NATIONAL COLD CHAIN ASSESSMENT

INDIA

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(2005-2012)

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LIST OF ACRONYMS

ACCO	Assistant Cold Chain Officer
AD	Auto Disable
AEFI	Adverse Event Following Immunization
AMC	Annual Maintenance Contract
ANM	Auxiliary Nurse Midwife
BCG	Bacille Calmette Guerin
CBR	Crude Birth Rate
CC	Cold Chain
CCH	Cold Chain Handler
CCL	Cold Chain Logistics
CCO	Cold Chain Officer
CFC	Chloro Flouro Carbon (refrigerant)
CFWS	Central Family Welfare Store
CHC	Community Health Center
CIC	Coverage Improvement Plan
CPWD	Central Public Works Department
CS	Civil Surgeon
DDI	Deputy Director Immunization
DF	Deep Freezer
DIC	District Immunization Coordinator
DIO	District Immunization Officer
DPHN	District Public Health Nurse
DPN	District Project Manager
DPT	Diphtheria, Pertussis, Tetanus
DS	District vaccine Store
DS	District Store
DT	Diphtheria, Tetanus
DVS	Divisional Vaccine Store
EEFO	Early Expiry First Out
EVSM	Effective Vaccine Store Management
FIC	Fully Immunized Child
FW	Family Welfare
GAVI	Global Alliance for Vaccine and Immunization
GMSD	Government Medical Supply Depot
GoI	Government of India
HSS	Health System Strengthening
ILR	Ice Lined Refrigerator
INR	Indian Rupees
JE	Japanese Encephalitis
KVA	Kilo Volt Ampere
LHV	Lady Health Visitor
MIS	Management Information System
MOHFW	Ministry of Health and Family Welfare
MPW	Multi Purpose Worker
MYSP	Multi Year Strategic Plan
NPSP	National Polio Surveillance Project
OPV	Oral Polio Vaccine
PHC	Primary Health Center

PIP	Project Implementation Plan
RCH	Reproductive and Child Health
RM	Refrigerator Mechanic
SIO	State Immunization Officer
SWAN	State Wide Area Network
TA	Technical Assistant
TT	Tetanus Toxoid
UIP	Universal Immunization Program
UNICEF	United Nation's Children Fund
V&LM	Vaccine and Logistics Management
VMAT	Vaccine Management Assessment Tool
VVM	Vaccine Vial Monitor
WHO	World Health Organization
WIC	Walk in Cooler
WIF	Walk in Freezer

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Executive Summary

India has one of the largest Universal Immunization Program (UIP) in the world and spends more than US$ 500 million[1] every year in immunization program for immunizing children against vaccine preventable diseases including polio eradication program. The country is advancing new strategies to increase immunization coverage and reach more children with quality vaccines. Cold chain being the most important component to ensure that quality vaccine reached to each and every child immunized.

UNICEF in collaboration with Govt. of India, state governments and WHO conducted a rapid assessment of cold chain system in the country to take stock of current situation, identify gaps, and assess the capacity of current cold chain to accommodate introduction of additional/new vaccines in order to support the MOHFW initiative on strengthening cold chain and logistic management in the country. The assessment included development of inventory of existing cold chain equipments/stores and forecasting the storage capacity for current and future needs of the UIP. The assessment also specifically looked into issues like obsolete CFC equipments which needs to be phased out by 2010 as per Montréal protocol; capacity for dry storage of essential supplies like Auto-Disable (AD) syringes; enhancing efficiency of Vaccine and logistics supply management system and finally to assess adequacy of trained manpower with essential qualifications at every level. The exercise began by desk review for very recent cold chain data received from all the states and UTs followed by field visits to selected states. The staffing pattern to support cold chain was also reviewed at all these levels. After extensive analysis, specific recommendations were also made to improve cold chain system in the country.

With the given 4 tier vaccine store network, country has a total of 66,765 operational refrigeration units (ILRs and deep freezers) and 199 walk in cold rooms and freezer rooms. Of these, 29,961 were CFC WIC/WIF/deep freezers/ice lined refrigerators. These equipments essentially should be replaced by end of 2010 with CFC-Free equipments. Most of the states, however, have been able to replace some proportion of these CFC equipments over last few years. In addition to the replacement of CFC equipments, other factors like old worn out non-CFC equipments (more than 10 years) and existing shortage of cold storage space were also considered to arrive at the net requirement of cold chain equipments. As per this calculation, there was a need of 160 WIC, 49 WIF, 25,196 ILR and 29,678 DF of varying sizes/capacity to address this alarming cold chain gap in UIP. Power back-up generator sets, auto start electric panels and voltage stabilizers etc were additional critical components that should be procured simultaneously to support cold chain capacity. Provision has been made for refrigerated vaccine vans that are vital link to prevent break in cold chain while transporting large quantities of vaccines from national or state stores. Additional equipments (approximately 30%) have been included in the forecasting to complement SIAs that are either ongoing or likely to be planned in future (measles, rubella and JE), however, there requirement will vary as per scope and type of SIA including non-electric cold chain equipments like vaccine carrier and cold boxes.

[1] Multi Year Strategic Plan, MoHFW 2004

India has 4 national vaccine stores called Government Medical Supply Depots (GMSDs), which receives, stores and supply huge quantity of vaccines, cold chain equipments and logistics to all over country. All of these GMSDs were operating in very old, damaged, derelict buildings, which need urgent renovation and construction of additional space. EVSM and VMAT assessment should be carried out periodically to identify and address gaps.

Presently, management of entire cold chain infrastructure and logistics suffers from acute shortage of trained manpower. Over the year UIP has expanded and requires specialized staff to manage cold chain and logistics at all levels. Training of existing staff and deployment of additional trained staff like vaccine and logistic manager, cold chain technicians should be urgently put in position for optimal functioning at all levels. Many of the much needed positions have not been officially sanctioned. It is proposed to expand the manpower and logistics to effectively compliment the UIP across the country. It is recommended that there is need of having a national cold chain and logistics manager. In larger states, Assistant Cold Chain Officers should be placed to share the responsibilities with state cold chain officer. National and state stores should also have trained vaccine and logistics manager to forecast, track and supply vaccine, cold chain and logistics as per guideline. Most of districts have vacant positions of cold chain mechanics which needs to be filled up urgently to bring down the sickness rate below 2%.

On the job capacity building in cold chain management was of utmost important. At present, there was only one specialized training centre in Pune with limited capacity which provides 'on the job' cold chain training at national level. Other important trainings have been decentralized with compromised quality and delays in the whole lot of training. It is, therefore, proposed that one more national level training centre be established with requisite infrastructure and human resources to expedite the pace and improve quality of trainings.

The current practice of recording and reporting of cold chain equipments, spare parts, vaccine and logistics at all stores was on paper that prevents appropriate supply chain management and timely forecasting resulting in stock out situations. Improved management and forecasting techniques for vaccines and other logistics is mandatory to control programme cost and improve operational efficiency. It is recommended that all national, state and divisional stores should have real time web-based MIS (Management Information System) to track and monitor vaccine and logistics movement and help in timely forecasting. This should later be expanded to include all districts and block level stores as well. It is also equally important to monitor the cold room performance by continuous temperature monitoring system.

To summarize, a National Cold Chain Plan (NCCP) should be prepared and implemented as a part of Multi Year Strategic Plan. This plan should be comprehensive enough to include cold chain assessment, forecasting, procurement and supply, replacement, program review, logistics and supply chain management.

1 Introduction

India has one of the largest Universal Immunization Program (UIP) in the world in terms of quantities of vaccines used, number of beneficiaries (27 million[2] infants and 30.2 million pregnant women), geographical spread (29 States and 6 Union Territories) and manpower involved. India spends more than US$ 500 million[3] every year in immunization program for immunizing children against vaccine preventable diseases including polio eradication program.

Government of India has developed ambitious Multi Year Strategic Plan for 2005-10 to take UIP to the next level. The overall UIP program management requirements, over the year, have grown and diversified tremendously. The country is advancing new strategies to increase immunization coverage and reach more children with quality vaccines. Cold chain being the most important component to ensure that quality vaccine reached to each and every child immunized. This is also important in light of new costly vaccines introduction and also thrust on reduction and elimination of certain diseases like Measles, Tetanus etc.

2 Background

India is considering strengthening of cold chain and logistics management system across the country using GAVI funds for Health System Strengthening (HSS). Government of India is also considering introduction of new vaccine in the UIP in 2009. Successful Universal Immunization Program (UIP) requires a robust cold chain system to supply potent vaccines to the target children. UNICEF India country office, with support from partners conducted a rapid assessment of cold chain system in the country to take stock of current situation, identify gaps, and assess the capacity of current cold chain to accommodate additional vaccines, to support MOHFW initiative of strengthening cold chain and logistic management in the country.

2.1 Immunization facts

UIP program targets immunizing 27 million[4] infants and 30.2 million pregnant women every year. The Fully Immunized Child (FIC) is protected against the 6 deadly Vaccine Preventable Diseases (VPD) namely Tuberculosis, Diphtheria, Tetanus, Pertussis, Polio and Measles. Hepatitis B vaccine has been introduced in 11 states of the country and it has been proposed to cover entire nation in the next phase. Immunization services are provided through vast health care infrastructure consisting of 618 district hospitals, 4045 community health centers (CHC), 22,394 PHCs and 144,988 sub-centers. The country faces stiff challenges in reaching all the target children, with coverage evaluation surveys[5] showing fully immunized children dismally below 62.4% level, apart from maintaining the potency of all vaccines till vaccination site. All Vaccines requires a storage temperature in the range of +2 to +8 Deg Celsius, except for Oral Polio Vaccine which need to be stored in frozen state (-25 to -15 deg Celsius) at all stores except PHC/ CHC/Health post.

[2] Family Welfare Statistics in India – 2006, MOHFW, Government of India
[3] Multi Year Strategic Plan, MoHFW 2004
[4] Family Welfare Statistics in India – 2006, MOHFW, Government of India
[5] Coverage Evaluation Survey – 2006, UNICEF

Table 1: WHO norms of storing vaccine[6]

<table>
<tr><td rowspan="2"></td><td rowspan="2">Primary</td><td colspan="2">Intermediate</td><td>Health centre</td><td>Health post</td></tr>
<tr><td>State</td><td>District</td><td></td><td></td></tr>
<tr><td>OPV</td><td colspan="2">-15°C to -25°C</td><td rowspan="12">+2°C to +8°C</td><td rowspan="12"></td></tr>
<tr><td>BCG</td><td colspan="2" rowspan="6">WHO no longer recommends that freeze-dried vaccines be stored at -20°C. Storing them at -20°C is not harmful but is unnecessary. Instead, these vaccines should be kept in refrigeration and transported at +2°C to +8°C.</td></tr>
<tr><td>Measles</td></tr>
<tr><td>MMR</td></tr>
<tr><td>MR</td></tr>
<tr><td>YF</td></tr>
<tr><td>Hib freeze-dried</td></tr>
<tr><td>HepB</td><td colspan="2" rowspan="6"></td></tr>
<tr><td>DT</td></tr>
<tr><td>DTP</td></tr>
<tr><td>DTP-HepB</td></tr>
<tr><td>Hib liquid</td></tr>
<tr><td>Td</td></tr>
<tr><td>TT</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="6">Diluents vials must NEVER be frozen. If the manufacturer supplies a freeze-dried vaccine packed with its Diluent, ALWAYS store the product at between +2°C and +8°C. If space permits, diluents supplied separately from vaccine may safely be stored in the cold chain between +2°C and +8°C.</td></tr>
</table>

2.2 Immunization schedule and current coverage

Table 2: National Immunization Schedule

Vaccine	When to give	Dose
For Pregnant Women		
TT-1	Early in pregnancy	0.5 ml
TT-2	4 weeks after TT-1	0.5 ml
TT- Booster	If pregnancy occur within three yrs of last pregnancy and two TT doses were received	0.5 ml
For Infants		
BCG	At birth or along with DPT-1	0.1ml (0.05ml in infants)
OPV-0	At birth or within 15 days after birth	2 drops
OPV 1, 2 & 3	At 6 weeks, 10 weeks & 14 weeks	2 drops
DPT 1, 2 & 3	At 6 weeks 10 weeks & 14 weeks	0.5 ml
Hep B* 1, 2 & 3	6 weeks 10 weeks & 14 weeks, *At Birth***	0.5 ml
Measles	9-12 months***	0.5 ml
For Children		
DPT booster	16-24 months, 5-6 years	0.5 ml
OPV Booster	16-24 months	2 drops
TT	10 years & 16 years	0.5 ml

** Pentavalent vaccine (DPT + Hep B + Hib) is likely to be introduced in future will replace DPT and Hep B vaccines given at 6, 10 and 14 weeks*
*** In Institutional delievery, additional birth dose of Hep B is given within 24 hours of birth*
**** Additional Measles-Rubella vaccine is likely to be introduced in some states at 16-24 months*

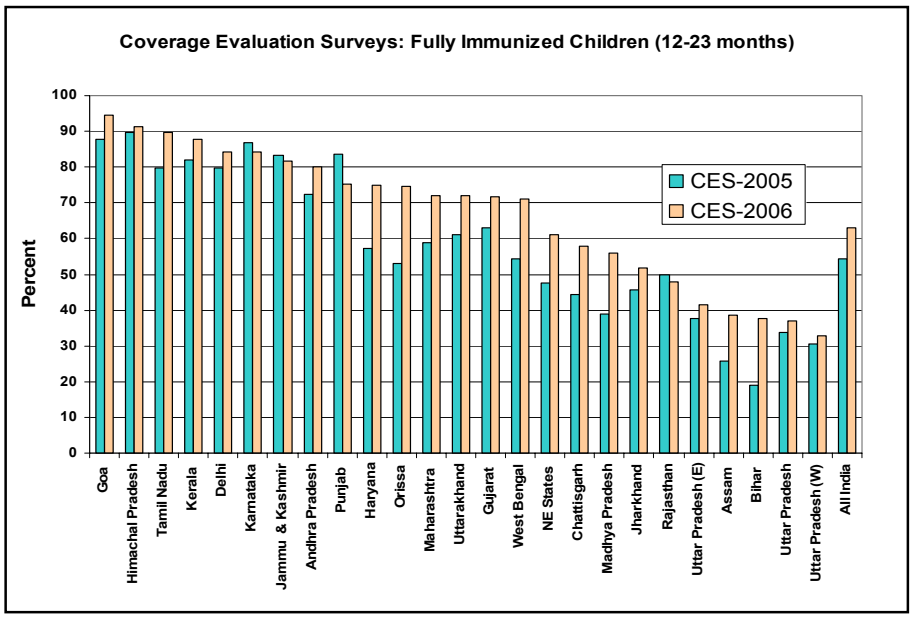
[6] Applies to WHO pre-qualified vaccine. Source: Temperature Sensitivity of Vaccine, WHO/IVB/06.10

Table 3: Vaccine storage specifications[7]

Vaccine	Number of Doses per vial	Storage volume per dose (cm^3)	Wastage rate	Net Storage volume per dose	Number of doses per target	Storage volume required per target (cm^3)
Vaccine to be stored at +2 and +8 Deg at intermediate stores						
BCG	10	1.2	25%	1.60	1	1.60
DPT	10	3	25%	4.00	5	20.00
TT	10	3	25%	4.00	3.5[8]	14.00
Measles	5	3.5	25%	4.67	1	4.67
Hep B	10	3.8	25%	5.07	3	15.20
Vaccine to be stored at -25 to -15 Deg at intermediate stores						
OPV	20	1	25%	1.33	4	5.33
Diluent to be stored at +2 to +8 Deg at Primary Health Centers						
BCG	10	0.7	25%	0.93	1	0.93
Measles	5	4.0	25%	5.33	1	5.33
Net storage volume required for +2 to +8 Deg C at **Intermediate** Vaccine Stores						**55.47**
Net storage volume required for -25 to -15 Deg C at **Intermediate** Vaccine Stores						**5.33**
Net Storage volume required for +2 to +8 Deg C at Primary Health Centers						**60.80**

The UIP targets 100% coverage of infant population in the country. As per the immunization schedule given above, country needs to procure, store, and supply approximately 560 million doses per year[9] (100% requirement of doses + additional doses covering expected 25% wastage). The volume of vaccine translates into 55.47 cm^3 per FIC of cold storage requirement per year. Presently, India has annual birth cohort of 27 Million children. These 27 million children are served through 5 tiers of vaccine stores.

Figure 1: Coverage evaluation survey 2006



[7] Vitamin A is included in the immunization schedule but it is not reflected here as it is not a part of cold chain logistics

[8] Government of India procures and supplies 3.5 doses of TT per target pregnant women (1.5 doses) and child (2 doses)

[9] Including Hepatitis B which was introduced in 11 states only at the time of assessment

2.3 Cold chain network in the country

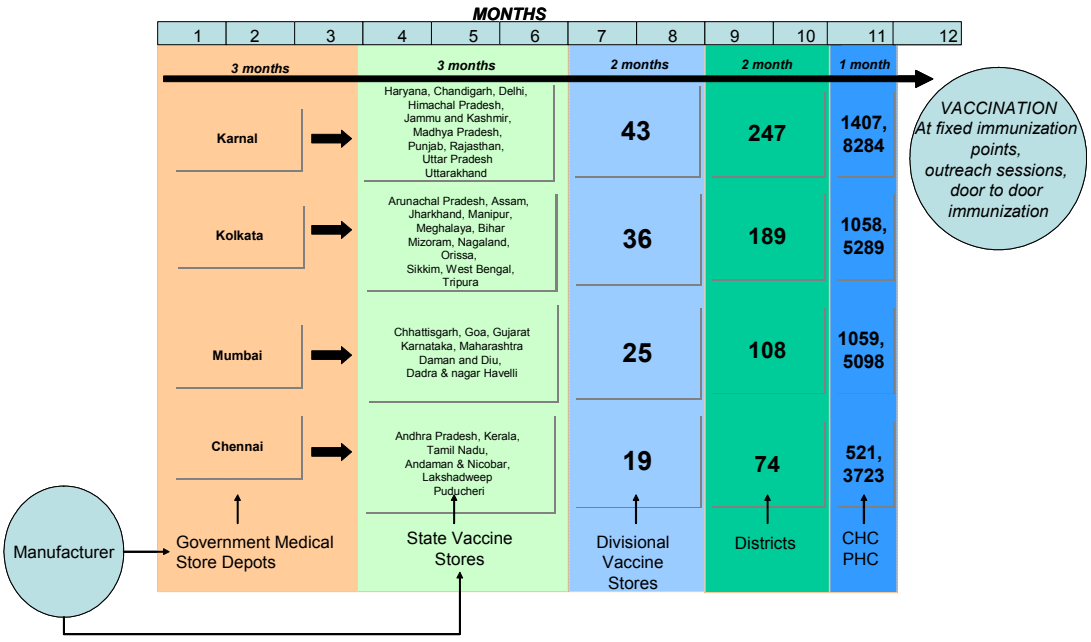
Since the inception of UIP, a wide network of cold chain stores have been created consisting of Government Medical Supply Depots (GMSD), State, Regional/Divisional Vaccine stores, District and PHC/CHC vaccine storage points. Cold chain network in the country has been the backbone to ensure that right quantity and right quality of vaccine reaches the target population. Table 4 lists out the number of vaccine stores at various levels in the country

Table 4: Number of vaccine stores in the country

Store level	Numbers
GMSD	**4**
State Vaccine stores	**39**
Divisional vaccine stores	**123**
District vaccine stores	**618**
CHC	**4,045**
PHC	**22,394**

This logistics has been managed through the cycle of storing and transporting vaccine through pre-defined network. The vaccine typically arrives at the primary stores called Government Medical Store Depots (GMSDs) where stock is maintain for maximum of 3 months. There are 4 GMSDs in the country (Karnal, Chennai, Mumbai and Kolkata). Vaccines then are transported to state vaccine stores and through divisional and district vaccine store it reaches the last storage point of CHC or PHC. Figure 2 shows the flow of vaccine through the network with approximate duration of storage.

Figure 2: Vaccine storage network and timeline



All vaccines are required to be maintained in a temperature range of +2 to +8 Deg C except for OPV which required to be in the temperature range of -25 to -15 Deg C (except at primary health centers where OPV should be stored in refrigerator for

maximum period of 1 month). The potency of vaccine should be protected right from the time vaccine leaves manufacturer till the vaccination is carried out.

2.4 Multi Year Strategic Plan 2005-10

Government of India's Multi Year Strategic Plan 2005-10 (MYSP) for Universal Immunization Program also specifically addressed the burning issues of Vaccine, Cold Chain and Logistics.

Most prominent constrains listed were: Coverage not uniform, Poor implementation of program, Poor monitoring , High drop-outs rates, Declining coverage in some major States, Over-reporting, Injection safety, AEFI monitoring inadequate, Re-orientation of staff, Inadequate cold chain replacement plan, Vacancy of staff at the field level, Surveillance of vaccine-preventable diseases , Vaccine logistics issues, Poor Maintenance of equipment.

Table 5: Multi Year Strategic Plan 2005-10: Priority Actions

MYSP Objective	Multi-Year Plan Priority Actions
1.1: Regular Sessions 1.2: Adequate Staffing	• Support each state district, block, PHC & SC to develop and monitor a Coverage Improvement Plan (CIP) to reach every child • Improve service quality through supportive supervision that provides monitoring and on-the-job training
6.3: Coverage Monitoring	• Use supportive supervision to improve data quality & use: a) Record, report and track immunizations; b) Analysis & feedback of performance at each level, including process indicators such as percent of planned sessions held; c) Validate reported data d) Develop modular learning materials and simple tools/job aids.
4.1:Social Mobilization	• Support states to develop a social mobilization plan that a) Engages existing and new partners to link with the community b) Develops communication resources and c) Stimulates community ownership for the UIP (incl. community based tracking and monitoring services)
1.5: Safe Injection	• Provide health workers with the required inputs for safe injection & disposal: a) Guidelines and training on injection technique and disposal; b) Safe injection supplies (AD syringes where possible)
1.4: Logistics	• Improve vaccine stock management through developing and implementing guidelines to specify standard processes for ordering and maintaining stock levels; monitor stock-outs and wastage
1.3: Cold Chain	• Develop and implement guidelines on cold chain management (including to rationalize location of vaccine depots and replace ageing cold chain equipment)

2.5 National UIP Review 2004

Cold Chain, Vaccine management and logistics were key issues critically appraised in National UIP Review conducted in 2004. Some of the specific shortcomings observed were:

1. Vaccine Logistics:

a. Vaccine procurement was out of sync with the realities of vaccine supply

b. There was not enough human resource capacity at national level to attend to vaccine supply, procurement and distribution
c. Large differences between reported and evaluated coverage was impacting vaccine supply
d. AD syringe quantities and delivery schedules are often not matched
e. Instances of shortages and stock-outs affecting different vaccines at different times in different parts of the system
f. Wastage was high and not monitored at any level
g. Vaccines 'pushed' down from national, state to districts as a result there was no matching of supply with requirement
h. Calculation of vaccine requirements not linked to micro-plan or realistic coverage or wastage data; there is no forecasting or adjusting supply based on use

2. Cold Chain:

a. Cold chain management was poor in some places (including private practices), particularly for temperature recording and risk of freezing the freeze-sensitive vaccines.
b. Cold chain equipment not used because no power back up and insufficient POL and funds for maintenance of cold chain equipment and generators
c. Poor response time for repairs; lack of cold chain staff and spare parts
d. Inadequate temperature recording in some places, including at some walk-in coolers/freezers

3 Rationale of current assessment

1) To assess the status and adequacy of the existing cold chain and make recommendations as per the optimal cold chain required per unit population also taking into consideration the future requirements
2) Most of the current stores and equipment are considerably old and substantial up-gradation of cold chain system may be required to meet the current and future needs of the UIP.
3) A large part of the cold chain equipment in the country known to be operating on obsolete CFC refrigerant. These equipments should be replaced with CFC-Free machines as a part of Montréal protocol.
4) Apart from the additional cold chain capacity for the proposed new vaccines, the system also urgently requires creation of additional capacity for dry storage of essential supplies like Auto-Disable (AD) syringes and efficient logistics and supply chain management system.
5) There was need to assess adequacy of trained manpower with essential qualifications at every level.

4 Scope of assessment

1) To review and identify gaps in the vaccine storage capacity of GMSDs, State Vaccine Stores, Divisional Vaccine Store and District Vaccine Stores. This information has been collated from available sources in relation to cold chain capacity of routine vaccines in immunization schedule with the inclusion of Hepatitis B.
2) To estimate the refurbishment requirements of the vaccine stores, GMSD's in particular with regards to strengthening the cold chain support structure.

3) To review the man power adequacy and capacity at vaccine stores at GMSD, state and divisional vaccine store.

5 Methodology

The desk review team focused on reviewing the assessment of cold chain logistics in the country at the Government Medical Store Depots (GMSDs), State vaccine stores and Divisional/Regional vaccine stores. The staffing pattern to support cold chain was also reviewed at all these levels.

The methodology of Vaccine Volume Calculator tool published by WHO[10] was used to arrive at the vaccine storage and dry storage area requirements at all the vaccine storage points in the country except at health facility levels. The tool considers the storage volume of each vaccine per dose, estimated wastage factor of vaccine and number of doses per Fully Immunized Child (FIC). Further the frequency of vaccine arrival and safety stock level of vaccine (as a policy) was considered to arrive at net vaccine storage requirement per FIC at vaccine store at GMSD, State, Divisional/regional and District levels. The net storage requirement was then translated into capacity of Walk-in-Coolers/Freezers, refrigerators and freezers by considering the target population of each vaccine store.

It was considered out of scope to review the present detailed physical inventory of all cold chain equipment at all the health facilities in the entire country, therefore, a cumulative method[11] of arriving at CC equipment requirement for each state was used. This was compared with the present inventory of cold chain equipment at each state to identify gaps in CC equipment storage.

The dry storage requirements for storing diluents supplied with BCG and Measles vaccines, Auto-Disable syringes for vaccination and disposable syringes for re-constitution of lyophilized vaccine was calculated using the storage requirement factor per dose of vaccine administration.

Staffing requirements was computed by accessing the tasks to be undertaken at each level of functionaries as listed in table 30. The information on the sanctioned posts, filled posts and training status of posted staff was collected and the gap between required number of personnel, posted personnel and number of people needing training was determined.

5.1 Desk review

Desk review of cold chain situation in the country covered following activities:

1. Reviewing the cold chain inventory from Ministry of Health record books
2. Reviewing the cold chain assessment reports, EVSM reports, VMAT and other cold chain assessment report of Jharkhand, Chhattisgarh, Bihar, Karnal MSD, Orissa and Rajasthan
3. The presentations by state Cold Chain Officers during cold chain officers meeting held in New Delhi 2006, Lucknow 2008, Guwahati -2008 and Pune 2008.
4. Collecting information through telephone calls to state vaccine stores and CCOs.
5. Computing the building construction cost to cover deficit dry store space
6. Reviewing the refurbishment cost estimate of improving the GMSDs

[10] Vaccine volume calculator: An aid for the introduction of new vaccines (WHO/V&B/01.24)
[11] Small ILR was considered ideal for PHC and large ILRs and DFs were considered to be ideal for district stores and CHCs.

7. Reviewing the staffing requirement to support Cold chain logistics

5.2 Field visit

The States were categorized into EAG (Empowered Action Group), North Eastern and Better performing states. As per programme priority, more number of EAG states were selected namely Uttar Pradesh, Rajasthan, Madhya Pradesh Bihar, Orissa, Jharkhand and Chhattisgarh. Assam from North East and Tamil Nadu and West Bengal from better performing states were also selected. In addition, two GMSDs (Chennai and Kolkatta) were also taken for assessment. Following methodology was used for assessment:

1. 4 Core teams were forms to do the assessment. Each team had minimum of 2 members. Additionally, officials/consultants from state joined the respective teams. Annex 2 lists out the team members and respective states covered by them.
2. GMSDs of Chennai and Kolkatta was assessed
3. States of Assam, Uttar Pradesh, Rajasthan, Madhya Pradesh, Tamil Nadu, Bihar, Jharkhand, Orissa, Chhattisgarh and West Bengal were visited during assessment.
4. State vaccine store, 2 divisional vaccine stores, 1 district and minimum of 1 PHC of each district were randomly picked for each state visited.
5. Standardized data collection forms were used (attached as annex 5).
6. Officials and technical staff members responsible for cold chain and vaccine management were interviewed.
7. On-site observations were noted with regard to standards of site maintenance, vaccine management practices, cold chain equipment conditions and effective store management.

6 Field assessment findings

The rapid cold chain assessment was carried out in 2 GMSDs and 10 states. During the assessment the state vaccine store along with selected regional, district and PHCs were visited. Annex 6 lists out the detailed field assessment report of all the 10 states visited along with a summary table of findings.

The Kolkatta GMSD was found to be having shortage of vaccine storage capacity as the concrete cold room units were functioning inadequately. Store was also facing problems of poor vaccine supply management, as the information of quantity of vaccine required for each of the states, where vaccine was supplied through this GMSD, was not shared with GMSD. The store was acting as a warehouse, where, they receive the vaccine issue and receipt orders from MoHFW. Additionally the cold rooms at the store had no electricity backup as the 75 KVA generator supplied in year 2007 was yet to be installed. The authorities, however, had identified a suitable location for installation of generator. Apart from this, the refrigerated vaccine of GMSD was not being used to deliver vaccine to states. The van had a low ground clearance as cooling unit of van was fixed at the low height between front and rear wheels on left side of vehicle.

The Chennai GMSD was facing similar problems in terms of storage capacity as the concrete cold room was performing inadequately. The WIC/WIF had no shelves and vaccine was stored on floor. The store had huge stock of poorly maintained spare parts. There was no dedicated refrigerator mechanic allotted to GMSD. The delivery of vaccine to states was often delayed due to shortage of transport facility.

The concrete cold rooms of both the GMSDs of Chennai and Kolkatta need immediate attention as the cooling units need replacement and the roof, walls and floor should be refurbished.

Among the states visited, Uttar Pradesh, West Bengal and Madhya Pradesh had no reliable information on cold chain inventory. It was also found, through communication with state authorities, that the cold chain inventory of Karnataka was not updated. These states should collect and tabulate the cold chain inventory with latest operating status of machines.

The power backup through generator was either not available or not functioning adequately (no auto start) at the state vaccine stores of Madhya Pradesh, Uttar Pradesh (poor wiring), Assam and West Bengal.

There were no dedicated cold chain mechanics at state vaccine stores of Jharkhand, West Bengal, Tamil Nadu and Bihar.

The preventive maintenance was found to be poor in all the states visited. There was no contingency and preventive maintenance plan at all the states visited. There was no provision of recording the damaged and expired vaccine in stock registers. The cold chain handlers and store keepers were, by and large, not trained in vaccine management and cold chain maintenance. The temperature recording was not reliable and there was a shortage of dry space at all the state vaccine stores visited.

7 Cold chain capacity

7.1 Present status

In this section, the situation of the present cold chain storage capacity at various levels is presented; followed by the assessment of vaccine storage capacity required based on the UIP program and the target population for each vaccine storage level. Benchmark norms and assumptions were created and used for analysis and forecasting of cold chain infrastructure in terms of capacity, manpower development for future UIP need.

7.1.1 Summary – the big picture

With the given 4 tier vaccine store network, country had a total of 66,765 operational refrigeration units of ILRs and deep freezers. In addition, India also had a total 199 cold rooms and freezer rooms. Table 6 lists out the summary of cold chain equipment in the entire country.

Table 6: Summary of cold chain equipment in the country

Equipment type	Number (CFC)	Numbers (CFC-Free)	Items stored
Concrete cold rooms	5	None	BCG, Measles, TT, DPT, DT, HepB, JE
WIC 32 m^3	12	15	BCG, Measles, TT, DPT, DT, HepB, JE
WIC 16.5 m^3	108	26	BCG, Measles, TT, DPT, DT, HepB, JE
WIF 32 m^3	2	17	OPV, Ice packs
WIF 16.5 m^3	11	8	OPV, Ice packs
ILR Large	681	1,999	BCG, Measles, TT, DPT, DT, HepB, JE
ILR Small	15,484	20,229	BCG, Measles, TT, DPT, DT, HepB, JE, Diluent (BCG and Measles)
DF Large	1,086	2,223	OPV, ice packs
DF Small	12,572	12,491	OPV, Ice packs
Cold box (20 Liters)		22,801	Mixed antigens
Cold box (5 Liters)		18,878	Mixed antigens
Vaccine carrier		1,035,049	Mixed antigens

7.1.2 Concrete cold rooms

Concrete cold rooms had been built more then 25 years ago at GMSDs of Karnal, Kolkata and Chennai based on the refrigeration technology available at that time. These large sized cold rooms were meant to store substantial volume of vaccine at these depots. With necessary refurbishment of cold rooms and replacement of cooling units with CFC-Free based compressors, these concrete cold rooms could continue to be suitable for storing vaccine

Table 7 lists the size and location of concrete cold rooms in the country used for storing UIP vaccines.

Table 7: Specification of concrete cold rooms in country

Location	Specifications of cooling units	Capacity of storage (in m^3)[12]	Population coverage capacity
GMSD Karnal	CFC	76.44 m^3	206 Million
GMSD Kolkatta	CFC	108 m^3	290 Million
GMSD Chennai	CFC	53.76 m^3	144 Million
Greater Mumbai Municipal Corporation	CFC	27 m^3	24.45 Million
Nagpur DVS	CFC-Free	35 m^3	31.7 Million

7.1.3 Walk in Coolers & walk in Freezers

There were 27 number of large WIC (32 m^3), 134 small WIC (16.5 m^3), 19 Large WIF (32m^3) and 19 small WIF (16.5 m^3) in the country. WICs and WIFs were installed at GMSD, state, regional and divisional vaccine stores. Table 8 lists out the details of installed cold rooms and freezer rooms in the country. CFC/Non-CFC status is indicated by color codes.

Table 8: Cold rooms in the country

State	Location	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Legends: State vaccine store	*CFC* CFC free				
GMSD					
Tamil Nadu	Chennai	1			1
Haryana	Karnal		1	3	
West Bengal	Kolkatta	1[13]	1	2	
Maharashtra	Mumbai	4[14]		2	1[15]
States and Divisional vaccine stores					
Arunachal Pradesh	Itanagar SVS		1		
Assam	Guwahati		1		1
	Dibrugarh		1		
	Silchar		1		
	Tejpur		1		
	Golpara		1		
Andhra Pradesh	Hyderabad SVS	1 1		1	
	Kurnool DVS		1		
	Guntoor DVS		1		
	Vishakapatnam DVS		2		
	Nizamabad DVS		1		
	Warangal DVS		1		
Bihar	Patna State vaccine store	1 2			1 1
	Bhagalpur		1		
	Muzaffarpur		1		
	Purnia		1		

[12] Vaccine storage capacity taken as 42% of gross volume
[13] 1 WIF has been converted into WIC
[14] 4 Cold rooms combined into 1 single custom built
[15] Awaiting installation

State	Location	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Legends: State vaccine store / *CFC* / CFC free					
	Motihari		1		
	Saran		1		
	Darbanga[16]		1		
	Aurangabad		1		
Chhattisgarh	Raipur	1[17]	1		1
	Jagdalpur		1		
Delhi	Delhi	1			
Gujarat	Gandhinagar		1 1	1	
	Baroda		1 1		
	Rajkot		1		
	Kutch		1		
	Surat		1		
	Bhavnagar		1		
Haryana	Panchkula		1		1
	Kurukshetra		1		
	Hissar		1		
	Gurgaon		1		
Himachal Pradesh	Shimla		1		
	Dharamshala		1		
	Mandi		1		
Jammu & Kashmir	Jammu		1		
	Srinagar		1 1		
Jharkhand	Namkum, Ranchi		2 1		1
	Giridih		1		
Karnataka	Bengaluru	1	1		1
	Belgaum	1[18]	1	1	
	Gulbarga		1		1
	Chitradurg		1		
	Mysore		1		
	Mangalore		1		
Kerala	Trivendrum		1		
	Ernakulam		1		
	Calicut		1		
Madhya Pradesh	Bhopal	1	1	1	1
	Indore		1		
	Rewa		1		
	Jabalpur	1[19]	1		
	Gwalior		1		1

[16] Old WIC was condemned (flooded) and replaced with a new one
[17] One unit awaiting installation
[18] One unit awaiting installation
[19] One WIC awaiting installation

State	Location	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Legends: State vaccine store / *CFC* / CFC free					
	Chhattarpur		1		
	Ratlam		1		
	Betul		1		
	Ujjain		1		
Maharashtra	Pune		1	1	1 1
	Aurangabad		2		1
	Kolhapur		1		
	Nasik		1		
	Parbhani		1		
	Nagpur		1		
	Akola		1		
	Thane		1		
	Latur		1		
Manipur	Imphal		1		
Meghalaya	Shillong		1		
	Tura		1		
Mizoram	Aizwal		1		
Nagaland	Kohima		1		
Orissa	Bhubneshwar	1	1	1	
	Bolangir		1		
	Phulwani		1		
	Balasur		1		
	Sambalpur		1		
	Ganjam		1		
	Koraput		1		
	Sundarghar		1		
Punjab	Chandigarh		1 1		1
	Amritsar		1		
	Firozpur		1		
	Hoshiarpur		1		
Rajasthan	Jaipur		2	1	
	Ajmer		1		
	Kota		1		
	Bikaner	1	1		
	Jodhpur		1		
	Udaipur		1		
	Bharatpur		1		
Tamil Nadu	Chennai	1	1	1	
	Coimbatore		1		1
	Cuddalore	1[20]			

[20] Awaiting installation

State	Location	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Legends: State vaccine store / *CFC* / CFC free					
	Madurai		1		1
	Thirunelvelli		1		
	Thanjavur		1		
	Vellore		1		
	Trichy		1		
	Ramnathpuram		1		
Tripura	Agartala		1		
Uttar Pradesh	Lucknow	2		1	
	Meerut	1	1	1	
	Agra	1		1	
	Faizabad		1		
	Varanasi		1 1		1
	Allahabad	1	1		
	Gorakhpur		1		
	Kanpur		1		
	Moradabad		1		
	Jhansi		1		
	Bareilly		1		
	Azamgarh		1		
	Basti		1		
	Saharanpur		1		
Uttrakhand	Dehradun		1		
	Almora		1		
	Paudi Garwal (Srinagar)		1		
West Bengal	Kolkata	1 1	1	1	
	Bardhman		1		
	Darjeeling		1		
	Murshidabad		1		
	Midnapur		1		
	Purulia		1		
	24 Parganas North		1		
	West Denajpur		1		
	Raiganj		1		
	Kooch Bihar		1		
Total CFC Free		**15**	**26**	**17**	**8**
Total CFC		**12**	**108**	**2**	**11**
Grand total		**27**	**134**	**19**	**19**

7.1.4 Refrigerators and freezers

There were 66,765 refrigerators and freezers installed and operational in the country. The cold chain equipment in the country has been installed based on

population density of each district. Out of total 66,765 equipment, 63,726 (95%) were placed in 20 larger states and rest of 5% equipment was installed in smaller states and Union Territories. Figure 3 shows the proportion of cold chain equipment installed in each states of the country.

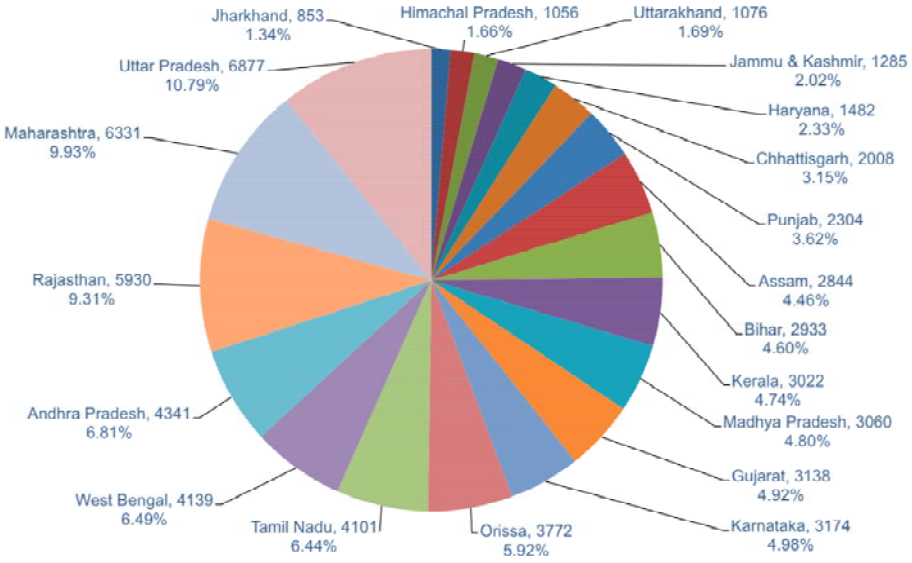


Figure 3: Share of Cold chain equipment installed per state

Table 9 summarizes the distribution of equipment for each state.

Table 9: ILRs and DFs installed, summarized by state

State	No of districts	No of CHC	No of PHC	ILR Large[21]	ILR small[22]	DF large	DF small
Andaman & Nicobar	2	4	20	4	48	2	27
Andhra Pradesh	23	167	1570	119	2742	125	1355
Arunachal Pradesh	16	31	85	20	175	21	109
Assam	23	100	610	119	1411	161	1153
Bihar	38	70	1648	144	1440	280	1069
Chhattisgarh	16	118	518	60	1261	58	629
Chandigarh	0	2	24	15	48	10	6
Dadra and Nagar Haveli	0	1	6	2	13	4	12
Daman & Diu	2	1	3	4	24	5	11
Delhi	9	0	8	10	133	22	132
Goa	2	5	19	5	70	5	32
Gujarat	26	273	1073	159	1618	190	1171
Haryana	21	86	411	33	829	66	554
Himachal Pradesh	12	71	443	32	544	36	444
Jammu & Kashmir	22	80	374	76	694	85	430
Jharkhand	22	194	330	128	467	70	188

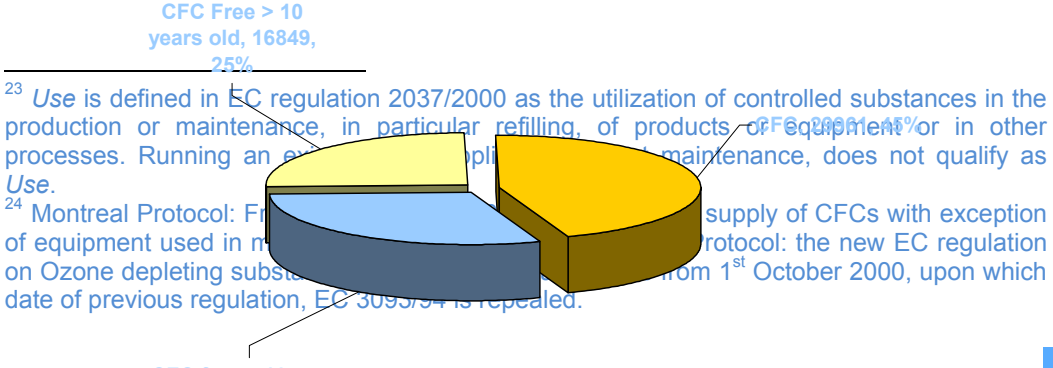
[21] Typically a large ILR is suitable for District stores and CHC's
[22] Small ILR is suitable for Primary Health Centers

State	No of districts	No of CHC	No of PHC	ILR Large[21]	ILR small[22]	DF large	DF small
Karnataka	27	254	1679	115	1753	183	1123
Kerala	14	107	909	66	1563	78	1315
Lakshadweep	0	3	4	3	33	2	22
Madhya Pradesh	48	270	1149	198	1548	234	1080
Maharashtra	35	407	1800	189	3903	228	2011
Manipur	9	16	72	25	146	28	117
Meghalaya	7	26	103	10	228	13	156
Mizoram	8	9	57	17	123	23	78
Nagaland	8	21	84	33	150	18	98
Orissa	30	231	1279	141	1812	158	1661
Puducherry	4	4	39	16	89	8	82
Punjab	20	126	484	81	1174	125	924
Rajasthan	32	337	1499	112	3310	174	2334
Sikkim	4	4	24	12	47	7	46
Tamil Nadu	31	236	1181	64	2238	163	1636
Tripura	4	10	75	25	254	18	143
Uttrakhand	13	49	232	99	534	78	365
Uttar Pradesh	70	386	3660	427	3274	481	2695
West Bengal	20	346	922	117	2017	150	1855
Total	**618**	**4,045**	**22,394**	**2,680**	**35,713**	**3,309**	**25,063**

7.1.5 CFC equipment

In addition to upgrading the cold chain capacity, country is required to plan the replacement of refrigeration units that have potential of depleting the ozone layer (CFC machines). Country had total of *29,961* CFC units including concrete cold room WIC, WIF, refrigerators and freezers. As per the Montreal Protocol the production and use[23] of CFC substances should be reduced to zero by year 2010, however the equipment running on CFC can continue to operate beyond 2010 with no scope of repair and maintenance. With the exception of refrigerant leak free equipment it has become impractical to operate CFC based equipment ever since beginning of 2001[24]. Most of the states however, have already received the part replacement of CFC equipment.

Figure 4: Share of CFC and CFC-Free equipment in the country



[23] *Use* is defined in EC regulation 2037/2000 as the utilization of controlled substances in the production or maintenance, in particular refilling, of products or equipment or in other processes. Running an ex... maintenance, does not qualify as *Use*.

[24] Montreal Protocol: Fr... supply of CFCs with exception of equipment used in r... rotocol: the new EC regulation on Ozone depleting subst... from 1st October 2000, upon which date of previous regulation, EC 3093/94 is repealed.

Table 10 lists the CFC cold chain equipment in the country that needed replacement at priority.

Table 10: CFC equipment in the country

Type of equipment	Number of CFC units
Concrete cold room	5
WIC 32 m^3	12
WIC 16 m^3	108
WIF 32 m^3	2
WIF 16 m^3	11
ILR Large	681
ILR small	15,484
DF Large	1,086
DF small	12,572
Total	**29,961**

7.1.6 Cold boxes & vaccine carriers

The cold boxes are required to transport vaccine between regional, district vaccine stores, CHCs and PHCs. There were total 22,801 large cold boxes with 20 liters of storage capacity and 18,878 small cold boxes of 5 liters of storage capacity. Large cold boxes are typically needed at intermediate stores and small cold boxes at PHCs.

Vaccine carriers are used for outreach and campaign immunization sessions by vaccinators. There were total of 1,035,049 vaccine carriers in the country. Table 11 shows the stock position of cold boxes and vaccine carriers in the country summarized by states.

Table 11: Inventory of cold boxes and vaccine carrier

State/Union Territories	Vaccine carrier with 4 IP available	Cold box	
		20 Liters	5 Liters
A & N Islands	555	21	30
Andhra Pradesh	75,120	280	50
Arunachal Pradesh	2,172	134	195
Assam	30,000	1,120	196
Bihar	51,119	2,003	1,373
Chandigarh	615	2	0
Chhattisgarh	26,245	708	221
D & N Haveli	100	0	0
Daman & Diu	188	5	4
Delhi	110	42	8
Goa	853	0	240
Gujarat	40,000	1,370	40
Haryana	20,500	100	0
Himachal Pradesh	12,295	235	435
Jammu & Kashmir	15,228	283	162
Jharkhand	32,949	1112	1,338

State/Union Territories	Vaccine carrier with 4 IP available	Cold box	
		20 Liters	5 Liters
Karnataka	47,735	2100	804
Kerala	11,100	100	100
Lakshadweep	50	0	40
Madhya Pradesh	91,000	1,525	1,350
Maharashtra	77,936	2,093	1,651
Manipur	6,400	0	10
Meghalaya	5,476	60	300
Mizoram	2,500	0	100
Nagaland	5,000	180	123
Orissa	30,330	998	1,528
Puducherry	772	36	121
Punjab	28,165	702	456
Rajasthan	95,580	1,700	600
Sikkim	1,470	5	146
Tamil Nadu	38,500	2,820	1,647
Tripura	6,225	51	172
Uttar Pradesh	149,026	2,108	3,989
Uttrakhand	20,300	280	450
West Bengal	109,435	628	999
Total	1,035,049	22,801	18,878

7.2 Storage capacity analysis

The vaccine storage requirement was calculated based on storage volume required per Fully Immunized Child. The annual volume required per FIC was estimated as 55.47 cm^3 for +2 to +8 Cº storage and 5.33 cm3 for -25 to -15 Cº storage. Refer to table 3 for details of storage calculations per FIC.

Annual volume of vaccine storage requirement was then factored to the frequency of vaccine arrival at vaccine stores. Normally, if there is higher number of shipments per year, then the storage required per FIC is lower.

The net storage requirement per shipment cycle was translated into population covered by each equipment. Table 12 shows the population coverage by each typical type of equipment installed in the country.

This capacity of population coverage was compared with the existing cold chain capacity in the country for every store. The phase out of CFC equipment and all cold chain equipment aged more then 10 years were factored out for replacement. The net total requirement of each vaccine store was then calculated.

The terms used in this document and chart to define the requirement of CC equipment are as follows:

CFC equipment	Cold Chain equipment using CFC gas that must be replaced by non CFC as per Montréal protocol

Equipment more than 10 year old[25]	Equipment that were procured more than 10 years ago (as they are more expensive to repair and maintain)
Shortage	Cold chain equipment needed as per the population served by the store's geographical coverage minus already existing equipment that are CFC-free and less than 10 year old
CFC free	Equipment that are CFC free and have age less than 10 years

Requirement of new cold chain equipment has been calculated by adding the following:

- ☞ The equipment required for routine immunization as per population coverage ***plus***
- ☞ 30% additional reserved equipment for campaigns ***minus***
- ☞ Operational CFC free equipment of less then 10 years of age

Table 12: Population coverage of cold chain equipment

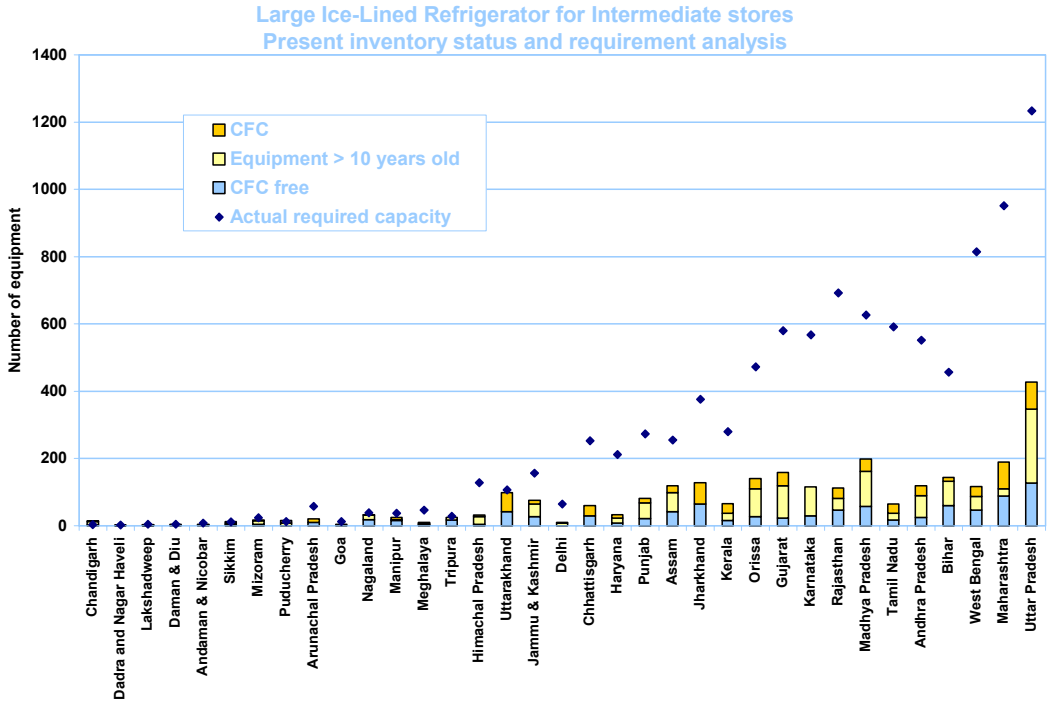
Particulars	Cold chain equipment							
	WIC		WIF		ILR (Large)	Deep freezer (Large)	ILR (Small)	Deep Freezer (small)
	16.5 m^3	32 m^3	16.5 m^3	32 m^3				
Net vaccine Storage volume per equipment (in Cubic centimeter)	6,930,000	13,440,000	6,930,000	13,440,000	108,000	213,000	45,000	72,000
Number of shipments per year	4	4	4	4	6	6	12	12
Total vaccine storage capacity (net volume x frequency)	27,720,000	53,760,000	27,720,000	53,760,000	648,000	1,278,000	540,000	864,000
Volume required per Fully immunized child	55.47	55.47	5.33	5.33	55.47	5.33	60.80	5.33

[25] All the equipment procured before year 2001.

Particulars	Cold chain equipment							
	WIC		WIF		ILR (Large)	Deep freezer (Large)	ILR (Small)	Deep Freezer (small)
	16.5 m^3	32 m^3	16.5 m^3	32 m^3				
(in cubic centimeter)								
Safety Stock 25 %	13.80	13.80	1.38	1.38	13.80	1.38	15.20	1.38
Target population (infant) covered/equipment	400,173	776,093	1,002,532	1,944,304	9,354	46,221	7,105	31,248
Target population covered (in Millions)	0.40	0.77	1.00	1.94	0.009	0.05	0.007	0.03
Total Population covered /equipment (assuming CBR 0.03) in million	**13.34**	**25.67**	**33.42**	**64.81**	**0.30**	**1.54**	**0.24**	**1.04**

The large ILRs used primarily at district and PHC/CHC level, are typically sufficient to cover the 0.33 million of population. The net assessed requirement of large ILR across country was 9,931 machines. Presently, there were 2,680 large ILRs installed in the country out of which 886 were CFC-free of less then 10 years age, 1,113 CFC-free of age more then 10 years and 681 CFC units. All Large ILRs that were more than 10 year of age including CFC needed to be discarded. This brings the net requirement to 9,045 additional new large ILRs.

The small ILRs are normally sufficient to cover the 0.24 million population and were installed at PHC level. The net requirement of small ILR across country was 29,126 machines. Presently, there were 35,713 working small ILR in the country out of which 13,064 were CFC-free of less then 10 years age 7,165 CFC-free of age more then 10 years and 15,484 CFC units. All small ILRs that were more than 10 year of age including CFC needed to be discarded. This brings the net requirement to 16,151 additional small ILRs. Figure 5 shows the requirement analysis of ILRs in the country.



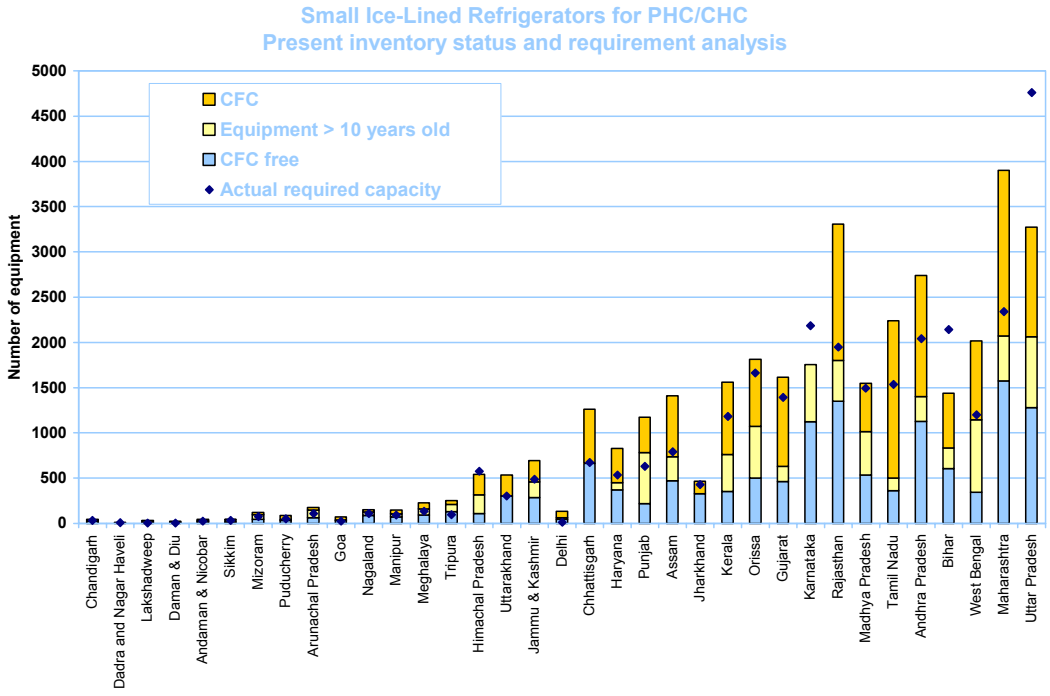
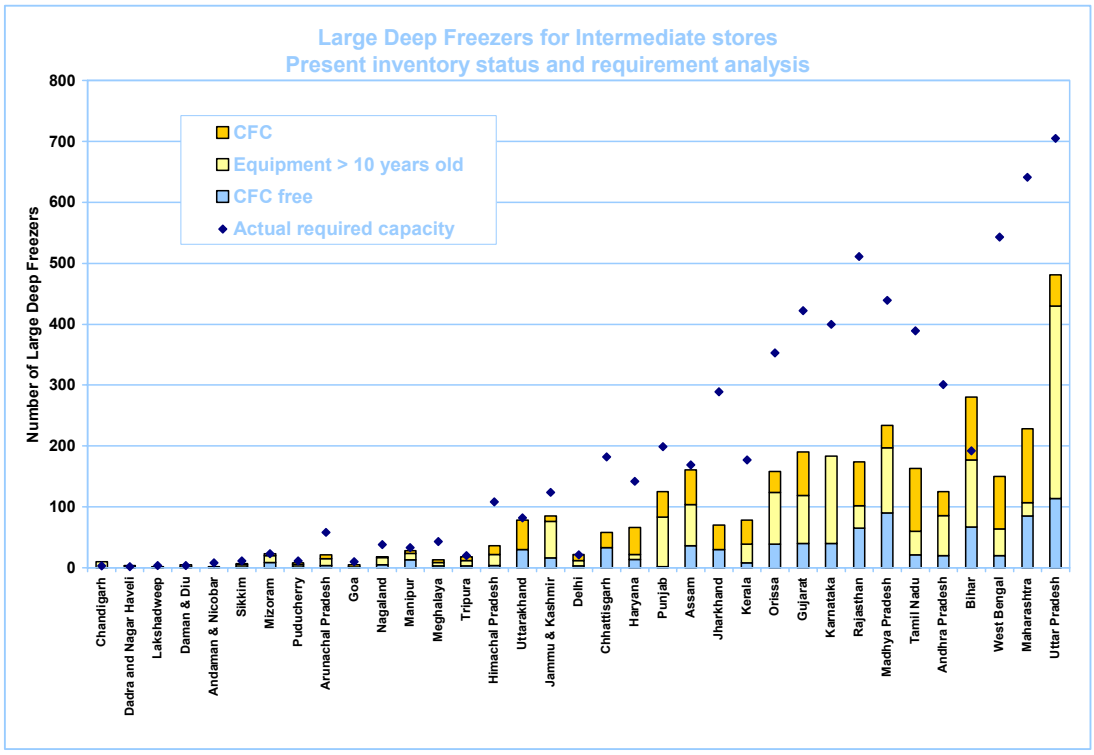


Figure 5: Situation of ILRs in the country

The large DFs used primarily at district and CHC level stores are typically sufficient to cover the 1.54 million of population. The net assessed requirement of large DFs across country was 6,657 machines. Presently, there were 3,309 large DFs installed in the country out of which 818 were CFC-free of less then 10 years age, 1,405 CFC-free of age more then 10 years and 1086 CFC units. All large

DFs that were more than 10 year of age including CFC needed to be discarded. This brings the net requirement to 5,839 additional new large DFs.

The small DFs are normally sufficient to cater to 1.04 million population and were installed at PHC level. The net requirement of small DF across country was 29,126 machines. Presently, there were 25,063 small DF working in the country out of which 5,325 were CFC-free of less then 10 years age 7,166 CFC-free of age more then 10 years and 12,572 CFC units. All small DFs that were more than 10 year of age including CFC needed to be discarded. This brings the net requirement to 23,839 additional small DFs.



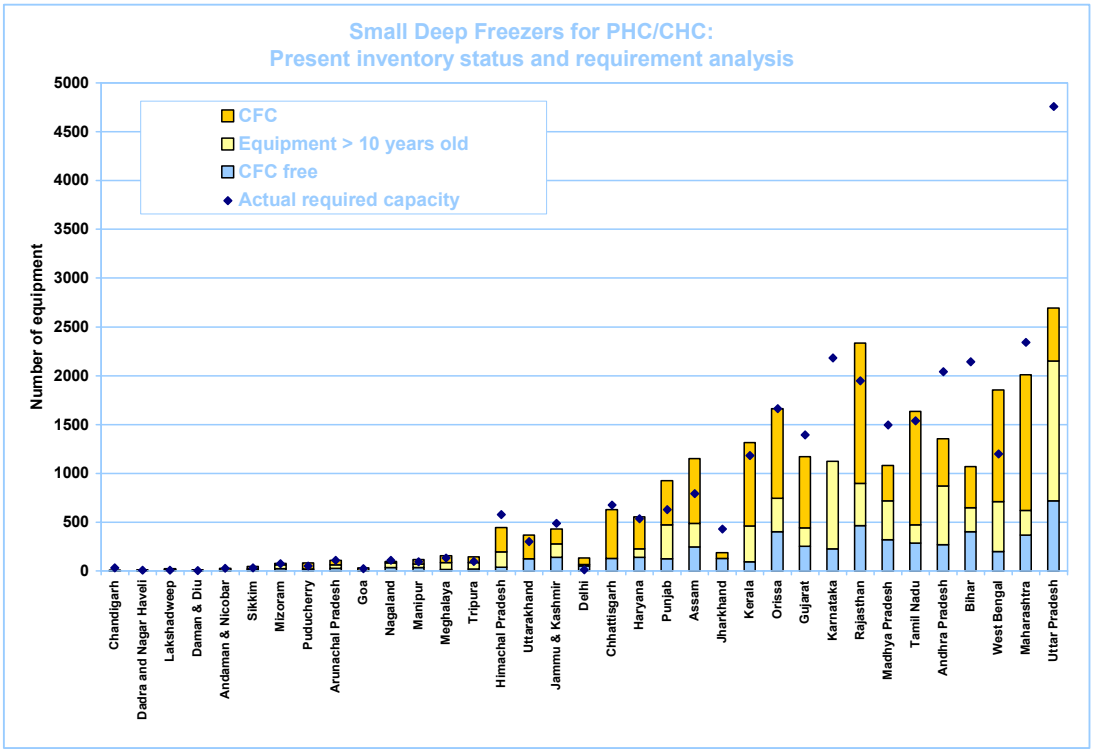


Figure 6: situation of DF's in the country

Though the storage volume requirement of DFs is much less then of ILRs as per FIC but the minimum requirement per storage point demands at least one DF at each storage facility. It is to be noted that from the period of 2004 till 2008 Government of India has procured and installed total number of 15,814 equipment towards CFC replacement out of which ILRs share 72% of total equipment procured and DFs (both large and small) accounted for 28% of total procurement. This has lead relatively to a DF shortage in the country.

7.3 Storage Capacity enhancement

7.3.1 Summary

The vaccine storage capacity at various store levels need enhancement as there are equipment that needed replacement and there was critical shortage of vaccine storage space at various levels. Following section lists out the total additional cold chain equipment requirement considering following factors:

- *Replacement of CFC equipment wherever needed*
- *Replacement of CFC-Free equipment which are more then 10 years of age*
- *Additional equipment to address shortage of cold storage space*

Table 13: Summary of cold chain equipment required

Type of equipment	Additional equipment required[26]
WIC 32 m^3	55
WIC 16 m^3	105
WIF 32 m^3	38
WIF 16 m^3	11
ILR large	9,045
ILR small	16,151
DF large	5,839
DF small	23,839

7.3.2 Walk in Cooler & Walk in Freezer requirements[27]

All the CFC WIC/WIF are required to be replaced with CFC-Free. The GMSDs has serious vaccine storage constrains and additionally needed 23 Large WICs and 14 Large WIFs to address the present storage shortage. Further, state vaccine stores needed additional 47 WIC's and 10 WIF's to address the deficiency of storage. Table 14 Lists out the summary of required WIC/WIF in the country. Annex 7 lists the details of WIC/WIF required at relevant sites.

Table 14: Additional requirement of WIC and WIF in the country

Vaccine store	Deficit		CFC replacement				Total			
	WIC 32 m^3	WIF 32 m^3	WIC 32 m^3	WIC 16 m^3	WIF 32 m^3	WIF 16 m^3	WIC 32 m^3	WIC 16 m^3	WIF 32 m^3	WIF 16 m^3
GMSD Chennai	3	2					**3**		**2**	
GMSD Karnal	9	5		1			**9**	**1**	**5**	
GMSD Kolkata	2	3		1			**2**	**1**	**3**	
GMSD Mumbai	9	4	4				**13**		**4**	
Total of GMSD	**23**	**14**	**4**	**2**			**27**	**2**	**14**	
State vaccine stores	16	1	11	20	1	8	**27**	**20**	**2**	**8**
Divisional vaccine stores		21	1	83	1	3	**1**	**83**	**22**	**3**
Grand Total	**39**	**36**	**16**	**105**	**2**	**11**	**55**	**105**	**38**	**11**

There was a net requirement of 54,874 additional refrigerators/freezers in the country. The detailed requirement is listed below through Table 15 to Table 19.

Table 15: Summary of ILRs/DF required

Equipment	Requirement by Target population	Available CFC-Free < 10 yrs age	Additional requirement
ILR Large	9,931	886	9,045

[26] Inclusive of CFC replacement
[27] Only at GMSD & state vaccine stores. Regional/divisional vaccine stores to be evaluated

Equipment	Requirement by Target population	Available CFC-Free < 10 yrs age	Additional requirement
ILR Small	29,126	13,064	16,151
DF Large	6,657	818	5,839
DF Small	29,126	5,325	23,839

Table 16: Large ILR requirement

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Chandigarh	3	2		11	2	1
Dadra and Nagar Haveli	2			1	1	2
Lakshadweep	4	1		1	1	3
Daman & Diu	4		1	2	2	4
Andaman & Nicobar	8	2	2		2	6
Sikkim	11	4		4	4	7
Mizoram	24	5	2	10	2	19
Puducherry	13			8	8	13
Arunachal Pradesh	58	10	24		10	48
Goa	13	4	5		1	9
Nagaland	39	18		14	1	21
Manipur	37	16	3	2	7	21
Meghalaya	47	3	26	3	4	44
Tripura	28	17		8		11
Himachal Pradesh	128	5	67	22	5	123
Uttrakhand	107	42			57	65
Jammu & Kashmir	156	27	44	38	11	129
Delhi	64		39	8	2	64
Chhattisgarh	253	29	134		31	224
Haryana	212	8	130	15	10	204
Punjab	273	21	129	47	13	252
Assam	255	42	77	57	20	213
Jharkhand	376	65	147		63	311
Kerala	280	16	149	21	29	264
Orissa	472	27	246	83	31	445
Gujarat	580	23	300	96	40	557
Karnataka	567	30	308	85		537
Rajasthan	692	47	425	34	31	645
Madhya Pradesh	626	58	207	104	36	568
Tamil Nadu	591	17	375	20	27	574
Andhra	552	25	297	64	30	527

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Pradesh						
Bihar	457	60	211	73	11	397
West Bengal	814	47	509	40	30	767
Maharashtra	952	88	583	22	79	864
Uttar Pradesh	1233	127	559	220	80	1106
Total	**9,931**	**886**	**4,999**	**1,113**	**681**	**9,045**

Table 17: Small ILR requirement

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Chandigarh	32	27		11	10	5
Dadra and Nagar Haveli	8	2			11	6
Lakshadweep	6	10		18	5	
Daman & Diu	4	9		6	9	
Andaman & Nicobar	26	23		5	20	3
Sikkim	32	16		25	6	16
Mizoram	75	45		50	28	30
Puducherry	51	33		8	48	18
Arunachal Pradesh	111	65		84	26	46
Goa	25	34		5	31	
Nagaland	110	87		40	23	23
Manipur	94	70		36	40	24
Meghalaya	134	91		71	66	43
Tripura	98	131		78	45	
Himachal Pradesh	576	109		206	229	467
Uttrakhand	302	303			231	
Jammu & Kashmir	487	287		173	234	200
Delhi	11	48		15	70	
Chhattisgarh	674	664			597	10
Haryana	535	371		79	379	164
Punjab	630	217		567	390	413
Assam	793	472		264	675	321
Jharkhand	429	329			138	100
Kerala	1182	354		406	803	828
Orissa	1663	500		572	740	1163
Gujarat	1395	461		170	987	934
Karnataka	2183	1123		630		1060
Rajasthan	1949	1353		449	1508	596

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Madhya Pradesh	1494	535		481	532	959
Tamil Nadu	1536	364		137	1737	1172
Andhra Pradesh	2041	1130		271	1341	911
Bihar	2143	604	208	229	607	1539
West Bengal	1199	347		796	874	852
Maharashtra	2340	1572		500	1831	768
Uttar Pradesh	4758	1278		783	1213	3480
Total	**29,126**	**13,064**	**208**	**7,165**	**15,484**	**16,151**

Table 18: Requirement of Large DF

State	Requirement by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Chandigarh	3			10		3
Dadra and Nagar Haveli	2			3	1	2
Lakshdweep	4		1	1	1	4
Daman & Diu	4	1	2		4	3
Andaman & Nicobar	8		4		2	8
Sikkim	11	1	1	4	2	10
Mizoram	23	9		11	3	14
Puducherry	11	1		4	3	10
Arunachal Pradesh	58	4	23	11	6	54
Goa	10	1	3		4	9
Nagaland	38	5	11	12	1	33
Manipur	33	13		11	4	20
Meghalaya	43	3	20	6	4	40
Tripura	20	3		9	6	17
Himachal Pradesh	108	4	45	18	14	104
Uttrakhand	82	30			48	52
Jammu & Kashmir	124	16	10	60	9	108
Delhi	21	3		9	10	18
Chhattisgarh	182	33	82		25	149
Haryana	142	14	43	8	44	128
Punjab	199	2	28	81	42	197
Assam	169	36		68	57	133
Jharkhand	289	30	42		40	259
Kerala	177	8	58	31	39	169
Orissa	353	39	113	85	34	314

State	Requirement by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Gujarat	422	40	116	79	71	382
Karnataka	400	40	104	143		360
Rajasthan	511	65	213	37	72	446
Madhya Pradesh	439	90		107	37	349
Tamil Nadu	389	21	150	39	103	368
Andhra Pradesh	301	20	25	66	39	281
Bihar	192	67		110	103	125
West Bengal	543	20	267	44	86	523
Maharashtra	641	85	243	22	121	556
Uttar Pradesh	705	114	50	316	51	591
Total	**6,657**	**818**	**1,654**	**1,405**	**1,086**	**5,839**

Table 19: Requirement of small DF

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Chandigarh	32	5	1		1	27
Dadra and Nagar Haveli	8	2			10	6
Lakshadweep	6			15	7	6
Daman & Diu	4	4			7	
Andaman & Nicobar	26	2		6	19	24
Sikkim	32	14		8	24	18
Mizoram	75	25		36	17	50
Puducherry	51	15		6	61	36
Arunachal Pradesh	111	26		35	48	85
Goa	25			5	27	25
Nagaland	110	35		46	17	75
Manipur	94	35		34	48	59
Meghalaya	134	15		69	72	119
Tripura	98	20		64	59	78
Himachal Pradesh	576	40		154	250	536
Uttrakhand	302	125			240	177
Jammu & Kashmir	487	140		139	151	347
Delhi	11	49		16	67	
Chhattisgarh	674	130			499	544
Haryana	535	140		88	326	395
Punjab	630	125		347	452	505
Assam	793	244		243	666	549
Jharkhand	429	130	38		58	299

State	Require-ment by Target population	Available CFC-Free < 10 years old	Shortage	Available CFC-Free > 10 years old	Available CFC equipment	Net additional required
Kerala	1182	95		366	854	1087
Orissa	1663	402		343	916	1261
Gujarat	1395	255		185	731	1140
Karnataka	2183	225		898		1958
Rajasthan	1949	465		434	1435	1484
Madhya Pradesh	1494	320		399	361	1174
Tamil Nadu	1536	285		188	1163	1251
Andhra Pradesh	2041	270		599	486	1771
Bihar	2143	402	579	245	422	1741
West Bengal	1199	200		511	1144	999
Maharashtra	2340	365		256	1390	1975
Uttar Pradesh	4758	720	789	1431	544	4038
Total	**29,126**	**5,325**	**1,407**	**7,166**	**12,572**	**23,839**

7.3.3 Cold boxes and vaccine carriers

Cold boxes are required for transportation of vaccine at all levels except from MSD to regional vaccine stores. The appropriate number of cold boxes was calculated based on following criteria:

Store	20 Liters	5 Liters
District vaccine store	5	
CHC	3	
PHC	1	1

Given the above criteria, the country need total 37,001 of 20 Liters sized cold boxes and 22,394 of 5 Liters cold boxes. As there were 22,801 and 18,878 numbers of large and small cold boxes respectively, there was a need of additional 15,238 and 7022 of large and small cold boxes respectively. Table 20 lists the requirement of cold boxes summarized by state.

Vaccine carriers are required for outreach immunization sessions and immunization campaigns. Vaccination in India has normally been carried out by ANMs and vaccinators during campaigns. There were 1,035,049 vaccine carriers as against 167,642 positions[28] of ANMs. The number of vaccine carriers was 6 times more then the numbers of ANM and considering the SIAs/campaigns of Polio, JE and Measles the numbers are sufficient in quantity. However the effective age of vaccine carrier is about 5 years, there is a need of replacing 20% of vaccine carriers every year. Given this the net present requirement of vaccine carriers is 200,000 approximately.

[28] Required number of ANMs in the country as on March 2007. Source MoHFW

STATE/UT	No of Districts	No of PHC	No of CHC	Appropriate number of cold boxes						Total available[29]		Cold box Additional requirement	
				PHC		CHC	District	Total		Large	Small	Large	Small
				Large	Small	Large	Large	Large	Small				
A & N Islands	2	20	4	20	20	12	8	40	20	21	30	19	
Andhra Pradesh	23	1570	167	1570	1570	501	92	2163	1570	280	50	1883	1520
Arunachal Pradesh	16	85	31	85	85	93	64	242	85	134	195	108	
Assam	23	610	100	610	610	300	92	1002	610	1120	196		414
Bihar	38	1648	70	1648	1648	210	152	2010	1648	2003	1373	7	275
Chandigarh		24	2	24	24	6		30	24	2		28	24
Chhattisgarh	16	518	118	518	518	354	64	936	518	708	221	228	297
D & N Haveli		6	1	6	6	3		9	6			9	6
Daman & Diu	2	3	1	3	3	3	8	14	3	5	4	9	
Delhi	9	8		8	8		36	44	8	42	8	2	
Goa	2	19	5	19	19	15	8	42	19		240	42	
Gujarat	26	1073	273	1073	1073	819	104	1996	1073	1370	40	626	1033
Haryana	21	411	86	411	411	258	84	753	411	100		653	411
Himachal Pradesh	12	443	71	443	443	213	48	704	443	235	435	469	8
Jammu & Kashmir	22	374	80	374	374	240	88	702	374	283	162	419	212
Jharkhand	22	330	194	330	330	582	88	1000	330	1112	1338		
Karnataka	27	1679	254	1679	1679	762	108	2549	1679	2100	804	449	875
Kerala	14	909	107	909	909	321	56	1286	909	100	100	1186	809
Lakshdweep		4	3	4	4	9		13	4		40	13	

[29] Availability of cold boxes and vaccine carriers as presented by CCOs during cold chain review meetings held in 2007-2008

STATE/UT	No of Districts	No of PHC	No of CHC	Appropriate number of cold boxes						Total available[29]		Cold box Additional requirement	
				PHC		CHC	District	Total		Large	Small	Large	Small
				Large	Small	Large	Large	Large	Small				
Madhya Pradesh	48	1149	270	1149	1149	810	192	2151	1149	1525	1350	626	
Maharashtra	35	1800	407	1800	1800	1221	140	3161	1800	2093	1651	1068	149
Manipur	9	72	16	72	72	48	36	156	72		10	156	62
Meghalaya	7	103	26	103	103	78	28	209	103	60	300	149	
Mizoram	8	57	9	57	57	27	32	116	57		100	116	
Nagaland	8	84	21	84	84	63	32	179	84	180	123		
Orissa	30	1279	231	1279	1279	693	120	2092	1279	998	1528	1094	
Puducherry	4	39	4	39	39	12	16	67	39	36	121	31	
Punjab	20	484	126	484	484	378	80	942	484	702	456	240	28
Rajasthan	32	1499	337	1499	1499	1011	128	2638	1499	1700	600	938	899
Sikkim	4	24	4	24	24	12	16	52	24	5	146	47	
Tamil Nadu	31	1181	236	1181	1181	708	124	2013	1181	2820	1647		
Tripura	4	75	10	75	75	30	16	121	75	51	172	70	
Uttar Pradesh	70	3660	386	3660	3660	1158	280	5098	3660	2108	3989	2990	
Uttrakhand	13	232	49	232	232	147	52	431	232	280	450	151	
West Bengal	20	922	346	922	922	1038	80	2040	922	628	999	1412	
Total	**618**	**22,394**	**4,045**	**22,394**	**22,394**	**12,135**	**2,472**	**37,001**	**22,394**	**22,801**	**18,878**	**15,238**	**7022**

7.4 Support supplies

7.4.1 Generator

Electric supply for sufficient duration is essential for maintenance of cold chain environment required for vaccines. In the event of continuous power failure for more then 4 hours, WIC/WIF require alternate power source such as diesel generators. Typically one generator of 15 KVA is needed to operate one WIC or WIF. Therefore, with every new installation of WIC/WIF, a diesel generator (along with AMF panel) is required.

7.4.2 Refrigerated vaccine trucks

The chances of breakage of cold chain during the transportation of the vaccines are very high. During the field visit, it was pointed out that, the volume capacity of the insulated vaccines vans provided by Government of India was too less. Hence GMSDs were hiring the refrigerator vaccine trucks for transporting the vaccines to state vaccine stores. State stores generally transport the freeze sensitive vaccine in primary packaging (not in cold box) to regional or district vaccine stores. Hence, it is proposed that all GMSDs should have 2 refrigerated trucks and each State/Regional/Division stores should have one refrigerator truck so that the vaccines can be transport with in the temperature range of 2^{o} C to 8^{o} C.

7.4.3 Cold Chain Mobile Workshop

Many states have shown practical and useful innovation in maintenance and repair of cold chain equipment. Tamil Nadu and Rajasthan have mobile cold chain repair workshops which are maintaining the equipments across the states very efficiently and effectively. The break down rate of cold chain equipment in these states was very low. The mobile workshop mounted on light motor vehicle has one 3 KVA diesel generating set along with complete tools, spares and other accessories for repairs of all cold chain equipments at any PHC even in remote locations. The major break downs such as replacement of compressors could also be attended to within 24 hrs. Since the hold over time of WIC/WIF is very less, this mobile workshop was very useful to attend the repairs of WIC/WIF too.

It is proposed that each State/Regional store should have at least one vehicle mounted mobile cold chain repair workshop with sufficient manpower like cold chain mechanic and driver.

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Table 20: Infrastructure required on support structure

Equipment type	Number of units
Diesel Generators[30] (15 KVA rating)	215
Refrigerator vaccine van[31]	43
Cold Chain Mobile Workshop[32]	158

[30] one for each WIF/WIC
[31] 2 each for GMSDs + One for each state head Quarter
[32] 1 each for State and regional head quarter

Equipment type	Number of units
Voltage Stabilizers for ILR and DF[33] (1 KVA rating)	54874
Spare parts[34]	
Starting device for compressor	11415
Capacitor for compressor	3807
Thermostat	11415
Compressor	3807
Fan motor	11415

8 Infrastructure development

8.1 Building maintenance

The vaccine stores should be equipped with specific set of amenities and facilities. All the buildings of vaccine stores should be furbished according to "Guidelines for establishing or improving primary and intermediate vaccine stores, WHO/V&B/02.34". There is need of additional dry storage area as with the introduction of AD-syringes in 2005 in UIP, dry store area requirement has gone up considerably.

8.2 E-Governance

Cold chain information in India is mostly recorded and reported on paper and communicated at health centers. The practice of maintaining stock registers is well established, but critical components such as batch numbers, expiration dates and vaccine damage were inconsistently included in ledger entries. Equipment records were also maintained, but not in a manner that facilitates maintenance and procurement planning. The existing system is unable to meet the program needs of the Universal Immunization Program (UIP). Improved management and forecasting techniques for vaccines and other logistics is mandatory to control programme cost and improve operational efficiency. Central and State Government officials, UIP managers, storekeepers at Government medical store depots (GMSD), state, regional and districts stores face unprecedented challenges in the area of Cold Chain Management Information System (MIS), which calls for a twenty-first century technological solution.

The monitoring and surveillance of vaccine stores through electronic means (internet, email and fax) can be effectively done through web-based MIS (Management Information System). The basic requisites of implementing E-Governance are: Availability of computer kit, internet connection, trained staff and tools to implement MIS. It is of equal importance to monitor the cold room performance by recording and analyzing the temperature of cold room on continuous basis through computerized temperature monitoring system. MSD's and state vaccine stores are required to be E-enabled immediately so that the MIS of cold chain management and logistics can be implemented by Dec 2008. However, many fold increase in cost will be needed, once this will be expanded down the line to district and block level, which includes expansion of scope of software, training and hardware support.

[33] 1 for each ILR and DF respectively
[34] Refer to annex 13 for detailed list of spare parts required

8.3 National Cold Chain Training Center

It was evident from field visits that the training of staff at all level was a crucial issue and adversely affecting the UIP programme. It is proposed that a new National Cold Chain Training Center exclusively for cold chain be established at a suitable place in India. This should be in addition to SHTO Pune, which at present is the only training centre imparting cold chain trainings. The proposed training center should have good infrastructure, full time dedicated faculty, adequate cold chain equipments and spare parts to facilitate training.

The specifications of training centre are as under:

Course	Vaccine and logistics management Cold chain equipments maintenance (on the job training)
Trainees	Vaccine and logistics manager Cold chain officers Store keeper s Refrigerator mechanics Cold Chain handlers Refrigerator van drivers
Faculty	Director (Training) – 1 Course Coordinators – 3 Technical facilitators – 2
Area required	1000 meter^2
Facilities required	Lecture hall: complete with all amenities Furnished Office rooms and cabin for staff On job training workshop with working tables Library Mini bus for field visits during trainings
Equipment needed	Walk-In-Freezer: 1 Number Walk-In-Cooler: 1 Number Generator sets: 2 numbers of 15 KVA AMF panels Ice Lined Refrigerators: 10 Numbers Deep Freezers: 10 Numbers Solar refrigerators and Solar Chill: 10 Numbers Voltage stabilizers: Few Numbers Cold boxes: Few Numbers Vaccine Carriers: Few Numbers

9 Human resource

9.1 Post justification

Presently, management of entire cold chain infrastructure and logistics suffers from acute shortage of trained manpower. Over the year UIP has expanded and requires specialized staff to manage cold chain and logistics at all levels. Many of the much needed positions have not been officially sanctioned. It is proposed to expand the manpower and logistics to effectively compliment the UIP across the country. The details are given below.

9.1.1 Cold chain officer

The cold chain officer should be an engineering graduate, having adequate experience of maintenance in refrigeration and air conditioning. He should be well conversant with intricacies of the universal immunization programme.

The CCO will be responsible to maintain cold chain equipment with in prescribed response time and break down time, Preventive maintenance, inventory control of spare parts and training to Medical officers, refrigerator mechanics and cold chain handlers.

The requirement of CCO is:

National level (With MoHFW)	One
State level (With DFW)	One for each state

9.1.2 Vaccine and logistics manager

The vaccine and logistics manager (V&LM) is required at national and state levels. The vaccine and logistics manager should be specialist in supply chain management preferably be a logistician, pharmacist or an IT person with good knowledge of MIS. Good computer knowledge is essential asset.

The V&LM will be responsible to manage stock of vaccine and other logistics as per WHO guidelines at all the levels of vaccine store.

The requirement of V&LM is:

National level (With MoHFW)	One
State level (With DFW)	One for each state

9.1.3 Assistant cold chain officer

In larger states like Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Maharashtra, one assistant cold chain officer may be deployed at selected regional level. The officer will be responsible to maintain cold chain of one or more region of the state. The assistant cold chain officer should be diploma engineer in refrigeration and air conditioning and worthwhile experience of maintenance of cold chain.

The responsibility of the assistant cold chain officer will be same as of cold chain officer.

9.1.4 Store keeper

Every store up to the level of district, should have dedicated store keeper to handle the vaccine, cold chain and other logistics. Store keeper could be either pharmacist or science graduate. Good computer knowledge is essential asset. Before deployment, adequate training should be provided on vaccine management and storing in cold chain as per the national/ WHO guidelines

9.1.5 Technical assistant cold chain

To assist cold chain officer at state level one Technical Assistant is recommended by Government of India at state level, however, very few states had posted a technical person on this post. The technical assistant should have diploma in refrigeration and air conditioning and adequate experience of cold chain maintenance

9.1.6 Cold chain technician

It is proposed that all cold chain stores from GMSD upto district store level should have one or more cold chain technicians to maintain the cold chain equipments. The technician is responsible to maintain equipment available at particular level.

At GMSD, state and regional/divisional level, the technician will be responsible for the maintenance of cold chain equipments and in districts he will be responsible for the major and minor repairs. The technician should have ITI in refrigeration and air conditioning and 5 years experience of repairs of CFC-free refrigerators and air conditioner.

9.1.7 Cold chain handler

The cold chain handlers will be responsible for the movement of the vaccines in State, Region, District and PHCs stores. At present cold chain handlers are LHV/ANM/MPW available in the PHC but they are not exclusively trained for managing vaccines and logistics. They are also not given any induction training before given the responsibility of cold chain handling.

The person given the responsibility of cold chain handling should be given adequate prior training and refresher trainings at frequent intervals. Given the vaccine and logistics load, two dedicated cold chain handlers are recommended at each GMSDs, State, regional and district level and one each at PHC level

9.2 Post requirements

Table 21: post requirements

Designation	Total positions needed	In position	Additional required
Cold chain officer	36	20	16
Vaccine and logistics manager	36	Nil	36
Astt. Cold chain officer	15	Nil	15
Technical assistant	35	22	13
Store keepers	749	NA*	NA*
Cold chain mechanics	753	387	366
Cold chain handlers	27,951	27,442	509

* Information not available

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10 Financial implications

Ever since the inception of UIP, there have been substantial efforts to expand and maintain the cold chain in the country. The process of assessment, forecasting, procurement and replacement of aged/defective equipment is continuous and need regular large investments. The requirement of maintaining and upgrading the system increases every year if this regular investment in cold chain is not made.

In the past for many years, adequate quantity of cold chain equipments has not been systematically procured. It has lead to large gaps in the CC equipment requirement. Present financial estimates have been made to refurbish the entire cold chain system as per the proposed norms for the first two years. However, a part of the estimated budget required to support the cold chain logistics will be recurring and should be included in annual budget.

During the estimate, it was assumed that average life of electrical cold chain equipment is ten years, therefore every year 10% of total equipments needs replacement and should be budgeted for in annual health budget. Similarly non electrical cold chain equipments (vaccine carrier, cold boxes) have an average life of 5-6 years, and therefore needs regular replacement. In India, there are approximately 1,000,000 vaccine carriers and 41,000 cold boxes. Every year 15-20% of these should be replaced after a life span of 5-6 years. This will not only prevent sudden upsurge in financial requirement in any particular year but also maintain working cold chain through out year at all places.

The details of the investment for the first two years (table 22) and thereafter every year is listed as table 23 below.

Table 22: Cost estimates for revamping cold chain system in first 2 years

Components	Equipment type	Cost per unit (in USD)	Requirement	Total cost(USD)
Electrical Cold Chain Equipments	Concrete cold room cooling units	$5,000	5	$25,000
	WIC 32 m^3	$32,500	55	$1,787,500
	WIC 16.5 m^3	$28,750	105	$3,018,750
	WIF 32 m^3	$33,000	38	$1,254,000
	WIF 16.5 m^3	$29,000	11	$319,000
	ILR Large	$1,067	9045	$9,651,015
	ILR Small	$775	16151	$12,517,025
	DF Large	$737	5839	$4,303,343
	DF small	$570	23839	$13,588,230
	Total Equipments			**$46,463,863**
Support Supplies	Generators	$4,500	215	$967,500
	Refrigerated vaccine van	$30,000	43	$1,290,000
	Mobile workshop	$22,500	158	$3,555,000

Components	Equipment type	Cost per unit (in USD)	Requirement	Total cost(USD)
	Voltage stabilizer	$75	54874	$4,115,550
	Computers/ MIS software installation/ trainings/ accessories	(average)		$2,500,000
	Vaccine carrier	$15	200,000	$3,000,000
	Cold boxes	$100	10,000	$1,000,000
	All Spare parts	(average)		$1,500,000
	Total Support supplies			**$17,928,050**
GMSDs up gradation	Repair and renovation of store buildings	$250,000	4	$1,000,000
	Repairs of cold rooms	$60,000	3	$180,000
	Electronic temperature monitoring	$50,000	4	$200,000
	Computer kit and other logistics	$20,000	4	$80,000
	Total GMSD up gradation			**$1,460,000**
Trainings	Infrastructure for new training centre	$500,000	1	$500,000
	Equipments & supplies	$250,000	1	$250,000
	Running cost (2 years)	$400,000	1	$400,000
	costs of participants and trainers (2 years)	$500	1,000	$500,000
	Total Trainings			**$3,110,000**
			Grand total	**$68,961,913**

The above estimate doesn't include cost of additional human resources required at different levels like Assistant cold chain officers, Store manager, National CCO and logistic managers etc.

Table 23: Annual recurrent cost for maintaining cold chain system

Components	Equipment type	Cost per unit (in USD)	Requirement	Total cost(USD)
Cold Chain Equipments	WIC 32 m^3	$32,500	1	$32,500
	WIF 32 m^3	$33,000	0.5	$16,500
	ILR Large	$1,067	88	$93,896
	ILR Small	$775	1300	$1,007,500
	DF Large	$737	82	$60,434
	DF small	$570	532	$303,240

Components	Equipment type	Cost per unit (in USD)	Requirement	Total cost(USD)
	Total Equipments			**$1,514,070**
Support Supplies	Generators	$4,500	25	$112,500
	vaccine van (refrigerated/ other)	$30,000	10	$300,000
	Voltage stabilizer	$75	2000	$150,000
	Vaccine carrier	$15	100,000	$1,500,000
	Cold boxes	$100	10,000	$1,000,000
	Total Support supplies			**$3,062,500**
Trainings	Running cost of training centre	$200,000	1	$200,000
	costs of participants and trainers	$500	500	$250,000
	Total Trainings			**$450,000**
			Grand total	**$5,026,570**

11 Alternate scenarios

11.1 Inclusion of Measles-Rubella (MR) and Pneumococal Vaccine in routine immunization

In the future Government of India may decide to introduce the MR and Pneumococal vaccine in routine immunization. This section presents the impact of introduction of these two vaccines on cold chain storage requirement. Table 24 lists the specifications of these two vaccines.

Table 24: Specifications of new vaccine

Specifications	MR vaccine	Pneumococal vaccine
Number of doses per target	One	Three
Vial representation	10 dose vial	PCV-7 single dose, pre-filled syringe
Vaccine storage temperature range	+2 to +8 Deg C	+2 to +8 Deg C
Storage Volume required per dose	2.5 cm^3	59.7 cm^3
Estimated wastage rate per dose	25%	10%
Net storage volume required per dose	3.33 cm^3	66.33 cm^3

11.2 Changes to the vaccine storage requirements

The vaccine storage volume per FIC with inclusion of MR in immunization schedule will increase to 56.8 cm^3 (approx. 7% increase as compared to present schedule) at national and intermediate stores. The requirement of cold chain

equipment however will increase only by 3% as the capacity of each equipment is fixed and occupancy will never 100% full.

The storage volume requirements per FIC will increase substantially (403%) with inclusion of Pneumococal vaccine. This is primarily because the vaccine is represented in single dose pre-filled syringe form. The requirement of WIC (large) will go up by 296%. Requirement of large ILR would be higher by 327% considering providing Large ILRs to 50% of PHCs which cover large portion of population. The ratio of additional WICs to ILRs is higher because the several divisional vaccine stores would qualify for new WICs.

Finally the storage requirement per FIC would increase by 409% considering introduction of both MR and Pneumococal vaccine in routine immunization.

Table 25 lists the impact of various scenarios to the vaccine storage requirements.

Table 25: Impact of introduction of vaccine to cold chain requirements

Immunization scenarios	Storage volume required per FIC (cm^3)[35]	WIC 16 m^3	WIC 32 m^3	Large ILR	Small ILR
Present schedule with EPI vaccine including HepB.	55.47	134	70[36]	9931	29126
Present schedule with inclusion of **MR** vaccine	58.80	134	71	10233	29126
Present schedule with inclusion of **Pneumococal** Vaccine	252.47	134	277	42369	29126
Present schedule with inclusion of both **MR** and **Pneumococal** Vaccine	257.8	134	279	42659	29126

11.3 Inclusion of Pentavalent vaccine

Government of India may consider introducing the Pentavalent vaccine in immunization schedule. The Pentavalent vaccine will replace 3 doses of DTP and 2 doses of Hepatitis B (1st birth dose of Hepatitis B will continue to be part of routine). The known representations of Pentavalent vaccine with 3 doses per FIC is reflected in table below.

Vaccine representation	Doses per vial	Storage volume per dose (cm^3)	Expected wastage rates	Net vaccine storage requirement per FIC[37] (cm^3)
Liquid + lyophilized	1	22	10%	106.67
Liquid + lyophilized	2	11	10%	70.00
Liquid + lyophilized	10	5.3	25%	54.53
Liquid	1	12.9	10%	76.33

[35] For +2 to +8 Deg C temperature storage. There will not be any changes in -25 to -15 Deg C storage requirement as both MR and Pneumococal vaccine is required to be stored at +2 to +8 Deg C

[36] Including CFC free WIC currently operational, CFC replacement and deficit requirement

[37] Including the other EPI vaccine in present immunization schedule

Looking at scenario above, if single dose liquid presentation is included in immunization schedule, the net storage requirement per FIC will go up by 42% compared to storage volume required for present immunization schedule. The introduction of lyophilized Pentavalent vaccine of 10 dose vial presentation will decrease the cold chain vaccine storage requirement by about 2% or, in other words, will not have any impact on vaccine storage space requirement. The storage volume of 5 and 10 dose liquid presentation of Pentavalent vaccine is not yet known. However, assuming the storage volume of 10 dose liquid presentation of vaccine is less then 10 dose lyophilized vaccine, there will be no additional requirement of cold chain storage space. Similarly, the 5 dose liquid presentation with storage volume of 5.5 cm3 or less per dose will not require additional vaccine storage space.

12 Recommendations

12.1 Overall

1) A National Cold Chain Plan should be prepared as a part of the Multi Year Strategic Plan of the UIP. This plan should be reviewed and revised periodically. The essential components of the plan should include regular cold chain assessment, cold chain equipment forecasting, procurement and supply, regular retiring of old and sick cold chain equipment, regular program review with cold chain officers, staff trainings, maintenance and servicing of cold chain equipment, implementation of MIS, logistics and supply chain management.
2) Country requires urgent replacement of cold chain equipment. It is recommended that country should:
    a. Replace all equipment that are CFC/ non functional/more than 10 year of age in the next 2 years
    b. Upgrade the capacity of all cold chain stores based on the target population of the area served as has been proposed in this assessment
3) Cold chain replacement could be divided into three parts
    a. Urgent – Where there is requirement of additional cold chain space
    b. Essential-Replacement of CFC equipment with CFC free as per Montreal protocol by not repairing these equipment especially when there is gas leakage
    c. Desirable -Replacement of 10 year old CFC free equipment as repair cost is un-economical
4) The condition of the GMSDs was poor and requires urgent renovation. It is recommended that the capacity and infrastructure of all GMSD(4) to be upgraded to meet the National and WHO's EVSM requirements which includes renovation, refurbishment, adding more storage capacity, continuous temperature monitoring, computerization and real time tracking of vaccine and logistics. Later, this should be scaled up to state and districts stores as well.
5) It is recommended that the management of all vaccine stores at national (GMSDs) and state (State/Regional/Divisional) should adhere to WHO standards of Effective Vaccine Store Management. It is therefore suggested that self-assisted EVSM assessment should be carried out at all GMSDs, State/Regional/Divisional vaccine stores at the earliest in a planned phased manner. Subsequently, EVSM self assessment should be carried out by each store as per their annual action plan.
6) Vaccine Management Assessment Tool (VMAT) is an effective tool to implement good vaccine management practices at state and district level. Many states like Orissa and Bihar have drawn considerable benefits out of VMAT assessments. It is recommended that VMAT should be implemented in all the states across the country.

7) It is recommended to conduct a study on vaccine wastage rates to find out actual vaccine wastage. This is particularly important, while planning to introduce costlier new vaccines.

8) Incorrect interpretation of VVM is a major issue in management of vaccine supply and is acting as a barrier in vaccine supply chain. It is recommended that all states and districts should receive clear guidelines and training on interpretation of Vaccine Vial Monitors (VVM). Rejection of vaccine, when in usable stage should be strongly discouraged. Guidelines should enforce and encourage fast movement of vaccines to immunization centers if they are in stage II of VVM.

9) Staff efficiency is linked to their technical capacity and understanding of the program especially when they are newly appointed. It is recommended that:

    a. New National Cold Chain Training Center should be established

    b. Refresher training of cold chain staff on maintenance and repair of cold chain and allied supporting equipment (Generators, Voltage Stabilizers, Electric Panels

    c. Training to be conducted on installation, maintenance and troubleshooting of new advanced equipment like CFC free WIC/WIF, solar refrigerators, solar chills, etc.

    d. All newly appointed staff who handle cold chain and vaccine logistics should be provided with induction training on UIP, basics of cold chain and vaccine handling including stock keeping practices, equipment maintenance, VVM interpretation and other basics of immunization. There should also be regular refresher training to upgrade the knowledge and skill.

10) Often the supply of vaccines was not correctly bundled with diluents and other stores. It is recommended that guidelines on bundling of vaccine and related consumables (diluents, syringes, droppers, etc) should be circulated to all the stores.

11) To meet the requirements of special immunization campaigns such as polio, measles, rubella, and Japanese encephalitis, it is recommended that additional cold chain storage space at all levels should be planned and created in consultation with program managers to meet the requirement of such special campaigns. This additional store space should include both electrical (DF, ILR) and non electrical equipments (Vaccine carrier, cold boxes). The additional quantity requirement may vary as per scope and type of campaign.

12) Deployment of requisite human resources is essential to keep pace with the development and expansion of cold chain system for UIP. It is recommended that new positions should be created and staff recruited to support the cold chain and logistics as proposed in section 9.

13) A robust MIS to manage supply line of expensive vaccines flowing through the cold chain system should be implemented for real time management of supply chain of vaccine/logistics and cold chain system. All stores from national to district level should be provided with computers system along with broadband internet connections to implement the MIS.

14) All the vaccine stores including state, divisional and districts should be provided with dry storage space with the norms of 14.82 m^3 per million of population.

15) As per electrical safety norms of India, all the electrical points in vaccine stores should be connected to ISI sockets and proper earthing.

16) The generators installed to provide power backup to all the WICs should be attached to AMF panel and made auto-start.

17) Fire extinguishers should be installed at all the vaccine stores in the country.

18) All the non functional/ condemned cold chain equipment should be auctioned immediately as these are occupying much needed dry space.

19) All vaccine storage sites should have contingency and emergency plans in the event of failure of power or breakdown of cold chain equipment.

20) State should be encouraged to establish and maintain spare parts depot at state vaccine stores with the adequate quantity of spare.

21) All refrigeration mechanics should be provided with cold chain repair and maintenance toolkit.

12.2 Government Medical Store Depots

1) All GMSD need dedicated manpower for vaccine/logistics store management, cold chain equipment maintenance and temperature monitoring. Necessary staff should be provided as recommended in section 9.
2) Repair the concrete cold rooms of Karnal, Kolkatta and Chennai including reinforced flooring, sealing of leakages on roof, insulation, air ducting and replacement of cooling units.
3) Install the 75 KVA generator at Kolkatta GMSD to provide power back to all the cold rooms (Concrete/WIC/WIF) at the suitable location.
4) Improve the ground clearance of refrigerated van in GMSD Kolkatta by repairing/modifying the AC unit location to make the vehicle operational as it is not being used currently due to low ground clearance. The AC unit is presently installed at the bottom section of vehicle between the left side of front and rear wheel of the van.
5) GMSD Kolkatta should receive the copy of vaccine requirement requests from states that are covered by GMSD for delivery of vaccine. Presently the GMSD could not access the vaccine shipment projection that affects their efficiency of managing the vaccine stocks.
6) GMSD should improve and align the frequency and quantity of vaccine shipped to the states to the national immunization targets and schedules.
7) GMSDs should improve the administrative co-ordination between CPWD and GMSD for the repair and maintenance of building infrastructure.
8) GMSD should define strategy of handling stocks of vaccine and other commodities that were not accepted by states for given reasons. There were 2 instances observed at GMSD Kolkatta where GMSD was holding stocks of HepB vaccine and glass syringe with no clear guidelines on how to deal with this stock.
9) Provide a dedicated cold chain technician to look after the GMSDs. The maintenance of concrete cold room in Kolkatta and Chennai was done by CPWD and WIC/WIFs have been outsourced to a private agency in Kolkatta.
10) Post of Astt. Depot Manager (ADM) at Chennai GMSD was lying vacant for more than 6 months, which needs to be filled up urgently.
11) Store Superintendent and store keeper of GMSD Chennai should be trained on vaccine management. Under the light of this requirement a training program on vaccine management should be organized for all the staff managing vaccine and cold chain at GMSDs.

12) The two cooling units of concrete cold room in GMSD Chennai were outdated and functioning inadequately and these should be replaced on priority basis.
13) Review the performance of contractor under AMC of cold chain equipment at GMSD Chennai. The Cold chain equipment at GMSD Chennai is poorly maintained and warrant urgent attention.
14) Shelves to be provided for WIF in GMSD Chennai and concrete cold rooms at GMSD Kolkatta and Chennai.
15) A team of cold chain technicians should be deployed to review and prepare the inventory of spare parts at Chennai GMSD.
16) Mumbai GMSD should be assigned a dedicated space for vaccine and related supplies in form of Immunization Warehouse.

12.3 State Specific

12.3.1 Assam

1) State should be provided with two additional vaccine vans for state store and one each for Karbi Anglong, NC hills, Hailakandi, Cachar and Silcher. All vaccine vans should be four wheel drives.
2) The batteries of all the solar refrigerators in the state should be replaced.
3) 500 additional power stabilizers should be provided for power protection of cold chain units. Out of these 300 should of rating 90-280 volts.

12.3.2 Bihar

1) Vacant positions of DIOs & Refrigerator Mechanic should be filled up in each district urgently.
2) All staff handling cold chain and vaccine management should be regularly trained through refresher training programs.
3) New PHCs should be made functional with regards to last vaccine storage point with provision of ILR and DF on priority.
4) Preventive maintenance plan should be reviewed and strengthen with the present private service provider (under AMC) to minimize the sickness rate.

12.3.3 Chhattisgarh

1) Provide and install the generators at all the vaccine stores including state, divisional and district vaccine stores.
2) Establish a separate district vaccine store of Raipur and separate the facility from state vaccine store including the vaccine storage equipment, dry storage area and stock registers.
3) Replace the WIF installed at secretariat and install it at state vaccine store.
4) Post qualified and trained cold chain handlers at five district stores of Korea, Korba, Janjgir-Champa, Mahasamund and Dantewada.
5) Wiring and earthing should be improved at all the vaccine stores on a priority basis.
6) Assess the feasibility of converting the Korba district vaccine store to divisional vaccine store such that the vaccine can be supplied to northern districts of the State from Korba.
7) An intensive training programme should be conducted for all health workers with cold chain responsibilities and middle level managers with immunization responsibilities.

12.3.4 Jharkhand

1) Establish the three divisional vaccine stores at Deoghar, Palamau and Chaibasa as proposed in PIP.
2) Install the newly supplied WIC at Deoghar which is currently lying at the vaccine store.
3) Regularize the schedule of salary and other payments that help in motivating personnel.
4) The cold chain maintenance should be decentralized by posting one cold chain mechanic at each district store. These mechanics should be trained in maintaining and repairing solar cold chain equipment also.
5) Rationalize and restructure the distribution plan of hybrid (solar and electrical) refrigerators.
6) Rationalize distribution of cold chain equipment and adopt a 5-year equipment procurement plan.
7) A plan as to what is to be done with beyond repair and non-working equipment needs to be prepared. Special care needs to be taken when it comes to disposal of CFC machines.
8) All the solar refrigerators installed in the state should:
    a. Be protected with caging of solar panels to prevent theft.
    b. The size solar panels should be increased to appropriate numbers based on location and size of solar refrigerator/freezer installed.

12.3.5 Madhya Pradesh

1) CCO should be provided with adequate mobility, computer and internet facility.
2) Issue and Install the 84 CFC free ILRS and 10 DFs as allotted to PHCs.These equipment are presently lying at state vaccine store.
3) The maintenance and repair of WIC/WIF should be contracted as an AMC to qualified agency.
4) Generators should be connected to cold chain equipment at Raisen district store. The generator was installed and operational but found not connected to equipment.
5) Vaccine arriving directly from manufacturer should be delivered up to the state vaccine store. The vaccine is presently picked by the state vaccine store from Airport.

12.3.6 Orissa

1) Update the cold chain handlers modules with examples of practical demonstration and inclusion of vaccine logistics management.

12.3.7 Rajasthan

1) Dock for loading and unloading vaccine at the state vaccine store should be constructed.
2) State store should be renovation to fix the water seepage through the roof.
3) Vaccine van of Alwar, Bhilwara, Nagaur and Jaipur should be replaced and the present vans should be condemned as they are in poor condition.
4) Create 2 new state vaccine stores at Udaipur and Jodhpur to simplify the vaccine distribution logistics as suggested in figure 7.

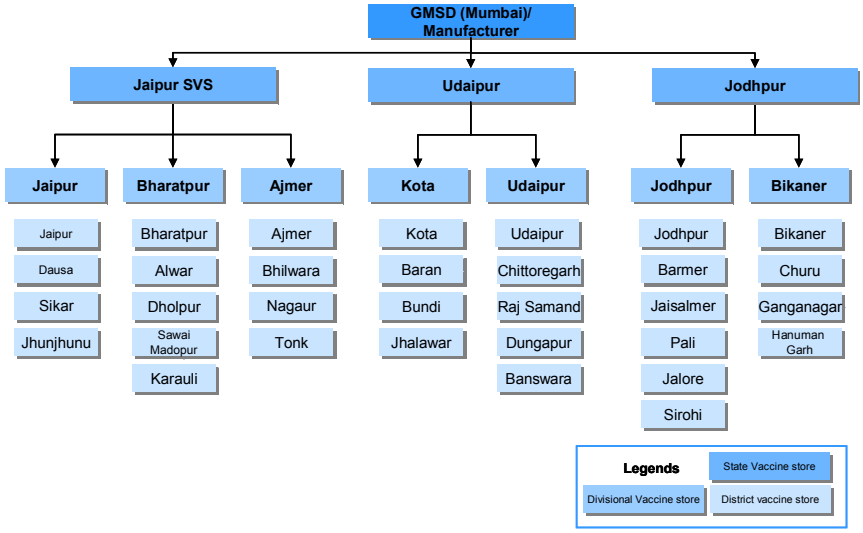

Figure 7: Proposed Vaccine supply network of Rajasthan

5) Provide dedicated and adequate dry storage area at all the divisional vaccine stores. The dry storage area was found to be adequate only at Jaipur state vaccine, Bharatpur and Bikaner.
6) Provide separate building and infrastructure facilities of Jaipur Divisional vaccine store and Jaipur district vaccine store as both are presently operating from a common location.
7) Given the large size of the state, the logistics and vaccine manager is required at state level.
8) The vacant post of technical assistant should be filled at state level.
9) A dedicated Pharmacist or a store keeper should be posted at state vaccine store, Jodhpur divisional, Ajmer divisional vaccine store. Presently the refrigerator mechanics are deployed at this position. Following the posting at these positions, the refrigerator mechanics should be relocated to district stores where the post of refrigerator mechanic is vacant.

12.3.8 Tamil Nadu

1) Preventive maintenance plan should be strengthen with the present private service provider (under AMC) to minimize the sickness rate.

12.3.9 Uttar Pradesh

1) Given the large size of the state, the logistics and vaccine manager is required at state level. Additionally an assistant CCO is required to be posted at Agra, Meerut and Varanasi state vaccine stores.
2) State Vaccine store of Lucknow should be relocated to new premises with minimum constructed area of 800-1000 m^2.
3) Inventory of cold chain equipment in the state should be updated.
4) The vaccine and diluents are stored at two different locations far from each other under state vaccine store Lucknow. It is recommended to stock the vaccine and related supplies together at Lucknow state vaccine store for the ease of bundling while distribution.

12.3.10 West Bengal

1) The store facility of state vaccine store should be re-organized and refurbished. The stocks of spare parts and other supplies should be stored in an organized manner.
2) The 10 KVA generator supplied with new WIC (2007) should be installed and commissioned.
3) Store incharge and store supervisor should be training in vaccine management as there has been clear evidence of vaccine not being issued in right quantities to designated districts.
4) Provide protection of power through stabilizer to all the WIC/WIFs installed at state vaccine store. These WIC/WIFs were found to be operating without any protection.
5) Inventory of cold chain equipment in the state and spare parts at the state vaccine store should be prepared. Setup a mechanism to update the cold chain inventory through the existing repair and maintenance agency. CCO should be provided with technical support from cold chain expert to set up the mechanism.

ANNEXURES

ANNEX 1: CREDENTIALS

Authors

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Ranjit Dhiman, UNICEF

Advisors

Dr Sunil Khaparde, Deputy Commissioner MoHFW, Govt. of India
Dr Naresh Goel, Assistant Commissioner MoHFW, Govt. of India
Dr Marzio Babille, UNICEF
Dr Satish Kumar Gupta, UNICEF
Dr Dhananjoy Gupta, UNICEF
Dr Paul Francis, WHO

ANNEX 2: TEAM COMPOSITION

Team Member	Organization	Desk Review	Field Assessment
Satish Kumar Gupta	UNICEF	✓	Bihar
Sunil K Saxena	UNICEF	✓	Tamil Nadu, Rajasthan, Madhya Pradesh
Ranjit Dhiman	UNICEF	✓	Uttar Pradesh, West Bengal
Dhananjoy Gupta	UNICEF	✓	-
Harish Kumar	UNICEF	✓	Uttar Pradesh, West Bengal
Paul Francis	WHO	✓	-
Pragati Kamthan	WHO	✓	Tamil Nadu
Pravin Khobragade	UNICEF		Chhattisgarh
Saurabh Sharma	UNICEF		Chhattisgarh
Sanjay Bhardwaj	UNICEF		Uttar Pradesh
Siddharth Shankar Dutta	WHO		Uttar Pradesh
Kamlesh lal Chandani	UNICEF		Uttar Pradesh
Manish Jain	Immunization Basics		Uttar Pradesh
Manisha Nair	WHO		Rajasthan
Krishnendu Bhattacharya	UNICEF		West Bengal
Kaninika Mitra	UNICEF		West Bengal
Preetam Patro	UNICEF		Bihar
Narottam Pradhan	UNICEF		Bihar
Renu Paruthi	WHO		Madhya Pradesh
Srihari Dutta	UNICEF		Orissa
Ajay Trakroo	UNICEF		Assam
Jhankar Hazarika	UNICEF		Assam
Madhulika Jonathan	UNICEF		Jharkhand
Dhananjay Singh	UNICEF		Jharkhand
Sumant Mishra	Immunization Basics		Jharkhand

ANNEX 3: SITES COVERED THROUGH ASSESSMENT

State	Team members	Sites assessed
Assam	Ajay Trakroo Jhankar Hazarika	1) DVS Golpara 2) DS Golpara 3) PHC Agia
Bihar	Satish Gupta Sherin Varkey Preetam Patro Narottam Pradhan	1) SVS Patna 2) DVS Muzzaffapur 3) DS Hajipur
Chhattisgarh	Pravin Khobragade Saurabh Sharma	1) SVS Raipur 2) DS Dhamtari
Madhya Pradesh	Sunil Kumar Saxena Renu Paruthi	1) SVS Bhopal 2) DVS Bhopal 3) DS Bhopal 4) DS Raisen 5) PHC Sanchi, Raisen 6) PHC Gandhinagar, Bhopal 7) PHC Misrodh, Bhopal 8) PHC Salamatpur, Raisen
Orissa	Srihari Dutta R K Nath S M Palo R C Mohanty D B Das Suresh Ch. Jena Sanjay K Satpathy	1) DS Bargarh 2) DVS Sambalpur 3) CHC Barpalli (Bargarh) 4) PHC Odopada (Dhenkanal) 5) CHC Banrpal 6) DS Bolangir 7) DS Dhenkanal 8) DS Angul
Rajasthan	Sunil Kumar Saxena Manisha Nair	1) SVS Jaipur 2) DVS Jaipur 3) DS Jaipur 4) DS Sikar 5) PHC Palsana, Sikar 6) PHC Raloni, Sikar 7) PHC Vatika, Jaipur 8) PHC Beelwa, Jaipur
Tamil Nadu	Sunil Kumar Saxena Pragati Kamthan	1) GMSD Chennai 2) SVS Chennai 3) DVS Kancheepuram 4) DS Chennai 5) DS Kancheepuram 6) PHC Nandivaram, Kancheepuram 7) PHC Avulur, Kanchipuram 8) PHC Walajvadh, Chennai
Uttar Pradesh	Ranjit Dhiman Harish Kumar Kamlesh lal Chandani Sanjay Bhardwaj Siddharth Shanker Dutta	1) SVS Lucknow 2) DVS Faizabad 3) DS Faizabad 4) PHC Sahawat, Faizabad 5) PHC Navabganj, Kanpur 6) DS Unnao
West Bengal	Ranjit Dhiman Harish Kumar Krishnendu Bhattacharya	1) GMSD Kolkata 2) SVS Kolkata 3) DS Nadia 4) PHC Chapra, Nadia

ANNEX 4: OFFICIALS MET DURING FIELD VISITS

State	Name of Official Met	Designation and organization	Date Visited
Assam	Hemanta K Medhi	UDA cum Cold Chain Storage Incharge, DVS Golapara	7-Jun-08
	Jyostna Diamary	LHV, PHC Agia, Goalpara	7-Jun-08
	Labanya Rabha	LHV, PHC Agia, Goalpara	7-Jun-08
	N N Patuary	ACMHO, DVS Goalpara	7-Jun-08
Bihar	Udai Singh Kumawat	Executive Director, NRHM, Patna	4-Jun-08
	Gopal Krishna	State Programe Officer Immunization, Patna	4-Jun-08
	Manika Sinha	Executive Director, SVS Patna	4-Jun-08
	Hemant Kumar	CCH, RS(WIC) Muzaffarpur	4-Jun-08
	Prabhu Tandon	DIO, DS, Hajipur	4-Jun-08
	Rajender Das	DIO, RS(WIC), Muzaffarpur	4-Jun-08
	Surajnandan Prasad	Storekeeper, SVS, Patna	4-Jun-08
	Satyender Kumar	Vaccinator, RS(WIC), Muzaffarpur	4-Jun-08
Chhattisgarh	J S Khalsa	DIO, Dhamtari	3-Jun-08
	L K Verma	RM, Raipur	3-Jun-08
	N R Dhankar	RM, Dhamtari	3-Jun-08
Madhya Pradesh	Ajay Saxena	RM, Bhopal	9-Jun-08
	B.S. Ohri	Joint Director(RS), Bhopal	9-Jun-08
	H.S. Kasotiya	CMO, Bhopal	9-Jun-08
	Hafizan Bee	HW(F), Salamat Pur, Raisen	10-Jun-08
	Halke Singh Ahiwar	MPW, PHC Salamat Pur, Raisen	10-Jun-08
	K. C. Dubey	DIO, Bhopal	9-Jun-08
	L N Sarathi	Compounder, CHC Sanchi, Raisen	10-Jun-08
	M.S. Thakur	CCO(MPW) Bhopal	9-Jun-08
	Manisha Sharma	LHV, CHC Gandhi Nagar, Bhopal	10-Jun-08
	Manoj Nigam	MO, PHC Misrod, Bhopal	9-Jun-08
	Manoj Singh	RM, Raisen	10-Jun-08
	Neeraj Shukla	Pharmacist, Bhopal	9-Jun-08
	Ratna Mulay	DIC, Bhopal	9-Jun-08
	Sonal Onkar	MOIC, PHC Misrod, Bhopal	9-Jun-08
	Soumen Das	MOIC, CHC Sanchi, Raisen	10-Jun-08
	V.K. Chobey	CMO, Raisen	10-Jun-08
Orissa	Anand Kumar	Statistical Assistant, DVS Bolangir	9-Jun-08
	Anil K Nanda	RM, DS Angul	7-Jun-08
	Asit Pattanaik	RM, DS Dhenkanal	7-Jun-08
	B. Dixit	ADMO(FW), DS Bhadrak	9-Jun-08
	B.B.Beura	RM(Cuttak & Jaipur) DVS Cuttak	7-Jun-08
	B.B.Beura	RM, PHC Tangi Choudwar, Cuttack	7-Jun-08

State	Name of Official Met	Designation and organization	Date Visited
	B.C. Behera	ADMO, DS Khurda	10-Jun-08
	B.M. Patra	ADMO(FW), DVS Balosore	9-Jun-08
	B.P.Tripathy	RM, DVS Balasore	9-Jun-08
	Baidyanath Nayak	MOIC, CHC Jatani, Khorda	10-Jun-08
	Basanti Mahdli	LHV, PHC Odopada (Dhenkanal)	7-Jun-08
	Bhabagrahi Sahu	Health Worker, PHC Madhuban, Jajpur	7-Jun-08
	Binapani Das	Health Supervisor, PHC Banrpal, Anugul	10-Jun-08
	Binapani Pangari	LHV, PHC Tangi Choudwar, Cuttack	7-Jun-08
	Biren Pradhan	RM, DS Bargarh	8-Jun-08
	Bishnupriya Nayak	LHV, PHC Betanati, Mayurbhanj	8-Jun-08
	Chandramani Das	I/C, DVS Cuttak	7-Jun-08
	Chhabi Bala Patnaik	LHV, PHC Madhuban, Jajpur	7-Jun-08
	Dipankar Mukherjee	MOIC, PHC Betanati, Mayurbhanj	8-Jun-08
	G C Mohanta	ADMO(FW), DS Baripada	8-Jun-08
	Gelhamani Dei	LHV, CHC Kostha, Mayurbhanj	8-Jun-08
	Golak CH. Parida	BEE, CHC-II Simulia, Balasore	9-Jun-08
	Gouranga C Nayak	MO, PHC(N) Balikhunta, Baragada CHC-II Simulia, Balasore	9-Jun-08
	Janaki Dei	HW(F) I/C, PHC, DS Jajpur	7-Jun-08
	Janardan Mishra	MOIC, PHC KC Pur, Mayurbhanj	8-Jun-08
	Jibanlal Dandsena	RM, DVS Sambalpur	8-Jun-08
	Jyotshna Sahu	LHV, DS Dhenkanal	7-Jun-08
	Jyotshnarani Das	H.W.(F) I/C, DS Jajpur	7-Jun-08
	Kanak Prava Tripathy	DPHN, DVS Cuttak	7-Jun-08
	Kanchanbala Malla	LHV, DS Angul	7-Jun-08
	Karunakar Lenka	MPW, PHC Betanati, Mayurbhanj	8-Jun-08
	Ketaki dei	ANM, PHC Odopada (Dhenkanal)	7-Jun-08
	Krupasindhu Patra	Co-ordinator, DVS Sambalpur	8-Jun-08
	Kshyma Sagar Sahu	MOIC, PHC Tangi Choudwar, Cuttack	7-Jun-08
	Labanya Mohanty	LHV, CHC-II Simulia, Balasore	9-Jun-08
	Laxmidhar Nath	Health Worker, PHC KC Pur, Mayurbhanj	8-Jun-08
	Lucas Minz	RM, DS Bolangir	9-Jun-08
	Manas Ranjan Samal	DHIO I/C, DS Jajpur	7-Jun-08
	Minati Mishra	Staff Nurse I/C, DS Jajpur	7-Jun-08
	Nayana Mallick	Health Worker, PHC Tangi Choudwar, Cuttack	7-Jun-08
	Nirupama Hota	LHV, DS Jajpur	7-Jun-08
	Nishamani Singh	LHV, DS Baripada	8-Jun-08
	P.K.Rath	CS, PHC Madhuban, Jajpur	7-Jun-08
	Puspalata Jena	MOIC, DS Khurda	10-Jun-08
	R. Brahma	MOIC, CHC Kostha, Mayurbhanj	8-Jun-08

State	Name of Official Met	Designation and organization	Date Visited
	Ramapati Panda	MOIC, CHC-II Simulia, Balasore	9-Jun-08
	Ratnamani Devi	LHV, CHC Jatani, Khorda	10-Jun-08
	S C Sharma	ADMO(Medi), DS Bhardrak	9-Jun-08
	S.C.Das Mohapatra	Sanitary Inspector I/C, DVS Balasore	9-Jun-08
	S.K. Mohanty	Sr. Asst. I/C, SVS Bhubaneswar	10-Jun-08
	S.Khatua	Block Programme Organiser, PHC Betanati, Mayurbhanj	8-Jun-08
	S.N.Satapathy	ADMO(FW & Imm), PHC Tangi Choudwar, Cuttack	7-Jun-08
	Sailasuta Bag	Health worker, CHC Barpalli (Bargarh)	9-Jun-08
	Sandhyarani Jena	HW(F) I/C, SVS Bhubaneswar	10-Jun-08
	Sandhyarani Pradhan	LHV, DS Khurda	10-Jun-08
	Sanjukta Das	LHV, DS Bargarh	8-Jun-08
	Santanu K BHOI	DHIO, DS Bhardrak	9-Jun-08
	Santosh K Dash	RVS Co-ordinator, DS Bolangir	9-Jun-08
	Snehalata Das	DPHN, DVS Sambalpur	8-Jun-08
	Suchismits Mahakud	Block Programme Organiser, PHC Odopada (Dhenkanal)	7-Jun-08
	Susanta K Panda	DPM, DS Bhardrak	9-Jun-08
	Tarun K Sahu	MOIC, PHC Banrpal, Anugul	10-Jun-08
	Tarun kumar Adhakam	RM, DS Baripada	8-Jun-08
	Tuni Hansada	BEE, CHC Kostha, Mayurbhanj	8-Jun-08
	Usharani Sahu	LHV, PHC KC Pur, Mayurbhanj	8-Jun-08
Rajasthan	Ashok Meheriya	DIO, Sikar	7-Jun-08
	B. M. Jakhar	MOIC, PHC Palsana, Sikar	7-Jun-08
	Bansi Lal	Store Keeper, Sethi Colony Raj. (State Store)	7-Jun-08
	Garinul Ram	MPW, PHC Ranoli, Sikar	7-Jun-08
	Hari Ram Katani	MOIC, PHC Ranoli, Sikar	7-Jun-08
	Kanta Sharma	ANM, PHC Vatika, Jaipur	8-Jun-08
	L H Ola	MOIC, PHC Ranoli, Sikar	7-Jun-08
	Mala Kar	MPW, Jaipur regional & district store	8-Jun-08
	Mukesh Harsh	RM, DVS Sikar	7-Jun-08
	Neeraj Varshey	RM, Jaipur regional and district store	8-Jun-08
	O.P. Gupta	MOIC, PHC Vatika, Jaipur	8-Jun-08
	R.S. Rathore	DDI, Jaipur	7-Jun-08
	Ram Niranjan Mahua	MPW, DVS Sikar	7-Jun-08
	Rameshwari Sharma	MPW, PHC Beelwa, Jaipur	7-Jun-08
	S.K. Vrshney	RM, Jaipur	7-Jun-08
	Shankar Lal	MPW, Jaipur regional and district store	8-Jun-08
	Shankar Singh	TA, Cold Chain, Jaipur	7-Jun-08
	Smita Dwedi	MOIC, PHC Beelwa, Jaipur	7-Jun-08

State	Name of Official Met	Designation and organization	Date Visited
	Surendra Singh	RM, Jaipur state store	7-Jun-08
	V.K. Vyas	CCO, Jaipur	7-Jun-08
Tamil Nadu	C. Annammm	ANM, PHC Avulur, Kancheepuram	5-Jun-08
	C. Kotteswaram	Health Infrastructure, Chennai	4-Jun-08
	C.Bala Subramaniam	RM, Chennai (State & Regional Store)	4-Jun-08
	K M Punmiya	Assistant Director General(MS), GMSD Chennai	4-Jun-08
	R Baburam	Senior Store Superintendent, GMSD Chennai	4-Jun-08
	R. Subramaniam	RM, Chennai	4-Jun-08
	Rathi Naval	Pharmacist, PHC Nandivaram, Chennai	4-Jun-08
	S. Sasi Rekua	LHV, PHC Avulur, Kancheepuram	5-Jun-08
	T.A.Devapartha Sarthy	Deputy Director Health Services, Chennai	5-Jun-08
	V. Ramalingam	Statistical Officer, State & Regional Store	4-Jun-08
	V. Usha	Store Superintendent, GMSD Chennai	4-Jun-08
Uttar Pradesh	Atul Nigam	Store Keeper (State & Regional)	4-Jun-08
	B. N. Yadav	MOIC, Sahawat Faizabad	5-Jun-08
	Mr. Gupta	DIO, Faizabad	5-Jun-08
	Jagdish K Mehrotra	RM, Faizabad	5-Jun-08
	Meera Pathak	AD, UIP,Lucknow	4-Jun-08
	Momhemas Hassan	Health Worker, PHC Navabganj, Kanpur	7-Jun-08
	Pawan Kumar	CCO , Uttar Pradesh	4-Jun-08
	R K Sahani	CMO, Unnao (District Store)	7-Jun-08
	Rakesh Srivastava	Health Worker, PHC Navabganj, Kanpur	7-Jun-08
	Ram Karan Tyagi	Pharmacist, Faizabad	5-Jun-08
	Ramesh Gupta	RM (State & Regional)	4-Jun-08
	S P Chaudhary	DIO, Unnao (District Store)	7-Jun-08
	Vijay Kumar	WIC Attendent, Faizabad	5-Jun-08
	Yogesh Tiwari	RM, Faizabad	5-Jun-08
West Bengal	Neela Mukherjee	RCH officer, W.B.	9-Jun-08
	S S Chaudhary	CCO	9-Jun-08
	Partho Sarathi Chaudhary	ADHS, GMSD, Kolkata	9-Jun-08
	Ashok S Baldwa	Assistant Depot Manager, GMSD Kolkata	9-Jun-08
	Aurbindo Roy	Senior Store Superintendent, GMSD Kolkata	9-Jun-08
	Dipyendu Patra	Pharmacist, GMSD, Kolkata	9-Jun-08
	Krishna Vaso Rai	PHN, CHC Chapra, Nadiya	10-Jun-08
	L.K. Hatuy	DCMOH, Nadiya	10-Jun-08
	Suboth K Mandal	MOH, CHC Chapra, Nadiya	10-Jun-08
	Sukanta Seal	DIO, Nadiya	10-Jun-08

ANNEX 5: FORMS FOR DATA COLLECTION DURING FIELD VISIT

Rapid Cold chain assessment – 2008

Section 1: Background

Name of assessor	
Name of the State	
Name of the site	
Type of store visited	GMSD State Regional/Divisional District PHC
Date visited	

Officials met

Name	**Designation**

Section 2 (a): Cold chain inventory of store visited

Name of the site:

Type of equipment *(Concrete cold room WIC/WIF/ILR-Large/ILR-Small)*	Make, Model *(HUREE/Blue Star etc, 2001)*	Operational status *(working, repairable, Beyond repair)*	Size (H/L/W) for WIC/WIF or Litres for ILR/DF *(400cm x 400cm x 210 cm) or 70 Litres gross*	Stabilizer attached *(Yes/No)*	Size of stabilizer (KVA)	*Number of equipment attached with stabilizer*	Refrigerant *(CFC/CFC free)*	Problems reported *(Narration on known problems with the unit)*

Cold chain assessment - 2008
Form "A"
Cold chain refrigeration equipment inventory

Please provide information of all the vaccine stores up to District level in your state (one line per store)

Name of the State: _____ **Date:** _____

Number of units

S No	Store name[1]	Store level[2]	CFC **Free** : Less then 10 years old								CFC **Free**: More then 10 years old				**CFC Equipment** (ONLY Operational)			
			ILR				**Deep Freezer**				**ILR**		**Deep Freezer**		**ILR**		**Deep Freezer**	
			Large		Small		Large		Small		Large	Small	Large	Small	Large	Small	Large	Small
			Working	Repairable	Working	Repairable	Working	Repairable	Working	Repairable	Working	Working	Working	Working	Working	Working	Working	Working
Refer to example sheet for guidance on how to fill this form																		
Use extra copy of this sheet if necessary																		

[1] *include the State vaccine store, regional vaccine stores (if any), Divisional vaccine stores and district vaccine stores*

[2] *Specify the level of vaccine store as "State" for state vaccine store, "Regional" for regional vaccine store, "Divisional" for "Divisional Vaccine store and "District" for district vaccine store*

Full name and Designation *Signature* *Official Stamp*

Cold chain assessment - 2008

FORM - "B"

Vaccine Store Infrastructure, Vaccine shipment & transportation

Please provide information of all the stores up to District level in your state (one line per store)

Name of the State: **Date:**

S No	Store name[1]	Store level[2]	Target population	Number & size of generators	Dry Storage area for Diluents/ Syringes etc (in Sq Feet)	Number of Computers available at vaccine store	Internet connection available (Yes/No)	Number of cold boxes	
								LARGE	**SMALL**
Refer to example sheet for guidance on how to fill this form									
Use extra copy of this sheet if necessary									

[1] *include the State vaccine store, regional vaccine stores (if any), Divisional vaccine stores and district vaccine stores*

[2] *Specify the level of vaccine store as "State" for state vaccine store, "Regional" for regional vaccine store, "Divisional" for "Divisional Vaccine store and "District" for district vaccine store*

Full name and Designation *Signature* *Official Stamp*

Cold chain assessment - 2008
Form - "C"
Staff information

Please provide information of state/Regional/Divisional vaccine stores (one store information per line)

Name of the State: _____ **Date:** _____

		Pharmacist / Store keeper		Cold chain mechanic		Driver		Number of clerk/assistant /Computer operator	
Store name & location[1]	Store level[2] (State/Regional/Divisional)	Sanctioned	in position	Sanctioned	in position	Sanctioned	in position	Sanctioned	in position
Refer to example sheet for guidance on how to fill this form									
Use extra copy of this sheet if necessary									

[1] *include the State vaccine store, regional vaccine stores (if any) and Divisional vaccine stores.* ***DO NOT Include*** *information of District vaccine stores and Primary Health Centers*

[2] *Specify the level of vaccine store as "State" for state vaccine store, "Regional" for regional vaccine store and "Divisional" for "Divisional Vaccine store*

Full name and Designation *Signature* *Official Stamp*

Cold chain assessment 2008
FORM - "D"
Vaccine distribution coverage

Name of state:	**Date:**

	List of divisional vaccine stores and their respective districts	
Serial number	*Name of Divisional vaccine store*	*Names of districts served by divisional vaccine store (mention all the districts served by the store)*
Refer to example sheet for guidance on how to fill this form		
Use extra copy of this sheet if necessary		

Full name and Designation *Signature* *Official Stamp*

Section 5: Store specific Questionnaire

1. Electricity availability 1.1 Number of Hours available per day: 1.2 Dedicated Genset available : if yes, size: 1.3 Genset usage per month (Hrs): 1.4 Electric connections are properly connected with ISI mark plug sockets? (Yes/No) 1.5 Proper Earthing done (Yes/No)?:	**2. Generator usage: (if available)** (a) Use immediately after power cut (b) Use whenever temperature rises (c) Use only during pulse polio (d) Never used because no fuel (e) Not working	**3. Fuel Availability** (a) Always in stock (b) No fund for fuel (c) Inadequate stock (d) Fuel not available
4. Dry Storage area: Size (in cubic meters: (HxLxW):		
VACCINE		
5. Temperature booklet maintained[1]: (Yes/ No) **6. Vaccine stock register maintained: (Yes/ No)** 6.1 Batch number recorded (Yes/No) 6.2 Expiry date recorded (Yes/No) 6.3 Quantity of Diluent issued match with quantity of vaccine (check register for last 1 year recording) (Yes/No) 6.4 Randomly check 2-3 diluent cartoons, note the vaccine batch number and check if the vaccine batch is in stock. Do they co-relate (Yes/No)	**7. Vaccine Arrive from (Site):** **8. Vaccine arrival frequency** (a) on demand (b) Weekly Fixed Day : Y/N (c) Monthly Fixed Day : Y/N (d) Unscheduled arrival **9. Vaccine issue/receive Challans**: (Yes/ No)	**10. Arrival method:** (a) Supplied[2] (b) Fetched ourselves (C) Usually supplied but fetched on demand 11. During the last year, whether an advance intimation of vaccine arrival was given at least 48 hrs prior to arrival of vaccine? **(Yes/No)** **12. Vaccine Physical verification:** Check physical stock of any one vaccine. Does it match with record book? **(Yes/No)**

[1] Readings from all the equipment twice a day, record book signed by supervisor, power failure recorded
[2] Vaccine dispatched by the sender to the destination city

13. VVM Status: interview the person handling vaccine and assess: 13.1 Is he/she aware of VVM **(Yes/ No)** 13.2 Checks VVM status on arrival of vaccine?**(Yes/ No)** 13.3 Checks VVM status before issuing **(Yes/ No)**	**14. Conditioning of ice-packs:** (a) Ice packs conditioned (b) Use frozen Ice Packs
15. Problem reporting: (tick) (a) Damaged vaccine for any reason recorded and reported[3] (b) no entry for damaged vaccine	**16. Action taken: (tick)** (a) damaged vaccine disposed Safely[4] (b) Damaged vaccine returned back (c) Disposed unprotected

17. ADMINISTRATION

People involved in cold chain : Name	Designation	Job Responsibilities *(Temp record, vaccine stock, Equip. Maintenance, vaccination)*	Last training attended (month/n Year)	Exper-ience Yrs	present site Yrs

Cold chain worker level of understanding of Cold Chain: (**Non exposure of equipment to sunlight** *Yes/No*), (**Know thermostat setting** *Yes/No*), (**Defrost machine** *Yes/No*), (**Site adequately ventilated** *Yes/No*), **Level at equipment mounted** *Good/Bad*), (**Equipment secured and locked** *Yes/No*), (**Equipment maintained and cleaned** *Yes/No*) *(Tick as applicable)*

[4] Open and broken vials Disinfected before disposing at designated pits. Un-open expired (damage due to expiry date and exposure to extreme temperatures) vials should be opened and disinfected in 1% sodium hypo-chloride solution prior to disposal at designated pits/open waste

Technician visits: Technician last visited :	Frequency of visit: (Number of visits per year) :
Comments:	

18. (Only for PHC) **Size of target population:**	**19. (for all stores)**
No of sub centres serviced from PHC : Vaccine delivery/fetch day: M/T/W/Th/F/Sa/Su Immunisation day: M/T/W/Th/F/Sa/Su Travel time for delivery/immunisation to most distant outreach: Hrs Mode of transport: Service vehicle: ☐ Bus: ☐ Foot: ☐ Other: ☐ Fund for travel with: MOIC ☐ CS ☐ Storekeeper ☐ No fund ☐ Number of functional Hub cutters available:	Number of stem/dial thermometers : W NW Number of dial thermometers (on cold room) : W NW Handler can read the Thermometer : Yes / No Handler record temperature from: Internal (Stem/dial) External (fixed on machine) (tick) Difference in the internal and external thermometer reading : Degrees C Temperature required for Storing :BCG Measles OPV Is Vaccine placement in ILR/ DF OK : Yes / No Is Air circulation around vaccine OK : Yes / No Does store follow EEFO[5] policy?: Yes / No Know How to find if T series vaccine is OK(Shake Test) : Yes / No Who do they report failure to: ☐MOIC ☐DIO ☐ CS ☐ No One Does store have adequate contingency plan? (Yes/No) Number of PHC\s Created in last 2 years (applicable for state and district store) : Total number of PHCs (applicable for state and district store): Number of PHC equipped with ILR and DF:

[5] EEFO: Early Expiry First Out

Report CC breakdowns to (designation): Date of last breakdown report: **Maintenance technician location** Same district/other district/State Distance : Fund for repair and maintenance: At State: (Yes/No) At District: (Yes/No) At PHC: (Yes/No)	Report generator breakdown to: Date of last report: Date of repair: Fund available: Local repair possible: Y/N	Vaccine basket is available inside ILR : Yes/ No *Cold rooms ONLY: Measure the size of shelves and list here:* *Number of shelf rows:* *Total length of shelves:* *Width of shelf:* *Gap between shelf:* *Is vaccine stored on floor?(Yes/No)* Is storage capacity sufficient to store keeper's satisfaction? (Yes/No)?

	20. PRIVENTIVE MAINTENANCE
20.1	Is there any preventive maintenance Plan **(Yes/ No)**?
20.2	Was the plan followed **(Yes/ No)**?
20.3	Preventive maintenance: recorded and reported **(Yes/ No)**?
20.4	Inventory of spare parts are maintained **(Yes/ No)**?
20.5	Is there any shortage of spares **(Yes/ No)**? (If yes attach the requirement)
20.6	Number of preventive services done during the year 2007-08 (attach service report)
20.7	Is any follow up action taken after preventive maintenance service **(Yes/ No)**?
	21. BREAKDOWN
21.1	Number of Break down repair done during the year 2007-08:
21.2	Average response time:

21.3	Average break down time:
21.4	Was repair carried out satisfactory **(Yes/ No)**? (Check the service report)
	22. COLD ROOM Specific (Only GMSD/State/Divisional Vaccine store)
22.1	Cold room is accessible easily **(Yes/ No)**?
22.2	Is there loading unloading dock available **(Yes/ No)**?
22.3	Vaccine van can reach the loading/unloading dock easily **(Yes/ No)**?
22.4	Both cooling units are functional? **(Yes/ No)**?
22.5	Are there provisions for adequate ventilation[6] of the cold store **(Yes/No)**?
22.6	Are fire extinguishers installed in the vaccine store **(Yes/ No)**?
22.7	Is there a proper arrangement of drainage of water from cold room **(Yes/ No)**?
22.8	Periodical monitoring by supervisor **(Yes/ No)**?
22.9	Vaccine stored as per norms[7] inside cold room **(Yes/ No)**?
22.10	Frosting observed on the evaporator/cooling unit **(Yes/ No)**?
22.11	Genset is functioning **(Yes/ No)**?
22.12	Genset auto start is functioning **(Yes/ No)**?
22.13	Genset has capacity of taking load of both cooling units **(Yes/ No)**?
22.14	Alarm/hooter is functional **(Yes/ No)**?
22.15	24 hours temperature recording chart maintained **(Yes/No)**?

[6] Check for exhaust fans, size of windows
[7] Vaccine should be stored on shelves, not on floor, and freezer sensitive vaccine should be stored away from cooling units

ANNEX 6: REPORT OF FIELD VISITS

1 GMSD

1.1 Government Medical Store Depot, Kolkata, West Bengal

1.1.1 Management: Current status

GMSD of Kolkata supplies vaccine to 13 states namely: West Bengal, Bihar, Orissa, Assam, Meghalaya, Manipur, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Jharkhand, Andaman-Nicobar and Tripura. The vaccine shipment to these states did not have a pre-determined frequency of vaccine delivery. The mechanism was worked out on combination of "push" mechanism and sometimes on "demand" from states.

There was a stock of AD syringes in the store which did not tally with vaccine in stock as the vaccine in stock was less in proportion of requirement. Table below summaries the stock of syringes.

Table 26: Stock of syringe at GMSD, Kolkata

Size	Type	Stock	Comments
0.1 ml	A D Syringe	6,07,600	
0.5 ml	A D Syringe	1,27,09,443	91,94,000 is meant to be supplied to Bihar as per MOHFW order. The AD syringes have been withheld here as the state store is not in position to receive the syringes due to inadequate storage space.
5 ml	Disposable (mixing) syringe	30,78,899	
2 ml	Glass Syringe	2,00,977	Was procured for Jharkhand but kept in stock as the glass syringes is no longer in use any more in UIP

1.1.2 Management: Barriers

GMSD acts a warehouse with practically no control over quantity and frequency of vaccine shipment. The vaccine delivery works on push mechanism with irregular vaccine distribution and supply patterns. GMSD neither received copies of vaccine requirements of the states, nor received the copies of purchase orders placed with manufacturers.

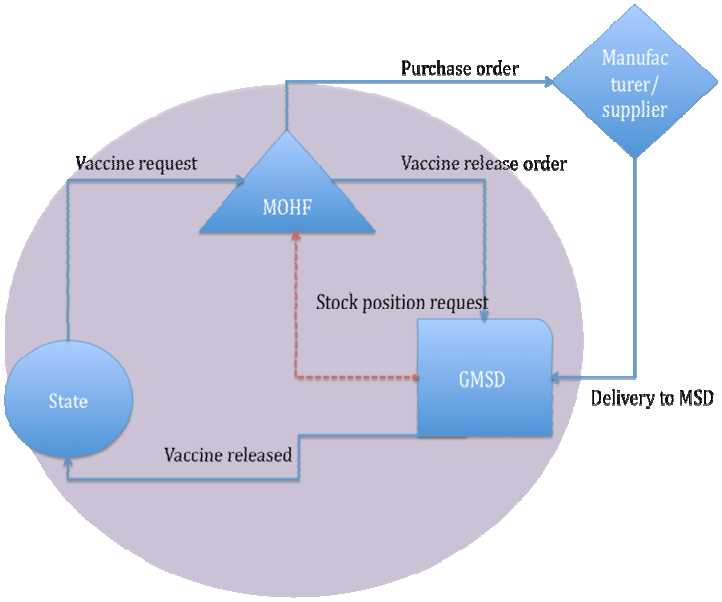


Figure 8: Vaccine request and distribution network of GMSD Kolkata

The cold store facility is partially maintained by CPWD. The facility enhancement like installation of electricity backup generator, repairing of concrete cold room and fixing the ground clearance of refrigerated van has taken long time due to administrative procedures. There was a lack of administrative coordination between CPWD and GMSD.

Supply of vaccine to states was found to be erratic, there was no forecasting done at GMSD and shipments were not planned. It was found that shipment of spares and other supplies was issued months after receiving the allocation from government of India.

Due to inadequate vaccine storage capacity, the vaccine was often pushed down to the state vaccine stores at short notice. This has impact on efficient program management.

States sometimes refuse to accept the vaccine and consumable supplies as they themselves do not have capacity to store the supplies. In that situation, GMSD has little option but to manage the stock themselves. This has resulted in disproportionate shipment of vaccines causing stock-out situations at few states and over stock of same vaccine at other states.

There was lack of clarity and procedures to interpret the VVMs on vaccine vials. Vaccine in stage II was normally rejected by recipient states resulting in vaccine being kept in dead lock situation at GMSDs. Hepatatis B has been an example where the large quantity of vaccine was stocked up in Kolkata GMSD.

There was a lack of trained and dedicated staff for vaccine management and cold chain maintenance.

1.1.3 Infrastructure: Current status

The store's primary concrete cold room (gross size of 466 $m^{3)}$ which holds large portion of vaccine storage capacity of the store was not functioning adequately. The cooling units of this cold room were not able to maintain +2 to +8 Deg temperature because of leakage of water, poor condition of floor and roof insulation.

To combat the problem of shortage of storage space of +2 to +8 Deg, one of the WIF was converted into WIC where measles and BCG was stored. Additionally, a new WIC was requested by GMSD. There is an area of 16m x 5m x 5m reserved for installation of new proposed WIC. Additionally, Store has hired one WIF storage space at Clide road to manage the sudden surge in storage requirement for OPV and ice pack preparation.

The authorities have submitted the approximate estimate of 1.3 Million INR (31,000 USD) towards repair of concrete cold room and overall renovation of GMSD building to CPWD.

The entire store has stable power supply; however the cold rooms had no emergency power backup. A new 75 KVA generator has been supplied 2 years ago which was still awaiting installation. This generator can provide backup to all the cold storage units. An adequate room was identified to install this generator.

Store has one refrigerated van for vaccine delivery but the van was not in use because the chiller unit has low ground clearance and thus cannot be used on most of roads. This can be easily rectified by the automobile engineers.

1.1.4 Infrastructure: Barriers

The entire cold room was not dedicated for UIP program since the cold room catered to other RCH drugs supply as well. Given these two broad issues, GMSD was facing severe shortage of cold storage space. Freezing capacity of the GMSD to store OPV was constrained since the WIFs were also used for freezing ice packs. The GMSD had no dedicated dry storage area for ADS, diluents and droppers.

1.2 Government Medical Store Depot, Chennai, Tamil Nadu

1.2.1 Management Current status

This store supplies vaccine to 6 states namely: Andhra Pradesh, Kerala, Tamil Nadu, Andaman & Nicobar, Lakshdweep and Puducherry. The vaccine shipments to these states had no pre-determined frequency. The mechanism was worked out on demand basis.

The store only maintained the buffer stock of vaccine supplied by manufacturers based in India. However, stock of imported vaccines is maintained as per schedule.

50 vials of OPV were found in VVM stage 2. Entire stock of HepB at GMSD was found to be in stage II; the vaccine had arrived in stage I as per records.

1.2.2 Management: Barriers

The receipt and delivery of vaccines was un-scheduled and irregular. No advance intimation was given to GMSD for arrival of vaccine.

There was a delay in the delivery of vaccine after getting allocation from GoI. The delivery of vaccine was highly dependent on availability of transport facility.

Absence of refrigeration mechanic has led to poor stock maintenance of spare parts. Huge quantities of spare parts were lying in the GMSD as un-identified.

1.2.3 Infrastructure: Current status

Store's primary concrete cold room which forms maximum cold chain capacity of this store was not functioning adequately. The cooling units were not able to maintain +2 to +8 Deg temperature because of leakage of water, poor condition of floor and roof insulation. GMSD was facing severe shortage of cold storage space. Freezing capacity of the store was also constrained as well since the WIF's were used to freeze ice packs too.

To overcome the shortage of space problem, one of the WIF was converted into WIC where measles and BCG was stored.

The authorities have submitted a proposal for construction of complete warehouse to CPWD.

The entire store had stable power supply and cold room rooms had emergency power backup.

The store had no refrigerated vaccine van.

Vaccine was stored in poor conditions (stored on the floor) as there were no shelves in the WIF/WIC.

1.2.4 Infrastructure: Barriers

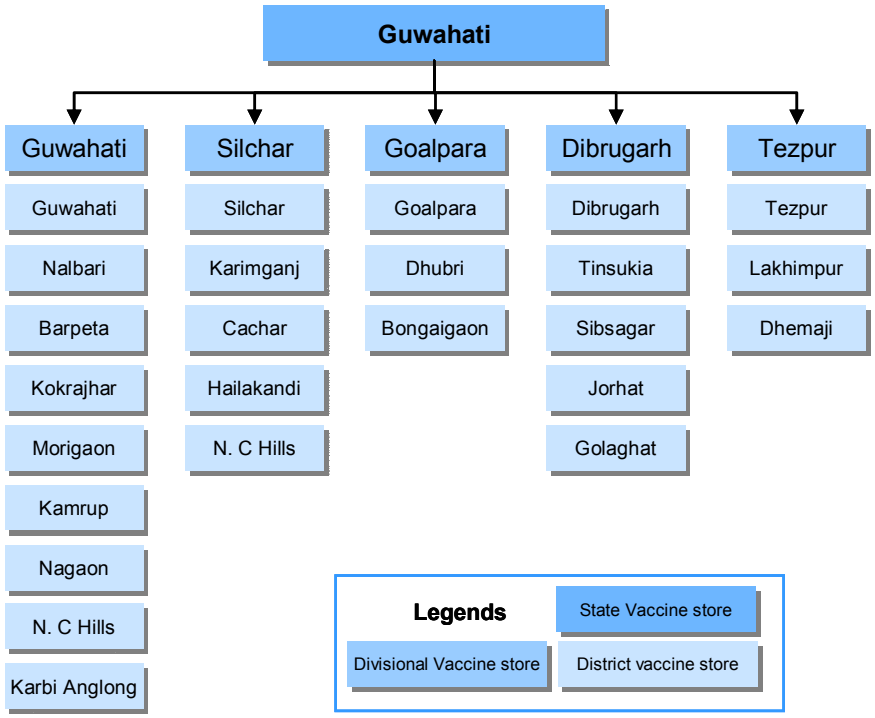
There was no monitoring of performance of the private agency who was awarded with AMC for the GMSD. The post of Assistant Depot Manager is lying vacant and there was no one to monitor and manage the services of contractor. As a result, It was found that temperature recorder not working since last two years. Defrosting of WIF was not done for long time.

2 State field assessments

2.1 Assam

Management	
Current Status	Barriers
Regular CCO was posted at the State vaccine store. There was no cold chain mechanic at the state cold chain store. There was shortage of TT, DT and Hep B vaccine since the last three months.	There was no cold chain store keeper at the state cold chain store. The state cold store had no preventive maintenance plan for the cold chain equipments. Private mechanics were hired on the demand basis. There was inadequate staff at the state headquarter. The post of the store keeper at the state store was lying vacant. There was no vaccine handler, no dealing assistant and no data manager at the state level. In the 27 districts of Assam, there were 4 sanctioned post for refrigerator mechanic of which only 13 were filled up. In Silchar District, there was no RM for the WIC .The district which do not have RM are Tinsukia, Sibsagar, Morigaon, N.C.Hills, Karbianglong, Lakhimpur, Hailakandi, Cachar, Bongaigaon, Chirang, Buska and Udalguri.
Infrastructure	
Current Status	Barriers
Storage space (dry and vaccine) was inadequate at the state level, divisional level and the district level. There was 1 WIC and 1 WIF at the state headquarter. The WIC was more than 18 year old and had frequent breakdowns and it requires replacement. The servo stabilizer was working with WIF only. WIC was without servo stabilizer. The electrical wiring and the earthing at the state cold chain store was not according to the norms. The temperature monitor at the state headquarter is not functional. There is one generator of 10 KVA available at the state cold chain store but it is non functioning. Moreover the generator is being operated manually.	There was inadequate space for storage of ADS and logistics. An office room of the Directorate of Health services, (FW) was being used temporarily as a store for the ADS and logistics. The state cold chain store was ill ventilated and is not as per norms.

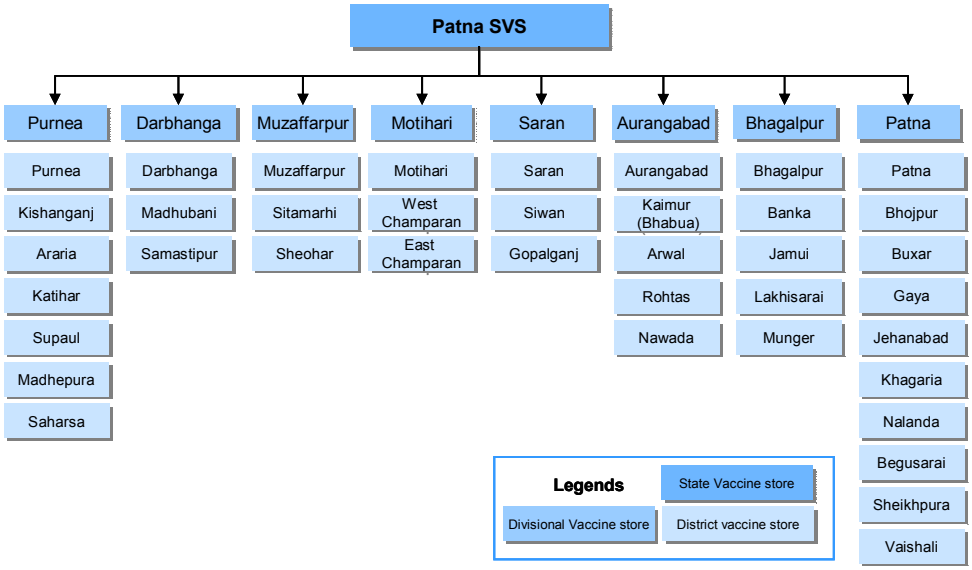
Vaccine distribution network



2.2 Bihar

Management	
Current Status	Barriers
One contractual cold chain officer in place through State Health Society but having multiple responsibilities, often with limited time to oversee and manage cold chain issues. The posts of District Immunization officers are not filled in all districts and are held by officers with other principal charges and responsibilities. Servicing and repairs of equipment (deep Freezer and ILR) are through an Annual maintenance contract with an external agency; however response of the agency is often slow as dependant on mechanics serving 2-3 districts. Large quantity of Vestfrost CFC equipment available which need replacement. Indian deep freezers which have been supplied during 1996 have rusted and need to be replaced. Documentation of vaccines and logistics stocks in cold chain stores was not uniform and incomplete and was manually maintained. Use of computer and internet for record keeping and sharing was not undertaken at any level. The vaccine carriers were reported to be in poor condition due to rough handling.	No specific cadre of store keepers or pharmacists was identified to manage cold chain stores. Often cold chain stores were managed by untrained staff. The state has very few refrigerator mechanics (6 in entire state) and their deployment is limited to 4 stores.
Infrastructure	
Current Status	Barriers
The state store in Patna had no telephone line and operates from a very old building (nearly 100 years old) which requires refurbishment. There was cluttering of old/ condemned equipments lying at all levels which occupy a large part of dry space area.	There was no telephone, computer and internet facility at the state vaccine store. Some of the PHC are located in flood prone areas where the damages to equipment occur annually. Vaccine vans were available in all districts but no system was in place nor provision made for carrying out the repairs. Upto 13 districts's vaccine vans were stranded due to need of repairs. Spare parts for vaccine vans were not available (Tempo model which is now called "Force").

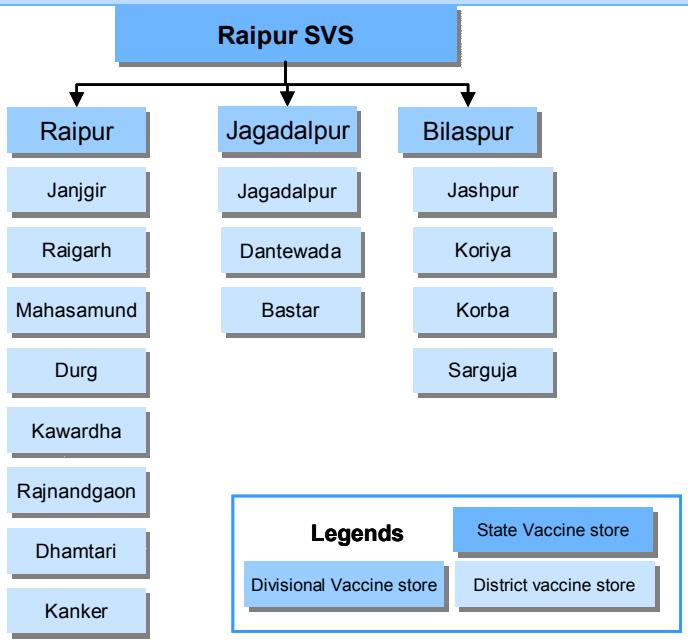
Vaccine distribution network



2.3 Chhattisgarh

Management	
Current Status	Barriers
A large proportion of district and sub district stores were handled by untrained staff. Five district stores viz Korba, Korea, Jangir Champa, Mahasamund and Dantewada fall dismally below the required operating standards. They lack efficient manpower, space and the stores were not easily accessible. At the State WIC, vaccine distribution was not systematized. Actual vaccine quantities issues to the district stores were high when compared to quantities planned for the year. The state and Raipur districts stores were operated from the same premises and vaccine record maintenance was not transparent.	Though a WIC of 32 cu meters and generator for backup power was supplied last year, the State Government had not yet finalized alternative space for its installation. This has considerably delayed the inclusion of Hepatitis B vaccine in routine immunization in the State. Though the state has potentially made progress quantitatively by reaching to unreached beneficiaries through the bi-annual Sishu Sanrakshaan Maah, the poor quality of vaccines due to poor management of cold chain systems could derail the good intentions. There was very little awareness with regard to quality indicators for T series vaccines. Most of the staff did not know how to perform or interpret the Shake test.
Infrastructure	
Current Status	Barriers
By and large, the state's power supply was adequate and reliable but there were no adequate arrangements for power back-up at many sites. This hampered cold chain in instances of sudden power failure in southern districts that are conflict affected. The state level WIF was located in the same building as the Secretariat where access is difficult. In most of the CHC and PHC stores, the existing voltage stabilizers were ill-equipped to handle voltage below 150 Volts. The WIC and WIF that was installed in Bilaspur district to cater to the northern districts were lying condemned. These districts pick up the vaccine directly from the State store. All the Haier ILRs supplied by GoI in 2005 do not have baskets leaving the T – series vaccines at high risk of getting frozen.	Many condemned cold chain equipments have not yet been auctioned and are occupying space at block and district stores. Generally, the quality of wiring was sub-standard. Several sites do not have proper plugs and sockets and the wires are directly inserted into the sockets. Often, the earthing was bypassed.

Vaccine distribution network



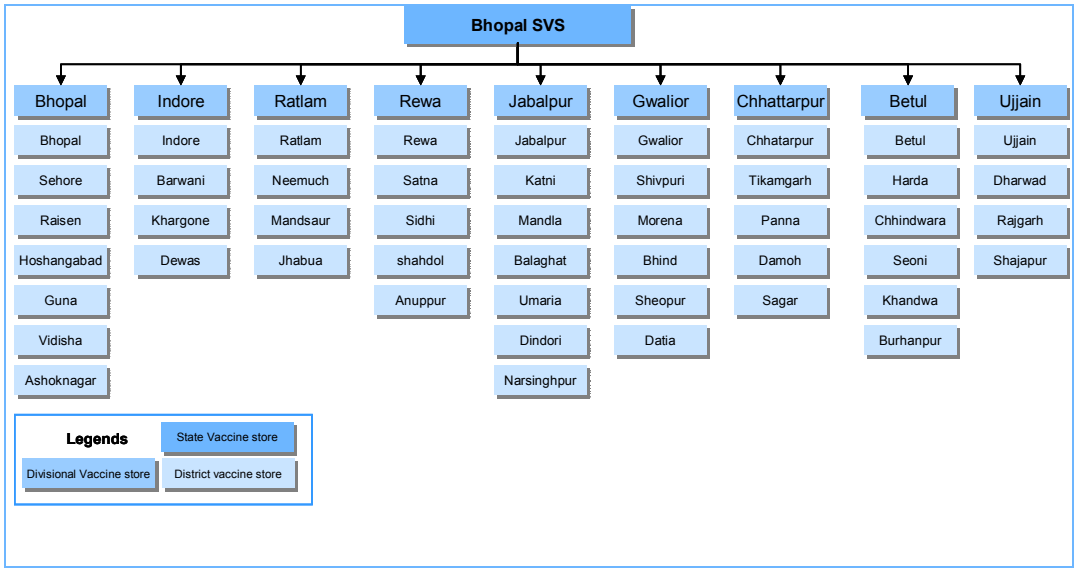
2.4 Jharkhand

Management	
Current Status	Barriers
There was no functional regional or divisional store in the state. The WIC at regional store, Giridih was out of order since 2002. In RI PIP there was a proposal for three regional stores at Deoghar, Palamau and Chaibasa. The WIC equipment of Deoghar had reached the site but has not been installed as yet. An Electrical Engineer has been hired on a contract as the CCO of Jharkhand, under NRHM. CCO does not have independent mobility support. Stock management has been ineffective. There have been situations of over stocks and stock outs. This was primarily because the vaccine distribution system was pull basis with no regular and standard intimation in advance. The most recent training held for CC handlers was in Sept' 2007.	The cold chain equipment was irrationally distributed across the state. PHCs having population of 74130 with target beneficiary of 1854 had received 6 to 9 electrical cold chain equipment. Some of the cold chain equipments were in packed state as it was more than the required numbers. The newer districts like Khunti, Ramgarh, Saraikela have shortage of both electrical and non electrical cold chain equipment. There was no refrigeration mechanic posted in the state.
Infrastructure	
Current Status	Barriers
The state vaccine store had no dedicated computer. There was no internet facility at for all the personnel involved in cold chain management. Internet connectivity was limited to some officials' desk. The capacity of cold storage was sufficient to meet the demand with 3 WIC and 1 WIF in place. The dry storage area for storing ADS and logistics was only 6000 Sq. Ft. There was no preventive maintenance plan and equipments were repaired as and when required. The repair of the electrical cold chain equipment was done at state store and was outsourced to M/s Climate Control, Ranchi. The four working WIC / F were attached to 8.6 KVA stabilizers. The generators were not auto-start. Also, generators were in working condition but they were very old and require frequent repairs and do not run for long period of time at a stretch. The continuous temperature monitor of all the equipments was out of order.	Solar panels were stolen from many locations, and the replacement panels have not been mounted for fear of further theft. At some sites the solar panels have been demounted due to fear of theft (CKP in West Singbhum)

One regional store at Deoghar was in the process of development. The building for WIC was constructed and the electrification process was in progress. The regional store at Giridh was non functional since 2002. Solar equipments are installed at many places but either the solar panels were stolen or batteries have worn out and most of them were not functioning.	

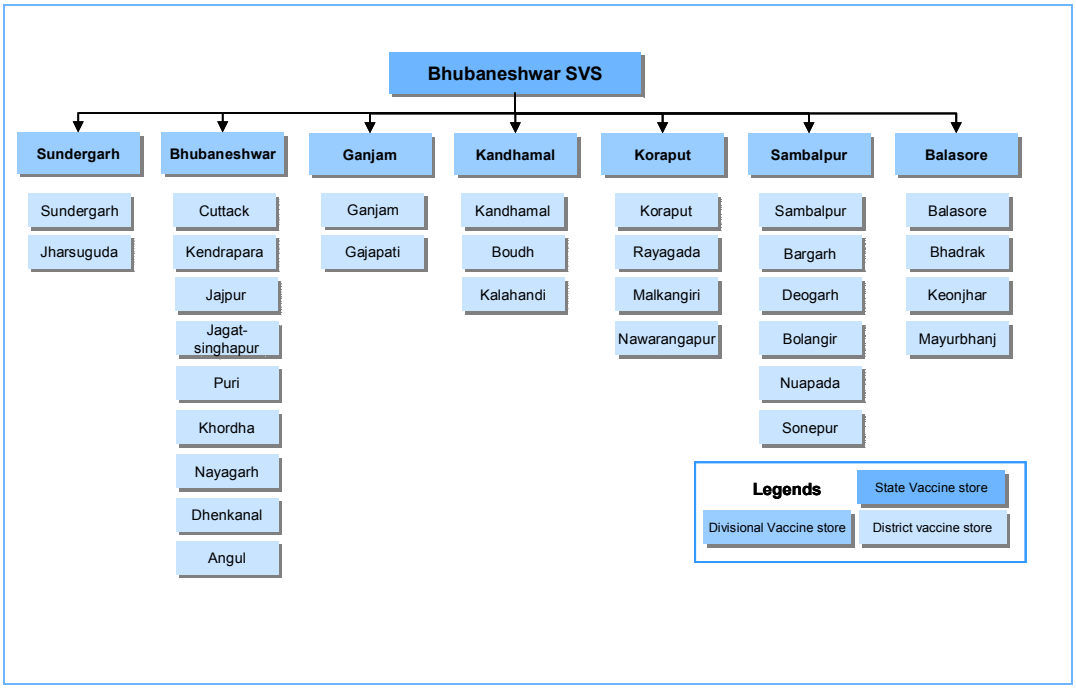
2.5 Madhya Pradesh

Management	
Current Status	Barriers
Regular CCO was posted at state vaccine store. However few districts do not have DIOs posted as required. There were total 103 ILRs and 10 DFs including 19 CFC ILRs stocked up at state vaccine store in packed state since last 2 years. No provision for recording discarded vaccine due to damage or expiry One generator of 10 KVA was available at state vaccine store but was not connected to equipment. The generator is in operational status.	25 out of 48 districts had no refrigerator mechanics. Vaccine supply was found to be Irregular, and state had experienced stock out situations of several vaccines over past two- three months. ADS supply was found to be regular. Store keepers posted at district stores were not trained in vaccine management and cold chain logistics. As a result the stock books were not optimally maintained. PHC do not have trained cold chain handlers appointed as often personnel were transferred or assigned multiple responsibilities. Cold chain handlers exhibit poor knowledge of thermostat setting, packing of vaccine carrier and conditioning of Ice packs. Poor handling of cold chain equipment and vaccine leads to danger of damaging the vaccine.
Infrastructure	
Current Status	Barriers
Seepage was observed in dry storage area at state vaccine store. There was inadequate dry space for storing ADS and other supplies. There was no preventive maintenance plan for cold chain equipment. There was no Loading/unloading dock for vaccine van at state vaccine store.	State vaccine store had the shortage of vaccine storage capacity. State store can only accommodate the supply of 1.5 months of routine vaccine. State store does not have any telephone, computer or internet facility. The needles and syringes were disposed unsafely due to lack of adequate training and facilities in handling medical waste.
Vaccine distribution network	


Bhopal SVS
Bhopal
Bhopal
Sehore
Raisen
Hoshangabad
Guna
Vidisha
Ashoknagar
Indore
Indore
Barwani
Khargone
Dewas
Ratlam
Ratlam
Neemuch
Mandsaur
Jhabua
Rewa
Rewa
Satna
Sidhi
shahdol
Anuppur
Jabalpur
Jabalpur
Katni
Mandla
Balaghat
Umaria
Dindori
Narsinghpur
Gwalior
Gwalior
Shivpuri
Morena
Bhind
Sheopur
Datia
Chhattarpur
Chhatarpur
Tikamgarh
Panna
Damoh
Sagar
Betul
Betul
Harda
Chhindwara
Seoni
Khandwa
Burhanpur
Ujjain
Ujjain
Dharwad
Rajgarh
Shajapur
Legends
State Vaccine store
Divisional Vaccine store
District vaccine store

2.6 Orissa

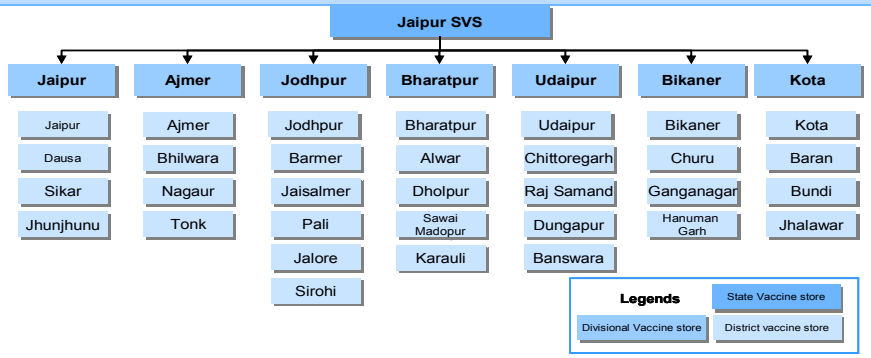
Management	
Current Status	Barriers
CCO was permanently posted in Directorate of Family Welfare, Orissa. One Cold Chain Consultant was placed by NRHM with the support of UNICEF. Out of 30 districts only 18 districts were provided by Refrigerator mechanics. These mechanics however provide service to other 12 districts also. Cold chain handlers in almost all districts have been trained in the last 2 years. Each PHC catered to 20-40 Health sub centers and additional PHCs and upto 80 Anganwadi centers on a given RI day for outreach services. The furthermost RI session site may be up to 25 kms from PHC. Temperature recording at PHC level was often irregular and not reliable as thermometers were either missing or not functioning at some PHCs. Documentation of vaccine stocks was poor: No record of diluents maintained. Stock record did not match with physical verification.	State store was managed by untrained cold chain handlers. Store keeper has no prior training on cold chain and vaccine management. No telephone, computer or internet facility at the State store. There was a lack of dry space to store syringes and diluents. These supplies are some times stored in corridor. Irregular supply of vaccine, stock out of several vaccines over two- three months. ADS supply presently regular.
Infrastructure	
Current Status	Barriers
State cold chain store having capacity to house up to 2 months regular supply of vaccines, more storage space needed to accommodate vaccines for campaigns. Working WIC / F in most places with servo stabilizer, auto start of generator was not functioning. Temperature monitor of cold rooms was irregular. Cold boxes, vaccine carrier and ice packs were inadequate in quantity.	Some PHCs were in flood prone areas where equipment prone to be damaged due to floods. These damages form a large portion in annual breakdowns. Poor wiring in most PHCs is the next prominent reason of breakdown of electrical cold chain equipment. Improper earthing increases the hazards of electric shock accident and increases the intensity of voltage fluctuation.
Vaccine distribution network	


Bhubaneshwar SVS
Sundergarh
Bhubaneshwar
Ganjam
Kandhamal
Koraput
Sambalpur
Balasore
Sundergarh
Jharsuguda
Cuttack
Kendrapara
Jajpur
Jagat-singhapur
Puri
Khordha
Nayagarh
Dhenkanal
Angul
Ganjam
Gajapati
Kandhamal
Boudh
Kalahandi
Koraput
Rayagada
Malkangiri
Nawarangapur
Sambalpur
Bargarh
Deogarh
Bolangir
Nuapada
Sonepur
Balasore
Bhadrak
Keonjhar
Mayurbhanj
Legends
State Vaccine store
Divisional Vaccine store
District vaccine store

2.7 Rajasthan

Management	
Current Status	Barriers
Regular CCO was posted with computer and internet facility. The vaccine was supplied and managed through Jaipur State vaccine store, Ajmer, Jaipur, Kota, Udaipur, Jodhpur, Bikaner and Bharatpur divisional stores. State store had no preventive maintenance plan for cold chain equipment. The districts of Dausa, Dhaulpur, Bharatpur and Doongarpur do not have refrigeration mechanics posted. However, Jaipur state vaccine had 3 additional RMs (1 posted against the position of T.A, 1 RM working as state store keeper, 1 posted in CMHO office for clerical job and Kota districts had 1 additional refrigerator mechanic at Addl. CMHO, FW office for clerical job.	Distance to Udaipur and Jodhpur divisions in particular is more then 350 kilometers from Jaipur state vaccine store. State face constrains in shipping vaccine to these divisions by road. This constrain can be addressed by upgrading these two divisional stores to state level such that they receive vaccine directly from GMSD Mumbai. Both these cities are well connected by air. State store had inadequate manpower to manage vaccine supplies. The responsibility was with refrigerator mechanic to manage the supply and distribution of vaccine. The refrigeration mechanic did not receive any formal training in vaccine management.
Infrastructure	
Current Status	Barriers
Dry storage area for storing AD-Syringes and other supplies was sufficient at state vaccine store (Jaipur), Bharatpur and Bikaner Divisional vaccine stores but it was in-sufficient in rest of the divisional stores. Electricity was available for more than 18 hours a day in urban areas of the state and 10-14 hrs in rural areas. More then 50% of PHCs require generator power backup. None of the PHCs have been provided with generators. Vaccine vans were available in all districts. However vaccine van of districts of Alwar, Bhilwara, Nagaur and Jaipur were in poor condition.	There was no separate regional vaccine store for Jaipur. The vaccine meant for Jaipur division and district was managed from district vaccine store. One single register was used to manage both divisional and district supplies. There was no telephone, computer or internet facility at the State vaccine store. No space was available for dry storage in few districts. ADS were unsafely stocked in corridor as these were exposed to rain and offer poor security from theft.

Vaccine distribution network

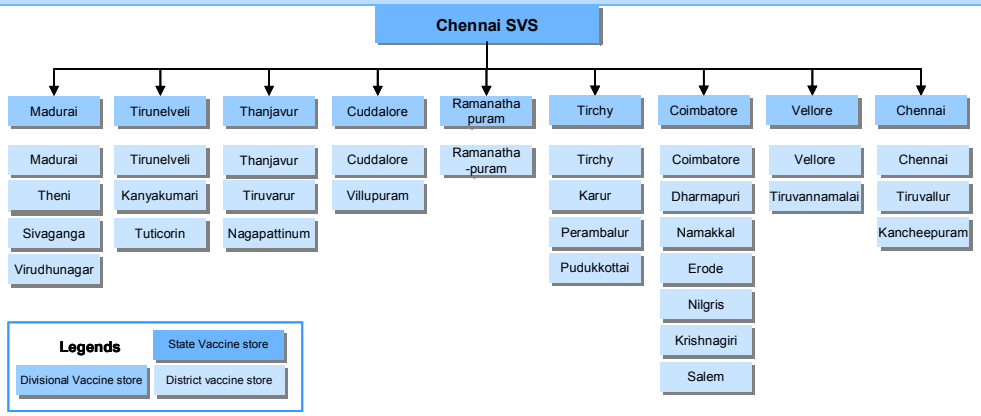


2.8 Tamil Nadu

Management	
Current Status	Barriers
The post of State cold chain officer was vacant in the state. Refrigerator mechanic post was vacant in 7 district stores. Store for ADS, Reconstitute syringes was located separately from vaccine store (store face difficulty in bundling the vaccine with related supplied while distributing). There was no preventive maintenance plan for cold chain equipment. Documentation of vaccine stocks was sub optimal: no record of diluents was maintained. Store keeper had no prior training on cold chain and vaccine management, and was mostly trained while working.	State store had inadequate manpower.

Infrastructure	
Current Status	Barriers
The CCO office was equipped with telephone, computer and internet facility and had mobility to travel across state. However there was no computer available at state vaccine store. Dry space for ADS, logistics often cluttered with condemned and non repairable equipment. The vaccine storage capacity of state and Chennai divisional store was inadequate. Poor wiring and earthing in most PHCs lead to higher damage rates of electrical cold chain equipment.	Temperature recorder of cold room at state vaccine store was not functional. There was no other reliable source to record daily temperatures. No space available for dry storage state vaccine store. ADS were unsafely stocked in corridor as these were exposed to rain and offer poor security from theft.

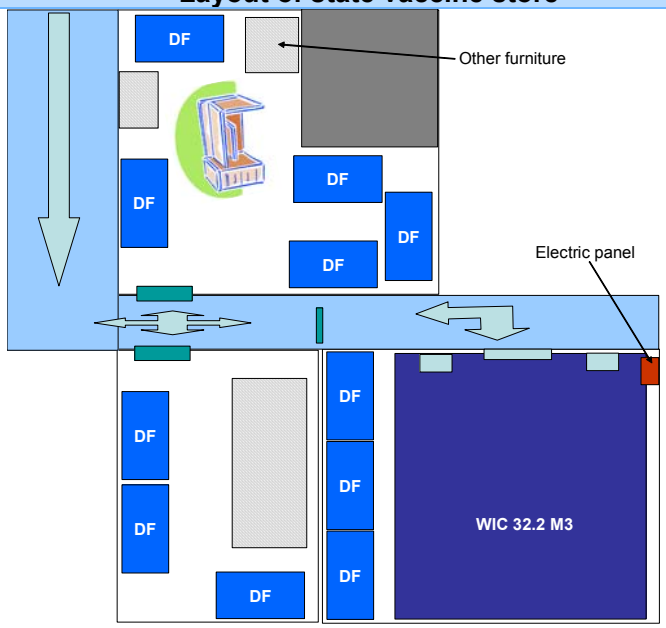
Vaccine distribution network



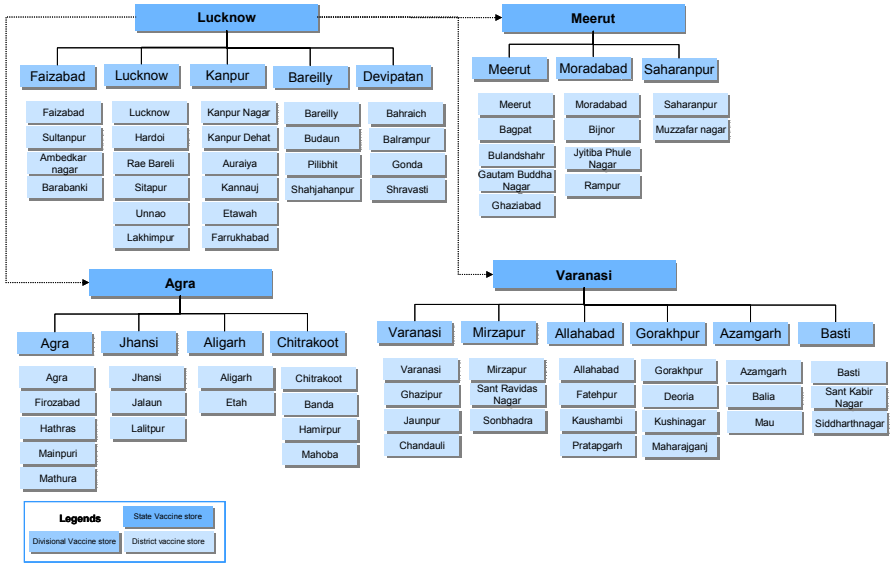
2.9 Uttar Pradesh

Management	
Current Status	Barriers
The target population for routine vaccine was 5.4 Million. Due to its large population and geographical coverage area, UP has 4 regional stores supplying the vaccine to 18 divisional stores which further distributes the vaccine to 70 district stores. Cold chain officer of the state has been operating from AD office complex which is next building to Silver Jubilee Hospital. In terms of manpower, the store had 2 dedicated staff, one cold chain mechanic who looks after the equipment maintenance, does temperature monitoring and acts as a standby store keeper.	The staff operating at the store had not been trained in vaccine management. Despite their sincere efforts, staff faces challenges of maintaining the potency of vaccine from freezing and exposure to high temperatures. For instance, The practices of EEFO was not followed (though FIFO is preferred), DTP was stocked next to evaporator unit, vaccine was over stocked and stored on floor (due to inadequate space) adds up the load on cooling unit to maintain the temperature inside the ageing unit. The shelves are depleting, making it both difficult and risky to arrange vaccine on them. The electrical connections were hazardously exposed /open causing high risk of short circuits and prone to malfunction resulting in shutting down the cooling unit without any alarm. Temperature hooter alarms were not functioning. The generator was found to be disconnected from WIC during visit, however cold chain technician restored the connection promptly.
Infrastructure	
Current Status	Barriers
The vaccine store of Lucknow is one of the 4 regional stores of UP. The store is located in the premises of General Hospital. The store is located in 4 rooms, where 1 room is occupied by WIC (old, more then 20 years), 1 room on 2nd floor hosts WIF (CFC-Free) and other 2 rooms has DFs installed. Store needs larger area to function effectively. CCO had suggested the need of constructing 800-1000 m^2 of area required for the store and the land was available to construct the store. In most of the CHC and PHC stores, the existing voltage stabilizers were ill-equipped to handle voltage below 150 Volts.	The store was located in congested area with practically very less room for packaging of vaccine. There was inadequate dry space for storing AD syringes, diluents etc. These non-cold storage supplies, except for diluents were kept in drug warehouse which is located far from state vaccine store. Refer to figure below for layout of vaccine store (except for WIC room which is located on 2nd floor). The WIC was more then 20 years old and need replacement. With the large coverage of population, the WIC is smaller in size to adequately accommodate the supplied vaccine. The wiring of generator to cold room was poor. The generator does not automatically start on power failure.

Layout of state vaccine store



Vaccine distribution network



2.10 West Bengal

Management	
Current Status	Barriers
The vaccine was not effectively managed in the state store. State practiced a push supply mechanism where the vaccine was pushed down the chain as the capacity at the State store for vaccine was limited. Vaccines were issued disproportionately to districts with little or no relevance to the target population. This had resulted in over stock of a particular vaccine in few districts and corresponding stock outs in other places. The state had appointed a cold chain officer on deputation since last 3 years. The cold chain officer had limited mobility in the state. There was no inventory record of cold chain equipment in the state. There was no mechanism in place for obtaining the information on cold chain equipment status. Cold chain maintenance had been out sourced and de-centralized to district level. Districts had selected different private firms through tendering process to maintain cold chain equipment. Therefore, there was huge diversity in cold chain equipment maintenance with low quality of maintenance while costs have risen.	The store had not been supervised by anyone. The building and amenities were in poor condition. Store was stacked with piles of spare parts and other supplies with no classification, though there were concrete slabs constructed to store spare parts. Cold chain maintenance mechanism of out-sourcing the services was by and large seen as a failure as the districts do not have technical capacity to manage logistics and they look forward to support from state. Also, the servicing agencies were required, upon signing of contract, to be provided with 2% spare parts pertaining to the total number of equipment in the state by State CFWS as buffer stock. No supporting document was furbished during assessment to claim that this clause was fulfilled. The cold chain handler in the district vaccine had not been trained in cold chain operational maintenance and vaccine handling. There was no mechanism of training new staff upon their deployment. There was a shortage of vaccine carriers during SIAs(polio SNID/ mop up)
Infrastructure	
Current Status	Barriers
The state store located at CFWS, Bagbazar, Kolkata stocks the spare parts however spare part inventory was not maintained. Spares are piled up in adhoc manner. A new generator of 10 KVA was supplied along with new 30 cubic meter WIC in 2007. The generator was fixed in a separate room but commissioning is pending till date. Temperature monitoring was not practiced across the stores in the state. In most of the CHC and PHC stores, the existing voltage stabilizers were ill-equipped to handle voltage below 150 Volts.	The cold rooms in the state have been maintained by a servicing agency under AMC. The quality of service provided by the agency was inadequate as 3 of WICs in the state store are operating without stabilizer protection and overall cold rooms have been poorly maintained (for ex. Ice formation on WIF floor, one WIC is out of order). The state vaccine store does not have electricity backup for its cold storage.

3 Summary of assessment

Area of assessment	Government Medical stores				State Vaccine stores									
	Chennai	Kolkata	Mumbai	Karnal	West Bengal	Tamil Nadu	Uttar Pradesh	Assam	Jharkhand	Chhattisgarh	Madhya Pradesh	Rajasthan	Bihar	Orissa
Statistics														
Number of states receiving supply	6	13	6	10										
Number of divisions covered					None	8	16	5	5	3	5	7	8	8
Number of districts covered					20	30	70	23	24	16	48	32	38	30
Total population covered (in Millions)	200	290	370	420	87	66.4	190	29.4	30.8	23.2	69.4	65.2	98.5	39.9
Infant population covered (in million)	6	8.7	11.1	12.6	1.64	1.09	5.84	7.42	8.16	6.38	2.9	1.7	2.9	0.89
Cold chain capacity (+2 to +8 Deg storage) to serve population (in million)	206	308	144.8	224	91.7	36.2	36.2	18.1	56.1	18.7	36.2	36.2	108.6	54.9
Cold chain capacity (-25 to -15 Deg Storage) to serve population (in Million)	426	815	615.5	708	324.1	324.1	324.1	167.1	324.1	324.1	324.1	324.1	334.2	324.1
Storage capacity deficit (+2 to +8 Deg)	Adequate	Adequate	39%	53%	Adequate	55%	19%	62%	182%	81%	52%	56%	Adequate	138%
Storage capacity deficit (-25 to -15 Deg)	213%	281%	166%	169%	373%	488%	171%	568%	1052%	1397%	467%	497%	339%	812%
Infrastructure														

	Government Medical stores				State Vaccine stores									
Area of assessment	Chennai	Kolkata	Mumbai	Karnal	West Bengal	Tamil Nadu	Uttar Pradesh	Assam	Jharkhand	Chhattisgarh	Madhya Pradesh	Rajasthan	Bihar	Orissa
Adequate dry storage area	✓	✓	×	×	×	×	×	×	✓	×	×	✓	✓	×
Scope of enhancing dry storage area	✓	✓	×	✓	✓	×	✓	✓	✓	×	×	✓	✓	×
Availability of space to upgrade cold storage	✓	✓	×	✓	✓	×	✓	✓	×	×	✓	✓	✓	×
Adequate availability of electricity	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electrical connections as per standards	✓	✓	✓	✓	×	✓	×	✓	×	✓	✓	✓	✓	✓
Safety of electrical connection (earthing)	✓	✓	✓	✓	×	✓	×	×	×	×	✓	✓	✓	✓
Accessibility of cold storage facility	✓	✓	✓	×	✓	×	×	×	✓	×	×	×	✓	×
Adequate ventilation facilities of vaccine store	✓	✓	✓	×	✓	×	×	×	✓	✓	×	×	✓	✓
Appropriate water drainage facilities at vaccine store	×	×	×	×	×	×	×	×	×	×	×	×	✓	×
Adequate and effective fire extinguishers installed	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Availability of telephone connection at vaccine store	✓	✓	✓	✓	✓	×	×	✓	✓	×	×	×	×	×
Availability of computer	✓	✓	✓	✓	×	×	×	✓	✓	×	×	×	×	×
Availability of internet connection	✓	✓	✓	✓	×	×	×	✓	✓	×	×	×	×	×

	Government Medical stores				State Vaccine stores									
Area of assessment	Chennai	Kolkata	Mumbai	Karnal	West Bengal	Tamil Nadu	Uttar Pradesh	Assam	Jharkhand	Chhattisgarh	Madhya Pradesh	Rajasthan	Bihar	Orissa
Cold chain														
Gross +2 to +8 capacity of store (in cubic meters)	128.5	466	128	182	80	16.5	64	16.5	48	16.5	32	22	96	31
Gross -25 to -15 capacity of store (in cubic meters)	22	50	60	70	32	16.5	32	16.5	16	32	32	16.5	32	24
Recording of temperature twice a day	✗	✗	✓	✗	✗	✓	✗	✓	✗	✓	✓	✓	✓	✓
Adequate inventory of spare parts	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓
Vaccine stored as per WHO standard norms	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✓	✗	✓	✓
Alarms/Hooters are functional	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗
Vaccine Management														
Did store received vaccine as per required schedule in last 1 year?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Did store receive the right quantity of vaccine as per schedule in last 1 year?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Did store receive advance intimation 48 hours prior to receiving the vaccine?	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗

	Government Medical stores				State Vaccine stores									
Area of assessment	Chennai	Kolkata	Mumbai	Karnal	West Bengal	Tamil Nadu	Uttar Pradesh	Assam	Jharkhand	Chhattisgarh	Madhya Pradesh	Rajasthan	Bihar	Orissa
Was vaccine issued to lower stores as per schedule?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓
Was the right quantity issued as per schedule?	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✓
Is diluent's inventory book maintained separately?	✗	✗	✗	✗	✗	✗	✗	✗		✗	✗	✗	✗	✗
Is vaccine inventory book maintained?	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Are batch numbers and expiry date recorded in inventory book?	✓	✓	✓	✓	✗	✓	✓	✓		✓	✓	✓	✓	✓
Is EEFO practiced?	✗	✗	✗	✗	✗	✗	✗	✓		✓	✗	✗	✗	✓
Maintenance														
Is there any contingency plan in the event of cold chain failure?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Is plan practiced?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Is there a cold chain preventive maintenance plan?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Is plan practiced?	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Is there a dedicated staff for maintenance of cold chain equipment?	✗	✗	✗	✗	✗	✓	✓	✗	✗	✓	✓	✓	✓	✓

	Government Medical stores				State Vaccine stores									
Area of assessment	Chennai	Kolkata	Mumbai	Karnal	West Bengal	Tamil Nadu	Uttar Pradesh	Assam	Jharkhand	Chhattisgarh	Madhya Pradesh	Rajasthan	Bihar	Orissa
Are Cold rooms/WIC/WIF maintained satisfactorily?	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✓	✓	✓	✗
Are other cold chain equipment maintained satisfactorily?	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✓	✓
Are breakdowns of cold chain equipment attended and repaired within 7 days from reporting?	✓	✗	✓	✓	✗	✓	✗	✓	✓	✗	✓	✓	✓	✓
Human resources														
Is there a dedicated CCO in the state?					✓	✗	✓	✓	✗	✗	✓	✓	✓	✓
Is there a dedicated cold chain technician for the store?	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✓	✓	✗	✓
Is there a dedicated staff appointed to handle vaccine logistics?	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗
Are cold chain and vaccine handlers trained?	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✗

ANNEX 7: DETAILED LIST OF ADDITIONAL WIC AND WIF REQUIRED

Vaccine store	Deficit		CFC replacement				Total			
	WIC 32m^3	WIF 32m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
GMSD										
Chennai	3	2					3		2	
Karnal	9	5		1			9	1	5	
Kolkata	2	3		1			2	1	3	
Mumbai	9	4	4				13		4	
Total	23	14	4	2			27	2	14	
State Vaccine stores										
Andhra Pradesh	1		1				2			
Arunachal Pradesh				1				1		
Assam	1			1			1	1		
Bihar			2			1	2			1
Chhattisgarh				1		1		1		1
Delhi			1				1			
Gujarat	1			1	1		1	1	1	
Haryana	1			1		1	1	1		1
Himachal				1				1		
Jammu & Kashmir				2				2		
Jharkhand				1		1		1		1
Karnataka	1		1			1	2			1
Kerala	1	1		1			1	1	1	
Madhya Pradesh	1		1			1	2			1
Maharashtra	3					1	3			1
Manipur				1				1		
Meghalaya				1				1		
Mizoram				1				1		
Nagaland				1				1		
Orissa			1				1			
Punjab				1		1		1		1
Rajasthan	1			2			1	2		
Tamil Nadu	1		1				2			
Tripura				1				1		
Uttar Pradesh	4		2				6			
West Bengal			1	1			1	1		
Total	16	1	11	19	1	8	27	19	2	8

Vaccine store	Deficit		CFC replacement				Total			
	WIC 32m^3	WIF 32m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Divisional vaccine stores										
Dibrugarh (Assam)				1				1		
Silchur (Assam)				1				1		
Tejpur (Assam)				1				1		
Kurnool (A.P)		1		1				1	1	
Guntoor (A.P)		1		1				1	1	
Vishakapatnam (A.P)		1		2				2	1	
Nizamabad (A.P)				1				1		
Warangal (A.P)		1		1				1	1	
Aurangabad (Bihar)		1		1				1	1	
Bhagalpur (Bihar)				1				1		
Muzaffarpur (Bihar)				1				1		
Purnia (Bihar)				1				1		
Motihari				1				1		
Saran ((Bihar)				1				1		
Jagdalpur (CG)				1				1		
Kurukshetra (Har.)				1				1		
Hissar (Har.)				1				1		
Gurgaon (Har.)				1				1		
Dharamshala (H.P)				1				1		
Giridih (Jharkhand)				1				1		
Belgaum (Kar.)				1				1		
Gulbarga (Kar)				1				1		
Chitradurg (Kar.)				1				1		
Mysore (Kar.)				1				1		
Mangalore (Kar.)				1				1		
Ernakulam (Ker.)				1				1		
Calicut (Ker.)				1				1		
Rajkot (Guj.)				1				1		
Kutch (Guj.)				1				1		
Surat (Guj.)				1				1		
Vadodara (Gujarat)		1		1				1	1	
Indore (M.P)		1		1				1	1	
Rewa (M.P.)				1				1		
Jabalpur (M.P.)		1		1				1	1	
Gwalior (M.P.)				1		1		1		1
Chhattarpur (M.P)				1				1		
Ratlam (M.P.)				1				1		

Vaccine store	Deficit		CFC replacement				Total			
	WIC 32m^3	WIF 32m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Betul (M.P)				1				1		
Aurangabad (Mah.)				2				2		
Kolhapur (Mah.)				1				1		
Nasik (Mah.)		1		1				1	1	
Nagpur (Mah.)				1				1		
Akola (Mah.)				1				1		
Parbhani (Mah.)				1				1		
Thane (Mah.)		1							1	
Tura (Meg.)				1				1		
Phulwani (Orissa)				1				1		
Balasur (Orissa)				1				1		
Sambalpur (Orissa)				1				1		
Ganjam (Orissa)				1				1		
Amritsar (PB)				1				1		
Firozpur (PB)				1				1		
Hoshiarpur (PB)				1				1		
Ajmer (Raj.)				1				1		
Kota (Raj)				1				1		
Jodhpur (Raj.)		1		1				1	1	
Udaipur (Raj.)		1		1				1	1	
Coimbatore (T.N)				1		1		1		1
Madurai (T.N)				1		1		1		1
Thirunavelli (T.N)				1				1		
Thanjavur (T.N)				1				1		
Vellore (T.N)				1				1		
Trichy (T.N)				1				1		
Ramnathpuram (T.N)				1				1		
Agra (U.P)			1		1		1		1	
Faizabad (U.P.)		1		1				1	1	
Allahabad (U.P.)		1							1	
Gorakhpur (U.P.)		1		1				1	1	
Kanpur (U.P)		1		1				1	1	
Moradabad (U.P)		1		1				1	1	
Jhansi (U.P.)				1				1		
Azamgarh (U.P.)				1				1		
Basti (U.P.)				1				1		
Saharanpur (U.P.)				1				1		
Varanasi (U.P.)				1				1		

Vaccine store	Deficit		CFC replacement				Total			
	WIC 32m^3	WIF 32m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3	WIC 32m^3	WIC 16m^3	WIF 32m^3	WIF 16m^3
Bareilly (U.P.)		1							1	
Almora (Uttrakhand)				1				1		
Paudi Garwal (Uttrakhand)				1				1		
Murshidabad (W.B)		1							1	
Bardhaman (W.B)				1				1		
Darjeeling (W.B)				1				1		
Murshidabad (W.B)				1				1		
Midnapur (W.B)		1		1				1	1	
West Denajpur (W.B)		1		1				1	1	
Purulia (W.B)				1				1		
24 North Parganas (W.B)				1				1		
Total		**21**	**1**	**84**	**1**	**3**	**1**	**84**	**22**	**3**
Grand total	**39**	**36**	**16**	**105**	**2**	**11**	**55**	**105**	**38**	**11**

ANNEX 8: ASSUMPTIONS & PARAMETERS

Table 27: Vaccine arrival frequency and safety stock policy

Vaccine store level	Frequency of vaccine arrival (number of shipment per year)	Safety stock (%)
MSD	4	25%
State vaccine store	4	25%
Divisional vaccine store	6	25%
District vaccine store	6	25%

Table 28: Specifications of cold chain equipment in the country

Equipment type	Vaccine stores	Gross storage volume		Net storage volume	
		Liters	m3	Liters	m3
Walk-in-Cold room (WIC)	MSDs, State, Divisional vaccine stores	32000	32	13440	13.44
		16500	16.5	6930	6.93
Walk-in-Freezer room (WIF)		16500	16.5	6930	6.93
Custom made cold rooms (with concrete walls)	MSDs	(custom made)			
Ice-Lined Refrigerators (ILR) – Large size	District	304	0.304	108	0.108
Ice-Lined Refrigerators (ILR) – Small size	Health Facilities	144	0.144	45	0.045
Deep Freezer (DF) - Large	State, Divisional and District	314	0.314	264	0.264
Deep Freezer (DF) – Small	Health facilities	144	0.144	70	0.07

Table 29: Norms of calculating the dry storage requirement

Safe-injection equipment, diluents & other supplies	Unit packed volume(cm^3)	Expected quarterly quantity needed(units)	Total storage volume(m^3)
A	**B**	**C**	**D=(B*C)/1,000,000**
0.1 ml AD syringes(only used for BCGI	35.9	27750	1.00
0.5 ml AD syringes	60.6	165000	10.00
2 ml dilution syringes	34.3	41875	1.44
5 ml dilution syringes (only used for measles)	57.2	3325	0.19
Safety boxes(5 liters)	800.0	2395	1.92
Sub total syringes	**988.0**	**240345**	**14.54**
Diluents for BCG	0.7	50000	0.04
Diluents for Measles	4.0	33250	0.13
Sub Total Diluents	**4.7**	**83250**	**0.17**
Droppers for OPV(20 dose vial)	0.9	133000	0.12
Grand Total in m^3 per million of population			**14.83**

Table 30: Norms for cold chain staff at National/State/Regional/District level

Designation of Staff	GMSD level	National level	State level	Regional level	District level	PHC Level
Cold Chain Officer	None	1	1	None	None	None
Vaccine & logistics manager	None	1	1	None	None	None
Assistant Cold Chain Officer	None	None	None	14[38]	None	None
Store Superintendent	1	None	None	None	None	None
Store Keeper	1	None	1	1	1	None
Technical assistant cold chain	None	None	1	None	None	None
Cold Chain Technician	1	None	1	None	1	None
Cold Chain Handler	2	None	1	1	1	1
Driver	3	None	1	1	1	None

[38] Specific sites identified where CCA is required.