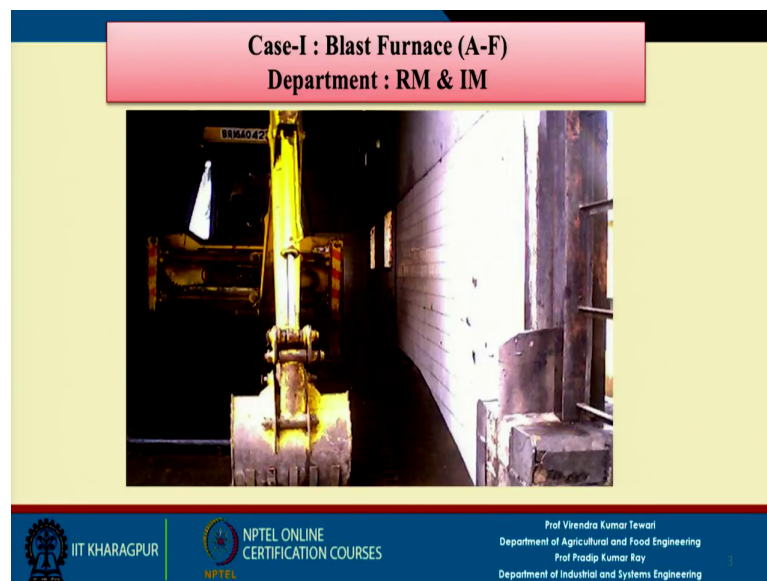


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Lecture - 59
Application of EPI Model in Different Worksystems

Let us come back to the next lecture where we will be talking of how do we actually verify that model, some of the case studies which I told in my previous lecture that we should be validating them and make you understand that how a particular system could be picked up. Then we can show you that ergonomic performance indicator is calculated and what is the implication of that on any verdict that we give with regard to any system which is given to us.

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In this case, we are talking of the applications. One case we have taken blast furnace, a situation in a blast furnace where we are talking of a portion of blast furnace. This is just an example, there are furnaces between A to F and all those in the department of RM and IM, we had gone in Tata Steel and then those things we have tested.

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Assigned Rating of Case -I			
Item	Data Collected or Information Available	EPI Factor Influenced	Rating Assigned
HC-6	Hole shifting of skip line rope, Mudgun changing, Lorry car cylinder changing	F1. Pace or speed of work under the control of the operator	6
HC-7	Bogies of CT car and lorry car, mudgun arm and power arm, UTA boxes	F2. Adequacy of fatigue allowances for jobs	6
HC-3	Gauge rod changing, Handling of Tuyser stock, Wire rope changing(skip and bills	F5. Frequency of lifting of weights	6
HC-4	Tuyser changing, Mudgun changing, Wire rope changing	F6. Force required to push or pull objects	12
HC-5	City car or lorry car component changing, wire rope changing, cast house equipment like mudgun and drill machine	F7. Movements of human body	15
PE-2	Stoke house operation, furnace top equipment inspection, cooling plants piping inspection	F8. Assessment of visual environment in the workplace	6

In this case we wanted to sign certain rating for this particular case. In case I, certain items were there, certain jobs are being performed. If we talk of whole shifting of skip line rope, mud gun changing, lorry car cylinder changing, these are the tasks which are there which we call as item HC-6.

This was the EPI factor which is influenced factor F1. Therefore, assigned rating is 6. Now, when you go to the bogies of CT car and lorry car, mud gun arm and power arm and UTA boxes, on the basis of those tasks, we have tried to categorize and try to fit in which of the factors come into play from all the 15 factors. So, as we go for the items of H 6, H 7, H 3, H 4 and HC 5, PE 2. Correspondingly we have fit the factor F1 or F7. In case of the first job we saw that pace or feed of work is under the control of the operator. So, we say that factor F1 is applicable for that particular item.

Similarly, adequacy of fatigue allowance for jobs. The bogies of CT car and lorry gun, mud gun arm and power arm, when these tasks are being done whether enough fatigue allowance is given, enough rest in between the jobs or not. There is a concept introduced for that and therefore, F 2 was picked up for as an influence.

Then, similarly, F5 frequency of lifting of weights, now F3 and F4 did not come into picture because those were not relevant in this particular case. But, in case of say gauge rod changing, handling of Tuyser stock, wire rope changing; these are some of the terms which are actually used in the production.

If you see a particular task where the frequency of lifting of weights are there, we had given a lot of items in those factors 5. Similarly, if you pick up any one of them and it is matching with the requirement, you can assign that particular factor. And accordingly, you can assign a particular mark.

Force required to push or pull. In the next task of HC 4 where you are talking of mud gun changing, wire rope changing; when you are doing this task, what is the amount of force that the person is either pushing pulling or he is applying. Depending on this the level has been put. You see that F 6 and a level of 12 has been given; there is enough provision for either pulling or pushing of the load in such a way that it is not undue disadvantage to the person concerned.

There may be some other provisions are made because of which he is in a position to lift that load or push that load. Movement of human body. It may happen that he has to push himself or walk from one location to another location to shift the load. F7 comes into play because there is a movement of the human body.

F8 is a visual environment. On the basis of that at the work place, you can see a scale rating of 6 has been assigned.

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PW-2	Wire clamp inspection of skip drive, CT car etc.	F9. Engineering Anthropometry	6
PE-4	Tuber stock changing near non drainable tap hole area, Tough patching operation, cleaning of skip pit, store area of all furnaces, furnace top area of each furnaces, high line operation, store operation, cost house operation	F11. Assessment of thermal environment in the workplace	6
PE-5	Maintenance of lorry car equipment, dust value of dust catcher, mudgun equipment, furnace top equipment like small bell, big bell, lockers and begs.	F12. Workers complain about physical environment in their workplaces	6
HC-8	Tuyer stock changing, Tuyser changing, mudgun fixing, tuyser stock changing, drift motor changing, wire rope changing, bogie changing of CT car and lorry car, tuyser stock changing always standing, gauge rod changing standing	F14. 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	12
Total			81

Now, as the item changes, what is the level of engineering anthropometry which have been introduced in that, whether the lifting, lowering or shifting of load or the interaction between the intervention between the person and the machine.

Depending on that you can say that engineering anthropometry has been assigned only value of 6; that means, hardly anything has been thought of about the anthropometry part of where the human being is involved with regard to the interventions which should have been done in that location. Now, when you go to the next task you can see that a lot of job is being done. And, all these assessment of thermal environment in the workplace, which will be because we are talking of blast furnace.

The level at which this task P 4 is being done; thermal environment is being assessed.

There we find that the interventions are of a lower level. So, it has been given a factor of 6. Similarly, we go to P 5, maintenance of logic or equipment dust value and dust catcher. Now, you look at those things which are there, we find that workers complain about physical environment in their workplaces.

Therefore, F12 has been taken, but it has been given as a scale rating of 6 only because, when we talk to the workers in confidence with all the managements consent of course, we were trying to improve the system. Therefore, it was possible for us to discuss with these workers and come out with suitable values because the management is interested to see that all these work production shops are graded and well-ergonomically matured systems.

When you say repetitive motions, frequent use of hand tools, you may see the factor 14.

Correspondingly when you see the tasks in HC 8, we find that all these with regard to the overload, insufficient time to sense and respond to the signal, physical fitness required, knowledge of the training, both hands and feet operating.

Depending upon the intervention a scale of 12 has been given., we find that if you see many such factors, only 10 factors are being considered in this case I of the blast furnace.

Here we have got the factors and the total is 81.

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The slide displays the following content with handwritten red annotations:

- $$NTR = \frac{[\sum_{i=1}^n SR_i + m]}{[n \times 18 + 10]} \times 100$$
- CO-SA = 8
- So, TSR = 81 + 8 = 89
- Maximum Scale Rating = 18 x 10 = 180
- Maximum TSR = 180 + 10 (CO-SA) = 190
- So, NTR = TSR / Maximum TSR
- $$= 89 / 190 = 0.47$$
- EPI Grade of the Worksystem = Poor
- Work condition not acceptable.
- Needs immediate ergonomic intervention.

The footer contains the following information:

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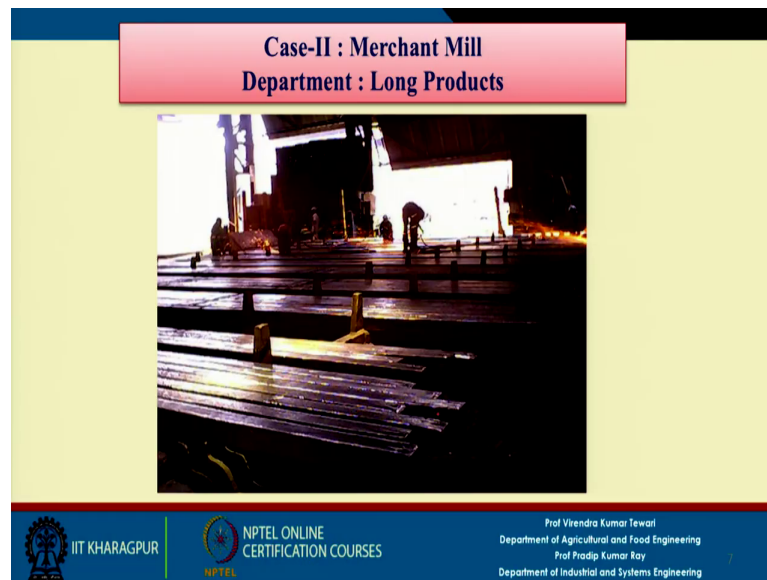
When you get the NTR is this value formula which we have shown to you. Then, the concept of safety awareness. This concept of safety awareness was very good and that is why we have given a value of 8. So, the total scale rating is $81 + 8 = 89$. Now, you see 89, maximum scale rating is 18×10 which is 180, because each scale when we are talking of up to 10 and we have got a rating of maximum 18.

So, maximum TSR is $180 + (10 \times 10)$ which is for the concept of safety awareness because concept of safety awareness we have taken a scale of 0 to 10. So, the total value is 190. Therefore, we are talking of NTR as $89 / 190 = 0.47$. So, you can see that when we are talking of normalized total rating of the EPI, we got a poor value.

If you go back to your grading system of EPI which has been given excellent, very good, good, poor and all that, you will have to fit this value. Work condition is not acceptable and needs immediate ergonomic intervention.

It is the adjustment and it is the requirement of the management. Management really feels that we should improve these conditions, ergonomic maturity must be high level so that our workers will be not at disadvantageous position and they will perform better.

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Second case is this long products department and merchant mill.

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Assigned Rating of case-II			
Item	Data Collected or Information Available	EPI Factor Influenced	Rating Assigned
HC-6	Packing & strapping of furnished base, scale removal from the furnace, removal of cutting from cold shear	F1: Pace or speed of work under the control of the operator	12
HC-7	Pushing out the billets from the furnace, crane drives in finishing & stripping section, pulpit B operates while seeing loop in the bar	F2: Adequacy of fatigue allowances for jobs	6
HC-3	Removal of bullet front and cuttings, removal of scale from mill tunnel, sorting on the hold up bed	F5: Frequency of lifting of weights	6
HC-4	Billet tilting on conveyer roll prior to furnace, putting motor house breaker in or taking out, pulling and pushing oxygen and weight cylinder trolley	F6: Force required to push or pull objects	6
HC-5	Seeing the entry and exit guide setting, alignment of TMT heeding, alignment of pendulum shear with roughing	F7: Movements of human body	6
PE-2	Face area, gas lines water seal etc, cold shear area, bearing shop for roll assembly, billet yard	F8: Assessment of visual environment in the workplace	9
PW-1	Cleaning and maintenance below gearbox, cleaning below cold sheets and cold sheet2	F10: Work Posture	6

In case II, we have the department of long products department, we find several tasks which are the items, which are packing and strapping of furnished base, scale removal from the furnace, removable cutting from cold shear. Then, second is pushing out of billets from the furnace, crane drives in finishing and stripping section, removal of bullet from front and cuttings, removal of a scale from mill tunnel.

Similarly, billet tilting on conveyer roll prior to furnace, putting motor house breaker in or taking out, pulling or pushing oxygen and weight cylinder trolley, these are the task which are being performed. Seeing the entry and exit the guide setting, the alignment of TMT heeding, alignment of pendulum shear with roughing.

Face area, gas lines water seal areas etc; I think then cleaning and maintenance of gearbox, cleaning below cold sheets. You can see that the various tasks have been detailed and with regard to each of these, we have got the factors which are being influenced. We found that factor F1 is influenced because there is a speed of work which is under the control of the operator.

F2 which is also adequate allowance, in the sense that when he is shifting from one task to the other one; requirement is put in such a way that he has to wait for some time and possibly that has been considered as the fatigue allowance. It is very difficult to say that this fatigue allowance is exactly same what we could have given to a person when the job is completely over.

This requires some sort of the expertise of the analyst or the experimenter who is doing this task or the person who is assessing the situation. If he is not well experienced, he will make mistake in picking up the factors which are correspondingly being influenced, because of the task which is in question. F2, F5, F3 and F4 are not in a picture here.

Frequency of lifting weights, F6. Force required to push or pull. F7- movement of human weight. F8- assessment of visual environment in the workplace. In some case from 12 to 6, some case 9, work posture is very poor.

The work posture which is being involved in these cleaning and maintenance below gearbox, you can see that possibly the person has to bend or sit down or maybe we have to sleep inside and then do the task depending upon where it is. So, the power posture is not acceptable. Therefore, we find that seven factors have come up.

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PE-4	Charging bed conveyer roll area prior to furnace, billet pushing cabin, billet withdrawing cabin, crane operator cabin, pushing cabin on the backside of the furnace, crossover bridge for inspection of cooling bed, crane drivers cabin, withdrawal & twist pinch roll operator's cabin, cold sheet operator rear sheet	F11. Assessment of thermal environment in the workplace	9
PE-5	Grinding operation while guides are grinded, face area hydraulic purees platform, TMT heads presume gauge display	F12. Workers complain about physical environment in their workplaces	6
HC-8	Cutting from behind near cold sheet bars o be removed and sorted manually, twist pinch roll operator, twist pinch roll operator critically operates control using both hands, changing bed pulpit operator, motor house substation in charge, pulpit operator, This person when asked to tilt the billet which have got struck midway inside the furnace, when new system in hydraulic/pneumatic was commissioned all the people did not have appropriate knowledge of training	7	9
PE-1	Face area, cold sheet 1, cold sheet 2, roller's cabin where grinding of guides is done, big dia base moving on the roller from the shuffle bar,	2	6
Total			81

Let us see what other tasks are involved. These are the two factors. We are talking of assessment of thermal environment in the workplace and workers complain about physical environment in their workplace.

These factors have to be taken because cutting behind near cold; these factors we will have to add; by mistake possibly we have not been in a position to do it. But these factors will be taken care of and accordingly the 9 and 6 have been added. Now, depending on the task, even if the factor is not influenced, these factors are totally depending on the nature of the job that is being done over here.

This is the nature of job which is being done, otherwise we will not be in a position to identify a factor. Assuming that this is a factor which has been on the basis of one of these factors assigned 9 and assigned 6, definitely human factor has not been considered. It is 6 and 9; that means, human factor has been taken care of a bit better than this; interventions are within the acceptable limit. So, total rating is again 81 for this case.

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CO-SA = 5 ✓
So, TSR = 81 + 5 = 86 ✓

Maximum Scale Rating = 18 x 11 = 198 ✓
Maximum TSR = 198 + 10(CO-SA)
= 208 ✓

So, NTR = TSR/Maximum TSR
= 86/208
= 0.452 ✓

EPI Grade of the Worksystem = Poor

Work condition not acceptable. ✓
Needs immediate ergonomic intervention. ✓

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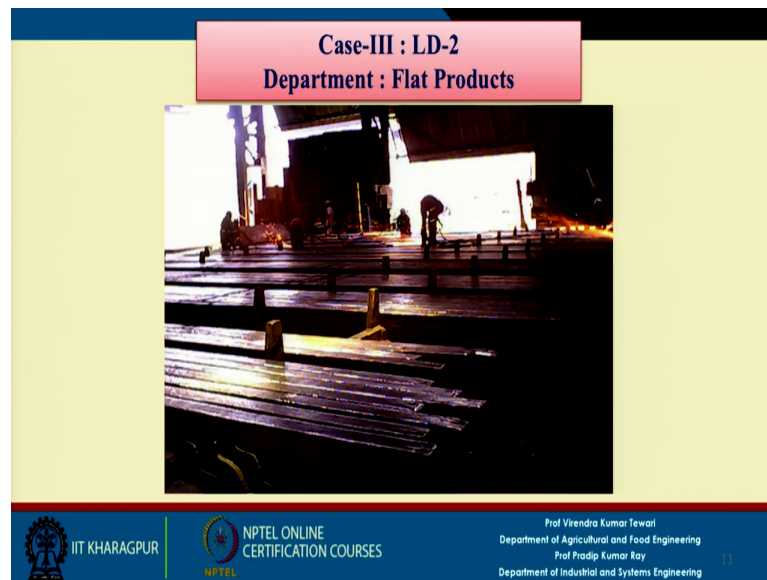
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When we go for adding concept of safety awareness, we have given a very poor value of ϕ . We did not find that the safety awareness holdings or the trainings has been really taken care of and, therefore, the total is 86.

If you follow the same scale, 11 factors have been taken out of the total factors which are considered here. This value of 0.452 you can consider and you can check these values. When we are getting a value of 0.45; that means, roughly 45; we can say that this condition is also very poor and not acceptable.

With the help of the management we wanted to modify and see what best can be done. Since this is a large workshop, it not possible to pick up every details. You could see that we have tried our level best to visualize each and every aspect of the ergonomic maturity of the system with regard to all the tasks which are being done and we have given our conclusions.

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We go to another case; the department is same.

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Assigned Rating of Case-III			
Item	Data Collected or Information Available	EPI Factor Influenced	Rating Assigned
HC-3	Changing of hot metal in vessel, keeping steel cod lion on tunnel, planning HM in different car	F5, Frequency of lifting of weights	9
HC-5	During changing the ladder hook, during plaining of mould in cast	F7, Movements of human body	6
PE-2	Regular chaining of craning, operation of cranes	F8, Assessment of visual environment in the workplace	15
PW-1	Engine hook/coddle area to load, maintenance of crane, controlling panel equipment, crane operation, running maintenance of crane	F9, Engineering Anthropometry	9
PW-2	maintenance of crane, controlling panel equipment, crane operation, running maintenance of crane	F10, Work Posture	9

We will talk of the signed rating. We are not telling you what is there in LD2, but definitely the department is known. So, you know the department and we have given just a representative picture of that.

In each of these cases, we have hidden certain things from you. But we are telling you that the tasks are identified, you can take up those tasks and then match with the requirement of the parameters.

We are just giving you an example of the task which are actually being done and how they are influenced by certain factors, that we have tried to match and given these values. In this case, you will get certain factors which are influenced like factor F5, F7, F8, F9 and F10 or the factors which are influenced because of the jobs items which are detailed here. Like changing of hot metal in vessel, during changing the ladder hoop, regular chaining, chaining and craning, operations of the crane.

Then, engine block, hook or coddle area to load, maintenance of the crane, controlling panel equipment, crane operation, running maintenance of the crane. These are the various tasks that we are done. You need to know is what is the nature of the task. This is the nature of the task which we have detailed, given the information that we have collected from that shop.

We are talking of how best we can utilize this to influence to find out the factors which are influencing. Depending upon the level of the parameter and the influence of it because of the task, we have assigned factor of 9 for 5. Then factor of 6 for F, where movement of human body, a lot of movement and no facility is given.

Similarly, visual environment has been taken properly and that is why the value of 15 has been allotted. Then, engineering anthropometry, possibly some provisions are there because of which the person is a bit better condition as compared to a condition, where no engineering anthropometry has been thought of; maybe the handle, which he is using is good enough whether the load or thermal environment is slightly away. Some of the activities which are being done in this: maintenance of crane, controlling panel equipment depending on the posture, depending upon the engineering anthropometry which has been introduced. So, we are at any value of 9.

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PE-4	Crane operation, crane changing, slag area crane operation, slag area crane maintenance, all H.M. cranes.	F11. Assessment of thermal environment in the workplace	12
PE-5	Prom shag craning, all H. M. craning, lance craning	F12. Workers complain about physical environment in their workplaces	6
HC-8	Loading and unloading of watering, loading and unloading of lodge, during EOT crane operation both hand & one leg is always in use, free falling, spreading of hot metal, reaction of slag, lifting of hot metal more than the capacity of the cranes. crane operation has to be done by shifting only	F14. 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	6
PE-1	Communication system in crane operation cabin	F15. Assessment of Auditory Environment	15
Total			87

Some of the other factors in the crane operation, changing area, slag area crane, then, we are talking of the craning and lance craning, these are the task which have been designed.

Similarly, loading and loading of watering, loading and unloading of and lodge, EOT crane, several tasks are being put together. Accordingly we have said that factor 14 is the one where lot of repetitive motion, frequent use of the hand tools, both hands and feet are operating, information overload. The sense and respond to insufficient time to sense and respond to the signals, physical fitness required, knowledge of training etc.

Since these are applicable in the task which has been given at HC 8, you will be able to see which parameter is affecting and the communication system in crane operation.

F15: Assessment of ordinary environment has picked up and the value of 15 has been given. Now, in the next case, we have picked up certain parameters and the total is 87. Now, you see how many parameters have been picked up, what is the scale rating and what value we get.

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CO-SA = 8
So, TSR = 87+8
=95
Maximum Scale Rating = 18 x 9 = 162
Maximum TSR = 162+10 (CO-SA) = 172
So,
NTR = TSR/ Maximum TSR
= 95/172 = 0.552
EPI Grade of the Worksystem = Good

Excellently
V. Good
Good

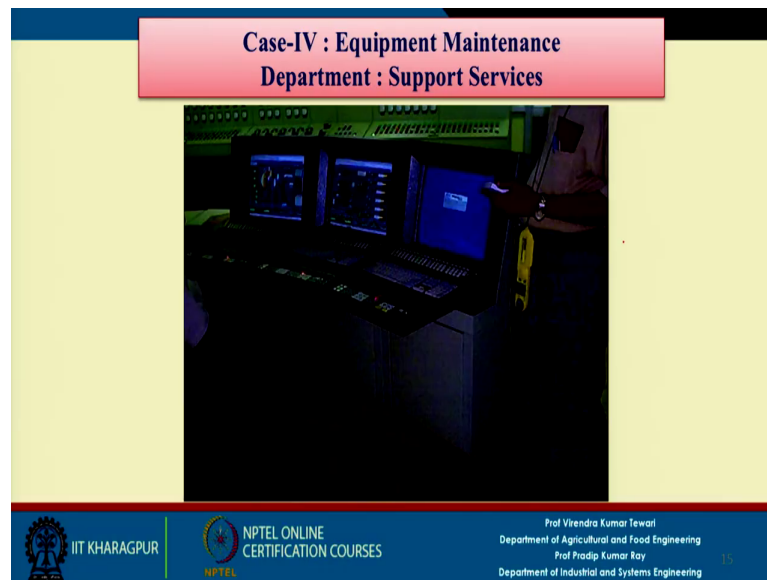
Acceptable work condition with a great scope for improvement.
A time-bound ergonomic intervention required.

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We again get 87 and CO-SA is 8. We get a value of 95 and again with this we get a value of 55.2% and, that means, it is just good. If you go back to the condition of the table, you will find that acceptable work condition with a great scope of improvement on the basis of rating which is about 50 and above. So, 55 is good, but it needs a lot of interventions as we say that great scope of interventions and time bound ergonomic interventions are required.

Because, from a good we have to go to very well, then we have to think of excellent and all that. In order to check these, the experimenter has to be smart enough and understand the system which is evaluating. Then only he will be able to check and decide the ergonomic maturity of a particular system.

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Now, we have taken case IV, where equipment maintenance department support services, certain things are given.

Here we have taken certain data on the basis of what is going on in the task, but it talks about a case study where equipment maintenance is going on. There are various types of equipment which are maintained over a period of time, otherwise this task will not be performed properly and the equipment will have some problem.

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Assigned Rating of Case-IV			
Item	Data Collected or Information Available	EPI Factor Influenced	Rating Assigned
HC-3	Lifting of oil drum, lifting of ladder	F5. Frequency of lifting of weights	12
HC-4	Drawing trolley with motor/weight, pulling of brakes out of service, raising eels rapper motors to esp top, pulling of chain block chain with weight	F6. Force required to push or pull objects	9
HC-5	Dragging of trolley with materials, putting breakers in service position, some valve operation	F7. Movements of human body	6
PE-2	Turbine control at BCD, electrical control at ECR, any job in basement, equipment overhauling	F8. Assessment of visual environment in the workplace	6
PW-2	Esp top gear box, inspection of motors, Tu hall operator, thermal control, BCD operation, electrical operation at electrical control, panel overhauling, boiler control operation, thermal control room operation unit, old thermal room operationTrf overhauling pump house operation, use of ladder, basement floor movement etc	F9. Engineering Anthropometry	9

So, in this case as well, we have the factors which are influenced. Now, you can see the task, data collected and information available. These are the items we can see. The lifting of oil drum, lifting of the ladder. You can see the task which are difficult, what is the frequency of lifting of the weights. Now, you see the lifting of the ladder, lifting of the oil drum.



Some provision is there, that is why this value 12 has been given. Similarly, drawing a trolley with motor or weight, pulling of brakes out of service, raising yields rapper motors to some top position, pulling of chain.

Out of all these things when you find that the factor 9 which is engineering anthropometry is at stake particularly at the gearbox inspection of motors, thermal control, BCD operation, electrical operation at electrical control, then boiler control operation, thermal control room operation unit, old thermal room operation.

Several tasks we have watched and, on that basis, we have said that we have concluded that this will fall into factor 9, where we found that when these things are being done, there is some mismatch between the engineering anthropometry. So, we assigned a value of 9.

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PW-2	ESP emulator changing, changing of pumps and motors, working in shift area ✓	F10. Work Posture ✓	9
PE-4	Loco operator's cabin, loco operation in Ld & B1 furnace area ✓	F11. Assessment of thermal environment in the workplace	15
HC-8	Cutting with hacksaw, grinding, use of drill, control room operators-controlling boilers, controller in electrical control room, boiler controllers controlling boiler operation, men at electrical control room, controlling at ECR, boiler control	F14. 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	12
PE-1	Load testing of diesel engine	F15. Assessment of Auditory Environment	9
Total			87

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Similarly, for the changing of pumps and motors working in the shift area, it is the work posture which comes into play. Then, loco operators cabin, loco operator in L_d and B1

furnace area. You can see assessment of thermal environment. Depending upon what is that assessment we are doing, the values have been assigned.

Similarly, cutting with hacksaw, grinding, use of drill. Now, these are some basic tasks which are being performed in HC 8, PE 4 and PW 2. PE 1 loading is load testing of diesel engine. This is also being done where we are thinking of auditory environment which is very high.

A total of 87, you are taking into all these factors which is coming up here. Let us see the CO-SA.

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CO-SA = 8
So, TSR = 87 + 8 = 95

Maximum Scale Rating = 18 x 10 = 180
Maximum TSR = 180 + 10(CO-SA) = 190

So, NTR = TSR / Maximum TSR
= 95 / 190
= 0.52

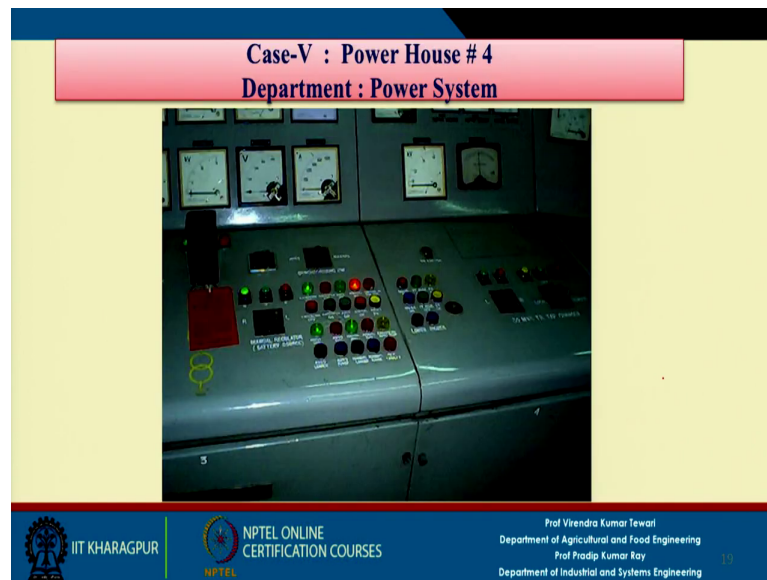
EPI Grade of the Worksystem = Good

**Acceptable work condition with a great scope for improvement.
A time-bound ergonomic intervention required**

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The CO-SA has been given 8; that means, the concept of safety awareness is there in that location and ultimately, we get a value of 52. So, this is also a good condition and hence we find that this also requires attainment.

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We have taken another case study.


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Assigned Rating of Case -V			
Item	Data Collected or Information Available	EPI Factor Influenced	Rating Assigned
HC-3	Lifting of oil drum, lifting of ladder	F5. Frequency of lifting of weights	12
HC-4	Drawing trolley with motor/weight, pulling of brakes out of service, raising eels rapper motors to esp top, pulling of chain block chain with weight	F6. Force required to push or pull objects	9
HC-5	Dragging of trolley with materials, putting breakers in service position, some valve operation	F7. Movements of human body	6
PE-2	Turbine control at BCD, electrical control at ECR, any job in basement, equipment overhauling	F8. Assessment of visual environment in the workplace	6
PW-2	Esp top gear box, inspection of motors, Tu hall operator, thermal control, BCD operation, electrical operation at electrical control, panel overhauling, boiler control operation, thermal control room operation unit, old thermal room operationTrf overhauling, pump house operation, use of ladder, basement floor movement etc	F9. Engineering Anthropometry	9

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PW-2	ESP emulator changing, changing of pumps and motors, working in shift area	F10. Work Posture	9
PE-4	Loco operator's cabin, loco operation in Ld & Bl furnace area	F11. Assessment of thermal environment in the workplace	15
HC-8	Cutting with hacksaw, grinding, use of drill, control room operators-controlling boilers, controller in electrical control room, boiler controllers controlling boiler operation, men at electrical control room, controlling at ECR, boiler control	F14. 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	12
PE-1	Load testing of diesel engine	F15. Assessment of Auditory Environment	9
Total			87


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You can see this another condition is also 52. You should be able to take care of the task and the nature of the factors which have been given and relate. And, then check where the interventions are, what sort of what level of interventions have been done or allotted in these tasks.