Sustainable Materials and Green Buildings
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Lecture 38
ECBC Compliant Methodology

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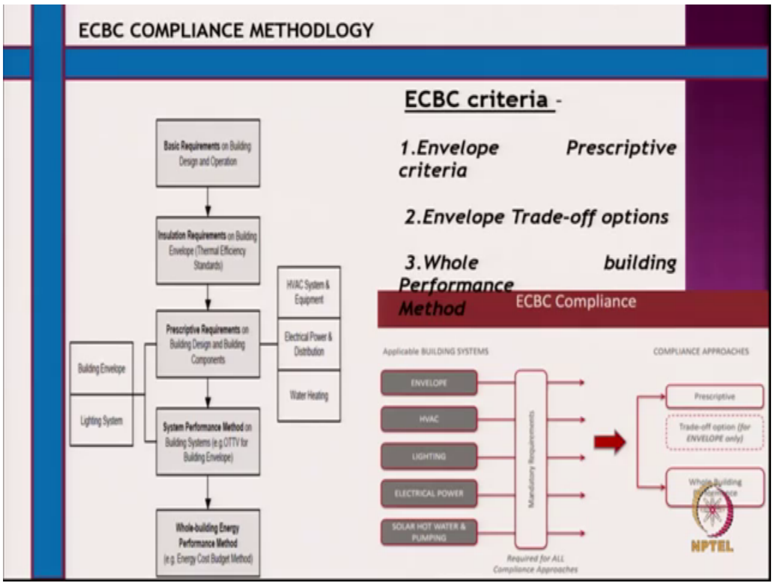

So, continuing with the code, energy code, you know last class you were looking at and we said that there are three types of options that is Prescriptive criteria which we have discussed then trade off option and then whole building performance.

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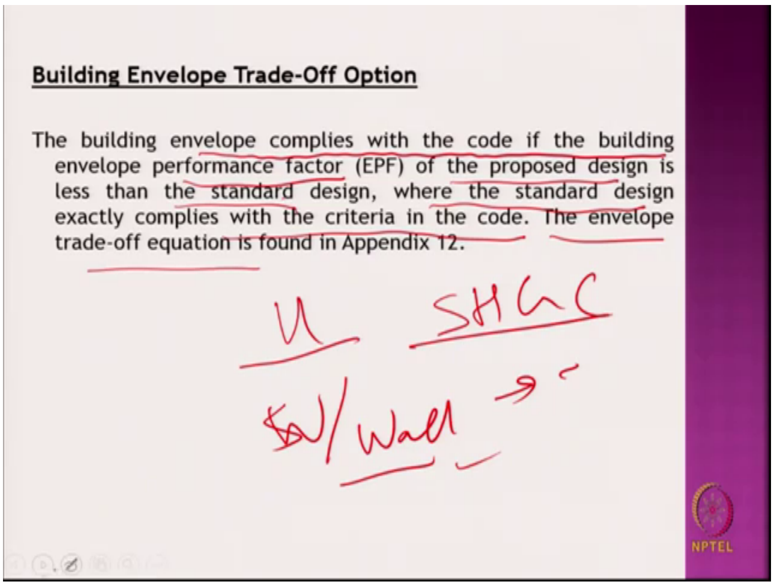

So, if you look at trade off option, last class we said that basic principle is if building envelope complies with the code if the building envelope performance factor of the proposed design is less than the standard design, so the standard design is suggested for your floor area etc etc and where the standard design exactly complies with the criteria of the code. So, that complies with the criteria of the code that is your prescriptive criteria and all that. Now, the envelop trade off equation then it is given which is given in appendix 12 that means that actually it should perform better than the standard.

So, standard is suggested which satisfies the prescriptive requirement all. You can alter something one, for example you may have a better envelope performance while you might have a somewhat worst mechanical control performance. So, this trade-off is possible as long as the total energy consumption is in the your building or your design building proposed design is less than the standard, so the trade-off is allowed.

Now therefore for that corresponding to let us say you have a layout plan and the occupancy type corresponding to that the standard design you can generate as per the guideline of the code and then this performance should be also it gives you when you generate such standard building, it will give its insulation requirement etc. So, those which are fixed like orientation and other requirement, functional requirement, orientation spaces relative distance or relative agency of the spaces all these are fixed.

So, according to that you generate the standard design which will have insulation requirement, SHGC requirement and you know the requirement that we described in cases prescriptive criteria, all requirements will be satisfied that means your U values will be satisfied, SHGC will be satisfied for given window to wall ratio. The effect of shading window to wall ratio and orientation etc so those values are given. Theta values SHGC U those were given for prescriptive. So, standard design will satisfy all the prescriptive requirement which we have discussed earlier.

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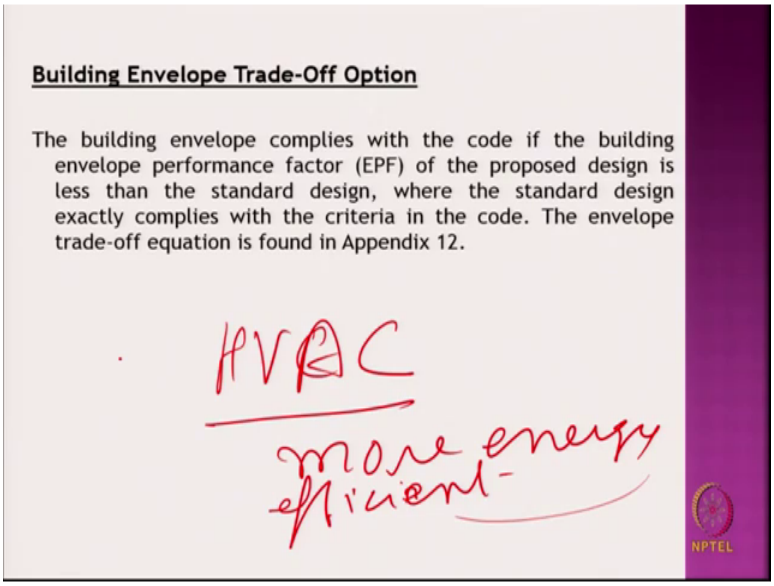

Now, your building when you look at its performance, overall performance maybe calculate estimates its energy consumption, annual energy consumption that should be less than the one that is generated through the codes guideline for standard design so that is what it is. So, in that case what will happen for example you might choose HVAC which is more efficient more energy efficient but maybe the envelope is performance is somewhat poor. May be envelope performance is somewhat poor. But overall the whole thing satisfies.

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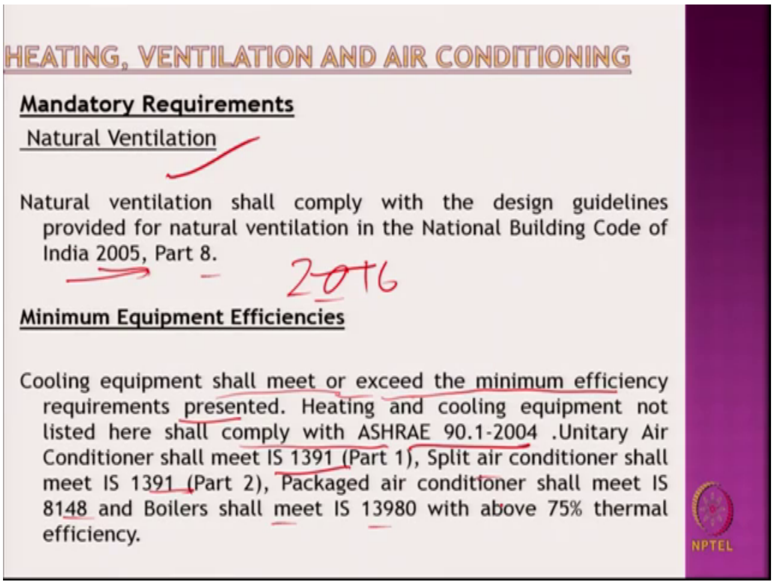

But there are certain mandatory requirements for example natural ventilation, natural ventilation shall be minimum that is required for hygienic requirements. So that is given as per this is now changed to 2016 in the national building code. This gives you the ventilation, minimum ventilation, hygienic ventilation requirement. So, it should be according to that.

And then cooling equipment should meet to the minimum efficiency requirement presented the test, you know equipment shall comply with ASHRAE this guidelines etc. So, this split air conditioner shall meet IS 1391, packaged air conditioner should meet IS 8148 etc and so on. So, these are the mandatory requirements. Here, you have no compromise, you cannot compromise.

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Table 5.2.2-2 Chillers

Equipment Class	Minimum COP	Minimum IPLV	Test Standard
Air Cooled Chiller <530 kW (<150 tons)	2.90	3.16	ARI 550/590-1998
Air Cooled Chiller ≥530 kW (≥150 tons)	3.05	3.32	ARI 550/590-1998
Centrifugal Water Cooled Chiller < 530 kW (<150 tons)	5.80	6.09	ARI 550/590-1998
Centrifugal Water Cooled Chiller ≥530 and <1050 kW (≥150 and <300 tons)	5.80	6.17	ARI 550/590-1998
Centrifugal Water Cooled Chiller ≥ 1050 kW (≥ 300 tons)	6.30	6.61	ARI 550/590-1998
Reciprocating Compressor, Water Cooled Chiller all sizes	4.20	5.05	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller <530 kW (<150 tons)	4.70	5.49	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller ≥530 and <1050 kW (≥150 and <300 tons)	5.40	6.17	ARI 550/590-1998
Rotary Screw and Scroll Compressor, Water Cooled Chiller ≥ 1050 kW (≥ 300 tons)	5.75	6.43	ARI 550/590-1998

You can compromise on certain other things so this you can have better but not worst. Similarly, chillers, so this prescriptions are given and this is mandatory, so mandatory requirement you have to satisfy if you are doing trade off.

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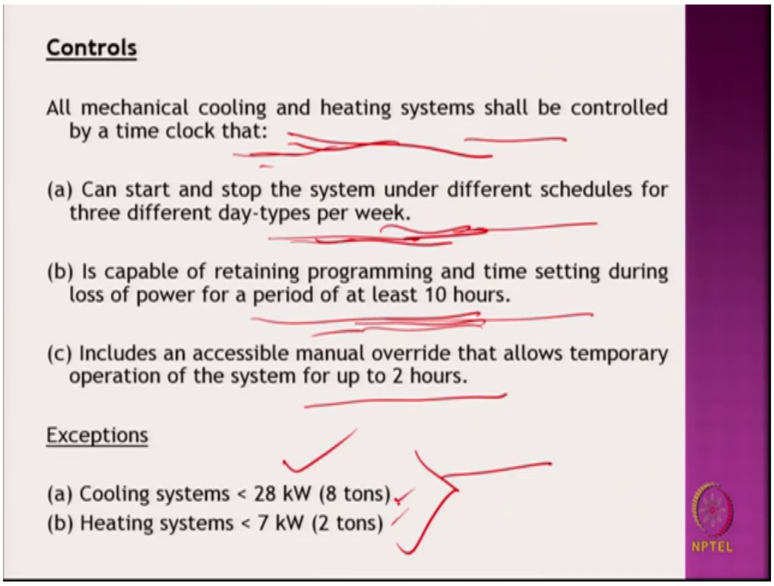

Controls, all mechanical and heating system shall be controlled, I think as mentioned in this last class might have a two point often control minimum right? That means it is put on at 8 AM if then office is starting at 9 AM it is put on around 8 or 8:30 AM and then remains therefore five so and then it is put off. So, there is a control system that has to have; can start-stop system under different schedule and as I mentioned in the last class 3 different schedule could be at least there for example a weekday schedule for office buildings right? And maybe half day schedule sometime and third schedule is holiday.

So, if it is a weekday schedule it is possibly operate from 9 to 5 or 9 to 6 depending upon type of occupancy. Some cases even shopping centers it might remain open for longer period of time during weekend, one-day it might be close and so on. So, this schedules according to the schedule it should operate capable of retaining the program even if there is a power failure for at least 10 hours and manual override has to be there. This is of course not required for if you have cooling system that consumes less than 28 kilo Watt or 7 k 8 tons and 2 tons heating system cooling system is this not required.

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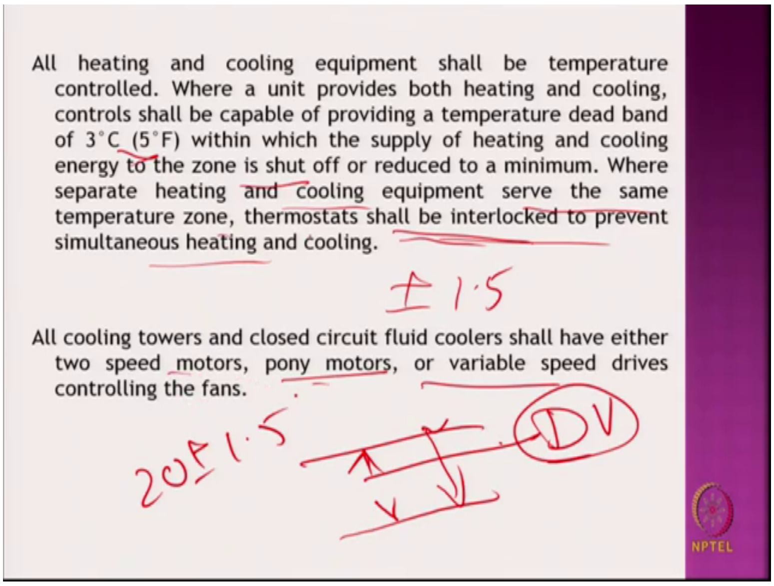

So, there should be temperature controlled even both cooling and heating, so plus minus 1.5 degree as I have saying plus minus 1.5 will make it 3 degree, so that is what it is. What we called this is, this is your desired value, design value, right? Supposing I want to maintain this room where designed value 25 degree centigrade let say or some cases it could be you know depending upon the situation. Because people in tropical climate can tolerate somewhat higher temperature than lesser somebody from subtropical areas.

So, there it might be 20 degree and the design value will be 20 plus minus 1.5 that means this band is 3. So, it should operate within 3 degrees and you know, so that is what it says and then serve same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling. So, simultaneous heating and cooling would operate because usually cooling you would require in summer and heating you will require in winter.

So, sometime some places it may be needed but not simultaneously for example if it is a 24-hourly operation of the hospital. Hospitals had 24 hourly operation, so in that case may be early in the morning you need heating and peak of the day, end of the day you might need cooling but both on you will not need together either heating or cooling. So, that kind of control should be there. And so generally, types of motors etc, the speed control and so on those are also there.

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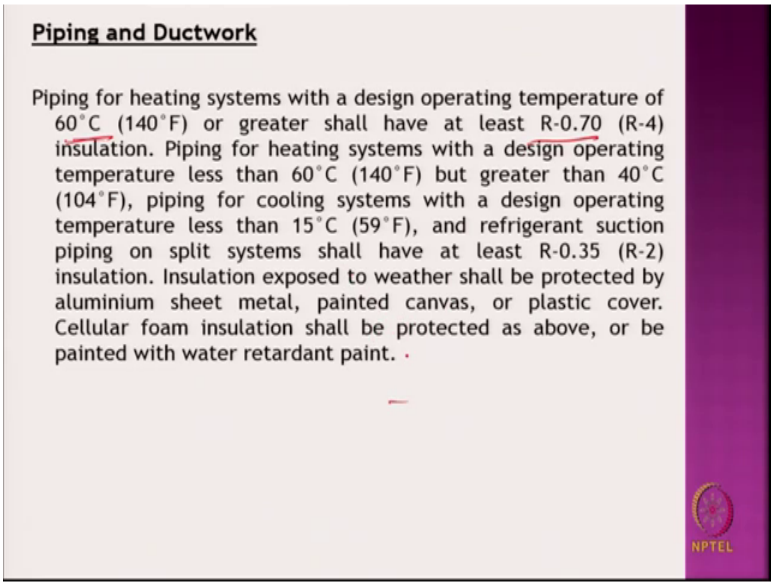

Piping and Duct insulations have minimum specified R value 0.70 and temperature of 60 degree centigrade operating temperature and so on. So, all these are mandatory requirements of specified. So, the point there is, point is that if you go for prescriptive, prescriptive means you do not do anything just take the values. If you are going for trade-off then you have to generate a standard design corresponding to your own design. And that would have properties since you generated it, it will have all the material properties U values etc. as per the prescriptive requirement.

Certain things are mandatory, you will have to maintain that and then check, you know after that you generate your standard design and your own design you check and if its performance is better than the standard then it is acceptable.

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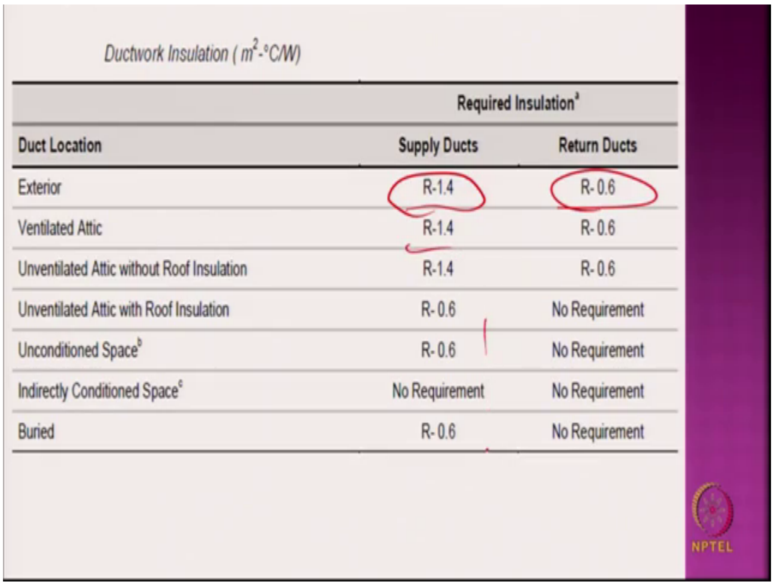

Ductwork Insulation (m^2-°C/W)

	Required Insulation[a]	
Duct Location	Supply Ducts	Return Ducts
Exterior	R-1.4	R-0.6
Ventilated Attic	R-1.4	R-0.6
Unventilated Attic without Roof Insulation	R-1.4	R-0.6
Unventilated Attic with Roof Insulation	R-0.6	No Requirement
Unconditioned Space[b]	R-0.6	No Requirement
Indirectly Conditioned Space[c]	No Requirement	No Requirement
Buried	R-0.6	No Requirement

So, similarly for ductwork you know, the resistance values are given, insulation values these are all these are prescriptive.

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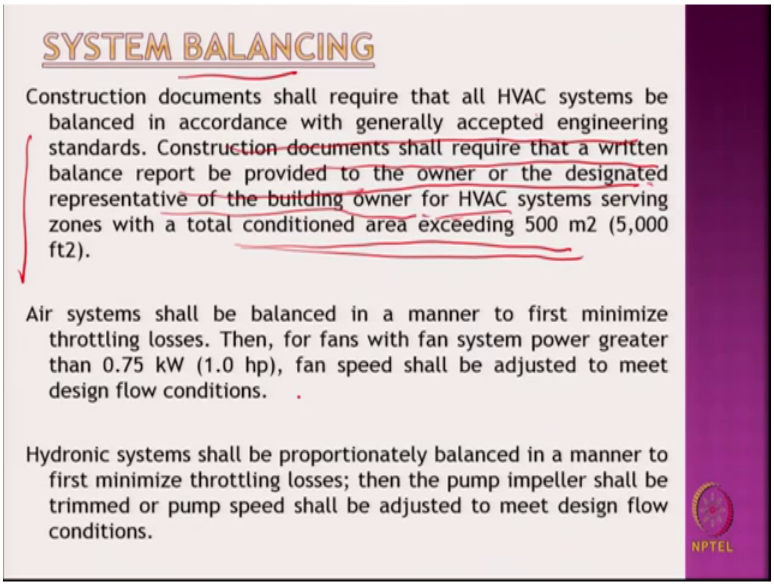

Then that, then there is clause related to the system balancing should be balanced according to generally accepted engineering standard. That means the quality of the HVAC system there are some guide line related to that as well and HVAC serves total conditioned areas you know so these are provided you know construction documents shall require that a written balance report provided to the owner or the design representative or building owner etc. Serving zones of total conditioned exceeding 500. So, if area conditioned is more than 500 meter square, so certain documents have to be prepared and all losses etc so this is to be also prepared.

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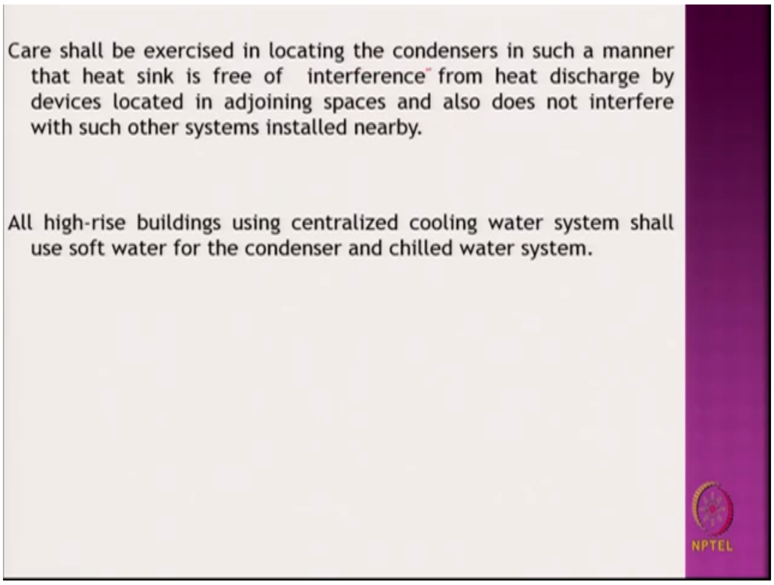

Location of the condensers and HVAC, etc these are also specified. Water supply system must use soft water for condenser and chilled water system.

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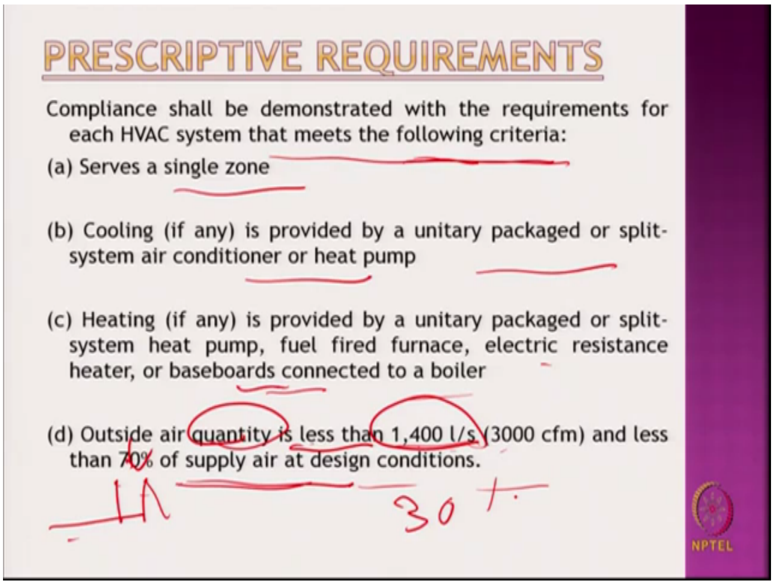

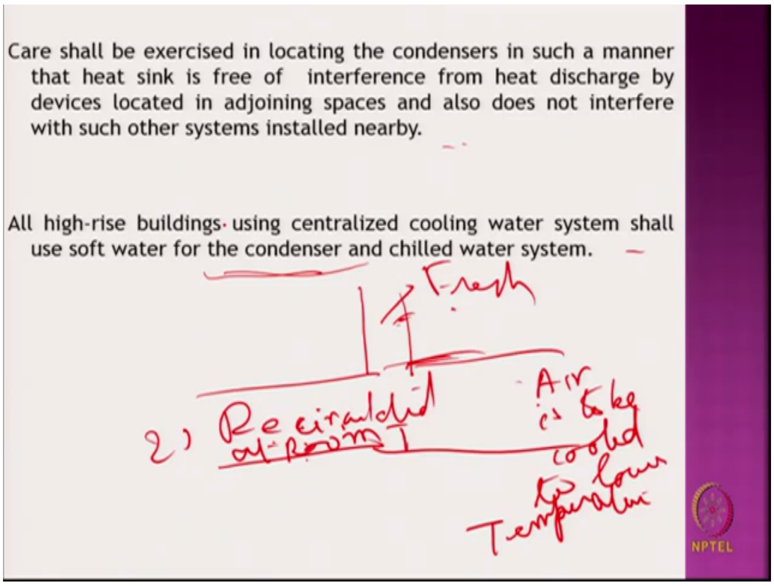

So, compliance shall be demonstrated with the requirements for the HVAC system is the following criteria serving single zone, cooling provided by a unitary packaged, split etc. Heating is provided by a unitary packaged or split system pump well, electric resistance heater and so on. Outside air quantity is should be you know 1400 liters per second air quantity actually the quantity the airflow and less than 70 percent of supply air at design conditions.

Now, one thing you need basically minimum ventilation requirement or fresh air requirement for hygienic condition but if you increase the fresh air requirement cost of cooling increases, energy requirement will increase. So, that is why there is a less than 1400 liters per second flow rate is again controlled. And less than 70 percent of the supply air at design condition. So, what we do is we mix up two air, so air from the fresh air comes and this is a recirculated air some air is recirculated or let we draw it somewhere here.

Fresh air comes like this, recirculated air which will be at room temperature, this is fresh air and this combined mixed air, this is then will be some mixture temperature. It will be not at room temperature neither the fresh air temperature. It will somewhere in between. So, this will be this air will be cooled to a temperature lower than the room temperature and as it enter into room it will again gain heat and its temperature will increase and that will attain the room temperature.

Air at lower temperature enters the room and attains the room temperature, that is how it absorbs the heat. So, you know cooled to lower temperature as I said. So, if I increase this fresh air intake that means outside air temperature might be 30 or 35 degree centigrade or 40 degree centigrade. This air might be at 25 degree centigrade. So, following law of mixture, this air temperature will be some were in between say 40 and 25 somewhere in between.

Now, I have to cool it to lower temperature than room temperature. As it enters into the room it will absorb the heat. Now, what it is saying is that I must have fresh air requirement less than 1400 liter per second or 70 percent of the supply air condition that means 30 percent can be right. So, outside air quantity should be less, minimum 30 percent should be recirculated air, so this will but it is much higher, usually it is much higher to reduce down the cooling energy requirement.

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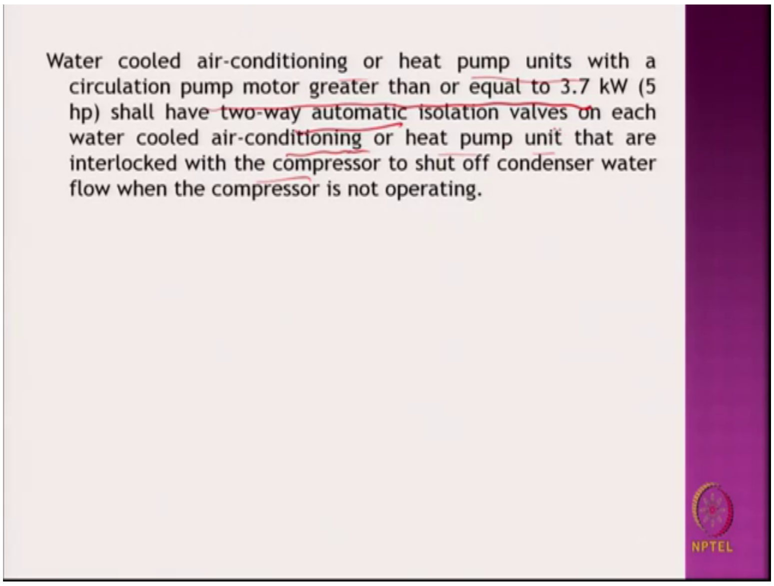

Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 3.7 kilo Watt shall have two-way automatic isolation valves, water cooled air-conditioning or heat pump unit that are interlocked that is if you both act together then you should have isolation valves so one goes other does not work.

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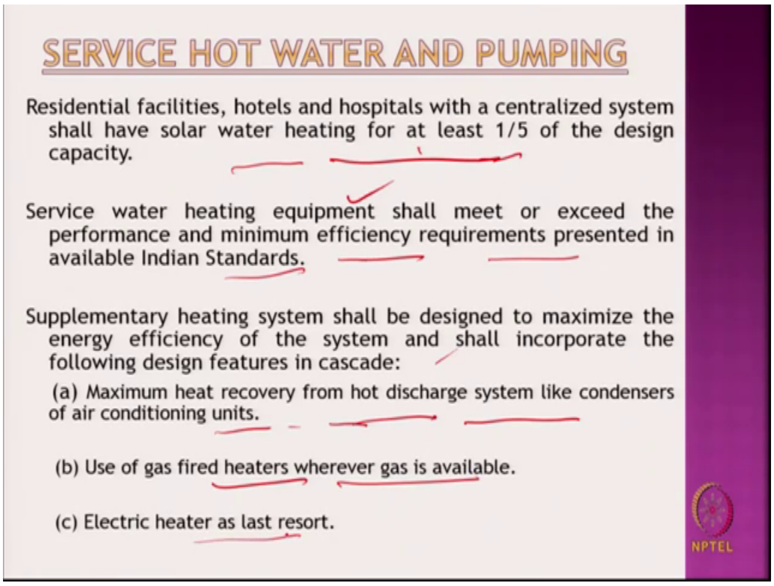

Similarly, such prescriptive requirements are also given for service hot water and pumping that means these are mandatory requirements even when you have trade off option. So, centralized system shall have solar water heater minimum at least one fifth of the design capacity should be through solar heat water.

Service water heating equipment shall meet or exceed the performance and minimum efficiency requirement presented in available Indian standards. So, heating equipment must have the efficiency as per the standard and one fifth must be solar heater.

Supplementary heating system shall be designed to maximize the energy efficiency of the system and shall incorporate the following design features maximum heat recovery from hot discharge system like condensers and air-conditioning, so as much as heat required is possible. Because in air-conditioning system or if you just look at refrigerator what happens its backside is warm.

In a refrigeration system, refrigerant is compressed and then it evaporates again in its core cycle and while evaporating it takes the heat from the chamber from where it is supposed to take heat, where it is supposed to cool. But again it absorbs becomes vapor and under pressure it becomes liquid again. So, when it becomes liquid it will actually dissipate that energy. So, that energy if you can recover this it has to be recovered that is what it is saying as much as possible. So, maximum heat recovery should be so there should be heat recovery system as well. Use of gas-fired heater wherever gas is available, electric heater is usually last because of the efficiency and so on.

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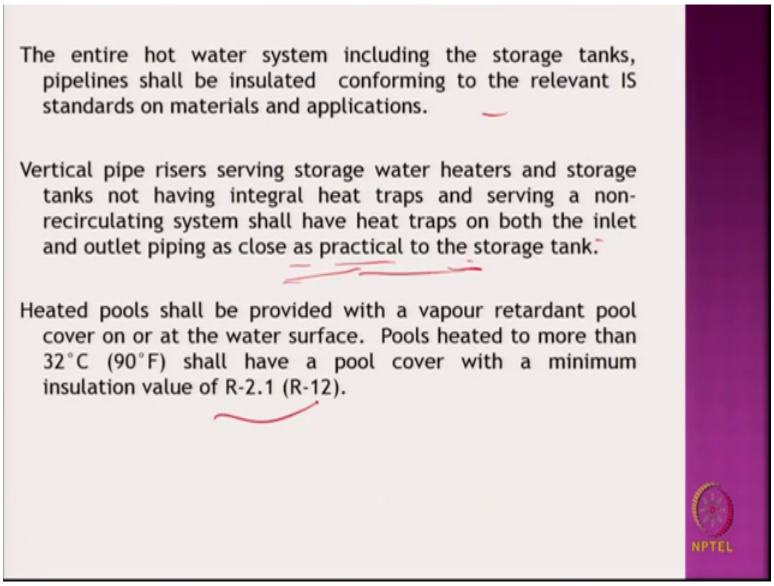

The entire hot water system includes storage tanks, pipelines that as per design and you know shall have heat traps on both the inlet and outlet and heated swimming pools if they are there shall be provided with a vapor retardant pool cover. So, minimizing the loss and pools heated to more than 32 degree centigrade shall have a pool cover with a minimum insulation of this. So, these are the mandatory requirements given.

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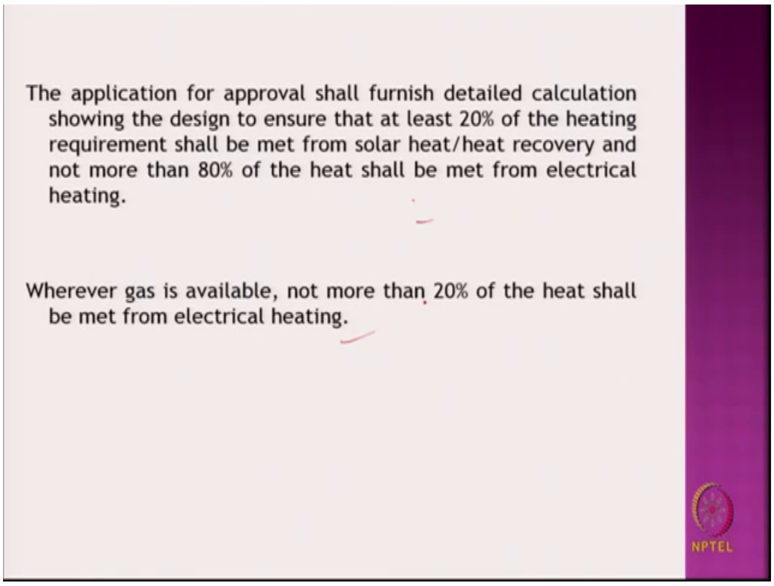

Application of approval shall furnish all this detailed wherever gas is available, not more than 20 percent of the heat shall be met with electrical heating. So, if gas is available use 80 percent by gas, 20 percent on electrical.

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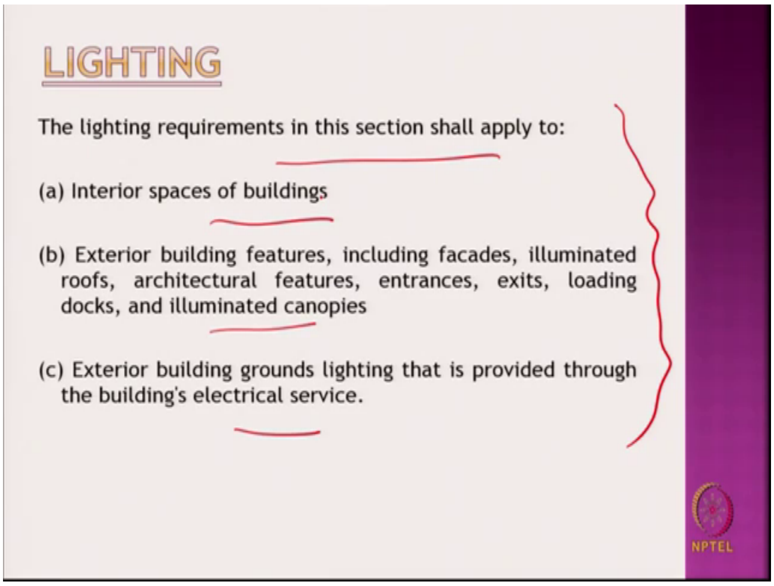

Similarly, lighting requirements interior space building, exterior building features and exterior building grounds lighting that is provided through the building electrical service. So, all this the lighting requirement shall apply to all this whatever lighting requirement I think we discussed some of them during prescriptive condition so that should be met.

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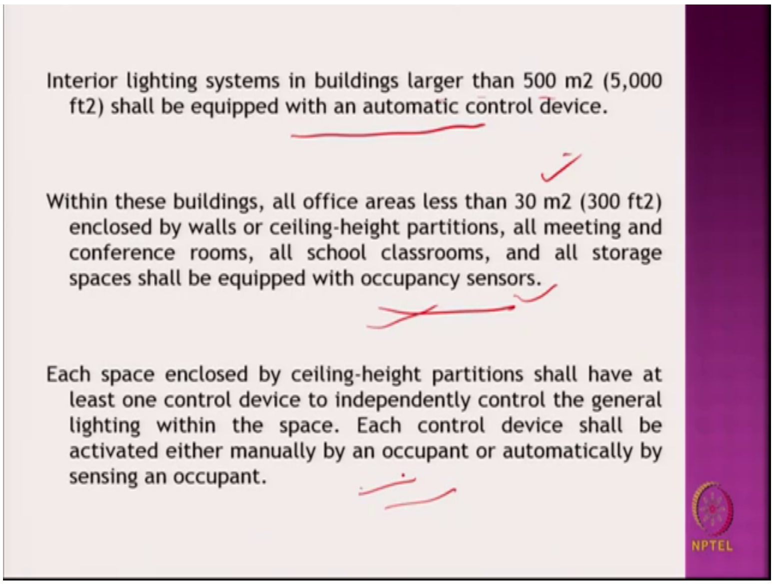

It is already given, the interior lighting system in buildings larger than 500 meter square shall be equipped with an automatic control device. So, when you required put it on otherwise no. Within these buildings and office areas less than 30 meter square enclosed by walls or ceiling- height partitions and meeting and conference room etc. shall be equipped with occupancy sensors. That means as you enter the lights is on. As soon as one is outside intelligent systems sort of essentially they could be infrared sensing. If somebody comes in its senses and the lights becomes on, so it also says that you can put it.

Each space enclosed by ceiling- height partitions shall have at least one control devices to independently control and general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing the occupant.

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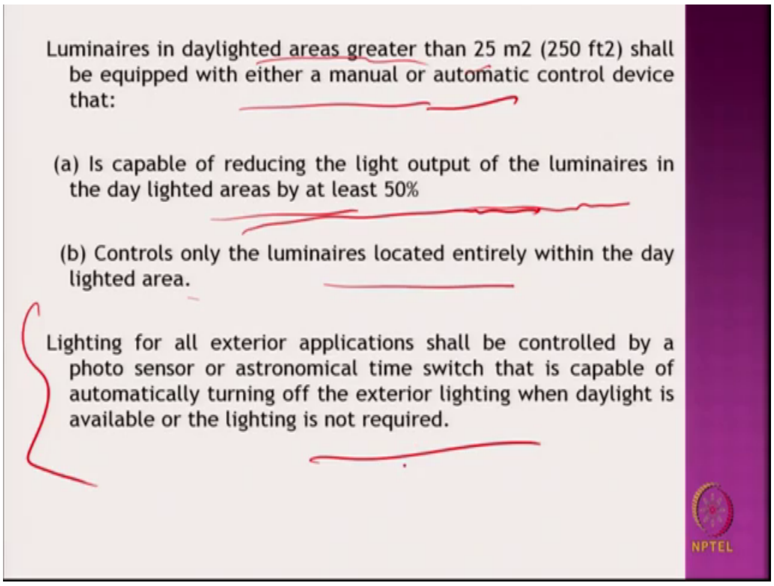

Then it also talks about the fitting, light fitting luminaires in day lighted area greater than 25 meter square shall be equipped with either a manual or automatic control devices. So, luminaries is light on the fitting, so it should be capable of reducing the light output of the luminaries in the day lighted areas by 50 percent. So, try to utilize maximum daylight and controls only the luminaries located entirely within the day lighted area.

Lighting for all exterior applications shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or lighting is not required.

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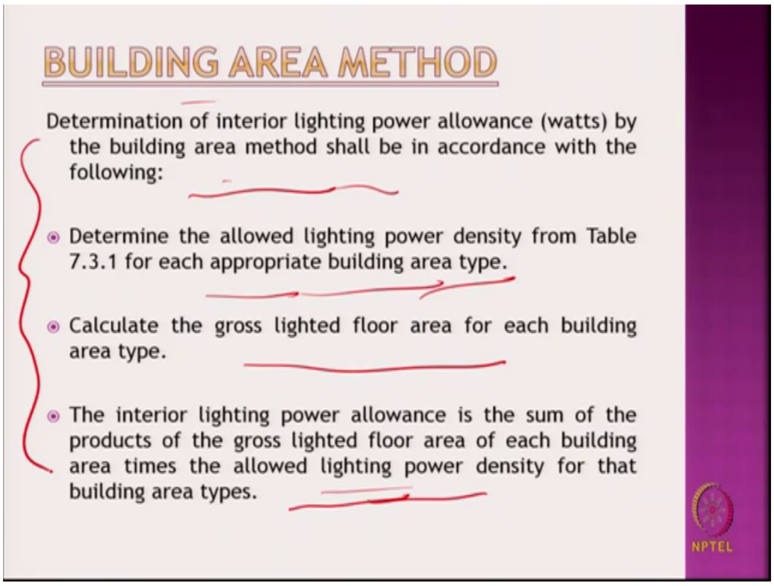

So, first is the prescriptive. Now, this is all descriptive information but if you know the information you can make compliances. You can look at the code and then you can use the compliances. The strategy is three four, one is prescriptive which is not a very best strategy because you can in freedom is not there with the designer.

The second strategy is the trade-off and the third of course we will look at whole building performance. Now, here through building area method interior lighting, total lighting power unit area is given in table. For example, for a classroom, floor area, how much Watt? So, this is given in tabular form. Gross lighted floor area of each building time one can calculate. Interior lighting power allowance is for the sum of the products of Gross lighted floor area of each building times the allowed lighting power density for building area. So, basically it is telling you how to find out the quantity of lighting required.

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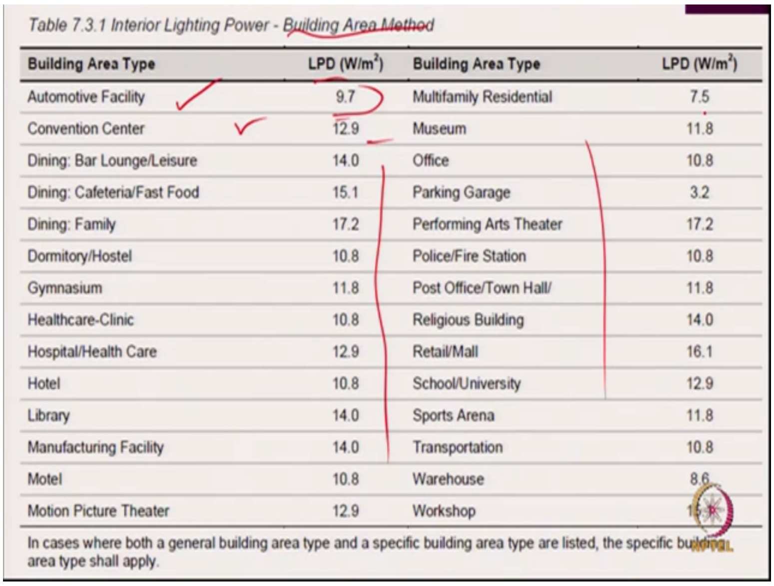

Table 7.3.1 Interior Lighting Power - Building Area Method

Building Area Type	LPD (W/m²)	Building Area Type	LPD (W/m²)
Automotive Facility	9.7	Multifamily Residential	7.5
Convention Center	12.9	Museum	11.8
Dining: Bar Lounge/Leisure	14.0	Office	10.8
Dining: Cafeteria/Fast Food	15.1	Parking Garage	3.2
Dining: Family	17.2	Performing Arts Theater	17.2
Dormitory/Hostel	10.8	Police/Fire Station	10.8
Gymnasium	11.8	Post Office/Town Hall/	11.8
Healthcare-Clinic	10.8	Religious Building	14.0
Hospital/Health Care	12.9	Retail/Mall	16.1
Hotel	10.8	School/University	12.9
Library	14.0	Sports Arena	11.8
Manufacturing Facility	14.0	Transportation	10.8
Motel	10.8	Warehouse	8.6
Motion Picture Theater	12.9	Workshop	[illegible]

In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

And this is what is given in tabular form. So, from building area method you can find out what is the lighting required. Lighting power demand is for automotive facility, convention Centre these values are given, museum, so per unit area, watt per meter square therefore how much lighting is required is given.

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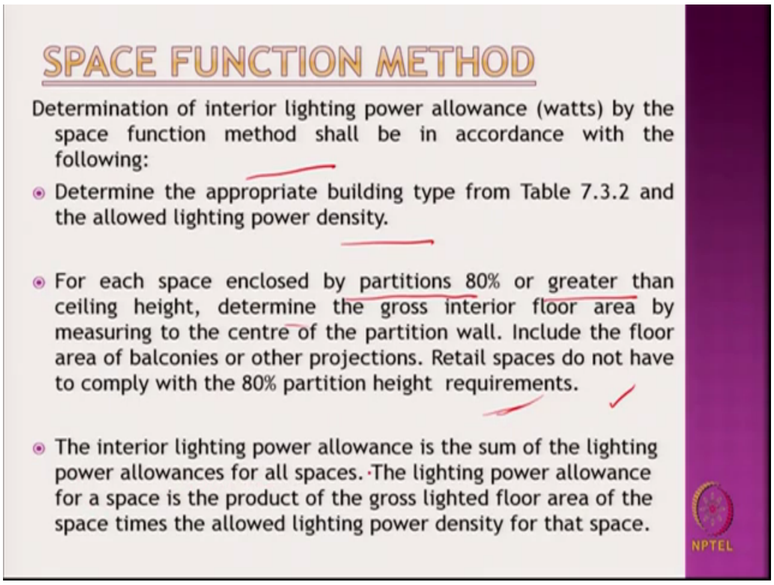

Some cases it might be you can find out the lighting through space function method. Determine the appropriate building type again from a table. Each space enclosed partition is 80 percent or greater than ceiling height, determined gross interior floor area by measuring the center of the partition. Include the floor area of balconies and other projections. So, retail space do not have to comply with 80 percent etc. So, interior lighting power allowance is the sum of the lighting power of allowances for all spaces.

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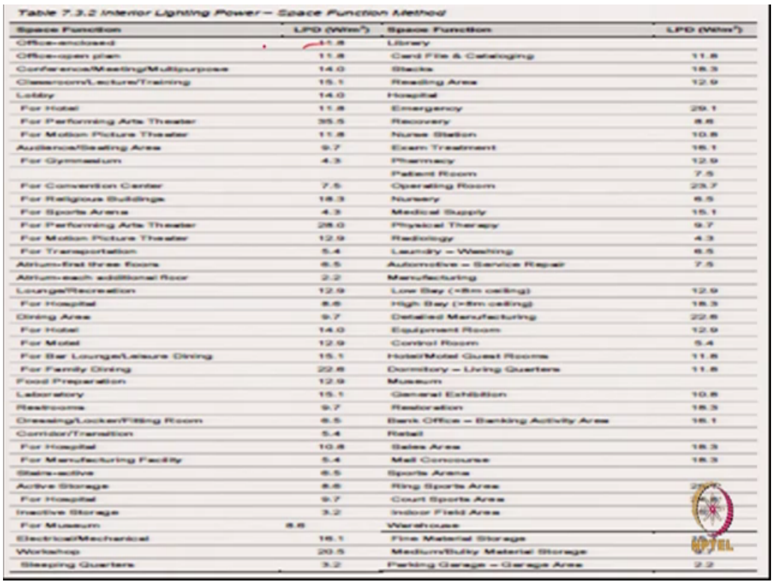
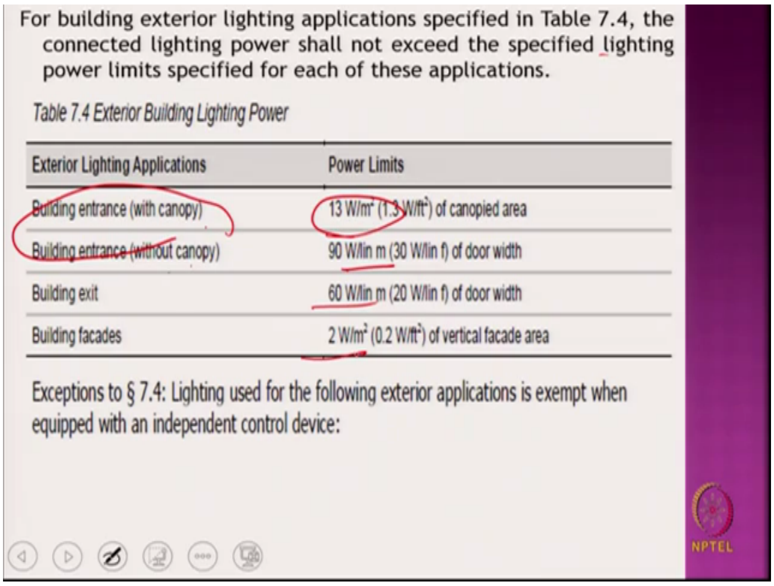


Table 7.3.2 Interior Lighting Power – Space Function Method

Space Function	LPD (W/m²)	Space Function	LPD (W/m²)
Office-enclosed	11.8	Library	
Office-open plan	11.8	Card File & Cataloging	11.8
Conference/Meeting/Multipurpose	14.0	Stacks	18.3
Classroom/Lecture/Training	15.1	Reading Area	12.9
Lobby	14.0	Hospital	
For Hotel	11.8	Emergency	29.1
For Performing Arts Theater	35.5	Recovery	8.6
For Motion Picture Theater	11.8	Nurse Station	10.8
Audience/Seating Area	9.7	Exam Treatment	16.1
For Gymnasium	4.3	Pharmacy	12.9
		Patient Room	7.5
For Convention Center	7.5	Operating Room	23.7
For Religious Buildings	18.3	Nursery	6.5
For Sports Arena	4.3	Medical Supply	15.1
For Performing Arts Theater	28.0	Physical Therapy	9.7
For Motion Picture Theater	12.9	Radiology	4.3
For Transportation	5.4	Laundry – Washing	6.5
Atrium-first three floors	6.5	Automotive – Service Repair	7.5
Atrium-each additional floor	2.2	Manufacturing	
Lounge/Recreation	12.9	Low Bay (<8m ceiling)	12.9
For Hospital	8.6	High Bay (>8m ceiling)	18.3
Dining Area	9.7	Detailed Manufacturing	22.6
For Hotel	14.0	Equipment Room	12.9
For Motel	12.9	Control Room	5.4
For Bar Lounge/Leisure Dining	15.1	Hotel/Motel Guest Rooms	11.8
For Family Dining	22.6	Dormitory – Living Quarters	11.8
Food Preparation	12.9	Museum	
Laboratory	15.1	General Exhibition	10.8
Restrooms	9.7	Restoration	18.3
Dressing/Locker/Fitting Room	6.5	Bank Office – Banking Activity Area	16.1
Corridor/Transition	5.4	Retail	
For Hospital	10.8	Sales Area	18.3
For Manufacturing Facility	5.4	Mall Concourse	18.3
Stairs-active	6.5	Sports Arena	
Active Storage	8.6	Ring Sports Area	[illegible]
For Hospital	9.7	Court Sports Area	[illegible]
Inactive Storage	3.2	Indoor Field Area	[illegible]
For Museum	8.6	Warehouse	
Electrical/Mechanical	16.1	Fine Material Storage	[illegible]
Workshop	20.5	Medium/Bulky Material Storage	[illegible]
Sleeping Quarters	3.2	Parking Garage – Garage Area	2.2



For building exterior lighting applications specified in Table 7.4, the connected lighting power shall not exceed the specified lighting power limits specified for each of these applications.

Table 7.4 Exterior Building Lighting Power

Exterior Lighting Applications	Power Limits
Building entrance (with canopy)	13 W/m² (1.3 W/ft²) of canopied area
Building entrance (without canopy)	90 W/lin m (30 W/lin f) of door width
Building exit	60 W/lin m (20 W/lin f) of door width
Building facades	2 W/m² (0.2 W/ft²) of vertical facade area

Exceptions to § 7.4: Lighting used for the following exterior applications is exempt when equipped with an independent control device:

And this is again another table it is given. So, here it is given again lighting power demand for interior lighting power that is required. So, for building exterior lighting applications this is a building entrance 13 watt. So, here area wise it is given entrance this, exit this much, building facades this much. Then this is all related to trade off. So, trade off these are the mandatory requirement.

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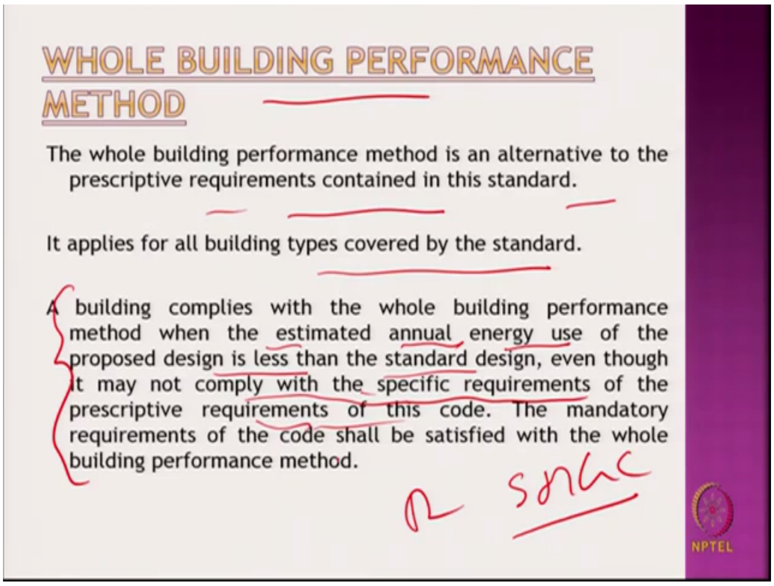

Now, the last is prescriptive then trade-off, last is whole building performance method. In this one again you have to generate, so whole building performance method is an alternative to the prescriptive requirements given in the standard. Now, this is a basic thing. Building is said to be complying with the whole building performance method when estimated annual energy use of the proposed design is less than the standard design.

So, again you generate a standard design. Even though it may not complies with specific requirements of the prescriptive requirements. Now, previous one you can violate somewhere. Here, if you have come up with an innovative design you can violate little bit in all of them. Actually the prescriptive one if you remember that I said that it is generated based on life-cycle costing in about 8, 9 points regression from that they actually found out what is the insulation value, what should be the solar heat gain coefficient and so on. Therefore, this is grossly conservative.

So, if one looks at whole building performance, then it is much more flexible. You can do it in your own way and just show that it is better than one that will follow the standard design. So that is it. So, mandatory requirements again has to be followed. So, the mandatory requirements must be followed.

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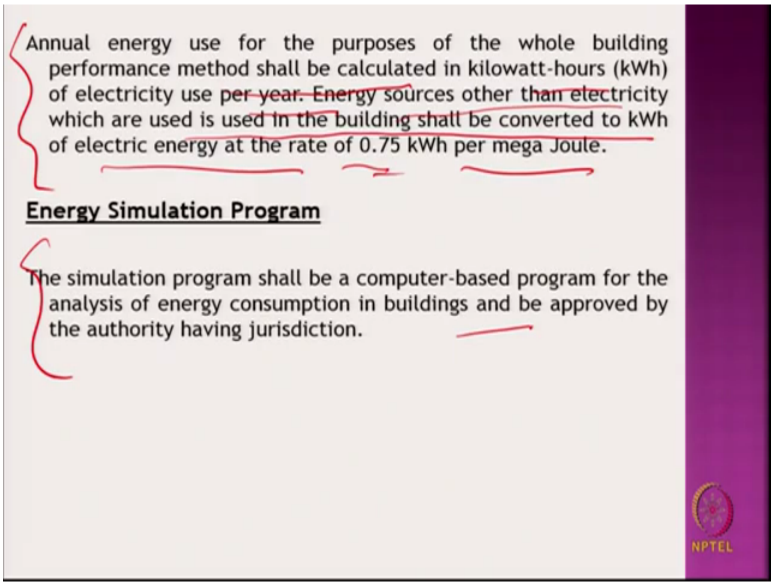

So, annual energy use of course you will calculate whole building performance, calculate kilowatt-hours of electricity per year. Energy sources other than electricity which are used in the building shall be converted into kilowatt of equivalent energy, electrical energy at the rate of 0.75 kilowatt per mega joule. For example, if you are using a boiler steam or something. So, whatever mega joule power you have convert that into equivalent electrical and then use simulation programs. Now, this simulation programs also it is specified or given some range of simulation program which you can use.

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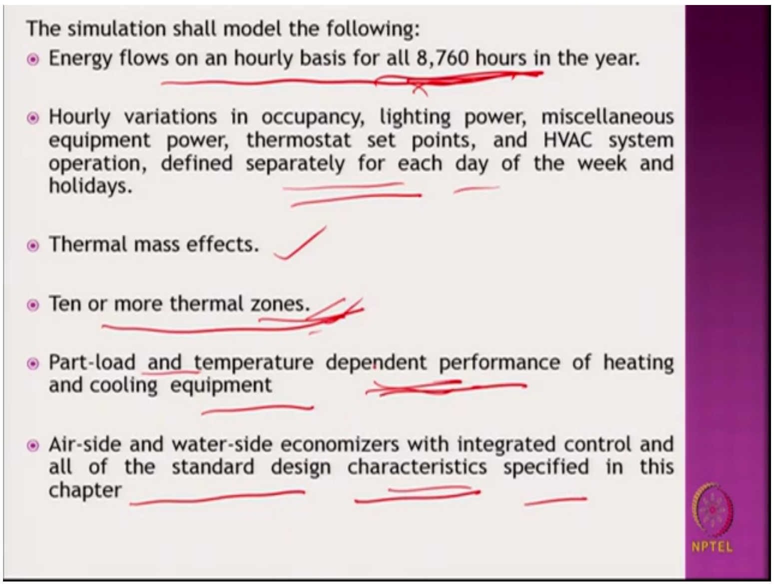

So, it would calculate out 8760 hours of the year that means for every 365 days 24 hours, so such as energy plus (())(24:36) they can calculate out. Now, in design, if you are designing the building envelope you do not need this kind of robust calculation for that many hours. What you need is, compare you might take a typical summer day, typical winter day or maybe combinations of them, number of them maybe and then find out, in case of design.

And find out relatively which is better. But this has to be a robust calculation, that means every hourly estimation of energy should be there. And it must take into account of all the variations in occupancy, lighting power, miscellaneous equipment power, all and such software can take care of this. Thermal mass effect of the overall building. Then they calculate internal heat distribution also.

If somebody is designing only the envelope then need not look into internal heat distribution in a big way but this would also look into the internal heat distribution for example for this building this is facing south-east, this side is facing south-east, this is facing a corridor, now this will gain some heat, corridor where heat transfers from this space to the corridor and the other one, if other side if I have some other room which face north-west. So, in the afternoon there is heat coming in from those spaces also.

So, internal distribution of the heat, cooling load or heating load between all the rooms has to be also found out. So, normally you have divided building into zones. So, thermal zones actually. So, inter zone heat transfer is also to be taken into account and part load and temperature dependent performance of heating and cooling equipment that has to be taken.

Because some of those could be temperature dependent itself, so load might be a function of the temperature. And part of the time the load is actually part cooling I need. I do not need whole cooling. Some portion I may not be applying the cooling and things like that. So, if there are something like evaporative fountains or some (())(27:10) I am using or integrated control I am using there is a software should be able to take that kind of thing.

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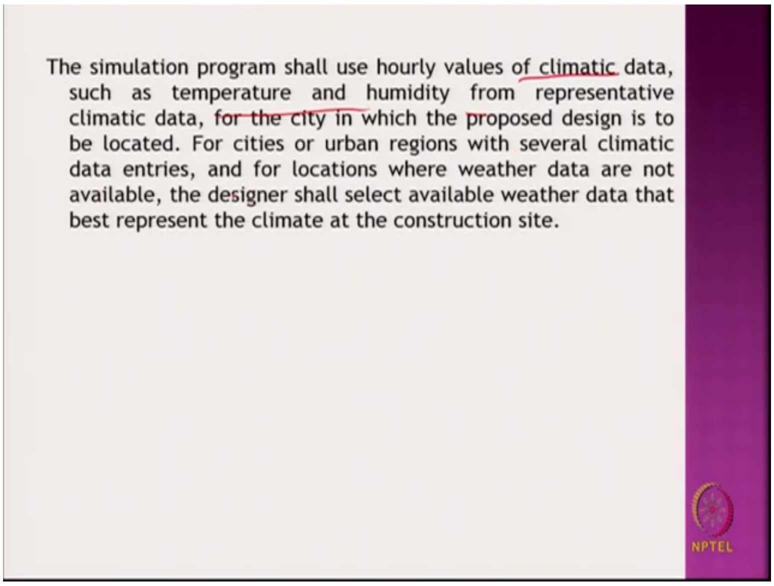

So, this simulation program shall calculate hourly basis, values of climatic data, temperature and humidity from representative, now that is a problem. Normally, most of the software will have a data bank. Many of them for all major cities of the world, so they will have data bank but there are other societies for example Indian Society for heating and refrigeration in East way air conditioning they have data for Indian sites.

Similarly, (())(27:46) will have for American and so on. So even (())(27:49) has got for some Indian data because software is developed in America they will have, since they use elsewhere also, so they have internal data in fact. So, you have representative data that means actually according to the representative data if you are trying to find out whether this will be complying with the requirement of not.

It does not mean the next year you will find energy as you have calculated because every year temperature and relative humidity, velocity or climatic parameters they are not same. So whether parameters are not same, so therefore this is for compliance purposes a standard data is used.

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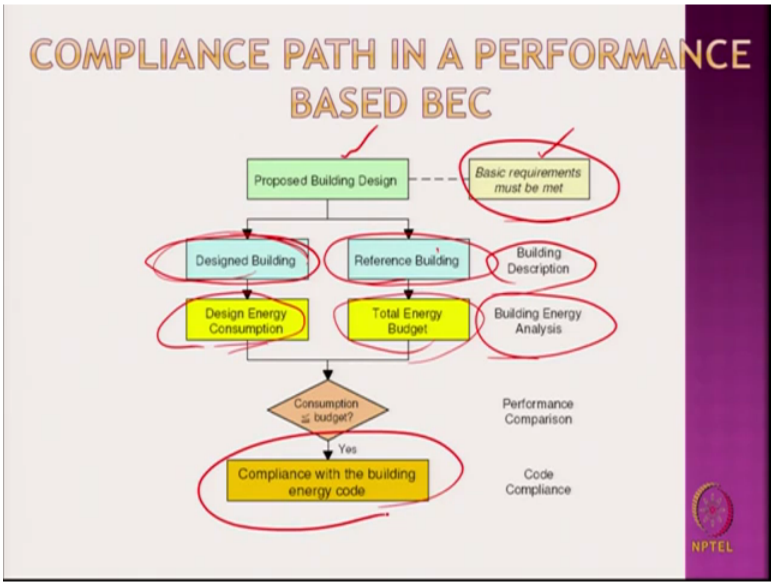

So, compliance with the performance based that is what it is. This is the guideline, proposed building design. Basic requirement must be met that means fundamentally safe, structural safety that must be met and as we said in the beginning as and when this comes, the safety comes into picture they will overwrite the energy codes requirement. So, basic requirement must be met that means fire safety, structural safety this must be met.

Then you design the building maybe you have alternative design, corresponding to that you will have a reference building which might be same because your functional requirement is already finalized and location is finalized. May be you have followed the bylaws, shape orientation that may also be finalized but if there is a variation one can take it. So, this is building description.

So, according to that you generate the reference building. And this is your design of building. Design energy consumption. Total energy budget comes from there. Building energy analyses you do. So, if the consumption is less than the budget then this is accepted. So, then it complies with the code. So, that is how the code works.

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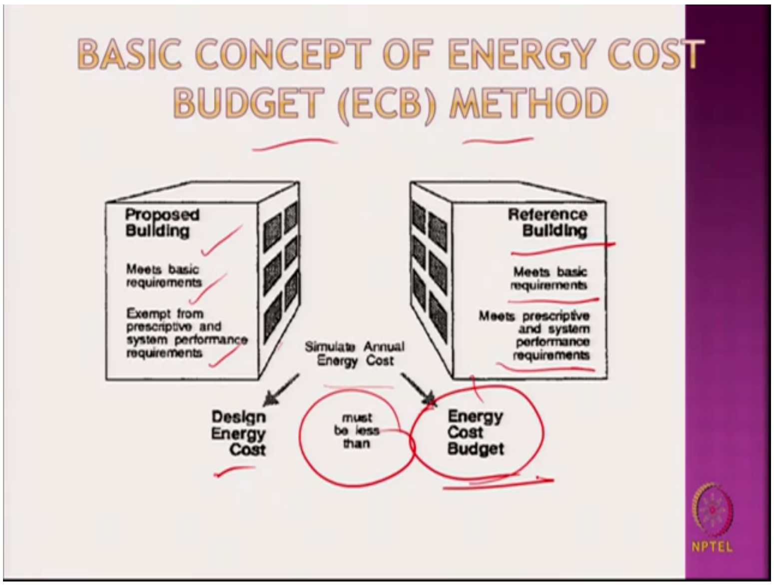

So, for example basic, proposed building, meets basic requirement, exempt from prescriptive and system performance requirements. So, no prescriptive requirement here. And this is the reference building, meets basic requirements. Meets prescriptive and system performance requirements. This gives me from simulation energy cost budget and this gives me design energy cost budget. This should be less than this one. So, as long as your design gives you that is satisfied.

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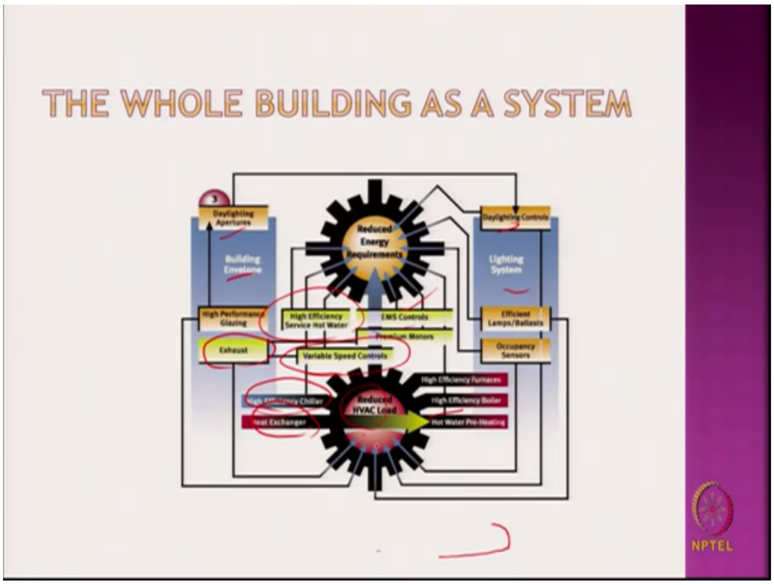

So, this is as a system for example this is the day light features, all day light apparatus you might have, this is the building envelope, lighting system, so envelope part, lighting system controls then energy management system control actually high efficiency service of hot water. Visible speed control, exhaust etc. high-efficiency chiller, heat exchanger, so you might reduce HVAC load because of the envelope and lighting etc. And then use an efficient system, high-efficiency process and all this when complies you will automatically get this.

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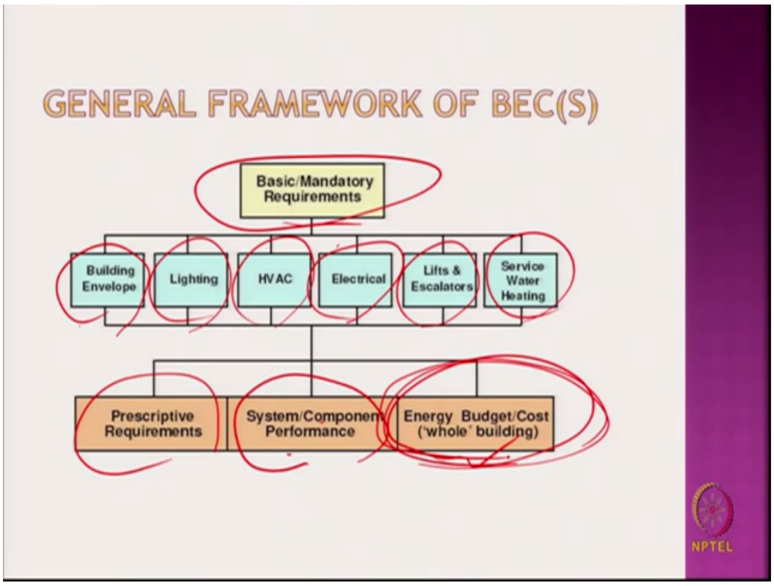

So, general framework of the building energy codes, if you see any code actually there will be some mandatory requirements. Safety is for example one of them. Besides that this mandatory requirements, some building envelop, lighting, HVAC minimum, electrical, lifts and escalators, service water system and then prescriptive requirements, system compliance, energy budget cost whole building.

System or component, so here trade-off means some system compliance, some component compliance, not all component, prescriptive means just took the values from the code and used them. And this one some components will and some components may not but it satisfies the requirement and whole building performance deals with energy cost which will be less than the standard. So, that is what it is.

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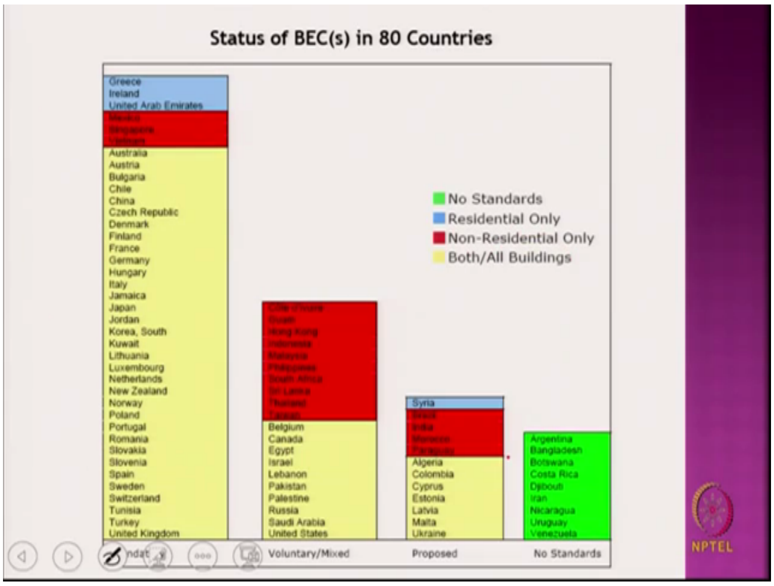

So, look into some other kind of course, let us see what are the status of the code elsewhere in the world slightly some years earlier but even this because the history, a little bit of history and then we will go to any other kind of approach to control the energy.