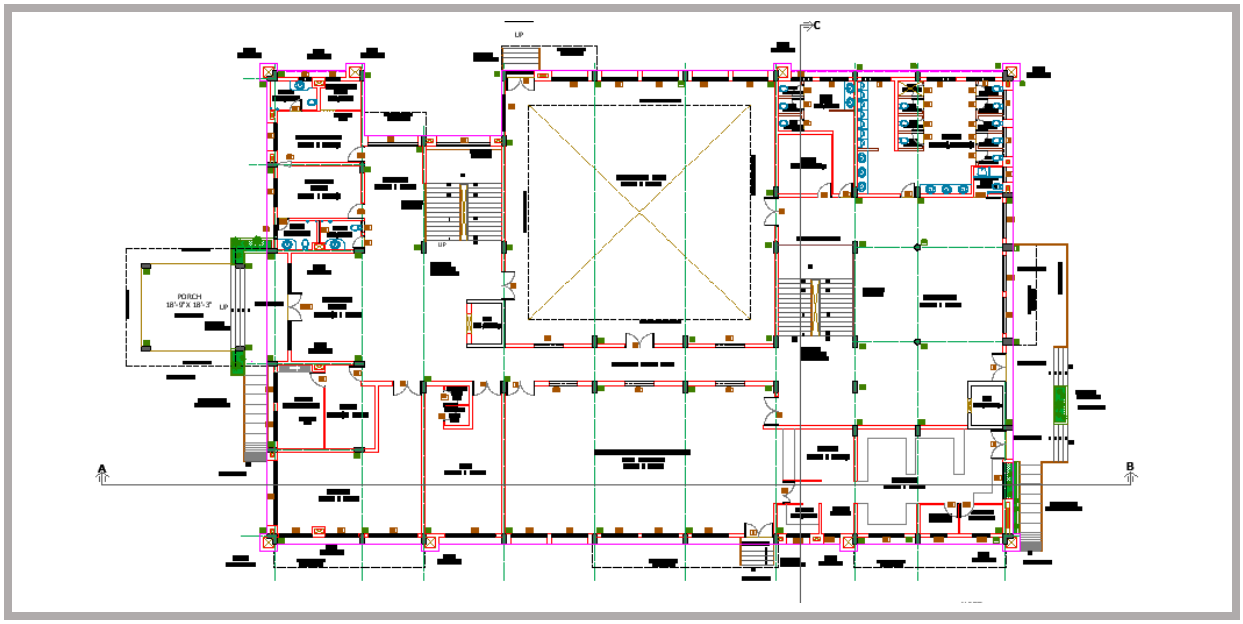
ENERGY EFFICIENT IMPROVEMENTS IN NON STAR HOSPITABILITY BUILDINGS

ECBC COMPLIANCE REPORT



Boys Sports Hostel, Ambala Cantt.

Building Type - Hospitality

Climate - Composite

Project Team
HAREDA ECBC Cell,
Institutional Plot 1,
Sector -17, Panchkula

Published by
United Nations Development Programme
55, Lodhi Road, New Delhi-110003

Disclaimer

This report has been compiled based on the recommendations and implementation of interventions adopted in the demonstration building to achieve ECBC compliance. The views expressed in this publication, however, do not necessarily reflect those of the United Nations Development Programme and the Bureau of Energy Efficiency, Ministry of Power, Government of India.

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1 EXECUTIVE SUMMARY

BUILDING NAME	**Boys Sports Hostel**
BUILDING TYPE	Hospitality
LOCATION	Ambala (Haryana)
CLIMATIC ZONE	Composite
AREA, m²	3511.7
CONDITIONED AREA, m²	-NA-
OCCUPANCY TYPE	24 hours building
Total Connected Load/ Contract Demand	To be estimated by PWD Department
ECBC compliance achieved	ECBC 2017
EPI (Baseline Case), KWh/m²/year	-
EPI (Proposed Case), KWh/m²/year	-
ENERGY CONSUMPTION BUSINESS AS USUAL, kWh/YEAR	-
ENERGY CONSUMPTION WITH ENERGY EFFICIENCY INTERVENTIONS, kWh/ YEAR	-
ENERGY SAVING ACHIEVED, kWh/ YEAR	-
Expected reduction in annual energy bills, INR **% over BAU**	-
Estimated GHG reduction, tCO_2 per year	-
Cost of project, total, incremental cost of interventions, INR	₹ 4,66,77,745
PAYBACK PERIOD (in years)	-
DETAILS OF CONTACT PERSON	Neelam Nauriya, Deptt of Architecture, Haryana, Ph: +91-8288996572

1.1 PROJECT BRIEF

- The project Ambala Boys hostel is an upcoming building designed by Department of Architecture with G+3.
- The project is located in Ambala Cantt, Haryana which lies under Composite region.
- The project is designed by the Department of Architecture, Haryana and the approved by PWD (B&R).

2 SUMMARY OF ECBC COMPLIANCE

2.1 ENVELOPE

2.2.1 Mandatory Provisions under ECBC

2.2.1.1 Fenestration U-Factor

U-factors shall be determined for the overall fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory, and labeled or certified by the manufacturer.

2.2.1.2 Air Leakage

Air blower test will be adopted for determining the air leakage for swinging entrance doors and revolving doors and it will be sealed, caulked, gasket, or weather-stripped in order to minimize air infiltration and leakage and shall not exceed 5.0 l/s-m^2. Air leakage for other fenestration and doors shall not exceed 2.0 l/s-m^2.

2.2.1.3 Fenestration Solar Heat Gain Coefficient

SHGC shall be determined for the overall single or multi glazed fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory, and labeled or certified by the manufacturer.

2.2.1.4 Fenestration Visual Light Transmittance

Visual light transmittance (VLT) shall be determined for the fenestration product in accordance with ISO-15099 by an accredited independent laboratory, and labeled or certified by the manufacturer.

2.2.1.5 Building Envelope Sealing

Following areas of the building envelope, of all except naturally ventilated buildings or spaces, shall be sealed, caulked, Gasketed, or weather-stripped:

- Joints around fenestration, skylights, and door frames
- Openings between walls and foundations, and between walls and roof, and wall panels
- Openings at penetrations of utility services through roofs, walls, and floors
- Site-built fenestration and doors
- Building assemblies used as ducts or plenums
- All other openings in the building envelope
- Exhaust fans shall be fitted with a sealing device such as a self-closing damper

- Operable fenestration should be constructed to eliminate air leakages from fenestration frame and shutter frame

2.2.2 Building Orientation and Massing

The longer axis of the building is in East-West direction. The true north can be seen in the below site plan. The Architectural drawings are placed at Annexure-1.

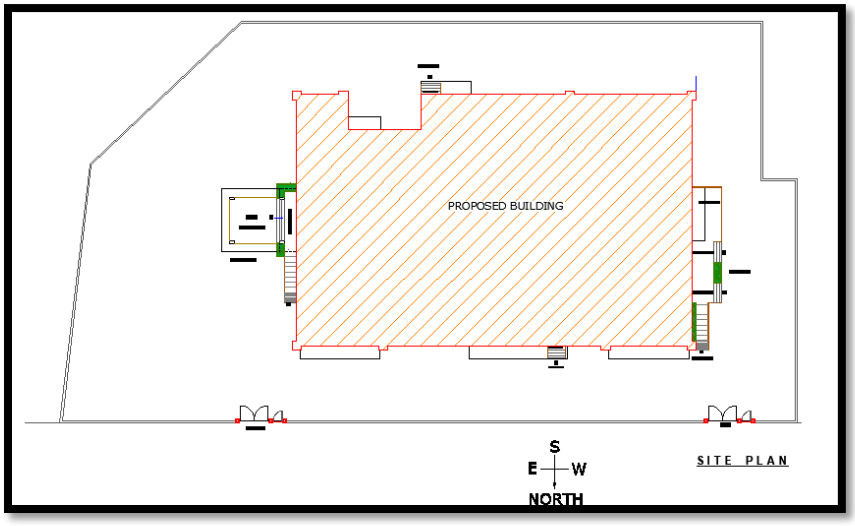

Figure 1: Layout Plan

2.2.3 Building Opaque Envelope

The project will go for double AAC block wall with 20 mm air cavity. The U-Factor of the wall assembly will be maintained at 0.425 W/m2 K. The wall section is provided in Annexure-2.

Roof assembly consists of over deck 75 mm XPS insulation to meet the ECBC 2007 requirement. The U-Factor of the roof assembly will be maintained at 0.33 W/m2 K using the XPS insulation. The roof section is provided in Annexure 2.

Table 1: Opaque envelope specification

OPAQUE ASSEMBLY	Construction Layers	Specification
Ext. WALL assembly	Assembly layers: a. Cement Plaster (20mm) b. AAC Block (115mm) c. Air Cavity (20mm) d. AAC Block (230mm) e. Cement Plaster (20mm)	U-value, W/m²K: 0.425 Assembly thickness, mm: 405
Wall insulation	Type: NA	R-value, K m²/W: - Thickness, mm: -
Roof Assembly	Assembly layers: a. White Tile (10mm) b. Cement Screed (20mm)	U-value, W/m²K: 0.33 Assembly thickness, mm: 275

	c. XPS Insulation (75mm) d. Cement Screed (20mm) e. Mother Slab (RCC) (150mm)	
Roof insulation	Type: XPS (Slab/Foam)	R-value, W/m²K: 2.6 Thickness, mm: 75mm

2.2.4 Window Wall Ratio

In Prescriptive Method, maximum allowable Window Wall Ratio (WWR) is 40%. Following is the WWR calculation which confirms that the Overall Window to Wall Ratio is around 34%.

Table 2: Window Wall Ratio

	Wall Area	Glazing Area	WWR
East	6228.8	1893.3	30%
West	6228.8	2394.7	38%
North	5143.5	1841.5	36%
South	5143.5	1553.4	30%
Total	**22744.63**	**7682.813**	**34%**

2.2.5 Solar Shading Analysis

In Prescriptive Method, maximum allowable Solar Heat Gain Co-efficient (SHGC) for Vertical Fenestration is:

- 0.27: For Non-North Façade
- 0.50: For North Façade

In this project, overhangs have been provided over the windows. In the below table 3, the effective SHGC calculated as per projection factor & SEF is shown. The maximum allowable SHGC value shall be increased due to shading effect. Here, the maximum allowable SHGC is calculated by multiplying the prescriptive SHGC requirement with the SEF. The detailed calculations are attached in Annexure-2.

Table 3: SHGC calculation

Façade Orientation	Window Type	ECBC Recommended SHGC	Projection Factor (PF)	Shading Equivalent Factor (SEF)	Equivalent SHGC
NORTH	G1	.50	**0.23**	**0.23**	**0.53**
NON- NORTH	G2	.27	**0.58**	**1.17**	**0.28**

2.2.6 Daylight Analysis

Above grade floor areas shall meet or exceed the useful daylight illuminance (UDI) area requirements listed in Table 4-1 for 90% of the potential daylight time in a year. For the ECBC Building compliance as per ECBC 2017, minimum 40% of above grade floor area shall meet the UDI requirement for this project.

The Glass with the VLT of more than 30% shall be proposed to be used in this project. Accordingly, the detailed calculation has been performed:

Table 4: Above Grade Area calculation

Total above grade floor area, m²		**5428.04**
Total daylight area per floor meeting UDI requirement during 90% of the year, m²	**TOTAL**	**2604.7**
% of above grade floor area meeting UDI requirements		**48 %**

The Above Grade Floor area has been calculated excluding toilet area.

According to the calculation the total % of Daylight Area Meeting the UDI Requirement for 90% of the Time in a Year come up to be around 48%, which meets the ECBC Building Mandatory requirement.

2.2.7 Glazing Recommendation

Table 5: Glazing Recommendation

GLAZING ASSEMBLY	Specification	Incremental cost (compared to BAU)
Non-North	Assembly layers: a. Toughened Glass (6mm) b. Air Cavity (12mm) c. Toughened Glass (6mm) U-value, W/m²K: 1.87 SHGC: 0.26 VLT: 23%	Rs. 65,28,419 (Compared to conventional clear glass)
North	Assembly layers: a. Single Glaze Glass U-value, W/m²K: 5.4 SHGC: 0.48 VLT: 43%	Rs. 26,90,959 (Compared to conventional clear glass)

Ecosense Enhance - 6 mm (Solar Control Glass) - 12 mm (airgap) - 6 mm (Clear Low-E Glass/Clear Essence)								
Product Name	Shade	Code	Visible Light			SF	SC	U-Value
			Transmission	Reflection				
				External	Internal			
			%	%	%	%		W/m²K
Dawn	Clear	SC 26/33	25	21	33	30	0.34	1.88
Spring	Clear	SC 59/52	55	29	27	51	0.59	1.88
Aura	Clear	SC 48/46	45	27	24	43	0.49	1.88
Snow	Clear	SC 21/28	20	26	34	26	0.3	1.88
Nectar	Clear	SC 32/35	31	23	20	32	0.37	1.87
Ivory	Clear	SC 20/25	19	34	22	21	0.24	1.86
Cove	Blue	SH 18/25	17	12	33	22	0.25	1.88
Marine	Blue	SH 38/37	36	19	29	33	0.38	1.88
Bay	Blue	SH 31/34	30	13	34	29	0.34	1.9
Orchid Blue	Blue	SH 13/23	13	14	34	19	0.22	1.88
Indigo	Blue	SH 22/26	20	12	20	23	0.26	1.87
Bluebell	Blue	SH 13/21	12	17	23	17	0.20	1.86
Pine	Green	SN 22/24	21	16	33	21	0.24	1.66
Meadow	Green	SN 49/38	47	25	28	34	0.39	1.88
Coral	Green	SN 39/35	37	20	24	30	0.34	1.88
Jade	Green	SN 18/24	18	20	34	21	0.24	1.88
Lime	Green	SN 27/26	26	18	20	23	0.26	1.87
Citrus	Green	SN 16/21	15	25	24	17	0.20	1.86

Figure 2: Glass Recommendation – Non North

Ecosense Enhance (Solar Control Glass) - 6 mm								
Product Name	Shade	Code	Visible Light			SF	SC	U-Value
			Transmission	Reflection				
				External	Internal			
			%	%	%	%		W/m²K
Dawn	Clear	SC 26/33	29	18	26	43	0.49	5.4
Spring	Clear	SC 59/52	65	26	26	64	0.73	5.4
Aura	Clear	SC 48/46	53	25	21	58	0.67	5.4
Snow	Clear	SC 21/28	23	26	36	38	0.44	5.4
Nectar	Clear	SC 32/35	37	22	16	45	0.52	4.8
Ivory	Clear	SC 20/25	23	34	19	34	0.39	4.5
Cove	Blue	SH 18/25	20	12	26	36	0.41	5.4
Marine	Blue	SH 38/37	43	17	28	48	0.55	5.4
Bay	Blue	SH 31/34	35	12	22	46	0.53	5.4
Orchid Blue	Blue	SH 13/23	15	14	35	35	0.4	5.4
Indigo	Blue	SH 22/26	24	12	16	38	0.43	4.9
Bluebell	Blue	SH 13/21	14	17	20	32	0.37	4.5
Pine	Green	SN 22/24	25	14	26	35	0.4	5.4
Meadow	Green	SN 49/38	56	22	26	48	0.56	5.4
Coral	Green	SN 39/35	44	19	22	46	0.53	5.4
Jade	Green	SN 18/24	21	20	35	36	0.41	5.4
Lime	Green	SN 27/26	31	17	16	37	0.43	4.8
Citrus	Green	SN 16/21	18	25	21	31	0.36	4.5

Figure 3: Glass Recommendation – North

2.2.8 Summary of Recommendations for Envelope

- The prescriptive requirement for maximum U-factor (W/m2.K) for Opaque External Wall Assembly for this project is 0.425 W/m2.K.
- The prescriptive requirement for maximum U-factor (W/m2.K) for roof Assembly for this project is 0.33 W/m2.K.
- The Overall SHGC for North façade is 0.53 and Non- North façade is .28
- Total daylight area per floor meeting UDI requirement during 90% of the year is 2604.7 m2 (48%) which satisfies the ECBC 2017 requirements.

2.2 COMFORT SYSTEMS AND CONTROLS

2.2.1 Mandatory ECBC Requirements

2.2.2 Natural Ventilation

The building does not utilize any Air Conditioning System, the project team has designed the building following all the necessary provisions of NBC 2005 including the design guidelines for effective Natural Ventilation. Since, there is no HVAC system provided by the hostel in rooms, so the rooms and building are designed such that there is proper ventilation in the rooms.

2.2.2.1 Minimum Equipment Efficiencies

The project team does not utilize and HVAC Systems in the project. The Project team utilizes BEE star rated fans in the building.

2.2.2.2 Controls

The Project does not utilize any HVAC systems. However, regulators are provided with the fans to control the Air flow.

2.2.3 Building HVAC design and systems

The project team does not utilize and HVAC Systems in the project.

2.2.4 Equipment and total system efficiency

The project team is recommended to use 5 Star Fans in the rooms and Dorm rooms.

2.2.5 Piping and ductwork

There are no piping and duct work in this project.

2.2.6 Condensers

The Project team does not utilize any condenser equipment.

2.2.7 Summary of recommendations for HVAC

- The project team does not utilize any HVAC Systems.
- The project team uses 5 Star Fans in the rooms and Dorm rooms.

2.3 SERVICE WATER HEATING

The building contains 30 rooms each consists of sharing of 8 persons. Assuming 8 persons per room, there will be total occupancy of 240. Assuming a person will require 20 Liter of hot water per day, 4800 Liters of hot water will be required per day

Table 6: Hot water requirement calculation

No of Habitable Rooms	No of Occupants per room	Hot water req /person /day (Liters)	Total water req (Liters)
30	8	20	4800

The building will install evacuated type solar water heaters with capacity of 1000 Liters per day to meet the minimum ECBC requirement of 20% hot water through solar water heaters. The brand and model have not been selected yet. The model will be selected such that it has minimum efficiency level mentioned in IS 13129 Part (1&2).

2.4 LIGHTING

2.2.1 Mandatory Requirement

The project will install occupancy sensors in common areas like corridors, toilets, TV rooms, warden offices and Astronomical time switch will be provided for exterior lighting.

2.2.2 Lighting Power Density

The project has adopted Building Area method. The required LPD for the project is 9.50 W/m² and the project team has proposed to provide 7 W/m² LPD throughout the building interior.

2.2.3 Lighting control

The project will be using occupancy sensors in the corridors, toilets, TV rooms, warden offices. There is much potential of energy saving with using occupancy sensors in this building as this building is operational for 24 hours. The occupancy/motion sensors will be installed in the building which specify the accessibility of the occupant in the specific areas mentioned.

2.2.4 Exterior lighting detail

LED lights with minimum 80 lm/W shall be used for exterior lighting. Astronomical timers will be used in the exterior lightings. The astronomical time switch will provide maximum energy efficiency which will operate according to the time already defined.

2.2.5 Summary of recommendations for lighting:

- LPD of the proposed case is 7 W/m² as per Building Area method.
- Occupancy sensors will be installed in common areas like Toilets and Corridors, TV rooms, warden offices.
- LED lights with min 80 lm/W shall be used in exterior lighting.
- Astronomical timers will be used in exterior lighting.

2.5 Renewable Energy

The project has not installed any renewable energy systems, however the project has provided vacant space in the terrace for any future installation of Renewable Energy systems.

2.6 ELECTRICAL

2.6.1. Transformer

11 KV / 433 – 250V 25 KVA Oil core Conventional type Aluminum conductor Distribution Transformers with BEE 5 Star Rating shall be installed in the project to maintain maximum power losses at 50% and full loading capacity.

2.6.2. Motors (Type, Efficiency)

Three phase induction motors with IS 12615 shall be installed in the project. IS Certified recommended motors improves better energy efficiency and consuming less energy as compared to conventional case.

2.6.3. Diesel Generator Sets

The project shall install Two 320 kVA, 415 V, 50Hz 3 phase water cooled silent type Diesel Generators with 4 Star BEE rating.

2.6.4. Check Metering and Monitoring

A HT side Incomer Panel, Main LT panel load manager to be provided and at the outgoing feeder MFM to be provided. The meters with MFM shall be done for all common loads like HVAC, plumbing, lighting, lifts, etc. All meters with RS 485 port total data from meters will be transferred to computer with the help of software for energy monitoring. The meters can display V, A, kVA, kWh, PF, current, voltage, THD.

2.6.5. Power Factor Correction

Automatic Power Factor Corrector with capacitor banks shall be provided for maintaining minimum power factor 0.95 to 1. The capacitor shall be of MPP/APP/MDXL type.

2.6.6. Power Distribution System

Project will install cables of adequate size to maintain the internal power distribution losses at max 1%.

3 COST ANALYSIS

For the increased energy performance of the building, energy efficient materials were used in the building which are not conventionally used. Cost comparison analysis was done for the building systems coming under the scope of ECBC for both the conventional and proposed ECBC complied building. The total investment in the conventional building is Rs. 13,03,11,468.4 for the building systems coming under the scope of ECBC. As for the proposed building it is Rs. 17,67,91,657. The incremental cost of investment in energy efficient systems is Rs. 4,64,80,189 which is 35.3% of BAU.

Since the building is in designing stage, cost reference is taken from the most accepted market price that was taken from market research.

The number of fixtures required in the building were estimated based on LPD. Conventional building has 40 W CFL fixtures for LPD of 12 W/m^2 and proposed case has 20 W LED fixtures for LPD of 7 W/m^2.

Table 7: Cost Analysis

S.No	Category	Conventional Case	Proposed Case	Cost
1	**Wall**	230mm thick brick wall	20mm Plaster + 115 mm AAC Block + 20 mm air cavity + 230 mm AAC Block + 20 mm Plaster	
	Wall Area	22744.63	22744.63	
	Cost Per Sqm	1220	1920	
	Total Cost	27748448.6	43669689.6	15921241

2	**Roof**	Heat reflective paint + 35mm Screed + 85mm EPS board Insulation +150mm BBC +150mm R.C.C + 15mm Plaster	20 mm Cement Screed + 150 mm R.C.C Slab + 75 mm XPS insulation + 20 mm Cement Screed + 12 mm Tiles	
	Roof Area	15195.21	15195.21	
	Cost Per Sqm	3346	4500	
	Total Cost	50843172.66	68378445	17535272.34
3	**Fenestration**	Single Clear 6 mm thick glass	Double Glazed Unit(6 mm Glass + 12 mm Airgap + 6 mm Glass)	
	Window Area	7682.813	7682.813	
	Cost Per Sqm	6700	7900	
	Total Cost	51474847.1	60694222.7	9219375.6
5	**HVAC**	Split AC	Split AC/Fan Coil Units	
	Quantity Tonnes (TR)	0	0	
	Cost Per Tonne (TR)	32990	45000	
	Total Cost	0	0	0
	Envelope Sealing (Weather Sealing, Gasketing and Caulking)			
	Quantity (Running Meter)	-	24886	24886
	Cost Per Running Meter	-	100	100
	Total Cost	-	2488600	2488600
	HVAC			
	Timer Based Control	-	-	-
	Variable Speed Drive for Fans	-	-	-

	System/Air Balancing and Commissioning	-	-	-
	Solar Water Heating			
	Solar Water Heating system as per ECBC (20% of Hot Water Requirement)	-	400000	400000
	Lightings			
	Light Fixtures	125000	264600	139600
	Lighting Controls			
	Passive Infrared (PIR) based occupancy sensor with daylight control			
	Quantity (Pcs)	-	45	
	Cost	-	4500	
	Total Cost	-	202500	202500
	Exterior Lighting Controls			
	Astronomical time switch for street light			
	Total Cost	-	12000	12000
	Electrical Systems			
	Energy Metering	40000	40000	0
	Service Water Pump and Motors	80000	80000	0
	Low Loss Transformers	Needs to be computed based on actual design after finalizing detailed electrical consumption		
	Power Factor Control	Needs to be computed based on actual design after finalizing detailed electrical consumption		
	Total Cost	130311468.4	176791657	46480189

	Capital Investment	**46480189**		
	Maintenance cost (@1%)	**4,64,802**		
	Total Investment	**4,69,44,991**		

*Note – The above cost details has been referred from market research assessment with various vendor's (manufacturers/suppliers) as per availability & selection of material/product in the state of Haryana. The Cost Analysis in Excel Sheet format is placed at Annexure – 3.

4 ECBC COMPLIANCE FORMS

ECBC Compliance Forms have been prepared and placed at Annexure- 4.

5 APPENDIX:

- Annexure 1 : Architectural Drawings
- Annexure 2 : Calculations (SEF, DEF, SHGC, WWR)
- Annexure 3 : Cost Analysis Report
- Annexure 4 : Compliance forms

** End of Report**