UNIT – V

GLOBAL ISSUES

Syllabus: Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

MULTINATIONAL CORPORATIONS

A multinational corporation (MNC), also called a transnational corporation (TNC), or multinational enterprise (MNE), is a corporation or an enterprise that manages production or delivers services in more than one country. It can also be referred to as an international corporation. The International Labour Organization (ILO) has defined[citation needed] an MNC as a corporation that has its management headquarters in one country, known as the home country, and operates in several other countries, known as host countries.

The Dutch East India Company was the first multinational corporation in the world and the first company to issue stock. It was also arguably the world's first megacorporation, possessing quasi-governmental powers, including the ability to wage war, negotiate treaties, coin money, and establish colonies.

The first modern multinational corporation is generally thought to be the East India Company. Many corporations have offices, branches or manufacturing plants in different countries from where their original and main headquarters is located.

Some multinational corporations are very big, with budgets that exceed some nations' GDPs. Multinational corporations can have a powerful influence in local economies, and even the world economy, and play an important role in international relations and globalization

Multinational corporations have played an important role in globalization. Countries and sometimes subnational regions must compete against one another for the establishment of

MNC facilities, and the subsequent tax revenue, employment, and economic activity. To compete, countries and regional political districts sometimes offer incentives to MNCs such as tax breaks, pledges of governmental assistance or improved infrastructure, or lax environmental and labor standards enforcement. This process of becoming more attractive to foreign investment can be characterized as a race to the bottom, a push towards greater autonomy for corporate bodies, or both.

However, some scholars for instance the Columbia economist Jagdish Bhagwati, have argued that multinationals are engaged in a 'race to the top.' While multinationals certainly regard a low tax burden or low labor costs as an element of comparative advantage, there is no evidence to suggest that MNCs deliberately avail themselves of lax environmental regulation or poor labour standards. As Bhagwati has pointed out, MNC profits are tied to operational efficiency, which includes a high degree of standardisation. Thus, MNCs are likely to tailor production processes in all of their operations in conformity to those jurisdictions where they operate (which will almost always include one or more of the US, Japan or EU) that has the most rigorous standards. As for labor costs, while MNCs clearly pay workers in, e.g. Vietnam, much less than they would in the US (though it is worth noting that higher American productivity—linked to technology—means that any comparison is tricky, since in America the same company would probably hire far fewer people and automate whatever process they performed in Vietnam with manual labour), it is also the case that they tend to pay a premium of between 10% and 100% on local labor rates.[10] Finally, depending on the nature of the MNC, investment in any country reflects a desire for a long-term return. Costs associated with establishing plant, training workers, etc., can be very high; once established in a jurisdiction, therefore, many MNCs are quite vulnerable to predatory practices such as, e.g., expropriation, sudden contract renegotiation, the arbitrary withdrawal or compulsory purchase of unnecessary 'licenses,' etc. Thus, both the negotiating power of MNCs and the supposed 'race to the bottom' may be overstated, while the substantial benefits that MNCs bring (tax revenues aside) are often understated

Market withdrawal

Because of their size, multinationals can have a significant impact on government policy, primarily through the threat of market withdrawal. For example, in an effort to reduce health care costs, some countries have tried to force pharmaceutical companies to license their patented drugs to local competitors for a very low fee, thereby artificially lowering the price. When faced with that threat, multinational pharmaceutical firms have simply withdrawn from the market, which often leads to limited availability of advanced drugs. In these cases, governments have been forced to back down from their efforts. Similar corporate and government confrontations have occurred when governments tried to force MNCs to make their intellectual property public in an effort to gain technology for local entrepreneurs. When companies are faced with the option of losing a core competitive technological advantage or withdrawing from a national market, they may choose the latter. This withdrawal often causes governments to change policy. Countries that have been the most successful in this type of confrontation with multinational corporations are large countries such as United States and Brazil[citation needed], which have viable indigenous market competitors.

Lobbying

Multinational corporate lobbying is directed at a range of business concerns, from tariff structures to environmental regulations. There is no unified multinational perspective on any of these issues. Companies that have invested heavily in pollution control mechanisms may lobby for very tough environmental standards in an effort to force non-compliant competitors into a weaker position. Corporations lobby tariffs to restrict competition of foreign industries. For every tariff category that one multinational wants to have reduced, there is another multinational that wants the tariff raised. Even within the U.S. auto industry, the fraction of a company's imported components will vary, so some firms favor tighter import restrictions, while others favor looser ones. Says Ely Oliveira, Manager Director of the MCT/IR: This is very serious and is very hard and takes a lot of work for the owner.pk

Multinational corporations such as Wal-mart and McDonald's benefit from government zoning laws, to create barriers to entry.

Many industries such as General Electric and Boeing lobby the government to receive subsidies to preserve their monopoly.

Patents

Many multinational corporations hold patents to prevent competitors from arising. For example, Adidas holds patents on shoe designs, Siemens A.G. holds many patents on equipment and infrastructure and Microsoft benefits from software patents. The pharmaceutical companies lobby international agreements to enforce patent laws on others.

Government power

In addition to efforts by multinational corporations to affect governments, there is much government action intended to affect corporate behavior. The threat of nationalization (forcing a company to sell its local assets to the government or to other local nationals) or changes in local business laws and regulations can limit a multinational's power. These issues become of increasing importance because of the emergence of MNCs in developing countries.

Micro-multinationals

Enabled by Internet based communication tools, a new breed of multinational companies is growing in numbers.(Copeland, Michael V. (2006-06-29). "How startups go global". CNN. http://money.cnn.com/2006/06/28/magazines/business2/startupsgoglobal.biz2/index.htm. Retrieved 2010-05-13.) These multinationals start operating in different countries from the very early stages. These companies are being called micro-multinationals. (Varian, Hal R. (2005-08-25). "Technology Levels the Business Playing Field". The New York Times. http://www.nytimes.com/2005/08/25/business/25scene.html. Retrieved 2010-05-13.) What differentiates micro-multinationals from the large MNCs is the fact that they are small businesses. Some of these micro-multinationals, particularly software development companies, have been hiring employees in multiple countries from the beginning of the Internet era. But more and more micro-multinationals are actively starting to market their products and services in various countries. Internet tools like Google, Yahoo, MSN, Ebay and Amazon make it easier for the micro-multinationals to reach potential customers in other countries.

Service sector micro-multinationals, like Facebook, Alibaba etc. started as dispersed virtual businesses with employees, clients and resources located in various countries. Their rapid growth is a direct result of being able to use the internet, cheaper telephony and lower traveling costs to create unique business opportunities.

Low cost SaaS (Software As A Service) suites make it easier for these companies to operate without a physical office.

Hal Varian, Chief Economist at Google and a professor of information economics at U.C. Berkeley, said in April 2010, "Immigration today, thanks to the Web, means something very different than it used to mean. There's no longer a brain drain but brain circulation. People now doing startups understand what opportunities are available to them around the world and work to harness it from a distance rather than move people from one place to another."

ENVIRONMENTAL ETHICS

Environmental ethics believes in the ethical relationship between human beings and the natural environment. Human beings are a part of the society and so are the other living beings. When we talk about the philosophical principle that guides our life, we often ignore the fact that even plants and animals are a part of our lives. They are an integral part of the environment and hence have a right to be considered a part of the human life. On these lines, it is clear that they should also be associated with our guiding principles as well as our moral and ethical values.

What is Environmental Ethics?

We are cutting down forests for making our homes. We are continuing with an excessive consumption of natural resources. Their excessive use is resulting in their depletion, risking the life of our future generations. Is this ethical? This is the issue that environmental ethics takes up. Scientists like Rachel Carson and the environmentalists who led philosophers to consider the philosophical aspect of environmental problems, pioneered in the development of environmental ethics as a branch of environmental philosophy.

The Earth Day celebration of 1970 was also one of the factors, which led to the development of environmental ethics as a separate field of study. This field received impetus when it was first discussed in the academic journals in North America and Canada. Around the same time, this field also emerged in Australia and Norway. Today, environmental ethics is one of the major concerns of mankind.

When industrial processes lead to destruction of resources, is it not the industry's responsibility to restore the depleted resources? Moreover, can a restored environment make up for the originally natural one? Mining processes hamper the ecology of certain areas; they may result in the disruption of plant and animal life in those areas. Slash and burn techniques are used for clearing the land for agriculture.

Most of the human activities lead to environmental pollution. The overly increasing human population is increasing the human demand for resources like food and shelter. As the population is exceeding the carrying capacity of our planet, natural environments are being used for human inhabitation.

Thus human beings are disturbing the balance in the nature. The harm we, as human beings, are causing to the nature, is coming back to us b resulting in a polluted environment. The depletion of natural resources is endangering our future generations. The imbalance in nature that we have caused is going to disrupt our life as well. But environmental ethics brings about the fact that all the life forms on Earth have a right to live. By destroying the nature, we are depriving these life forms of their right to live. We are going against the true ethical and moral values by disturbing the balance in nature. We are being unethical in treating the plant and animal life forms, which coexist in society.

Human beings have certain duties towards their fellow beings. On similar lines, we have a set of duties towards our environment. Environmental ethics says that we should base our behavior on a set of ethical values that guide our approach towards the other living beings in nature.

Environmental ethics is about including the rights of non-human animals in our ethical and moral values. Even if the human race is considered the primary concern of society, animals and plants are in no way less important. They have a right to get their fair share of existence.

We, the human beings, along with the other forms of life make up our society. We all are a part of the food chain and thus closely associated with each other. We, together form our environment. The conservation of natural resources is not only the need of the day but also our prime duty.

COMPUTER ETHICS

Ethics is a set of moral principles that govern the behavior of a group or individual. Therefore, computer ethics is set of moral principles that regulate the use of computers. Some common issues of computer ethics include intellectual property rights (such as copyrighted electronic content), privacy concerns, and how computers affect society. For example, while it is easy to duplicate copyrighted electronic (or digital) content, computer ethics would suggest that it is wrong to do so without the author's approval. And while it may be possible to access someone's personal information on a computer system, computer ethics would advise that such an action is unethical.

As technology advances, computers continue to have a greater impact on society. Therefore, computer ethics promotes the discussion of how much influence computers should have in areas such as artificial intelligence and human communication. As the world of computers evolves, computer ethics continues to create ethical standards that address new issues raised by new technologies.

WEAPONS DEVELOPMENT

A weapon is an instrument used for the purpose of causing harm or damage to people, animals or structures. Weapons are used in hunting, attack, self-defense, or defense in combat and range from simple implements like clubs and spears to complicated modern machines such as intercontinental ballistic missiles. One who possesses or carries a weapon is said to be armed.

In a broader context weapons include anything used to gain an advantage over an adversary or to place them at a disadvantage. Examples include the use of sieges, tactics, and psychological weapons which reduce the morale of an enemy

Classification

By user

- *what person or unit uses the weapon*

- Personal weapons (or small arms) - designed to be used by a single person.
- Hunting weapon - primarily for hunting game animals for food or sport
- Infantry support weapons - larger than personal weapons, requiring two or more to operate correctly.
- Fortification weapons - mounted in a permanent installation, or used primarily within a fortification.
- Mountain weapons - for use by mountain forces or those operating in difficult terrain.
- Vehicle weapons - to be mounted on any type of military vehicle.
- Railway weapons - designed to be mounted on railway cars, including armored trains.
- Aircraft weapons - carried on and used by some type of aircraft, helicopter, or other aerial vehicle.
- Naval weapons - mounted on ships and submarines.
- Space weapons - are designed to be used in or launched from space.

By function

- *the construction of the weapon and principle of operation*

- Antimatter weapons (theoretical) would combine matter and antimatter to cause a powerful explosion.
- Archery weapons operate by using a tensioned string to launch a projectile.
- Artillery are capable of launching heavy projectiles over long distances.
- Biological weapons spread biological agents, causing disease or infection.
- Chemical weapons, poisoning and causing reactions.
- Energy weapons rely on concentrating forms of energy to attack, such as lasers or sonic attack.
- Explosive weapons use a physical explosion to create blast concussion or spread shrapnel.
- Firearms use a chemical charge to launch projectiles.
- Improvised weapons are common objects, reused as weapons.
- Incendiary weapons cause damage by fire.
- Non-lethal weapons are designed to subdue without killing.
- Magnetic weapons use magnetic fields to propel projectiles, or to focus particle beams.

- Melee weapons operate as physical extensions of the user's body and directly impact their target.
- Missiles are rockets which are guided to their target after launch. (Also a general term for projectile weapons).
- Nuclear weapons use radioactive materials to create nuclear fission and/or nuclear fusion detonations.
- Primitive weapons make little or no use of technological or industrial elements.
- Ranged weapons (unlike Mêlée weapons), target a distant object or person.
- Rockets use chemical propellant to accelerate a projectile
- Suicide weapons exploit the willingness of their operator to not survive the attack.
- Trojan weapons appear on face value to be gifts, though the intent is to in some way to harm the recipient.

By target

- the type of target the weapon is designed to attack

- Anti-aircraft weapons target missiles and aerial vehicles in flight.
- Anti-fortification weapons are designed to target enemy installations.
- Anti-personnel weapons are designed to attack people, either individually or in numbers.
- Anti-radiation weapons target sources of electronic radiation, particularly radar emitters.
- Anti-satellite weapons target orbiting satellites.
- Anti-ship weapons target ships and vessels on water.
- Anti-submarine weapons target submarines and other underwater targets.
- Anti-tank weapons are designed to defeat armored targets.
- Area denial weapons target territory, making it unsafe or unsuitable for enemy use or travel.
- Hunting weapons are civilian weapons used to hunt animals.
- Infantry support weapons are designed to attack various threats to infantry units

Consultants are individuals who typically work for themselves but may also be associated with a consulting firm. They, for a fee, gives advice or provides a service in a field of specialized knowledge or training. Most consultants carry their own life and health insurance, pay their own taxes, most have their own tools and equipment. The consultant can work alone or with the client's staff.

Consultants can play a multi-faceted role. They can, for example function as advisors, fixers, bosses, generalists, stabilizers, listeners, advisors, specialists, catalysts, managers or quasi-employees. The actual work that consultants perform for one company to another may vary greatly, i.e. tax account to office decoration. However, the typical underlying reasons that a consultant is hired are universal. A problem exists and the owner or manager of the company has decided to seek the help of an expert.

Bringing in an expert can save time, effort and money. It has been estimated that approximately 3/4 of all companies call upon consultants at one time or another. Many companies claim that they receive a higher return for their invested dollars by using consultants for specific tasks.

Most companies have experienced the problem of needing short-term technical expertise. Perhaps the company's existing staff is already working to capacity. In many cases, the engineering skills required for a project can be satisfied with a full time employee. When they can not fully justify bringing someone on board full time, their answer is to hire a consultant. By doing so, the businessman solves his immediate problem without permanently increasing his payroll and payroll taxes.

Consultants can be hired when the company may not have anyone on staff capable of solving the specific problem. At such times, a costly learning curve on the part of the engineering staff is associated with the project. One example is using a consultant as a viable alternative during the development stages of new products. Hiring a consultant with experience in a given area can then cut days, weeks or even months off a project schedule. In addition, he can help the staff avoid mistakes they may otherwise make. When the project reaches a certain point, the permanent staff can then take over.

Consultants can deal directly with owners and upper management. In this role, consultants can provide an objective third-party view point. Critical objectives can then be identified and advise given in confidence.

Consultants are a viable alternative in assisting in feasibility studies or in proposal preparation.

Perhaps the manager cannot justify shifting the duties of existing staff members.

Another time that consultants become useful is when a company is just starting a business. The development of the company's new product can be begun by the consultant while a full time permanent technical staff member is being hired.

Finding the right consultant can be difficult. Managers can rely on referrals from their friends or hire the consultant who happens to call at the right time. Once the decisions is made to hire a consultant, the need is immediate and one may not have the time to shop for a consultant. As a part of planning ahead, it is wise to meet various consultants on an informal basis before the need to hire one arises. Then when the time comes, you will know exactly who to call for you have already established an informal relationship

ETHICS IN ASCE

To preserve the high ethical standards of the civil engineering profession, the Society's ethics program includes:

- Edict
  The Society maintains a Code of Ethics.
- Enforcement
  The Society enforces the Code by investigating potential violations of the Code and taking disciplinary action if warranted.
- Education
  The Society endeavors to educate its members and the public on ethics issues.

IEEE code of Ethics

1. to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to be honest and realistic in stating claims or estimates based on available data;
4. to reject bribery in all its forms;

5. to improve the understanding of technology, its appropriate application, and potential consequences;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
9. to avoid injuring others, their property, reputation, or employment by false or malicious action;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics

Ethics in Indian Institute of Materials and Management

- To consider first, the TOTAL interest to one's organization in all transactions without impairing the dignity and responsibility to one's office;
- To buy without prejudice, seeking to obtain the maximum ultimate value for each Rupee of Expenditure;
- To subscribe and work for honesty and truth in buying and selling, to denounce all forms and manifestations of commercial bribery and to eschew anti-social practices;
- To accord a prompt and courteous reception so far as conditions will permit, to all who call upon a legitimate business mission;

To respect one's obligations and those of one's organization, consistent with good business practice

Ethics in Institute of Engineers

1.1 Engineers serve all members of the community in enhancing their welfare, health and safety by a creative process utilising the engineers' knowledge, expertise and experience.

1.2 Pursuant to the avowed objectives of The Institution of Engineers (India) as enshrined in the presents of the Royal Charter granted to the Institution, the Council of the Institution prescribed a set of "Professional Conduct Rules" in the year 1944 replacing the same with the "Code of Ethics for Corporate Members" in the year 1954 which was revised in the year 1997.

1.3 In view of globalisation, concern for the environment and the concept of sustainable development, it has been felt that the prevailing "Code of Ethics for Corporate Members" needs review and revision in letter and spirit. The engineering organisations world over have updated their Code of Ethics.

1.4 The Council of the Institution vested with the authority in terms of the Present 2(j) of the Royal Charter adopted at its 626th meeting held on 21.12.2003 at Lucknow the "Code of Ethics for Corporate Members" as provided hereinafter.

1.5 The Code of Ethics is based on broad principles of truth, honesty, justice, trustworthiness, respect and safeguard of human life and welfare, competence and accountability which constitute the moral values every Corporate Member of the Institution must recognize, uphold and abide by.

1.6 This "Code of Ethics for Corporate Members" shall be in force till the same is revised by a decision of the Council of the Institution.

CODE OF ETHICS FOR Institute of Engineers

1.0 Preamble

1.1 The Corporate Members of The Institution of Engineers (India) are committed to promote and practice the profession of engineering for the common good of the community bearing in mind the following concerns :

1.1.1 Concern for ethical standard;

1.1.2 Concern for social justice, social order and human rights;

1.1.3 Concern for protection of the environment;

1.1.4 Concern for sustainable development;

1.1.5 Public safety and tranquility.

2.0 The Tenets of the Code of Ethics

2.1 A Corporate Member shall utilise his knowledge and expertise for the welfare, health and safety of the community without any discrimination for sectional or private interests.

2.2 A Corporate Member shall maintain the honour, integrity and dignity in all his professional actions to be worthy of the trust of the community and the profession.

2.3 A Corporate Member shall act only in the domains of his competence and with diligence, care, sincerity and honesty.

2.4 A Corporate Member shall apply his knowledge and expertise in the interest of his employer or the clients for whom he shall work without compromising with other obligations to these Tenets.

2.5 A Corporate Member shall not falsify or misrepresent his own or his associates' qualifications, experience, etc.

2.6 A Corporate Member, wherever necessary and relevant, shall take all reasonable steps to inform himself, his employer or clients, of the environmental, economic, social and other possible consequences, which may arise out of his actions.

2.7 A Corporate Member shall maintain utmost honesty and fairness in making statements or giving witness and shall do so on the basis of adequate knowledge.

2.8 A Corporate Member shall not directly or indirectly injure the professional reputation of another member.

2.9 A Corporate Member shall reject any kind of offer that may involve unfair practice or may cause avoidable damage to the ecosystem.

2.10 A Corporate Member shall be concerned about and shall act in the best of his abilities for maintenance of sustainability of the process of development.

2.11 A Corporate Member shall not act in any manner which may injure the reputation of the Institution or which may cause any damage to the Institution financially or otherwise.

3.0 General Guidance

The Tenets of the Code of Ethics are based on the recognition that –

3.1 A common tie exists among the humanity and that The Institution of Engineers (India) derives its value from the people, so that the actions of its Corporate Members should indicate the member's highest regard for equality of opportunity, social justice and fairness;

3.2 The Corporate Members of the Institution hold a privileged position in the community so as to make it a necessity for their not using the position for personal and sectional interests.

4.0 And, as such, a Corporate Member –

4.1 should keep his employer or client fully informed on all matters in respect of his assignment which are likely to lead to a conflict of interest or when, in his judgement, a project will not be viable on the basis of commercial, technical, environmental or any other risks;

4.2 should maintain confidentiality of any information with utmost sincerity unless expressly permitted to disclose such information or unless such permission, if withheld, may adversely affect the welfare, health and safety of the community;

4.3 should neither solicit nor accept financial or other considerations from anyone related to a project or assignment of which he is in the charge;

4.4 should neither pay nor offer direct or indirect inducements to secure work;

4.5 should compete on the basis of merit alone;

4.6 should refrain from inducing a client to breach a contract entered into with another duly appointed engineer;

4.7 should, if asked by the employer or a client, to review the work of another person or organisation, discuss the review with the other person or organisation to arrive at a balanced opinion;

4.8 should make statements or give evidence before a tribunal or a court of law in an objective and accurate manner and express any opinion on the basis of adequate knowledge and competence; and

4.9 should reveal the existence of any interest – pecuniary or otherwise – which may affect the judgement while giving an evidence or making a statement.

5.0 Any decision of the Council as per provisions of the relevant Bye-Laws of the Institution shall be final and binding on all Corporate Members

ASME Code of Ethics of Engineers

ASME requires ethical practice by each of its members and has adopted the following Code of Ethics of Engineers as referenced in the ASME Constitution, Article C2.1.1.

CODE OF ETHICS OF ENGINEERS

The Fundamental Principles

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

I. Using their knowledge and skill for the enhancement of human welfare;
II. Being honest and impartial, and serving with fidelity the public, their employers and clients; and
III. Striving to increase the competence and prestige of the engineering profession.

The Fundamental Canons

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in the areas of their competence.

3. Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall associate only with reputable persons or organizations.
7. Engineers shall issue public statements only in an objective and truthful manner.
8. Engineers shall consider environmental impact in the performance of their professional duties.

The ASME criteria for interpretation of the Canons are guidelines and represent the objectives toward which members of the engineering profession should strive. They are principles which an engineer can reference in specific situations. In addition, they provide interpretive guidance to the ASME Board on Professional Practice and Ethics on the Code of Ethics of Engineers.

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.

   a. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices.

   b. Engineers shall not approve or seal plans and/or specifications that are not of a design safe to the public health and welfare and in conformity with accepted engineering standards.

   c. Whenever the Engineers' professional judgments are over ruled under circumstances where the safety, health, and welfare of the public are endangered, the Engineers shall inform their clients and/or employers of the possible consequences.

(1) Engineers shall endeavor to provide data such as published standards, test codes, and quality control procedures that will enable the users to understand safe use during life expectancy associated with the designs, products, or systems for which they are responsible.

(2) Engineers shall conduct reviews of the safety and reliability of the designs, products, or systems for which they are responsible before giving their approval to the plans for the design.

(3) Whenever Engineers observe conditions, directly related to their employment, which they believe will endanger public safety or health, they shall inform the proper authority of the situation.

d. If engineers have knowledge of or reason to believe that another person or firm may be in violation of any of the provisions of these Canons, they shall present such information to the proper authority in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required.

2. Engineers shall perform services only in areas of their competence.

a. Engineers shall undertake to perform engineering assignments only when qualified by education and/or experience in the specific technical field of engineering involved.

b. Engineers may accept an assignment requiring education and/or experience outside of their own fields of competence, but their services shall be restricted to other phases of the project in which they are qualified. All other phases of such project shall be performed by qualified associates, consultants, or employees.

3. Engineers shall continue their professional development throughout their careers, and should provide opportunities for the professional and ethical development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.

a. Engineers shall avoid all known conflicts of interest with their employers or clients and shall promptly inform their employers or clients of any business association, interests, or circumstances which could influence their judgment or the quality of their services.

b. Engineers shall not undertake any assignments which would knowingly create a potential conflict of interest between themselves and their clients or their employers.

c. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed to, and agreed to, by all interested parties.

d. Engineers shall not solicit or accept financial or other valuable considerations, for specifying products or material or equipment suppliers, without disclosure to their clients or employers.

e. Engineers shall not solicit or accept gratuities, directly or indirectly, from contractors, their agents, or other parties dealing with their clients or employers in connection with work for which they are responsible. Where official public policy or employers' policies tolerate acceptance of modest gratuities or gifts, engineers shall avoid a conflict of interest by complying with appropriate policies and shall avoid the appearance of a conflict of interest.

f. When in public service as members, advisors, or employees of a governmental body or department, Engineers shall not participate in considerations or actions with respect to services provided by them or their organization(s) in private or product engineering practice.

g. Engineers shall not solicit an engineering contract from a governmental body or other entity on which a principal, officer, or employee of their organization serves as a member without disclosing their relationship and removing themselves from any activity of the body which concerns their organization.

h. Engineers working on codes, standards or governmental sanctioned rules and specifications shall exercise careful judgment in their determinations to ensure a balanced viewpoint, and avoid a conflict of interest.

i. When, as a result of their studies, Engineers believe a project(s) will not be successful, they shall so advise their employer or client.

j. Engineers shall treat information coming to them in the course of their assignments as confidential, and shall not use such information as a means of making personal profit if such action is adverse to the interests of their clients, their employers or the public.

(1) They will not disclose confidential information concerning the business affairs or technical processes of any present or former employer or client or bidder under evaluation, without his consent, unless required by law or court order.

(2) They shall not reveal confidential information or finding of any commission or board of which they are members unless required by law or court order

(3) Designs supplied to Engineers by clients shall not be duplicated by the Engineers for others without the express permission of the client(s).

k. Engineers shall act with fairness and justice to all parties when administering a construction (or other) contract.

l. Before undertaking work for others in which Engineers may make improvements, plans, designs, inventions, or other records which may justify seeking copyrights, patents, or proprietary rights, Engineers shall enter into positive agreements regarding the rights of respective parties.

m. Engineers shall admit their own errors when proven wrong and refrain from distorting or altering the facts to justify their mistakes or decisions.

n. Engineers shall not accept professional employment or assignments outside of their regular work without the knowledge of their employers.

o. Engineers shall not attempt to attract an employee from other employers or from the market place by false or misleading representations.

5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.

a. Engineers shall negotiate contracts for professional services on the basis of demonstrated competence and qualifications for the type of professional service required.

b. Engineers shall not request, propose, or accept professional commissions on a contingent basis if, under the circumstances, their professional judgments may be compromised.

c. Engineers shall not falsify or permit misrepresentation of their, or their associates, academic or professional qualification. They shall not misrepresent or exaggerate their degrees of responsibility in or for the subject matter of prior assignments. Brochures or other presentations used to solicit personal employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers, or their accomplishments.

d. Engineers shall prepare articles for the lay or technical press which are only factual. Technical Communications for publication (theses, articles, papers, reports,etc.) which are based on research involving more than one individual (including students and supervising faculty, industrial supervisor/researcher or other co-workers) must recognize all significant contributors. Plagiarism, the act of substantially using another's ideas or written materials without due credit, is unethical. (See Appendix.)

e. Engineers shall not maliciously or falsely, directly or indirectly, injure the professional reputation, prospects, practice or employment of another engineer, nor shall they indiscriminately criticize another's work.

f. Engineers shall not use equipment, supplies, laboratory or office facilities of their employers to carry on outside private practice without consent.

6. Engineers shall associate only with reputable persons or organizations.

a. Engineers shall not knowingly associate with or permit the use of their names or firm names in business ventures by any person or firm which they know, or have reason to believe, are engaging in business or professional practices of a fraudulent or dishonest nature.

b. Engineers shall not use association with non-engineers, corporations, or partnerships to disguise unethical acts.

7. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering.

b. Engineers shall be completely objective and truthful in all professional reports, statements or testimony. They shall include all relevant and pertinent information in such reports, statements or testimony.

c. Engineers, when serving as expert or technical witnesses before any court, commission, or other tribunal, shall express an engineering opinion only when it is founded on their adequate knowledge of the facts in issue, their background of technical competence in the subject matter, and their belief in the accuracy and propriety of their testimony.

d. Engineers shall issue no statements, criticisms, or arguments on engineering matters which are inspired or paid for by an interested party, or parties, unless they preface their comments by identifying themselves, by disclosing the identities of the party or parties on whose behalf they are speaking, and by revealing the existence of any financial interest they may have in matters under discussion.

e. Engineers shall be truthful in explaining their work and merit, and shall avoid any act tending to promote their own interest at the expense of the integrity and honor of the profession or another individual.

8. Engineers shall consider environmental impact in the performance of their professional duties.

a. Engineers shall concern themselves with the impact of their plans and designs on the environment. When the impact is a clear threat to health or safety of the public, then the guidelines for this Canon revert to those of Canon 1.

9. Engineers accepting membership in The American Society of Mechanical Engineers by this action agree to abide by this Society Policy on Ethics and procedures for its implementation.

Moral Leadership

Moral Leadership brings together in one comprehensive volume essays from leading scholars in law, leadership, psychology, political science, and ethics to provide practical, theoretical policy guidance. The authors explore key questions about moral leadership such as:

- How do leaders form, sustain, and transmit moral commitments?
- Under what conditions are those processes most effective?
- What is the impact of ethics officers, codes, training programs, and similar initiatives?
- How do standards and practices vary across context and culture?
- What can we do at the individual, organizational, and societal level to foster moral leadership?

ENGINEERS AS EXPERT WITNESS AND ADVISORS

Engineering expert witnesses are highly credentialed mechanical, safety & civil, geotechnical, chemical and electrical engineers specializing in the areas of design, construction & structural engineering, failure analysis, human factors, occupational safety, metallurgy and more. They provide litigation support through review and evaluation of distressed structures for land slide and erosion cases; performance of forensic studies on hydraulics, power plants, pipelines, boiler systems, traffic, automotive, electrical fire involving electrical systems of machinery; site research and inspection, laboratory testings, report writing, depositions and court testimony.

Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering.

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Chapter 5

LAW OF CONTRACTS AND CONSUMER PROTECTION

Learning Objectives:

After reading through this chapter, the reader will be able to:

- Define the term contract
- State the difference between agreement and contract
- Discuss the essential elements of a contract
- Discuss the procedure for forming a contract
- Define the term free consent and coercion
- State the objectives of consumer protection law
- Detail out the structure for implementing the consumer protection law in the 1986 Act
- Discuss the changes made in the consumer protection act 2019
- Define the term tort giving two examples
- Explain the concept of law of torts and state how it differs from other laws
- Explain the meaning of *damnum sine injuria* and *injuria sine damnum*

5.1 INTRODUCTION

This chapter deals with some important aspects of laws of interest. The idea is not to present the laws from a legal or lawyers' point of view but to understand some of the features of these laws. Law of contracts is a law coming from the British era (in 1872). As times changed, two sections of this law have been removed from this and made into separate laws. Law of Torts is an uncodified law and depends on case laws and judgments for hearing and deciding the cases. Another important aspect of interest is consumer protection. The Consumer Protection Act 1986 has been specially enacted to protect the interests of the consumers of both Goods and Services. This Act has now been replaced by the Consumer Protection Act 2019 with some modification in the earlier act considering the new ways of buying goods and marketing like E-commerce, teleshopping and multi-level marketing.

5.2 INDIAN CONTRACT LAW 1872

The Indian Contract Law 1872 is a British Law made applicable to the Indian State in 1872. The law as made applicable at that time had 266 sections. Over a period of time, in addition to amendments as required by demand of situations, some sections were removed from the Act. The sections originally included are:

1 to 75 — General provisions

76 to 123 — Sales of Goods

124 to 147 — Indemnity/Guarantee

148 to 181 — Bailment and Pledge

182 to 238 — Agency

239 to 266 — Partnerships

Two of these categories, 76 to 123 (Sale of goods) and 239 to 266 (Partnerships) were removed from the Contract Law and have been made into separate laws.

Agreement and Contract: All contracts are agreements but all agreements are not contracts. An agreement enforceable by law is a contract. Enforceable by law means legal remedy is available in case of any breach of contract to the aggrieved party.

Essential elements: Some essential elements of a valid contract are:

- At least two (or more parties) must participate in the contract (One makes an offer and the other(s) accept it)
- Offer made is accepted by the other party
- Acceptance is by free consent (and not by force or any form of coercion)
- Both parties agree to have a legal relationship
- Agreement must be on potentially possible actions
- Capacity or eligibility for entering into contract (not a minor or of unsound mind etc.)
- Objective of contract must be lawful
- Both the parties understand the contract in the same way
- Contract cannot be on illegal activities
- Legal formalities, as required, are completed like written and signed agreements, registration, payment of dues, witnesses etc.)

Proposal and Acceptance:

(*a*) When one person signifies to another his willingness to do or to abstain from doing anything, with a view to obtaining the assent of that other to such act or abstinence, he is said to make a proposal;

(*b*) When the person to whom the proposal is made signifies his assent thereto, the proposal is said to be accepted. A proposal, when accepted, becomes a promise;

The consideration or object of an agreement is lawful, unless—

- it is forbidden by law; or
- is of such a nature that if permitted, it would defeat the provisions of any law; or
- is fraudulent; or
- involves or implies injury to the person or property of another; or
- the Court regards it as immoral or opposed to public policy.

5.3 FORMATION OF CONTRACTS

Sections 2 to 6 of the act deal with this aspect:

a) Making a proposal: to do or not to do something. Person to whom the proposal is made signifies his assent, the proposal is accepted; Person making the proposal is the ‘promisor’ and person accepting it is the ‘promisee’. When the promisee acts according to the desire of the promisor, it is ‘consideration for the promise’. Every promise in consideration of each other is an agreement. Agreements not enforceable by law is said to be void. Legally enforceable agreements are contracts.

b) Formation of contract involves communicating the proposal and acceptance of the proposal.

c) A proposal can be revoked by communication to the other party or if the acceptance is not made in time as specified or by nonfulfillment of conditions by any of the parties.

5.4 ESSENTIALS OF CONTRACTS

Sections 10 to 23 deal with this aspect of contracts.

a) All agreements are contracts if the if they are made with the free consent of the parties competent to contract, object of contract is lawful, for a lawful consideration and are not declared void. All legal requirements like contract in writing, registration of documents and signature of witnesses need to be complied with.

b) Competent to contract means the person(s) of legal maturity, of sound mind and is not disqualified by any law.

c) Sound mind means the person capable of understanding the contract and is able to form rational judgments about its effect on his interests.

d) Consent by two or more persons means that they agree upon some thing with the same understanding on all its aspects.

e) Free consent happens when it is free of any coercion, undue influence, fraud, misrepresentation or mistake.

f) Coercion is committing any unlawful act forbidden by Indian penal laws.

g) Undue influence (in entering into a contract) happens when one of the parties hold such powers as to dominate the decision of the other by apparent authority or the other party is of weal disposition.

h) Fraud means making a suggestion that something is true when it is not, concealing facts, making promises with no intention of doing it or by doing anything fraudulent.

i) Misrepresentation means positively asserting something as true when it is not, breach of duty to gain some advantage and causing someone to make a mistake.

j) An agreement arrived at by coercion is voidable; same is the case for fraud and misrepresentation.

k) The agreement is also voidable if both the parties make mistake in understanding substance of the agreement.

l) Lawful object of any agreement means that the object is not specifically forbidden in law. (Example: agreement to supply prohibited drugs or make forbidden weapons)

5.5 SAFETY IN PRODUCTS

It is important to recognize that there is much greater awareness about safety today than earlier. Engineered products can cause harm to individuals (such as shock from an electrical appliance), harm to a community (such as the breaching of a dam), economic loss (due to fi re in an automobile), and environmental degradation (due to the construction of dams). The risk involved can be in the short term like an economic loss or in the long term as in environmental degradation.

Individuals can be at harm when an engineering product's designs are faulty or when the materials used are defective. A mobile phone that explodes due to a defective battery is an example. A person who buys an electric iron and gets an electric shock from it has reasons to complain.

The construction of a dam, which causes displacement of people due to water storage and also results in environmental degradation, is an example of an engineering product that can cause both economic loss and suffering to people. However, a dam is an essential part of our lives and necessary for the benefit of the community. The ethical aspect is involved in the way we deal with the risks. Dams are necessary, but the risks must be properly accounted for.

When we discussed the skill sets of engineers in Chapter 4, we included many points that are not part of the curriculum of an engineering course. Their importance becomes evident when we look at the designing and implementation of engineering products. Engineering needs to have a human face to look at the safety aspects. The risks, if any, take place in the future. The engineer needs to ascertain the risks and provide measures for their avoidance. This involves innovative and creative abilities. This is more so when a new product is designed. There is no past experience to fall back upon in such a case. The engineer needs to think creatively, and perceive and provide for the likely risks. This is the crux of engineering design from an ethical point of view.

Risk & Cost

A safe design involves building in safety features, which of course involves some cost. Also, some of the obvious risks, as in the case of a dam where rehabilitation of people displaced is a humane aspect, need to be considered. There are many misconceptions about cost. Some of hem are as follows:

- Designing for safety is a costly affair. While the substance of this statement is true, the perception needs to be clarified. Providing safe products is ethical and mandatory. In addition, it is the duty of the manufacturer to ensure safety of the product and he/she cannot compromise safety considering the expenses involved in providing for it. The engineer must always look at the cost aspect even if he/she does not want to make provisions for safety. For one, designing a safe product will not be as costly as modifying the design later to build in safety features. The loss of the company's credibility due to unsafe products will also prove to be very costly, affecting the business in the future. Even a redesigned safe product can be economical in the long run considering the lifecycle of the product.
- As the safety of the product is not known beforehand, it can be ascertained only during the testing stage. Many products do not show lapses in safety until they are tested. Design for safety must be initiated in advance because some harm could occur during the testing of the product.
- Customers may misuse the product and come to harm, which cannot be accounted for. This is again a false notion. We have to take into account the customer while designing the product. A computer, for example, is used by many people who are not engineers and are completely unaware of its intricacies. However, a personal computer is so designed that it does not depend upon the knowledge of the user. In addition to proper documentation for the use of a consumer, the product is so designed and helplines are provided so that the consumer does not find it difficult to use. Safety devices in automobiles and other equipment can help prevent accidents even if the operators make mistakes.

That laxity in safe product preparation can be costly is easily seen. The case of the Delhi Metro Rail Corporation (DMRC) is an example. The DMRC has received recognition for efficiency, timely completion of projects, and safety. However, the collapse of a girder causing a lot of damage has put a question mark on its credibility. The overturning of a crane pressed into service for removing the girder has further damaged the image of the company. Whether the mishap is due to faulty design or any other cause does not matter. There are a number of questions being raised about the company's methods and procedures.

Engineer's Responsibility for Safety

Engineers are responsible for designing, manufacturing/constructing, and controlling quality of safe products. They must be aware of this responsibility and the ethics involved in their functioning. While a corporate leader may think of finances, costs and profit, and bottom lines, engineers need to think about safe products and the likely risks. The engineers involved in the design of products must be sure that the product satisfies the minimum standards laid down for product safety. Such standards are well known and available for perusal. Engineers must constantly refer to safety standards while designing products. Designing a conceived engineering product is an iterative process. The design is iterative because some assumptions are made in the design. The design is repeated with the data from the first design to make better assumptions. Alternative solutions and an optimum solution may be available and can be found. This calls for greater ingenuity and creativity on the part of engineers to look for alternate solutions that may be safer. It is a tedious process to arrive at alternative solutions and evaluate each one of them based on technical criteria and safety standards. The best solution must be arrived at after due consideration of all aspects of the design. As an example, consider the following.

The Australian Competition and Consumer Commission (ACCC) enforces mandatory product safety and information standards and bans on unsafe goods declared under the Trade Practices Act. Fair Trading Offices also have an important role in product safety within their own states. The following guidelines have been prescribed for product safety:

Product Safety

Product suppliers and manufacturers have an obligation to ensure that only safe products are marketed. This can be done by providing clear instructions for use, including

- warnings against possible misuse;
- being aware of and meeting industry and mandatory standards;
- developing product recall plans and procedures including effective communication strategies to the public (e.g., advertisements in papers);
- incorporating safety into product design;
- developing appropriate safety standards through product improvement;
- implementing a quality assurance programme, which includes consumer feedback; and
- responding quickly to safety concerns that arise.

While designing a product, engineers must first consider the current accepted engineering practice. Design methods and materials available for use keep changing with time, and with advanced computational techniques, the possibility of looking at alternatives becomes easier. Secondly, engineers need to constantly update themselves on the design practices. In addition, they can update themselves through training programmes available in their area of work. They must recognize that there is a need for continuous learning, as learning never stops (even after leaving college) and this alone can give them a competitive edge.

The third consideration that engineers need to keep in mind is that the product is likely to go into the hands of a user not conversant with the intricacies of engineering design. Therefore, it is a good idea to prepare and give a product information document to the consumer. At the same time, the pitfalls and risks created by not-so-well-informed consumers must be taken into account. The consumer may misuse the product and come to harm despite the documentation, demonstration, and advice given on the use of the product. This requires engineers to foresee and provide for all kinds of risks associated with the product. Great ingenuity, study, and knowledge about the likely consumers are needed to make a safe product.5.3

Designing for Safety

In the realization of a product, the point at which the question of safety must be considered is the design stage. It is at this stage that the product takes a physical form and many of the intricacies of the practical aspects of the conceived product are seriously considered. This involves product detailing, analysis and design, prediction or assessment of possible risks, and incorporating safety features in the product. In assessing the possible risks, the consumers of the product need to be considered. There is no doubt that everyone wants a safe product. Engineers are responsible for ensuring that the product is safe for the consumer. Safety does cost more but will be worth it, and so cost should not be a prime consideration at this stage.

Product Costs

The cost of a product can be divided into two parts. The product has a primary cost due to the materials involved, production cost, overhead cost, etc. If you draw a graph between the primary cost and safety, you will see that the cost increases as the safety components are increased (refer to Fig. 5.1a). This costing is straightforward as all engineers are familiar with the costing of known components. On the other hand, there are secondary costs, which include downtime, warranty liability, loss of customer goodwill, etc. These increase with low-safety designs (refer to Fig. 5.1b).

The costing of these is difficult as the cost cannot be exactly estimated and has to be surmised based on experience. The combination of these two costs is the total cost of the engineering product (refer to Fig. 5.1c). The total product cost curve is a sagging curve with a minimum appearing somewhere in between. This shows that the minimum cost is obtained when the primary cost and secondary cost increases balance each other after a certain point ‘L’. Absolute safety cannot be built in nor is it attainable. The highest acceptable risk needs to be evaluated and the costing done at this or a higher level.

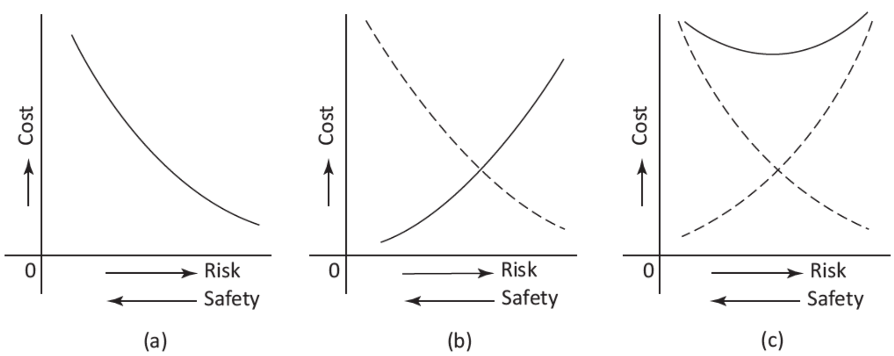

Figure 5.1 Cost of safety (a) Primary cost (b) Secondary cost (c) Total cost

Probability of Safety and Risk

Safety and risk are both probability based. As shown in Fig. 5.2, we can make curves of statistical distribution of loads on a machine component and the load carrying capacity of that component. Most design codes now have a probabilistic method of strength design. Figure 5.2(a) shows a situation when the loads on the component and the capacity of the component are such that the capacity is more and the two curves do not overlap. The curves are asymptotic but can be terminated at a certain confidence level. The peaks of the curves in the two cases are the expected values, while the load and capacity may vary and reach the two extremes. The situation shown in Fig. 5.2(a) is a safe design. Figure 5.2(b) shows a situation where, while the expected values seem to indicate a safe design, the possible values at a certain probability level show an unsafe zone due to the overlap between the two curves. This is a danger zone and can lead to possible failure.

With increasing consumer activism and awareness, faulty designs are likely to lead to much higher secondary costs by way of litigation and replacement costs. The product safety standards in India are presently not very satisfactory. The Bureau of Indian Standards has product standards for only a few products such as electrical appliances, but many countries have very stringent product safety standards and marketing any product not satisfying those standards is punishable.

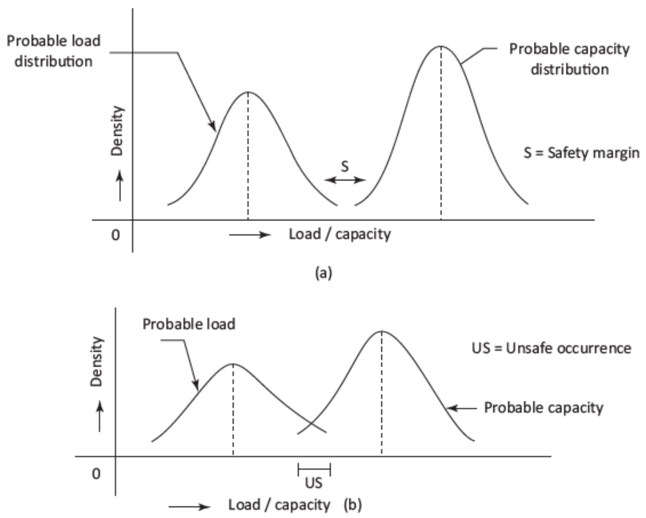

Figure 5.2 Safe and unsafe probabilities (a) Distributions in case of safe element (b) Distributions in case of unsafe elements

5.6 CONSUMER PROTECTION

You often hear in business conferences that "consumer is king." If consumer is king, why does he need protection? Many practices by companies, sales personnel are unethical and fraudulent. Some of the reasons for the vigorous steps taken by governments of many countries for consumer protection are because of the following:

- Advertisements making tall and fraudulent claims on products and services
- The goods and services supplied are not the same as what is advertised and promised
- Sales personnel act very consumer-friendly only till they effect a sale; they do not respond afterwards
- Many provisions in the warranty or product information are not explained to the consumer
- Lot of information in fine print is not generally studied in detail by the consumer and also not explained to him; consumer feels cheated later on.
- Consumer desirous of seeking legal remedies finds the process very costly and time consuming.
- Consumers not being aware of their rights and remedy available in case they feel cheated by business entities.

Consumer protection became a key element of fair and ethical business practices and many laws were enacted and remedial structures were set up for the purpose. We briefly look at salient aspects of consumer protection.

5.6.1 Product Safety Standards

Almost all countries have product safety standards. The objectives of standardization are to:

- Ensure quality of goods
- Ensure uniformity (compatibility and interoperability) of goods by different manufacturers
- Ensure safety in goods supplied to consumers
- Enable certification of goods by standards organization of different countries

Three types of standards are generally considered

- De facto standards followed by convention and use
- De jure standards that are enforceable by law and regulations
- Voluntary standards that are available for the user to decide their quality and use

Products having certification by standards organizations have greater acceptance in the market though they may not necessarily be true all the time. Standardization deals with materials, processes, dimensions, test procedures, permitted variability etc. Standardization helps manufacturers and consumers by

- Guaranty quality of a manufactured product
- Improving productivity of business as the standards can reduce time by standardizing process without any confusion
- Uniformity and predictability by standardized processes
- Creating brand value for products
- Customers get better products and services

Some details of standards organization in some countries are given below.

a) USA: USA has a consumer product safety commission established under the consumer product safety act. The objectives of the commission are to:

- To protect the public against unreasonable risks of injury associated with consumer products;
- To assist consumers in evaluating the comparative safety of consumer products;
- To develop uniform safety standards for consumer products and to minimize conflicting State and local regulations; and
- To promote research and investigation into the causes and prevention of product-related deaths, illnesses, and injuries

The web site of CPSC states: “CPSC is charged with protecting the public from unreasonable risks of injury or death associated with the use of the thousands of types of consumer products under the agency's jurisdiction. Deaths, injuries, and property damage from consumer product incidents cost the nation more than $1 trillion annually. CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard. CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals -

contributed to a decline in the rate of deaths and injuries associated with consumer products over the past 40 years."

There are many acts passed to ensure safety in all consumer products. These can be seen at cpsc.gov.

b) Australia: The Australian Competition and Consumer Commission is authorized to enforce mandatory product safety and information standards. This is as per the Consumer and Competition Act (2010). The general principles are:

- Any one selling products to Australian consumers in physical stores or on-line should ensure that the products satisfy the Australian Consumer Law
- All manufacturers and suppliers are mandatorily required to comply with the Australian Safety Standards
- Selling products not complying with safety standards is illegal and invites penalties

Businesses are required to:

- Ensure mandatory levels of safety in products
- Ensure that the products are tested to ensure safety
- Ensure that products do not cause harm when used in a reasonable manner and reasonable misuse

Product safety is ensured by:

- providing clear instructions for use, including warnings against possible misuse
- being aware of and meeting industry and mandatory standards
- developing product recall plans and procedures including effective communication strategies to the public (eg. advertising)
- incorporating safety into product design
- developing appropriate safety standards through product improvement
- implementing a quality assurance program which includes consumer feedback
- responding quickly to safety concerns that arise.

There are two types of mandatory product standards:

**Safety standards* - goods must comply with particular performance, composition, contents, methods of manufacture or processing, design, construction, finish or packaging rules.

**Information standards* - prescribed information must be given to consumers when they purchase specified goods (e.g. labelling for cosmetics, tobacco products and care labelling for clothing and textile products).

c) European Union: European Union is a union of 29 countries in Europe who adopt standards developed at the Union level for compatibility and acceptability across all countries. There are National Standard Boards in countries who adopt the union standards and delete those that are in conflict.

European standards are adopted by one of the three European Standardisation Organizations:

- European Committee for Standardisation (CEN)
- European Committee for Electro-technical Standardization (Cenelec)
- European Telecommunications Standards Institute (ETS)

Businesses and consumers are helped by compliance to standards in many ways:

- Building consumer confidence
- Ensures high level of safety and quality for consumers
- Help consumer health
- Protecting the environment
- Open up markets for better accessibility
- Ensuring Compatibility and interoperability

d) India: Bureau of Indian Standards (BIS) is the National Standards Body of India established under the BIS Act 2016 for the harmonious development of the activities of standardisation, marking and quality certification of goods and for matters connected therewith or incidental thereto. BIS has helped in the following through standardisation, certification and testing.

- providing safe reliable quality goods;
- minimising health hazards to consumers;
- promoting exports and imports substitute;
- control over proliferation of varieties etc.

To protect the interests of consumers as well as the industry, BIS is involved in various activities as given below:

- Standards Formulation
- Product Certification Scheme
- Compulsory Registration Scheme
- Foreign Manufacturers Certification Scheme
- Hall Marking Scheme
- Laboratory Services
- Laboratory Recognition Scheme
- Sale of Indian Standards
- Consumer Affairs Activities
- Promotional Activities
- Training Services, National & International level
- Information Services

The Bureau publishes a number of standards related to products, processes and services.

5.6.3. Product Information

Product information is mandatory under consumer protection acts of different countries. The present times witness a global market for many products. Product information has thus to satisfy customers across the world. Product information is given in a booklet or a leaflet to the consumer. Product information includes a user manual that informs the user of the correct use of the product. The following features are common:

Multi-lingual: As the product gets marketed worldwide, product information is given in many languages. Even items considered local today have instructions in many languages. Many spices, packaged foods, frozen foods have instructions given in many languages. It is mandatory to give ingredients, manufacturing and expiry dates and storage information.

Clarity: Clarity comes from step-by-step detailing of assembling and use. The user must be able to read and put the product to use in many instances. Some products do need installation and commissioning by a qualified engineer.

Illustrations: Figures, photographs or diagrams are commonly used for clarity. Japanese firms are known to use a lot of illustrations in their user manuals.

Technical details: Many customers may not understand the technical details like power requirements in terms of voltage and frequency of power supply. Power connections used are also different in different countries. Technical details must be explained to the consumer at the time of purchase.

Precautions: Customers need to be told the correct use, storage, transportation and other precautions to be taken while using the equipment. Many times customers are told not to open the product to check as there may not be any parts that are serviceable by users. Warnings against possible misuse should be given clearly in terms of 'don't' lists.

Simple troubleshooting: Most companies give some simple checks that the consumer can undertake before rushing with complaints but generally advise them to call a qualified technician mandatory declarations. In many products, radiation levels may be important as in smart phones. These declarations are to ensure that the product satisfies such requirements of the country where it is sold.

Medium for product information: Product information can be provided through a variety of media.

- Printed: The most common form is the written or printed form. This is used for small or large amount of information. As there is a need to move towards a paperless, alternate medium, other forms are becoming popular.
- E-versions: E-formats for catalogues and product information are very common now-a-days. Many user manuals are downloadable from the Internet. Product help (for use) is also many times provided.
- Combination mode: A combined form using paper and e-versions are also provided. A small product information booklet can be provided with detailed user manuals provided in the e-format. The choice depends upon the product and extent of detailing of information.
- Video clips: These are becoming popular both as advertising material and for giving product information through demonstration. They can be useful for people who need such a mode of information and can see a CD again as per need.

Product information management is a new area that helps in marketing and selling of products. This requires the creation of a central product database. This can be used then to supply information to a variety of users in different places and in a form suitable to them. The information can be used to print catalogues and place information on web sites or for other people as per their needs. Information made available in this form helps to market and sell products through a variety of distribution channels and modes.

Product information management systems are useful to:

- Create a central database of a large number of products
- Preparation of electronic catalogues
- Get product information in hard copy form
- Cater to different geographic locations in local language
- Global access to marketing and sales personnel
- Facility for making changes on product modification and maintenance of records

5.6.4 Consumer Protection

As mentioned in the beginning, 'Consumer is king' is the common refrain among business managers. Consumers can make or break a product. If consumer is the king, why does he/she need protection? This is probably because consumers get cheated by businesses i) with spurious products, ii) by not offering any services after an item is sold and iii) sometimes even supplying unsafe products. Consumer activism was unheard of earlier. At present, consumer protection is legally enforced by enacting consumer protection laws. Consumer protection is applicable to products and services. Almost all countries have such laws.

A consumer is one who purchases goods or services by paying for it and for personal use. A consumer can be cheated in many different ways:

- Product not conforming to the specifications advertised or told to the consumer at the time of purchase
- Not informed of actual pricing or cost of accessories necessary to operate the product.
- Spurious product being supplied as a branded product.
- Many things in fine print not explained to the consumer
- Overcharging for the product or service
- High cost of replacement parts
- Absence of appropriate maintenance service or high service charges
- Supplying old refurbished product as original and new

With consumer complaints mounting about many products and services, thinking about consumer rights and laws to protect them became imperative. It is also in the interest of the business to ensure that consumer remains satisfied about any product or service. Consumer rights can be generally stated as:

Safe product: Consumer is entitled to receive a safe product that does not cause any harm during use. Safety has already been highlighted in the earlier discussion as well. An electrical product like an iron or washing machine that gives an electrical shock to the user is definitely an unsafe product. Similarly, many children's toys need to be so designed as to be safe for the type of use that children generally do. No toxic material should be used in making the product. Even if the children bite or press the toy on their face, no harm should result. Depending upon the type of product, many safety considerations should go into the design of the product. Consumers can also ask for certification that ensures quality and safety. Many goods are purchased for use over a long period of time. The product must be able to give reasonably good and safe service over the expected use by the consumer.

Product Choice: The availability of goods/service at reasonable price is a right of the consumer. Competition in the market generally ensures variety of choices and fair prices for the consumer.

Monopoly by any company for a particular good or service will affect availability and fair pricing. If you take the case of automobiles, four decades ago, there was very little choice. There were two car brands (Ambassador and Fiat) and two two-wheeler brands (Bajaj and Lambretta). Availability was very much restricted and the models did not advance technologically. Today, we have many, many brands of cars (entry level, mid-size, luxury segment) and consumer has a great choice. Due to competition, there are enough discounts and freebies that the companies are ready to give away. Choice and free availability are consumer rights.

Product Information: It has been discussed earlier. Product information has to be clear and accurate and in sufficient detail to enable the consumer to make an informed decision about purchase and use. This is generally done by advertising through a variety of media, through product brochures and product labeling. The consumer has the right to get all the information about the product and it must be available to him from people trying to sell the product/service to him/her. The product quality, service requirements and availability, cost and yearly payments, precautions in use etc. are important for the consumer to decide about purchase. Many consumers fall for high-pitched advertisements and buy goods which finally prove to be highly unsatisfactory. Consumers have to be on guard and the protection laws are meant to help him get justice. In certain areas, where public health and safety are involved, stringent requirement of product information is mandatory. All the ingredients need to be disclosed in food items and the manufacturing date and expiry period are to be clearly specified.

Consumer grievance and redressal: When a consumer has purchased a product, it is quite possible that the product malfunctions or the consumer has problems with it. There must be a mechanism by which his grievances are heard and if required appropriate action is taken to address the same. Generally, retailers act only as selling points and the consumer complaints are to be dealt with by the company people only. Toll free numbers, local service centre contact details and the person to contact are invariably required by the customer in case he has any complaints. The company should ensure a strong follow-up action plan with the customer at least during the warranty period. Customers have a right to be heard and the grievances addressed and set right in good time.

Consumer Education: Consumer education is important to get an informed and active consumer community. Consumer education is the responsibility of the government, consumer activist groups and the business itself. Essentially, consumer education educates the consumers about their rights, about various goods and services, prices, quality and durability, trade practices and also about being an ethical consumer.

Consumer education needs to promote critical thinking, problem solving, and action. The objectives of consumer education are:

- Gain knowledge to act as informed consumers. For example, knowledge of consumer rights
- Develop an understanding of society's function as a whole and the specific role of consumers. For example, the understanding of the role of companies in the economic system; the role of the government in society and the role of consumer organizations.
- Master skills to function as informed and responsible consumers. For example, the methods and procedures for complaint redressal; spotting sales gimmicks and using products knowledgeably.
- Appreciate the importance of being an informed consumer.
- Act as informed, educated and responsible and ethical consumers.

Generally consumer education focuses on developing understanding about buying quality goods at low prices, and avoiding marketing and sales gimmicks in the marketplace. The focus should be on maximizing personal benefits at minimum cost. Consumer education also needs to focus on being an informed and ethical consumer.

- Learn to buy only in absolute need; must be able to ask informed questions.
- Consumer education gives the consumer knowledge and skills to demand their rights and ensure that their voices are heard.
- Consumers must be aware of the impact of their actions on others, particularly the disadvantaged.
- Consumers should make an informed choice of buying goods and services that do not harm the environment or violates basic human and animal rights.
- Possible to be effective by forming consumer groups; groups are more effective to fight for consumer rights.

5.6.5 Consumer Protection Acts: Consumer protection acts addresses the rights of consumers given above. The objectives of the Consumer Protection Act are to:

- Give a legal status to consumer rights
- Facilitate formation of consumer organizations
- Provide a forum for the consumers to go to with their complaints
- Provide a structure for speedy redressal of grievances
- Give the consumer a speedy but simpler and cost-effective means to get his complaints resolved

We will briefly see the consumer protection laws in many countries including India.

USA: The Federal Trade Commission has a Bureau of Consumer Protection with the objective of:

- Stopping unfair deceptive and fraudulent business practices
- Receive complaints from consumers and conduct investigations
- Promote competitive business environment
- Prosecute companies and people breaking the law
- Developing rules to ensure fair trade practices
- Educating consumers and businesses about theur rights and duties

European Union: In 2012 the European Commission adopted the European consumer agenda that identifies the key measures needed to empower consumers and to maximize their participation. The agenda outlines the strategic vision on consumer policy with 62 action points grouped around 4 pillars of

- promoting consumer safety
- enhancing knowledge of consumer rights
- strengthening the enforcement of consumer rules
- integrating consumer interests into key sectorial policies

As a long-term objective, the Commission also works to empower consumers through

- choice of product/service

- information about product/service
- awareness of consumer rights and means of redressal

Australia: The Australian Consumer Law sets out consumer rights that are called consumer guarantees. These include your rights to a repair, replacement or refund as well as compensation for damages and loss and being able to cancel a faulty service.

Guarantees: Under the Australian Consumer Law, when you buy products and services they come with automatic guarantees that they will work and do what you asked for. If you buy something that isn't right, you have consumer rights.

Repair, replace, refund: If a product or service you buy fails to meet a consumer guarantee, you have the right to ask for a repair, replacement or refund under the Australian Consumer Law. The remedy you're entitled to will depend on whether the issue is major or minor.

Cancelling a service: Under the Australian Consumer Law, you have certain rights to cancel a service.

Compensation for damages & loss: You can seek compensation for damages and losses you suffer due to a problem with a product or service if the supplier could have reasonably foreseen the problem. This is in addition to your repair, replacement or refund rights.

Warranties: Under the Australian Consumer Law, automatic consumer guarantees apply to many products and services you buy regardless of any other warranties suppliers sell or give to you.

India: Consumer Protection Act (1986) is the main legislation to protect the interests of consumers in India. In addition to detailing the consumer rights and consumer empowerment, the act provides for quasi-judicial structures for speedy and less-costly processes for grievance redressal for consumers. Earlier, consumer awareness was less. Also the only forum for redressal of complaints was the normal judicial system. Consumers were unwilling to register complaints due to the high cost and extreme delay in getting justice. The Consumer Protection Act recognizes the rights of consumers as:

- Right to be protected against marketing of goods and services that are hazardous to life and property
- Right to be informed about the quality, quantity, standard, and price of goods or services so as to protect the consumer against unfair trade practices
- Right to receive assured access, wherever possible, to a variety of goods and services at competitive prices
- Right to be heard and to be assured that consumers interests will receive due consideration at appropriate forums.
- Right to seek redressal against unfair trade practices.
- Right to consumer education

The consumer protection act seeks to protect the interest of consumers against deficiencies or defect in product or service. The act applies to only individual consumers purchasing goods/services for personal use and applies to all goods and services unless specifically mentioned otherwise.

Consumer Protection Act, 1986 was enacted to facilitate quick redressal of consumer grievances by avoiding long-drawn litigation and court fees. A structure is created from the district level to National Level for smoother, simpler and quicker functioning of the system. The essential idea is to help the consumer and supplier to negotiate and arrive at a consensus to solve the problems of the consumer. The Act covers all goods and Services (unless exempted specifically) and covers public, private and co-operative sectors. Consumer courts provide relief only to goods and services bought for personal use and does not cover items meant for commercial use.

5.7 CONSUMER PROTECTION ACT 2019

We have outlined the consumer protection act 1986 giving some salient features. This act has been replaced by the Consumer Protection Act 2019 which came into effect in 2020. While many features remain the same, there are some significant changes which only will be discussed here.

The Consumer Protection Act 2019 (CPA 2019) is given in 8 chapters (31 sections) as:

CHAPTER I PRELIMINARY

CHAPTER II CONSUMER PROTECTION COUNCILS

CHAPTER III CENTRAL CONSUMER PROTECTION AUTHORITY

CHAPTER IV CONSUMER DISPUTES REDRESSAL COMMISSION

CHAPTER V MEDIATION

CHAPTER VI PRODUCT LIABILITY

CHAPTER VII OFFENCES AND PENALTIES

CHAPTER VIII MISCELLANEOUS

In 1986, consumers in general used to go to physical stores and purchase goods or services by paying a price. By 2019, the purchase methods have considerably changed with a number of E-commerce platforms having come into existence. In addition, telemarketing and multi-level marketing became common. The CPA 2019 takes into account this change also.

The Act provides:

- Enhanced protection to consumers from fraudulent or unfair trade practices;
- Covers consumers who purchase from online platforms/telemarketing or multilevel marketing;
- Makes it easier for consumers to make a complaint against goods or service provider allowing e-filing of complaints and online fighting of cases by video conferencing

Consumer: In CPA 2019, a consumer is defined as:

(i) buys any goods for a consideration which has been paid or promised or partly paid and partly promised, or under any system of deferred payment and includes any user of such goods other than the person who buys such goods for consideration paid or promised or partly paid or partly promised, or under any system of deferred payment, when such use is made with the approval of such person, but does not include a person who obtains such goods for resale or for any commercial purpose; or

(ii) hires or avails of any service for a consideration which has been paid or promised or partly paid and partly promised, or under any system of deferred payment and includes any beneficiary of such service other than the person who hires or avails of the services for consideration paid or promised, or partly paid and partly promised, or under any system of deferred payment, when such services are availed of with the approval of the first mentioned person, but does not include a person who avails of such service for any commercial purpose.

Consumer Rights: CPA 2019 lists the rights as:

(i) the right to be protected against the marketing of goods, products or services which are hazardous to life and property;

(ii) the right to be informed about the quality, quantity, potency, purity, standard and price of goods, products or services, as the case may be, so as to protect the consumer against unfair trade practices;

(iii) the right to be assured, wherever possible, access to a variety of goods, products or services at competitive prices;

(iv) the right to be heard and to be assured that consumer's interests will receive due consideration at appropriate fora;

(iv) the right to seek redressal against unfair trade practice or restrictive trade practices or unscrupulous exploitation of consumers; and

(v) the right to consumer awareness;

While the consumer is the person who buys it for a consideration for his own use or use by a house member, a complainant going to make a complaint may be:

- Consumer individually
- Consumer associations
- Central or state Governments
- Two or more persons having common interest
- Legal heir of a consumer in case of his death

A complaint is generally made in written forming the case of

- Defective product or deficient service
- Unfair or restricted trade practice
- Excess charge or pricing
- Selling goods hazardous to health

Consumer Dispute Redressal Agency (CDRA): The new act has a name change for these authorities and their jurisdiction has also been changed. There are three levels in which thee agencies function - district, state and national.

District Consumer Forum: At the district level, the redressal forum will have three members: president and two members (at least one of the two must be a woman). The President must be person qualified to become a district judge.

The jurisdiction of this forum is up to 1 crore in monetary value. (In the 1986 Act, this limit was 20 lakhs)

The act also allows the setting up of more than one forum in a district.

State Consumer Commission: Similar to the district level forum, state level commission also will have three members, president and three members. The president should be qualified enough to become the judge of the High Court of the state. Of the two members, at least one should be a woman.

The jurisdiction of the Commission at state level is 10 crores. (In the 1986 Act, this limit was 1 crore.)

National Consumer Commission: The national level commission will have a president and four members, with at least one woman among the four members. The President of the commission will be person qualified enough to become a Supreme Court judge.

Consumer complaints involving monetary value of 10 crore and above can be filed directly filed in the National commission. (This limit was 1 crore in the 1986 Act.)

All complaints can be entertained only if filed within 2 years of the cause of action.

Appeal: A complainant can go in appeal within 30 days of order from any forum or commission. From district to state to national will be the order of appeal. A complainant can go to the Supreme Court against national commission's order.

Mediation: At every level of complaint hearing, there will be a mediation facility available to the complainant and the supplier of goods/services. Councillors or mediators will be available to the parties to help them arrive at a settlement of the case between them.

Central Consumer Protection Authority: The act proposes many structures for consumer protection:

Central consumer protection council is an agency set up by the central government to give advice on matters related to consumer protection under the Act. Minister in charge of the department of consumer affairs will be the chair person with a number of members as may be specified. Similar structures at the state level will be formed with the state minister as chairperson for the state council and the District collector as chairperson for the district council.

The central government will establish a Central Consumer Protection Authority (CCPA) to "*regulate matters relating to violation of rights of consumers, unfair trade practices and false or misleading advertisements which are prejudicial to the interests of public and consumers and to promote, protect and enforce the rights of consumers as a class.*"

CCPA will be headed by a chief commissioner and will have as many commissioners as may be prescribed by the central government. The purpose of CCPA is to (as stated in the Act):

- protect, promote and enforce the rights of consumers as a class, and prevent violation of consumers rights under this Act;
- prevent unfair trade practices and ensure that no person engages himself in unfair trade practices;
- ensure that no false or misleading advertisement is made of any goods or services which contravenes the provisions of this Act or the rules or regulations made thereunder;
- ensure that no person takes part in the publication of any advertisement which is false or misleading.

CCPA will have the powers to take actions like (as stated in the Act):

(a) inquire or cause an inquiry or investigation to be made into violations of consumer rights or unfair trade practices, either suo motu or on a complaint received or on the directions from the Central Government;

(b) file complaints before the District Commission, the State Commission or the National Commission, as the case may be, under this Act;

(c) intervene in any proceedings before the District Commission or the State Commission or the National Commission, as the case may be, in respect of any allegation of violation of consumer rights or unfair trade practices;

(d) review the matters relating to, and the factors inhibiting enjoyment of, consumer rights, including safeguards provided for the protection of consumers under any other law for the time being in force and recommend appropriate remedial measures for their effective implementation;

(e) recommend adoption of international covenants and best international practices on consumer rights to ensure effective enforcement of consumer rights;

(f) undertake and promote research in the field of consumer rights;

(g) spread and promote awareness on consumer rights;

(h) encourage non-Governmental organisations and other institutions working in the field of consumer rights to co-operate and work with consumer protection agencies;

(i) mandate the use of unique and universal goods identifiers in such goods, as may be necessary, to prevent unfair trade practices and to protect consumers' interest;

(j) issue safety notices to alert consumers against dangerous or hazardous or unsafe goods or services;

(k) advise the Ministries and Departments of the Central and State Governments on consumer welfare measures;

(l) issue necessary guidelines to prevent unfair trade practices and protect consumers' interest.

The Structure for Consumer Protection in India

The structure includes i) National Consumer Disputes Redressal Commission (NCDRC) ii) State Consumer Disputes Redressal Commission (SCDRC) and iii) District Consumer Disputes Redressal Commission.

National Consumer Disputes Redressal Commission: NCRDC is a national level quasi-judicial commission to hear grievances of consumers for defective product or deficiency in service. The jurisdiction of NCRDC is:

- To entertain complaints having a value of more than Rs 10 Million
- To have appellate and revisional jurisdiction on cases heard by the District and State level commissions.

The Commission is normally headed by a sitting or retired judge of the Supreme Court. The Commission will have four members with at least one woman member. The order given by the National level Commission can be challenged in the Supreme Court of India within a period of 30 days.

However, the Supreme Court of India has held that the jurisdiction of National Commission under Revision Jurisdiction is very limited and can only be exercised when State Commission exceeds its jurisdiction, fails to exercise its jurisdiction or there is material

State Consumer Disputes Redressal Commission: These are set up by the State Governments. There may be one or more State Level Consumer Commissions in a state. The State level Commissions can be approached by consumers in situations where the value is more than 2 million but less than 10 million. The state level commission is headed by a sitting or retried High court judge and will have at least three members. The State level Commission can entertain:

Complaints where the value of the goods or services and compensation, if any, claimed exceeds rupees twenty lakhs but does not exceed rupees one crore (R10 million); and

- Appeals against the orders of any District Forum within the State; and
- To call for the records and pass appropriate orders in any consumer dispute

District Consumer Disputes Redressal Commission: DCDRCs are established by the state governments in every district of the state. Each district of the state will have at least one district level commission to whom consumers can approach with their complaints. The District level commission will be chaired by a sitting or retired district court judge and will have at least three members. Subject to the provisions in the Consumer Protection Act.

The District Forum shall have jurisdiction to entertain complaints where the value of the goods or services and the compensation, if any, claimed does not exceed rupees twenty lakhs.

Consumer protection Councils: Consumer protection Act also stipulated the establishment of consumer protection councils at the central and state levels. The primary aim of establishing such councils was to create awareness about consumer rights and promote participation of consumers in activities promoting and protecting consumer rights. The Objectives of the councils can be stated as the right to be:

- Protected against the marketing of goods and services which are hazardous to life and property
- informed about the quality, quantity, potency, purity, standard and price of goods or services, as the case may be so as to protect the consumer against unfair trade practices;
- assured, wherever possible, access to a variety of goods and services at competitive prices;
- heard and to be assured that consumer's interests will receive due consideration at appropriate forums
- seek redressal against unfair trade practices or restrictive trade practices or unscrupulous exploitation of consumers and;
- given access to consumer education.

There are three levels at which such councils are established:

Central Consumer protection Council is established by the Central Government with Minister in-charge of consumer affairs as its chairman. The council will have as many number of official and non-official members representing the government and other interest groups as required for its working. The council will be reconstituted after a period of three years. The Council may also constitute a working group with the member secretary as the chairman.

State Consumer protection Councils are established by the State Governments. Minister holding the charge of Consumer affairs will be the chairman of the council. There will be ten representatives of the Central government in addition to the official and non-official members representing varied interest groups.

District Consumer Protection Councils are established by the State Governments in every district of the state. The District Collector will be the chairman of the council. A number of official and non-official members will be appointed to the council to represent a wide spectrum of interests in consumer protection.

5.8 PRODUCT AND PRDUCT LIABILITY:

"Product" means any article or goods or substance or raw material or any extended cycle of such product, which may be in gaseous, liquid, or solid state possessing intrinsic value which is capable of delivery either as wholly assembled or as a component part and is produced for introduction to trade or commerce, but does not include human tissues, blood, blood products and organs;(as defined in the Act).

Defect and Deficiency:

"Defect" means any fault, imperfection or shortcoming in the quality, quantity, potency, purity or standard which is required to be maintained by or under any law for the time being in force or under any contract, express or implied or as is claimed by the trader in any manner whatsoever in relation to any goods or product and the expression "defective" shall be construed accordingly;

"Deficiency" means any fault, imperfection, shortcoming or inadequacy in the quality, nature and manner of performance which is required to be maintained by or under any law for the time being in force or has been undertaken to be performed by a person in pursuance of a contract or otherwise in relation to any service and includes:

(i) any act of negligence or omission or commission by such person which causes loss or injury to the consumer; and

(ii) deliberate withholding of relevant information by such person to the consumer;

Product Liability:

"Product liability" means the responsibility of a manufacturer or seller, of any product or service, to compensate for any harm caused to a consumer by such defective product manufactured or sold or by deficiency in services relating thereto;

"Product liability action" means a complaint filed by a person before a District Commission or State Commission or National Commission, as the case may be, for claiming compensation for the harm caused to him;

A product manufacturer shall be liable in a product liability action, if

(a) the product contains a manufacturing defect; or

(b) the product is defective in design; or

(c) there is a deviation from manufacturing specifications; or

(d) the product does not conform to the express warranty; or

(e) the product fails to contain adequate instructions of correct usage to prevent any harm or any warning regarding improper or incorrect usage.

A product service provider shall be liable in a product liability action, if

(a) the service provided by him was faulty or imperfect or deficient or inadequate in quality, nature or manner of performance which is required to be provided by or under any law for the time being in force, or pursuant to any contract or otherwise; or

(b) there was an act of omission or commission or negligence or conscious withholding any information which caused harm; or

(c) the service provider did not issue adequate instructions or warnings to prevent any harm; or

(d) the service did not conform to express warranty or the terms and conditions of the contract.

A product seller who is not a product manufacturer shall be liable in a product liability action, if

(a) he has exercised substantial control over the designing, testing, manufacturing, packaging or labelling of a product that caused harm; or

(b) he has altered or modified the product and such alteration or modification was the substantial factor in causing the harm; or

(c) he has made an express warranty of a product independent of any express warranty made by a manufacturer and such product failed to conform to the express warranty made by the product seller which caused the harm; or

(d) the product has been sold by him and the identity of product manufacturer of such product is not known, or if known, the service of notice or process or warrant cannot be effected on him or he is not subject to the law which is in force in India or the order, if any, passed or to be passed cannot be enforced against him; or

(e) he failed to exercise reasonable care in assembling, inspecting or maintaining such product or he did not pass on the warnings or instructions of the product manufacturer regarding the dangers involved or proper usage of the product while selling such product and such failure was the proximate cause of the harm.

5.9 LAW OF TORTS

In the Oxford dictionary, you find the meaning of tort as “something wrong that somebody does to somebody else that is not criminal but that can lead to action in a civil court”, Law of torts apply in cases where a ‘civil wrong' has been committed by one person against another. Defamation is a typical example of tort. The word ‘tort’ is derived from a Latin word ‘tortum’, meaning twisted or crooked. Law of torts is not a codified law like the criminal procedure code. Law of torts essentially comes from case laws or judgments given in different cases. There are no sections in Tort law as in the penal code. There are also no pre-defined punishment or damages in tort law.

The main purpose tort law is to enforce the duties and rights of citizens. This also leads to damages claimed by the person whose right is violated. The rights can in general be considered as:

- Right of reputation
- Right to bodily safety and freedom
- Right of property

Tort law is applicable where a civil wrong is committed. Civil wrong is different from a criminal wrong: A civil wrong under tort is a violation somebody’s right by another person and is a private wrong, there is no codified rules for dealing with torts, monetary compensation is the most common claim for the injury (right violation) caused and compensation is not pre-determined and is decided by the court in each case. A criminal wrong on the other hand is a public wrong, case is generally given by the state and is dealt with procedures detailed in the code and punishment is generally laid out in the code for different types of criminal wrongs.

Every wrong act may not come under the law of torts. Three conditions need to be fulfilled for dealing with it under the law of torts:

- Existence of wrongful act causing injury (violation of right)
- Legal damages (Existence of actual damages or legally received damages)
- Legal remedy ('ubi jus ibi remedium' For every wrong, law provides a remedy.)

All the three conditions must be fulfilled for considering the incident under the law of torts. You can generally classify torts into three types:

- Intentional torts like defamation
- Negligence, not taking proper care to avoid wrong to others
- Strict liability, hazardous activities with potential for damage

Two important tort principles are:

Injuria sine Damnum (injury without damage) is a case where right violation happens but without damage. An exemplary case for this is a case of voting rights (Ashby Vs White). A person was prevented from voting by the returning officer of a voting station. The candidate to whom this person wanted to vote did win the election despite this person not voting. The person, who was not allowed to vote went to the court for damages for violation of the right to vote. The returning officer's case was that the candidate for whom the person wanted to vote has won the election in any case. There was no damage done and hence they are not liable to compensate the person. The court took the view that there was violation of right to vote and the entitlement to compensation remained irrespective of there being no damage.

Damnum Sine injury (Damage without injury) is the second principle governing the violation of right and damage. An example quoted to illustrate this principle is that of a school teacher who left the school he was working with and started a school nearby. This act led to the loss of students for the old school and in order to be competitive the school had to reduce fees as well. They suffered a loss because of this act of the old teacher. In this case, while there is damage and loss to the school, they are not entitled to any compensation as there was no violation of any of their rights. The teacher who left the school was well within his right to start a school and this act was not a violation of any right of the school. The school was not this entitled to any claim of compensation.

Some exceptions to the Tort law can come from:

- Personal fault of the injured party
- Act of God (vis major)
- Consent of plaintiff (violent non-fit injuria)
- Inevitability
- Necessity

Act done by a statutory authority (like police or IT personnel coming into your property as a part of investigation; it is not trespassing) Vicareous liability comes as a part of third party liability, as in the case of the liability of an employer for a wrongful act by the employee.

Absolute liability comes because of dangerous activity which has a potential to cause damage even if the actual damage is caused by not an individual fault. (Bhopal gas leak case)

Law of Torts is not a codified law but is based of previous cases and pronounced judgments. Remedy in Tort cases is mainly monetary compensation and is decided by the court in each case based upon the extent of injury and other factors.

REVIEW QUESTIONS:

I) Explain the difference between an agreement and a contract giving an example of each.

ii) Explain the statement: All contracts are agreements but all agreements are not contracts.

iii) List any six essential elements of a legally valid contract.

iv) Explain the formation of contracts giving the steps required to make a valid contract.

v) Enlist the rights of a consumer

vi) Explain the structure in India for consumer grievance redressal.

vii) Briefly state the new provisions in the consumer protection Act 2019.

viii) Explain the concept of product liability.

ix) List the powers of the Central Consumer Protection Authority.

x) Explain the meaning of the term'Tort' with examples.

xi) Explain the basis for dealing with a tort case as it is not a codified law.

xii) Explain the concept of tort cases with three examples.

xiii) Explain the essential features of a tort case.

xiv) Explain the terms *'injuria sine damnum*' and '*damnum sine injuria*' with examples.

xv) Explain the concept of product safety with examples.

xvi) Explain the consideration risk and cost in product design with an example.

UNIT –III

ENGINEER'S RESPONSIBILITY FOR SAFETY

Syllabus: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and chernobyl case studies.

SAFETY AND RISK

Risk is akey element in any engineering design.

Concept of Safety:

A thing is safe if its risks are judged to be acceptable. Safety are tactily value judgments about what is acceptable risk to a given person or group.

Types of Risks:

Voluntary and Involuntary Risks

Short term and Long Term Consequences

Expected Portability

Reversible Effects

Threshold levels for Risk

Delayed and Immediate Risk

Risk is one of the most elaborate and extensive studies. The site is visited and exhaustive discussions with site personnel are undertaken. The study usually covers risk identification, risk analysis, risk assessment, risk rating, suggestions on risk control and risk mitigation.

Interestingly, risk analysiscan beexpanded to fullfledgerisk managementstudy. The risk management study also includes residual risk transfer, risk financing etc. ***Stepwise, Risk Analysis will include:***

- Hazards identification
- Failure modes and frequencies evaluation from established sources and best practices.
- Selection of crediblescenarios and risks.
- Fault and event trees for various scenarios.
- Consequences-effect calculations with work out from models.
- Individual and societal risks.
- ISO risk contours superimposed on layouts for various scenarios.
- Probability and frequency analysis.
- Established risk criteria of countries, bodies, standards.
- Comparison of risk against defined risk criteria.
- Identification of risk beyond the location boundary, if any.
- Risk mitigation measures.

The steps followed are need based andall or some of these may be required from the above depending upon the nature of site/plant.

Risk Analysis is undertaken after detailed site study and will reflect Chilworth exposureto varioussituations. Itmay also includestudy on frequency analysis, consequences analysis, risk acceptability analysis etc., if required. Probability and frequency analysis covers failure modes and frequencies from established sources and best practices for various scenarios and probability estimation.

Consequences analysis deals with selection of credible scenarios and consequences effect calculation including worked out scenarios and using software package.

RISK BENEFIT ANALYSIS AND REDUCING RISK

Risk-benefit analysisis the comparison of theriskof a situation to its related benefits.

For research that involves more than minimal risk of harm to the subjects, the investigator must assure that the amount of benefit clearly outweighs the amount of risk. Only if there is favorable risk benefit ratio, a study may be considered ethical.

Risk Benefit Analysis Example

Exposure to personal risk is recognized as a normal aspect of everyday life. We accept a certain level of risk in our lives as necessary to achieve certain benefits. In most of these risks we feel as though we have some sort of control over the situation. For example, driving an automobile is a risk most people take daily. "The controlling factor appears to be their perception of their individual ability to manage the risk-creating situation." Analyzing therisk ofasituation is, however, very dependenton theindividualdoing theanalysis. When individuals are exposed to involuntary risk, risk which they have no control, they make risk aversion their primary goal. Under these circumstances individuals require the probabilty of risk to be as much as one thousand times smaller then for the same situation under their perceived control.

Evaluations of future risk:

- Real future risk as disclosed by the fully matured future circumstances when they develop.
- Statistical risk, as determined by currently available data, as measured actuarially for insurance premiums.
- Projected risk, as analytically based on system models structured from historical studies.
- Perceived risk, as intuitively seen by individuals.

Air transportation as an example:

- Flight insurance company -statistical risk.
- Passenger -percieved risk.
- Federal Aviation Administration(FAA) -projected risks.

How to Reduce Risk?

1.Define the Problem

2.Generate Several Solutions

3. Analyse each solution to determine the pros and cons ofeach

4. Test the solutions

5.Select the best solution

6. Implement the chosen solution

7. Analyse the risk in the chosen solution

8. Try to solve it. Or move to next solution.

Risk-Benefit Analysis and Risk Management

Informative risk-benefit analysis and effectiverisk managementare essential to the ultimate commercial success of your product. We are a leader in developing statistically rigorous, scientifically valid risk-benefit assessment studies that can be used to demonstrate the level of risk patients and other decision makers are willing to accept to achieve the benefits provided by your product.

Risk-Benefit Modeling	Systematically quantify the relative importance of risks and benefits to demonstrate the net benefits of treatment
Risk-Benefit Tradeoffs	Quantify patients' maximum acceptable risk for specific therapeutic benefits

CHERNOBYL CASE STUDIES

What Happened?

At 1:24 AM on April 26, 1986, there was an explosion at the Soviet nuclear power plant at Chernobyl. Oneof thereactorsoverheated, igniting apocket ofhydrogen gas. Theexplosion blew the top off the containment building, and exposed the molten reactor to the air. Thirty-one power plant workers were killed in the initial explosion, and radioactive dust and debris spewed into the air.

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Ittook severaldaysto putoutthefire. Helicoptersdropped sand and chemicalson thereactor rubble, finally extinguishing the blaze. Then the Soviets hastily buried the reactor in a sarcophagus of concrete. Estimates of deaths among the clean-up workers vary widely. Four thousand clean-up workers may have died in the following weeks from the radiation.

The countries now known as Belarus and Ukraine were hit the hardest by the radioactive fallout. Winds quickly blew the toxic cloud from Eastern Europe into Sweden and Norway. Within a week, radioactive levels had jumped over all of Europe, Asia, and Canada. It is estimated thatseventy-thousand Ukrainianshavebeen disabled, and fivemillion peoplewere exposed to radiation. Estimates of total deaths due to radioactive contamination range from 15,000 to 45,000 or more.

To give you an idea of the amount of radioactive material that escaped, the atomic bomb dropped on Hiroshima had a radioactive mass of four and a half tons. The exposed radioactive mass at Chernobyl was fifty tons.

In themonthsand yearsfollowing, birth defectswerecommon for animalsand humans. Even the leaves on the trees became deformed.

Today, in Belarusand Ukraine, thyroid cancer and leukemiaarestillhigher than normal. The towns of Pripyat and Chernobyl in the Ukraine are ghost towns. They will be uninhabitable due to radioactive contamination for several hundred years. The worst of the contaminated area is called “The Zone,” and it is fenced off. Plants, meat, milk, and water in the area are stillunsafe. Despitethecontamination, millionsofpeoplelivein and near TheZone, too poor to move to safer surroundings.

Further, human genetic mutations created by the radiation exposure have been found in children who have only recently been born. This suggests that there may be another whole generation of Chernobyl victims.

Recentreportssay thattherearesomeindicationsthattheconcretesarcophagusatChernobyl is breaking down.

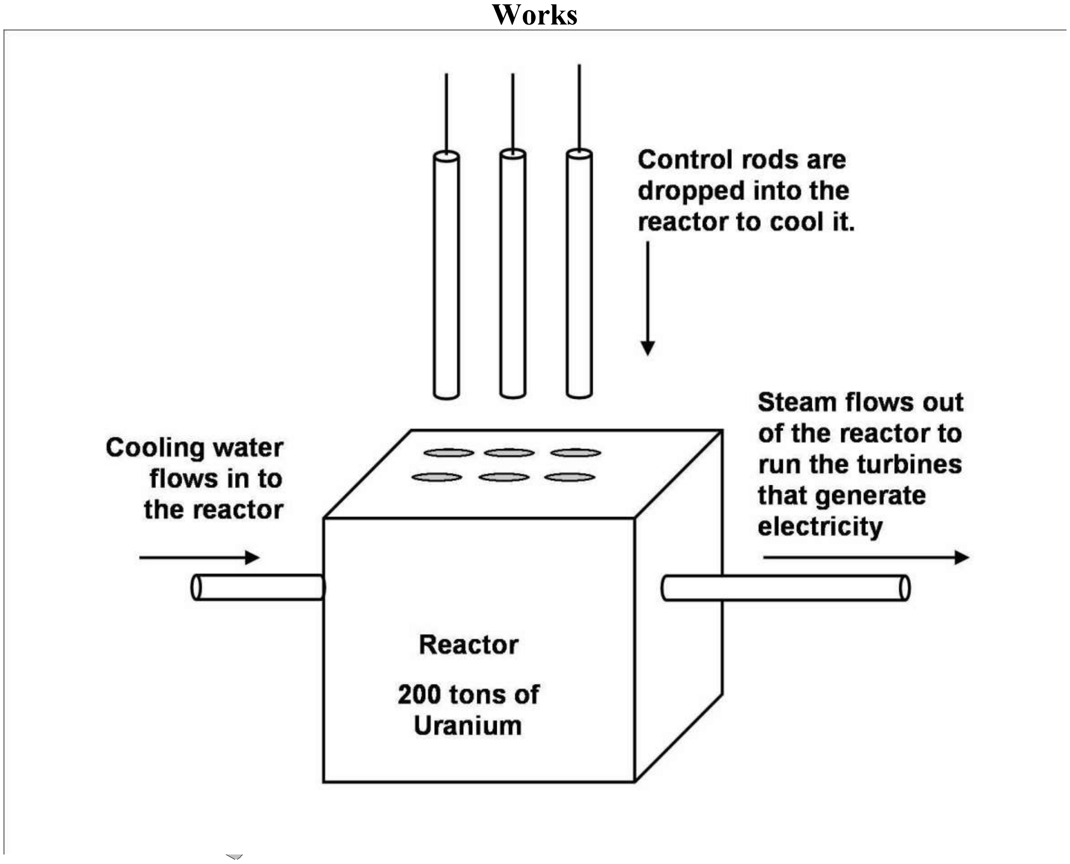
How a Nuclear Power Plant Works

The reactor at Chernobyl was composed of almost 200 tons of uranium. This giant block of uranium generated heat and radiation. Water ran through the hot reactor, turning to steam. The steam ran the turbines, thereby generating electricity. The hotter the reactor, the more electricity would be generated.

Leftto itself, the reactor would become too *reactive*—it would become hotter and hotter and more and more radioactive. If the reactor had nothing to cool it down, it would quickly *meltdown*Ña process where the reactor gets so hot that it meltsÑmelting through the floor. So, engineers needed a way to control the temperature of the reactor, to keep it from the catastrophic meltdown. Further, the engineers needed to be able to regulate the temperature of the reactor—so that it ran hotter when more electricity was needed, and could run colder when less electricity was desired.

The method they used to regulate the temperature of the reactor was to insert heat-absorbing rods, called *control rods*. These control rods absorb heat and radiation. The rods hang above the reactor, and can be lowered into the reactor, which will cool the reactor. When more electricity is needed, the rods can be removed from the reactor, which will allow the reactor to heat up. The reactor has hollow tubes, and the control rods are lowered into these reactor tubes, or raised up out of the reactor tubes. At the Chernobyl-type reactors, there are 211 control rods. The more control rods that are inserted, the colder the reactor runs. The more control rods that are removed, the hotter the reactor becomes.

How a Nuclear Power Plant Works



Soviet safety procedures demanded that at least 28 rods were inserted into the Chernobyl reactor at all times. This was a way to make sure that the reactor wouldn't overheat.

Water was another method to moderate the temperature of the reactor. When more water ran through the reactor, the reactor cooled faster. When less water ran through the reactor, the reactor stayed hot.

Chernobyl Background

The list of senior engineers at Chernobyl was as follows: Viktor Bryukhanov, the plant director, was a pure physicist, with no nuclear experience.

Anatoly Dyatlov, the deputy chief engineer, served as the day-to-day supervisor. He had worked with reactor cores but had never before worked in a nuclear power plant. When he accepted the job as deputy chief engineer, he exclaimed, "you don't have to be a genius to figure out a nuclear reactor."

Theengineers were Aleksandr Akimov, serving his first position in this role; NikolaiFomin, an electrical engineer with little nuclear experience; Gennady Metlenko, an electrical engineer; and Leonid Toptunov, a 26 year-old reactor control engineer. The engineers were heavy in their experience of electric technology, but had less experience with the uniqueness of neutron physics.

The confidence of these engineers was exaggerated. They believed they had decades of problem-freenuclear work, so they believed thatnuclear power wasvery safe. Theengineers believed that they could figure out any problem. In reality, there had been many problems in the Soviet nuclear power industry. The Soviet state tried to keep problems a secret because problems are bad PR.

TheSovietshad anumber ofnuclear accidents(thisisapartiallistofSovietaccidentsbefore Chernobyl). In 1957 in Chelyabinsk, therewasasubstantialreleaseofradioactivity caused by a spontaneous reaction in spent fuel; in 1966 in Melekess the nuclear power plant experienced a spontaneous surge in power, releasing radiation; In 1974, there was an explosion at the nuclear power plant in Leningrad; Later in 1974, at the same nuclear power plant, threepeoplewerekilled and radiation wasreleased into theenvironment;in1977, there wasapartialmeltdown ofnuclear fuelatByeloyarsk;in 1978 atByeloyarsk, thereactor went out of control after a roof panel fell onto it; In 1982 at Chernobyl, radioactivity was released into the environment; In 1982, there was there was a fire at Armyanskaya; In 1985, fourteen people were killed when a relief valve burst in Balakovo.

Had the engineers at Chernobyl had the information of the previous nuclear accidents, perhaps they would have known to be more careful. It is often from mistakes that we learn, and the engineers at Chernobyl had no opportunity to learn.

As a footnote, don't think that the problems were just those mistake-laden Soviets. Here is a partial list of American accidents before Chernobyl: In 1951, the Detroit reactor overheated, and air was contaminated with radioactive gasses; In 1959, there was a partial meltdown in Santa Susanna, California; In 1961, three people were killed in an explosion at the nuclear power plant at Idaho Falls, Idaho; In 1966, there was a partial meltdown at a reactor near Detroit;In 1971, 53,000 gallonsofradioactivewater werereleased into theMississippiRiver from the Monticello plant in Minnesota; In 1979, there was population evacuation and a discharge of radioactive gas and water in a partial meltdown at Three Mile Island; in 1979 there was a discharge of radiation in Irving Tennessee; In 1982, there was a release of radioactive gas into the environment in Rochester, New York; In 1982, there was a leak of radioactive gasses into the atmosphere at Ontario, New York; In 1985, there was a leak of radioactive water near New York City; In 1986, one person was killed in an explosion of a tank of radioactive gas in Webbers Falls, Oklahoma.

The engineers at Chernobyl didn't know about these nuclear accidents. These were secrets thattheSovietskeptfromthenuclear engineers. Consequently, no onewasableto learn from the mistakes of the past. The nuclear plant staff believed that their experience with nuclear power was pretty much error-free, so they developed an overconfidence about their working style.

So, according to Gregori Medvedev (the Soviet investigator of Chernobyl), their practice becamelazy and their safety practicesslipshod. Further, theheavy bureaucracy and hierarchy of the Soviet system created an atmosphere where every decision had to be approved at a variety of higher levels. Consequently, the hierarchical system had quelled the operators' creativity and motivation for problem-solving.

April 25th, 1:00 PM

The engineers at Chernobyl had volunteered to do a safety test proposed by the Soviet government. In theeventofareactor shutdown, aback-up systemofdieselgeneratorswould crank up, taking over the electricity generation. However, the diesel engines took a few minutes to start producing electricity. The reactor had a turbine that was meant to generate electricity for a minute or two until the diesel generators would start operating. The experiment at Chernobyl was meant to see exactly how long that turbine would generate the electricity.

The experiment required that the reactor be operating at 50% of capacity. On April 25th, 1986, at 1:00 PM, the engineers began to reduce the operating power of the reactor, by inserting the control rods into the reactor. This had the effect, you may recall, of cooling off the reactor—making it less reactive.

They also shutdown theemergency cooling system. They wereafraid thatthecooling system might kick in during the test, thereby interfering with the experiment. They had no authorization to deactivate the cooling system, but they went ahead and deactivated it.

The experiment called for running the reactor at 50% capacity, thereby generating only half the electricity. At 2:00 PM, a dispatcher at Kiev called and asked them to delay the test because of the higher-than-expected energy usage. They delayed the test, but did not reactivate the emergency cooling system.

April 25th, 11:00 PM

At11:00 PM, they began thetestagain. Toptunov, thesenior reactor controlengineer, began to manually lower the reactor to 50% of its capacity so that they could begin the turbine safety experiment.

Lowering the power generation of a nuclear reactor is a tricky thing. It is not like lowering thethermostatin ahouse. When you lower thethermostatinthehousefrom72 to 68 degrees, the temperature in the house will drop to 68 degrees and stay there. But in a nuclear reactor, thedropping ofthetemperatureisnotonly the*result*oflowering thereactivity, butitisalso a *cause* of lowering the reactivity. In other words, the coldness of the reactor will make the reactor colder. This is called the *self-damping effect*. Conversely, when the reactor heats up, the heat of the reactor will make itself hotter (the self-amplifying effect).

So, when the control rods are dropped into the reactor, the reactivity goes down. And the water running through the reactor also lessens reactivity. But the lower reactivity also makes thereactor itselflessreactive. So, theChernobylreactor damped itself, even asthewater and the control rods damped its reactivity.

It is typically hard for people to think in terms of exponential reduction or exponential increase. Wenaturally think ofalinear (straight-line) reduction or alinear increase. Wehave trouble with self-damping and self-amplifying effects, because they are nonlinear by definition.

So, theengineersoversteered theprocess, and hitthe50% mark, butthey wereunableto keep it there. By 12:30 AM, the power generation had dropped to 1% of capacity.

Chernobyl-type reactors are not meant to drop that low in their capacity. There are two problemswith thenuclear reactor running at1% ofcapacity. When reactivity dropsthatlow, the reactor runs unevenly and unstably, like a bad diesel engine. Small pockets of reactivity can begin thatcan spread hotreactivity through thereactor. Secondly, thelowrunning ofthe reactor creates unwanted gasses and byproducts (xenon and iodine) that poison the reactor. Because of this, they were strictly forbidden to run the reactor below 20% of capacity.

In the Chernobyl control room, Dyatlov (the chief engineer in charge of the experiment), upon hearing thereactor wasat1%, flewinto arage. With thereactor capacity wasso low, he would notbeableto conducthissafety experiment. With thereactor at1% capacity, Dyatlov had two options:

1. One option was to let the reactor go cold, which would have ended the experiment, and then they would have to wait for two days for the poisonous byproducts to dissipate before starting the reactor again. With this option, Dyatlov would no doubt have been reprimanded, and possibly lost his job.
2. The other option was to immediately increase the power. Safety rules prohibited increasing the power if the reactor had fallen from 80% capacity. In this case, the power had fallen from 50% capacity—so they were not technically governed by the safety protocols.

Dyatlov ordered the engineers to raise power.

Today, we know the horrible outcome of this Chernobyl chronology. It is easy for us to sit back in our armchairs, with the added benefit of hindsight, and say Dyatlov made the wrong choice. Of course, he could have followed the spirit of the protocols and shut the reactor down. However, Dyatlov did nothavethebenefitofhindsight. Hewasfaced with thechoice ofthe*surety*ofreprimand and theharming ofhiscareer vs. the*possibility*ofsafety problems. And, we know from engineers and technical operators everywhere, safety protocols are *routinely* breached when faced with this kind of choice. Experts tend to believe that they are experts, and that the safety rules are for amateurs.

Further, safety rules are not designed so that people are killed instantly when the safety standard isbroken. On a55-mileper hour limiton ahighway, carsdo notsuddenly burstinto flames at 56 miles per hour. In fact, there is an advantage to going 56 miles an hour as opposed to 55 (you get to your destination faster). In the same way, engineers frequently view safety rules as troublesome, and there is an advantage to have the freedom to disregard them.

In fact, we experience this psychologic every day, usually without thinking about it. When you come toward an intersection, and the light turns yellow, you reach a point where you either haveto go through on ayellowlight, or cometo astop. Many peoplego through on the yellow, even though thereisagreater risk. So, in asplitsecond, wedecidebetween thesurety of sitting at a red light or the possibility, albeit slight, of a safety problem to go through the yellowlight. Thereisaclear advantageto taketherisk (aslong asyou aren'tin an accident). While the stakes were higher at Chernobyl, the same psychologic applies.

At this point in the Chernobyl process, there were 28 control rods in the reactor—the minimumrequired. Increasing power would mean thateven morecontrolrodswould haveto be removed from the reactor. This would be a breach of protocol--the minimum number of rods was 28. Dyatlov gave the order to remove more control rods.

Toptunov, the reactor control engineer, refused to remove any more rods. He believed it would be unsafe to increase the power. With the reactor operating at 1%, and the minimum number of control rods in the reactor, he believed it would be unsafe to remove more rods. He was abiding by a strict interpretation of the safety protocols of 28 rods.

But Dyatlov continued to rage, swearing at the engineers and demanding they increase power. Dyatlov threatened to fire Toptunov immediately if he didn’t increase the power.

The 26-year-old Toptunov was faced with a choice. He believed he had two options:

1. He could refuse to increase power—but then Dyatlov would fire him immediately, and his career would be over.
2. His other choice was to increase power, recognizing that something bad *might* happen.

Toptunov looked around. Alltheother engineers—including hissupervisors—werewilling to increase power. Toptunov knew he was young and didn't have much experience with reactors. Perhaps this kind of protocol breach was normal. Toptunov was faced with that choice of the *surety* of his career ending, vs the *possibility* of safety problems. Toptunov decided to agree and increase the power.

Tragically, it would be the last decision Toptunov would ever make.

April 26th, 1:00 AM

By 1:00 AM, the power of the reactor was stable at 7% of capacity. Only 18 control rods were in the reactor (safety protocols demanded that no less than 28 control rods should always be in the reactor).

At1:07 AM, theengineerswanted to makesurethereactor wouldn'toverheat, so they turned on more water to ensure proper cooling (they were now pumping five times the normal rate of water through the reactor). The extra water cooled the reactor, and the power dropped again. Theengineersresponded by withdrawing even morecontrolrods. Now, only 3 control rods were inserted in the reactor.

The reactor stabilized again. The engineers, satisfied with the amount of steam they were getting (they needed steamfor their experiment) shutoffthepumpsfor theextrawater. They shut off the water, apparently only considering the effect that the water would have on the experiment—and did notconsider theeffectthatthewater washaving on thereactor. Atthis point, with only 3 control rods in the reactor, the water was only thing keeping the reactor cool. Without the extra cool water, the reactor began to get hot. Power increased slowly at first. As the reactor got hotter, the reactor itself made the reactor hotter—the self-amplifying effect. The heat and reactivity of the reactor increased exponentially.

The engineers were trying to watch multiple variables simultaneously. The water, the steam, the control rods, and the current temperature of the reactor all were intertwined to affect the reactivity of the reactor. People can easily think in cause and effect terms. Had their only been one variable that controlled the reactivity, the results would probably have been different. However, people have difficulty thinking through the process when there are a multitude of variables, all interacting in different ways.

Peoplearenotprocessorsofunlimited information. Thereisalimited amountofinformation with which a person can work. With the safety of hindsight, we can sit back and make a judgment saying, "they didn't think through all their information." However, this kind of linear judgment does not tell us*why*they didn't see what is obvious to our hindsight.

At1:22 AM(90 secondsbeforetheexplosion), theengineerswerestillrelaxed and confident. Dyatlov, in fact, wasseeing histurbinesafety experimentcoming to asuccessfulconclusion. In whatturned outto beatragicirony, heencouraged hisengineersby suggesting, “in two or three minutes it will all be over.”

Thirty seconds before the explosion, the engineers realized the reactor was heating up too fast. With only 3 control rods in the reactor, and then shutting off the water, the reactor was superheating. In a panic, they desperately tried to drop control rods into the reactor, but the heat of the reactor had already melted the tubes into which the control rods slid.

Thefloor ofthebuilding began to shake, and loud banging started to echo through thecontrol room. Thecoolantwater began to boilviolently, causing thepipesto burst. Thesuper-heating reactor was creating hydrogen and oxygen gasses. This explosive mixture of gasses accumulated abovethereactor. Theheatofthereactor wasbuilding fast, and thetemperature of the flammable gasses was rising.

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April26th, 1:24 AM

Finally, the gasses detonated, destroying the reactor and the protectivecontainmentbuilding. The control room was far enough away from the containment building to escape destruction, but the explosion shook the entire plant. Debris caved in around the control room members, and Dyatlov, Akimov, Toptunov, and the others were knocked to the floor. Dust and chalk filled the air. While they knew there had been an explosion, they hoped and prayed the explosion had not come from the reactor. Toptunov and Akimov ran over the broken glass and ceiling debris to the open door, and ran across the compound toward the containment building. There, they saw the horrifying, unspeakable sight. There was rubble where the reactor had been. They sawflamesshooting up 40 feethigh, burning oilsquirting frompipes onto theground, black ash falling to theground, and abrightpurplelightemanating fromthe rubble.

Within a few minutes, fire fighters had arrived. The fire fighters, most with no protective equipment, heroically worked to extinguish the fire, hoping to prevent further damage to the three other reactors at the plant. Most of the fire fighters died from the radiation exposure.

Bryukhanov (theplantdirector), who wasnotattheplantatthetime, had been contacted and told about an explosion. In the chaos, those informing Bryukhanov of the explosion still did not know the total amount of devastation. Bryukhavov, still desperately hoping that the reactor wasintact, called Moscowto informthemthatwhiletherehad been an explosion, the reactor had not sustained any damage.

Again, with thebenefit of hindsight, we can say that Bryukhanov should have acted quicker. It's true that many lives could have been saved if he had acted differently. However, his actions are not uncommon in these kinds of situations. A common reaction is called "horizontalflight,"wherepeopleretreatfromtheworst-casescenario, convincing themselves to believethebest-casescenario. Bryukhanov had convinced himselfthatthereactor wasnot in danger. And after all, someonefromtheplanthad called and given an ambiguousmessage. Surely they would have known if the reactor had been destroyed.

April 26th, 4:00 AM

At 4:00 AM, the command from Moscow came back: *Keep the reactor cool*. The authorities in Moscow had no idea that the damage was so catastrophic.

Akimov, Dyatlov, and Toptunov, their skin brown from the radiation, and their bodies wrenched from internal damage, had already been taken away to the medical center.

At 10:00 AM, Bryukhanov, the plant director, was informed that the reactor had been destroyed. Bryukhanov rejected the information, preferring to believe that the reactor was still intact. He informed Moscow that the reactor was intact and radiation was within normal limits.

Later that day, experts from around the Soviet Union came to Chernobyl, and found the horrifying truth. Thereactor had indeed been destroyed, and fifty tonsofradioactivefuelhad instantly evaporated. The wind blew the radioactive plume in a northwesterly direction. Belarus and Finland were going to be in the path of the radioactive cloud.

The Days Afterward

The secretive Soviet state was slow to act. Soviet bureaucracy debated whether to evacuate nearby cities, and how much land should be evacuated. They were slow in their response, slow to evacuate, and slow to inform the world of the disaster. It took over 36 hours before authorities began to evacuate nearby residents. Two days later, the nightly news (the fourth story) reported that one of the reactors was "damaged."

Within a few days, radiation detectors were going off all over the world. The Soviets continued to try to hide the issue from the world and their own residents.

Several months later, Bryukhanov was arrested, still believing that he did everything right. Dyatlov survived the radiation sickness, and was arrested in December of that year. He believed hewasascapegoatfor theaccident. Akimov died afewweeksafter thedisaster, but till the very end continued to say, "I did everything right. I don't know how it happened."

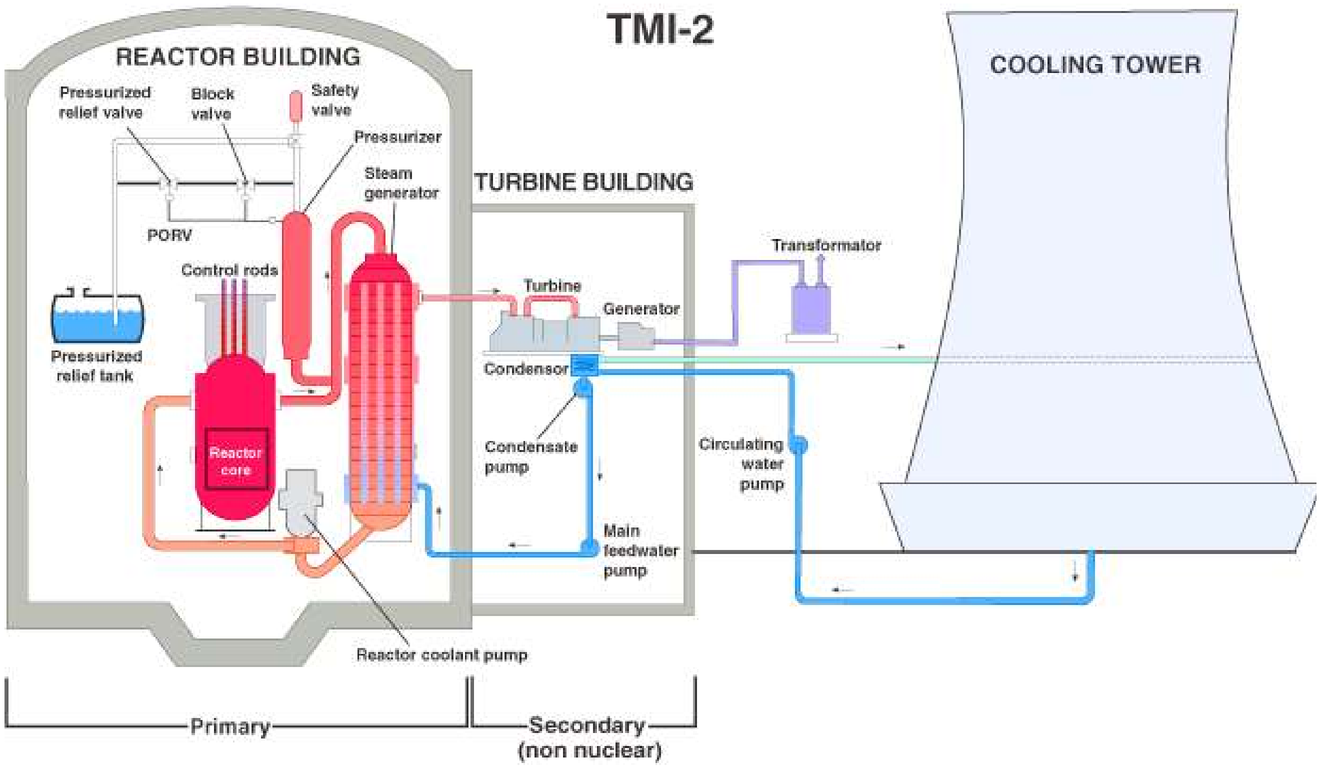
The radiation cloud on April 27th, 1986

THREE MILE ISLAND ACCIDENT

(*March 2001*, *minorupdateJan 2010*)

- **In 1979 at Three Mile Island nuclear power plant in USA a cooling malfunction caused part of the core to melt in the # 2 reactor. The TMI-2 reactor was destroyed.**
- **Some radioactive gas was released a couple of days after the accident, but not enough to cause any dose above background levels to local residents.**
- **There were no injuries or adverse health effects from the Three Mile Island accident.**

The Three Mile Island power station is near Harrisburg, Pennsylvania in USA. It had two pressurized water reactors. OnePWR wasof800 MWe(775 MWenet) and entered servicein 1974. It remains one of the best-performing units in USA. Unit 2 was of 906 MWe (880 MWe net) and almost brand new.



Theaccidentto unit2 happened at4 amon 28 March 1979 when thereactor wasoperating at 97% power. Itinvolved arelatively minor malfunction in thesecondary cooling circuitwhich caused the temperature in the primary coolant to rise. This in turn caused the reactor to shut down automatically. Shut down took about one second. At this point a relief valve failed to close, butinstrumentation did notrevealthefact, and so much oftheprimary coolantdrained away that the residual decay heat in the reactor core was not removed. The core suffered severe damage as a result.

The operators were unable to diagnose or respond properly to the unplanned automatic shutdown of the reactor. Deficient control room instrumentation and inadequate emergency response training proved to be root causes of the accident

The chain of events during the Three Mile Island Accident

Within seconds of the shutdown, the pilot-operated relief valve (PORV) on the reactor cooling system opened, as it was supposed to. About 10 seconds later it should have closed. But it remained open, leaking vital reactor coolant water to the reactor coolant drain tank. The operators believed the relief valve had shut because instruments showed them that a "close"signalwassentto thevalve. However, they did nothavean instrumentindicating the valve's actual position.

Responding to thelossofcooling water, high-pressureinjection pumpsautomatically pushed replacement water into the reactor system. As water and steam escaped through the relief valve, cooling water surged into thepressuriser, raising thewater levelin it. (Thepressuriser is a tank which is part of the primary reactor cooling system, maintaining proper pressure in the system. The relief valve is located on the pressuriser. In a PWR like TMI-2, water in the primary cooling system around the core is kept under very high pressure to keep it from boiling.)

Operatorsresponded by reducing theflowofreplacementwater. Their training told themthat thepressuriser water levelwastheonly dependableindication oftheamountofcooling water in the system. Because the pressuriser level was increasing, they thought the reactor system was too full of water. Their training told them to do all they could to keep the pressuriser from filling with water. If it filled, they could not control pressure in the cooling system and it might rupture.

Steam then formed in the reactor primary cooling system. Pumping a mixture of steam and water caused the reactor cooling pumps to vibrate. Because the severe vibrations could have damaged the pumps and made them unusale, operators shut down the pumps. This ended forced cooling of the reactor core. (The operators still believed the system was nearly full of water becausethepressuriser levelremained high.) However, asreactor coolantwater boiled away, the reactor?s fuel core was uncovered and became even hotter. The fuel rods were damaged and released radioactive material into the cooling water.

At 6:22 am operators closed a block valve between the relief valve and the pressuriser. This action stopped thelossofcoolantwater through thereliefvalve. However, superheated steam and gases blocked the flow of water through the core cooling system.

Throughout the morning, operators attempted to force more water into the reactor system to condense steam bubbles that they believed were blocking the flow of cooling water. During the afternoon, operators attempted to decrease the pressure in the reactor system to allow a low pressure cooling system to be used and emergency water supplies to be put into the system.

Cooling Restored

By late afternoon, operators began high-pressure injection of water into the reactor cooling system to increase pressure and to collapse steam bubbles. By 7:50 pm on 28 March, they restored forced cooling of the reactor core when they were ableto restartonereactor coolant pump. They had condensed steam so that the pump could run without severe vibrations.

Radioactive gases from the reactor cooling system built up in the makeup tank in the auxiliary building. During March 29 and 30, operators used a system of pipes and compressors to move the gas to waste gas decay tanks. The compressors leaked, and some radioactive gas was released to the environment.

The Hydrogen Bubble

When the reactor's core was uncovered, on the morning of 28 March, a high-temperature chemicalreaction between water and thezircaloy metaltubesholding thenuclear fuelpellets had created hydrogen gas. In the afternoon of 28 March, a sudden rise in reactor building pressure shown by the control room instruments indicated a hydrogen burn had occurred. Hydrogen gas also gathered at the top of the reactor vessel.

From 30 March through 1 April operators removed this hydrogen gas "bubble" by periodically opening the vent valve on the reactor cooling system pressuriser. For a time, regulatory (NRC) officials believed the hydrogen bubble could explode, though such an explosion was never possible since there was not enough oxygen in the system.

Cold Shutdown

After an anxious month, on 27 April operators established natural convection circulation of coolant. The reactor core was being cooled by the natural movement of water rather than by mechanical pumping. The plant was in "cold shutdown".

Public concern and confusion

When the TMI-2 accident is recalled, it is often in the context of what happened on Friday and Saturday, March 30-31. The drama of the TMI-2 accident-induced fear, stress and confusion on those two days. The atmosphere then, and the reasons for it, are described well in the book "*Crisis Contained, TheDepartmentofEnergyatThreeMileIsland*," by Philip L Cantelon and Robert C. Williams, 1982. This is an official history of the Department of Energy's role during the accident.

"Friday appears to have become a turning point in the history of the accident because of two events:thesudden risein reactor pressureshown by controlroominstrumentson Wednesday afternoon (the "hydrogen burn") which suggested a hydrogen explosion? became known to the Nuclear Regulatory Commission [that day]; and the deliberate venting of radioactive gases from the plant Friday morning which produced a reading of 1,200 millirems (12 mSv) directly above the stack of the auxiliary building.

"Whatmadethesesignificantwasaseriesofmisunderstandingscaused, in part, by problems of communication within various state and federal agencies. Because of confused telephone conversationsbetween peopleuninformed abouttheplant'sstatus, officialsconcluded thatthe 1,200 millirems (12 mSv) reading was an off-site reading. They also believed that another hydrogen explosion was possible, that the Nuclear Regulatory Commission had ordered evacuation and that a meltdown was conceivable.

"Garbled communications reported by the media generated a debate over evacuation. Whether or not there were evacuation plans soon became academic. What happened on

Friday was not a planned evacuation but a weekend exodus based not on what was actually happening at Three Mile Island but on what government officials and the media imagined might happen. On Friday confused communications created the politics of fear." (Page 50)

Throughout the book, Cantelon and Williams note that hundreds of environmental samples were taken around TMI during the accident period by the Department of Energy (which had the lead sampling role) or the then-Pennsylvania Department of Environmental Resources. But there were no unusually high readings, except for noble gases, and virtually no iodine. Readings were far below health limits. Yet a political storm was raging based on confusion and misinformation.

No Radiological Health Effects

TheThree Mile Islandaccident caused concerns about the possibility of radiation-induced health effects, principally cancer, in the area surrounding the plant. Because of those concerns, the Pennsylvania Department of Health for 18 years maintained a registry of more than 30,000 people who lived within five miles of Three Mile Island at the time of the accident. Thestate's registry was discontinued in mid 1997, withoutany evidenceof unusual health trends in the area.

Indeed, more than a dozen major, independent health studies of the accident showed no evidence of any abnormal number of cancers around TMI years after the accident. The only detectable effect was psychological stress during and shortly after the accident.

The studies found that the radiation releases during the accident were minimal, well below any levelsthathavebeen associated with health effectsfromradiation exposure. Theaverage radiation dose to people living within 10 miles of the plant was 0.08 millisieverts, with no more than 1 millisievert to any single individual. The level of 0.08 mSv is about equal to a chestX-ray, and 1 mSv isaboutathird oftheaveragebackground levelofradiation received by U.S. residents in a year.

In June1996, 17 yearsafter theTMI-2 accident, Harrisburg U.S. DistrictCourtJudgeSylvia Rambo dismissed a class action lawsuit alleging that the accident caused health effects. The plaintiffs have appealed Judge Rambo's ruling. The appeal is before the U.S. Third Circuit Court of Appeals. However, in making her decision, Judge Rambo cited:

· Findings that exposure patterns projected by computer models of the releases compared so well with data from the TMI dosimeters (TLDs) available during the accident that the dosimeters probably were adequate to measure the releases.

·Thatthemaximumoffsitedosewas, possibly, 100 millirem(1 mSv), and thatprojected fatal cancers were less thanone.

· The plaintiffs' failure to prove their assertion that one or more unreported hydrogen "blowouts"in thereactor systemcaused oneor moreunreported radiation "spikes", producing a narrow yet highly concentrated plume of radioactive gases.

Judge Rambo concluded: "The parties to the instant action have had nearly two decades to muster evidencein supportoftheir respectivecases.... Thepaucity ofproofalleged in support of Plaintiffs' case is manifest. The court has searched the record for any and all evidence which construed in a light most favourable to Plaintiffs creates a genuine issue of material fact warranting submission of their claims to a jury. This effort has been in vain."

More than a dozen major, independent studies have assessed the radiation releases and possible effects on the people and the environment around TMI since the 1979 accident at TMI-2. The most recent was a 13-year study on 32,000 people. None has found any adverse health effects such as cancers which might be linked to the accident.

The TMI-2 Cleanup

The cleanup of the damaged nuclear reactor system at TMI-2 took nearly 12 years and cost approximately US$973 million. The cleanup was uniquely challenging technically and radiologically. Plant surfaces had to be decontaminated. Water used and stored during the cleanup had to be processed. And about 100 tonnes of damaged uranium fuel had to be removed from the reactor vessel--all without hazard to cleanup workers or the public.

Acleanup plan wasdeveloped and carried outsafely and successfully by ateamofmorethan 1000 skilled workers. Itbegan in August1979, with thefirstshipmentsofaccident-generated low-level radiological waste to Richland, Washington. In the cleanup's closing phases, in 1991, finalmeasurementsweretaken ofthefuelremaining in inaccessiblepartsofthereactor vessel. Approximately onepercentofthefueland debrisremainsin thevessel. Also in 1991, the last remaining water was pumped from the TMI-2 reactor. The cleanup ended in December 1993, when Unit 2 received a license from the NRC to enter Post Defueling Monitored Storage (PDMS).

Early in the cleanup, Unit 2 was completely severed from any connection to TMI Unit 1. TMI-2 today isin long-termmonitored storage. No further useofthenuclear partoftheplant isanticipated. Ventilation and rainwater systemsaremonitored. Equipmentnecessary to keep the plant in safe long-term storage is maintained.

Defueling theTMI-2 reactor vesselwastheheartofthecleanup. Thedamaged fuelremained underwater throughout the defueling. In October 1985, after nearly six years of preparations, workers standing on a platform atop the reactor and manipulating long-handled tools began lifting the fuel into canisters that hung beneath the platform. In all, 342 fuel canisters were shipped safely for long-term storage at the Idaho National Laboratory, a program that was completed in April 1990.

TMI-2 cleanup operations produced over 10.6 megalitres of accident-generated water that was processed, stored and ultimately evaporated safely.

In February 1991, the TMI-2 Cleanup Program was named by the National Society of Professional Engineers as one of the top engineering achievements in the U.S. completed during 1990.

In 2010 the generator was sold by FirstEnergy to Progress Energy to upgrade its Harris nuclear power plant in North Carolina. It is being shipped in two parts, the rotor, which weighs 170 tonnes, and the stator, which weighs about 500 tonnes.

The NRC website has afactsheet on Three Mile Island.

TMI-1: Safe and World-Class

From its restart in 1985, Three Mile Island Unit 1 has operated at very high levels of safety and reliability. Application of the lessons of the TMI-2 accident has been a key factor in the plant's outstanding performance.

In 1997, TMI-1 completed the longest operating run of any light water reactor in the history of nuclear power worldwide - 616 days and 23 hours of uninterrupted operation. (That run wasalso thelongestatany steam-driven plantin theU.S., including plantspowered by fossil fuels.) And in October 1998, TMI employees completed threemillion hours of work without a lost-work day accident.

AtthetimeoftheTMI-2 accident, TMI-1 wasshutdown for refueling. Itwaskeptshutdown during lengthy proceedings by the Nuclear Regulatory Commission. During the shutdown, the plant was modified and training and operating procedures were revamped in light of the lessons of TMI-2.

When TMI-1 restarted in October 1985, GeneralPublicUtilitiespledged thattheplantwould be operated safely and efficiently and would become a leader in the nuclear power industry. Those pledges have been kept.

- The plant's capability factor for 1987, including almost three months of a five-month refueling and maintenanceoutage, was74.1 percent, compared to an industry average of 62 percent. (Capability factor refers to the amount of electricity generated compared to the plant'smaximum capacity.)
- In 1988 a 1.3% (11 MWe) uprate was licensed.
- For 1989, TMI-1's capability factor was 100.03 percent and the best of 357 nuclear power plants worldwide, according to *NucleonicsWeek*.
- In 1990-91, TMI-1 operated 479 consecutive days, the longest operating run at that point in the history of US commercial nuclear power. It was named by the NRC as one of the four safest plants in the country during this period.
- By the end of 1994, TMI-1 was one of the first two plants in the history of US commercial nuclear power to achieve a three-year average capability factor of over 90% (TMI-1 had 94.3%).
- In October 1998, TMI workers completed two full years without a lost workday injury.
- Since its restart, TMI-1 has earned consistently high ratings in the NRC's program, Systematic Assessment of Licensee Performance (SALP).
- In 2009, the TMI-1 operating licence was renewed, extending it life by 20 years to 2034.
- Immediately following this, both steam generators were replaced as TMI's "largest capital project to date"

In 1999, TMI-1 waspurchased by AmerGen, anewjointventurebetween British Energy and PECO Energy. In 2003 the BE share was sold so that the plant became wholly-owned by Exelon, PECO's successor. It is now listed as producing 786 MWe net.

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Training improvements

Training reforms are among the most significant outcomes of the TMI-2 accident. Training became centred on protecting a plant's cooling capacity, whatever the triggering problem mightbe. AtTMI-2, theoperatorsturned to abook ofproceduresto pick thosethatseemed to fittheevent. Nowoperatorsaretaken through asetof"yes-no"questionsto ensure, *first*, that thereactor'sfuelcoreremainscovered. *Then*they determinethespecificmalfunction. Thisis known as a "symptom-based" approach for responding to plant events. Underlying it is a style of training that gives operators a foundation for understanding both theoretical and practical aspects of plant operations.

The TMI-2 accident also led to the establishment of the Atlanta-based Institute of Nuclear Power Operations (INPO) and its National Academy for Nuclear Training. These two industry organisationshavebeen effectivein promoting excellencein theoperation ofnuclear plants and accrediting their training programs.

INPO was formed in 1979. The National Academy for Nuclear Training was established under INPO's auspices in 1985. TMI's operator training program has passed three INPO accreditation reviews since then.

Training hasgonewellbeyond button-pushing. Communicationsand teamwork, emphasizing effective interaction among crew members, are now part of TMI's training curriculum.

Close to half of the operators' training is in a full-scale electronic simulator of the TMI controlroom. The$18 million simulator permits operatorsto learn and betested on allkinds of accident scenarios.

Increased safety & reliability

Disciplinesin training, operationsand eventreporting thatgrewfromthelessonsoftheTMI-2 accident have made the nuclear power industry demonstrably safer and more reliable. Those trends have been both promoted and tracked by the Institute for Nuclear Power Operations(INPO). To remain in good standing, anuclear plantmustmeetthehigh standards set by INPO as well as the strict regulation of the US Nuclear Regulatory Commission.

A key indicator is the graph of significant plant events, based on data compiled by the Nuclear Regulatory Commission. The number of significant events decreased from 2.38 per reactor unit in 1985 to 0.10 at the end of 1997.

On the reliability front, the median capability factor for nuclear plants - the percentage of maximum energy that a plant is capable of generating - increased from 62.7 percent in 1980 to almost 90 percent in 2000. (The goal for the year 2000 was 87 percent.)

Other indicators for US plants tracked by INPO and its world counterpart, the World Association of Nuclear Operators (WANO) are the unplanned capability loss factor, unplanned automatic scrams, safety system performance, thermal performance, fuel reliability, chemistry performance, collective radiation exposure, volume of solid radioactive waste and industrial safety accident rate. All are reduced, that is, improved substantially, from 1980.

UNIT –II

ENGINEERING AS SOCIAL EXPERIMENTATION

Syllabus: Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study

ENGINEERING AS EXPERIMENTATION

Experimentation plays an important role in the process of designing the product. When it is decided to change a new engineering concept into its first rough design, preliminary tests or simulation should be conducted. Using formal experimental methods, the materials and methods of designing are tried out. These tests may be based on more detailed designs. The test for designing should be evolved till the final product produced. With the help of feedback of several tests, further modification can be made if necessary. Beyond these tests and experiments, each engineering project has to be viewed as an experiment.

Similarities to Standard Experiments

There are so many aspects, which are of virtual for combining every type of engineering works to make it suitable to look at engineering projects as experiments. The main three important aspects are:

1) Any engineering project or plan is put into practice with partial ignorance because while designing a model there are several uncertainities occurred. The reason to the fact that engineers don’t have all the needed facts available well in advance before starting the project. At some point, both the theoretical examining and the laboratory testing must be by-passed for the sake of completing the project. Really, the success of an engineer is based on the his talent which is exactly being the ability to succeed in achieving jobs with only a partial knowledge of scientific laws about the nature and society.

2) The final outcomes of engineering projects are generally uncertain like that of experiments what we do.

In engineering, in most of the cases, the possible outcomes may not be known and even small and mild projects itself involve greater risks.

The following uncertainities occur in the model designs

1. Model used for the design calculations
2. Exact characteristics of the material purchased.
3. Constancies of materials used for processing and fabrication.

4. About the nature of the pressure the finished product will encounter.

For instance, a reservoir may cause damage to the surroundings and affect the eco-system. If it leaks or breaks, the purpose will not be served. A special purpose fingerprint reader may find its application in the identification and close observation on the disagreeing persons with the government. A nuclear reactor may cause unexpected problems to the surrounding population leading to a great loss to the owners. A hair dryer may give damage to the unknowing or wrong users from asbestos insulation from its barrel.

3) Good and effective engineering depends upon the knowledge possessed about the products at the initial and end stages.

This knowledge is very useful for increasing the effectiveness of the current products as well as for producing better products in future. This can be achieved by keenly observing on the engineering jobs by the way of experimentation. This monitoring is done by making periodic observations and tests by looking at for the successful performance and the side effects of the jobs. The tests of the product's efficiency, safety, cost-effectiveness, environmental impact and its value that depends upon the utility to the society should also be monitored. It also extends to the stage of client use.

Learning from the past

It has been expected that the engineers have to learn not only form their own design and the production system but also the results of others. Due to lack of communication, prejudiced in not asking for clarification, fear of law and also mere negligence, these things can happen to the continuation of past mistakes. The following are some of the examples:

1. The tragedy of 'Titanic' happened because of the sufficient number of life boats. The same disaster took place in the steamship "the Arctic" some years before, because of the same problem.

2. The fall down of "the Sunshine Skyline Bridge" in the bay of Thamba at Sweden in 1980, on a moving ship due to improper matching of horizontal impact forces in mind. This could have been avoided of the engineers had known about the striking of the ships with the Maracaibo Bridge at Venezulea in 1964 and the Tasman Bridge of Australia in 1975.

3. The nuclear reactor accident at Three Mile Island on March 1979, was due to malfunctioning of the valves. Valves though minute items, are being among the least reliable components of hydraulic systems. It was a pressure relief valve and lack of information about its opening or closing state contributed to a nuclear reactor accident at Three Mile Island. This malfunction was already happened because of the same reasons at other locations.

4. The disaster of Tettron Dam in Los Angles was due to rapid flow of water and sudden break down. The builder didn't consider the case of the Fontenelle Dam, which was also collapsed due to the same problem.

So, to say that engineers should not fully depend on handbooks and they should have some review of the past cases relating to their current task.

Comparisons with standard Experiments

Engineering is entirely different from standard experiments in few aspects. Those differences are very much helpful to find out the special responsibilities of engineers and also help them in knowing about the moral irresponsibilities which are involved in engineering.

1. **Experimental Control**

Members for two groups should be selected in a standard experimental control, i.e Group A and Group B. The members of the group 'A' should be given the special experimental treatment. The group 'B' do not receive the same though they are in the same environment. This group is called the ***'control group'***

Though it is not possible in engineering but for the projects which are confirmed to laboratory experiments. Because, in engineering the experimental subjects are human beings who are out of the control of the experimenters. In engineering, the consumers have more control as they are the selecting authority of a project. So in engineering it is impossible to follow a random selection. An engineer has to work only with the past data available with various groups who use the products.

So engineering can be viewed as a natural experiment which uses human subjects. But today, most of the engineers do not care for the above said Experimental Control.

2. **Informed Consent**

Engineering is closely related to the medical testing of new drugs and techniques on human beings as it also concerned with human beings.

When new medicines have been tested, it should be informed to the persons who undergo the test. They have moral and legal rights to know about the fact which is based on **"informed consent"** before take part in the experiment. Engineering must also recognize these rights. When a producer sells a new product to a firm which has its own engineering staff, generally there will be an agreement regarding the risks and benefits form that testing.

Informed consent has two main principles such as knowledge and voluntariness.

First, the persons who are put under the experiment has to be given all the needed information to make an appropriate decision. Second, they must enter into the experiment without any force, fraud and deception. The experimenter has also to consider the fundamental rights of the minorities and the compensation for the harmful effects of that experiment.

In both medicine and engineering there may be a large gap between the experimenter and his knowledge on the difficulties of an experiment. This gap can be filled only when it is possible to give all the relevant information needed for drawing a responsible decision on whether to participate in the experiment or not.

In medicine, before prescribing a medicine to the patient, a responsible physician must search for relevant information on the side effects of the drug. The hospital management must allow him to undergo different treatments to different patients and finally the patient must be ready to receive that information from the physician. Similarly it is possible for an engineer to give relevant information about a product only when there is a better co-operation by the management and quick acceptance from the customers.

The following conditions are essential for a valid informed consent

a. The consent must be given voluntarily and not by any force.

b. The consent must be based on the relevant information needed by a rational person and should be presented in a clear and easily understandable form.

c. The consenter must be capable of processing the information and to make rational decisions in a quick manner.

d. The information needed by a rational person must be stated in a form to understand without any difficulty and has to be spread widely.

e. The experimenter's consent has to be offered in absentia of the experimenter by a group which represents many experiments.

Knowledge Gained

Scientific experiments have been conducted to acquire new knowledge. Whereas engineering projects are conducted as experiments not for getting new knowledge. Suppose the outcomes of the experiment is best, it tells us nothing new, but merely affirms that we are right about something. Mean while, the unexpected outcomes put us search for new knowledge.

ENGINEERS AS RESPONSIBLE EXPERIMENTERS

The engineers have so many responsibilities for serving the society.

1. A primary duty is to protect the safety of human beings and respect their right of consent. [A conscientious commitment to live by moral values].
2. Having a clear awareness of the experimental nature of any project, thoughtful forecasting of its possible side effects, and an effort to monitor them reasonably. [A comprehensive perspective or relative information].
3. Unrestricted free personal involvement in all the steps of a project. [Autonomy]
4. Being accountable for the results of a project [Accountability]
5. Exhibiting their technical competence and other characteristics of professionalism.

Conscientiousness

Conscientiousness implies consciousness (sense of awareness). As holding the responsible profession with maintaining full range moral ethics and values which are relevant to the situation. In order to understand the given situation, its implications, know-how, person who is involved or affected, Engineers should have open eyes, open ears and open mind.

The present working environment of engineers, narrow down their moral vision fully with the obligations accompanied with the status of the employee. More number of engineers are only salaried employees, so, they have to work within large bureaucracies under great pressure to work smoothly within the company. They have to give importance only to the obligations of their employers. Gradually, the small negative duties such as not altering data by fraud, not violating patent right and not breaking confidentiality, may be viewed as the full extent of moral desire.

As mentioned, engineering as social experimentation brings into light not only to the person concerned but also to the public engineers as guardians of the public interest i.e., to safeguard the welfare and safety of those affected by the engineering projects. This view helps to ensure that this safety and welfare will not be affected by the search for new knowledge, the hurry to get profits, a small and narrow follow up of rules or a concern over benefits for the many and ignoring the harm to the few.

The social experimentation that involved in engineering should be restricted by the participants consent.

Relevant Information

Without relevant factual information, conscientious is not possible. For showing moral concern there should be an obligation to obtain and assess properly all the available information related to the fulfillment of one's moral obligations. This can be explained as:

1) To understand and grasp the circumstance of a person's work, it is necessary to know about how that work has a moral importance. For example, A person is trying to design a good heat exchanger. There is nothing wrong in that. But at the same time, if he forgets the fact that the heat exchanger will be used in the manufacture of an illegal product, then he is said to be showing a lack of moral concern. So a person must be aware of the wider implication of his work that makes participation in a project.
2) Blurring the circumstance of a person's work derived from his specialization and division of labour is to put the responsibilities on someone else in the organization. For example if a company produces items which are out of fashion or the items which promotes unnecessary energy wastage, then it is easy to blame sales department.

The above said means, neglecting the importance of a person's works also makes it difficult in acquiring a full perspective along a second feature of factual information i.e., consequence of what one does.

So, while giving regard to engineering as social experimentation, points out the importance of circumstances of a work and also encourage the engineers to view his specialized activities in a project as a part of a large social impact.

Moral Autonomy

This refers to the personal involvement in one's activities. People are morally autonomous only when their moral conduct and principles of actions are their own i.e., genuine in one's commitment to moral values.

Moral beliefs and attitudes must be integrated into an individual's personality which leads to a committed action. They cannot be agreed formally and adhered to merely verbally. So, the individual principles are not passively absorbed from others. When he is morally autonomous and also his actions are not separated from himself.

When engineering have seen as a social experimentation, it helps to keep a sense of autonomous participation in a person's work. An engineer, as an experimenter, is undergoing training which helps to form his identity as a professional. It also results in unexpected consequence which helps to inspire a critical and questioning attitudes about the current economic and safety standards. This also motivates a greater sense of personal involvement in a person's work.

Accountability

The people those who feel their responsibility, always accept moral responsibilities for their actions. It is known as accountable. In short, 'accountable' means being culpable and hold responsible for faults. In general and to be proper, it means the general tendency of being willing to consider one's actions to moral examinations and be open and respond to the assessment of others. It comprises a desire to present morally convincing reasons for one's conduct when called upon in specific circumstances.

The separation of causal influence and moral accountability is more common in all business and professions and also in engineering. These differences arising from several features of modern engineering practices are as follows:

1. Large – scale engineering projects always involve division of work. For each and every piece of work, every person contributes a small portion of their work towards the completion of the project. The final output us transmitted from one's immediate work place to another causing a decrease in personal accountability.
2. Due to the fragmentation of work, the accountability will spread widely within an organization. The personal accountability will spread over on the basis of hierarchies of authority.
3. There is always a pressure to move on to a different project before finishing the current one. This always leads to a sense of being accountable only for fulfilling the schedules.
4. There is always a weaker pre-occupation with legalities. In other words this refers to a way a moral involvement beyond the laid down institutional role. To conclude, engineers are being always blamed for all the harmful side effects of their projects. Engineers cannot separate themselves from personal responsibilities for their work.

CODES OF ETHICS

The codes of ethics have to be adopted by engineering societies as well as by engineers. These codes exhibit the rights, duties, and obligations of the members of a profession. Codes are the set of laws and standards.

A code of ethics provides a framework for ethical judgment for a professional. A code cannot be said as totally comprehensive and cover all ethical situations that an engineer has to face. It serves only as a starting point for ethical decision-making. A code expresses the circumstances to ethical conduct shared by the members of a profession. It is also to be noted

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SENSES OF 'ENGINEERING ETHICS'

Ethics is relevant to you in your everyday life as at some point in your professional or personal life you will have to deal with an ethical question or problem, e.g. what is your level of responsibility towards protecting another person from threat, or whether or not you should tell the truth in a particular situation?

Ethics

"Ethics is an activity which concerns with making investigations and knowing about moral values, finding solutions to moral issues and justifying moral issues and justifying moral judgments"

Or

"A branch of philosophy concerned with that which is deemed acceptable in human behaviour, with what is good or bad, right or wrong in human conduct in pursuit of goals and aims."

Ethics explores the nature of rights, of moral responsibilities, and of how to go about addressing an ethical problem.

Engineering Ethics

Like the ethics, engineering ethics also aims at knowing moral values related to engineering, finding accurate solutions to the moral problems in engineering and justifying moral judgments of engineering.

Or

Engineering ethics is the field of applied ethics which examines and sets standards for engineers' obligations to the public, their clients, employers and the profession and is appropriate in all aspects of professional practice.

From these senses of engineering ethics, one can realize that it is the study of morality.

What is morality?

The term "morality" concerns with

(a) What should or should not to be done in a given situation,

(b) What is right or wrong in handling it,

(c) What is good or bad about the persons, policies and principles involved in it

"According to the Oxford dictionary, morality means principles concerning right and wrong or good and bad behaviour"

- If an action is said to be morally right or a principle is said to be morally good, then they are said to be had some moral reasons in supporting it.
- Moral reasons: Moral Reasons include respecting others and ourselves, respecting the rights of others, keeping promises, avoiding unnecessary problems to others and avoiding cheating and dishonesty, showing gratitude to others and encourage them to work.

- So, if an engineering decision is said to be a good one, it has to meet out all the specifications. These specifications must be covered both the technical and the moral
- Specifications such as safety of the product, reliability, easy maintenance and the product should be user-friendly with environment.

VARIETY OF MORAL ISSUES

- There are so many engineering disasters which are greater / heavier than the level of acceptable or tolerable risk.
- Therefore, for finding and avoiding such cases such as nuclear plant accident at Chernobyl (Russia), Chemical plant at Bhopal (India) where a big disaster of gas leakage, occurred in 1980, which caused many fatal accidents.
- In the same way, oil spills from some oil extraction plants (the Exxon Valdez plant) hazardous waste, pollution and other related services
- Natural disasters like floods, earth quake and danger from using asbestos and plastics are some more cases for engineering disasters.

These fields should be given awareness of engineering ethics. Hence, it is essential for engineers to get awareness on the above said disasters. They should also know the importance of the system of engineering

When malfunction of the system is a rapid one, the disaster will be in greater extent and can be noticed immediately. So, the engineers should not ignore about the functions of these systems.

These cases also explain and make the engineers to be familiar with the outline of the case in future and also about their related ethical issues.

Approaches to Engineering Ethics:

(1) Micro-Ethics: This approach stresses more about some typical and everyday problems which play an important role in the field of engineering and in the profession of an engineer.

(2) Macro-Ethics: This approach deals with all the social problems which are unknown and suddenly burst out on a regional or national level.

So, it is necessary for an engineer to pay attention on both the approaches by having a careful study of how they affect them professionally and personally. The engineers have to tolerate themselves with the everyday problems both from personal and societal point of view.

The varieties of moral issues are:

1. Organization oriented issues

- Being an employee to firm, the engineer has to work towards the achievement of the objectives of his/her organization.
- Engineers have to give higher priority to the benefits of the organization than one‘s own benefits.
- Engineers should be able to work collectively with colleagues and other members in order to achieve firm‘s goals.

2. Clients or customers oriented issues

- As we know, the purpose of any business is to reach and satisfy the end users. Therefore the customers ‘requirements should be met.
- In this regard, engineers have a major role to play in identifying the customer voice‘, and incorporating the voice of the customer into the product design and manufacture.
- Apart from engineering technicality issues, engineers also should face other moral and ethical issues with clients/customers.

3. Competitors oriented issues

- In order to withstand in a market, engineers should produce things better than their competitors by all means.
- But engineers should not practice cut-throat competition. They should follow certain professional behaviour while facing their competitors.
- Thus engineers should hold paramount the safety, health and welfare of the customers in the performance of their professional duties.

4. Law, government and public agencies oriented issues

- The engineers should obey and voluntarily comply with all the governmental rules and regulations related to them.
- They should also respect and honestly practice all other similar laws, policies, and regulations.

Professional societies oriented issues

The engineers should follow strictly the various codes of ethics by various professional societies such as National Society of Professional Engineers (NSPE), the Institute of Electrical and Electronics Engineers (IEEE), and American Society of Mechanical Engineers (ASME), in order to perform standard professional behaviour.

Professional codes of ethics reflect basic norms of conduct that exist within a particular professional and provide general guidance relating to a variety of issues.

5. Social and environmental oriented issues

Since the works of engineers have a direct and vital impact on the quality of life for all people, the engineers should be dedicate to the protection of the public health, safety and welfare.

Also engineers need to be aware their role as agents of experimenters. They should have a united commitment in protecting the environment. They should not involve in any unethical environmental issues such as misusing scarce resources, and fouling environment.

6. Family oriented issues

As a human being and the member of a family, the engineers do have family obligations to take care the needs of their family members. But they should not take any decisions for their own benefits at the cost of public, clients, or employers.

Thus the above discussion explains how the ethical problems often arise in the engineering profession.