Sustainable Architecture
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Lecture - 50
Introduction to Whole Building Simulation-II

Good morning. Welcome to this lecture for the ongoing online course on Sustainable Architecture where we are discussing Whole Building performance method. So, in the previous lecture, we discussed about the different components which would go in the whole building performance method and how the simulation should start. So, what are the various inputs which will be required is what we discussed.

In today's lecture, we would discuss about what are the differences between the proposed case and the base case. So, we have been talking about the different codes and standards and we have already seen that what are the different inputs which are required. Now how do we compare that the performance of a proposed case is better than the base case? So, what is that difference and how will there are difference be brought in simulation?

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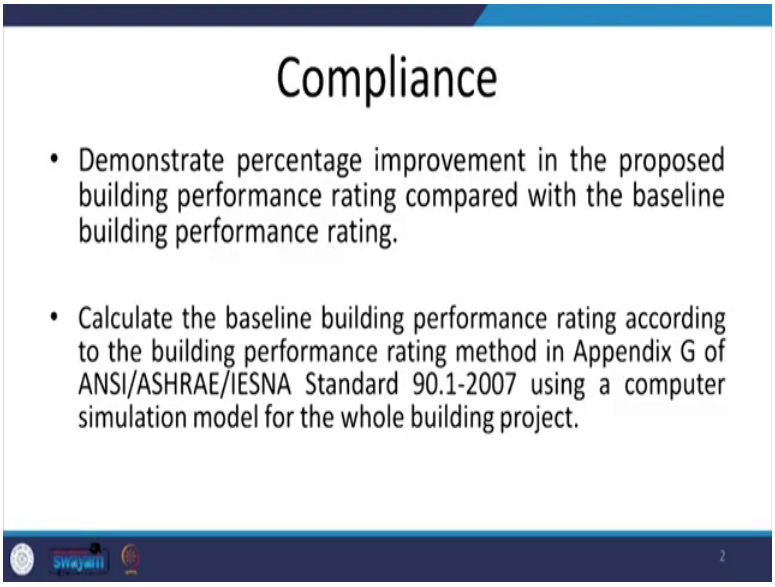

So, when we are talking about the compliance as per whole building performance method, we have already seen that we have to demonstrate through simulation that the energy consumption either the energy consumption of proposed case is less than that of the base case as calculated through the calculation of EPI, Energy Performance Index which is a

normalized rate of energy consumption. Or we calculate that the number of unmet hours of thermal comfort of proposed case is less than that of the base case.

So, either of the two ways will be used for demonstrating the compliance depending upon whether the building is an air conditioned building or a naturally ventilated building. Now, for doing that we have already seen through codes and standards that we use Appendix G of ASHRAE Standard 90.1 or if we are using it for showing compliance for IGBC rating system or Griha rating system then instead of ASHRAE Standard 90.1 Appendix G, we would be using the ECBC appendix for creating a base case.

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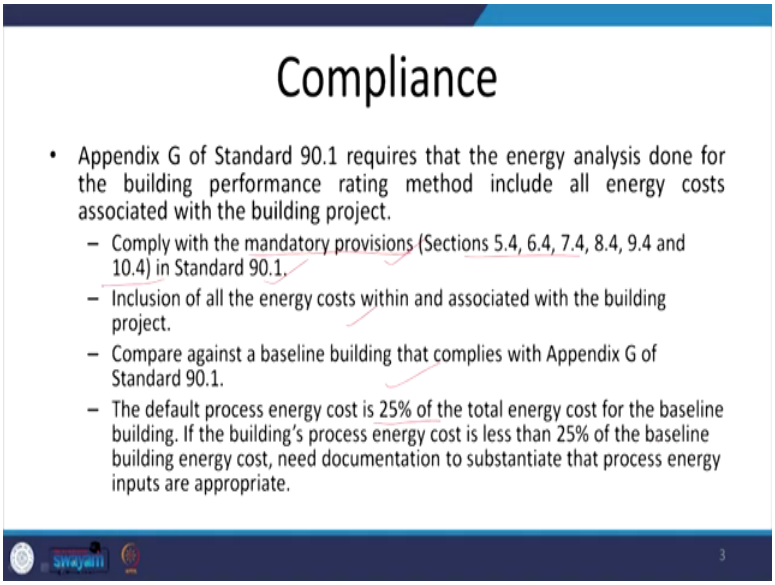

So, when we are talking about compliance, we are talking about the energy analysis which needs to be done to prove the performance of proposed case as compared to the base case using the building performance rating method. And it includes all the energy costs which are associated with the building project.

So, here we are talking about complying with the mandatory provisions which is; so, here the mandate is to comply with the mandatory provisions which are given in the Sections 5.4 till 10.4 of Standard 90.1. If we are talking about ASHRAE in case of ECBC again through chapters 4 to 7, we talk about complying with the mandatory provisions of ECBC.

Then secondly, inclusion of all the energy costs within and associated with the building project would be included. And then we compare against a baseline building that complies

with Appendix G of Standard 90.1. Here the default process energy cost is 25 percent of the total energy cost for the baseline building and in case the process energy cost is less than that of 25 percent of the baseline energy cost, then we need to the substantiate that claim with necessary documentation.

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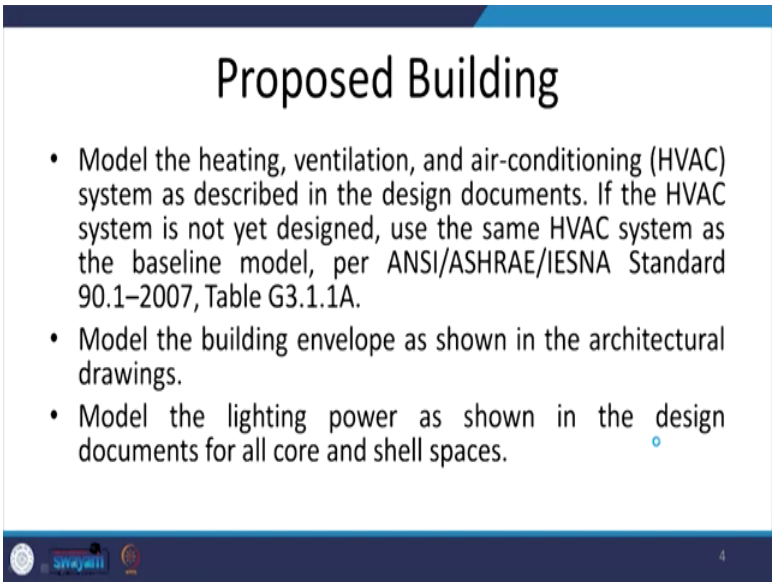

So, when we are talking about the base case or proposed case, there are distinct definitions. The proposed case is actually the building as designed or as it is going to be constructed. It includes the building geometry selection of materials, selection of active systems like HVAC, lighting, solar water heater all of that will be included as designed and as it is going to be constructed when we are talking of the proposed building.

However, when we are talking of the base case, we are talking of a building having the same geometry, but the materials and active systems and couple of passive systems as prescribed through standard. The standard could be ASHRAE 90.1 or ECBC whatever is relevant. But the base case would follow all the prescriptions as given in the code as the standard. So, let us see what those differences would be.

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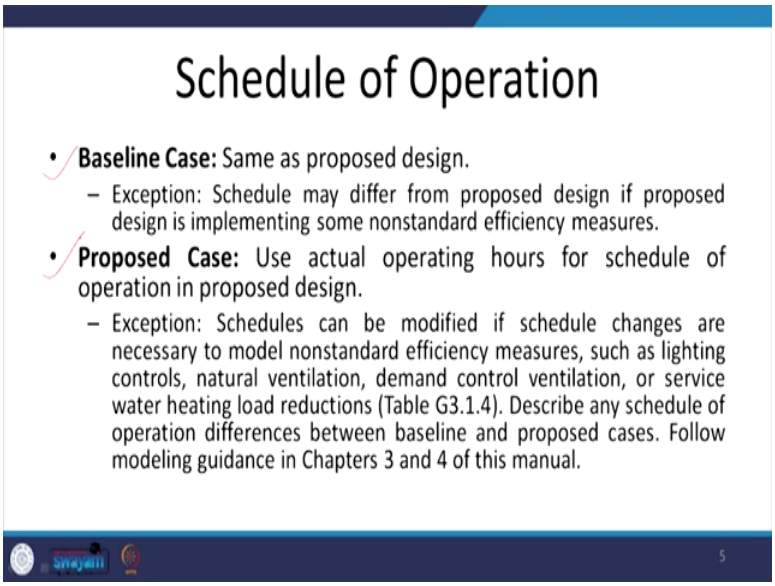

So, first of all let us look at the schedule of operation and we will keep taking each parameter, each head and discuss it for base case and the proposed case. So, the base case schedule of operation is exactly the same as that of proposed case except for where the schedule may differ in case of the non standard efficiency measures.

For example if the lighting controls are added. So, the schedule for lighting control which is given in the proposed case will not be the same as that in the baseline case because this is something which is being done over and above the standard efficiency measures. So, for example, the lighting controls or natural ventilation control or demand control ventilation all of that will be incorporated and proposed case, but not in the baseline case.

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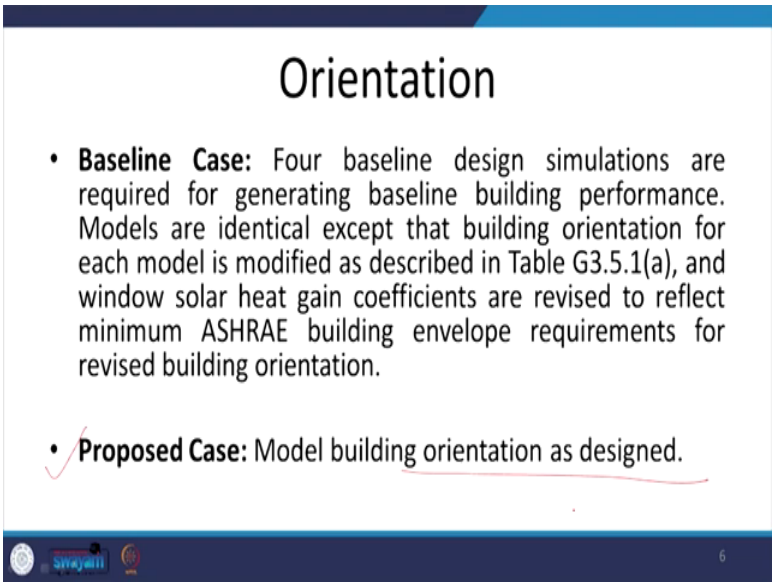

The next is orientation of the building keeping the building geometry as exactly the same. So, the total floor area, the building surface area all of that remains the same for both baseline and proposed case. However, for orientation the baseline will be calculated by simulating the building geometry which is same as the proposed case for all the four orientations and then taking an average to calculate the base case energy consumption or EPI.

However, for the proposed case the model building orientation will be the orientation as design. So, this is done in order to give the advantage to the designer for taking into consideration the correct orientation. So, for example, the building has been designed in such a manner that the larger facade faces north and appropriately the windows have been designed.

So, in baseline case the performance of the building will be calculated by rotating it in all the four orientations. In that manner the consideration towards design in proposed case, we will be given an advantage.

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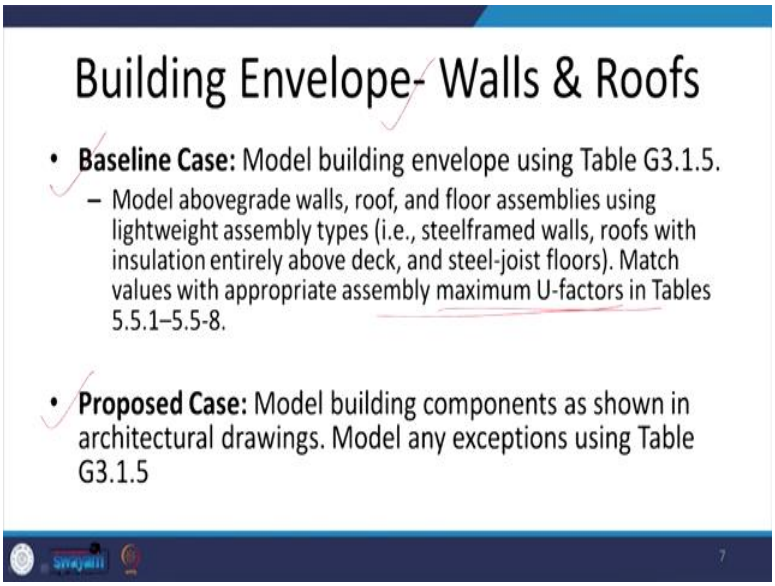

The next is building envelope. So, we have already seen what are the prescriptive requirements as per standards as per codes. When we are talking about baseline method the U factors, the U values, SHGC of the building envelopes will be taken as it is given in the prescriptive requirement of the code.

However, when we are talking of the proposed case, we will use the building components and model them as per the architectural drawings and specifications. So, the U values, the maximum U values permitted will be the ones which will be used in base case proposed case may have higher or lower any of the U value which is used as per the specification.

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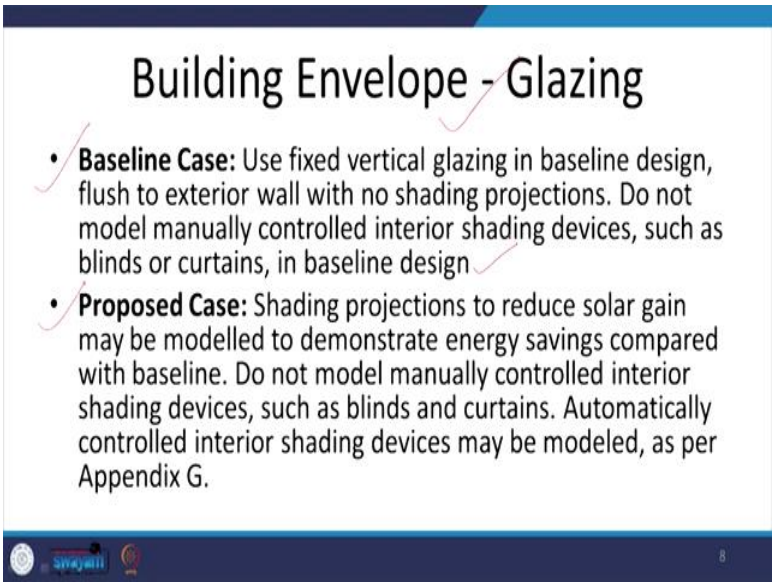

If you are talking about building envelope glazing, there are several factors as far as the material is concerned the U value and SHGC, we have already seen that it will be taken as per the standard in the base case while in the proposed case it will be what is proposed as per the specification. However, when we are talking about the shading devices the projections and WWR.

No shading device will be incorporated in the baseline case because it is a passive design strategy and it will be used in the proposed case as it is going to be designed. The second thing WWR that is window wall ratio; so, for base case the windows will be uniformly divided on all the facades in all orientations taking the minimum prescribed WWR as given in the code.

So, as per ECBC if forty percent is the WWR which is prescribed for a climatic zone, it will be taken as 40 percent and the windows will be uniformly divided on all the facades. However, in proposed case the WWR will be as per the design which is going to be constructed and also the division of windows, the windows will not be equally divided on all the facades it will be as per the design to give to account for the advantage which the designer has on the basis of this design.

In roof surfaces when you are talking about building envelope, the base case will be modeled with all the roof surfaces with a reflectivity of 0.3.

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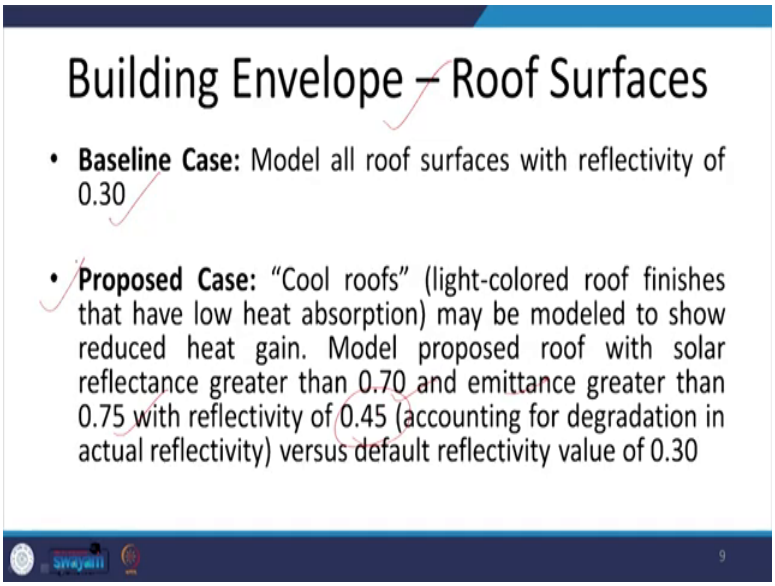

However, in proposed case, we might have different values which may be used in case say cool roofs are being used. So, cool roofs will have a solar reflectance which is greater than 0.7 and emittance which is greater than 0.75; so, with a reflectivity of 0.5. So, this is accounting for an informed choice by the designer and the proposer of the building. So, proposed case gives the advantage over this reflectivity value of 0.3. The next we talk about lighting systems here.

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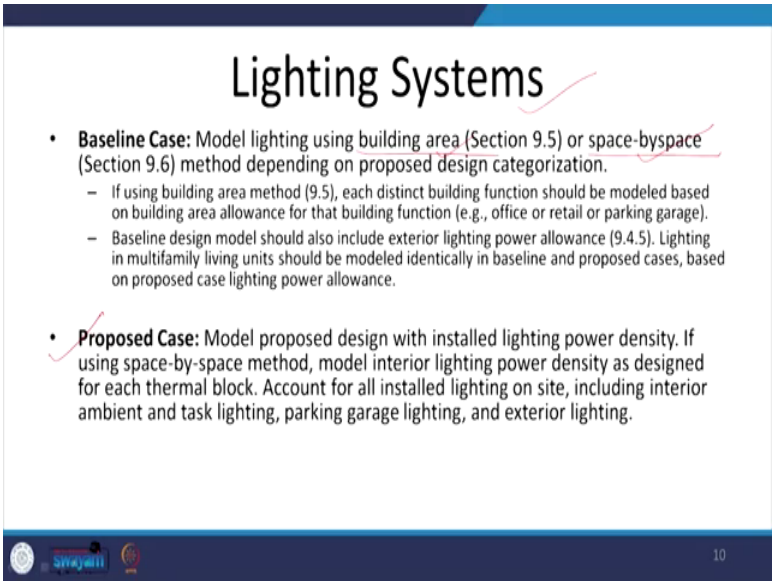

In base case the lighting systems which are used are as per the building area method or space by space method which is prescribed in the codes. The building area method and space by space methods are prescribed in ECBC which are further taken up from NBC only. If we are going for Indian codes; in case we are doing the whole building simulation for complying with lead, then the ASHRAE standard would be used here.

However in proposed case the proposed building will be designed as it is designed for the given installed lighting power density LPD. It could be more than the baseline case, it could be less than the baseline case. And in addition to that the controls will be added to the proposed case while the baseline case will not have any control such as the photo sensors, the daylight controls or occupancy controls or any other programmable control as such. So, proposed case will take advantage of installation of these controls.

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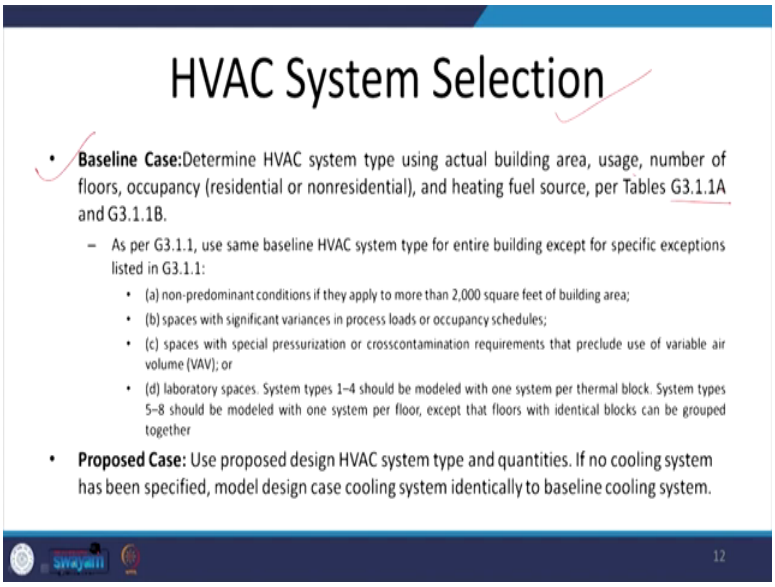

When we are talking about HVAC system selection, the system for baseline case will be determined using the actual building area usage, number of flows and occupancy as per the Appendix G's tables 3.1. So, the different sections of Appendix G 3.1 will be used to determine the HVAC system which will be used in the baseline case.

In case the HVAC system for the proposed building has not been designed as yet, then the same baseline case system which has been used will be used in the proposed case as well.

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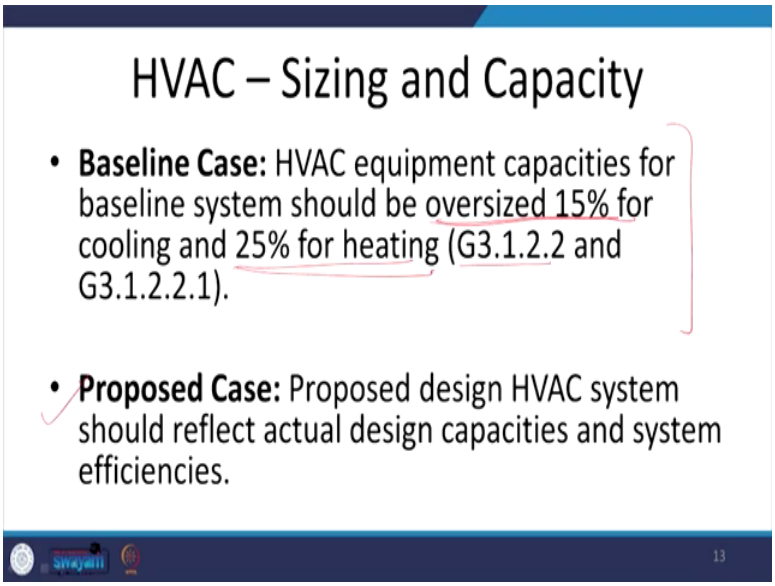

If the system has already been designed, in that case the proposed HVAC system types and quantities with the given efficiencies will be used. For sizing and capacity again for baseline case, it will be referring to G 3.1 one the different sections of this Appendix G 3.1 table and the system will be oversized, it will be calculated for an oversize of 15 percent of for cooling and 25 percent of heating. So, that is what the base case will be taking; however, the proposed case will be reflecting the actual design capacities and the system efficiencies.

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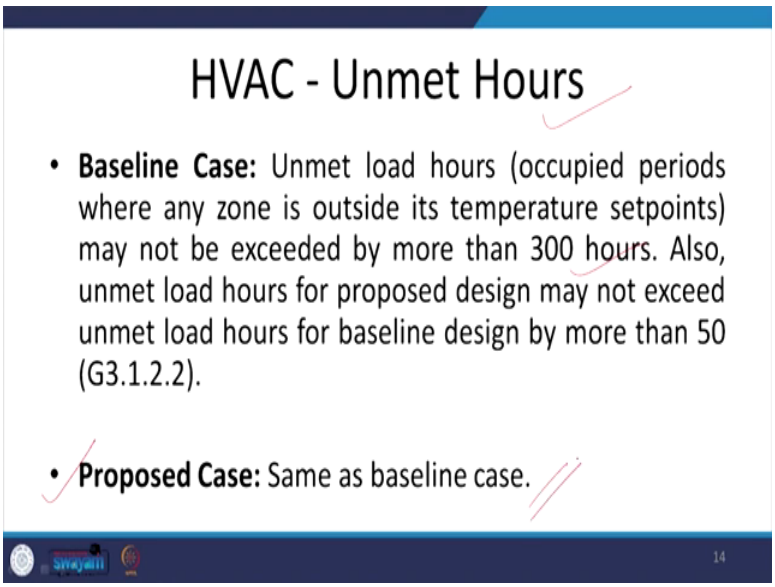

In case of HVAC unmet hours, the unmet load hours for base case will not be exceeded by more than 300 hours and this varies for different codes and different standards. However, when we are talking about the proposed case it will be kept the same as the baseline case and there will not be any variation in this. So, this remains more or less the same.

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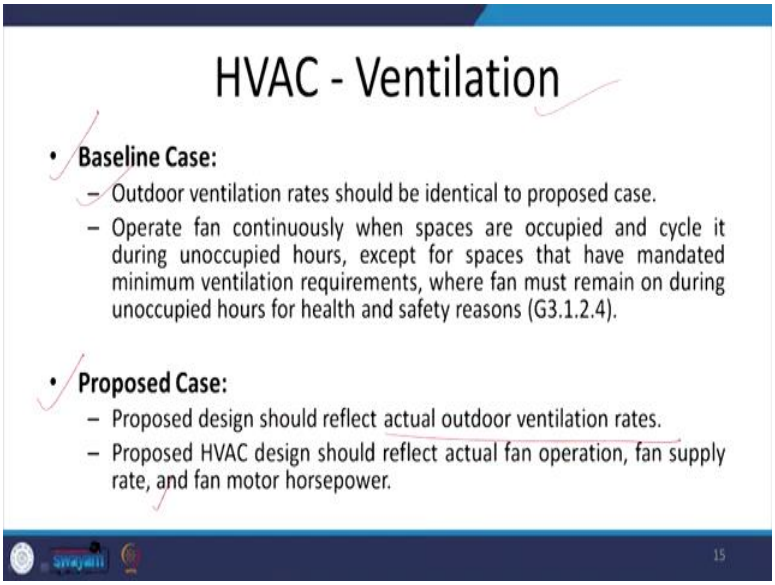

In ventilation the outdoor ventilation rates in both baseline and proposed case will be the same where it will reflect the actual outdoor ventilation rate. So, it should be reflecting the actual outdoor ventilation rate both in proposed and baseline case. However, the operation schedules may vary for proposed case where on the basis of the temperatures or the occupancies the supply of air to HVAC will be reduced or cut off if certain conditions are prevailing.

So, the schedules of operations which are programmed which are specialized may be used in proposed case, but not in the baseline case. Additionally the baseline case will not model the economizers and energy exhaust air energy recovery systems while it will be included in the proposed case to give an advantage of design to the designers.

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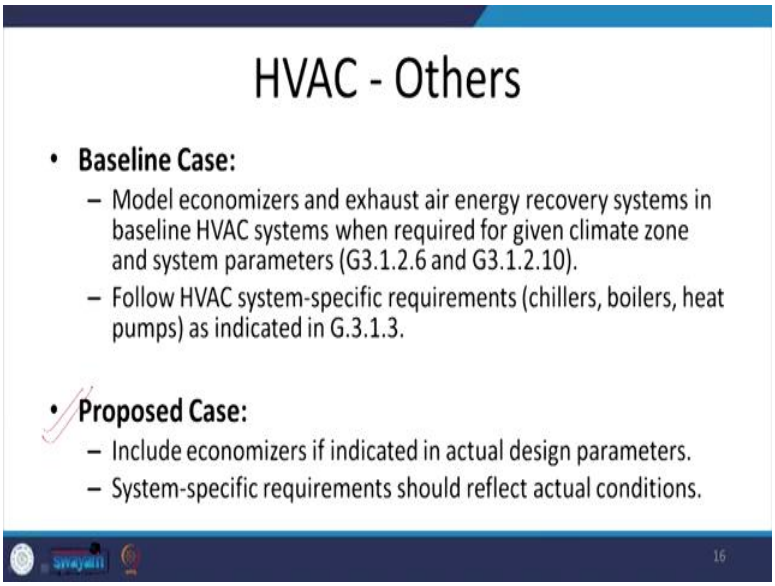

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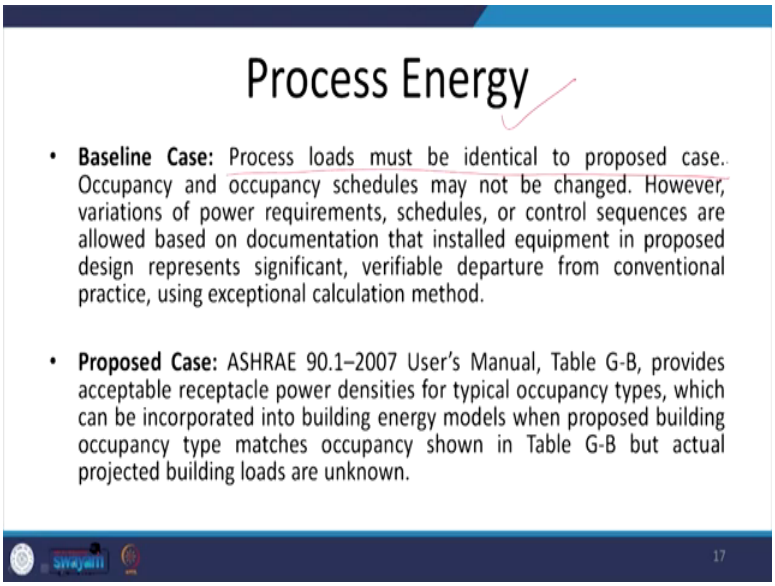

Last is process energy; the process loads in baseline case will be identical to that of the proposed case. So, wherever the process energy is being used for equipments, for other power requirements or the other processes, it will be kept as the same; however, the occupancy schedules for the controls may vary, but all other process loads will be kept identical for both the cases.

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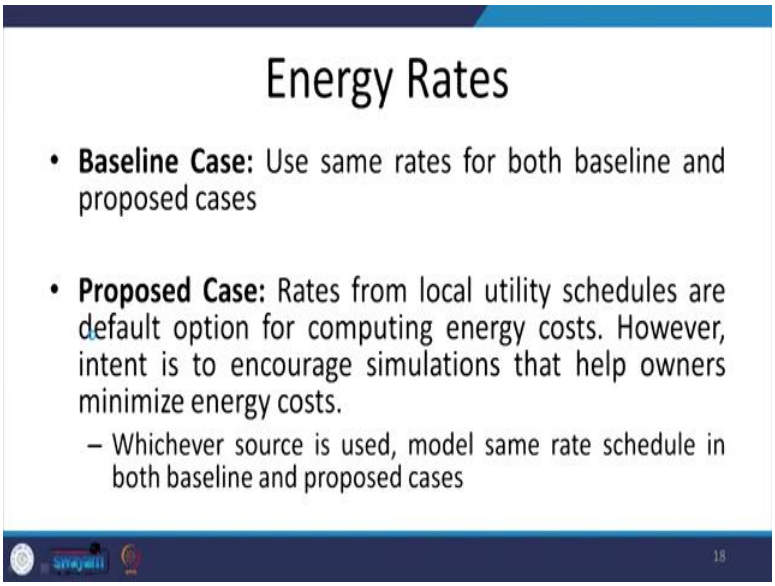

In both the cases both baseline case and proposed case, the same rates will be used and the rates from local utility will be used as the default option for computing the energy cost. So, to model this base case and proposed case, we have to use a simulation software for which the qualification criteria is also standardized as per ASHREA 90.1.

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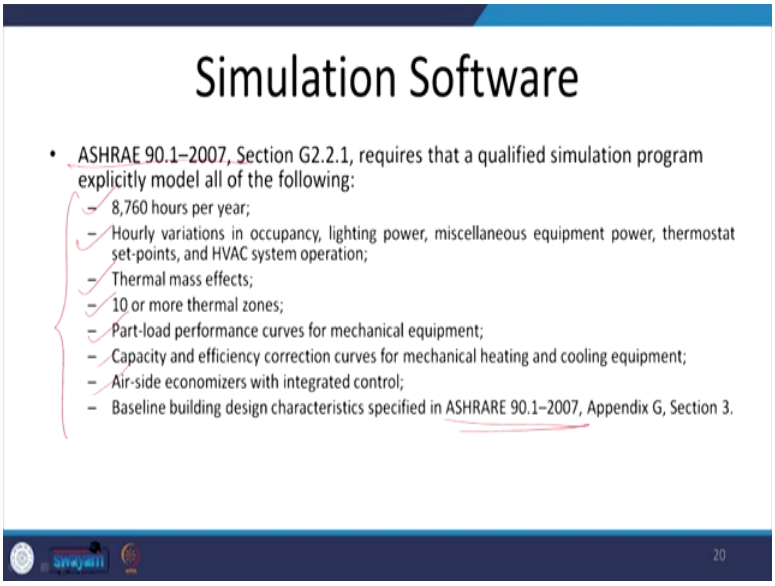

So, the simulation program which qualifies as per ASHRAE 90.1 should meet all these requirements. One it should be able to model the computerized model for an entire year on an hourly basis. So, all 8760 hours per year shall be modeled as per the simulation

programs. It should be able to depict the hourly variations in occupancy lighting power, the equipment power, the thermostat set points and HVAC system operations.

It should all be also be able to reflect the thermal mass effects and it should be able to handle 10 or more thermal zones. So, no clubbing of thermal zones should be happening. It should be able to model the part load performance curves for mechanical equipments and capacity and efficiency correction curves for mechanical heating and cooling equipment.

It should be able to model the airside economizers with integrated control and the baseline design characteristics as specified in ASHRARE 90.1. So, these are the specific requirements of the simulation software as per 90.1.

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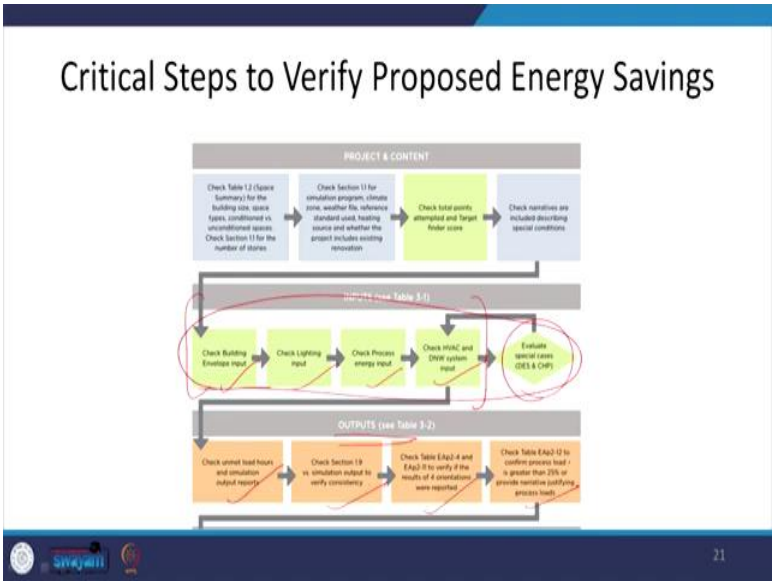

And there are several simulation softwares which are available in the market. Several of them are free to use, you can use any of these softwares, but the critical steps to verify the proposed energy savings and to demonstrate the compliance remain the same in all these software.

We will go and we will learn only one of these simulation softwares in subsequent lectures. However, here as I will very quickly take you through the critical steps of verification they remain the same. So, first of all, we check the total points which are attempted and the

targeted score for green building compliance because largely this whole building simulation is used for green building compliance for demonstrating the compliance.

And next we check all the inputs. So, we have discussed in detail what are the different inputs which are required; so, whether it is building envelope or lighting or process energy HVAC system. So, all these inputs will be required and we will evaluate the special cases if they are. Once the inputs have been sufficiently given, this will be based upon what the proposed building is and for the base case, it is coming from these standards. So, once the inputs have been done, we will then check the outputs.

The outputs for unmet hours or simulation output reports for simulation output for verifying the consistency and we will be verifying the consistency from its orientation point of view and its process load point of view. So, the outputs will be used to verify the inputs as well as the outputs.

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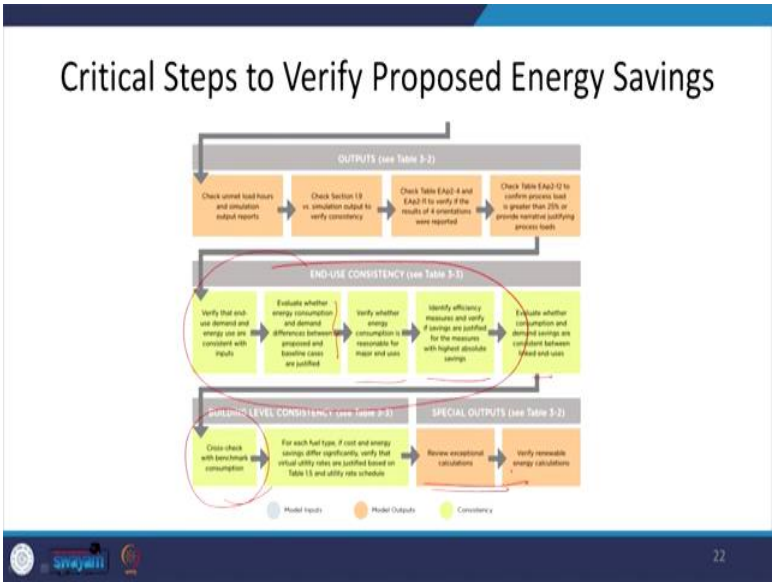

And then we will again go back to using the model for end use consistencies where we will be verify the end used demand and energy use, the consistency of that. We will be evaluating whether energy consumption and demand differences between the proposed and baseline cases are justified on the basis of the inputs that have been supplied. So, once we check for all these consistencies finally, we will cross check the benchmark consumption and we will make the calculations and hence the demonstrations.

So, this process remains the same whatever be the simulation tool. So, we will stop here for our discussion on baseline case and proposed case. And from next lecture onwards, we will be working on the simulation software. This tool that you have to install on your systems is the latest version of design builder. So, before you come to attend the next week of lectures you should have the design builder software installed on your systems. For one month the trial version of this software is available for free use.

After which if you wish to continue to use the same software, you may need like to purchase the license. If not other softwares are also available, but we will demonstrate the process of simulation and demonstration of compliance using design builder. So, before the next lecture, kindly install your software's and be prepared come ready where we will be starting with design builder simulation.

Thank you for being with us. See you again next week.

Thank you.