

**Department of Defence Research & Development,  
Ministry of Defence, Government of India  
DEFENCE INSTITUTE OF ADVANCED TECHNOLOGY  
(Deemed to be University under Section 3 of the UGC act 1956)  
Category 'A' declared by MHRD, Government of India and Accredited by NAAC  
Girinagar P.O., PUNE - 411025, Maharashtra, India  
www.diat.ac.in  
and  
CENTRE FOR FIRE EXPLOSIVES AND ENVIRONMENT SAFETY (CFEES), DRDO**

Defence Institute of Advanced Technology – Deemed to be University (DIAT) is the premier Technological University of Dept. of Defence R&D / DRDO – Ministry of Defence – Govt. of India, engaged in imparting technical education, in niche areas at PG (M. Tech.) & Ph. D levels over the last 60 years, in its various forms & capacities. The main focus of the institute is to evolve as an innovative Unique Teaching & Research University to develop indigenous contemporary defence related technologies. The University is spread over 496 acres in scenic beautiful location, overlooking Khadakwasla Lake, in Sahyadri hills. The University has been awarded various Education Excellence Awards. The University has well equipped laboratories with latest equipments and simulation / analysis software.

PG Diploma in “Fire Engineering and Integrated safety” is jointly organized by DIAT(DU), Pune and CFEES, Delhi. The PG Diploma program is designed to include Course of Study, Seminars, Project/Thesis, Practice School & Industry visit through which a student may develop his / her concepts and intellectual skills. Above all, the students is encouraged to develop a capacity for free and objectives enquiry, courage and integrity, awareness and sensitivity to the needs and aspirations of society. The emphasis is on practical, case studies & use of software. The PG Diploma will be of one year duration with total three trimesters with 4 months each. The second trimester will be conducted at CFEES, Delhi. All the three trimesters will be supported by CFEES, Delhi. The education system is Choice Based Credit System (CBCS) where teaching is done by well qualified faculty drawn from DIAT and serving / retired scientists & officers of DRDO, Services, ISRO, IITs, various R&D and teaching institutes in India and abroad. DIAT has MoUs with various Industries in India, Universities & Establishments across the world. DIAT has an active Placement Cell

**DIAT-CFEES announces admissions to the Post graduate diploma in Fire Engineering and Integrated safety (1 year) for the academic year 2016 – 17, for sponsored candidates from DRDO/Tri-Services/Defence PSUs and Industries.**

## **ELIGIBILITY CRITERIA**

Any graduate who has studied Mathematics at H.S.C. (+2) stage and at least one paper of Mathematics during the graduation (B.E / B. Tech. or B Sc etc).

Note: Age limit for the sponsored candidate should not be more than 50 Years.

PG DIPLOMA IN INTEGRATED SAFETY ENGINEERING  
I TO III SEMESTERS (TRIMESTER)  
COURSE STRUCTURE AND SYLLABUS

**Trimester I**

SN	Course Code	Course Title	L	T	P	C
<b>THEORY :</b>						
1	AM -501	Probability, Statistical & Simulation techniques	3	-	-	3
2	ME -502	Combustion and Heat transfer	3	-	-	3
3	MS/CF -503	Industrial safety	3	-	-	3
4	EE/AP -504	Electrical Safety	3			3
5	MS/AC/AP-505	<b>Elective- I</b> A. Environment Safety OR B. Nuclear and radiation safety	3			
<b>PRACTICAL</b> Allotment of project topic						
7	MS -506	Industrial Safety Laboratory	-	-	4	2
TOTAL						17

**Trimester II**

SN	Course Code	Course Title	L	T	P	C
<b>THEORY :</b>						
1	CF – 507	Fire safety	3			3
2	CF – 508	Disaster Management	3			3
3	CF – 509	SHE Legislation	3			3
4	CF – 510	Safety in Process Industries	3			3
5	CF – 511	Accident investigation and control measures	3			3
6	CF – 512	Elective II A. Human Factors and Behaviour based safety B. Aviation safety C. Explosive safety	3			3
<b>PRACTICALS</b>						
8	CF – 513	Fire Safety	-		4	2
TOTAL						17

**Trimester III**

SN	Course Code	Course Title	L	T	P	C
<b>THEORY</b>						
1	MS/CF – 514	Risk and hazard assessment	3			3
2	MS/CF – 515	Quality and Reliability Engineering	3			3
3	MS/CF- 516	Elective III A. Safety in Hydrocarbon Industry B. Powder Handling safety C. Safety in Marine systems	3			3
4						
<b>PRACTICALS</b>						
5	MS/CF- 517	Project work – Phase II Final			16	8
TOTAL						17

Syllabus of

PG Diploma in

*Fire engineering and Integrated Safety*

Organised by

**CENTRE FOR FIRE, EXPLOSIVE AND ENVIRONMENT SAFETY**

**Department of Defence Research & Development,**

**Ministry of Defence, Government of India**

**Timarpur, Delhi 110 007**

**[www.cfees.drdo.in](http://www.cfees.drdo.in)**

*In collaboration with*

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## **SYLLABUS DETAILS**

### **Semester I**

#### **AM – 501 :PROBABILITY, STATISTICAL & SIMULATION TECHNIQUES**

##### **UNIT I: PROBABILITY AND RANDOM VARIABLE**

Probability – Random variables – Moments – Moment generating function – Standard distributions – Functions of random variables – Two-dimensional R.Vs – Correlation and Regression.

##### **UNIT II: ESTIMATION THEORY**

Principle of least squares – Regression – Multiple and Partial correlations – Estimation of Parameters – Maximum likelihood estimates – Method of moments.

##### **UNIT III: TESTING OF HYPOTHESIS**

Sampling distributions – Test based on Normal, t-distribution, chi-square, and F-distributions – Analysis of variance – One-way and two way classifications.

##### **UNIT IV: INTRODUCTION TO SIMULATION:**

Introduction to modelling and simulation, Classification of systems into continuous and discrete, Structural characterization of mathematical model and validation techniques.

#### **REFERENCES**

1. Freund John, E and Miller, Irvin, "Probability and Statistics for Engineering", 5th Edition, Prentice Hall, 1994.
2. Jay, L.Devore, "Probability and Statistics for Engineering and Sciences", Brooks Cole Publishing Company, Monterey, California, 1982.
3. Anderson, O.D, "Time series Analysis: Theory and Practice", I.North-Holland, Amsterdam, 1982.
4. Gupta, S.C and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 1999.
5. Modelling Mathematical Methods & Scientific Computations, 1995, Nicola Bellomo & Luigi Preziosi, CRC Press.
6. Systems Modelling and Analysis, 2003, I.J. Nagrath, M. Gopal, Tata McGraw Hill, New Delhi.

#### **ME - 502 :COMBUSTION AND HEAT TRANSFER:**

##### **UNIT I**

Basic principles including chemical equilibrium, Arrhenius law, and Rankine-Hugoniot relations. Multi-component conservation equations with chemical reaction will be introduced. Combustion of fuel in premixed flames and in non-premixed flames gaseous fuels, liquid fuels, and solid fuels.

##### **UNIT II**

Various characteristics of premixed and diffusion flames which covers flame structure, flame stability, flame stabilization, flammability limit, quenching distance, and thermal explosion.

##### **UNIT III**

Combustion phenomena in gas turbines, gasoline engines, diesel engines and power plants. A matched asymptotic expansion technique and its application in analyzing flame structures.

##### **UNIT IV MODES OF HEAT TRANSFER**

**Conduction:** General Differential equation of Heat Conduction – Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation.

**Convection:** Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

## **Radiation:**

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

## **Textbook :**

1. "Combustion – Physical and Chemical principles, Modelling and Simulation, Experiments, Pollutant formation " by Warnatz, Maas and Dibble
2. "An introduction to Combustion – Concepts and Application", by Stephen R. Turns
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002 New Delhi,
4. Yadav, R., "Heat and Mass Transfer", Central Publishing House, 1995.

## **MS/CF – 503 : INDUSTRIAL SAFETY**

### **UNIT I PHYSICAL HAZARDS**

Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs- vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- nonionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers, TLV- cold environments, hypothermia, wind chill index, control measures- hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control

### **UNIT II CHEMICAL HAZARDS**

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling, Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods.

### **UNIT III OCCUPATIONAL PHYSIOLOGY**

Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

### **UNIT IV PERSONAL PROTECTION**

Concepts of personal protective equipment – types – selection of PPE – invisible protective barriers – procurement, storage, inspection and testing – quality – standards – ergonomic considerations in personal protective equipment design.

### **UNIT V INDUSTRIAL SAFETY AUDITS**

#### **A. INTRODUCTION**

Components of safety audit, types of audit, audit methodology, non conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor.

#### **B. SPECIFICATIONS FOR SAFETY AUDIT**

BIS : 14489: Objective ,scope and procedure of occupational safety and health audit, Making of check list and survey

## **REFERENCE**

1. Encyclopaedia of "Occupational Health and Safety", Vol.I and II, published by International Labour Office, Geneva, 1985
2. Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982
3. Indian standard : 14489 Code of practice on occupational safety and health

## **EE/AP – 504 : ELECTRICAL SAFETY**

### **UNIT I CONCEPTS AND STATUTORY REQUIREMENTS**

Introduction – electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference – Working principles of electrical equipment-Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety – first aid-cardiopulmonary resuscitation(CPR).

### **UNIT II ELECTRICAL HAZARDS**

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity.Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy current surges-Safety in handling of war equipment-over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity –definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc ignition energy-national electrical safety code ANSI.Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

### **UNIT III PROTECTION SYSTEMS**

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safelimits of amperage – voltage –safe distance from lines-capacity and protection of conductor-joints-and connections, overload and short circuit protection-no load protection-earth fault protection.FRLS insulation-insulation and continuity test-system grounding-equipment grounding-earth leakage circuit breaker (ELCB)-cable wires-maintenance of ground-ground fault circuit interrupter-use of low voltage-electrical guards-Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipment.

### **UNIT IV SELECTION, INSTALLATION, OPERATION AND MAINTENANCE**

Role of environment in selection-safety aspects in application - protection and interlock-self diagnostic features and fail safe concepts-lock out and work permit system-discharge rod and earthing devices safety in the use of portable tools-cabling and cable joints-preventive maintenance.Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies.

### **TEXT BOOK:**

1. Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1986.
2. "Accident prevention manual for industrial operations", N.S.C.,Chicago, 1982.
3. Indian Electricity Act and Rules, Government of India.
4. Power Engineers – Handbook of TNEB, Chennai, 1989.
5. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt.LTd., England, 1988.

## **Ms/AC/AP- 505 ELECTIVE - I**

### **A. ENVIRONMENT SAFETY**

#### **UNIT I AIR POLLUTION**

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution-hazards of air pollution-concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes-automobile exhausts-chemical factory stack emissions-CFC.

### **UNIT II WATER POLLUTION**

Classification of water pollutants-health hazards-sampling and analysis of water-water treatment different industrial effluents and their treatment and disposal -advanced wastewater treatment effluent quality standards and laws- chemical industries, tannery, textile effluents-common treatment.

### **UNIT III HAZARDOUS WASTE MANAGEMENT**

Hazardous waste management in India-waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes-incineration and vitrification - hazards due to bio-process dilution-standards and restrictions, recycling and reuse.

### **UNIT IV ENVIRONMENTAL MEASUREMENT AND CONTROL**

Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – lux meter-pH meter – gas chromatograph – atomic absorption spectrometer. Gravitational settling chambers-cyclone separators-scrubbers-electrostatic precipitator - bag filter – maintenance - control of gaseous emission by adsorption, absorption and combustion methods Pollution Control Board-laws.

### **UNIT V POLLUTION CONTROL IN PROCESS INDUSTRIES**

Pollution control in process industries like cement, paper, petroleum-petroleum products-textile tanneries-thermal power plants – dyeing and pigment industries - eco-friendly energy.

### **REFERENCES**

1. Rao, CS, "Environmental pollution engineering:", Wiley Eastern Limited, New Delhi, 1992.
2. S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.
3. Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.

## **B. NUCLEAR AND RADIATION SAFETY**

### **UNIT I INTRODUCTION**

Binding energy – fission process – radio activity – alpha, beta and gamma rays radioactive decay – decay schemes – effects of radiation – neutron interaction – cross section – reaction rate – neutron moderation – multiplication – scattering – collision – fast fission – resonance escape – thermal utilization – criticality.

### **UNIT II REACTOR CONTROL**

Control requirements in design considerations – means of control – control and shut down rods – their operation and operational problems – control rod worth – control instrumentation and monitoring – online central data processing system.

### **UNIT III REACTOR TYPES**

Boiling water reactors – radioactivity of steam system – direct cycle and dual cycle power plants, pressurized water reactors and pressurized heavy water reactors – fast breeder reactors and their role in power generation in the Indian context – conversion and breeding – doubling time – liquid metal coolants – nuclear power plants in India.

### **UNIT IV SAFETY OF NUCLEAR REACTORS**

Safety design principles – engineered safety features – site related factors – safety related systems – heat transport systems – reactor control and protection system – fire protection system – quality assurance in plant components – operational safety – safety regulation process – public awareness and emergency preparedness. Accident Case studies- Three Mile island and Chernobyl accident.

### **UNIT V RADIATION CONTROL**

Radiation shielding – radiation dose – dose measurements – units of exposure – exposure limits – barriers for control of radioactivity release – control of radiation exposure to plant

personnel – health physics surveillance – waste management and disposal practices – environmental releases.

## **REFERENCES**

1. M.M.E.L.Wakil, "Nuclear Power Engineering", International Text Book Co.
2. Sterman U.S. "Thermal and Nuclear Power Stations", MIR Publications, Moscow, 1986.
3. "Loss prevention in the process Industries" Frank P. Lees Butterworth-Hein-UK, 1990.
4. M.M.E.L.Wakil, "Nuclear Energy Conversion", International Text Book Co.
5. R.L.Murray, "Introduction to Nuclear Engineering", Prentice Hall.
6. Sri Ram K, "Basic Nuclear Engineering" Wiley Eastern Ltd., New Delhi, 1990.
7. Loffness, R.L., "Nuclear Power Plant" Van Nostrand Publications, 1979.

## **MS – 506 INDUSTRIAL SAFETY LABORATORY**

### **UNIT I NOISE LEVEL MEASUREMENT AND ANALYSIS**

Measurement of sound pressure level in dB for Impact, continuous and intermittent sources at various networks, peak and average values.

### **UNIT II FRICTION TEST**

Explosive materials like barium nitrate, gun powder, white powder, amorces composition etc.

### **UNIT III IMPACT TEST**

Explosive materials like gun powder, white powder, amerces composition etc.  
Burst strength test of packaging materials like paper bags, corrugated cartoons, wood etc.  
Auto ignition temperature test.

### **UNIT IV EXHAUST GAS MEASUREMENT AND ANALYSIS**

Measurement of SO<sub>x</sub>, NO<sub>x</sub>, CO<sub>x</sub>, and hydrocarbons.

### **UNIT V ENVIRONMENTAL PARAMETER MEASUREMENT**

Dry Bulb Temperature, Wet Bulb Temperature, Determination of relative humidity, wind flow and effective corrective effective.

Particle size Measurement

Air sampling analysis

### **UNIT VI Static charge testing**

on plastic, rubber, ferrous and non-ferrous materials.

### **UNIT VII Illumination testing–**

by lux meter and photo meter.

### **UNIT VIII Electrical safety**

Insulation resistance for motors and cables

Estimation of earth resistance

Earth continuity test

Sensitivity test for ELCB

### **UNIT IX Softwares : Introduction and Use**

Accident Analysis

Safety Audit Packages

Consequence Analysis (CISCON)

Fire, Explosion and Toxicity Index (FETI)

Reliability Analysis for Mechanical system and Electrical System

Failure Mode Analysis

### **Equipments Required**

1. Noise level meter :
2. Friction tester :



3. Impact tester :
4. Exhaust gas analyser:
5. High volume sampler :
6. PPE Set :
7. Static charge tester :
8. First aid kit :
9. Software : CISION, FETI and Failure Mode analysis

## **TRIMESTER II**

### **CF – 507 : FIRE SAFETY**

#### **UNIT I PHYSICS AND CHEMISTRY OF FIRE**

Sources of ignition – fire triangle – fire tetrahedron - principles of fire extinguishment - various classes of fires – types of fire extinguishing medias and fire extinguishers – foam making equipment ,their method of use

Fire properties of solid, liquid and gases –flash point, flammability limits, spontaneous combustion, fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour

#### **UNIT IIFIRE PREVENTION AND PROTECTION**

Active and passive fire protection systems, Advanced / latest fire prevention and fire protection systems. Fire accidents in the past and their case studies. Explosion – case studies.

#### **UNIT III INDUSTRIAL FIRE PROTECTION SYSTEMS**

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, Water mist system. Selection criteria of the above installations, reliability, maintenance, evaluation and standards –Fire detectionand alarm systems. Other suppression systems – CO<sub>2</sub> system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement –halon alternatives - smoke venting. Portable fire extinguishers – flammable liquids tank farms, firefighting systems.

#### **UNIT IV EXPLOSION PROTECTING SYSTEMS**

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection,Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure explosion venting-inert gases, plant for generation of inert gas-rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO<sub>2</sub>) and halons-hazards in LPG, ammonia (NH<sub>3</sub>), sulphur dioxide (SO<sub>2</sub>), chlorine (Cl<sub>2</sub>) etc.

### **REFERENCES**

1. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.
2. Gupta, R.S., “Hand Book of Fire Technology” Orient Longman, Bombay 1977.
3. “Accident Prevention manual for industrial operations” N.S.C., Chicago, 1982.
4. DinkoTuhtar, “Fire and explosion protection”
5. “Davis Daniel et al, “Hand Book of fire technology”
6. Fire fighters hazardous materials reference book Fire Prevention in Factories”, anNostrand Rein Hold, New York, 1991.
7. “Fire Prevention and fire fighting”, Loss prevention Association, India.
8. Relevant Indian Acts and rules, Government of India.

### **CF – 508 : DISASTER MANAGEMENT**

#### **UNIT I Meaning and types of disasters:**

1. Manmade and natural – earthquakes, volcanoes, landslides, floods, cyclones, tsunamis, anthropogenic, industrial, chemical and environmental, fire etc. Stages of a disaster mitigation plan- pre-disaster planning, disaster preparedness, monitoring phase, emergency response or damage assessment, recovery and relief phase.

2. Earthquakes: Causative factors, hazard assessment, selection of factors, creation of thematic data layers, preparation of seismic hazard zonation maps, regional risk assessment, risk mitigation plans; Tsunami and its impact, Case studies

3. Landslides: Causative factors, hazard assessment, selection of factors – triggering and nontriggering, creation of thematic data layers, preparation of landslide hazard zonation maps, regional and site specific risk assessments, risk mitigation plans; Case studies

4. Cyclones and Flooding: Cyclone: cyclone related parameters and effects on land and sea – damage assessment. Flooding: causes, flood prone area demarcation, analysis and management, risk assessment; Case studies

5. Drought and Desertification: Types of droughts, factors influencing droughts, identification of variables, delimiting drought prone areas, processes of desertification, over utilization of water and land resources. ; Case studies.

6. Anthropogenic Disasters: Atmospheric Disasters: Ozone layer depletion, green house / global warming – acid rain – snow melt – sea level rise – related problems. Case studies; Marine Disasters: oil spill and chemical pollution, coastal erosion and deposition, factor identification, management strategies; Case studies.

#### **UNIT II Introduction to disaster management:**

1. Definition and Introduction to disaster management, Disaster management before, during and after disaster event, disaster management cycle, preparedness, prevention, mitigation and response, relief ,reconstruction, rehabilitation activities. Disaster management in India. Disaster as an opportunity for development, Disasters Vs development: Disaster-development linkages, interaction of socio-economic developmental activities and disasters, development plans incorporating disaster risks.

**2. Emerging approaches in disaster management:** 1. Pre- disaster stage (preparedness) (a) Preparing hazard zonation and maps, Predictability/ forecasting & warning (b) Preparing disaster preparedness plan (c) Land use and zoning (d) Preparedness through (IEC) Information, education & Communication, 2. Emergency Stage (a) Rescue training for search & operations at national & regional level (b) Immediate relief (c) Assessment surveys Post Disaster stage-Rehabilitation.**Disaster Mitigation:** Warning and evacuation, do's and don't about disaster, damage survey for designing aid package and detailed survey for reconstruction, repair and retrofitting, post disaster surveys, long term measures- Disaster resistant construction, retrofitting cost-benefit analysis

**3. Institutional setup & programmes in India:** Institutions & National Centers for Natural Disaster reduction, Environmental Legislations in India, Awareness, Conservation Movement, Education & training. Voluntary action, voluntary organization and non-government organizations and their role in Disaster Management. Social Action Groups, Advocacy Initiatives, Civil Society Organizations and Social Movements and their role in disaster management.

**4. Standardization of the assessment of economic and social aspects:** Standardization of the assessment of economic, social and environmental aspects/losses of disaster management for comparative purposes and for an approach that reflects the reality on the community level. Community-based disaster management. Risk sharing and risk transfer (Insurance). Valuation of losses. Response strategies at National, Regional and community level.

**5. Knowledge Management:** Disaster knowledge management at international, national and regional level and strategies of handling disasters. Sharing of disaster handling

strategies at all levels. Case studies focusing on socio-economic and technical issues related to disasters about India, China, Indonesia and other Asian countries who have suffered from disasters

**6. Strategic Disaster Management:** Understanding the application of the principles and procedures of strategic management in the domain of disaster mitigation and management. Strategy formulation, understanding strategic intent, vision, mission for better forecasting of disaster threats and their prevention and strategic management of disaster. Strategic management principles, methods and tools. planning, organizing, leadership and monitoring and evaluation of all role-players in disaster management.

**7. Information Technology in Disaster Management:** Understanding the link between information and decision-making. Understanding and classifying information systems that can have an impact on the dynamic disaster environment

**8. Disaster Management Act:** Disaster management policy; Techno legal aspect: Techno-Legal and Techno-Financial workdevelopment control regulations and building bye-laws registration, qualification and duties of professionals, disaster response policy

### **UNIT III. Post disaster issues and sustainable development**

1. Post Disaster Reconstruction and recovery for sustainable development, issues and policies

2. Sustainable Development :Introduction to Sustainable Development-Bio Diversity- Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out-Sea level rise-El Nino and climate changes-Ecofriendly products-Green movements-Green philosophy-Environmental Policies-Environmental ImpactAssessment-case studies.

### **UNIT IV.CBRN**

1. Bioterrorism – Bioterror agents: Bacterial and viral; bioterrorism- introduction of plant and animal diseases

2. Infectious diseases – Infectious agents, mortality due to major bacterial outbreaks, spread of bacterial infections and the never ending fight, pathogens and multiple drug resistance, means of detecting and mitigating bacterial pathogens

3. Viral diseases - Outbreaks and incidences; Viral outbreaks – SARS, Bird flu, Swine flu and HIV, detection and mitigation of viral agents

4. Chemical Emergencies: Pesticides, industrial pollutants, heavy metal contamination.

5. Radiation emergencies: Nuclear radiation leakage, Chernobyl disaster and implications on biological systems, effect on genetic material; Mutations-chromosomal

6. Biotechnology and Biodiversity : Issues of Biodiversity, value of biodiversity; Emergence of Biotechnology; Biotechnology and promises to society; Biotechnology Techniques; Managing the Hazards of Genetic Engineering, regulations and control of biotechnology; Biosafety

### **REFERENCES**

- 1 Management: A Global Perspective, Wehrich, H. and Koontz, H., New York, McGraw Hill 2006
- 2 Disaster Management: A Disaster Managers Handbook, Carter, W.N., Manila, ADB. 2006
- 3 Mohanty, Ranjita and Prayag Mehta, NGOs and Civil Society, New Delhi: Sanskriti Publications. 2002
- 4 Siwach, Raj Kumar Voluntary Organizations and Social Welfare, Shanker Publications, Delhi, 2004
- 5 R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi. 2000
- 6 John A. M., Natural Hazards and Environmental Change, Bill McGuire 2002
- 7 Marcel, M., Flood risk management, Deltares 2010
2. Schumann, A., Flood Risk Assessment & Management, Springer Publication 2010
8. Central Water Commission, Manual on Flood Forecasting 1980
9. Reiter, L., Earthquake Hazard Analysis: Issues and Insights, Columbia University Press 2000
10. Hyndman D. and Hyndman D., Natural Hazard and Disasters, Brooks/Cole 2006

11. Bryant E., Natural Hazards, Cambridge University Press 2005
12. Disaster Management: A Disaster Managers Handbook, Carter, W.N., Manila, ADB. 2006
13. Mitigation of Natural hazards and Disasters: International perspective. Haque, C. Emdad, Springer, Dordrecht. 2005
14. Natural hazard risk assessment and Public policy. Petak, W.J. and Atkinson, A.D. Springer Verlag, NY 1982
15. Talwar A.K. and Juneja S., Cyclone Disaster Management, Commonwealth Publishers 2009
16. Dowrick D.J., Earthquake Risk Reduction, John Wiley & Sons 2003
17. Reiter, L., Earthquake Hazard Analysis: Issues and Insights, Columbia University Press
18. Agarwal P. and Shrikhande M., Earthquake Resistant Design of Structures, Prentice Hall of India 2006
19. Grey M. and Spaeth K., The Bioterrorism Sourcebook, McGraw Hill 2006
20. Yousef A. K., et.al., Biology, Pathogenicity, Epidemiology, and Biodefense, Wiley Blackwell 2007
21. Luther E. L., George Korch, Biological Weapons Defense: Infectious Diseases and Counter bioterrorism, Humana Press 2004
22. NDMA Publications on disaster management

## **CF – 509 SAFETY MANAGEMENT AND SHE LEGISLATION**

### **UNIT I CONCEPTS AND TECHNIQUES**

History of Safety movement – Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety, safety policy, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

### **UNIT II ACCIDENT INVESTIGATION AND REPORTING**

Concept of an accident, reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee – cost of accident.

### **UNIT III SAFETY PERFORMANCE MONITORING**

Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety score, safety activity rate – problems.

### **UNIT IV SAFETY EDUCATION AND TRAINING**

Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

### **UNIT VI SHE LEGISLATIONS**

#### **(A) FACTORIES ACT – 1948**

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948

#### **(B) ENVIRONMENT ACT – 1986**

General powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules, 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control

board. Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution – fund – accounts and audit, penalties and procedures.

### **(C) CHEMICAL RULES 1989**

Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets.

### **(D) OTHER ACTS AND RULES**

Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules, mines act 1952, workman compensation act, rules – electricity act and rules – hazardous wastes (management and handling) rules, 1989, with amendments in 2000- the building and other construction workers act 1996., Petroleum rules, Gas cylinderrules-Explosives Act 1983-Pesticides Act

### **(E) INTERNATIONAL ACTS AND STANDARDS**

Occupational Safety and Health act of USA (The Williames-Steiger Act of 1970) – Helath and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI).

### **REFERENCES**

1. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
2. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
3. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 1990.
4. John Ridley, "Safety at Work", Butterworth and Co., London, 1983.\
5. Dan Petersen, "Techniques of Safety Management", McGraw-Hill Company, Tokyo, 1981.
6. Relevant India Acts and Rules, Government of India.
7. Relevant Indian Standards and Specifications, BIS, New Delhi.
8. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973.
9. "Safety and Good House Keeping", N.P.C., New Delhi, 1985.
10. "Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982.
11. The Factories Act 1948
12. The Environment Act (Protection) 1986
13. Water (Prevention and control of pollution) act 1974.
14. Air (Prevention and control of pollution) act 1981.
15. The Indian boilers act 1923.
16. The Mines Act 1952.
17. The manufacture, storage and import of hazardous chemical rules 1989.

## **CF - 510 :SAFETY IN PROCESSING INDUSTRIES**

### **UNIT I SAFETY IN WELDING AND GAS CUTTING 9**

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing –explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

### **UNIT II SAFETY IN COLD FARMING AND HOT WORKING OF METALS**

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes, Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes , hazards and control measures.Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

### **UNIT III SAFETY IN FINISHING, INSPECTION AND TESTING**

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry industrial waste disposal.

### **UNITIV SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN**

Design process, conceptual design and detail design, assessment, inherently safer design-chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

### **UNIT V PLANT COMMISSIONING INSPECTION AND OPERATIONS**

Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, post commissioning documentation  
Plant inspection, pressure vessel, pressure piping system, non-destructive testing, pressure testing, leak testing and monitoring- plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission-pipe line inspection.  
Operating discipline, operating procedure and inspection, format, emergency procedures- hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel

### **UNIT VI PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING**

Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system- maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices- modification of plant, problems controls of modifications. Emergency planning, disaster planning, onsite emergency- offsite emergency.

### **REFERENCES**

1. "Accident Prevention Manual" – NSC, Chicago, 1982.
2. "Occupational safety Manual" BHEL, Trichy, 1988.
3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. "Safety in Industry" N.V. Krishnan JaicoPublishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

## **CF – 511 ACCIDENT INVESTIGATION & REPORTING: CASE STUDIES**

### **UNIT I**

Concept of an accident, reportable and non-reportable accidents, unsafe act and condition principles of accident prevention,

### **UNIT II**

Supervisory role- Role of safety committee – Accident causation models - Cost of accident.

### **UNIT III**

Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix,

### **UNIT IV**

Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports.

## **CF – 512 :ELECTIVE II**

### **(A) HUMAN FACTORS AND BEHAVIOUR BASED SAFETY**

#### **UNIT I ERGONOMICS AND ANATOMY**

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness, research directions

#### **UNIT II HUMAN BEHAVIOR**

Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes-Determination of attitudes, Changing attitudes Learning, Principles of Learning, Forgetting, Motivational requirements.

#### **UNIT III ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS**

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness. Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions

#### **UNIT IV MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK**

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine.

Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability

#### **UNIT V HUMAN SKILL AND PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS**

A general information-processing model of the users, cognitive system, problem solving, effectiveness.Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues.

#### **REFERENCES**

1. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis
2. Ergonomic design for organizational effectiveness, Michael O'Neill
3. Human factors in engineering and design, MARK S.SANDERS
4. The Ergonomics manual, Dan McLeod, Philip Jacobs and Nancy Larson

### **(B): AVIATION FIRE SAFETY**

#### **UNIT ICATEGORISATION OF AIRPORT AND HALIPAD**

1. Categorisation of Airports and level of Fire Protection. Concept of critical area & requirement of extinguishing agents. Organisation of rescue and Fire Fighting services at Airports.

2. Categorisation of Heliports and level of Fire Protection. Other Rescue & fire fighting facilities at Heliports.

### **UNIT II AIRCRAFT CONSTRUCTION, AIRCRAFT ENGINES AND FUEL HAZARDS**

1. Structural features of Aircrafts, Materials used in Aircraft construction & their hazards. Aircraft Access and Exits.

2. Types of Aircraft Engines and Hazards associated with each type.

3. Types of Aviation fuels used and their fire hazards.

### **UNIT III EMERGENCY PLANNING & PROCEDURES**

Preplanning for Emergencies, Categorization of Emergencies at Airports, Emergency organizations and procedure for responding to the emergency.

### **UNIT IV AIRCRAFT FIRE FIGHTING AND RESCUE PROCEDURE**

Aircraft Fires, Fire Fighting at Aerodromes, Positioning of appliances and methods of attack. Ground incidents and low speed accidents. Effects of water on hot brake and wheel assemblies. Foaming of Runway.

Aircraft rescue tactics and evacuation procedure. Rescue Equipment. Personal Protection Equipment.

### **UNIT V HAZARDS OF MILITARY AIRCRAFT**

Types and Construction of Military Aircrafts. Auxiliary Fuel Tanks, Auxiliary Power Plants. Fuel System, Compressed gases. Problems in dealing with Fire Accidents involving Aircrafts carrying Ammunition/Explosives. Symbols of hazardous materials carried in Aircrafts.

**Rescue from Military Aircraft** : Main entrance door, Emergency exits. Parachute and Catching Escapes panels, Canopies – Breaking through Proplex, Ejection Seats.

### **UNIT VI POST ACCIDENT MANAGEMENT**

Introduction and Significance, Removal of bodies, Movement of wreckage, Preservation of evidence etc.

### **UNIT VII FIRE PROTECTION OF AIRPORT TERMINAL BUILDINGS AND HANGARS**

1. Fire hazards associated with Airport Terminal Buildings and Fire safety Arrangements. Problems faced during fire fighting.

2. Classification of Hangars, Fire Hazards and Fire Safety arrangements.

### **UNIT VII CRASH FIRE TENDER DRILLS**

#### **(PRACTICALS)**

#### **Manning a Crash Fire Tender-**

- working with a Monitor on approach to Crashed Aircraft.
- Working twin Monitors on approach.
- Working on Monitor and two sidelines.
- Getting two sidelines to work on Crashed Aircraft.

#### **Replenishing the water tank of Air Crash Fire Tender from:**

- Water Tender
- Water Bowser
- Airport Hydrants

Fire Pumps (Supporting Appliances)

### **UNIT VIII RESCUE FROM CRASHED AIRCRAFT**



Standard Drills using different rescue techniques & equipment.

## **REFERENCES :**

1. ICAO standards
2. Hand book by NFPA
- 3.

## **(C) :EXPLOSIVE SAFETY**

### **UNIT I PROPERTIES OF EXPLOSIVE CHEMICALS**

Fire properties – potassium nitrate (KNO<sub>3</sub>), potassium chlorate (KClO<sub>3</sub>), barium nitrate (BaNO<sub>3</sub>), calcium nitrate (CaNO<sub>3</sub>), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (Al) powder- Reactions-metal powders, Borax, ammonia (NH<sub>3</sub>) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

### **UNIT II STATIC CHARGE AND DUST**

Concept-prevention-earthing-copper plates-dress materials-static charge meter lightning, Causes effects- hazards in fire works factories-lightning arrestor:concept-installation-earth pit-maintenance-resistance- legal requirements-case studies.

Dust: size-desirable, non-respirable-biological barriers-hazards-personal protective equipment, pollution prevention.

### **UNIT III PROCESS SAFETY**

Safe-quantity, mixing-filling-fuse cutting – fuse fixing – finishing – drying at various stages-packing-storage- hand tools-materials, layout: building-distances- factories act – explosive act and rules – fire prevention and control – risk related fireworks industries.

### **UNIT IV MATERIAL HANDLING**

Manual handling – wheel barrows-trucks-bullock carts-cycles-automobiles-fuse handling – paper caps handling-nitric acid handling in snake eggs manufacture-handling the mix in this factory-material movement-godown-waste pit.

### **UNIT V TRANSPORTATION:**

Packing-magazine-design of vehicles for explosive transports loading into automobiles-transport restrictions-case studies-overhead power lines-driver habits-intermediate parking-fire extinguishers, loose chemicals handling and transport.

### **UNIT VI WASTE CONTROL AND USER SAFETY**

Concepts of wastes – Wastes in fire works-Disposal-Spillages-storage of residues. Consumer anxiety hazards in display-methods in other countries-fires, burns and scalds-sales outlets-restrictions-role of fire service.

## **REFERENCES**

1. K.N.Ghosh, "Principles of fireworks", H.Khatsuria, Sivakasi, 1987.
2. "Proceedings of National seminar on Fireworks Safety-1999", MSEC-1999.
3. "Seminar on explosives", Dept.of explosives.
4. J.A.Purkiss, "Fireworks-Fire Safety Engineering"
5. Bill of once, "Fireworks Safety manual"
6. "Goeff, "Dust Explosion prevention, Part 1"
7. A.Chelladurai, "Fireworks related accidents"
8. A.Chelladurai, "Fireworks principles and practice"
9. A.Chelladurai, "History of the fireworks in India" Brock, "History of fireworks"

## **CF – 513 :PRACTICALS – FIRE SAFETY**

### **UNIT I FIRST AID FIRE EXTINGUISHER DRILL**

## **UNIT II PUMP DRILL AND HYDRANT DRILL WITH HOSES AND ALL TYPES OF BRANCHES AND FOAM MAKING EQUIPMENT**

### **UNIT III FIRE TENDER DRILL**

### **UNIT IV BA SET DRILL**

## **UNIT V INTRODUCTION AND OPERATION OF DISASTER MANAGEMENT EQUIPMENT**

## **Trimester III**

### **MS/CF – 514 :RISK AND HAZARD ASSESSMENT**

#### **UNIT I : HAZARD, RISK ISSUES AND HAZARD ASSESSMENT**

Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, Risk estimation, Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems.

#### **UNIT II : COMPUTER AIDED INSTRUMENTS**

Applications of Advanced Equipment and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyser(TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - Principles of operations, Controlling parameters, Applications, advantages, Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

#### **UNIT III : RISK ANALYSIS QUANTIFICATION AND SOFTWARES**

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index(FETI), various indices - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, HANGARS modules on Heat radiation, Pool fire, Jet, Explosion. Reliability softwares on FMEA for mechanical and electrical systems.

#### **UNIT IV :CONSEQUENCES ANALYSIS**

Logics of consequences analysis- Estimation- Hazard identification based on the properties of chemicals- Chemical inventory analysis- identification of hazardous processes- Estimation of source term, Gas or vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout.

#### **UNIT V : CREDIBILITY OF RISK ASSESSMENT TECHNIQUES**

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzindisaster(1966),Port Hudson disaster- convey report, hazard assessment of non-nuclear installation- Rijnmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report,Reactor safety study of Nuclear power plant

### **REFERENCES**

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II and III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Course Material Intensive Training Programme on Consequence Analysis, by Process Safety Centre, Indian Institute of Chemical Technology, Tarnaka and CLRI, Chennai.
4. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1988.
5. Brown, D.B. System analysis and Design for safety, Prentice Hall, 1976.
6. Hazop and Hazom, by Trevor AKlett, Institute of Chemical Engineering.
7. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
8. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AIChE 1992.

## **MS/CF – 515: QUALITY AND RELIABILITY ENGINEERING**

### **UNIT I : RELIABILITY CONCEPT**

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF), A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness.

### **UNIT II :FAILURE DATA ANALYSIS**

Time to failure distributions – Exponential, normal, Gamma, Weibull, ranking of data – probability plotting techniques – Hazard plotting.

### **UNIT III :RELIABILITY PREDICTION MODELS**

Series and parallel systems – RBD approach – Standby systems – m/n configuration – Application of Bayes' theorem – cut and tie set method – Markov analysis – Fault Tree Analysis – limitations.

### **UNIT IV : QUALITY MANAGEMENT**

Introduction to Quality-Principles and prescription-Needs, Requirements and Expectations-The Stakeholders-Defining Quality-The characteristics of Quality

### **UNIT V : AN OVERVIEW OF TOTAL QUALITY MANAGEMENT**

Evolution of Quality, Definition, TQM concepts, The Deming Philosophy, Quality Gurus, TQM Principles, TQM organisation

### **REFERENCES**

1. Srinath L.S, "Reliability Engineering", Affiliated East-West Press Pvt Ltd, New Delhi, 1998.
2. Modarres, "Reliability and Risk analysis", Maral Dekker Inc.1993.
3. John Davidson, "The Reliability of Mechanical system" published by the Institution of Mechanical Engineers, London, 1988.
4. Smith C.O. "Introduction to Reliability in Design", McGraw Hill, London, 1976.
5. A I Endres, "Implementing Juran's Road Map for Quality Leadership: Benchmarks and Results", Wiley, 2000
6. James W.Gairfield-Sonn, "Corporate Culture and the Quality organisation", Quorum Books, 2001
7. Jiju Antony, David Preece, "Understanding, Managing and Implementing Quality: Frameworks, Techniques and cases", Routledge, 2002

## **ELECTIVE III**

### **(A) : SAFETY IN HYDROCARBON INDUSTRIES**

#### **UNIT I**

Simplified flow diagrams of a typical refinery – distillation unit, catalytic cracker, reformer, treating unit (hydro forming, gas purification, Sulphur recovery, lubricating oil unit) Simplified flow diagrams of Petrochemical Industry – steam cracking, butadiene extraction, ethane recovery, butyl rubber polymerization.

#### **UNIT II**

Potential fire hazards in petroleum and petrochemical industries (ignition by local sources, spark, flame, hot surface, ignition of oil mists and fumes.). Storage tank farms of petroleum and petrochemical industries – Identification of Hazards, Type of Tanks, Design, Layout, Fire prevention measures including lightning protection. Fire protection arrangements in large tank farms, Design concepts of various fixed fire protection systems like Foam- Water Systems, Halogen & DCP systems. Lock out procedures. Salient features of codes / standards: NFPA, API, OISD and SHELL.

#### **UNIT III**

Fire protection facilities in Oil Refineries, Depots & Terminals- Transportation of petroleum and petrochemical products (safety considerations, statutory considerations). Design and Construction requirements for cross country hydrocarbon pipelines. Liquefied Petroleum Gas (LPG) Bottling Plant Operations. Design Philosophies. Operating Practices- Safety and Fire Protection in bottling plants. Internal Safety Audits in (Procedures and Checklist) Transportation of Bulk Petroleum Products. Storage and Handling of Bulk Liquefied Petroleum Gas.

#### **UNIT IV**

On- Shore and off- shore drilling. Classification of wells. Drilling method. Rotary drilling. Drilling equipment. Ground and offshore structures for drilling. Offshore platforms and drilling vessels. Drilling mud – functions, classification and properties. Blow-off, well kicks, Blow out preventer. Shallow gas. Directional drilling. Well killing procedure. Emergency shut down, Methods of Rescue & Fire Fighting.

#### **References:**

1. Frank P Lees :Loss prevention in Process Industries – Vol. I, II & III, Butter worth – Heinemann Publishing Company, UK.
2. Manual of Fireman ship – Vol. I to XIII, HMSO, London.
3. Fire Protection Hand book.
4. OISD guidelines.

### **(B) : SAFETY IN POWDER HANDLING**

#### **UNIT I :INTRODUCTION**

Powder classification-physical, chemical and other properties-metal powders-other non-metallic powders-handling methods-manual, mechanical, automatic-charges on powders-charge distribution charging of powders.

#### **UNIT II :METAL POWDERS AND CHARACTERIZATION**

Atomization, types – milling – electro deposition – spray drying, Production of iron powder, Aluminium powder, Titanium – screening and cleaning of metals – Explosivity and pyrophoricity – toxicity, Particle size and size distribution – measurement, types and significance – particle shape analysis, methods, surface area, density, porosity, flowrate – testing. Metal powders, applications as fuel, solid propellants, explosives, pyrotechnics.

#### **UNIT III :DUST EXPLOSION**

Industrial dust, dust explosion accidents – explosibility characteristics, minimum explosive concentration, minimum ignition energy, explosion pressure characteristics, maximum permissible oxygen concentration- explosibility tests, Hartmann vertical tube apparatus, horizontal tube apparatus, inflammatory apparatus, Godbert and Greenward furnace. Explosibility classification – Hybrid test – gas mixtures – Dust ignition sources – Dust explosion prevention – Dust explosion protection – Dust explosion venting, vent coefficient, various methods of design – venting of ducts and pipes – dust fire.

#### **UNIT IV:DUST HANDLING PLANTS AND ELECTRO STATIC HAZARDS**

Grinding mills, conveyors, bucket elevators, dust separators, dust filters, cyclones, driers, spray driers, silos, grain elevators, typical applications, hazards.

Electrostatic charges-energy released-type of discharge-spark-carona-insulating powders-propagating brush discharge-discharge in bulk lightning hazards in powder coating-electroplating.

#### **UNIT V :DUST EVALUATION AND CONTROL**

Evaluation, methodology, Quantitative, sampling, measurements – control approaches and strategies– control of dust sources, dust transmission – role of workers, PPE and work practice – House keeping – storage –labelling – warning sign – restricted areas - Environmental protections.Evaluation procedures and control measures for particulates (Respirable), Asbestos and other fibres, silica in coal mine - NIOSH guide to the selection and use of particulate respirators – case studies

#### **REFERENCES**

1. Martin Glor, “Electro Static Hazard in Powder Handling” Research studies Press Ltd.,UK,1988.
2. Major hazard control-ILO Geneva, 1987.
3. Seminar on “Hazard recognition and prevention in the work place-airborne dust” Vol.I and SRMC, Chennai, 4/5, Sept.2000.
4. ASM Metals hand book, Ninth edition, Vol.7, Powder Metallurgy.

### **(C) SAFETY IN MARINE SYSTEMS**

#### **DOCK SAFETY**

##### **UNIT I :HISTORY OF SAFETY LEGISLATION**

History of dock safety statues in India-background of present dock safety statues- dock workers (safety, health and welfare) act 1986 and the rules and regulations framed there under, few cases laws to interpret the terms used in the dock safety statues.

Responsibility of different agencies for safety, health and welfare involved in dock work – Responsibilities of port authorities – dock labour board – owner of ship master, agent of ship – owner of lifting appliances and loose gear etc. – employers of dock workers like stevedores – clearing and forwarding agents – competent persons and dock worker. Forums for promoting safety and health in ports – Safety Committees and Advisory Committees. Their functions, training of dock workers.

##### **UNIT II :WORKING ON BOARD THE SHIP**

Types of cargo ships – working on board ships – Safety in handling of hatch beams – hatch covers including its marking, Mechanical operated hatch covers of different types and its safety features –safety in chipping and painting operations on board ships – safe means of accesses – safety in storage etc. – illumination of decks and in holds – hazards in working inside the hold of the ship and on decks – safety precautions needed – safety in use of transport equipment - internal combustible engines like fort-lift trucks-pay loaders etc. Working with electricity and electrical management – Storage – types, hazardous cargo.

##### **UNIT III :LIFTING APPLIANCES**

Different types of lifting appliances – construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling/lifting appliances like portainers, transtainer, top lift trucks and other containers – testing and examination of lifting appliances, portainers, transtainers, top lift trucks – derricks in different rigging etc. Use and care of synthetic and natural fibre ropes – wire rope chains, different types of slings and loose gears.

**UNIT IV :TRANSPORT EQUIPMENT**

The different types of equipment for transporting containers and safety in their use-safety in the use of self-loading container vehicles, container side lifter, fork lift truck, dock railways, conveyors and cranes. Safe use of special lift trucks inside containers – Testing, examination and inspection of containers – carriage of dangerous goods in containers and maintenance and certification of containers for safe operation

Handling of different types of cargo – loading and unloading of cargo identification of berths/walking for transfer operation of specific chemical from ship to shore and vice versa – restriction of loading and unloading operations.

**UNIT V :EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW) REGULATIONS**

Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc., - gas leakages and precautions concerning spillage of dangerous goods etc., - Preparation of onsite emergency plan and safety report.

Dock workers (SHW) rules and regulations 1990-related to lifting appliances, Container handling, loading and unloading, handling of hatch coverings and beams, Cargo handling, conveyors, dock railways, forklift.

**REFERENCES**

1. Safety and Health in Dock work, IInd Edition, ILO, 1992.
2. "Dock Safety" Thane Belapur Industries Association, Mumbai.
3. Taylor D.A., "Introduction to Marine Engineering".
4. Srinivasan "Harbour, Dock and Tunnel Engineering"
5. Bindra SR "Course in Dock and Harbour Engineering"

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