Human Factors Engineering
Prof. V. K. Tiwari
Prof. P. K. Ray
Department of Agricultural and Food Engineering
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture - 58
Valorisation of Waste into Value-added Products

It was essential to know what is the ergonomic maturity of a particular workshop or a production system which has dependent on several factors.

We should know what is the level of the safety awareness which is provided in the system, what sort of different levels of grading's of the work which has been given, how a particular grading will affect the overall performance of the person. We have said that we are talking of a human machine and environment system.

We had talked of a concept of 6 level of variation of the human contribution, the machine contribution and the environment contribution vary.

Depending upon this there will be change in these values of concept of 6, we had talked of how this concept varies as the level of automation or level of provisions made for the operator to be comfortable in the system and do the task without harming himself.

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Today we will be discussing factors and their level of assessment.

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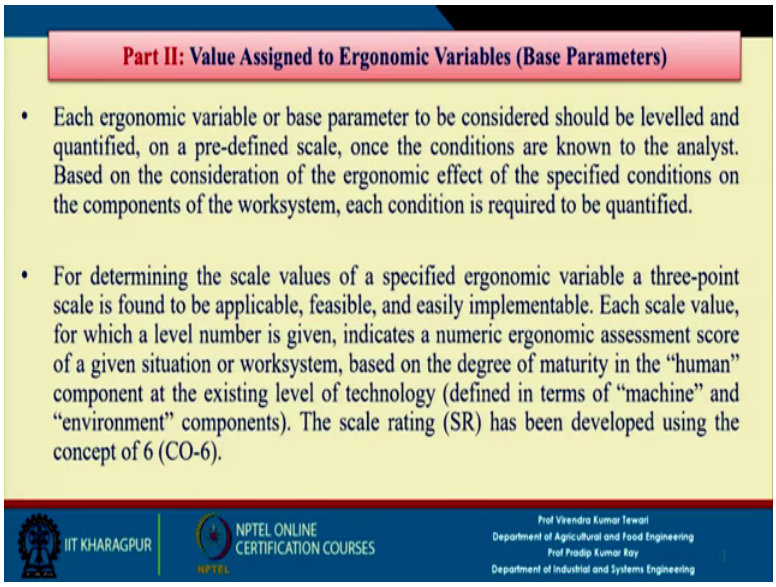

Each ergonomic variable or base parameter to be considered should be levelled and quantified, on a pre-defined scale, once the conditions are known to the analyst. Based on the consideration of the ergonomic effect of the specified conditions on the components of the worksystem, each condition is required to be quantified.

For determining the scale values of a specified ergonomic variable, a three-point scale is found to be applicable, feasible, and easily implementable. Each scale value, for which a level number is given, indicates a numeric ergonomic assessment score of as given situation or worksystem, based on the degree of maturity in the “human” component at the existing level of technology (defined in terms of “machine” and “environment” components). The scale rating (SR) has been developed using the concept of 6 (CO-6).

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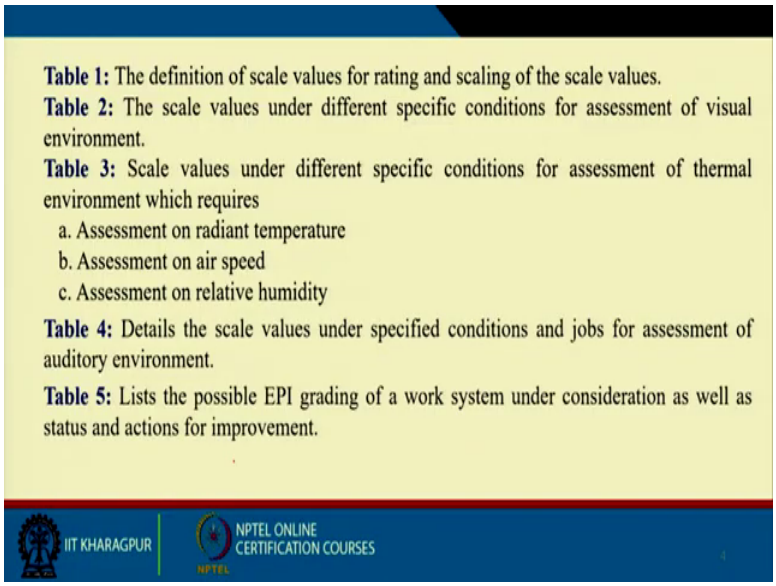

Now, these are put into different tables which is from 1 to 6.

Table 1: The definition of scale values for rating and scaling of the scale values.

Table 2: The scale values under different specific conditions for assessment of visual environment.

Table 3: Scale values under\ different specific conditions for assessment of thermal environment which requires

1. Assessment on radiant temperature
2. Assessment on air speed
3. Assessment on relative humidity

Table 4: Details the scale values under specified conditions and jobs for assessment of auditory environment.

Table 5: Lists the possible EPI grading of a work system under consideration as well as status and actions for improvement.

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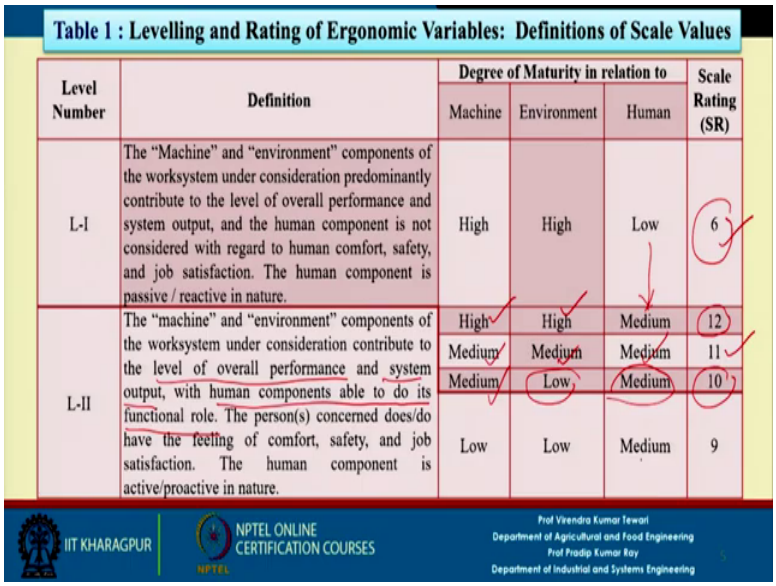

Now, here table 1. The leveling and rating of ergonomic values, the definitions of the scale. Initial level- depending upon the level of maturity of the human machine and the environment we had put that. If machine and environment are at the highest level and the human being; that means, the care or the provisions for human being are not taken care of to that extent and that the care or the percentage of thinking about the human being in the system is lower, then we will have a value which is rating of 6. Where the machine is performing at its highest environment is also high means we have taken care of the value and the human is low.

Now when you go to level 2 the machine and environment components of work system under consideration contribute to the level of overall performance and the system output with human components able to do its function role. Now when degree of maturity in relation to machine is high and environment is high and human is medium then the rating will be 12. Now when degree of maturity in relation to machine, environment and human is medium then the rating will be 11. When degree of maturity in relation to machine is medium and environment is low and human is medium then the rating will be 10. When degree of maturity in relation to machine is low and environment is low and human is medium then the rating will be 9.

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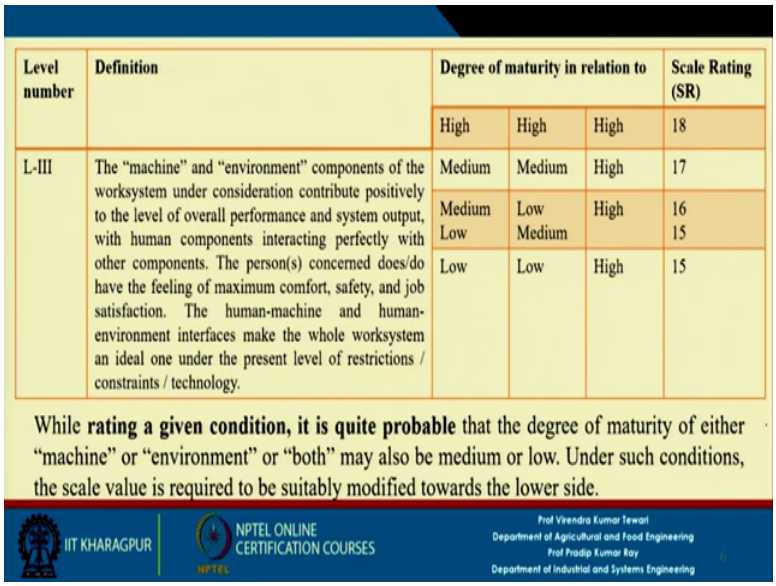

Level 3 talks of the machine and environment components of the work system under consideration contribute positively to the level of overall performance and system output, with human components interacting perfectly with the other components yes. Now this is the one where we are talking of everything very good; that means, fully automated system.

And then we say that the human being has been also taken care of properly while designing the system, the environment the effect of environment has also been taken care of and proper provisions have been made, proper detailing of the design of the whole system has been done and machine is completely human friendly and it does not require very high level of automation, in the sense that the person is in a position to interact with very well. When degree of maturity in relation to machine is high and environment is high and human is high then the rating will be 18. Now when degree of maturity in relation to machine is medium and environment is medium and human is high then the rating will be 17. When degree of maturity in relation to machine is medium and environment is low and human is high then the rating will be 16. When degree of maturity in relation to machine is low and environment is medium then the rating will be 15. And when degree of maturity in relation to machine is low and environment is low and human is high then the rating will be 12.

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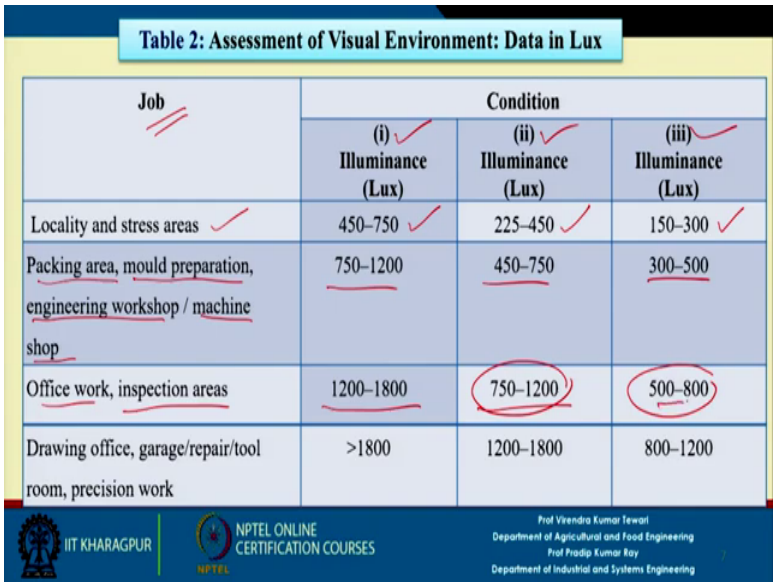

In assessment of visual environment, now we go into table 2.

There are three conditions here and then accordingly the local locality and stress areas; we have to consider the job and then the condition. Suppose where packing is going on mould preparation is going on engineering workshop machine and machine shop etc. Depending upon these we will be in a position to check whether we should have the illumination level of 450 to 750 or we should go for 225 to 450 or 150 to 300.

This has to be on the basis of the locality and stress areas. Then packing area, mould preparation, engineering workshop, machine shop etc. you will find that these values are varying. Because, that is the level of illumination required at that shop or at that point of job which is being done. When we are talking of the different condition office work and inspection areas in case of office work and inspection areas the illumination level is very high 1200 to 1800 lux.

Similarly, when you are talking the level condition in the second condition or the third condition where you are thinking of that automation is better than you may not require the 750 you may be with the level lower level you can still go ahead.

Similarly, with the illumination level of the third condition and there you can have 500 to 800 itself because others will take care of. That, you will have to read this with regard to what is the existing condition, how does it compare with the job which is given here and

where is this job located? For example, office work inspection area production area and then drawing office garage repair workshop and all that.

If you would look for those locations you will be in a position to check those values and get the exact signed lux. And once you know the value what is the illumination level you could be able to decide what how many of the tube lights or bulbs or other illumination features you will include.

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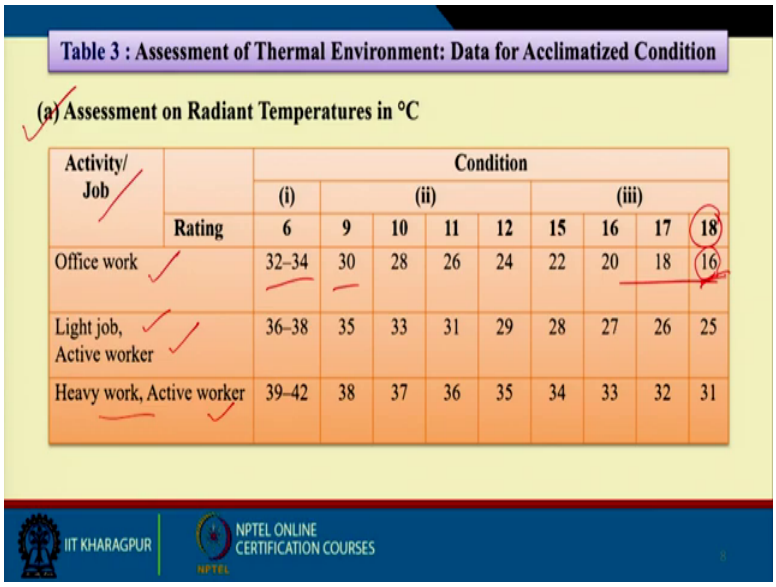

Now, assessment of thermal environment, we have this assessment because when we are talking of environment temperature humidity will have a different level. If it is very high temperature low humidity, very high humidity low environment, this will go in a long way and then only you will be in a position to understand what exactly is the thermal environment.

And hence we have separately done for the temperature. So, we can get assessment in table 3 we are talking of the different type of activity or job office work light job activity work or heavy work and active worker depending upon the rating is given here condition 1 condition 2 and condition 3.

Now, here we have to go back at what we decided there the rating of that scale see at the rating from 6, 9, 10, 11, 12, 15, 16, 17 and 18 we have not got anything between 13 and

14, because we created something like 6, 12 and 18 and equally between 6 and 12, we have got about 9 and 9, 10, 11, 12.

Similarly, when we are talking of 18, we talked of 15, 16, 17, now this is these are the things which we designed and we have not picked up some are the values in between say 6 and 9 between 12 and 15 we have not picked up. Now in case of office work, the temperatures value which have been given for instance. you should see when you are talking of something 18 then the environment is about 16 degrees or so temperature.

So, you should know that when we are talking of high, high and high where for human machine and environment all three are high, there we are giving a value signed value as 18 scale rating is 18. So that means, the condition is about 16 or a temperature where it is worth accepting. So, similarly for the light job and where the active worker is there may be heavy work or active worker is there why we say that active worker.

That means worker is not being so much affect affected, but the type of job is one which is dictating us as to what should be the value depending upon the condition. And therefore, you can see that for a temperature as well we have described depending upon those values. So, when you add all these scale ratings you will get a final scale rating which we will talk of the comprehensive ergonomic performance indicator value.

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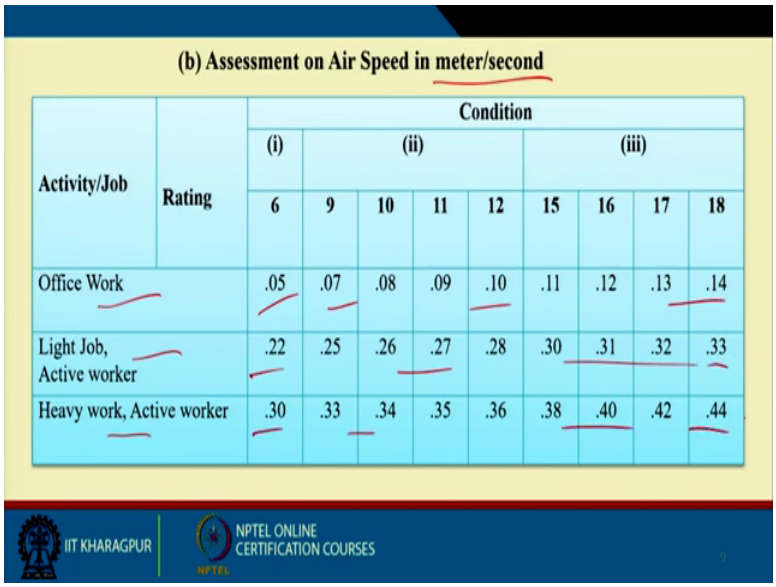

For a temperature similarly you will get for the air speed. Depending on a similar condition you can get for office work, for light job and heavy work, the conditions which have been talked of here are the air speed in meter per second. These values are air speeds in meter per second depending on what is required where is the condition what is outside or wherever and the air speed is also recommended.

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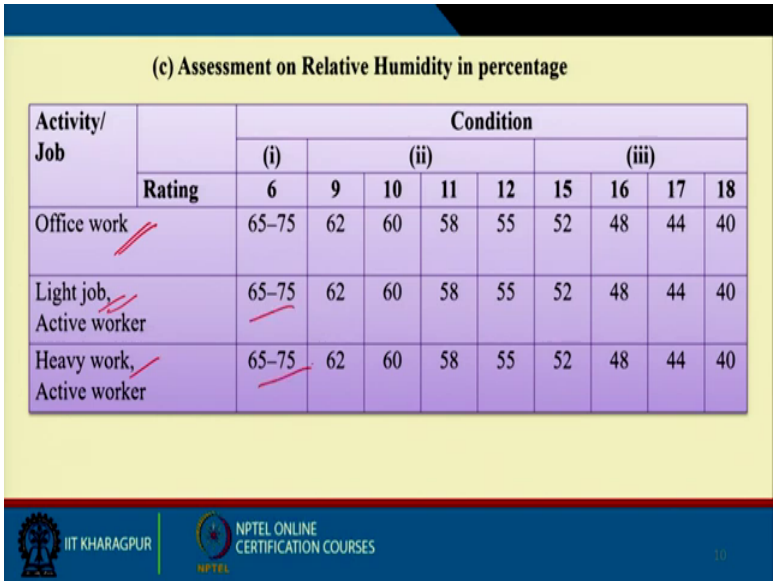

Similarly for the humidity, because we know that temperature and humidity go together and therefore, we need to have a value of temperature and humidity we have separated them. So, you will be able to understand.

Similarly, for all the three jobs the ratings have been given whether it is an office work or a light job where either be in the production shop or assembly line wherever and if it is a heavy work, then what will happen how the values rating will change and what should be the percentage. Depending upon the percentage of the humidity you will have the ratings values which has to be added in the scale.

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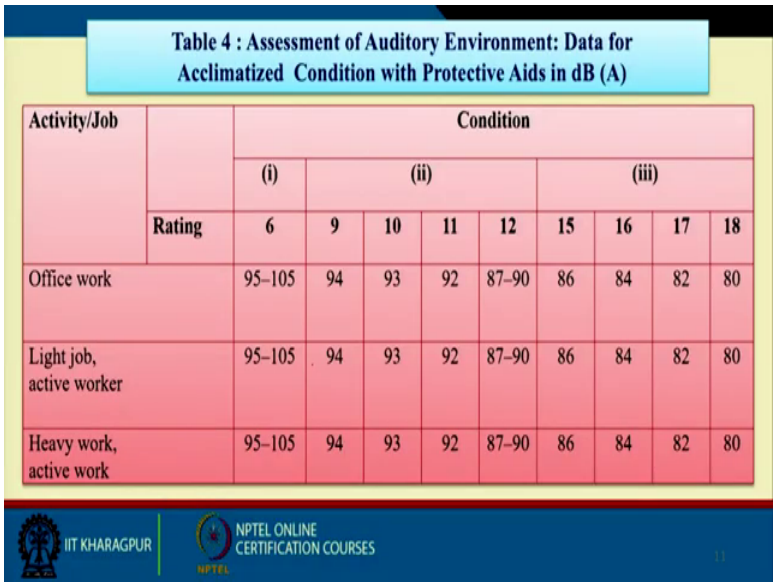

Activity/Job		Condition								
		(i)	(ii)				(iii)			
	Rating	6	9	10	11	12	15	16	17	18
Office work		95–105	94	93	92	87–90	86	84	82	80
Light job, active worker		95–105	94	93	92	87–90	86	84	82	80
Heavy work, active work		95–105	94	93	92	87–90	86	84	82	80

Now, we go to assessment the auditory environment and it is important because many a times when you have this auditory environment of the person, how much he is in a position to listen and act properly if he does not listen properly. If lot of noise is emanating from the location where he is positioned for doing the job, he is likely to make mistakes.

And therefore, we have to have a proper auditory environment and accordingly for the office work for light job for heavy work on a similar level we have designed these values from 6 to 9 in the ratings. What are the auditory values which you should have 95 to 105 and then 94 93 and all these are the auditory values in decibels.

We need to maintain in the rating from 6 to 18, humidity you will maintain, then the air velocity you will maintain and auditory you will maintain depending upon condition.

If it is a hospital what you will maintain, if it is a light production job what you will maintain, if it is very heavy production job lot of things are happening then what is the level of decibels you need to maintain? Because ultimately the person will be getting affected and physically, he will have problem if he gets affected over a period of time, he is assigned the job in each of the ships for may be months together. So, he has to take into consideration the shifts in which he is doing the job.

How long which shift he is continuing and what is the nature of job.

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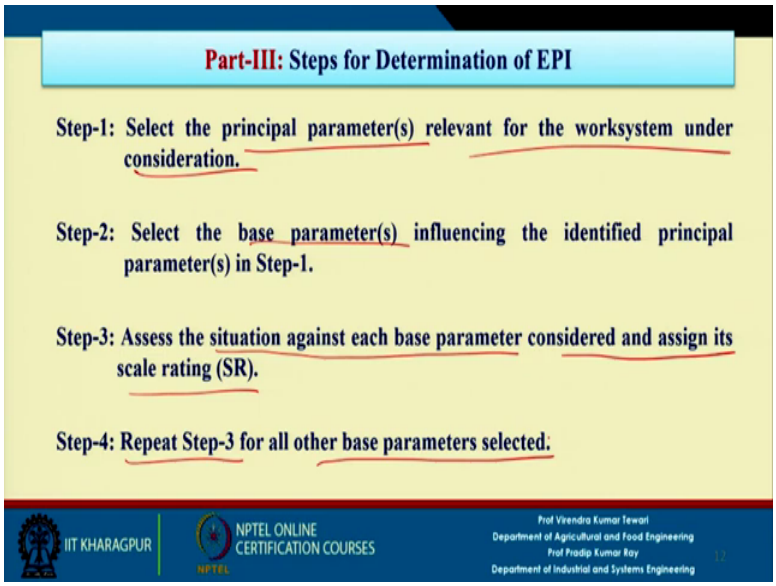

Now part 3 Step for Determination of EPI. Now, there are certain steps that need to be followed to get the EPI,

Step-1: Select the principal parameter(s) relevant for the worksystem under consideration.

Step-2: Select the base parameter(s) influencing the identified principal parameter(s) in Step-1.

Step-3: Assess the situation against each base parameter considered and assign its scale rating (SR).

Step-4: Repeat Step-3 for all other base parameters selected.

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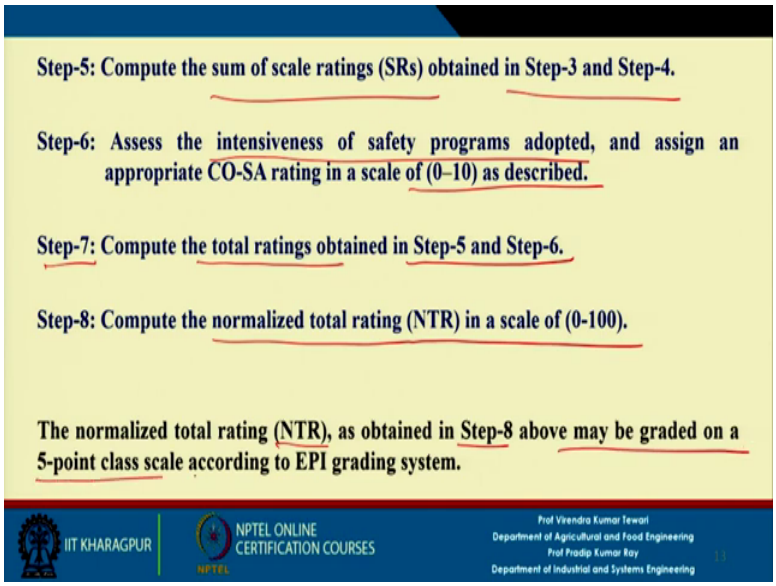

Step-5: Compute the sum of scale ratings (SRs) obtained in Step-3 and Step-4.

Step-6: Assess the intensiveness of safety programs adopted, and assign an appropriate CO-SA rating in a scale of (0–10) as described.

Step-7: Compute the total ratings obtained in Step-5 and Step-6.

Step-8: Compute the normalized total rating (NTR) in a scale of (0-100).

The normalized total rating (NTR), as obtained in Step-8 above may be graded on a 5-point class scale according to EPI grading system.

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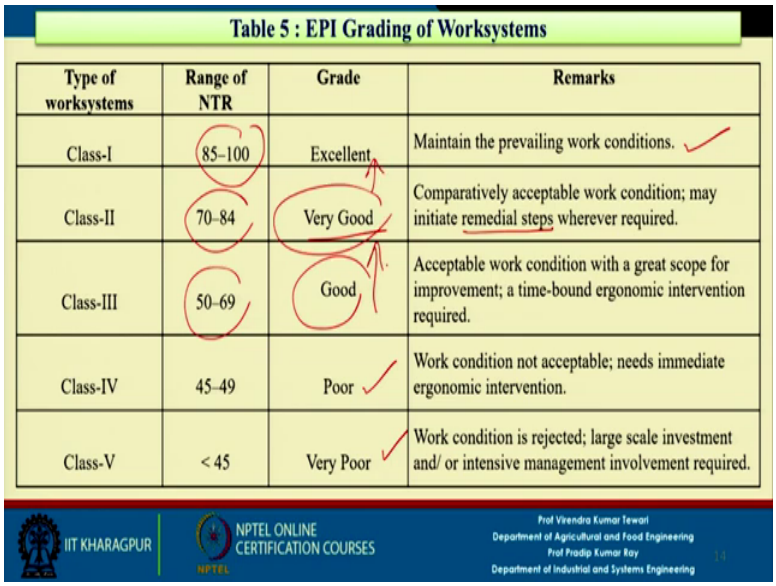

Therefore, you will get the EPI grading system which is here class 1 class 2 class 3 class 4 and 5. So, depending upon what is the value if it is excellent 85 to 100 you may recall I have talked of hitting the bull's eye.

When we are talking of hitting the bull's eye 85 to 100, 75 to 84 is very good, 50 to 69 is good, but then below that we have poor and very poor. Resulting is that maintain the prevailing condition if it is excellent comparatively accept working condition and may initiate a remedial step because it is very good and it must go to excellent.

If it is good, that means there are time bound ergonomic interventions are required, in order that it will go to good and that to excellent and poor and very poor. We have to introduce those factors otherwise lot of accidents will take place and then you will not be in a position to take care of the safety and you will have to incur loss of lot of money for their medical and other litigations and all that.

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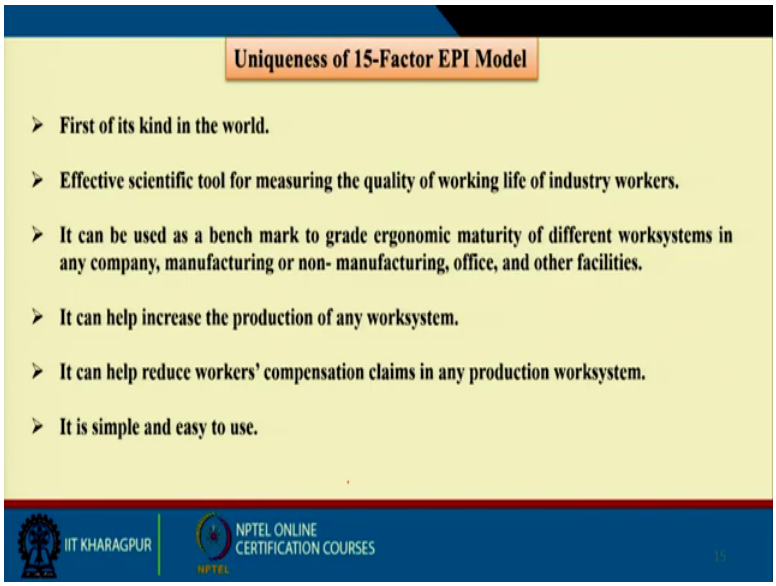

The uniqueness of factor 15 factor EPI model is the first of its kind in the world. Effective scientific tool for measuring the quality of working life of industry workers. It can be used as a bench mark to grade ergonomic maturity of different worksystems in any company, manufacturing or non- manufacturing, office, and other facilities. It can help increase the production of any worksystem. It can help reduce workers' compensation claims in any production worksystem. It is simple and easy to use.

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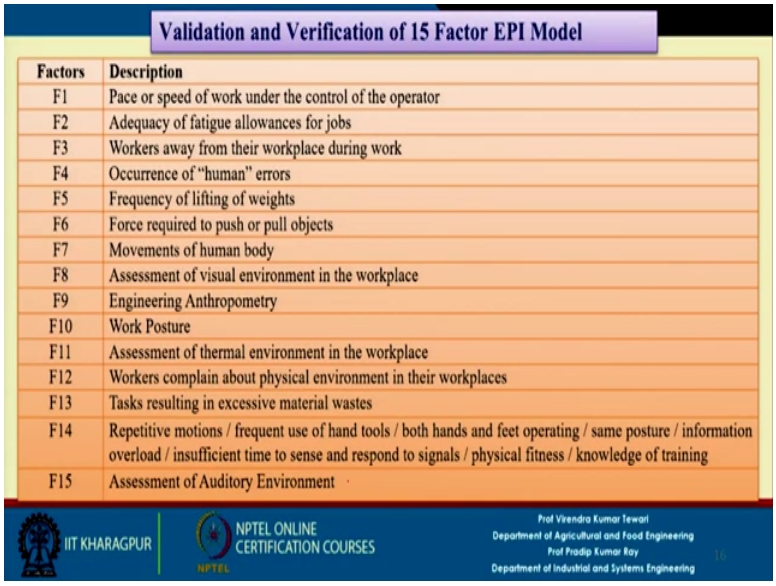

So, the validation and verification of 15 factor EPI model are listed as follow:

Factor 1: Pace or speed of work under the control of the operator.

Factor 2: Adequacy of fatigue allowances for jobs.

Factor 3: Workers away from their workplace during work.

Factor 4: Occurrence of “human” errors.

Factor 5: Frequency of lifting of weights.

Factor 6: Force required to push or pull objects.

Factor 7: Movements of human body.

Factor 8: Assessment of visual environment in the workplace.

Factor 9: Engineering Anthropometry.

Factor 10: Work Posture.

Factor 11: Assessment of thermal environment in the workplace.

Factor 12: Workers complain about physical environment in their workplaces.

Factor 13: Tasks resulting in excessive material wastes.

Factor 14: Repetitive motions / frequent use of hand tools / both hands and feet operating / same posture / information overload / insufficient time to sense and respond to signals / physical fitness / knowledge of training.

Factor 15: Assessment of Auditory Environment.

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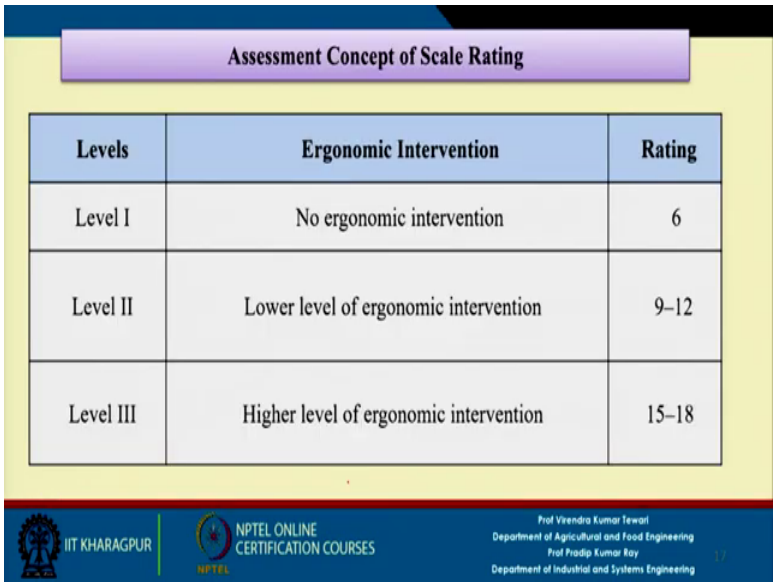

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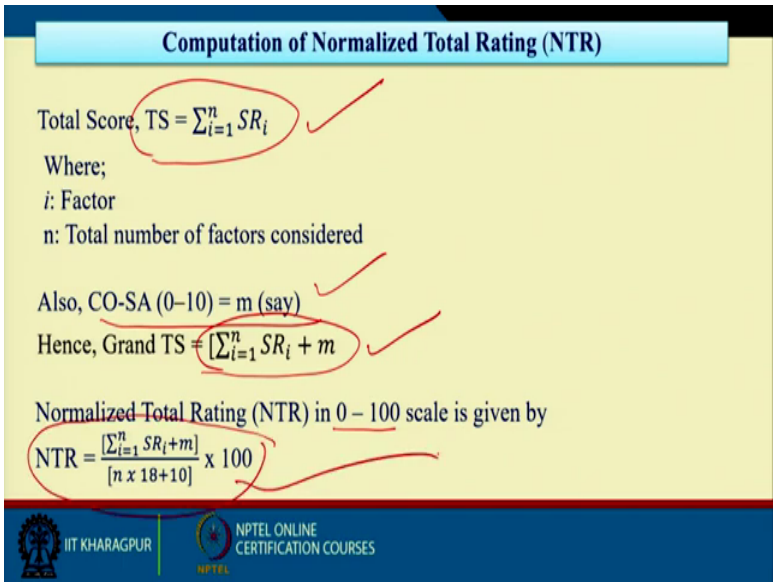

The assessment of scales.