

**Health, Safety and Environmental Management in Petroleum and offshore  
Engineering**

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**Module No. # 01**

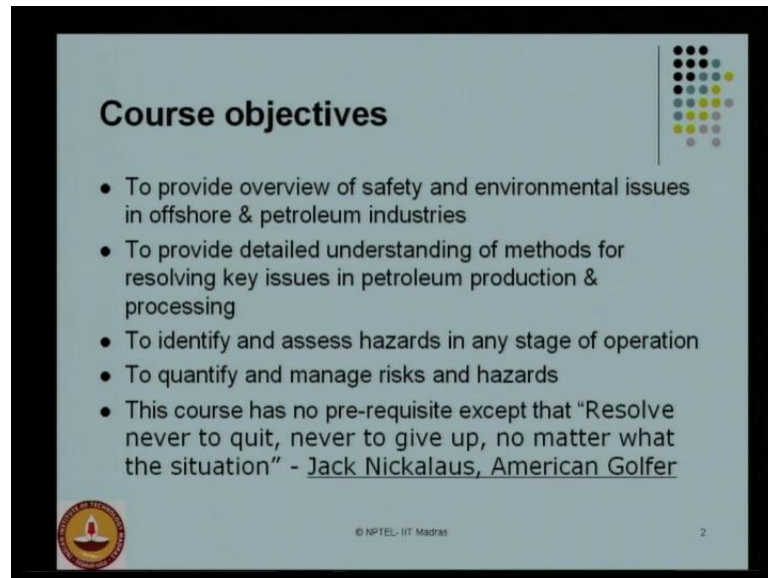
**Introduction and terminologies**

Hello, good morning to all of you. Today under the braces of NPTEL, IIT Madras; we are introducing to you, a new course by the name Health, Safety and Environmental Management in Petroleum and offshore engineering. This course is briefly called as HSE; this course is gaining momentum in the recent future. There are reasons for this, as we all know financial audit is mandatory for every petroleum company. Similarly, HSE audit has become mandatory under the current legislation of many countries. This course is vital in the research point of view as well as for practicing engineers in petroleum industry.

This course will be described and explained by myself, I am doctor Srinivasan Chandrasekar and my colleague Professor Subratokumar Bhattacharya who is presently heading the department of ocean engineering IIT Madras. For any queries you have in this course, you are most welcome to write an email to me under the address given here [drsekaran@iitm.ac.in](mailto:drsekaran@iitm.ac.in). The subject matter embodied in this course has some classified information. My humble request to all listeners is that this can be used for academic purpose, but kindly do not circulate or reproduce this without the permission of the author.

Let us now see, what HSE means, the course objectives are slated like this.

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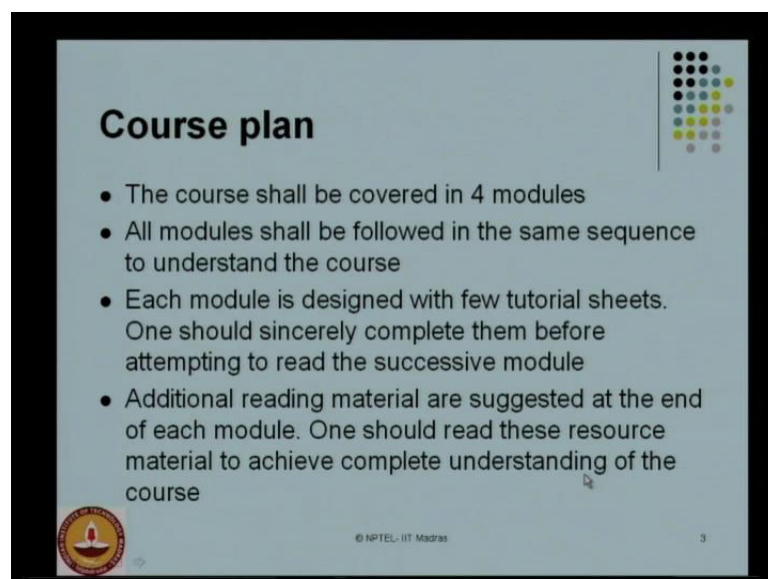
**Course objectives**

- To provide overview of safety and environmental issues in offshore & petroleum industries
- To provide detailed understanding of methods for resolving key issues in petroleum production & processing
- To identify and assess hazards in any stage of operation
- To quantify and manage risks and hazards
- This course has no pre-requisite except that "Resolve never to quit, never to give up, no matter what the situation" - Jack Nickalaus, American Golfer

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To provide an overview of Safety and Environmental issues in offshore and petroleum industries. To provide detailed understanding of methods for resolving key issues in petroleum production and processing. To identify and assess hazards in any stage of operation. To quantify and manage risks and hazards. This course has of course, no pre-requisite except that I quote from Jack Nicholas, American Golfer that resolves never to quit, never to give up, no matter what the situation is.

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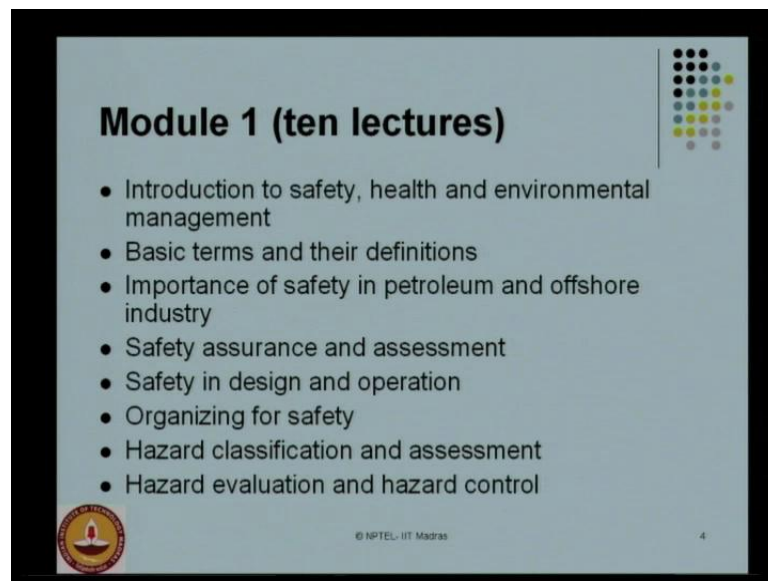
**Course plan**

- The course shall be covered in 4 modules
- All modules shall be followed in the same sequence to understand the course
- Each module is designed with few tutorial sheets. One should sincerely complete them before attempting to read the successive module
- Additional reading material are suggested at the end of each module. One should read these resource material to achieve complete understanding of the course

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How do we plan for this course? The course plan will be covered basically in four modules. All modules shall be followed in the same sequence to understand the course. On the other hand, understand the module first, do the tutorials then get to module two and so on. Each module is designed with a few tutorial sheets. One should sincerely complete them before attempting to read the successive module. Additional reading materials are suggested at the end of the each module. One should read these resource materials to achieve a complete understanding on the course.

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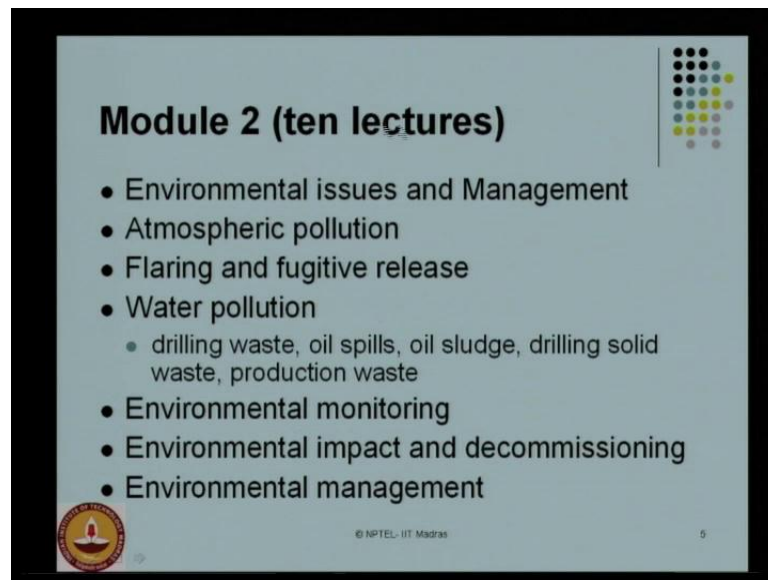
**Module 1 (ten lectures)**

- Introduction to safety, health and environmental management
- Basic terms and their definitions
- Importance of safety in petroleum and offshore industry
- Safety assurance and assessment
- Safety in design and operation
- Organizing for safety
- Hazard classification and assessment
- Hazard evaluation and hazard control

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What do we see in module 1; module 1 is expected to be completed in ten lectures. We talk about introduction to safety, health and environmental management. Basic terms and their definitions in HSE. Importance of safety in petroleum and offshore industry. Safety assurance and assessment. Safety in design and operation; organizing for safety; hazard classification and assessment; hazard evaluation and hazard control. These will be covered in module 1.

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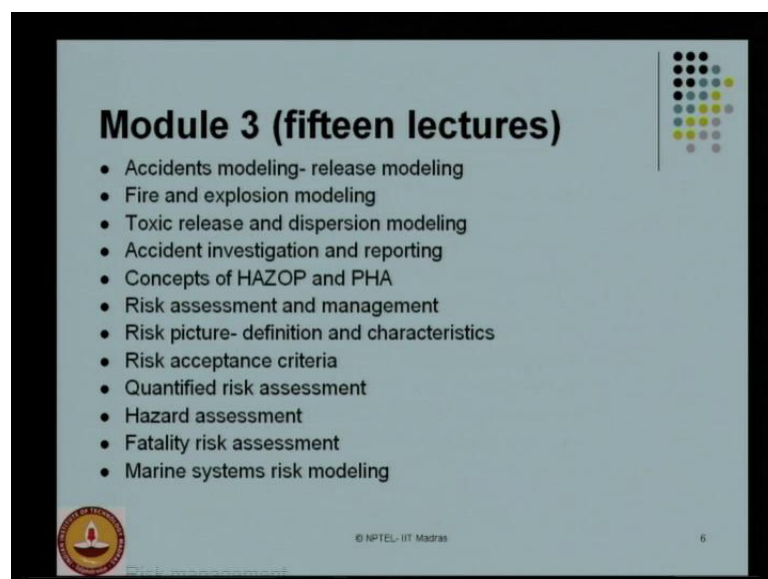
**Module 2 (ten lectures)**

- Environmental issues and Management
- Atmospheric pollution
- Flaring and fugitive release
- Water pollution
  - drilling waste, oil spills, oil sludge, drilling solid waste, production waste
- Environmental monitoring
- Environmental impact and decommissioning
- Environmental management

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Module 2 followed by 1 will again be a capsule of ten lectures. These lectures will cover environmental issues and management; atmospheric pollution; flaring and fugitive release modeling. Water pollution: we discuss drilling waste, oil spills, oil sludge, drilling solid waste, and production waste. Environmental monitoring; environmental impact and decommissioning, and of course, environmental management. These topics will be covered in module two.

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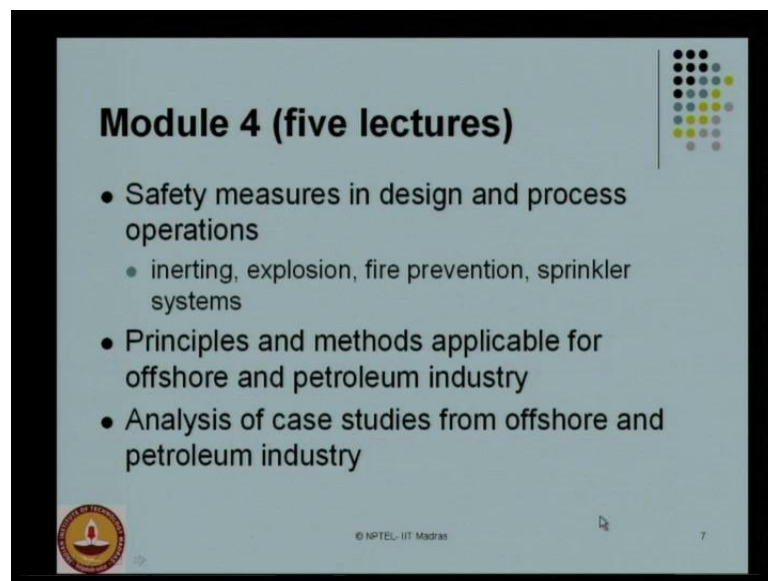
**Module 3 (fifteen lectures)**

- Accidents modeling- release modeling
- Fire and explosion modeling
- Toxic release and dispersion modeling
- Accident investigation and reporting
- Concepts of HAZOP and PHA
- Risk assessment and management
- Risk picture- definition and characteristics
- Risk acceptance criteria
- Quantified risk assessment
- Hazard assessment
- Fatality risk assessment
- Marine systems risk modeling

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Followed by which we will have fifteen lectures on module 3, in which we will talk about accidents modeling-release modeling; fire and explosion modeling; toxic release and dispersion modeling; accident investigation and reporting; concept of HAZOP and PHA; risk assessment and management. Risk picture, its definition and characteristics; risk acceptance criteria; quantified risk assessment; hazard assessment; fatality risk assessment; marine systems' risk modeling and risk management.

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**Module 4 (five lectures)**

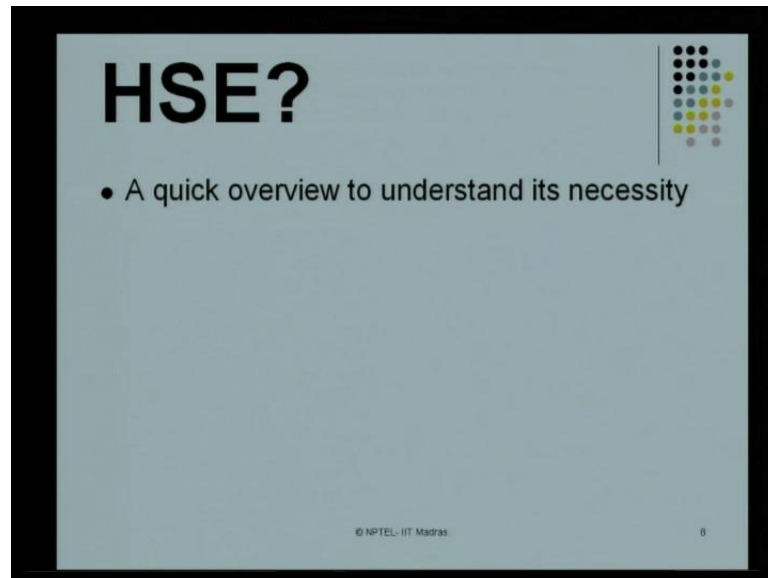
- Safety measures in design and process operations
  - inerting, explosion, fire prevention, sprinkler systems
- Principles and methods applicable for offshore and petroleum industry
- Analysis of case studies from offshore and petroleum industry

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Followed by which, we have the last module that will be covered in five lectures, which we will have safety measures in design and process operation like inerting, explosion, fire prevention and sprinkler system design. Principles and methods applicable for offshore and petroleum industry, and interestingly we will discuss some important case studies from offshore and petroleum industry.

Dear friend, HSE course is designed to cover in four modules as explained before.

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Let us ask a question to follow further, what is HSE? A quick review to understand its necessity.

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There are some black spots in oil and gas exploration. This makes us to understand why HSE is important. For example, Black spot number-one: in oil and gas exploration happened in Three Mile Island, middle-town of Pennsylvania on March 28, 1979. The failure was mainly due to the pilot operated relief valve, which cause the explosion on the cooling tower. This is a sad picture after the disaster had occurred.

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**Black spot- TWO**

- Bhopal Gas Tragedy, India
- Dec 2<sup>nd</sup>, 1984
- Leak of methyl isocyanate gas
- Exothermic reaction
  - increased temperature to 200 °C
  - Raised pressure
  - Resulted in gas leak




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Black spot number-two: Unfortunately happened in India. This is famously known as Bhopal disaster. It happened on 2nd of December, 1984; it was mainly due to the leakage of methyl isocyanide gas. An exothermic reaction is responsible for this disaster. The temperature was increased to 200 degree Celsius. The pressure was raised and as a result of which the gas leaked. My dear friends look at this photograph on your right side. A lady is feeding a child, but she is closing a nose with one of her hands. This is unfortunately not expected for any human being, be an Indian, be an American or a foreigner.

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**Black spot- Three**

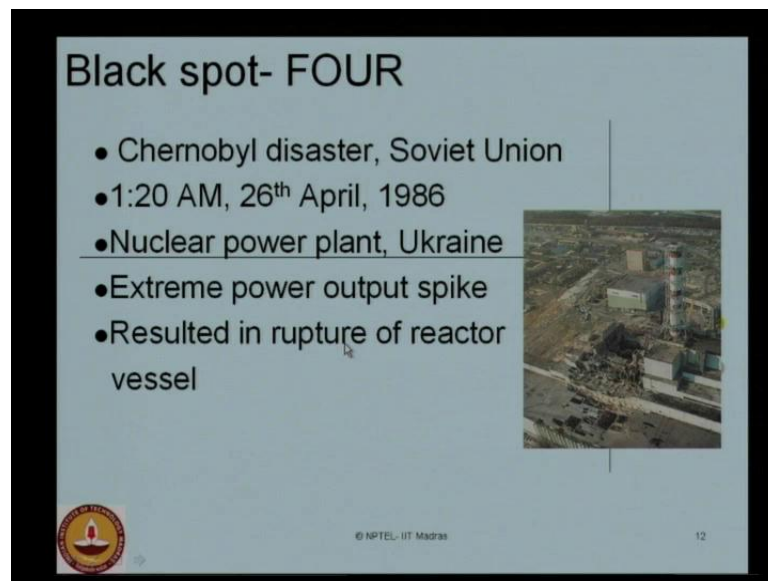
- The Space Shuttle Challenge disaster
- Jan 28<sup>th</sup>, 1986
- O-ring seal failed
- Pressurized hot gas released
- 7 crew member died
- Shuttle disintegrated



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Black spot number-three: Interestingly, it is identified as a space shuttle challenge disaster. This happened on January 28th, 1986; though, this case is not closely related to offshore and petroleum industry, but anyway this is identified as one of the interesting black spot for safety. The failure actually occurred because of an O-ring seal failure and the release of pressurized hot gas. My dear friends look at the photograph of a seven crew member who had been travelling in the space shuttle, the space shuttle got disintegrated and none of them are alive now.


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**Black spot- FOUR**

- Chernobyl disaster, Soviet Union
- 1:20 AM, 26<sup>th</sup> April, 1986
- Nuclear power plant, Ukraine
- Extreme power output spike
- Resulted in rupture of reactor vessel



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Black spot number-four: Chernobyl disaster, Soviet Union occurred on 1986, 26th April in the early morning. It was actually a failure or a partial failure of a nuclear power plant in Ukraine. The failure actually occurred because of the extreme power output spike that happened which resulted in the rupture of one of the reactor vessels.



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**Black spot -Five**

- BP oil disaster, GoM
- 20<sup>th</sup> April 2010
- Fateful day in oil industry
- BOP failed despite all critical efforts

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The slide features a grid layout. The top right contains an image of an offshore oil platform on fire. The bottom right contains an image of an offshore oil platform at sea. A decorative graphic of colored dots is positioned between the two images.

Black spot number-five: All of us know, it is a recent disaster which happened and is considered as a milestone in offshore and petroleum industry. This is the famous BP oil disaster that happened in Gulf of Mexico on 20th April, 2010. This is identified as one of the fateful days in the oil industry. The blow out prevention failed despite all the critical efforts taken to save the platform as well as the human lives in the disaster.

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**What do these events teach us?**

- Limitations of knowledge to predict events
- Past experience is not sufficient to estimate them
- Why do they happen?
- These events are VERY RARE
- But IMPACT IS SEVERE
- If so, how to guarantee the human and process safety under such conditions?

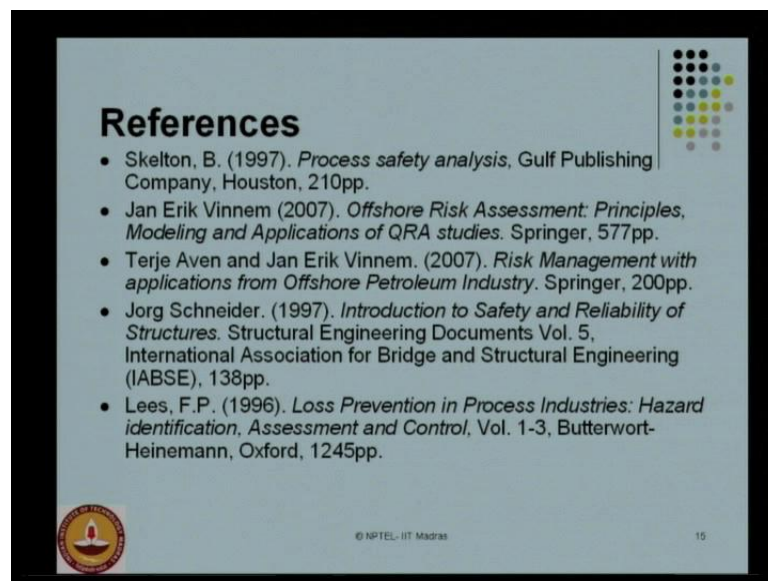
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The slide features a grid layout. The right side contains a decorative graphic of colored dots.

What do these events teach us? They very clearly tell us, there exist limitations of knowledge to predict such events. The past experience what we have is not sufficient to

estimate them. Then the next question asked is, why do these events happen? Before we answer why do they happen, let us understand some important points behind this with respect to safety point of view. These events are very rare, but the impact created by these events is severe. If so, then how can one guarantee the human and process safety under such conditions? A very interesting question which leads to an initiative to follow a course called HSE.

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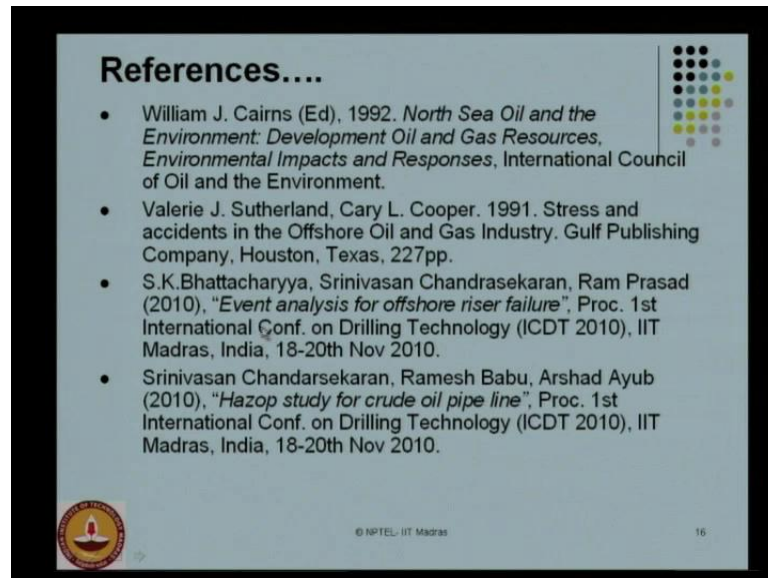
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- Jan Erik Vinnem (2007). *Offshore Risk Assessment: Principles, Modeling and Applications of QRA studies*. Springer, 577pp.
- Terje Aven and Jan Erik Vinnem. (2007). *Risk Management with applications from Offshore Petroleum Industry*. Springer, 200pp.
- Jorg Schneider. (1997). *Introduction to Safety and Reliability of Structures*. Structural Engineering Documents Vol. 5, International Association for Bridge and Structural Engineering (IABSE), 138pp.
- Lees, F.P. (1996). *Loss Prevention in Process Industries: Hazard identification, Assessment and Control*, Vol. 1-3, Butterworth-Heinemann, Oxford, 1245pp.

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There are some interesting references which are listed to you. I humbly request all the readers to go through them for understanding and parallel learning as the course proceeds further.

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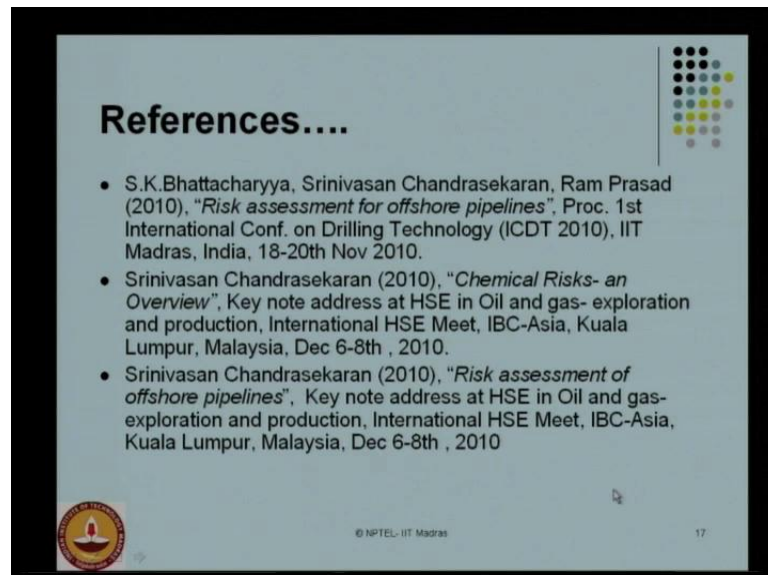
Slide 16: References....

- William J. Cairns (Ed), 1992. *North Sea Oil and the Environment: Development Oil and Gas Resources, Environmental Impacts and Responses*, International Council of Oil and the Environment.
- Valerie J. Sutherland, Cary L. Cooper. 1991. *Stress and accidents in the Offshore Oil and Gas Industry*. Gulf Publishing Company, Houston, Texas, 227pp.
- S.K.Bhattacharyya, Srinivasan Chandrasekaran, Ram Prasad (2010), "Event analysis for offshore riser failure", Proc. 1st International Conf. on Drilling Technology (ICDT 2010), IIT Madras, India, 18-20th Nov 2010.
- Srinivasan Chandrasekaran, Ramesh Babu, Arshad Ayub (2010), "Hazop study for crude oil pipe line", Proc. 1st International Conf. on Drilling Technology (ICDT 2010), IIT Madras, India, 18-20th Nov 2010.

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Some of the references are available in the net as a free loading material. Some of the references are also quoted as some of my papers presented in the recent international conference held in IIT Madras. If you want to have an access of these papers kindly write to me. I can pass on these copies of papers to you for additional reading.

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Slide 17: References....

- S.K.Bhattacharyya, Srinivasan Chandrasekaran, Ram Prasad (2010), "Risk assessment for offshore pipelines", Proc. 1st International Conf. on Drilling Technology (ICDT 2010), IIT Madras, India, 18-20th Nov 2010.
- Srinivasan Chandrasekaran (2010), "Chemical Risks- an Overview", Key note address at HSE in Oil and gas- exploration and production, International HSE Meet, IBC-Asia, Kuala Lumpur, Malaysia, Dec 6-8th , 2010.
- Srinivasan Chandrasekaran (2010), "Risk assessment of offshore pipelines", Key note address at HSE in Oil and gas- exploration and production, International HSE Meet, IBC-Asia, Kuala Lumpur, Malaysia, Dec 6-8th , 2010

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We recently gave the key note invited lectures in Kuala Lumpur, Malaysia at an international HSE meet held in December, 2010. If you wish to have some of the lecture notes of this kind for your understanding we can pass on that to you.

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**HSE comes in CANS**

- I CAN
- YOU CAN
- WE CAN

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My dear friends HSE comes in cans. I can do it; you can do it and we can do it.

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**Can we prevent such disasters?  
If not, can we predict them?**

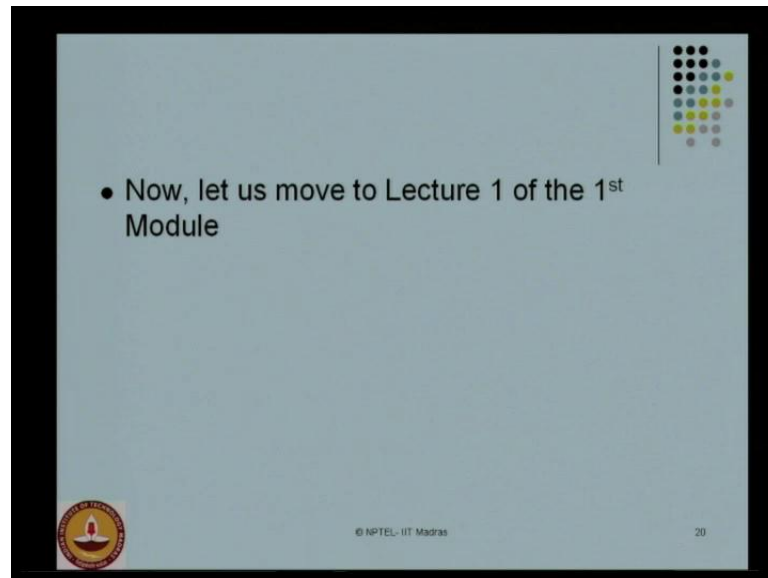
3 mile island nuclear plant partial meltdown

BHOPAL, INDIA: HEALTHY THE GUYANA CHINA GO DOES THE STRONG

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Can we prevent such disasters? If not, can we predict them? These are some of the case studies, which we just presented very briefly to you for your interesting knowledge. To have sympathy on human kind, kindly remember as an Indian, the Bhopal gas tragedy.

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Now that we have understood the necessity for learning a course on HSE, you are prepared to know, why you want to learn a course on HSE. Now, I will take you to the next lecture which is lecture number 1 on the first module.

Thank you.