVE DEVICE SETTING**

**QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK**

**FAILURE TO COMPLY MAY LEAD TO DAMAGE, FIRE HAZARD, DEATH**

- e. Check if all cable terminal connectors on the MCCB are secured and restraints the cables (Incoming & Outgoing) in a secured manner. Tighten as/where necessary by using an insulated screwdriver with a correct head size. DO NOT over tighten these fasteners as it may damage the threading. If threads are loose and cannot secure the cable, replace MCCB, Do not attempt to repair or modify components.

**Δ CAUTION**

**NO OPERATOR SERVICABLE PARTS INSIDE**

**FAILURE TO COMPLY MAY LEAD TO DAMAGE AND FIRE HAZARD**

- f. Check if MCCB is free from dust, insect nesting, clear of debris and main switch is operable.
- g. Rotate or flick the main switch to check if it operates correctly, if jammed in closed circuit position, remove and replace MCCB.

## Minature Circuit Breaker (MCB) MONTHLY INSPECTION

### **Δ DANGER**

### **ELECTRICAL PROTECTIVE DISCONNECT DEVICE**

**FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO ARCING FIRE**

**HAZARD**

**SECONDARY ELECTRICAL HAZARD**

**RISK OF DAMAGE TO EQUIPMENT, SERIOUS INJURY, PERMANENT DAMAGE  
OR/AND DEATH**

- a. Check if MCB (SP, SPN, DP, TP, TPN) systems are operational, this will ensure that the system gets totally disconnected completely in a short circuit condition.
- b. Check if MCB is correctly rated for the panel's load. MCB should protect its associated cables and should be rated lower than cable carry current. Engineers Calculation Required.
- c. Check if MCB is original, from a legit manufacturer. To ensure this, check manufacturer's specification, where here, reference to weight ratio will be treated as a primitive test. Non- authentic MCB would have a lower weight than that specified. If weight found to be different, consult with an Electrical Engineer to remove, carry out further test (voltage breakdown test) or/and replace with an authentic protection device.
- d. Check if installed interrupting capacity (Isc) are as per Electrical engineers calculations. If not available, check if installed MCB are of  $I_{sc}=6kA$ . Conditions may vary from case to case, therefore consult with a qualified Electrical Engineer to determine the rating if in doubt. Do not exceed recommended settings as this may fail to disconnect in a serious short circuit.

**Δ WARNING****PROTECTIVE DEVICE SETTING**

**QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO DAMAGE, FIRE HAZARD, DEATH**

- e. Check if all cable terminal connectors on the MCB are secured and restraints the cables (Incoming & Outgoing) in a secured manner. Tighten as/where necessary by using an insulated screwdriver with a correct head size. DO NOT over tighten these fasteners as it may damage the threading. If threads are loose and cannot secure the cable, replace MCB, Do not attempt to repair or modify components.

**Δ CAUTION****NO OPERATOR SERVICABLE PARTS INSIDE**

**FAILURE TO COMPLY MAY LEAD TO DAMAGE AND FIRE HAZARD**

- f. Check if MCB is free from dust, insect nesting, clear of debris and main switch is operable.
- g. Rotate or flick the main switch to check if it operates correctly, if jammed in closed circuit position, remove and replace MCB.

## **Earth Leakage Circuit Breaker (ELCB), Residual Current Device (RCD), Residual Current Circuit Breaker with Overload Protection (RCBO) MONTHLY INSPECTION**

Note: Above mentioned types of circuit breakers (ELCB, RCD) share the same functions except for RCBO where it has both functions as RCD and MCB.

To be installed if No physical Grounding is present in the electrical system, to protect humans and sensitive equipment from leakages to ground.

### **Δ DANGER**

#### **ELECTRICAL SHOCK PROTECTIVE DISCONNECT DEVICE**

**FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO DEATH**

**SECONDARY ELECTRICAL HAZARD**

**RISK OF DAMAGE TO EQUIPMENT, SERIOUS INJURY, PERMANENT DAMAGE  
OR/AND DEATH**

- a. Check if RCD (2pSPN, 4pTPN) systems are operational, this will ensure that the system gets totally disconnected completely in a short circuit condition, leakage to ground, difference in neutral, which automatically senses that a short circuit or/an leakage is in place. Ensure that the setting is  $\Delta I_n=30\text{mA}$  for normal electrical usage and  $\Delta I_n=10\text{mA}$  in wet areas. Form Main circuit, ensure that the setting is  $\Delta I_n=100\text{mA}$  or 300mA.

Press “Test” Button on the RCD, every month once to check its operations. If it does not trip, replace immediately.

- b. Check if RCD is correctly rated for the load. MCB should protect the RCD and its associated cables. Cable sizing should be determined by an Electrical Engineers’ Calculation. RCBO should be rated accordingly, if used.

- c. Check if RCD is original, from a legit manufacturer. To ensure this, check manufacturer's specification, where here, reference to weight ratio will be treated as a primitive test. Non- authentic RCD would have a lower weight than that specified. If weight found to be different, consult with an Electrical Engineer to remove, carry out further test (voltage breakdown test/Trip Tests) or/and replace with an authentic protection device.

**Δ DANGER**

**ELECTRICAL SHOCK PROTECTIVE DISCONNECT DEVICE**

**FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO DEATH**

**SECONDARY ELECTRICAL HAZARD**

**RISK OF DAMAGE TO EQUIPMENT, SERIOUS INJURY, PERMANENT DAMAGE  
OR/AND DEATH**

- d. Check if all cable terminal connectors on the RCD are secured and restraints the cables (Incoming & Outgoing) in a secured manner. Tighten as/where necessary by using an insulated screwdriver with a correct head size. **DO NOT** over tighten these fasteners as it may damage the threading. If threads are loose and cannot secure the cable, replace RCD, Do not attempt to repair or modify components.

**Δ CAUTION**

**NO OPERATOR SERVICABLE PARTS INSIDE**

**FAILURE TO COMPLY MAY LEAD TO DAMAGE AND FIRE HAZARD**

- e. Check if RCD is free from dust, insect nesting, clear of debris and main switch is operable. Rotate or flick the main switch to check if it operates correctly, if jammed in closed circuit position, remove and replace RCD.

**Grounding System**  
**Lightning System**  
**MONTHLY INSPECTION**

**Δ DANGER**

**ELECTRICAL IMPULSE REMOVAL SYSTEM**

**FAILURE TO CHECK, RECTIFY OR REMEDY MAY LEAD TO FIRE HAZARD,  
DEATH, PERMANENT DAMAGE  
PRIMARY ELECTRICAL HAZARD**

- a. Check if grounding rods and lightning protection system are connected correctly.
- b. Test for mega ohm breakdown on system. Test results should register between  $< 3 - 5$  ohms. If system cannot sustain, then add extra grounding rods to achieve.
- c. Check if test pits are wet, especially during April thru October.
- d. Check if roof lightning arrester system connected continuously to ground.
- e. Ensure that Lightning rods and building grounding rods system should be separate and should never be interconnected to one another. Lightning rod system should be at least 6m below ground level and at least 12m-15m apart from building grounding rod, this is to ensure that EMF does not travel into a grounding system of the building leading to Fire Hazard and Death.
- f. Ensure that Building grounding rod system is minimum of 2.5m-3m below ground level.
- g. Check if the cable for building ground system is  $16\text{mm}^2$ , bare copper cable.

- h. Check if the cable for Lightning grounding system is Galvanised strip, approximately 4mm x 20mm
- i. Electrical engineer to determine the country's static air conditions prior to determining how much lightning arresters are required per roof area (m<sup>2</sup>)
- j. Lightning conductor down runs from roof to ground can be installed within PVC or Galvanized Steel Tube conduit, providing test points for period yearly tests.

## Fire Control System

### MONTHLY INSPECTION

#### **Δ WARNING**

#### **FIRE CONTROL SYSTEMS**

**TECHNICALLY COMPETENT PERSONNEL REQUIRED FOR THIS SERVICING  
RISK OF FALLING FROM HEIGHT**

- a. Check smoke, heat, fire detectors, manual call points, horns and strobes for physical damage, insect nesting, free from dust and operational functions.
- b. Check interior of components, use a ladder and reach out to these components, remove the cover, inspect for oxidation on wires, clean sensors with brush, reinstall.
- c. Use non-toxic testing aerosol test kit for detectors. If device fails to actuate, remove and check contact points, retest again, if consistently fails for 3 times, remove and replace components.
- d. Check FACP (Fire Alarm Control Panel) for correct registration of failure and fault identification codes. Remedy, Rectify immediately.
- e. Check Fire extinguishers for correct type/rating and filled level. Ensure that the correct class of fire extinguishers are installed at correct locations to serve its purpose without indirect hazard. Due date for servicing should be recorded and renewed in a timely manner.
- f. Check all emergency doors, windows and exit points are free from obstruction.
- g. Check all Exit signs are placed correctly and operating, this is necessary to guide personnel to be guided out of the building in case of fire. If electrical type, check battery functions, operations.
- h. Announce Testing to public to reduce panic.
- i. RECORD all testing into maintenance log.

**High Voltage Room  
Transformer  
MONTHLY INSPECTION**

**Δ DANGER**

**ELECTRICAL HIGH VOLTAGE EQUIPMENT**

**FAILURE TO COMPLY WILL LEAD TO DEATH OR/AND DAMAGE TO  
EQUIPMENT**

**PERSONNEL SHOULD BE 72 HOUR ALCOHOL FREE, DRUG FREE, 8 HOURS  
SLEEP REQUIRED PRIOR TO TESTS**

**ELECTRICAL HV SYSTEMS QUALIFIED PERSONNEL REQUIRED FOR  
INSPECTION – 3 MAN TEAM**

- a. Ensure that personnel wear PPE (Personal Protective Equipment) and are trained in HV System and has current qualification to enter and service this section.
- b. No electronics, smoking, magnetic, jewellery allowed beyond this point of entry.
- c. Check that exterior door is free from obstruction, ventilation grills are installed with bird wire mesh and properly grounded. Ensure that door is properly grounded, as float static voltage exists in this room.
- d. Check if rubber insulated mats are not damaged.
- e. Check disconnect switches are operating correctly, with an insulated handle release and are installed with a locking pin, free from moving parts.
- f. Check if fire Extinguishers are charged, operation and correct class.
- g. Check if fire control devices are working correctly.
- h. Check HV Panel has all voltage, ampere and indicator on panels working properly. Record into maintenance log voltage and current of incoming service. All systems should be normal and not overheating.

- i. Check that all lighting fixtures, emergency lights and exit lights are functioning correctly.
- j. Ensure that grounding port is connected correctly.
- k. Never attempt to clean system with a motorized equipment, i.e. vacuum cleaner.
- l. Check Transformer Oil level, ensure that at all times, it is filled to a correct indicated level, read manufacturer's specification for correct grade and type of oil before filling.
- m. Check that all incoming service cables are roped and tied down. Visual check required.
- n. Use a contactless thermometer and measure each phase lug, record in maintenance log.
- o. Check if built-in thermometer on the transformer is operating, replace if faulty.
- p. Physically inspect that the transformer body is grounded.

**Generator****WEEKLY INSPECTION****Δ DANGER****ELECTRICAL EMERGENCY POWER EQUIPMENT**

**FAILURE TO COMPLY WILL LEAD TO DEATH OR/AND DAMAGE TO  
EQUIPMENT, FIRE HAZARD**

**PERSONNEL SHOULD BE 72 HOUR ALCOHOL FREE, DRUG FREE, 8 HOURS  
SLEEP REQUIRED PRIOR TO TESTS**

**ELECTRICAL HV SYSTEMS QUALIFIED PERSONNEL REQUIRED FOR  
INSPECTION – 3 MAN TEAM**

- a. Ensure that personnel wear PPE (Personal Protective Equipment) and are trained in Generator System and has current qualification to enter and service this section.
- b. Check that exterior door is free from obstruction, ventilation grills are installed with bird wire mesh and properly grounded. Ensure that door is properly grounded.
- c. No electronics, smoking, magnetic, jewellery allowed beyond this point of entry.
- d. Check and disable ATS (Automatic Transfer Switch) – This is to ensure that generator does not start while servicing is being carried out. Press emergency 'STOP' Button on generator.
- e. Check Engine Oil level, fill accordingly. Do not overfill. Read Manufacturer's specification for correct fluid type and grade.
- f. Check Coolant level, fill accordingly. Do not overfill. Read Manufacturer's specification for correct fluid type and grade.

- g. Check operating hours and carry out maintenance as per manufacture's specification and procedures. Maintain tracking on log book. Ensure that Fuel, Air and Oil filters are changed on time.
- h. Check for fuel leaks. Clean up and rectify immediately.
- i. Check for functional operation of heater unit
- j. Check if generator works via automatic transfer switch, cuts in and cuts out as per setting.
- k. Check if all digital display units are operating correctly.
- l. Enter detailed findings in maintenance log book.

# **Maintenance of Ventilation & Air Conditioning Systems**

## Mechanical HVAC System

### **Δ WARNING**

#### **LOW VOLTAGE ELECTRICAL SHOCK RISK**

MOVING MECHANICAL PARTS INSIDE  
REMOVE POWER BEFORE SERVICING AND MAINTENANCE  
QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO ELECTRICAL SHOCK, DAMAGE TO  
EQUIPMENT OR/AND DEATH

### **Δ HEALTH HAZARD WARNING**

#### **BIOLOGICAL & CHEMICAL CONTAMINATION**

WEAR FACE MASK, SURGICAL GLOVES AND SAFETY EYE GOGGLES  
DECONTAMINATION MUST BE CARRIED OUT PRIOR TO SERVICING  
QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO PROLONGED HEALTH PROBLEMS OR/  
AND DEATH

## Split Air Conditioning Units

- a. Check if indoor unit filter is congested with dust. Remove, wash and refit. Clean top cover, ventilation blower fins and louvers with damp cloth, squeezed dry with anti-bacterial solution in warm water
- b. Check Exterior unit evaporator coils. Clean with water, do not spray into the unit, but remove dirt by low pressure water from top to bottom. Carry out general cleaning of exterior unit
- c. Check refrigerant level and top up. Check manufacturer's specification for type of refrigerate used on the unit. Check and ensure that refrigerant filler valves are fastened and not leaking, use soap water to test for gas leakages. Cover with insulation after.
- d. Check condense water drain pipes are functioning. Use a flexible round ended hose to feed and remove dirt. If after retracting the hose, heavy dirt is found, use a 1/4" flexible hose to fill the interior unit where the condense water pipe is visible and flush with low pressure water. Ensure that interior unit is not flooded. Check and verify that water can flow from the interior unit to the exterior unit's drain pipe.
- e. Check if unit is completely dry before turning on power.
- f. Check physically by minimal force that the interior and exterior units are secured, if found loose, secure it. Check if refrigerant pipes are completed covered with thermo-pipe insulation or the same type as provided by manufacture. Ensure that all exposed piping fittings are covered, this will save energy and running cost.

**Table 7—Maintenance Checklist: Split Air Conditioning Units**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	Daily	Week	1m	3m	6m	12m
Check indoor filters, General cleaning (a)			<b>X</b>			
Check Exterior unit, General cleaning (b)				<b>X</b>		
Check Refrigerant Level (c)					<b>X</b>	
Check condense water drain pipes (d) (e)				<b>X</b>		
General Inspection (f)					<b>X</b>	

## Package Air Conditioning Units (PAC Unit)

- a. Check if unit filters are congested with dust and debris. Remove, replace or wash and refit. Clean top cover, ventilation blower fins and louvers with damp cloth, squeezed dry with anti-bacterial solution in warm water. Follow manufacture's instruction for changing or cleaning all air filters, read operator's manual to determine the frequency of replacement.
- b. Check Exterior unit evaporator coils. Clean with water, do not spray into the unit, but remove dirt by low pressure water from top to bottom. Ensure that leaves and other unwanted debris on the condenser grille are removed. Examine coils, fins and ensure they are not bent. Carry out general cleaning of exterior unit
- c. Check duct around air handler for holes, loose tape or separated sections that might allow air infiltration, rectify immediately.
- d. Check and clean return grills to prevent dust and debris from accumulating in duct and clogging filters
- e. Check refrigerant level and top up. Check manufacturer's specification for type of refrigerate used on the unit. Check and ensure that refrigerant filler valves are fastened and not leaking, use soap water to test for gas leakages. Cover with insulation after.
- f. Check for mechanical vibrations, noise or unusual findings. Check and ensure that all moving parts inside are working properly including linkage, dampers, motors, belts. Carry out lubrication as per manufacturer's instructions. Read manufacturer's operating manual.

- g. Check and maintain proper humidity level. This can reduce airborne allergens. Ensure pans and coils of humidifier/dehumidifier units are clean and free from debris. (See bottom sections for humidity setting)
- h. Check air system for balancing to avoid air pressure differentials pulling pollen and allergens into facility/room.
- i. Check thermostat mode for cooling and heating and ensure it works correctly. (See bottom section for setting)
- j. Carry out General visual inspection on unit

**Table 8—Maintenance Checklist: Packaging Air Conditioning Units**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	<b>Daily</b>	<b>Week</b>	<b>1m</b>	<b>3m</b>	<b>6m</b>	<b>12m</b>
Check filters, general cleaning & maintenance, (a, b, c, d)			<b>X</b>			
Check refrigerant level & pipe insulation (e)					<b>X</b>	
Check for mechanical operations (f)						<b>X</b>
Check, test and set humidifier/dehumidifier (g)					<b>X</b>	
Check, test Air balancing (h)						<b>X</b>
Check, test and set thermostat (i)						<b>X</b>
General Visual Inspection and checks (j)			<b>X</b>			

## Ventilation System

### Supply Air Fan for Air Ventilation System

- a. Check physically that the fan has no visible cracks on the blades. Check for correct rotation, rotation per minute (rpm). Ensure protection guards are in place and not damaged. Check if original assembly is in place and intact.
- b. Check for vibrations, unusual noise, loose nuts and bolts, electrical connections, insulation intact, fly wheel correctly mounted and not worn or dirty. Coupling and alignment checks required for direct drive fans.
- c. Check pulley & belt tension, tighten as/where necessary. Check for signs of bearing wear and tear.
- d. Check and Ensure that that there is adequate bearing lubrication, only use lubricants as directed by manufacturer. Refer and read manufacturer's operating manual and maintenance instructions.
- e. Provide corrosion protection paint coating if necessary.
- f. Check static pressure dropped across fan, if possible.
- g. General cleaning to be done.

**Table 9 --- Maintenance Checklist: Supply Air Fan for Air Ventilation System**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	<b>Daily</b>	<b>Week</b>	<b>1m</b>	<b>3m</b>	<b>6m</b>	<b>12m</b>
General Inspection (a)				<b>X</b>		
Mechanical inspection, wear and tear Checks (b)					<b>X</b>	
Lubrication (c)					<b>X</b>	
Corrosion protection (d)						<b>X</b>
Static pressure test (e)						<b>X</b>
General Cleaning (f)			<b>X</b>			

## Exhaust Extraction Air (Contaminated Air) Fan for Air Ventilation System

### **Δ HEALTH HAZARD WARNING**

#### **BIOLOGICAL & CHEMICAL CONTAMINATION**

**WEAR FACE MASK, SURGICAL GLOVES AND SAFETY EYE GOGGLES  
DECONTAMINATION MUST BE CARRIED OUT PRIOR TO SERVICING  
QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK  
FAILURE TO COMPLY MAY LEAD TO PROLONGED HEALTH PROBLEMS OR/  
AND DEATH**

- a. Check physically that the fan has no visible cracks on the blades. Check for correct rotation, rotation per minute (rpm). Ensure protection guards are in place and not damaged. Check if original assembly is in place and intact.
- b. Check for vibrations, unusual noise, loose nuts and bolts, electrical connections, insulation intact, fly wheel correctly mounted and not worn or dirty. Coupling and alignment checks required for direct drive fans.
- c. Check pulley & belt tension, tighten as/where necessary. Check for signs of bearing wear and tear. Ensure that the duct chamber is sealed and has no air leakage which could seriously cause biological and chemical contamination.
- d. Check and Ensure that that there is adequate bearing lubrication, only use lubricants as directed by manufacturer. Refer and read manufacturer's operating manual and maintenance instructions.
- e. Provide corrosion protection paint coating if necessary.
- f. Check UV decontamination duct is operating and lamps are 100% working. Replace immediately if necessary.
- g. Check static pressure dropped across fan, if possible.
- h. General cleaning to be done.

**Table 10—Maintenance Checklist: Exhaust Extraction Air (Contaminated Air) Fan for Air Ventilation System**

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
	General Inspection (a)				X	
Mechanical inspection, wear and tear Checks (b)				X		
Lubrication (c)				X		
Corrosion protection (d)						X
UV Decontamination duct Inspection or Servicing (e)		X				
Static pressure test (f)						X
General Cleaning (g)		X				

## Ventilation Duct Air Filters Bank Units

- a. Check and verify that the type of filters used are available in stock. Replace with correct type of filters. Ensure that inspection is done on filter efficiency (clean or blow if necessary), cleanliness of filters. Check for signs of filter bypassing, if such conditions exist, use anti-bacterial silicon to seal the lip. Check manufacturer's recommendations and operating manuals.

**Table 11—Maintenance Checklist: Ventilation Duct Air Filters Bank Units**

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
Check filters, general cleaning & maintenance, (a)				X		

## Supply Air Diffusers, Return Air Grilles

- a. Check if all delivery components are clean, free from dirt, debris, smell, vibration and other unusual noise. Dismantle and clean with anti-bacterial solution. Ensure upon removal that there is not obstruction and the grille and duct matches correctly, if seal lip cannot mate, use anti-bacterial silicone to seal. Reinstall and carry out air balance test.

**Table 12—Maintenance Checklist: Supply Air Diffusers, Return Air Grilles**

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
General cleaning & maintenance, (a)					X	

## Exhaust Fume Extraction Ventilation Hoods—for Kitchen

- a. Check for cleanliness, hood duct intact, no vibration, loose fittings. Ensure duct is sealed and free from debris, oil and clear from obstruction. Velocity is positive and no smoke is leaking from the connection sides.
- b. Check extraction exhaust fan motor. Check physically that the fan has no visible cracks on the blades. Check for correct rotation, rotation per minute (rpm). Ensure protection guards are in place and not damaged. Check if original assembly is in place and intact. Check pulley & belt tension (if available), tighten as/where necessary. Check for signs of bearing wear and tear.
- c. Check and Ensure that that there is adequate bearing lubrication, only use lubricants as directed by manufacturer. Check for vibrations, unusual noise, loose nuts and bolts, electrical connections, insulation intact, fly wheel correctly mounted and not worn or dirty. Coupling and alignment checks required. Refer and read manufacturer's operating manual and maintenance instructions.
- d. Provide corrosion protection paint coating if necessary.
- e. Check static pressure dropped across fan, if possible
- f. General cleaning to be done

**Table 13—Maintenance Checklist: Exhaust Fume Extraction Ventilation**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	Daily	Week	1m	3m	6m	12m
General Inspection (a)		X				
Mechanical inspection, wear and tear Checks (b)			X			
Lubrication (c)			X			
Corrosion protection (d)					X	
Static pressure test (e)					X	
General Cleaning (f)		X				

## Outdoor Air Intake Ventilation Ducted System

- a. Check location of related intake ducts. Check for duct dryness inside duct, cage guards are installed, securing bolts and nuts are tight and bird mesh is installed.
- b. Check and ensure that intake duct and exhaust duct are at least 5-8m apart to ensure that there is no recirculation of contaminated air fed back into the supply. Clean and replace duct filters to protect against biological and chemical contamination.
- c. Check if automatic motorized dampers (if installed) are properly lubricated, all moving parts, linkages, shafts, fins and louvers are working correctly. If mechanically actuated, then ensure that the actuator lever works and it seals the intake. If electrically actuated, then check if electrical connections, wiring and other accessories are in working condition.
- d. Proper cleaning. If necessary, strip unit to inspect walls in duct and clean with anti-bacterial solution or gas. Carry out general inspection to assess and arrest possibilities of contamination.

**Table 14—Maintenance Checklist: Outdoor Air Intake Ventilation Ducted System**

<b>CHECKS, SCHEDULED &amp; PREVENTIVE MAINTENANCE</b>	<b>Daily</b>	<b>Week</b>	<b>1m</b>	<b>3m</b>	<b>6m</b>	<b>12m</b>
Mechanical component security (a)					<b>X</b>	
Filter inspection, contamination prevention (b)			<b>X</b>			
Check automation devices (c)					<b>X</b>	
Cleaning and general inspection (d)		<b>X</b>				

## Thermostat Control Units

- a. Check if all thermostats are operating correctly and equipment registers changes. General cleaning required. Check battery (if wireless) controls are used. Set appropriate parameters as follows:

- Temperature Setting:

Cool Mode	Summer 24°C (Ambient Temperature at +33°C to +45°C)
Heat Mode	Winter 27°C (Ambient Temperature at -15°C to +15°C)

- Relative Humidity Setting:

Summer	70% (Ambient Humidity at 10% to 20%)
Winter	50% (Ambient Humidity at 40% to 60%)

- b. Check duct heater (if installed) thermostats. Ensure that the duct heater operates (cut-in / cut-out) at pre-set temperature. Clean duct thermostat.

**Table 15—Maintenance Checklist: Thermostat Control Units**

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
General cleaning & maintenance, (a)					X	

## Ductwork — General

- a. Check and ensure that duct is not damaged or dented, repair if in such conditions. Ensure that physical integrity of duct is maintained at all times. Reinsulate if necessary on areas where insulation has been exposed.
- b. Use an inspection camera to access the interior of the duct, if dirty, clean and make sure it is dry. Ensure that there is no mould, dirt, dead animals/insects or soot accumulated inside. Clean chamber floor, walls and ceiling surfaces with anti-bacterial solution if necessary. Dismantling may be required in such cases. Make sure that the duct is polarized for easy reassembly after cleaning. Save insulation if possible to be re-used during reassembly.
- c. Check insulation. Ensure that the duct is properly insulated, if in such cases it uses reheat circulation duct heaters. Ensure that all connections on the duct is sealed. Check for static pressure and air balancing, if possible. Check all electrical connections for duct heaters, ensure that the component is maintained as per manufacturer’s recommendation.

**Table 16—Maintenance Checklist: Ductwork**

CHECKS, SCHEDULED & PREVENTIVE MAINTENANCE	Daily	Week	1m	3m	6m	12m
General cleaning & maintenance, (a)			X			
In-depth Inspection, Cleaning, Disinfecting (b)				X		
Check insulation, electrics, heaters, testing (c)						X



# **Maintenance of Heating Systems**

## Boiler Room & Radiators

### **Δ WARNING**

### **LOW VOLTAGE ELECTRICAL SHOCK RISK**

### **MOVING MECHANICAL PARTS INSIDE**

**REMOVE POWER BEFORE SERVICING AND MAINTENANCE**

**QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK**

**FAILURE TO COMPLY MAY LEAD TO ELECTRICAL SHOCK, DAMAGE TO EQUIPMENT OR/AND DEATH**

- a. Check all valves, gauges, pipes, connections, fittings, insulation wraps and foils, shut off lever. Check and ensure that there are no signs of visible damage. Make sure that all gauge has its glass protection and the needle is present. Any gauges which are damage must be replaced immediately.
- b. Remove some anti-freeze solution from the system, and check if with a refractor-meter, ensure that temperature range is within  $-15^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ . Ensure that % of water-anti-freeze solution is at least 60%, 40% respectively. This will enable the system to peak  $+107^{\circ}\text{C}$  to  $+110^{\circ}\text{C}$ , in a close system, increasing boiler efficiency, heat distribution and energy efficiency. Note that raw water boiling point is lower than a solution described above, also raw water evaporates quicker, causing damage to equipment.
- c. Check Drain valve. Ensure that drain valve is not leaking. Check if drain is protected against infiltration and does not have any stagnant water. If required, clear cloaks and debris.

- d. Check submerged heater tubes. Check if heater tubes are not corroded and covered with lime. If necessary brush with soft brush, do not deface component, use only light plastic bristle brush. Check integrity and seals, ensure that there are no leakages around the assemblies. If removed, replace gasket and apply a layer of petroleum jelly as a seal abrasion protection layer, Wash after and apply high temperature silicone around exterior lip face. Allow drying for at least 8 hours before powering up the heater tubes. Carry out voltage and ampere tests by utilizing a digital multi-meter. Ensure that the system is filled with fluid prior to power on. NEVER turn on a heating element without fluid inside the boiler, this will damage the heater element.
- e. Check Wiring. Ensure that all wiring is installed in a metal conduit, conduits must be bent 12x its outside diameter and installed with pull boxes for ease of installation and disassembly. Never allow less than 40% spare space inside the conduit. Ensure that all ends of conduits are properly sealed with silicone, Ensure that if replacing of conduits are required, all bends are to be done by utilizing a pipe mandrel, so that all bends are uniform and do not kink or buckle, leading to reduced area at bends. Check and ensure that cable size are correct and meets all requirements of the load and circuit breakers. A qualified electrical engineer should determine this. Ensure that the body of all metal conduits are grounded, including flyover connectors bonded in a continuously manner. Failure to check and carry this out may cause irreversible damage to equipment, serious injury or death.
- f. Major electrical component. ELCB must be used throughout in this system, this is because any leakage in current will eventually lead to consumer end components, i.e. Electrocutation in shower, sink faucets, radiators. This is because within the boiler, there are sub section heater pipes which will feed into hot water system. Any leakage in current will therefore lead to consumer end-user's components. Check boiler control panel, ensure that all indicators, controls, PLC and other electric components are working correctly and the panel is free from dirt, oil,

dust, sealed properly.

- g. Check Pump, circulation pumps, motors, suction strainer, all valves. Check every component for damage, circulation and operations. Read specification and manufacturer's recommendation prior to removal, lubrication and reassembly. Ensure that these components are working properly and correctly.
- h. Check Air Vent Pipes. Ensure that all vent pipes are installed with wire mesh and has a dust hood.
- i. Check Overflow pipe. Ensure that overflow pipe is installed correctly and extends to a drain or reverse feed holding tank. All outlets are to be secured with a p trap to ensure that the system is free from insects and other debris. Drain the p trap bottom release to clear dirt. Refill until p trap is sealed.
- j. Check Fluid Holding tank. Ensure that the tank is sealed, integrated and with its own vent pipes. Remove the cover and inspect at the bottom of the tank for debris, remove debris and clean tank. Check filter, ensure that filter is clean and not choked. Recycle fluid and save as much anti-freeze solution as possible.
- k. Check Radiators. Ensure that radiators are free from water hammer, all air must be bled and system should have its thermostat working well. Check if by pass valves are operating and radiator is hot on the top and bottom. Ensure that there is no visible signs of leakages on the fin's joints, remedy immediately if leaking. Ensure that the system is filled with anti-freeze – water solution when not in use (summer), never leave the system dry, this will create corrosion. Check that the system is circulated (cold) in summer and it is not left stagnant, for this purpose, disconnect the circuit breaker for the heating elements prior to cold circulation. Check hot circulation in winter.
- l. Start up. Ensure that system is start up in a lower temperature, increase temperature gradually across 3-5 days span, this will enable the system

to have even expansion and create less leakages during winter months.

- m. Shut down. Ensure that the system is shut down gradually, similar method as stated for start-up. This will enable contraction in a controlled manner, leading to system being sustainable for a longer period of time without much maintenance.
- n. If system runs on gas as heating fuel. Check if all gas pipes, valves are free from leakage. Use soap solution to test for leaks, dry after. Check burners. Ensure that the nozzle is clean, use a proper cleaning tool to clear the nozzle. Check if flame is clean thru the viewing glass, ensure that there are no signs of orange flame, flame must be clear blue. If flame found to be orange, check for signs of leakages on flame regulator valve and air valves, ensure that there is not oil, grease and other lubricants around the system. Change valves and nozzle if necessary. Check all pipes are secured against a fixed surface, i.e. against wall secured with clamps. NO PIPES should be unsecured or loose. Check if exhaust chimney has signs of black smoke, do this by shining a LED white light torch light in the night, if exhaust is present, then check system properly. Note that in a gas chamber heating system, all electrical systems should be rated IP65 or higher, as any electrical sparks can trigger an explosion. Check all gas flow indicators are working correctly, flowing in the correct upstream position.
- o. For Overhaul, Disassembly and Reassembly. Check that person(s) tasked for this is supervised, qualified and has read the manufacturer's operating and servicing manual. NEVER change adhoc parts by substituting with other parts. Note that specific lubricants and grease should be used as recommended by manufacture. Failure to follow may damage the equipment. Take particular note of bolts, screws and other fasteners, polarize them, and indicate with color code if necessary to ensure that each fastener returns into its original position during reassembly. Use correct tools for the correct job, tools should be clean, free from oil and dirt. Any lubricants, oil or grease, should be handled

and applied as per manufacturer's specification correctly and with a clean application tool, do not mix different lubricants, maintain a few application tools, should not be mixed, as this may cause chemical or explosion risks which can damage the equipment, causing malfunction and cost to the facility. Any overhaul should be done in a clean workshop with racks to maintain flow of disassembly, this will help reduce confusion during reassembly. Ensure that parts that are recommended for change at schedule, must be adhered at all times, failure to do so may lead to equipment damage. Ensure that correct parts are used. Do not substitute without inquiring with the manufacturer or a subject matter expert on the system.

- p. All inspections, events, measurements and data should be recorded in the maintenance log book.

# **Maintenance of Medical Gas Supply**

## Maintenance of Medical Gas Supply

### MEDICAL GAS ROOM

WEEKLY: Check Ventilation fans. Ensure that fans blades are clean, fitted with wire mesh, electrical boxes are sealed, properly wired and lubrication carried out every 6 months.

WEEKLY: Check flooring. Ensure that floor surface is clean, free from debris and if surface is broken or cracked, seal with concrete floor sealants epoxy.

DAILY: Check entrance gate. Gate must be locked at all times, with keys maintained at locations mentioned above paragraphs.

WEEKLY: Check walls and ceilings. All surfaces in this room should be clean and free from dust.

DAILY: Check Firefighting equipment. Ensure that firefighting equipment are present and inspections are carried out.

WEEKLY: Check that all Bottled gases are placed on a wooden block, to prevent base from being in contact with water.

MONTHLY: Check Grounding. Ensure that grounding is in place and equipment are properly grounded.

WEEKLY: Check and ensure that no oil traces are present anywhere in this building, if necessary turn off all gases and clean with de-oiling detergent. Oil and Gas are explosive and therefore should be in contact at any time.

## MEDICAL GAS MAINTENANCE

### **△ WARNING**

#### **EXPLOSION AND GAS POISONING**

**RESPIRATION MASK, SAFETY GLOVES AND SAFETY EYE GOGGLES**

**NO ELECTRONICS TRANSMITTING OR RECEIVING DEVICES ALLOW INTO ANY GAS FACILITY**

**NO SMOKING INSIDE ANY GAS FACILITY / ROOMS / STORES**

**QUALIFIED PERSONNEL REQUIRED TO CARRY OUT TASK**

**FAILURE TO COMPLY MAY LEAD TO SERIOUS INJURIES, GAS POISONING, EQUIPMENT DAMAGE, EXPLOSION OR/AND DEATH**

**WEEKLY**: Check physically and visually all gauges and valves on supply station room where medical gas bottles are located. Ensure that all valves and gauges are present correctly with the corresponding pressure setting, installed with seals and not tampered.

**DAILY**: Check to ensure that all bottles are color coded with the correct colors and physical tags are clipped on the bottles. Note that the date on the bottle should be clearly visible.

**WEEKLY**: Check to ensure that the bottles are placed in a systematic manner and plugged into the correct pipes neatly. **DO NOT** mix lines that are of different gas types as this may cause an explosion or death to end-user/patient.

**MONTHLY**: Check to ensure that all bottles are placed on a wooden block to prevent corrosion at the bottom base, all bottles should be elevated at least 100mm above finished floor level.

**WEEKLY**: Check all bottles for signs of corrosion, if any, mark immediately, replace bottles with good ones. Remove bottle from medical gas storage room and store in an open locked area, inform supplier to carry out corrosion protection or supply the hospitals with proper bottles.

**NOTE**: Any removal of bottles are to be authorised by hospital director and head nurse, this is to ensure that there is no interruption of gas to any persons on life support gas.

**DAILY**: Check all gas supply distribution panels, ensure that the pressure is set and not tampered with at any time. Any change in requirements are to be brought to the knowledge of the hospital director and head doctors prior to adjustments. Documentation should be well noted for any actions with dealings on medical gas system.

**NOTE:** ANY works carried out on medical gas systems, maintenance team to ensure that written notification is given by authorised person. There should be no interruption to these live support gases at any time. Work can only be carried out after a “Permit-To-Work” has been issued by higher hospital authorities.

**READ:** Prior to any work being carried out on equipment, gas bottles and other apparatus, proper comprehension should be achieved by persons carrying out the maintenance. He/she should have a sound understanding of all related equipment and gases, prior to dismantling, assembling or maintaining a system.

**WARNING:** At no time should foreign substances, liquids, chemicals or oil should come into contact with any equipment, other than those clearly specified by the manufacturer of the equipment. Carefully read all warning and caution notes in the operating manual prior to handling any equipment that require maintenance.

**CAUTION:** All required PPE are to be used, as directed by Manufacturer or supplier. Failure to do this may result in injuries or death.

**MONTHLY:** Check and ensure that all personnel required for medical gas maintenance are trained and current. Any laps or approaching laps due dates, require personnel to undergo retraining on systems, equipment as that specifies within the hospital’s directive or/and manufacturer’s requirements. All training currency should be presented to Authorised person approving works to be carried out. He remains responsible for assessing the situation and can determine if the person carrying out the servicing is work-worthy to carry out such maintenance.

**DAILY:** Check all tools required for the task are serviceable, free from debris, clean and stored in a sealed container with shadow placement mats. This is to ensure that all tools are returned into the tool box, once the job is completed, failure to ensure that tools are return may lead to hazard, damage to equipment or death of end-users, as parts may get jammed and not work properly. Ensure that all tools are cleaned with disinfectant solution and dried, leaving no traces of debris. Surgical gloves are required for maintenance on clean room gas facilities. ALL tools and test equipment are to be accounted daily, before and after work. Any unaccounted tools are to be reported to the hospital director immediately.

**WEEKLY:** Check all test equipment for currency. Ensure that all test equipment are calibrated correctly to manufacturer’s recommendation. **READ MANUFACTURER’S RECOMMENDATION NOTES FOR CALIBRATION.** All calibrations are to be carried out by authorised person/company/firm, documented with proof of pre-tests. Calibrations are to be tracked by maintenance team on a daily basis to ensure that there are no lapse.

**WEEKLY:** Ensure that all tests carried out on terminal units are not only with blank test probes, but sufficient maintenance are done to ensure that leak tests, calibrated flowmeter tests, pressure gauges, correct flow direction

and pressure drop tests are carried out. This is to ensure that all system operates at maximum demand design load. Refer to manufacturer's recommendation for periodic interval testing.

WEEKLY: Ensure that visual inspection is done on regulators, vacuum line, and pipeline systems. Check for run color coding and gas tagging at the user-end. Make sure that the system is securely affixed against its intended mounting structure, i.e. wall, outlets and bed trays. All secondary gas lines are to be maintained accordingly, in all aspects.

**NOTE: Any work or repaired carried out are to be tested for debris or gas leaks.**

WEEKLY: FILTER TESTS. Ensure that filter tests are carried out at the supply end of every gas system. All filters are to be kept as proof of tests, and verified by the head doctor. He/she should be present to accept servicing or maintenance end results and should authorise works to be closed. Hospital director will undertake final approval and a copy of the test, servicing, maintenance report should be filled in each office.

MONTHLY: Check and ensure that all equipment, gas bottles, gas systems and outlets have properly secured drawings, circuit diagrams, valve charts and maintenance instructions affixed near its panel or associated equipment, also make sure that all diagrams are current and updated. All plant should have correct and real-time diagrams available with tags for emergency shut off instructions. This should be clearly defined and instructions should remain minimum to layman terms.

BI-ANNUALLY: Check and ensure that all equipment overhaul are carried out bi-yearly, or as that specified within the manufacturer's recommendation and operating manuals. All documentation are to be recorded and work permits to be authorised by hospital director prior to any overhaul.

WEEKLY: Check all emergency stand-by manifolds / gas cylinders / compressors. Ensure that all emergency gear are operating, correctly tagged, sealed and ready to use during an emergency demand. These should be properly stored in a clean and dry room, covered with plastic sheet only on the top, do not seal the bottom, as water moisture may collect within the equipment.

WEEKLY: Check all equipment counters, hour-meters and control panels, Ensure that all electrical components are connected safety and fitted with correctly sized circuit breakers and cables, plugs meet EU standards and are not broken.

WEEKLY: Inspect and monitor all compressors and vacuum pumps, ensure that all parts and components are operating properly and within correct intended function. If any abnormally, seek permission and authorization from hospital director to schedule a maintenance on these units as soon as

possible. READ manufacturer's recommendation and operating manual for details.

WEEKLY: Maintenance of filters. Replace, clean or maintain all equipment filters as directed by the manufacturer. READ manufacturer's recommendation and operating manual for details.

DAILY: Inspect and check medical gas manifolds for abnormally. Ensure that pressure regulators are set correctly, untampered, sealed, tagged, supply pressure gauges, light indicators and all other control indicators are not showing signs of error. If manifolds are operating on reserve bank, replace empty gas bottles/cylinders immediately. Ensure that gas supply is at its maximum limit at all times or more than 75% - 80% charged. No cylinder should be under 40%, if required, recharge or change cylinders at the end of the day. NEVER allow cylinders to reach a low %. Test all warning features on the control panels, ensure that all alarms, warning lights, sounders are operating.

DAILY: Inspection and checks to be carried out for liquid oxygen (LOX) systems. Ensure that all warning and alarm systems are operating correctly, pressure gauges are reading correctly, all mechanical joints are leak free, back up cylinders are full. No flammable items are present nearby. Maintenance should be carried out without any oil, this causes explosion when in contact with LOX, causing death.

WEEKLY: Inspect and change bacterial filters on vacuum systems. This should be carried out as per doctor's direction or upon requests. Ensure that full PPE is used prior to handling such filters. These filters contain bacteria that may cause permanent health hazard, and therefore should be stored in a sealed plastic zip lock bag immediately upon removal and burnt as soon as possible. For operations, changing method and maintenance, refer to manufacturer's recommendations and operating manual.

## Further Reading





Options for further reading are indicated below:

- Hospital Safety Toolkit—Book 1, UN Habitat:

[http://www.fukuoka.unhabitat.org/info/misc/pdf/02130216/hospital\\_safety\\_toolkit\\_book\\_1\\_new\\_design.pdf](http://www.fukuoka.unhabitat.org/info/misc/pdf/02130216/hospital_safety_toolkit_book_1_new_design.pdf)

- Hospital Safety Toolkit—Book 2, UN Habitat:

[http://www.fukuoka.unhabitat.org/info/misc/pdf/02130216/hospital\\_safety\\_toolkit\\_book\\_2\\_retro\\_maintenance.pdf](http://www.fukuoka.unhabitat.org/info/misc/pdf/02130216/hospital_safety_toolkit_book_2_retro_maintenance.pdf)

- Developing an Estate Strategy, NHS, UK:

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/144226/Developing\\_an\\_Estate\\_strategy.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/144226/Developing_an_Estate_strategy.pdf)