सत्यमेव जयते

NATIONAL HEALTH MISSION
राष्ट्रीय स्वास्थ्य मिशन

GUIDELINES FOR PLANNING AND ESTABLISHING DRUG WAREHOUSE

2021

Ministry of Health & Family Welfare
Government of India

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Government of India

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Government of India
Department of Health and Family Welfare
Ministry of Health and Family Welfare

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सचिव
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SECRETARY

Message

Availability of essential and quality medicines is one of the critical components of a responsive, equitable, effective and safe Health System. Recent data clearly reveals that the strengthening of the Health System under the National Health Mission (NHM) has started giving rich dividends. Out of pocket expenditure (OPE) on health has shown substantial decline from 69.4% in the year 2004-05 at the start of launch of National Health Mission to 48.8% in the National Health Accounts (NHA) for the year 2017-18. Since substantial out of pocket expenditure takes place on the medicines and diagnostics, the focus of the Health Ministry has been to support the states' efforts in strengthening these two important pillars of the service delivery.

In this direction Free Drug Service Initiative (FDSI) has been launched in the year 2015, for ensuring the availability of essential quality medicines at the consumers' end. Under the initiative, support is provided to States and Union Territories (UT) for strengthening/setting up robust systems of procurement, quality assurance, information technology (IT) backed supply chain management systems like Drugs and Vaccines Distribution Management Systems (DVDMS), warehousing, prescription audit, etc.

Warehousing services that are effective and efficient can significantly improve the delivery of public health by ensuring the availability of medicines at the health facilities. Warehouses that are effectively managed and stocked, ensure supply of stable and efficacious medicines and also enhance customer satisfaction. Most of the States experience challenges in planning and scientific designing of drug warehouses resulting in bottlenecks in supply chain management of essential free medicines.

Hence, the 'Operational Guidelines for Planning and Establishment of Drug Warehouse' have been developed to serve as a comprehensive handbook and a standard resource material for the public health professional, health manager, warehouse manager, administrator/authorities at the state or district level. I hope states/UTs find these guidelines useful to improve and increase their efficiencies while implementing them in drug warehouses.

Place : New Delhi
Date : 30.12.2021

(Rajesh Bhushan)

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MESSAGE

Access to affordable and quality medicines is pivotal for achieving Universal Health Coverage. Maintenance of proper storage and transportation conditions throughout the drug supply chain becomes a non-negotiable factor in preserving medicines' safety, quality, and efficacy.

In this strategic direction, the Free Drug Service Initiative was launched by the Ministry of Health and Family Welfare for establishing systems for effective rollout and implementation such as procurement, quality assurance, supply chain management and monitoring mechanisms.

The States are being supported under the National Health Mission not only for procurement of essential drugs but also for setting up and strengthening the systems of procurement, quality assurance, IT backed supply chain management, modern warehousing, prescription audits, standard treatment guidelines and grievance redressal.

Effective and efficient warehousing services play a crucial role in strengthening public health, especially in ensuring the availability of drugs and consumables at facilities. It also ensures improved service to their customers and helps overcome critical challenges such as consistent supply of medicines, increasing the number Stock Keeping Units (SKUs).

To act as a guiding principle for States/UTs and overcome the bottleneck in the supply chain system, the Ministry of Health has constituted a group of experts to design a 'Drug Warehouse Guidelines'. The objective of these guidelines include but are not limited to procurement, purchasing, storage, distribution, transportation, documentation, and record-keeping practices.

The National Health Mission is committed to assist in establishing the drug warehouses with both financial and technical assistance. I would encourage all states to implement these guidelines in order to achieve tangible results in the quickest period possible. I am certain that these guidelines will channelize our efforts on strengthening drug warehouses.

(Vikas Sheel)

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MESSAGE

One of the most significant links in supply chain management is the storage of medicines & consumables at Drug Warehouses. Under the 'National Free Drug Initiative,' the Ministry of Health and Family Welfare (MoHFW) launched Free Drugs Service Initiative which supports the States/UTs in the establishing and operationalizing of drug warehouses, as well as other critical components of supply chain management like procurement, supply chain management, logistics, quality assurance, IT enabled monitoring system, prescription audit, etc.

Drug warehouses placed strategically, meticulously planned, and scientifically operated in few states have enabled them in strengthening the supply chain management and making quality essential medicines available to all. But in most of states drug warehouses are poorly planned and designed with inadequate and inappropriate infrastructure, which have led to improper storage, overstocking, higher inventory carrying costs, frequent stockouts, deterioration, breakage and pilferage of medicines.

Therefore, to overcome this challenge 'Comprehensive Operational Guidelines for Planning and Establishment of Drug Warehouses' have been developed. These guidelines are expected to support the states in designing, implementing, and operationalizing a drug warehouse. I hope all states will now expeditiously implement these guidelines to improve their drug warehouse infrastructure so that free supply of essential medicines at all levels of healthcare may be strengthened.

(Vishal Chauhan)

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1 Introduction

1.1 Background & Rationale

Universal health coverage (UHC) means that all people have access to the health services they need, when and where they need them, without financial hardship. UHC is the global strategic priority and primary focus of Sustainable Development Goal-3 (SDG-3) which mandates the ensuring of healthy lives and promotion of well being for all at all ages."

Access to affordable and quality medicines is pivotal for achieving UHC. The SDG-3 strongly advocates the need to improve access to quality essential health care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.

In India's vision of UHC, the provision of essential drugs free of cost, especially for the poor, becomes a non-negotiable factor. India is among the countries with the highest out of pocket (OOP) expenses on health care. As per NSSO 68th round survey report[1], expenditure on drugs constitutes over 67% of out of pocket expenditure on health care due to inaccessibility to essential drugs[2].

Effective drug procurement, distribution and supply chain management system plays a critical role in availability of quality and affordable medicines for all citizens. Warehousing is an integral part of the Logistics and Supply Chain Management System in health care. Organisations like Amazon, Toyota and Walmart from the private sector have adopted modern, organised, systematic and professional approaches and techniques of warehousing. They have been successful in reducing inventory costs, reducing lead time, ensuring availability of products and enhancing customer satisfaction.

The Ministry of Health and Family Welfare (MoHFW) launched the 'Free Drugs Service Initiative' for enabling the provision of free essential drugs at all public health facilities. Under this initiative, support is provided to states and Union Territories (UT) for strengthening/setting-up robust systems of procurement, quality assurance, information technology (IT) backed supply chain management systems like Drugs and Vaccines Distribution Management Systems (DVDMS), warehousing, prescription audit, grievance redressal, Information, Education and Communication (IEC), training and dissemination of Standard Treatment Guidelines, etc.

Effective and efficient warehousing services can play a crucial role in improving public health, especially in ensuring availability of drugs and consumables at facilities. It is difficult to imagine a free flowing logistics and supply chain without a robust warehouse management system. Warehouses when properly managed and appropriately stocked, provide consistent supply of drugs and consumables and improved service to their customers leading to customer satisfaction and overcome critical challenges, such as increase in number of drugs and consumables or SKUs and fluctuating demand due to increase in demand or reduced lead time.

1 http://mospi.nic.in/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf

2 https://niti.gov.in/planningcommission.gov.in/docs/reports/genrep/rep_uhc0812.pdf

Challenges faced by public health can be addressed by adopting a professional approach to warehousing. Hence, it becomes critical for authorities and agencies handling supply chain management to have an overall plan for professional and reliable handling and storage facilities at warehouses. Strategically located, meticulously planned and scientifically operated drug warehouses in states like Rajasthan and Tamil Nadu have helped strengthen their supply chain management while providing quality drugs on a 'Free for all' basis.

However, in several states there is lack of comprehensive planning and scientifically designed drug warehousing, resulting in bottlenecks in supply chain management. No comprehensive guidelines for drug warehouses are available, often resulting in poorly and casually planned drug warehouses with inadequate and inappropriate infrastructure. Drugs and consumables are stored in state drug depots and district drug depots without essential requirements of warehousing. As a result, the following problems are faced by the states:

- Overstocking of drugs, consumables and other items
- Increased inventory carrying cost
- Frequent stock outs
- Deterioration, breakage and pilferage of drugs

Significant work has been done in the field of logistics, warehousing, inventory and supply chain management, both in private and public health. The two key milestones in public health are *'WHO Technical Report Series, No. 961, 2011'* and its subsequent supplements and Annexures and the 'DELIVER' project developed by the United States Agency for International Development (USAID), United Nations Children's Fund (UNICEF), and John Snow Inc. (JSI) in collaboration with the World Health Organization (WHO). In addition, there is the *'Procurement and operational manual for medical store organisation and Government store depot'* developed by the Director General of Health Services (DGHS), MoHFW, Government of India (GoI).

These are very reliable resources that have been referred to in these guidelines. But unfortunately, none of them meet the simple requirement of planning a District warehouse. The information provided in these documents is comprehensive but complex. Also, relevant information is scattered across several domains. Details of the inventory management system with information related to forecasting, indenting, tendering, procurement, inventory management and supply chain management are part of this planning process.

Against this backdrop, a set of comprehensive guidelines for drug warehouses have been developed by drawing relevant and useful information from the above and other resources *(See References*) and making them contextual by customising them as per needs and requirements of drug warehouses.

For ease of understanding, the Guidelines have been kept simple and jargon free. Complex technical terms have been avoided to the extent possible. These guidelines will support the states in designing, implementing and operationalising the drug warehouses and in finding solutions to warehousing challenges and requirements.

1.2 Scope of the Guidelines

- The scope of the document is limited to the 'Warehousing' component of the 'Supply Chain Management' system of public health facilities. These guidelines are not intended for procurement, distribution or inventory management.
- The focus of these guidelines pertains to a typical 'District Drug Warehouse.' This works as a transhipment warehouse that receives products in bulk from multiple suppliers; stores them for a period of time; and then breaks them down into suitably sized SKUs for onward delivery to lower level of health facilities.
- The guidelines are focused on planning, designing and commissioning new drug warehouses. However, they can also be used for upgrading existing warehouses and improving structural and operational efficiencies.
- The guidelines provide general advice and norms for planning, designing, and commissioning drug warehouse that may be adopted and customised by states and districts as per their needs and requirements.
- Scope of the guidelines is limited to warehouses for public health facilities.

1.3 Goals and Objectives of the Guidelines

- To help states in identifying their warehousing requirements.
- To provide guiding principles for planning and designing drug warehouses.
- To specify structural requirements of drug warehouses along with functional layout plans for operational efficiency.
- To provide guidance for special storage areas like Ice lined refrigerators (ILR) and Walk in coolers.
- To ensure equipment planning of warehouse with descriptions and specifications of the equipment required.
- To undertake human resource planning for the warehouse factoring in number and skills of personnel required to manage the drug warehouse.
- To specify requirements for ensuring safety and security at the drug warehouse.
- To guide in initiating operationalisation of drug warehouse and day to day management of warehouses.
- To provide general advice on the process of receiving, storing and issuing of drugs and consumables.
- To effectively build individual and organisational capacities and capabilities of those involved in the supply chain management system of the warehouse.
- To provide guidance on how to maintain complete and accurate records of the inventory (physical, buffer, on hand, distribution, contingency, temporary, in transit, expiry/near expiry drugs.
- Maintain adequate storage conditions, to ensure the inventory is in usable and/or serviceable condition when needed.
- Ensure the inventory is maintained according to the layout and storage plan and items are conveniently stocked.

A professional team must be commissioned to work with concerned authorities to develop a detailed site specific building brief with drawings, construction and tender documentation, and instructions for overseeing the construction and commissioning process.

1.4 Target Audience

This Guideline for warehousing drugs and consumables can be used by:

- Public health professionals and health managers.
- Authorities and agencies at the state and district level, who are responsible for 'Supply Chain Management' of drugs and consumables.
- Personnel and agencies who are responsible for designing and operations of the drug warehouse infrastructure.
- Nodal officers responsible for the 'Free Drugs Service Initiative' programme.
- Warehouse managers and other staff responsible for day to day operations of the warehouse.

The Guidelines will be handy for those at the institutional health facility level as well as the individual health care personnel level. They will be better placed to improve and increase efficiencies while implementing them in their new warehouse systems in an existing facility or redesigning their current system or if considering construction of a new drug warehouse.

Users can read the chapters in any order sourcing information in an accessible format to help make informed warehousing decisions.

2 Setting up of a Drug Warehouse

2.1 Overview

Drug warehousing is more demanding since it requires specialised understanding and handling to keep the drugs in the right condition. A drug warehouse is not just a space for storing drugs and consumables. It must be scientifically designed and meticulously planned to meet current and future requirements of receiving, storing, issuing drugs and consumables in a manner that makes the drugs available all the time to the health facilities. This calls for an efficiently designed receiving area, adequate storage areas with suitable conditions of temperature and humidity, and sufficient work space to assemble in advance, items that are being sent to the district warehouse or health facility. Carefully and well-planned warehouses go a long way in improving efficiency by reducing operational, transport and inventory carrying costs.

More time should be spent on planning each and every aspect of the drug warehouse. Usually, it has been seen that planning is often underestimated and far more attention is paid to the execution part. Ineffective planning often results in:

- Compromising space, security, efficiency and operability.
- Reworking, dismantling and rebuilding storage spaces.
- Inability to cope with future demands.
- Increase in cost.
- Delay in construction.

When State governments plan warehouses, several questions arise in the minds of planners as they consider building an effective, efficient, safe, and secure drug warehouse that meets all their storage requirements. Some of the key questions that need answering are:

- Number of drug warehouses required in a state?
- What should be the size of each warehouse?
- What is an ideal layout for a drug warehouse?

Number of drug warehouses required in a state

Learning from the success stories of Tamil Nadu and Rajasthan, one warehouse in each district seems most logical. In the absence of there being a central drug warehouse, suppliers deliver drugs and other products directly to the district warehouses. These are simple and practical and enhance operational efficiency while streamlining administrative control. However, states with small districts and good motorable road connectivity can have one drug warehouse for more than one district too.

A model with a central drug warehouse at the state level that receives products from suppliers and then transports them to district warehouses is not advocated. This adds one additional chain in the

logistics system and results in increase in lead time, transport cost, inventory carrying cost and greater chances of pilferage, deterioration and expiry of goods. It can also contribute to stock outs and a larger financial burden.

It is therefore important for the district to be the operational unit of the drug warehouse. Suppliers should directly deliver drugs and consumables to the district warehouse that is charged with distributing the same amongst facilities at the periphery level.

2.2 General Planning Considerations

Some of the key characteristics of a well planned warehouse that must be considered while building a drug warehouse are explained below.

Access to the warehouse: A warehouse must be easily accessible to all the health facilities and units that it serves. Preferably a warehouse should be built by itself on a separate plot of land to enhance security and reduce transport congestion. It should also have adequate road access for large transport movement.

The passage entryway and points must ensure movement of large and huge vehicles so that they can enter, move around and find suitable parking within the premises without trouble. Additionally, it is important to plan for a single point of entrance for the drug warehouse premises.

Trees: Plantation of shaded trees along the boundary wall will help reduce the internal warehouse temperature. Their conditions must be regularly checked. If there are any weak trees they must be trimmed and/or cut to avoid the falling of branches on the building. Ensure that the tree roots do not damage the warehouse building, now or later.

Warehouse boundary: The warehouse must have a boundary with plantation of large canopy trees to maintain the surrounding temperature. If snakes are known to be frequent visitors in the area, construct a snake proof fence around the perimetre of the facility. The fence should be made with a heavy, galvanised screen with a 6 mm wire mesh. The fence should be 90 cm tall with the lower end buried at least 10–16 cm in the ground. The above ground portion of the fence should be slanted at a 30° angle outward from the base and away from the building, using supporting stakes inside the fence.

Drainage: Build the warehouse on a raised foundation to allow rain water to drain away from its main structure. If possible, locate the warehouse on a higher ground that is not prone to flooding or drainage problems.

Doors: Plan the dimensions of the doors/metal shutters to ensure they are wide enough to allow free and easy movement and handling of products and equipment. Make sure the closing ends of rolling shutters meet the adjacent floor level to prevent entry of animals and insects inside the warehouse. Ensure doors are strong and reinforced for adequate security. It is important that the height and width of the door is adequate to accommodate pallet and pallet trucks.

Windows: To reduce the need for air conditioning, place windows high and wide enough for there to be ventilation. The height of the windows should be such that the shelves do not block them. Consider installing wire mesh and grating to keep out insects and to deter burglars. All window glasses should be laminated and adequate exhaust fans should be placed for air circulation.

Vents: The vents must be planned in accordance with the placement of the storage rocks. Storing racks should never obscure the vents or exhaust fans.

Flooring: In the warehouse planning for a ground floor slab is critical. This floor slab should meet the following criteria:

- Support applied loads without cracking or deforming.
- Have minimum number of exposed joints.
- Have maintenance free joints that do not impede movement of trucks and stackers.
- Be smooth and easy to clean, but not slippery.
- Be strong enough to handle loaded weight of stacker and its movement

Warehouse floors must meet stress and strength requirements, failing which they may fail because of pressure from loaded racks and heavy operating equipment. Following factors must be considered before deciding the floor:

- Floor surface, including surface material, depth of material, sub surface material, etc.
- Door openings, including surface material around loading/unloading dock doors, warehouse exit doors, etc.
- Loading dock and vehicle tailgate heights.
- Building column locations.
- Lift equipment aisle width requirements.
- Loading and floor stacking of material.
- Overall length of rack rows having possible effects on floor surface.

Having a concrete slab is a good option as it distributes the applied loads without deformation or cracking to the weaker subgrade below. Piles supporting the slabs can be designed as suspended ground slabs.

Roof & ceiling: Consider the slope of the roof and placement of roof support column, and its impact on height clearance for rack configuration and other warehouse operations. Avoid using non insulated galvanised steel metal sheeting for the roofing because it gets ultra heated. If the above situation is unavoidable, then create as much airflow as possible by using ventilation fans and tiered roof sections.

For optimal use of space and protection from heat, the best choice would be to have a building without an internal ceiling. Insulated roofing panels are highly recommended like with galvanised steel sheeting with a polyurethane insulation, which is available in 40 millimetre (mm)–100 mm widths. For their best performance these should have a reflective powder coated white paint or light grey. This is more efficient than an internal ceiling because it blocks the heat before it can enter any part of the building.

Suggested height of the drug warehouse and racks

S. No.	Room height of the warehouse (ft.)	Height of the rack (ft.)
1.	11	8
2.	17	14

Illumination

- Plan the warehouse with as much natural light (indirect sunlight) during the day, as possible. Florescent lighting emits ultraviolet rays, which can decrease potency of photo sensitive drugs.
- Incandescent bulbs emit heat. At the same time, ensure that the products themselves are not in direct sunlight. Solar panels for lights in premises could be an option for security at night.
- Placement of lights and fans must be planned in advance, keeping in mind the configuration of racks. Ceiling lights and ceiling fans are to be planned in between the racks, not just over the racks. Wall mounted lights are not preferred as they are obstructed by racks and stored goods.
- Likewise, air vents and exhaust fans are also placed in between the racks.

Power supply and back-up

- Install a diesel/ solar panel generator for uninterrupted alternative supply of electricity for cool rooms and refrigerators.
- If the generator is not solar powered, maintain a stock of fuel to run the generator for at least a few days. Run the generator regularly, at least once a month to ensure the system is working properly.
- It is advisable to maintain a three phase electric current supply to prevent overloading.
- Separate power plugs must be planned for and the power supply for AC, ILR, DF, water cooler, photocopier etc.
- Instal fire extinguisher at the sub station and where there are MCB boxes, generator sets and other areas that are prone to short circuits or fire.
- While designing, keep in mind (where applicable) that the lift door width is compatible with the width of the forks of pallet truck.

Linkage with a common biomedical waste treatment facility: This is an extremely critical aspect that must be taken care of while planning a drug warehouse. Whether for disposing of expired drugs or any other discarding of waste having a link with a common biomedical waste treatment facility will prevent any contamination, outbreak or release of noxious substances.

Signages

Critical signages must be placed at the:

1. Parking area
2. "No parking" in front of the gate
3. No smoking area
4. You are under CCTV surveillance
5. Office
6. WIC/ILR/Deep Freezer
7. Toilet
8. Quarantine area
9. Walk-in-cooler
10. Not of standard quality area
11. IV fluids area
12. Inwards
13. Outwards
14. Drinking water
15. Cool storage area
16. Dispensing area.
17. Certificates if any (ISO/OSHA etc)
18. Rack numbers

19. Products name stickers
20. Bilingual signages in local language and English
21. On the way signages
22. Safety hazards, caution and hazards signs at relevant places e.g., electric panels
23. Fire-exit signages in fluorescent colours
24. Complaint/Suggestion boxes along with details of the officer responsible for redressal of complaints

2.3 Selecting the Site for the Drug Warehouse

Key factors to be considered while selecting a site for a drug warehouse are:

Estimate size of the drug warehouse: It is essential to have a preliminary estimate of the size of the building of the warehouse before acquiring any site (as explained in section, "Estimating the size of a Drug Warehouse"). Compact layout with square or rectangular shape should be preferred.

Choose a secure site: Bear in vulnerability of a warehouse to criminal activity since valuable products are stored here. Security measures should be borne in mind while building the warehouse, or else later they would need to be installed at higher cost. Ask questions like;

- Is the site in a high or low crime area relative to general levels of crime in the wider location?
- Will employees be able to reach the site safely?
- Will vehicles entering or leaving the site be at risk of hijacking?
- Is there a police station in the vicinity and what response time can be anticipated in the event of a crime?
- Is there a fire station in the neighbourhood and what response time can be anticipated in the event of a fire breaking out?
- Can the site perimetre be adequately secured?
- Can access to the site be controlled?

Choose a 'future-proof' site: Wherever possible, the warehouse site chosen should provide space for future expansion and have direct access to a well maintained free flowing road network. Access to rail connections and nearby air or sea ports may also be necessary.

Ensure labour availability: Labour that is both skilled as well as unskilled should be readily available in and around the warehouse.

Assess weather and climate-related risks and natural hazards: The warehouse building should not be exposed to the risk of flooding. Warehouses should not be built on a flood plain or close to a coastline that is susceptible to inundation during storm surges. If no alternative site is available, the floor of the warehouse must be raised well above the predicted 100 year flood line, or the site must be fully protected by flood defences such as bunding or drainage swales and increase the flood risk outside the protected site.

Warehouses should be constructed on a site where there is minimum chance of damage owing to direct wind and rain, lightning strikes and flying debris and falling trees during high winds and tornadoes. In hilly or mountainous areas special care must be taken to protect the warehouse from rainfall induced landslides and avalanches.

Other natural hazards such as earthquakes, volcanic eruptions and tidal waves must be factored in the overall construction and planning. Locations that are close to known risks of this type must be avoided.

Assess fire hazards: Establish whether there are significant fire hazards in the immediate vicinity such as fire prone bush land, industrial facilities or informal settlements. Determine the location and likely response time of the local fire brigade and establish whether the site has access to an adequate year-round supply of water for fire fighting and/or operating a sprinkler based fire suppression system.

Ground conditions and pollution hazards: It is prudent to dig trial holes and obtain a structural engineer's report before committing to the purchase or use of any site. Ground conditions significantly affect building costs. Things to avoid while building a warehouse:

- Poor ground surface on account of landfills, shrinkable clay or expansive soils (black cotton soil).
- Permanently frozen ground (permafrost).
- Location in a mining area due to risk of settlement as a result of tunnel collapse and general ground movement.
- On brownfield sites, previously used for industrial purposes since there could be a risk of the ground containing hazardous materials, including chemical pollutants and other toxic substances.
- Natural seepage of radioactive radon (associated with uranium ores; phosphate rock; shales; igneous and metamorphic rocks such as granite, gneiss, and schist) poses a health hazard in some geological areas because the gas can migrate through ground floor structures and accumulate inside poorly ventilated buildings.
- Ground conditions will affect the cost and effectiveness of rainwater disposal and foul water drainage. If there is no main drainage and the ground is rocky, saturated or impermeable, septic tanks with soakaways will not be effective and other solutions will have to be found.
- Should be relatively free of termite, rodents, and wild animals.

Conduct a site survey: An accurate site survey needs to be carried out and a site plan drawn up. The survey should include adequate number of spot levels to establish site contours and include location of all existing buildings and identifiable above and below ground services and other features. This work must be completed before the design team can prepare accurate cost estimates and detailed building and site work drawings. A level survey is particularly important for a large warehouse development because significant falls across the site will affect the design of ground works and layout of access roadways.

Carry out well planned building surveys: If the site has existing buildings that are to be demolished, the cost of demolition works should be assessed. If any buildings on the site are to be retained for immediate use, or refurbished, adapted or extended, it is essential that they are included in the survey process. Each building should be physically measured and the survey team should draw up plans, sections and elevations. In addition, there should be a full condition survey which includes a structural assessment by a qualified structural engineer and assessment of the mechanical and electrical services by a qualified mechanical and electrical services engineer. Checks should be carried out to determine the presence of hazardous materials, such as asbestos.

Service connections to the site: A warehouse site will need adequate electricity, water supply, telephone and Internet services, piped gas and sewer connection. The capacity of all these connections and services needs to be enough to support the proposed building, including any future expansion.

2.4 Environment Friendly Green Drug Warehouse

Temperature controlled warehouses are potentially energy intensive because they incorporate energy hungry refrigeration and ventilation systems. However, careful design can greatly reduce energy consumption and it is possible to design these buildings so that they are net zero energy. In other words, they generate as much energy as they consume from an ambient energy source such as passive heating and cooling, roof mounted photovoltaic panels or other renewable energy sources. In addition, careful choice of locally available construction materials can further reduce the whole life environmental impact of the project.

Some sites offer the potential for on site energy generation using renewable technologies. Photovoltaic panels or solar thermal water heaters can be installed on sites with good sunlight. Ensure that the panels are not shaded by surrounding buildings or trees. If there is a suitable river or stream nearby, a small scale hydro power project may be considered. Rural sites with reliable wind may be suitable for wind turbines.

Sustainable ideas for warehouse designs can be implemented through eco design practices, some of which are listed below:

- Increasing the air tightness in the buildings to reduce heat loss.
- Establishing kinetic plates in the gateway to recover energy when vehicles arrive and leave the warehouse.
- Using biomass energy to supply for lighting and heating purpose. Recovering and managing rainwater by an innovative roof design.
- Using sleep mode conveyor system, solar hot water, high efficiency lights.
- Building the warehouse under 2.5 metres into the ground. Having an insulation and ground temperature effect to help maintain enough temperature without any heating/cooling system.
- Installing photovoltaic panels to generate energy.
- Lighting and electrical appliances as well as water appliances in the facility to be energy efficient through fans, LED lights, air conditioners, TV, geysers, pumps etc each of which have a Bureau of Energy Efficiency (BEE) rating of 3 star and above.
- Using eco friendly refrigerants.
- Installing halon free fire extinguishers.
- Saving energy by switching off energy consuming equipment (lights, fans, ACs etc) when not in use.
- Having an entryway system with metallic doormats that can capture dirt and particulates brought in from outside.

It is also recommended for the drug warehouse to adopt the 3R concept of Reduce, Reuse and Recycle. Few additional initiatives that can be taken up are listed below:

- Use photocopiers and printers in the facility to print on both sides.
- Reduce use of non food service paper products such as paper towels and napkins.
- Promote paperless or paper free offices where use of paper is eliminated or greatly reduced by converting documents and other papers into digital form.
- Use eco friendly stationary such as pencils, jute files, folder, cartridge etc.

Note: *If the site is located in an area of high biodiversity, careful consideration should be given to the impact which the development will have on its overall habitat and surroundings.*

2.5 Estimating Size of the Drug Warehouse

There are no universally accepted norms for calculating the size of a drug warehouse. A 'one size does not fit all' holds true as far as estimating the size of a warehouse is concerned. The overall size of a warehouse depends on two main factors:

- Total number and types of health care facilities to be catered by the warehouse.
- Total numbers and types of drugs/products to be stored in the warehouse.

Characteristics of the health care facilities catered by a drug warehouse

- Estimating the total number of health care facilities to be catered by the drug warehouse.
- Type of health care facilities to be catered by the drug warehouse viz. Medical College, District Hospitals (DH), Sub divisional Hospital (SDH), Community Health Centre (CHC), Primary Health Centres (PHC), and Health Sub Centres including Health and Wellness Centres (HWC).
- Size of each facility i.e., number of hospital beds and population.
- Utilisation of each facility i.e., average daily out patient department (OPD), bed occupancy rate, average length of stay etc.

Characteristics of the 'drugs/products to be stored' in a drug warehouse

- Total number of products (Drugs/Consumables etc) to be stored.
  i. AYUSH drugs to be stored or not?
  ii. Veterinary drugs to be stored or not?
  iii. Vaccines to be stored or not?
  iv. Drugs for National health programmes supplied from centre to be stored or not?
  v. Other products like consumables, stationary, equipment, linen etc to be stored or not?
  vi. Total number of drugs in Essential Medicine List (EML) of the state.
- Annual consumption of each product to be stored in the warehouse.
- Package size of each product.
- Volume of products flowing in and out of the warehouse.
- Inventory management system to be followed.
- At what temperature products to be stored (room, cool, cold or fridge)?
- Levels of safety and security required (e.g., normal security, controlled or hazardous)?
- How to manage near expiry/expired products?
- What type of transport required?
- Lead time.
- Buffer stock.

General norms for establishing the size of the district warehouse[3]

- For a country like India, size of a district drug warehouse may vary from 8,000 to 20,000 sqft. A warehouse of less than 8,000 sqft is not economically viable and a warehouse of more than 20,000 sqft is not feasible to operate.
- A general basic norm of 120–150 sqft per health care facility catered may be followed.
- For operational efficiency and economic viability, it is advised that a warehouse should cater to at least 50 health care facilities with a size of around 8,000 sqft.

Earmarking areas for the drug warehouse

A drug warehouse can broadly be differentiated into three major areas based on their functionality.

Drug storage area: It constitutes approximately 64% to 73% of the total warehouse area and comprises of the following sub areas:

S. No	Drug storage area	Area in %
1.	Active drug storage area	**33–35%**
2.	Quarantine area	**10–12%**
3.	Cool storage area	**8–10%**
4.	NOSQ (Not of standard quality)/expired area	**3.5–4.5%**
5.	WIC (walk in cooler)	**4.5-5%**
6.	Counting/packing/loading/dispatching/outgoing area (with a built platform of height 42 inches)	**3.5-4%**
7.	Unloading/receiving/incoming area (with a built platform of height 42 inches)	**1.5–2.5%**
Total area section- A		**64–73%**

*** Special intravenous fluid area (IVF area) may be designated for IV fluids as there are many complaints of fungus in bottles which is more of a storage problem than a quality issue, stacking more than advised number of cartons (usually 8 but it depends upon compressibility strength of carton as suggested by the manufacturer) or keeping the carton upside down to avoid leak/ crack which leads to fungus growth. The arrangements of racks may be such that more than 8 cartons cannot be placed (adjust horizontal bars of racks). This area in summer may be used for IV fluids and in winters for high consumption drugs like cough syrups etc.*

**** For the storage of portion of drug samples, a separate storage area may be delegated (as per requirement of the respective states), as collected samples may need to be kept for longer period till receipt of test report.*

3 The norms discussed are general approximates. Factors discussed in the preceding section may be considered in finalising the size of a warehouse.

Support and Ancillary Area: It constitute approximately 11% to 14% of total warehouse area with the following sub areas.

S. No.	Support and ancillary area	Area in %
1	Office/ administrative area	**4–5%**
2.	Manager room + toilet	**2.5–3%**
3.	Meeting room/dining/pantry	**1.5–2%**
4.	Record keeping area	**1–1.5%**
5.	Toilet area separate (staff male and female)	**1%**
Total support and ancillary area		**11–14%**

Circulation area: This constitutes approximately 18–20% of the total warehouse area that needs space for corridors, stairs, ramps and lifts.

Important: *Details of different areas of warehouse in % as well as square feet for small, medium and large drug warehouses are placed as Annexure-I)*

2.6 Estimating 'Net storage capacity' of a Drug Warehouse

The net storage capacity of a drug warehouse is a very critical part of the planning process. Based on these goods are allowed in and then placed as per a logical system.

Collect data related to products (size, volume, weight) to be stored in the warehouse: Demand for drugs and consumables is not predictable like vaccines. Hence, it is suggested to focus on collecting information of medicines that are high in demand ("A" category of items from ABC analysis which comprises 80% of throughput). Quantification and forecasting are the words used interchangeably. Generally, two methods are used for quantification and these are explained below.

***Consumption method*:** Uses the record of past consumption of individual medicines (adjusted for stock outs and projected changes in medicine use) to project future need.

***Morbidity method*:** Estimates the need for specific medicines based on the expected number of attendances, incidence of common disease and standard treatment pattern for the disease considered.

Each quantification methodology can only calculate physical unit and number of doses but fails to give information on physical characteristic of individual medicines (packing, dimensions and weight) which plays a role in logistics planning. For example, each state/UT has its own Essential List of medicines for procurement with different standard specifications for manufacturing. Same medicines will have different packaging, dimension and weight at different states/ UTs as per their respective set "Rate contract". The International Federation of Red Cross (IFRC) catalogue lists shipping weights and volumes for many products. *(http://procurement.ifrc.org/catalogue/detail.aspx?productcode=DORAACSA)*

In the absence of any reliable database of product, volume and weights, one can use available resources like data collected locally from onsite measurement and shipping documentation supplied by agencies, manufacturers and distributors.

Application of Volume Data and types of SKUs

For application of volumetric data, it is important to understand types of SKUs to be stored in the warehouse. Medicines and temperature sensitive products have four level of SKUs, that assist in warehouse sizing, namely:

- **Primary packaging**: Medicines come into direct contact with this packaging, which preserve the medicines.
- **Secondary packaging**: Primary packaging is packed by secondary packaging, which makes the handling of the product convenient.
- **Tertiary packaging**: Secondary packaging is packed by tertiary, which helps in handling during transportation.
- **Insulated packaging**: When vaccines are shipped by air, they are packed with coolant in insulated shipping cartons. Sometimes vaccines at the central warehouse are stored in these containers. The thickness of the insulation and the space occupied by coolant means that the volume per dose for this SKU type can be several times greater than the products listed volume per dose in a secondary carton SKU.

While calculating net volume, doubly ensure the correctness of data related to dimensions of the packages and their weights. Larger SKU with greater unit volumes to be stored at higher level warehouses. The SKU dimensions and unit volumes would be considerably smaller at peripheral facilities.

Estimating Maximum Inventory Size

Keep margins for fluctuations in demand and supply of an individual product. Also keep in mind the future programme expansion plans. Keep adequate allowances for new product lines. For calculating maximum net inventory volumes, the following formula is used:

$$\mathbf{IV_{max} = (AD \times 1/R_f \times (100+SS)/100 \times V_{unit})/U}$$

IV_{max} = Maximum inventory volume for the specific product line.

AD = Annual demand is the estimated number of units of the product required per year obtained from historical data.

R_f = Reorder frequency is the number of times that the product is scheduled to be received by a store/ facility in one year.

SS = Safety stock percent allows stores to be sized to allow for an appropriate reserve stock that varies from product to product depending upon its ABC or VED classification.

V_{unit} = Volume per unit is measured at the level of the type of SKU applicable to the store (primary container, carton, pallet or other SKU) and may be expressed in cm^3 (divisor = 1,000,000), litres (divisor = 1,000) or m^3 (divisor = 1).

U = Volume conversion unit is a divisor that is needed to convert the result into cubic metres.

Calculating net storage requirements: Using the formulae mentioned above, maximum inventory volume for each product line may be calculated. Unfortunately, this figure provides no information related to where the products are to be stored in the warehouse or how much space is required for storage. Hence, it is necessary to classify each product by storage temperature and security required. After that it is important to establish the most suitable type of load support system within each storage zone.

Classification of products based on their temperature and security requirement: Table 1 is a matrix of security and temperature requirements of a particular product. Spaces are allocated to products that require a 'normal' level of security. Controlled products such as narcotics or poisons (high illicit value/ dangerous), and hazardous products (inflammable, explosive or radioactive) may need an explosion proof refrigerator or room with an explosion hatch and one that is both 'controlled' and 'hazardous.

Table 1: Classification of products based on temperature and security requirement

Temperature	Normal security	Controlled	Hazardous	Controlled and Hazardous
Uncontrolled ambient				
+15.0 C to +25.0 C				
+8.0 C to +15.0 C				
+2.0 C to +8.0 C				
-2.0 to -15.0 C				
-15.0 C to -25.0 C				

Shelves and load support system for storage of medicines: Five types of load support systems are used to increase the efficiency of storage and picking.

- Shelves that can open and close
- Floor pallet
- Multi level racking system
- Secured cupboards for narcotics and hazardous materials
- Flow racking

The utilisation factor: Determined by its length, width, and height, each storage unit (shelf, drawer, shelving bay, pallet racking bay etc) in the warehouse has its gross storage capacity measure inside the cabinet, between the shelves or racking support and the like. This volume can be fully occupied only in extremely rare circumstances. In practice the available volume has to be modified using 'utilising factor' which is always less than one. The thumb rule is only half or two third of the gross shelving capacity can be occupied by products with utilisation factor between 0.5 and 0.65. Factors influencing the value of 'Utilisation factor' are:

Storage Method (Fixed or Fluid): In fixed method each SKU is always stored at a specific place. In fluid storage system, any SKU is assigned to any free location. It is possible to have both fixed and fluid systems operating in a warehouse simultaneously. Most bulk supplies are to be stored on pallets and loose items on shelves. A fixed location system is used for items stored on shelves while a fluid location system is used for pallets stored on pallet racks.

Table 2: Storage method by commodity type

Type of commodity	Storage method	Example types
Low inventory items stored and issued in smaller packs	Fixed (entire stock kept on shelves)	Specialised medicines
Bulky items stored and issued in complete pallets	Fluid (entire stock kept on pallets)	Equipment
Items contained in large cartons stored on pallets but issued in smaller packs	Fixed (stock to be issued kept on shelves) and fluid (bulk stock kept on pallets)	Essential drugs that are issued by bottles or small packs; condoms

Dimensional compatibility: This is determined with the way in which the product fits the available storage space. For example, a carton that is 25 cm high will make poor use of a shelving bay if the shelves are fixed at 50 cm apart.

Ventilation around the product: This is an important aspect that must be ensured, more so in cool rooms requiring good air flow so that there is even distribution of temperature.

Calculation of Pallet Bay: The volume of product that can be stacked on a pallet depends on the size of the pallet. On this basis, the following formula can be used to estimate the number of pallet bays required for each of the product lines.

$$\mathbf{N_{pallet} = IV_{max} / V_{pallet}}$$

Where:

N_{pallet} =Number of pallets required to store the product line.

IV_{max} =Maximum inventory volume for product line, in cubic metres.

V_{pallet} =Average volume of product per pallet, in cubic metres.

Calculation of shelving units: There are two formulae that can be used to calculate length of the shelving unit (metres) to store a net volume of product, expressed in cubic metres. The first formula is used where ceiling height is restricted (assumes a clearance of 10 cm between the top of the load and ceiling for air circulation).

$$\mathbf{L_{shelf} = IV_{max} / (H_{room} - (b + (n \times t) + 0.1)) \times w \times UF}$$

The second formula is used where ceiling height is not restricted (height of the load placed on the top shelf is assumed to be 40 cms) this figure can be changed.

$$\mathbf{L_{shelf} = IV_{max} / (H_{unit} + 0.4 - (b + (n \times t))) \times w \times UF}$$

Where,

$\mathbf{L_{shelf}}$ = Length of shelving unit required to store the product line, in metres.

$\mathbf{I_{Vmax}}$ = Maximum inventory volume for the product to be stored, in m^3

$\mathbf{H_{room}}$ = Room height, in metres.

$\mathbf{H_{unit}}$ = Height of shelving unit from floor to top shelf, in metres.

b = Height of undesired of bottom shelf from floor, in metres.

n = Number of shelves.

t = Shelf thickness, in metres.

w = Shelf width, in metres.

UF = Utilisation factor (from 0.5 to 0.65).

For ease of calculation and planning, it is advised that the dimensions of the shelving units are standardised across the state with a known storage capacity.

3 Design and Layout of the Drug Warehouse

3.1 Importance of Design and Layout

The most crucial aspect in establishing a warehouse relates to the utilisation of space. How health commodities are stored and work processes planned, profoundly affect the effectiveness of the staff and their capacity to improve administration conveyance. Layout planning is the discipline of assessing space requirements of a warehouse or other storage facility and specifying how that space should be organised to facilitate identifiable warehouse activities. Layout planning is required to ensure the following:

- Efficient usage of space.
- Increase efficiency of handling health commodities.
- Impart economical storage.
- Provide long term flexibility to accommodate new product lines; and implement new warehouse technologies and other warehousing requirements

The three essential steps in planning the layout of a drug warehouse relates to:

- Identifying activities that need to be carried out in the warehouse.
- Identifying requirements for the space and ideal layout for each activity.
- Building a realistic layout by accommodating space necessities with existing limitations.

Activities carried out in a drug warehouse: In a typical Drug Warehouse, operations include the following key activities:

- Receiving products in bulk from multiple suppliers.
- Storing them for a period of time and then breaking them down in suitably sized SKUs.
- Supplying onward and delivery to lower level stores or health facilities.

The Receiving and Supplying (Dispatching) activities take place in the same general area or dedicated separate areas inside the warehouse. The Receiving process includes accepting health commodities from suppliers and assembling these commodities for storage in the warehouse. The Supply/ dispatching process entails the preparation of health commodities for shipment on request of officials and placement of the same on vehicles and delivered to customers. Further, storing/retrieval are activities associated with storage of health commodities in the warehouse (on pallets, shelves and/or racks).

Storing is the process of shifting health commodities from the receiving area to pre defined locations within the warehouse (either on the pallet, shelf, or rack), until they are ready to be dispatched from the warehouse. Retrieval relates to shifting of health commodities from one or more allotted locations, such as the pallets, shelves, or racks and moving them to the shipping area where they can be further processed for shipment to customers.

It is important for the layout planning to include a plan for storing damaged stocks and those that entail spillage, pilferage, sub standard quality and expired/near expiry commodities which are separate from fresh stock. The unusable stock must then be shifted to a predefined location within the warehouse where it can remain until it can be evaluated and removed for proper disposal.

At the point when a layout plan is being developed, the storage of expired/Not of standard quality/ unusable commodities is regularly overlooked. Yet it might be similarly as significant as receiving/ shipping and storing/picking. In warehouses, space must also be allocated for in house administration activities: e.g., reception, administrative work including space to conduct meeting, procurement, and others.

3.2 Basic Layouts of a Drug Warehouse

Depending upon the requirements there are two primary layout options, namely the "U" flow and the "through" flow.

'U' flow warehouse layout: Health commodities receipt and dispatch areas are situated on a similar side of the structural building. Commodities are staged in accordance as per their ABC analysis, with easy accessibility of the most demanding items closest to the shipping area.

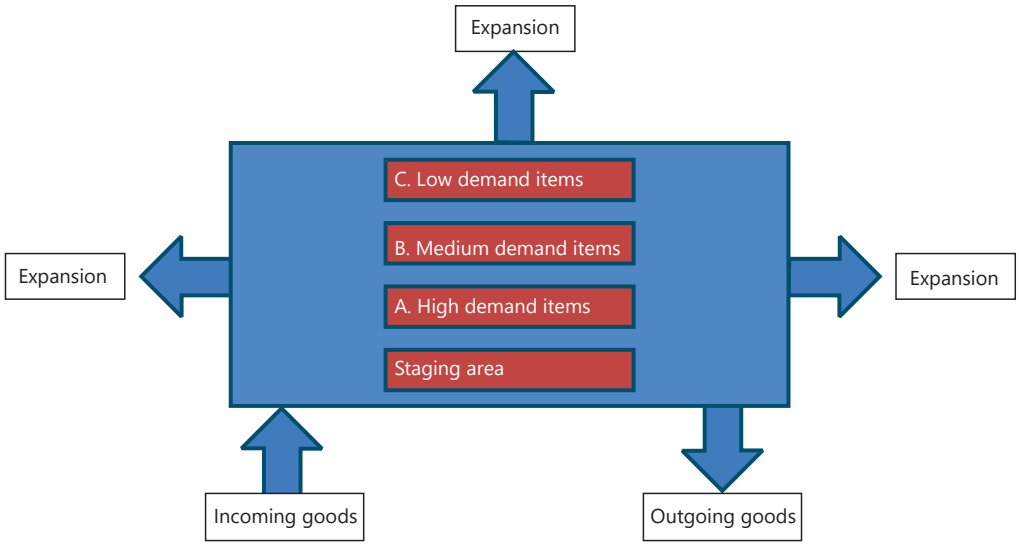


Figure 1: U-flow layout of drug warehouse

Advantages of 'U' flow layout

- Effective utilisation of resources with receiving and shipping activities taking place in the same dock area.
- Ease in cross docking because receiving and shipping areas share the same platform and can be blended together.
- Facilitate security because only one side of the building is used for both entry and exit.
- Allow scope of expansion in three directions.

Disadvantages of 'U' flow layout

One major disadvantage of the 'U' flow arrangement is that there is increase in traffic of incoming and outgoing items during peak hours of the day. And if there is poor attendance, the risk of mixing and errors in despatch of items of inflow increase.

'**Through' flow warehouse layout:** The receipt and dispatch areas for health commodities are located on opposite sides of the warehouse building. Location of high demand items are stored along the central axis as shown in Fig. 2. The advantage of this layout is that there is less risk of congestion at the dock during peak hours of the day. However, security is a significant area of concern because of separate entry and exit. This will require two security gates and two access roads. Also, the areas of horizontal expansion are restricted to two only.

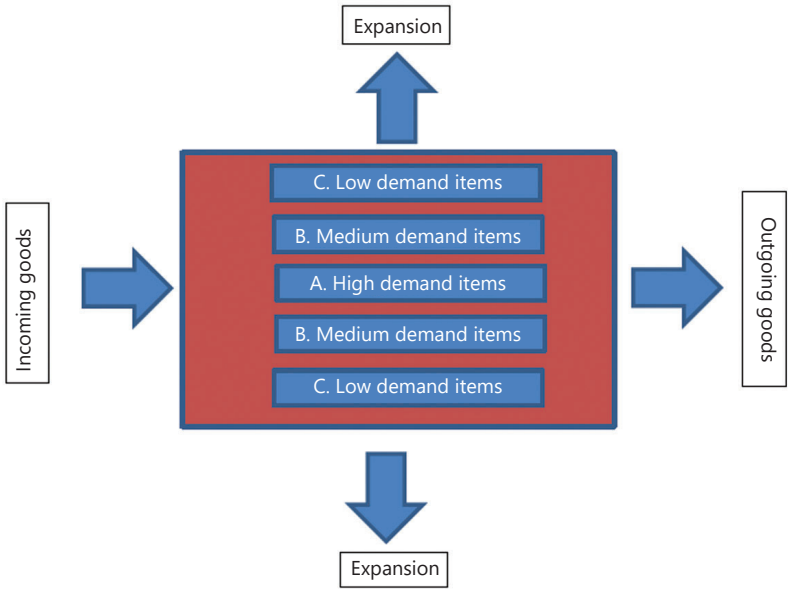


Figure 2: 'Through-flow' layout of drug warehouse

3.3 Truck Docking Requirements and Loading Docks

Space requirement for the docking truck depends on the angle they make with the dock. When the docking angle is 900, no space is required. The space requirement is proportional to the angle of delivery. If the angle is 450, the amount of space required for each docking space is a triangular space is approximately 4.25 metres (at entrance to warehouse) x 3 metres x 3 metres.

The loading dock floor should be at ground level and may be raised to the height of a standard delivery vehicle (usually 42 inches), or there may be a height adjustable mechanism to accommodate vehicles of different sizes. Vehicles should preferably be coupled to the building by a dock seal and must allow the closing off of the opening when no vehicle is in place. This arrangement is essential where vehicles are coupled to a temperature controlled loading bay/ holding area.

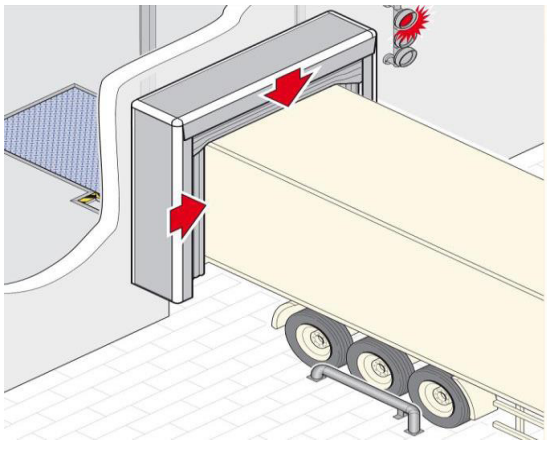


Figure 3: Dock seal

Source: http://www.hormann.co.uk

3.4 Manoeuvring Requirements

The space required to exit and enter the truck and to move products between the truck and shipment area depends on availability of the levelling device which lowers or raises the floor of the warehouse. If levelling devices are used, each device will require an area approximately 3 metres deep × 3 metres wide. If manual material handling equipment is used, an area 2.5 metres deep by the width of the designated receiving/ shipping area is required.

Note: *Area required for dispatching: An area of 2.5 metres × 3.5 metres is usually required.*

Packing Area or Order Assembly Area

Drugs, consumables and other products should be packed or be close to their labelled temperature. The packing area may be separated from the staging area, or be part of it depending on product type and its packaging.

If refrigerated trucks are used and products are packed in uninsulated containers, the holding area must be contiguous with the loading dock and kept at, or be close to, the labelled temperature of the product until the truck is loaded.

Quarantine Area

The Quarantine area is situated next to the loading dock. It is the zone where incoming and outgoing goods are held for despatch or temporarily stored in preparation for putting away into stock, or for moving returned or counterfeit products into quarantine. The temperature of the staging area should reflect the type of goods held and the way these goods are packed.

Three methods are used for estimating space requirement for staging:

- **Complete data estimation method:** When there is complete data on shipment received and shipment issued. The information includes date of receipt/issue; identity of commodities received/ issued; volume (width × length × height) of the packaging used (e.g., carton, bundle, wooden crate); contents of each package (items per package); and number of packages in the shipment. The next step would be to be gather all shipment lists for past few years. Identify the date on which the warehouse received largest shipment/s and thereafter issued the largest shipment/s, based on volume. Use a combination of largest receipt(s) and issue(s) to simulate largest surge the warehouse can expect. Calculate the total volume in cubic metre of the receipts/issues expected during the surge period. Estimate the number of pallets required to hold commodities, simultaneously, in staging area. The number of pallets must be equal to number of cubic metres, because each pallet typically holds about one cubic metre of goods.
- **Data-less methodology:** Thumb rule is to take up at least 10% of the warehouse's total space for staging area but never more than 40%. For district warehouses, an area of 10–12% is sufficient. It is important to maintain at all times an aisle space between the shipment and receiving staging area. The width of this aisle may be about 2.5 metres if manual material handling equipment is used and 3.5 metres if motorised material handling equipment is used.
- **Other areas**
  - Storage for empty pallets. An area of 2.5 metres × 1.25 metres is usually required.
  - Designated and locked area for holding Not of Standard Quality (NOSQ)/counterfeit/expired and returned products.

- A sampling area and secure zone is earmarked for keeping dangerous goods and controlled drugs; e.g., narcotic and psychotropic drugs.
- If explosive substances are stored, these should be in a separate explosion proof area fitted with an explosion hatch.

3.5 Special Temperature Zones

The size and layout of temperature zones within the warehouse will be determined by the storage temperature of the products to be stored, volume of goods in each of these categories and SKU for each product type.

Temperature-controlled storage areas

Cool storage area: Storage area of a warehouse where temperature is consistently maintained within a pre defined temperature range (usually between +8°C to +25°C) is called 'cool storage area. It constitutes 10–12% of the warehouse area.

Walk in cooler rooms (WIC): Cold rooms and freezer rooms are usually constructed using pre-fabricated insulated panels. These rooms should have 100% standby capacity in the event of a refrigeration unit failure. The room enclosure must be arranged in such a manner that both wall panels and roof panels can be accessed for maintenance. In India, ready to install, WICs are available in sizes of 28 and 32 cubic metres. For an average district warehouse, a 32 cubic metre size is sufficient while for smaller districts, a 28 cubic feet size may be considered. A space of 650–700 sqft constituting 4.5% to 5.0% of total floor area may be allocated for WIC. For the district drug warehouse, adjustable shelving is advocated as the load support system. In this layout, there is an area in the centre of the room for temporary storage of overspill products.

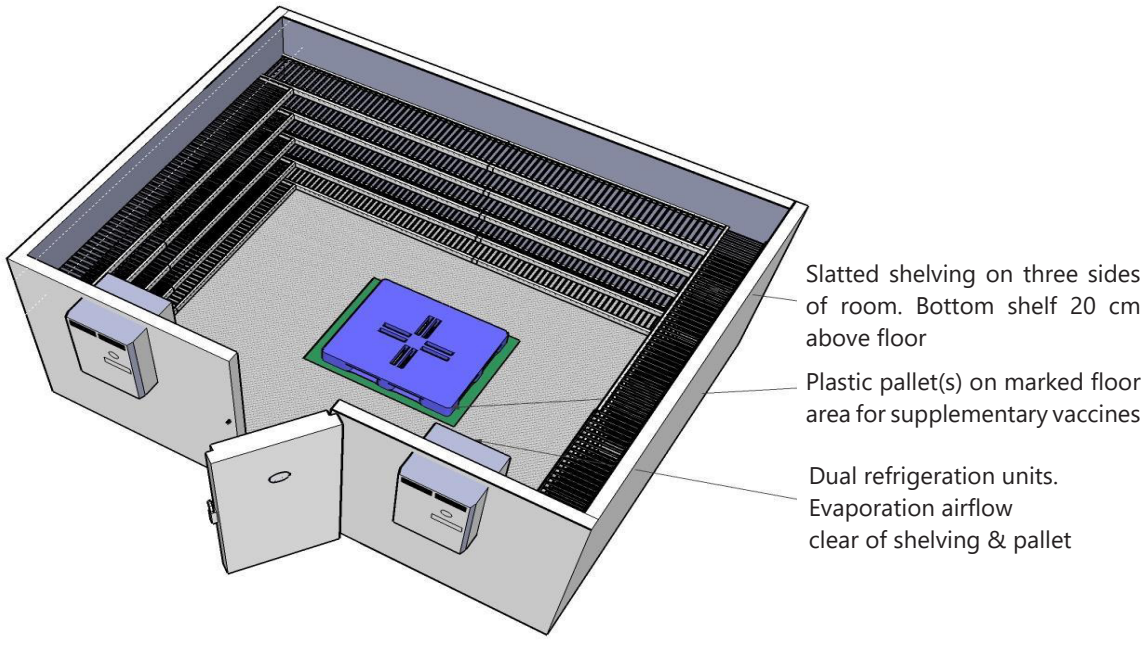


Figure 4: Walk-in cooler room

The diagram shows dual 'monobloc' refrigeration units. Monobloc units are easy to install but discharge waste heat from the condenser into the general warehouse space. In a country like India which has hot climate, a better arrangement is to have a 'split' system with the condenser unit located outside the building.

WICs have a floor made out of insulated panels. These are strong enough to take foot traffic or light trolleys but are unsuitable for heavy mechanical handling equipment. In the case of a freezer room, install a heater mat below or within the floor panels to prevent sub-zero temperatures propagating through the main floor of the building and freezing the sub soil.

Temperature and humidity monitoring and management: All freezer rooms, cold, cool rooms and temperature controlled storage, packing and staging areas must be equipped with continuous temperature and humidity monitoring equipment (e.g., wall hanging digital thermometer, digital hygrometer thermometer). It is also recommended that a centralised data logger system be installed to monitor temperature from a centralised location.

All these areas should be qualified and temperature mapped. Initial mapping should be carried out in both the hot and cold seasons. Mapping should be repeated at regular intervals and after any significant modification to the building. It should also be done for the stock layout, the heating and cooling systems.

3.6 Working Environment and Ergonomics

A good working environment promotes safe working and reduces stress levels for both staff and patients. Important points to bear in mind:

- Provide good quality lighting.
- Keep the working environment at a comfortable temperature, below +25°C, and at a comfortable humidity level.
- Ensure that work surfaces, shelving and computer workstations are designed to minimise fatigue.
- Go for grey or cream coloured finishes that are preferred.

3.7 Realistic Layout Reconciling Space Requirements and Constraints

In warehouse planning, the amount of space available and how the space is arranged is critical to creating an effective warehouse. Constraints including shortage of space and space management add to the challenges. In such cases there the following ways can help overcome constraints:

- **Seeking alternative storage systems**: When the warehouse is not able to accommodate the ideal layout because of size limitation, the situation can be managed in several ways without installing a new racking system. Some suggestions:
  - Change desired inventory level by reducing buffer stock or reschedule supplier's deliveries.
  - Eliminate unnecessary aisle space by eliminating some or all of the cross aisle.
  - Reduce space allocated for receiving and shipping. Although, ideal, but lighter pallets can be stored on heavier pallets.
  - Use different material handling equipment with less turning radius. An electric lift truck (sit down) requires more space to manoeuvre as compared to electric lift truck (stand up).
- **ABC methodology**: In a warehouse about 75% throughput is attributable to 15% items (often called Category A items) while another 15% of throughput is attributable to 15% of items (often called Category B items), and the remaining 10% of throughput is attributable to 70% of items (often called Category C items).

Note: *Category A items should be located in an area of the warehouse which has the most productive material handling and is as close as possible to the staging area. Category C items are to be stored in the back of the store.*

Similarity methodology: Items that are commonly shipped together should be stored near each other. For instance, for family planning programmes, T contraceptives may need to be stored in a similar location within the warehouse.

Size methodology: Heavy and bulky items should be stored close to the point of shipping to minimise the effort and cost of handling them. These heavy items should be stored as close to the floor as possible.

Product characteristic methodology: Some commodities have certain characteristics that dictate how and where they should be store within the warehouse. Temperature is one of the most important of these characteristics. In a country like India, certain medicines degrade under hot conditions. Each commodity should be analysed closely to determine its appropriate placement, given its temperature requirements. Place high value or controlled substances in the same location within the warehouse so that they can be secured or put in isolated storage.

Sample layouts are placed as Annexure-II with the following options.

1. *Separate 'Entry' and 'Exit' with NOSQ area away from Quarantine area (To avoid mixing of Quarantine and NOSQ drugs). Ground and First floor.*
2. *Separate 'Entry' and 'Exit' with NOSQ area near the Quarantine area. (For operational efficiency) Ground and First floor.*
3. *Separate 'Entry' and 'Exit'. (Ground Floor only)*
4. *Single Entry and Exit (First and Second Floor)*
5. *Vertical layouts for places with space constraints and Hilly areas.*

4 Equipment & Supplies Required for a Drug Warehouse

Storage system and material handling equipment constitutes the key equipment for a warehouse and are essential for its smooth functioning. Configuration of racks and storage area along with requisite maps and layouts to be decided before and in consultation with the warehouse manager and engineers. Their feedback based on experience of using the existing warehouse would be important to plan the new warehouse.

4.1 Storage System

There are several ways in which goods in a drug warehouse can be stored safely and as per standard protocols. Racking and shelving is an organised and well planned racking and shelving system not only helps in optimal utilisation of space but also provides simplicity in warehouse operations. The three most common type of storage system used are pallet stacking, static shelving and pallet racking.

Pallet stacking: The most basic form of a storage system, consists of placing boxes one on top of another in an organised way in a bonded fashion/arrangement.

Advantages of this system are that it is low cost, has flexible layout, can be moved and does not call for expensive floor renovations.

Disadvantages of pallet stacking are that it can become messy and make poor use of space in case height of the ceiling is more than 4.5 metres.

The product, its weight and dimensions will determine how high the stack can be and should be stacked. Always look at the packaging to see if the manufacturer has labelled the maximum height at which their boxes should be stacked, as well as for any arrow indicating the direction which the boxes should face.

Follow few general instructions:

- Stack the product on pallets off the floor to protect the product from dampness, dust, and pests. It must allow for ventilation and make use of a standard pallet.
- Place the product and stack it on level and smooth floors to prevent the product from falling over.
- Stack the product up to the edge of the pallets and position it in bonded or interlocked stacks to increase stability of the product and prevent it from falling over.
- Do not stack the product higher than 2.5 metres.
- Stack the product at least 30 cms from the wall and other stacks to allow for ventilation.

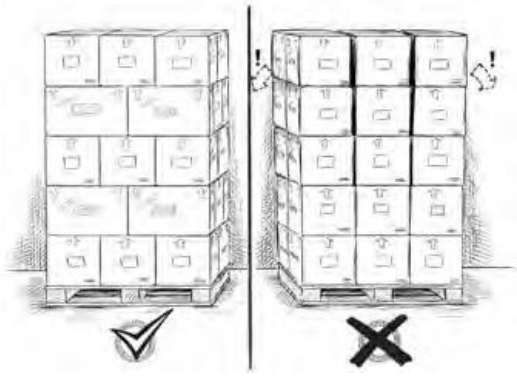


Figure 5: Bonding versus non-bonding stacking

Note: *Before you buy a storing system, do a baseline assessment of the available space utilisation of the warehouse using only pallet stacking storage on the floor and then compare it to shelving or racking systems.*

Static shelving: This is easy to assemble and simple to use. It serves as a foundation for any small and large scale storage facility. Steel shelving consists of basic sections that can be accessed from the floor and used to store a variety of products. The advantages of this system are that it is medium cost; has flexible layout and can be moved around; and does not call for expensive floor renovations. The disadvantages are that all products have to be hand carried; and there is poor utilisation of space in case the height of the ceilings is higher than 4.5 metres.

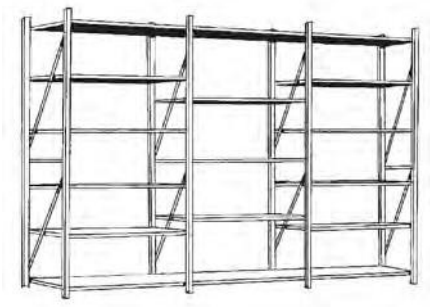


Figure 6: Shelving rack

A shelving rack system is suitable for low volume and/or low quantity warehouses that have many different SKUs. It is appropriate for warehouses with many different SKUs of heavy products (e.g., saline), as well as lighter products that are difficult to stack on pallets.

Pallet racking: Pallet racks are strong and can handle both large and small products and are best suited for a district drug warehouse. They can be used in storage systems for single level or multi level structures and to store single items or palletised loads and other types of containers. Additionally, rack structures provide access for order picking case lots or individual pallets. The advantages of this system are that it can be stacked very high, can hold heavy loads and is durable. Its disadvantages are that it needs a strong and levelled floor; is an expensive option; and cannot be easily re configured.

This is the most commonly used pallet storage equipment that comprises a number of rack bays. A rack bay can be one or more shelves high, with horizontal bars (beams) and vertical members (frames). It can suspend horizontal members off the warehouse floor. When two or more rack bays are connected lengthwise, it represents a row of racks. Each individual pallet is accessible from the aisle and allows more efficient use of floor space with single rows placed against walls. The selective pallet rack is one of the most flexible types of racking system because pallets can be stored, retrieved or picked without handling other pallets.

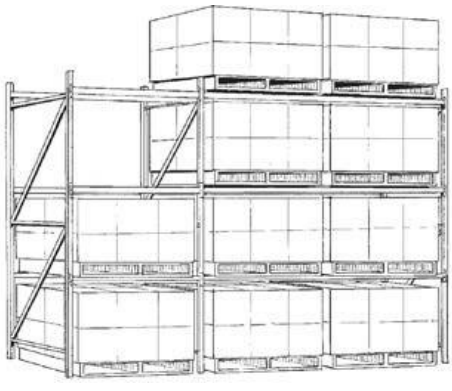


Figure 7: Pallet racks

Key points to remember

- Avoid dampness, termite and direct sun exposure.
- Lower shelves on racks to be used for storing heavy items, injectables and fragile items like glass packing etc.
- Middle shelves may be used for ointments, tube etc.
- Top shelves for surgical items, sutures, tablets, capsules etc.
- Space between racks can be decided as per pallets and electric stacker size. The electric stacker usually requires at least 6 feet for unidirectional movement (to be moved backwards without turning) and takes care of its turning radius at turns for multidimensional movements.

Planning for Pallet Racking: The racks should always be placed perpendicular to the exterior walls of the warehouse, to the extent possible. This has the following advantages:

- Optimal utilisation of the space with minimal 'dead space' loss.
- Protection from extreme temperature and humidity.
- Protection from termites.

4.2 Material Handling Equipment

For ensuring holistic performance of the warehouse, look at the storage system and material handling equipment in parallel with all planning stages. Criteria for selecting material handling equipment:

Human variables

- Who are the persons assigned to operate the equipment?
- What is the degree of skill that is required to operate an equipment (e.g., forklift)?
- What is the severity of fatigue caused by operating the equipment?

Mechanical variables

- Travel distance and the ability of the battery to sustain an eight hour shift.
- Maximum lift capacity, stocking heights of certain equipment, speed, operator comfort and turning radius etc.
- Service and maintenance requirements.
- Safety features of the equipment.

Operational variables

- What is the anticipated volume of product, human congestion, and width of aisle and loading blocks?
- What is the type and strength of floor and impact of the equipment (size, tyre, power)?
- What are the operating hours?
- What is the load?
- What is the type and condition of the building?

- How is the ventilation inside the warehouse and which truck would be better gas or electric?
- What is the minimum and maximum overhead clearance of the facility?
- What is the height of the door way and other passages and height of the vehicle?
- What is the width of the aisle?
- What is the availability of the spare part and repair facility?
- What is the cost of the equipment?

Important: An appropriate training and certification programme must be incorporated into the planning process. Consider all safety features and training strategies before making a purchase. To maximise return on investment, lift truck operators must be trained in the correct use of the equipment. Most manufacturer's offer drivers training programmes that are included in the purchase package.

4.3 Pallet Lift Truck Types

Below are some of the common pallet lift trucks based on lifting height and aisle space availability:

Table 3: Types of lift trucks

Lifting heights	Aisle width
Low-lifts • Pallet can be lifted 0.10 to 0.18 metres above the floor	**Wide-aisle trucks** • Aisles 3.5 metres and up
Medium-lifts: • Pallet can be lifted and stored on racks up to three shelves height.	**Narrow-aisle trucks** • Aisles 2.5 metres – 3 metres
High-lifts • Pallets can be lifted and stored on racks up to and greater than five shelves high.	**Very narrow aisle trucks** • Aisles 1.5 metres- 2.5 metres

Pallet jacks: Pallet jacks are manual or use electricity. Both the manual and electric model low lifts operate from the floor, are self loading, and fit between the top and bottom boards of a double faced pallet. The manually operated low lifts are usually called pallet jacks and are used whenever loads, grades, and distances are small enough to accommodate them. It is user friendly equipment that requires little training and can be used anywhere in the warehouse while loading docks, or inside all kinds of trucks. It provides exceptional manoeuvrability and flexibility of operation and is comparatively much lower in cost and maintenance expense. The electric powered jack, called walkie low lift trucks, is a hybrid pallet jack run by an on board rechargeable battery. Its average speed is 6 km/hour and it can transport heavier loads, over longer distance, at faster speed with great manoeuvrability while also being able to make tight turns.

Walkie stacker: These are walk behind pallet truck with a mast for lifting pallets up to heights over 4.5 metres. They are used when lift heights do not exceed 4.5 meters mostly indoors on flat concrete floors. The two types of commonly used walkie stackers are the walkie straddle stacker and the walkie reach stacker, both electrically powered by batteries. They are known for being efficient and economical.

Walkie straddle stacker: Walkie straddle stackers use straddle legs to distribute the load weight. These are good for floor stacking. When they are used in conjunction with pallet racking, it is important to design the racks with enough space to allow for wider straddle legs when loading pallets on and off racks. Lifting heights start at 2.6 metres and goes up to 4.8 metres.

Walkie reach stacker: These are a variation of the straddle truck. They are more manoeuvrable than standard forklift trucks and can usually operate in smaller spaces. Reach trucks have a scissors reach mechanism that moves the fork carriage forward into the load. Lifting heights start at 2.5 metres and can go as high as 4.54 metres.

Counterbalance lift trucks: A counterbalance lift truck uses a counterbalance near the back of the truck to stabilise loads that are being transported or lifted. They can be powered by either an internal combustion engine, gas, diesel, or liquefied petroleum gas or by a battery. With a capacity of 1,360 plus to 2,721 plus kgs, counterbalance trucks work well for dock, cross dock, and dock to stock applications. Counterbalance lift trucks offer a wide range of masts and attachments to handle all types of loads and are considered to be the backbone of the warehouse industry.

Rolling warehouse ladders: Rolling warehouse ladders provide a stable, transportable platform for maintenance, stock, and order picking; and for many other warehouse and non warehouse functions. Its key features include:

- Adjustable floor levellers and anti skid steps.
- Rolling warehouse ladder sizes can range from two steps to 15 steps; and 0.508 metres to 4.8006 metres in overall height.
- First-step actuated locking system which locks the ladder in place when a person steps on the first step.
- Available in steel or aluminium and in various degrees (48°–56°) of stairway slope.

A brief description along with photographs of the equipment used in the warehouse is detailed below.

Table 4: Some common equipment essential for a drug warehouse

Name of the equipment	Description of equipment	Image of equipment
Pallet	• The pallet is a flat structure used as a base for staging of goods in the supply chain. • Pallets are strong, rigid, portable, composite and horizontal platforms. • They are used as a platform for congregating, stacking, storing, transporting and handling products as a unit load.	

Name of the equipment	Description of equipment	Image of equipment
Heavy duty racks with shelves	• These are designed to store medium to heavy products in a smart way in the warehouse. • The shelves are vertically arranged. Products are stored according to their weight on each level of the shelf.	
Hydraulic manual pallet truck	• It is also called as pallet jack. • It is use to lift the pallets from one place to another within the warehouse.	
Electric low lift truck	• It is an advanced model of pallet jack. • Its functions are the same as a pallet jack but can operate with the speed of 6 kilometre per hour (kph). • It can lift 2.5 tonnes of weight at once and has an advantage over a manual pallet jack.	
Walkie stacker	• This is use for transporting & lifting pallets, where a forklift is not needed. • This stacker is perfect for transporting small capacity items within the warehouse premises. • It provides services for less than 5 hours a day.	

Name of the equipment	Description of equipment	Image of equipment
Counter balance lift truck	• This truck distributes load of item equally, allowing it to operate any narrow aisle safely. • It lifts standard pallets, unlike other standard walkie stackers.	
Walkie straddle stacker	• It has straddle legs for distributing load weight. • The legs propagate them to straddle a pallet, so that the stacker can drive up close to the pallet, without requiring much range.	
Narrow - aisle reach truck	• Lift truck manufacturers have developed variations on lifts that can operate effectively in narrower aisles. • The forks reach out beyond the stabilising legs into the racking, which allow these trucks to lift to a height greater than 10 metres, while still working in very tight aisles.	
Rolling ladder	• It is a stable, transportable platform for maintenance, stock, and order picking and for many other warehouse and non warehouse functions. • It has adjustable floor levellers and anti skid steps. • Rolling warehouse ladder sizes can range from two steps to 15 steps and 0.508 metres to 4.8006 metres in height.	

Name of the equipment	Description of equipment	Image of equipment
Manual warehouse floor cleaner	• It is used to clean the floors of the warehouse. • The advantage is that dirt and dust does not spread in the air and settle down on stored cartons.	
Carton Stripping machine	• It is used to strap the cartons which are ready to be shipped to the health facilities. • It protects the cartons and provides better handling.	
Plastic boxes and carets	• It is used for storing and transporting small quantities and loose drugs. • Prevents drugs falling from racks, prevent damage from rodents and is easy to locate the drug.	  OD: 540 × 360 × 292mm ID: 510 × 324 × 280mm

5 Human Resource Requirements to Manage the Drug Warehouse

Human resource plays an important role in performing warehouse operations. Trained and adequate number of professional staff is essential for performing daily activities with optimum utilisation of resources and in an efficient way. This will result in increased productivity and decreased inventory cost. A warehouse is an amalgamation of a group of activities that are performed by different skilled staff.

Common hierarchy of staff used in a typical 'transhipment warehouse' like a District drug warehouse is described below with each staff having a specific set of activities to perform for their daily operations.

5.1 Manpower Planning

Warehouse Manager (1)

Qualification and experience

i. MO/AYUSH, MO/Dental MO/ senior pharmacist.

ii. Certificate/ diploma course in warehouse/ inventory management or with specific training in this domain.

iii. Regular in service trainings.

Job responsiblities

- Having an officer in charge of the warehouse.
- Assisting the District/State officials in effective functioning of warehouse.
- Ensuring supply management, annual demand generation, verifying indents from HCF and timely dispatch of supplies.
- Coordinating the scheme in the district.
- Organising reports for meeting, video conferencing (VC), and any other occasion.
- Supervising all the staff that is working in the warehouse.
- Conducting monthly physical verification.
- Undertaking all types of maintenance of electricity/water/machines and building.
- Creating an environment that is conducive to innovation and adoption of new strategies for improvement.
- Adopting best practices and adapting them to suit the needs of the warehouse.
- Carrying out any other work desired by the State or District authorities.

Pharmacist *(Minimum 2, one per 25 HCF served)*

Qualification and experience: Graduate/Post Graduate in Pharmacy with two or more years of experience.

Job responsiblities

- Making arrangement for drugs in DWH.
- Receipts of supply, inspecting the drugs, sampling.
- Stock entries.
- Implementation of storage guideline and SOPs.
- Monthly physical verification.
- Cold chain maintenance.
- Distribution of supplies to HCF as per demand.
- Maintenance of issue vouchers.
- Following good dispensing practices.
- NOSQ Management.
- Any other order by Government/Manager.

Informatics Assistant/Data Entry Operator *(Minimum 2)*

Qualification and Experience: Recognised degree/diploma in computers with experience of working on a supply chain management software.

Job Responsibilities

- Recording all software entries.
- Timely reporting to state HQ.
- Maintaining all records and need based reports.
- Taking up typing work and making of PPTs and excel presentations.
- Sending emails.
- Undertaking all other computer related work.
- Being willing to take up and complete any other work assigned by the warehouse manager.

Packer/Helper/Loader/Machine Operator *(6)*

Qualification and experience

- Multipurpose worker.
- Trained in operating warehouse machines.
- Loader/helper can be hired on daily wages also.

Job responsiblities

- Unloading/ loading of cartons.
- Packing.

- Shifting of drugs from quarantine area to active area or NOSQ/expired area.
- Internal transportation of drugs.
- Arrangements in racks.
- Sample packing.
- Pallet truck/electric stacker operation.
- Plantation watering trimming.
- Water arrangements.
- Office works.
- DAK distribution.
- Any other work assigned by manager/pharmacist.

Housekeeping Staff *(1)*

- Premises cleaning.
- Sanitation and hygiene.

Security Guard *(One per shift/Entry of warehouse)*

- Armed/unarmed as per requirement.
- Responsible for safety and security of warehouse.

Equipment Maintenance Person (*One)*

- May be in house or on call.

Note: A common practice in our country is to fill all the posts by qualified pharmacists. Some jobs like Data entry operator and other purely clerical tasks may be assigned to less qualified personnel.

Other two important considerations are:

- Rationalisation of human resources (HR).
- Training and capacity building of HR (inventory management and software).

6 Safety and Security of the Drug Warehouse

6.1 Planning for Safety

Fire safety: Drug warehouse is a fire prone area. To prevent damage to products from fire, do the following:

- Install a sprinkler system, if possible.
- Keep standard fire extinguishers available in every storage facility, following national regulations see the various type of extinguishers in the text box to determine which are appropriate.
- Visually inspect fire extinguishers every 2–3 months to ensure that pressure is maintained and the extinguisher is ready for use.
- Service fire extinguishers at least every 12 months.
- Place smoke detectors throughout the storage facility and check them every 2–3 months to ensure they are working properly.
- Strictly prohibit smoking in the store.
- Conduct fire drills for personnel every six months.
- Clearly mark emergency exits and check regularly to be sure they are not blocked or inaccessible.
- Display fire precaution signs in appropriate places in the storage facility, especially locations where flammables are stored.
- Display emergency numbers of fire brigade, ambulance, and other helplines.
- Display work instructions on how to operate fire extinguishers.
- Ensure that medical store staff are trained in how to use the specific fire extinguisher or other equipment that is available at the warehouse.

First aid facility: Several aspects need to be catered to in order to ensure there is immediate help available in case of an emergency.

- Keep a well stocked first aid kit for employees and visitors. Update and replenish this every quarter.
- Place the kit in a central location that is easily accessible for all employees. Ensure it is clearly marked and that all employees know its location and contents.
- Provide first aid training to selected employees.

Personal Protective Equipment (PPE): This protects workers from workplace injuries. Warehouse operations present a wide variety of hazards for the worker and proper precautions should be taken. Typical PPE used in warehousing situations are:

- Steel toe shoes or work boots
- Hard hats
- Gloves
- Goggles

The occupational Safety and Health Administration (OSHA) publishes and enforces worker safety standards. They have numerous publications and information on how to conduct job hazard assessments. Any one of them could be referred for details on worker safety in warehouses and how to make them safer and more productive in terms of work environment.

For further details refer to the following document *www.osha.gov/Publications/3220_Warehouse.pdf*

6.2 Planning for Security

- Ensure selected and limited access to warehouse compound and building.
- Top up the boundary wall with barbed/ razor wire.
- Place a Security Guard at the entrance with visitor/guest registration handbook.
- Avoid hiring day labourers or temporary workers.
- Instal a robust and sturdy door at the entrance of the warehouse.
- Have at least two sets of locks with keys and give them to two different persons.
- Outfit all windows and ventilators with metal bars.
- Keep valuables (high cost/high demand) in locked cage room/ cabinet.
- Instal CCTV surveillance.
- Do pest control at periodic intervals for the safety of the stored inventory.

7 Maintenance of the Drug Warehouse

With passage of time, all buildings deteriorate and lose their integrity. Lack of or poor maintenance of drug warehouses often results in huge financial and human losses. Health care products stored at the warehouse and in transition state are more costly than the building itself. Any damage/loss of building can directly damage the products and lead to scarcity of supply in health facilities.

Hence, maintenance become a vital part to prevent its damage and loss. Maintenance rectifies integration of the building and facilitates the process of returning the building to its original state while also protecting the financial assets in the building.

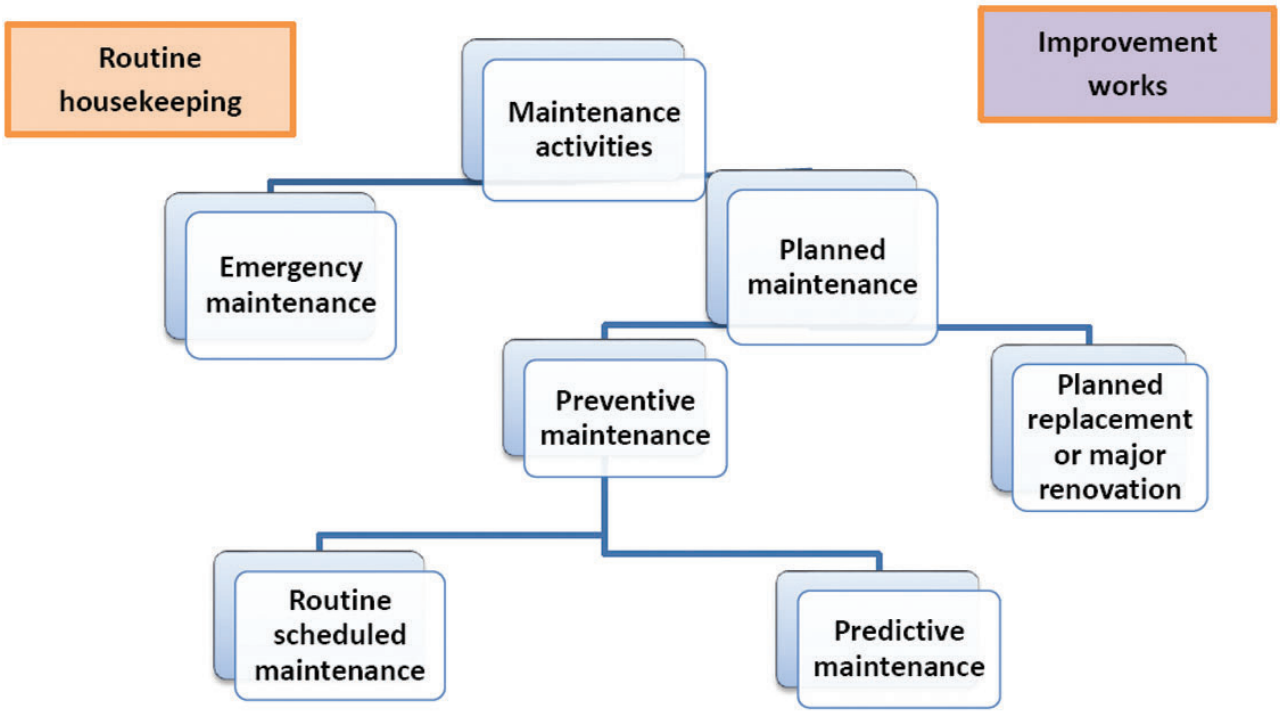


Figure 8: Types of maintenance work and related work in a warehouse

To ensure optimal utilisation of available resources (finance and operations), a well planned maintenance schedule is required. This will help reduce the requirement of emergency maintenance planning. However, since it will not zero down emergency maintenance completely, adequate resources will still need to be allocated to tackle the situation.

7.1 Programmed Maintenance

Programmed maintenance is sub categorised into the following:

Planned replacement: It ensures that building elements such as windows and roof finishes are replaced when they reach the end of their designated service life. It minimises the need for emergency maintenance and prevents consequential damage which may occur in the future if the element is left untouched/unresolved.

Preventive maintenance: It ensures that the warehouse building components are well maintained. The same can be attained by regular scheduled maintenance (for example regular remodeling of windows or periodic lubrication of mechanical elements). Preventive maintenance and routine servicing of air conditioners, WIC, ILR, DF, pallet trucks, electric stacker, water purifier etc must be carried out.

Predictive maintenance: This entails identification of any minor problem during a regular scheduled inspection, such as vibration in an air conditioning unit, before it enlarges into a major problem and becomes an emergency.

7.2 Incorporating Maintenance during Warehouse Building Design

It is important to involve the maintenance team and assess maintenance requirements during the planning phase of design and construction. For example, the need for safe access for inspection, repair and replacement will help reduce the risks of long term problems and their frequent recurrence.

Every building should have an operational and maintenance manual for updated information about the building and its installed equipment. In case of a new warehouse the building contractor must prepare the document and handover to the organisation all the essential information (day to day operation, maintenance, decommissioning and demolition of a building). In case of the existing building which has no existing manual, the organisation can collect and assemble operational and maintenance manual and health and safety file.

7.3 Operational and Maintenance Manual

Every warehouse should have a documented operational and maintenance manual including the following:

General operational guidance: It contains the non technical part of 'building user's guide'/ 'building log book' which provides information on how to use the warehouse building, housing energy efficiency, environmental controls, access, security and safety systems.

Comprehensive construction and operational guidance: It provide brief information of the warehouse layout design and building construction with structural frame, service installation, cladding, doors and windows, roof construction, finishes, and so on. This information will be useful for further phasing of the programme related to the site.

- Manufacturers' instructions should be incorporated for correct and efficient operation and health and safety information.
- Assembled drawings and related details with details of electric wiring, plumbing, sewerage etc.
- A record of plant and equipment installed in the building.
- Commissioning and test results.
- Certificates of compliance, warranties and guarantees.

- Specific requirements for demolition, decommissioning and safe disposal of the building, its systems and components.
- Above information will already be available in the warehouse, so preparing the O&M manual will only need compiling and assembling of the relevant material.

The O&M manual is a dynamic document and should be changed over the life of the buildings, to reflect changes that take place in the fabric of the building and its systems, along with details of maintenance that have taken place.

The health and safety document: Generally, health and safety issues may be missed out, which is equally important which is why it is there in O&M manual in the first place. This necessitates those good practices must be practiced. It is suggested to maintain separate files for the same with regular monitoring and maintenance. It suggests that cleaning, maintenance, refurbishment, alterations and eventual demolition must be carried out safely. The contents of the health and safety file may vary depending on the nature of the work being carried out. It can also contain:

- Description of the project.
- Description of any residual hazards that should be managed.
- Structural principles of the design.
- Identification of any hazardous materials used.
- Information about cleaning and maintenance equipment.
- Information about safe working in cold stores.
- Procedures for safe removal or dismantling of installed plant and equipment.
- Description of significant services and their location.
- Information and as built drawings of the structure, plant and equipment.

The health and safety file should be kept for lifetime of the building. The safety and risk factors are described in the previous chapter on 'Safety and Security'.

7.4 Challenges in Maintenance of Drug Warehouses

Due to several reasons, public health care drug warehouses lack in maintenance. Some of these are given below:

- Warehouse site may not be under direct control of MoHFW and may be managed by other departments like the public works department (PWD). In such a situation, Health managers may not have the authority/knowledge to implement an effective maintenance plan. At the same time, PWD may not understand and be able to meet specific maintenance needs of the drug warehouse with complex refrigeration requirements.
- May be managed by a state health department and the department may be lacking in knowledge that is needed to implement an effective maintenance regime.
- Annual budgeting process and competing demands for scarce resources make it difficult to fund and manage multi year planned maintenance programmes of the type advocated in this document.

Maintenance Plan

This plan should be updated yearly for a rolling period of at least 5 years. The plan may have the following elements:

Item wise maintenance plan: This should be based on a thorough inspection of the building and site. Planning should emphasise re roofing, periodic external and internal remodeling, regular annual maintenance of manual equipment and likewise.

Budget maintenance as per the maintenance plan: The budget should be realistic and accurately reflect anticipated costs for each item. It should consider an account of anticipated inflation over the plan period.

Work plan to accomplish objectives of maintenance plan: Where maintenance activities are likely to be outsourced, the programme should have the bidding process and/or the process of contract negotiation and draw up long term service agreements for renewal.

Planned maintenance must then be carried out in accordance with the schedule in order to ensure that the building and site remain in good condition.

Scheduled Regular Inspections

Scheduled inspections should be conducted at regular planned intervals, using facility specific and element specific checklists. When preparing an inspection plan, consider the following:

- When should inspections take place?
- What should be inspected?
- Who should carry out the inspection?
- When should elements be repaired?
- When should elements and components be replaced?

Planned service inspections: These must be conducted for all manual operating equipment by qualified technicians. Maintenance actions consist of lubrication, replacement of consumable filters and other time dependent activities recommended by the equipment manufacturer. Such inspections may take place several times in a year.

Emergency Maintenance

It should be carried out as rapidly as possible, consistent with the identified risk. For example, in case the temperature is fluctuating in the WIC, all store products may risk losing their potency due to delay in maintenance.

So, it becomes pivotal to plan the risk assessment exercise in order to identify and classify critical maintenance emergencies and establish a contingency plan to deal with the same. Time is of essence, as in the example above, a maximum response period should be mentioned in the relevant memorandum of understanding (MoU) or maintenance contract.

Maintenance can either be carried out by using direct labour employed or outsourced to an independent contractor.

Inspecting and signing off the Work

It is important to inspect the quality and completeness of all consequential maintenance work and then signing off. Generally, this function is performed by the supervisor of the maintenance team. However, in some circumstances when the supervisor is unavailable, a specialist contractor may certify

the work and label it as complete, satisfactory or not satisfactory by providing a signed copy of a completion and/or test certificate. This applies specially to adjusting the mechanical and electrical equipment and services, particularly where the manufacturer clearly publishes service instructions. Self affirmation is a regular practice and in case of a question, the contractual worker's confirming body can be acquired to arbitrate.

7.5 Maintenance of Cold Storage Facility

Cold storage facilities are used for temperature sensitive and control of health care products. The technician who is performing maintenance and repair work must be skilled and technically equipped to carry out this function. Maintenance can be performed by using the following equipment:

- Refrigeration equipment service manuals.
- Digital thermometer.
- Cleaning equipment (non solvent based).
- Insulated envelope repair equipment (sealant, plating, pop riveter).
- Multimetre for electrical testing, electronic leak detector (or sponge and soapy water).
- Manifold gauges set and refrigeration tools.
- Spare refrigerant.
- Spare parts kits.
- Refrigerant recovery machine and bottle.
- Vacuum pump and weighing scales.

Insulated container systems used for logistics: Reusable transportation cold boxes are commonly used with cooling elements such as frozen water packs, cool water packs, PCM packs or eutectic plates and possible dry ice (solid carbon dioxide). Their maintenance takes place by washing interior and exterior surfaces by spraying mild soapy solution or disinfectant solution containing sodium hypochlorite, 5.25% in water. Holes or cracks internally or externally indicates their end of life.

Refrigerators and freezers: Refrigerators and freezers contain an insulated envelope and cooling process that is done by sealed compression cycles. Maintenance mainly comprises of a cleaning process, which includes, keeping clean by regularly washing with mild soapy water solution; checking the operation of thermostat and defrost system (if fitted); keeping the door seals clean; avoiding build up of material between folds and at corners, removing build up of ice (using the defrost system or a blunt scraper); keeping the drains free of debris; checking appliance level to give a little tumble to the back (close to 4mm) to guarantee door closure; cleaning condenser coil (fins); and ensuring that the fins, cooling fans and any grills are free of dust fluff and debris.

Cool, cold and controlled ambient rooms: Freezer rooms, cold rooms and controlled ambient stores are essential to restore the potency of the temperature control of the health care products. These are categorised into two components:

- An insulated envelope developed from preformed insulated sandwich panels.
- A vapour compression mechanical refrigeration system.

Table 5: The temperature range as per zones

Zone	Temperature range
Freezer	-20°C or below
Cold rooms	+2°C to +8°C
Controlled ambient	+15°C to +25°C

Table 6: Components of freezer, cold and controlled ambient room with maintenance requirements

Components	Descriptions
Maintenance overview	• Mainly two components required for maintenance refrigerator equipment and insulated envelope. • To minimize potency loss of items, duplicate refrigeration system, an emergency power supply and sophisticated temperature monitoring and alarm system is required with regular maintenance.
Maintaining the cooling system	• Product potency loss could happen if temperature is either high or low. So, it becomes necessary to maintain the secondary system cuts when temperature exceeds maximum allowable levels. • For example, if the temperature control is by a solenoid valve framework, the low temperature security framework should remove the ability to the blower/compressor.
Maintaining insulated panels and vapour control sealing	• Maintenance of insulated envelope is equally important because it can increase the life twice.
Condensation control outside the cold store enclosure	• Condensation build up in the rooftop voids of the structure indicates a recurring issue in the store room. To resolve this, ventilate the voids with ambient air. • Ventilation of the space around cold store should associate with 10 air changes for each hour.
Frost heave control	• Frost heave happens when water in the subsoil water underneath a constantly running cooler room freezes after some time. • This can happen regardless of whether the floor is protected and the extension of the dirt can crack and lift the floor piece. • Ice hurl is commonly forestalled by introducing a radiator tangle under the cooler room floor. In a perfect world the tangle ought to reach out beneath the slender edge voids outside the cooler room fenced in the area.

Components	Descriptions
Cold store panel insulation	• Insulation can be done by using polyurethane. For freezer room 100 to 170mm, for cold room and controlled ambient room it should be 100mm. • An accurately determined panel insulation thickness should stop the insulation surface temperature from falling more than 2°C beneath the outside air, henceforth maintaining a strategic distance from the dewpoint and resulting in a build up of condensation.
Insulation for refrigeration pipes and other penetrations	• For the prevention of condensation process under all conditions, refrigeration pipework, electrical cables and other penetrations should be enclosed with an insulation sleeve that is 50–75mm thick. • These sleeves should be at a distance beyond the cold store board to prevent the encompassing air from cooling underneath the dew point.
Cold store maintenance schedule	Maintenance schedule should be developed as per need. See table 5 for example.

Table 7: Cold store maintenance schedule

Task	Frequency
Alarm systems heater mat	Daily
Removal of water ice and snow from roof voids	Daily
Check operations of "trapped man" alarms	Weekly
Check operations of door seals and heaters	Weekly
Fire alarm	Weekly
Check operation of emergency exits	Weekly or as required by legislation
"Walk round" inspection Professional condition survey Ten years	Monthly
Inspection of vapour seals to ceiling panels	Three monthly
Inspection of vapour seals to wall panels	Six monthly
Mechanical installation	Once a year
Inspection of cold store ceiling panel suspension rods and their attachments	Annually
Thermographic scan on commissioning and every five years thereafter Electrical systems	Once in five years
Professional condition survey	Once in ten years

For further details, refer to the following document.

https://www.who.int/biologicals/expert_committee/Supplement-5-TS-warehouse-maint-ECSPP-ECBS.pdf

8 Do's and Don'ts of Drug Warehouse

8.1 Do's: Best Practices

1. Check the following while receiving goods:
    - Torn/ripped packaging.
    - Quantity as per purchase order (PO).
    - Batch/date of expiry is as per invoice.
    - Discolouration or sedimentation, if any.
    - Broken vials, moisture, leakage in packaging.
    - Crumbled pills.
2. Conduct active verification of received products and documents and once they meet standards only then let the transport enter the warehouse premises.
3. Do batch wise physical verification every month.
4. Always receive and stack goods on pallets.
5. Segregate health care products and quarantine them from the active stock prior to issuing them in the warehouse.
6. Acknowledge physically received goods on the same day in the IT system.
7. Take samples within 24 hours of receiving the goods and batch wise sampling should be done.
8. Send packed samples within 48 hours of goods received to the empanelled laboratory for quality check and maintain the cold chain as required.
9. Complete picking and packing of goods for issuing drugs keeping in mind their near expiry date (drugs with nearer expiry date to be issued ahead of drugs with prolonged expiry date). There should be provision of First Expiry First Out (FEFO) in the software.
10. Store high demand and fast moving items near the shipment location with easy accessibility.
11. Store tablets, capsules, powder, ointment on upper shelves; liquids and injectables in the middle shelves and surgical and laboratory items in lower shelves.
12. Follow FEFO (First Expiry First Out) for better management of health care products.
13. Always keep doors of the cool & cold storage room closed and allow only authorised entry. The standard operating protocols (SOP) should be pasted on the door.
14. The supervisor should do daily monitoring of warehouse activities and its premises.
15. Update the tools and equipment of the warehouse and make it functional at all times.
16. Maintain decorum in the warehouse at all times.
17. Report all serious and minor incidents and injuries immediately.

18. Inspect all mobile power equipment using an authorised checklist prior to the operation.
19. Make sure that the "Stop" and "Sound horn" is used at all intersections when operating the mobile power equipment.
20. Always give pedestrians the right of way and make them aware of your presence.
21. Always wear required PPE like safety shoes, gloves and safety glasses.
22. Use proper lifting techniques such as lifting legs (not back); pivoting (not twisting); and keeping products close to avoid reaching.
23. Communicate all spills, when identified and clean immediately. However, NEVER attempt to clean up bleach, ammonia, or bodily fluids and in such an eventuality call the authorised personnel.
24. Assure all products are properly stacked and palletised.
25. Keep the volume of your authorised radio low enough to allow you and your nearest neighbour to hear incoming traffic and pager/ mobile communication system.
26. Ensure that the staff wears its uniform with ID cards at all times.
27. Install door alarm system, smoke detectors, CCTV as per requirement and budget.

8.2 Don'ts: Things to be Avoided

1. Avoid storing heavy, bulky items on the upper shelves of the racks.
2. Never issue goods in loose boxes.
3. Never let intruders enter into the storage area of the warehouse premises.
4. Do not spit, eat or smoke inside the storage area and warehouse premises.
5. Never sit/stand/sleep on the corrugated boxes stored at the warehouse.
6. Don't leave the premises in between working hours or without prior permission in case of an emergency.
7. Ensure that packed cartons are not taken out without their number and name of health facility marked clearly on them.
8. Do not try to consume warehouse commodities for your personal benefit.
9. Never use broom for warehouse cleaning and only use wet mop with disinfectant solution and vacuum cleaner.
10. Do not eat inside the storage area and leave edible waste inside the warehouse.
11. Do not forget to monitor cool & cold room temperature at least twice a day.
12. Do not stack cartons that are more than 2.5 m (8 feet) height and are not adequately bonded.
13. Do not pile the carton beyond its compressibility strength (usually 8 but must refer to the manufacturer's instructions).
14. Always keep the carton upright with arrow up.
15. Make sure that the batch and name of the product is always on the front side.
16. Do not use pallets on forklift trucks to access work at height or as working platforms.
17. Never use oppressive language or activities during working hours.
18. Do not block exits; make sure all exits are kept completely clear at all times.

19. Do not operate mobile powered equipment by anyone other than a qualified, trained and licensed instructor. Unlicensed trainees must be under the supervision of a qualified instructor during operations.
20. Do not exit aisles with forks first without a competent person safely guiding you out.
21. Do not double stack pallets in section slots.
22. Do not keep equipment or products closer than two bays away from an intersection.
23. Do not walk on empty pallets.
24. Do not use cell phones unless in a hazard free area (barriers around).
25. Never climb on racking.

Figure 9: How to prevent lifting injuries

Figure 10: Work instructions for warehouse staff

Annexure 1

Space Required for Different Areas of a Drug Warehouse

Layouts (Area required) for drug warehouse	
Total area required for an average district warehouse	**8000 TO 20,000 sqft**
Area required per health care facility catered	**120 TO 150 sqft/HCF**
Drug warehouse area	**Area (sqft)**

S. No.	Drug storage area (Section A)	Area in %	Small warehouse (12,500 sqft)	Medium warehouse (15,000 sqft)	Large warehouse (20,000 sqft)
1	Active drug storage area	33–35%	4000	5000	7000
2	Walk in Cooler (WIC/ILR/DF)	4.5–5%	650	650	700
3	Cold storage	8–10%	1000	1250	2000
4	NOSQ/Expired area	3.5–4.5%	500	600	800
5	Quarantine area	10–12%	1300	1800	2500
6	Unloading/Receiving/ Incoming area	1.5–2.5%	250	250	300
7	Counting/Packing/Loading/ Dispatching/Outgoing area	3.5–4%	450	600	650
	Total Section A	**64–73%**	**8150**	**10150**	**13950**

S.No.	Support and Ancillary area (Section B)	Area in %	Small size warehouse (12,500 sqft)	Medium size warehouse (15,000 sqft)	Large size warehouse (20,000 sqft)
1	Office / Administrative area	4-5%	600	600	650
2	Manager room + Toilet	2.5-3%	350	350	400
3	Meeting room/Dining/Pantry	1.5-2%	300	300	350
4	Record keeping area	1-1.5%	200	200	250
5	Toilet for staff (Male and Female)	1%	200	200	200
6	Toilet General (Male and Female)	1%	200	200	200
	Total -Section B	**11-16%**	**1850**	**1850**	**2050**
	Total (Section A+Section B)		**10000**	**12000**	**16000**

S.No.	Circulation Area (Section C)	Area in %	Small size warehouse (12,500 sqft)	Medium size warehouse (15,000 sqft)	Large size warehouse (20,000 sqft)
1	Circulation area stairs, ramps, lifts, corridors	18-20%	2500	3000	4000
	Total (A+B+C)	**100%**	**12,500**	**15,000**	**20,000**

Annexure 2

Sample Layouts of Drug Warehouse

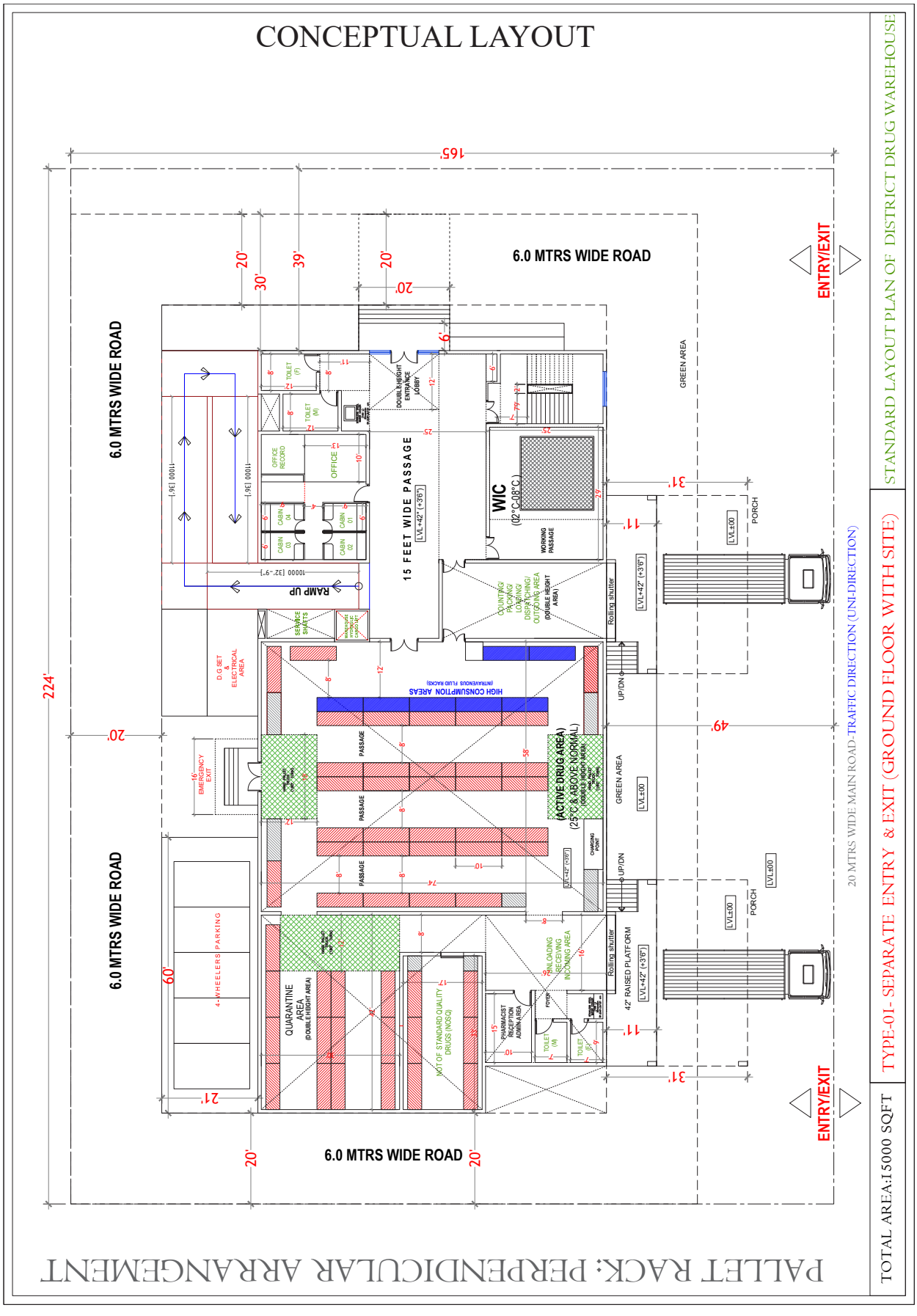
Disclaimer:

1. *The layouts are suggestive in nature (Not prescriptive) for planning an average size drug warehouse.*
2. *The State may modify the layout as per their needs, requirements and constraints.*
3. *All modifications should be proportionate to the planning norms.*

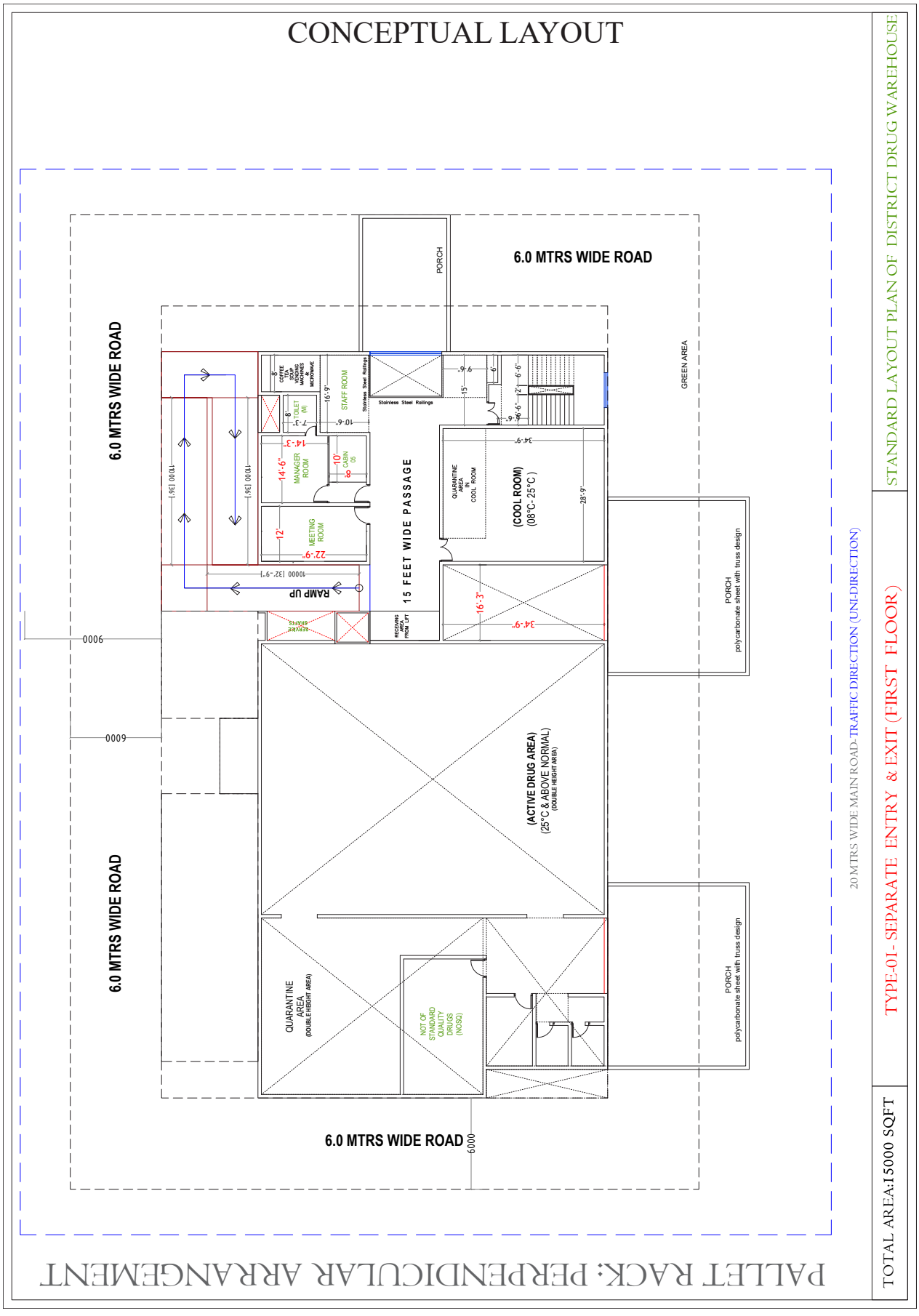
Remember

Layouts with separate ENTRY and EXIT are preferred because of their operational efficiency, optimal utilisation of space and reducing errors in receiving and dispatching.

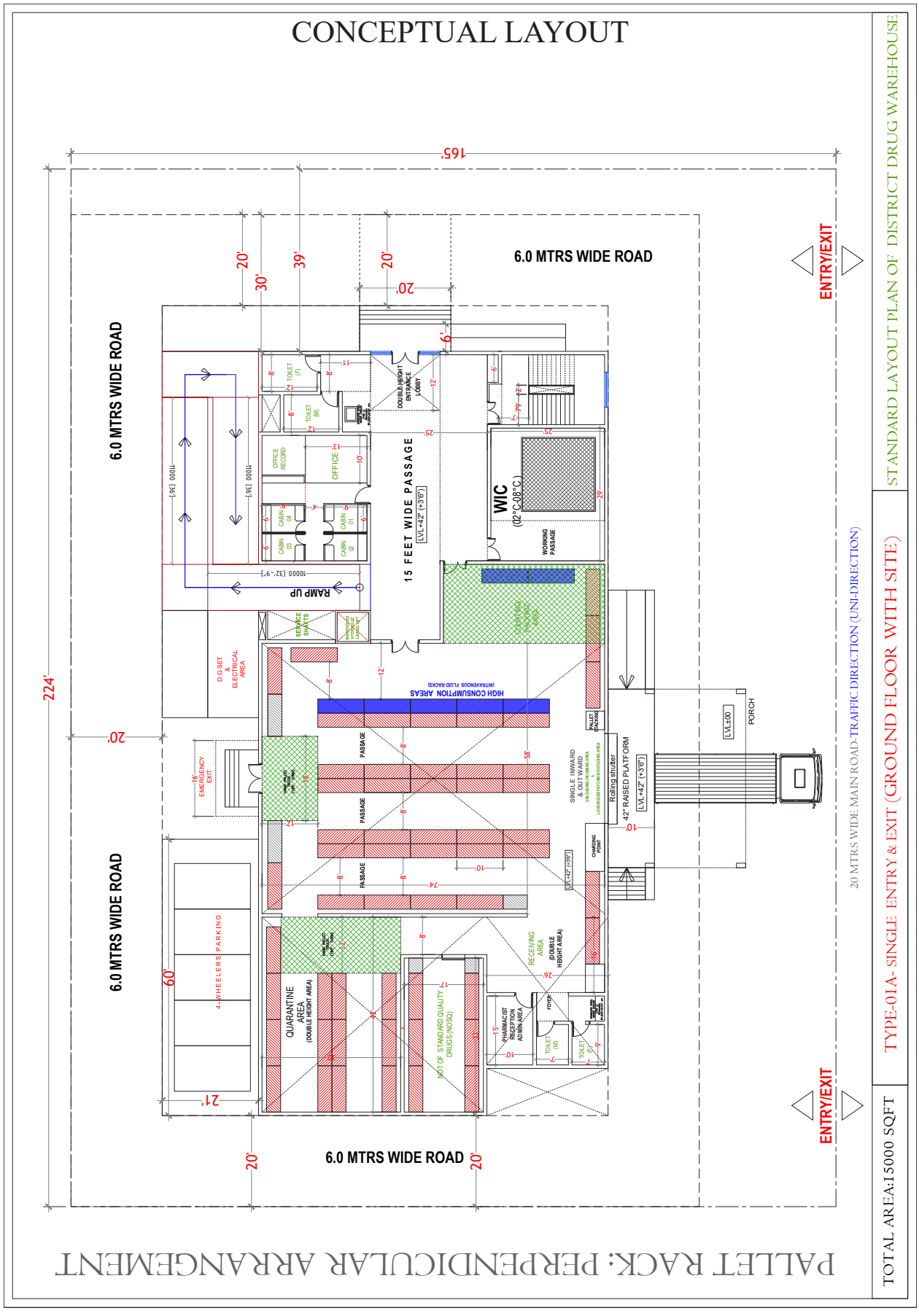
Single Entry and Exit may be used in situations when separate entry and exit are not feasible because of constraints of space and location.



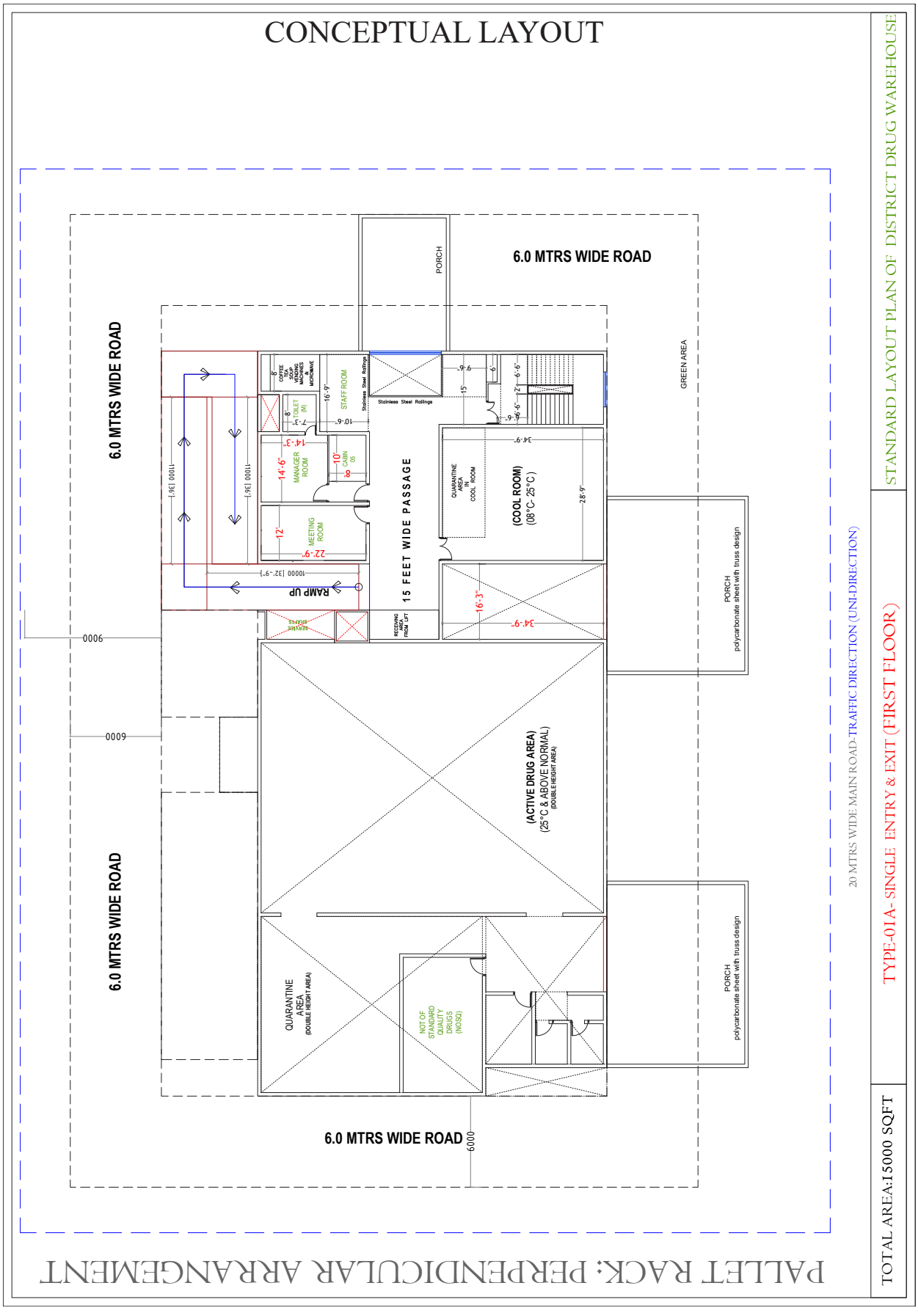
Type-01-Separate Entry & Exit (Ground Floor Area with Site)



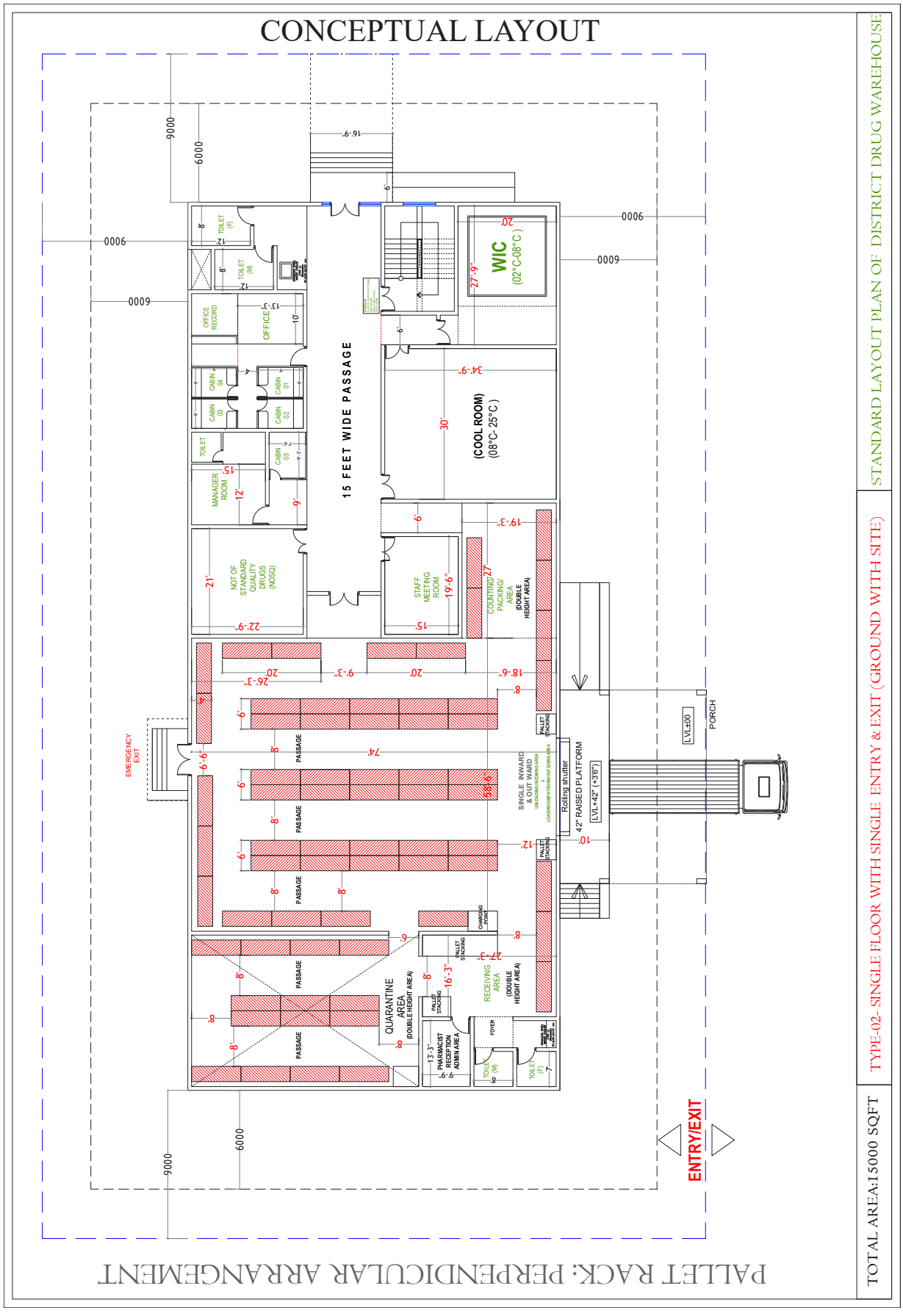
Type-01-Separate Entry & Exit (First Floor Area)



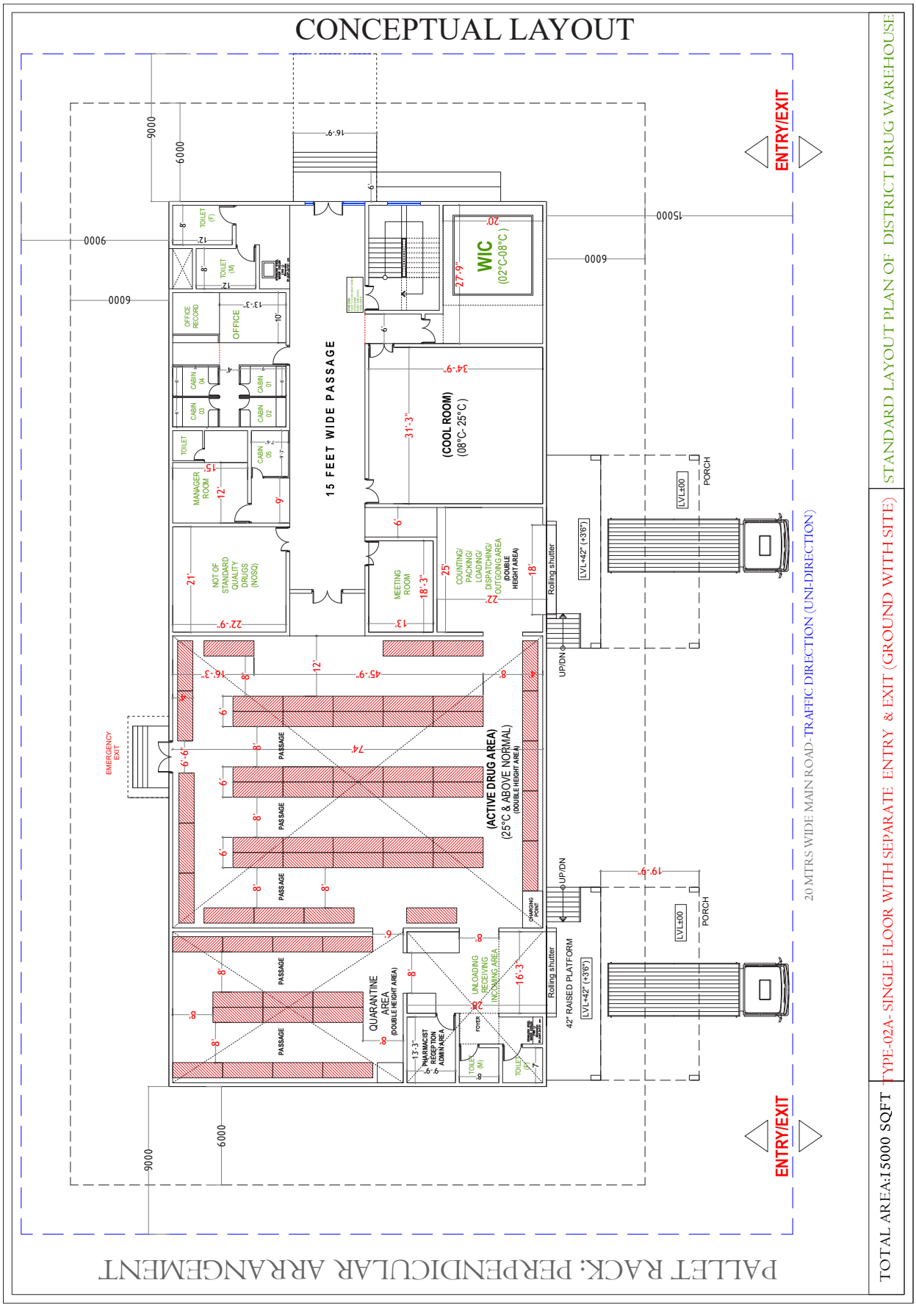
Type-01A-Single Entry & Exit (Ground Floor Area with Site)



Type-01A-Single Entry & Exit (First Floor Area)



Type-02-Single Floor with single Entry & Exit (Ground with Site)



Type-02A-Single Floor with Separate Entry & Exit (Ground with Site)

Type- 3A – Single Entry and Exit with Multi-floor (Space Constraints like for Hilly Areas)

Conceptual 3D View of Drug Warehouse – Front and side view

Conceptual 3D View of Drug Warehouse – Side and Aerial view

Acronyms

1.	BEE	Bureau of Energy Efficiency
2.	CHC	Community Health Centre
3.	DDO	Direct Demanding Officer
4.	DF	Deep Freezer
5.	DGHS	Director General of Health Services
6.	DH	District Hospital
7.	DVDMS	Drugs and Vaccines Distribution Management System
8.	DWH	Drug Warehouse
9.	EML	Essential Medicines List
10.	FEFO	First Expiry First Out
11.	FIFO	First In First Out
12.	GoI	Government of India
13.	GRP	Glass Reinforced Plastic
14.	HCF	Health Care Facility
15.	HR	Human Resource
16.	HWC	Health and Wellness Centre
17.	IEC	Information, Education and Communication
18.	IFRC	International Federation of Red Cross
19.	ILR	Ice lined Refrigerators
20.	IT	Information Technology
21.	IVF	Intravenous Fluid
22.	JSI	John Snow Inc.
23.	MoHFW	Ministry of Health and Family Welfare

24.	MoU	Memorandum of Understanding
25.	NOSQ	Not of Standard Quality
26.	O&M	Operation & Maintenance
27.	OOP	Out of Pocket
28.	OPD	Out Patient Department
29.	OSHA	Occupational Safety and Health Administration
30.	PCM	Phase Change Material
31.	PDT	Pre Dispatch Testing
32.	PHC	Primary Health Centre
33.	PO	Purchase Order
34.	PPE	Personal Protective Equipment
35.	SDG	Sustainable Development Goal
36.	SDH	Sub Divisional Hospital/Sub District Hospital
37.	SKU	Stock Keeping Unit
38.	SLA	Service Level Agreement
39.	SOP	Standard Operating Protocol
40.	UHC	Universal Health Coverage
41.	UNICEF	United Nations Children's Fund
42.	USAID	United States Agency for International Development
43.	UT	Union Territory
44.	VC	Video Conferencing
45.	VED	Vital, Essential, Desirable
46.	WHO	World Health Organization
47.	WIC	Walk in Cooler

Glossary of Terms

Drug warehouse: A facility which is used for storing drugs and consumables having storage racks, handling equipment and personnel and management resources which allow control of differences between incoming flow of drugs (received from suppliers) and outgoing flow of drugs (issued to customers).

Supply chain management: Planning and management of all warehouse activities involved in sourcing, procurement, conversion, and logistics. It incorporates coordination and joint effort with channel partners, such as service providers, intermediaries, third party service providers, and customers. It also integrates supply and demand management within and across the system.

Logistics: It is part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between point of origin and point of consumption in order to meet customers' requirements.

Galvanised screen: Electro galvanised zinc coated steel with a wire diameter of 0.009. The wire mesh is 18 × 14, that means there are 18 vertical wires per inch and 14 horizontal wires per inch.

Refrigeration equipment: The term 'refrigeration' or 'refrigeration equipment' means any equipment whose purpose is to lower air and product temperature and/or control relative humidity (cool room, cold room, fridge room, WIC room or controlled ambient room).

Buffer stock/safety stock/strategic stock: Supply of drugs held as a reserve in case there are future demand, unforeseen shortages and supply fluctuations. It is the excess inventory or safety stock, which retains some kind of buffer to protect in case of an uncertain future.

Cold chain system: System of storing and transporting temperature sensitive products/vaccines at recommended temperature from point of storage to point of use. It maintains the potency of products/vaccines.

Quantification: The process of estimating quantity and cost of medicines and health products required for a specific period and determining when shipment of the product should be delivered to ensure optimal and uninterrupted supply.

Layout: Arrangement or plan, especially schematic arrangement of parts/areas.

Spillage: To cause or allow, especially accidentally or unintentionally to fall, flow, or run out so as to be lost or wasted.

Pilferage: Theft of small quantities of goods or of low value goods.

Commodity/health-care product: Drug intended for human use or veterinary product intended for administration.

Fresh stock: Stock which is of standard quality and in active state for issuing to its direct demanding officers.

Incoming goods: Goods which are received at the warehouse.

Outgoing goods: Goods which are issued to the health care facility.

Manoeuvring: The action of cleverly planning something to secure an advantage.

Controlled substances: A drug or chemical whose manufacture, possession, or use is regulated by a government, such as illicitly used drugs or prescription medications designated by law.

Anti-skid steps: Allow prevention of slipping or skidding or not allowing something to slide.

VED analysis: Method for categorising stock as vital (V), essential (E), or desirable (D). VED analysis is often used to prioritise procurement when enough funds do not exist to purchase all items that have been requested. The system can also help determine which items should be kept in stock and which can be ordered when needed.

ABC analysis: Method used for reviewing stock movement, which categorises items by volume and value of consumption during a specific period of time, usually one year. Class A items 10 to 20% items, representing 75 to 80% of expenditure are mostly high volume, fast moving medicines. Class B items are usually 10 to 20% of items, and 15 to 20% of expenditure. Class C items often represent 60 to 80% of items but only about 5 to 10% of total expenditure. These are low volume, slow moving items. Thus, class C is a good place to look for items that might not be needed in stock at all times.

Stock Keeping Unit: In inventory management, a code number is typically used as a machine readable bar code, assigned to a single item of inventory. As part of a system for inventory control, SKU represents the smallest unit of a product that can be sold from inventory, purchased, or added to inventory. SKU assists in monitoring transactions, tracking customer spending patterns, controlling inventory and purchasing, and providing information about pricing.

Pallet: It is used for storing and handling cartons and is made up of a wooden or plastic platform designed to be lifted by a pallet jack or forklift truck.

Net storage capacity: This is the total volume available for storing drugs, consumables and other items in a warehouse. It depends upon the type of load support system employed (pallets or shelving units), as modified by the utilisation factor.

Utilisation factor: The percentage of total volume available that can be practically utilised in practice for storing drugs.

Primary container: Blister pack, strip, bottle, cartridge, vial, ampoule, prefilled device, plastic dispenser, tube, single dose container containing tablets, capsules, liquid preparation etc.

Secondary pack or carton: The pack/carton that contains one or more primary containers and is usually made up of light cardboard.

Tertiary pack or carton: A pack/carton that contains a number of secondary cartons and which is usually constructed of corrugated fibreboard.

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Notes

Ministry of Health & Family Welfare
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