

Risk and Reliability of Offshore Structures
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Module – 03
Risk assessment and Reliability Applications
Lecture – 15
Risk acceptability

Friends, welcome to the 15th lecture Risk accessibility.

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So, this is lecture in module 3 where we are focusing on risk assessment and reliability applications. We already said in series of lecture in module 3 that risk assessment deals essentially with evaluating the probability of occurrence of failure and the consequences, essentially one will be able to claim that risk assessment needs that is recommendation only, when the assessed risk becomes unacceptable. So, one can clearly ask question here, why risk should be acceptable; very interesting question, very genuine doubt.

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In fact, I really seeking offshore industry being highly vulnerable to serious consequences, if extent occur should not be having any acceptance criteria risk at all, however, you see accidents which are caused in offshore industry are purely unintentional, majority of them also cloud with environmental factors. I do agree and we are also known depending upon the previous case studies, what we studied in different lectures of other modules. We agree that there are some man made deficiencies in the design and operation which has led to accident; there is no doubt about it.

But there are factors which also play a role in causing distress to the personal working on road which results in accidents therefore, one cannot simply say i should operate at zero risk it is hundred percent ideally good that we should operate at zero risk, but offshore structures should have a predefined risk acceptability now risk acceptability term itself is highly subjective in nature for example, the risk acceptable level what i declare in my company may not be acceptable to you as an employ of the company or as a public or as a c e o of another company. So, risk acceptability is highly subjective they should be some scale some module some parameter by which this need to be normalize with almost all process industries therefore, risk acceptability is always declared and stated by regulatory agencies surprisingly the acceptability criteria is different for different countries there are couple of countries which even do not have a pre declared risk

acceptability levels for offshore structures or offshore platforms.

Then interestingly we have to look into this particular item or event more in detail. So, what you understand by risk acceptance criteria in offshore industry? We agree that risk is unavoidable, the reason is very simple, the process of exploring oil itself has got lot of risk attached to it. It is not due the fact that risk design is not possible, please understand it is not due to the fact that risk free design is not possible, it is very much possible you can always make risk free design. Why do we allow risk? It is because due to many uncertainties that arise during operational conditions which caused risk to the whole plant and essentially they come mainly from the environment also a typical offshore platform is one of the most complex electromechanical system.

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We have already seen the structural form or the structural geometry. The plants in equipments, the electronic components, the electrical layout of an offshore plant is highly complex. Therefore, there will be presence of risk we designed an operation inherently in the system.

However there is a very good understanding of the inbuilt risk phenomena present in the oil explanation process. Therefore, it is not always very difficult to really declare

acceptable risk criteria. However, it is still difficult for people to get convinced about the declared acceptable risk criteria. It is easy to declare acceptable risk criteria because based upon the complexity is involved in the system, based upon the complexities involved in the operational conditions one can always preset the acceptable risk levels, but it is very difficult to convince the people, the legislative body or the legal authority and the companies to this policies because anything towards risk management, anything towards risk management is always your financial investment. So, whenever there is an additional cost, whenever there is an additional cost involved in any product or any production line one should always check for its necessity and one should justify the investment that is very simple and very basic. So, even if we invest towards risk mitigation or risk management you should justify the investment.

So, how generally you justify investment based upon the return on investment, but we call ROI; Return on Investment. So, if the return is beneficial and much higher order in terms of investment then one can always say there is the no matter one can invest, whereas a risk management issues the return on such investment is only on the qualitative features, but not on the economic features at all because all the time in economic perspective any investment made towards this mitigation reduction is always an expense there is no gain, but on qualitative terms if the plant does not face an accident, there are no safety violations norms are not violated then it is always good that the plant does not encounter a very serious financial damage or a loss subjected to if accident should have occurred. I agreed that point there is no argument on that, but at the first outset any investment made towards risk management will always encounter the direct expenditure on a balance sheet.

Therefore one need to justify what is the return on that kind of investment. So, once you are looking at the economic perspective of investment for risk management that is what will be helpful to define the risk acceptability criteria. There is always a confusion people say, since risk is acceptable by a criteria it is mistaken by people.

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Public essentially thinking that risk is intentional please understand, since risk is acceptable there is a misconception; please note, risk is not allowed intentionally that is very, very important, it happens accidentally. So, you should have a clause to cover accidental occurrences of risk then only you will be able to save the financial investment. Therefore, risk acceptance is nothing, but a provision it is nothing, but the provision to take care of any unforeseen risk which arise from the complexities of the electromechanical system.

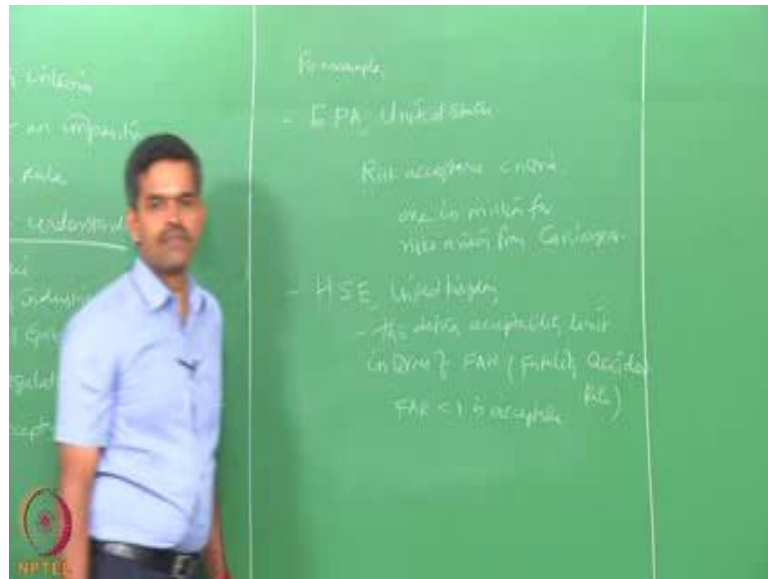
The mechanical systems are very complex in layout and design and we also saw acceptability of risk is the subjective issue. A risk level which is acceptable by a regulatory agency may not be acceptable to the competent authority of the CEO of the company or it can be vice versa. Therefore, a certain amount of risk is generally acceptable which becomes commonly acceptable to both the regulatory agency and also to the public; please understand a risk acceptability criterion is not an imposition.

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It is actually not a rule; it is a mutual understanding between whom, between the public, between the oil industries and the local government. All the three mutually agree to declare a specific level of risk which we call as risk acceptance. Therefore, the risk acceptance level should be defined with consistence of these three parties and hence it is defined in a different form in different agencies. Therefore, international regulatory authorities declare risk acceptance criteria we should be followed by oil and gas industries in yourself who was these agencies.

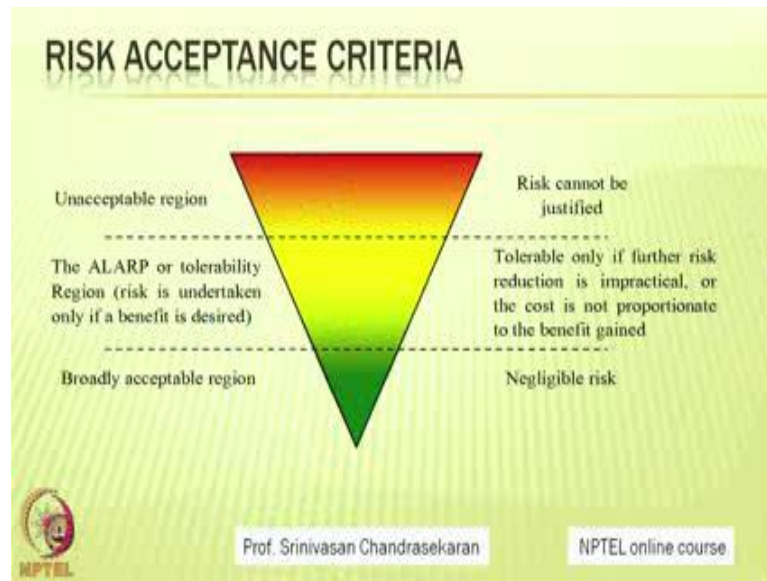
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For example one can look at the Environmental Protection Authority, United States as one of the agency which recommends the risk acceptance criteria on a lifetime risk. So, the risk acceptance criteria as proposed by EPA of United States is one in million for risks arising from carcinogens. Alternatively, accordingly UK Health and Safety Executive, United Kingdom, this standard defense acceptable risk in terms of fertility extended.

So, this defines acceptability limit in terms of FAR, which is called Fertility Accident Rate, it says that any acceptable value lower than 1 is acceptable in general acceptable risk is also defined rather it should be defined in terms of economic perspective as well, because that is very important risk has to address the economic perspective by all means. So, kindly pay attention to the figure shown on the screen now.

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Interestingly the screen shows an inverted triangle which is divided in three regions; one can see red, yellow and green. So, the red one show, if the risk falls in this region it is unacceptable region. So, one will be able to estimate the risk value based upon numerical studies, try to plot this value if it falls in terms of the estimated lines because these are the dividing lines between, what is your risk? Which is unacceptable, which is broadly acceptable which is in between? So, these lines or these limits or these boundaries are defined by various international agencies in different forms which are predefined we should be followed by oil gas industries.

However, these limits are not predefined by without any consensuses of the CEO's of the company, etcetera when these levels of boundaries as defined all the people in terms of public who are having expertise in oil gas production industries. The oil gas industries as the whole and the local government are involved in pre defining these boundaries of risk analysis and then these boundaries are drawn.

So, if the risk valve falls quantitatively in this part of the triangle then we can say this is unacceptable region. It means the risk cannot be justified at all. So, the risk should be completely of course, if the risk falls here in the green region then one can say the risk is broadly acceptable therefore, it is a negligible risk. So, there is no-zero risk here except

at the apex of the triangle, there is no-zero risk at all. However, when there is broadly falls in this region, we call risk as tolerable region. Now, interestingly the risk is declared tolerable only if further risk reduction is impractical or the cost of investing on further risk reduction is not proportionate the benefit gained. So, here when we declare this risk in this region we always look into the economic consideration also.

This region is what we call as ALARP region, ALARP stands for as low as reasonably practical. So, the risk region is of three acceptable tolerable unacceptable. So, the boundaries dividing these three regions are defined by international regulatory authorities, which are pre-declared to all oil and gas industries in the world, who has to follow this and then estimate risk as per the standard models available in the literature and plot and show where the risk is falling in which part of the triangle. Obviously, if the risk falls in this region which is locally defined by the authorities then one can always justify that the investing on risk mitigation, reduction is not practical as far as the investment towards risk reduction is not proportionate to the benefit gained by the risk mitigation process.

Therefore friends in this triangle, the red band actually represents intolerable risk where the risk cannot be justified on any ground. The yellow band represents the tolerable risk or the conditional level, which is called as ALARP region ALARP stands for as low as reasonably practical. So, risk is undertaken only if the benefit is desirable. On the other hand, risk is tolerable only if the risk is impractical. So, one can very clearly see here.

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In the ALARP region, risk is tolerable only if risk is impractical, it is very important. Alternatively, if the cost is disproportionate to the improvement suggested for risk reduction then also one can say the risk is tolerant, that is very important this is what we call as financing risk which Frank and Morgan has given a very interesting methodology which we discussed in this module in earlier lectures. So, one can always use this method to rank the risk available in the departments in a given plant and one will know which department given plant will require more attention.

If the risk investment becomes impractical and becomes disproportionate to the gain what you receive on the investment then also one can call the risk is intolerant. So, intolerable range of risk or on the other hand acceptability of risk closely depends on two factors; one what is the tolerance level the local authorities has imposed on the oil gas industry, two what would be the cost benefit of risk investment towards risk reduction in terms of achieving the benefit by investing this costs. So, two factors are parallelly considered to decide whether there is should fall in tolerable region or in acceptable region.

However by mistake or by unfortunate terms if the estimates fall in the red band then that is unacceptable by any method. You have to do this mitigation methods to control or to

reduce risk available in the plant of course, if the risk is falling on the green band which is broadly acceptable region then of course, there is no need for any deal working demonstrate ALARP, in this situation therefore, friends interestingly risk becomes completely tolerable if the cost of reduction would not exceed the improved gains in this region.

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So, one does an economic analysis with two parameters; one parameter is cost of reduction, the second parameter is gain of or gain or improvement in risk status if the cost of reduction of risk exceeds impractically this then we need not have to invest on risk reduction at all. If he does not exceed this if the benefits are far higher than the investment then one can do this therefore, it is where one has to apply the decision which is vested with each company or group of companies of oil and gas industries.

This is where the freedom is imposed on the companies by the regulatory agencies so that the companies can maintain the risk in the tolerable region. It is preferred the companies should maintain risk in the green band which is the safe region which is normally acceptable region, but please understand we make a strong statement here that oil and gas production process is not a zero risk process. It is not because one cannot design a zero risk system, it is because of the complexity is involved in the

electromechanical systems and the environmental conditions which becomes sometime unfavorable which can result in accidents unintentionally.

Therefore it is always better that the companies should aim to have a risk plot in the green band. However, the company can always have a decisive authority to say my risk level in a tolerable region which is also declared by the international agency. On the other hand, interestingly friends if this is my triangle, if these are the boundaries, if this is my yellow band which is called the tolerable region, it does not make a difference whether your risk values stay here, as long as the investment what you made to bring down the risk to here is not very expensive or the investment what you do not make will carry the risk to the red band.


Seriously, one has to decide upon the investments towards risk management and as long as the risk reduction on risk stays in the tolerable region it is always a freedom extended to the oil and gas industrial sector because for accounting the uncertainties involved in the whole process. So, by simply stating making a statement that risk acceptance is available offshore industry does not mean that risk is allowed intentionally, risk is not allowed intentionally. We also are capable of doing risk free design and process production. However, there are uncertainties in the electromechanical systems involved in oil and gas production which also get favored by the environmental status or conditions therefore, all the time it may not be possible to have risk at zero level.

Therefore, risk acceptability criteria are actually a provision in legal frame that if at all the risk is tolerable, it is permissible. However, if the risk goes to the red band, it is not acceptable; company has to invest to bring the risk down to either the tolerable region or preferably ideally the green band, which is acceptable region or normal region of risk. So, let us quickly see what are those maximum tolerable risk and negligible risk for different activities given by different agencies in the world. Please pay attention to the risk acceptability criteria table shown in the screen now.

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ACCEPTABLE RISK CRITERIA

Authority and Application	Maximum Tolerable Risk (per year)	Negligible Risk (per year)
VROM, The Netherlands (New)	1.0E-6	1.0E-8
VROM, The Netherlands (existing)	1.0E-5	1.0E-8
HSE, UK (existing-hazardous industry)	1.0E-4	1.0E-6
HSE, UK (New nuclear power station)	1.0E-5	1.0E-6
HSE, UK (Substance transport)	1.0E-4	1.0E-6
HSE, UK (New housing near plants)	1.0E-6	1.0E-7
Hong Kong Government (New plants)	1.0E-5	Not used



There are different agencies and authorities in applications industries which are used and indicated. Here, HSE stands for Health Safety Executive, United Kingdom for different activities and different applications, what is the maximum tolerable risk per year that is, it advises me the upper limit of this boundary, what is the maximum tolerable risk per year in terms of number? So, one can always quantify risk by various models which we have seen in the lectures. You get a number plot, this number and see and compare this with tolerable limits suggested by international agencies and if you say, negligible risk that is the lower boundary is also advised by this. So, one-tenth power minus 6, one-tenth power minus 8, maybe basically the boundary levels of risk which defines the tolerable region of risk given then the other hand which as per the new standard and so on.

So, this table gives you a compressive look out of various tolerable limits of risk proposed by international regulatory agencies which are mandatory to be followed by oil and gas industries. So, friends risk acceptability is a very highly subjective issue. It is generally confused in the public sense that people think that risk acceptability means that oil and gas industries are given new way the produce oil with high level of risk involved. It is not intentional it is because of uncertainties involved in oil and gas production which we have been seen in the whole semester and in the whole course which is nothing, but reliability estimates.

So, oil and gas production process is a zero risk process, I mean non-zero risk process, one cannot actually avoid risk in this because of complexities therefore, there should a provision made in the legal status and legal bases that if at all an accident happens because of risk involvement, what would be the acceptability criteria? So, it is for that provision risk acceptability criteria, predefined which should be mandatorily followed by oil and gas industries. I hope this will make you clear that risk acceptability does not impose an intentional risk in oil production at all.

Thank you very much.