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Key Principles
of Human,
Organisational and
Technological
Factors (HOT-F)
in Safety

Lifestyle
Diseases

Silent Killer of the
Millennium



Kudankulam Nuclear Power Plant
Tamilnadu



Part-A:

**Key Principles of Human, Organisational
and Technological Factors (HOT-F) in
Safety**

Contributors:

Shri A.Varshney, NPCIL

Shri S.G. Belokar, HWB

Dr K. K. Satpathy, IGCAR

Shri A. S. Vajarekar, BARC

Shri Sekhar Bhattacharyya, AERB

Dr Diptendu Das, AERB

Shri Rakesh Kumar, AERB

Shri K. H. Gharat, BARC

Ms Sadhvi Srinivasan, AERB

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1.0 INTRODUCTION

Recent studies have recognised that technological factors are not the only keys for the effectiveness of a system, in addition, human and organisational factors do play important role in effective management of safety. Human and organisational factors have contributed to the causes of several incidents, in a variety of safety critical industries. Understanding the role of human beings and the management of the organisation in complex technological systems like Nuclear and radiation Facilities is a key factor in achieving better safety performance. While the technological requirements are backed by vast area of work in research, development and engineering, the challenge lies in development of approach that integrates Human and Organisational Factors along with associated technological aspects.

India is a contracting party to the “Convention on Nuclear Safety (CNS)”. Article 12 of CNS specifies the contracting parties to take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear facility. To prove compliance with this article, each contracting party has to submit a report where the measures taken to implement this obligation are incorporated.

Chernobyl nuclear accident brought out the importance of safety culture, whereas the importance of human & organisational factors emerged after the Fukushima nuclear accident. Thus, after Fukushima, there is a systemic context of integration of individuals, organisation and technology.

This monograph provides an overview of the complex issue of the human and organisational factors that are important to nuclear safety, focusing in particular on the interactions among individuals, technology and organisations. The monograph also focuses the role of safety culture in organisational factors, their interactions with technology, and the effect of updated and new knowledge.

2.0 HUMAN, ORGANISATIONAL AND TECHNOLOGICAL FACTORS

2.1 Human Factors

Human factors in dealing with science or technologies are multidisciplinary in nature such as psychology, engineering, industrial design, statistics, operations research, anthropometry etc. It is an approach that covers the science of understanding the properties of human capability, the application of this understanding to the design, development, and deployment of systems and services, and the art of ensuring successful application of human factor principles into the working environment. Human

factors include capabilities/ limitations of a person, cognitive capabilities (e.g. memory, motivation/ driving forces), perception, stress, strength, anthropometry, knowledge, skills, reasoning, fitness for duty to name a few.

2.2 Organisational Factors

Analysis of the causes of major industrial accidents revealed that organisational factors are frequently present in their genesis. Therefore, analysing these organisational factors is important. These factors include

- Elaborated Management system, authorities commensurate with accountabilities/ responsibilities,
- An exclusive focus on certain issues and considerations (for example, financial)
- Disregard of employees with other considerations (such as safety)
- Pressure to achieve high productivity, which forces the system outside of the operating zone for which it was designed
- No reassessment of operating assumptions during changes in the use of facilities
- Design or modification processes are centralized or externalized, but there is no interaction with those responsible for operations locally
- Failures on the part of inspection authorities or regulators
- Conflicting priorities from different central services, with no harmonization by site management
- Organisations that are either so complex or change so often that employees neither know how to act with regard to them, nor whom turn to for answers
- Setting objectives that are out of phase with the allocation of resources for a particular sector of the system (“I don’t want to know” type of organisation)
- An increase in quality assurance processes, with no allocation of additional time resources, leading to a decrease in the actual time available to carry out operational tasks and a loss of precision in actions relating to safety
- Forcing employees or teams to compete against one another, which may lead to non-cooperation
- Processes for evaluating people, teams or establishments based on criteria that are inconsistent and non-uniform
- Tense relationships between the managers and the operators in their teams; lack of cohesion in the work groups, weak team spirit.
- Ignoring the whistle-blowers or giving importance for allegation without substantiating

2.3 Technological Factors

Now-a-days industries are considering automation to a greater extent. In the nuclear industry, the personnel employed are very sound on technological factors which are backed by vast experience gained from research & development in engineering. The technological factors include process complexity, equipment, procedures, user expectations and habits, technology including Human Machine Interaction (HMI), tools, equipment, plant design and plant processes.

The selection of technologies is one of the most challenging decision making areas the management of an organisation encounters. It is difficult to clarify the right technology alternatives because the number of technologies are increasing and becoming more and more complex. However, right technologies could create significant competitive advantages for a company in a complex business environment. The aim of technology selection is to obtain new know-how, components, and systems which will help the company to make more competitive products and services and more effective processes, or create completely new solutions.

2.4 Work Environment

Operator working on an aspect of the process is placed in a working environment that plays a part in determining his/her activity and therefore his/her observable behaviour. Social, economic, political aspects, National culture and the regulatory framework are a few factors which determine work environment.

Components of work environment like facilities available to a worker, tools and co-workers constitute its visible part. However, factors like organisation's strategy, the history of the facilities, the social relationships, the rules of the organisation, the work groups, the time needed to carry out operation are not necessarily visible, but significantly influence the work environment.

The operator is a part of the work environment. His or her own condition is extremely variable, as a result of tiredness, personal events. Managing one's own condition is part of individual activity. The situation that the operator has to manage is always unique. Even if the prescribed operation is habitual, certain factors are specific to particular time such as the weather conditions, the time and the day of the week, the state of the upstream or downstream facilities, the equipment to be used etc.

2.5 Human Factor Engineering (HFE) Process

The Human Factor Engineering (HFE) process can be grouped under the following:

- Programme management
- Analysis including lessons learned
- Design

- Verification and validation
- Implementation
- Human performance monitoring (HPM)

Interactions of HFE activities are integrated into the basic phases of an engineering process as illustrated on Fig.1.

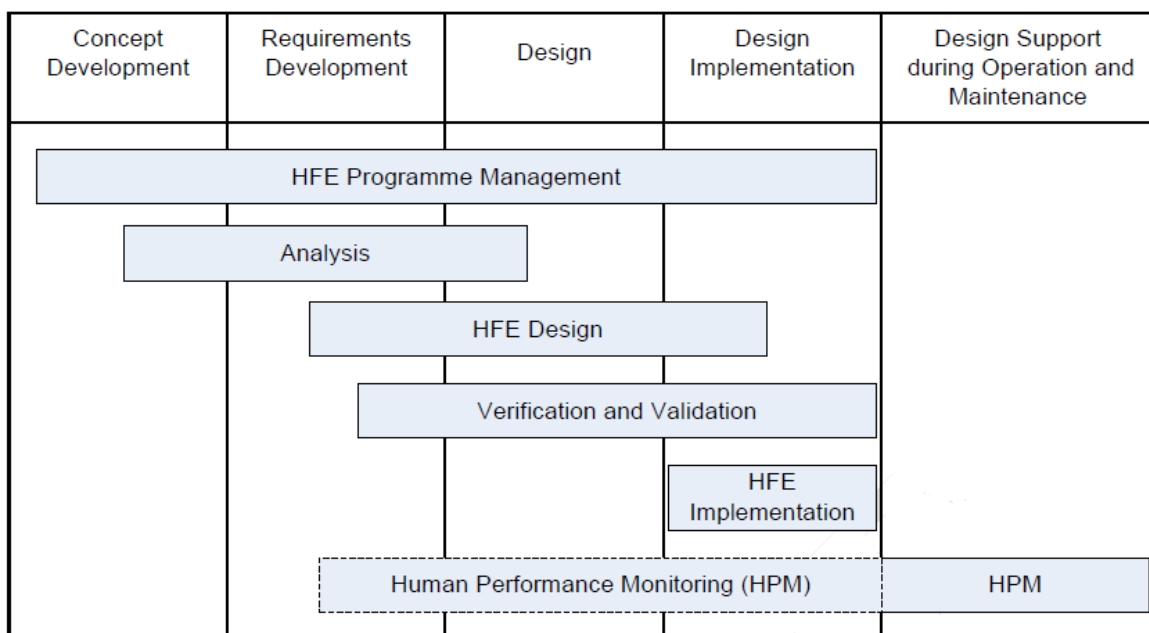


Fig.1: An example of HFE generic processes.

2.5.1 Concept Development Phase

The following HFE inputs are considered in the concept development phase:

- HFE programme management activities (i) identify a systematic integrated process, (ii) outline responsibilities and (iii) provide expected design inputs and outputs
- HFE programme establishes capable organisation with sufficient authority at all hierarchical levels for effective design changes to meet its expectations
- HFE programme management identifies the most recent HFE relevant codes, standards, methodologies and guidelines to the project
- HFE analysis

- identifies relevant operating experience (both positive and negative) with focus on human performance issues and potential human error and its mitigation
- provides inputs (such as operator needs and requirements) useful for defining and selecting relevant design choices
- helps in identifying the organisational architecture that frames the use of the HFE system, i.e. identification of users, their roles and responsibilities, required qualifications, regulatory requirements, and support the developed concepts of operation and maintenance
- provides allocation of functions and human information requirements for monitoring and controlling of the system, wherever applicable.
- provides insight and consideration as to how operators should respond and control (i) the system failures and (ii) Human Machine Interaction (HMI) failures.

2.5.2 Development Phase

The following HFE inputs are considered in the functional requirements development phase:

- Results of the functional analysis that lead to identifying functional requirements that are used while determining function allocation
- Results of task analysis, e.g. kind of alarms, information, procedures and controls
- Results of task analysis that provide insight into the possible sequence and flow of tasks
- Potential human errors as well as considerations that impact human performance and provide error reducing and performance enhancing design features
- Complex tasks that have safety significance warrant detailed analyses and HFE evaluation
- Insight into timeline constraints for significant tasks
- Specific HFE design principles and HMI design guidelines for the development of vendor technical specifications and for their incorporation into design requirements
- Insight into specific knowledge, skills, and abilities needed by personnel in order to perform their assigned task(s)

2.5.3 Design Phase

The following HFE inputs are considered in the design phase:

- Updates HFE requirements due to design evolution;
- Specific HFE design principles and HMI design guidelines for the definition of facility / workspace design and layout, HMI components and their architecture, i.e. redundancy, diversity and connectivity;
- Specific HFE design principles and guidelines for maintenance and testing considerations;

- Potential impact of new or modified designs to human performance, procedure development and training;
- Collection and analysis of user feedback through early HFE evaluations in the form of prototype or concept usability testing and user review;
- An insight into scope, content, and usability of operating procedures used to support the execution of safety critical tasks;
- An insight into scope and content of training.

2.5.4 Implementation Phase

The following HFE inputs are applied to the design implementation phase:

- Verification of design implementation against identified HFE design principles and applicable HFE design codes, standards, and guidelines;
- HFE validation of the degree to which HMI design and supporting mechanisms facilitate the achievement of safe operation of the plant;
- Confirmation of the feasibility of human tasks important to safety in the probabilistic and deterministic safety analyses through HFE validation;
- Confirmation of completion of HFE analyses and HFE input into design in accordance with HFE planning and regulatory expectations.

2.5.5 Operation and Maintenance Phase

Through the design stages consideration is made of constraints from the safety assessment and regulatory requirements that apply to the design of specific systems. Design support during the operation and maintenance phase includes human performance monitoring related to the implemented design in order to follow up and verify that the safe operation of the plant is valid throughout the plant life time. HFE activities supporting analyses, design, and verification and validation progress in an iterative manner consistent with the overall design project. HFE activities supporting analyses, design, and verification and validation are often collaborative and involve a multidisciplinary team with HFE expertise. In order to be properly addressed, the results of HFE analysis, design, and verification and validation activities are communicated to different disciplines participating in the design. HMI and its functionality are treated from the perspective of their being part of an integrated system and not as an assembly of discrete controls, indicators, and systems.

2.6 HOT – Factor Models

2.6.1 Human Factor Funnel Model (HFFM)

The HFFM conceptual framework proposes that there are many components/ parts throughout an organisation that can impact error causation and accidents. In its broader concept, the HFFM is analogous to how a funnel works (Fig.2).

Atmosphere:The opening is fairly wide and this depicts the Atmosphere (organisation). As the funnel tapers down, there are various individual factors that mix together. The combined influences of the Atmosphere and individual factors then flow to outcomes (or what pours out from the bottom). Outcomes are colour coded in red and green. Red indicates unsuccessful outcomes while green indicates successful outcomes.

The Atmosphere (or organisation) is at the top of the funnel as the organisation and corporate culture has an overarching effect on the rest of the funnel elements. Organisational culture can and will affect the overall performance of employees by setting precedents and behaviour. Some of the most dangerous organisation-wise negative norms may be propagated by the highest level.

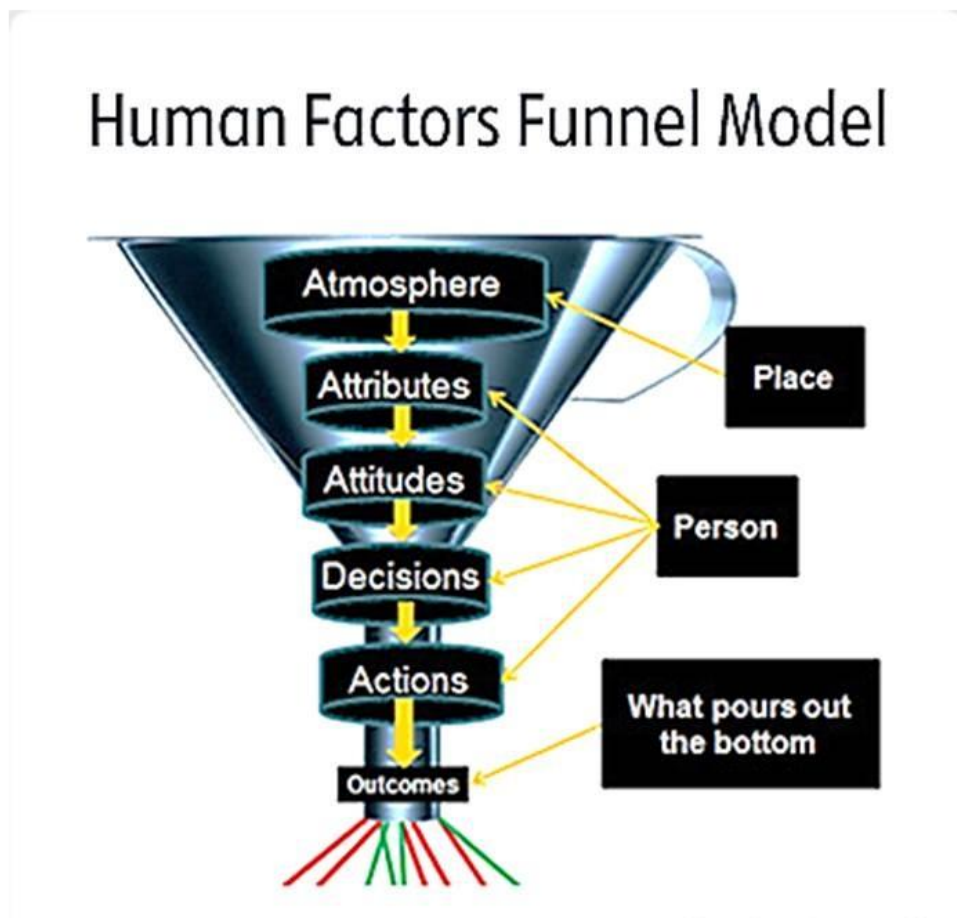


Fig.2: Human Factor Funnel Model (HFFM) [Reference: universalweather.com/blog]

Attributes: Attributes can best be described as the innate qualities a person possesses as part of his or her personality. These attributes are more or less ingrained in a person, resistant to change, and can have a significant impact on individual or team performance.

Attitudes: Attitudes can be described as the way someone feels about someone or something, which in turn may guide that person's behaviour. Unlike Attributes, Attitudes are a bit more dynamic and easier to change. A change in attitudes can result in something positive or negative occurring.

Decisions: Decisions are the choices we make based on multiple alternative solutions. Poor decision making skills continue to be cited in a multitude of accidents.

Actions: Since all components have mixed together in the funnel, a person's **actions** at this point will set the stage for final outcomes.

Outcome: HFFM does an effective job in depicting a range of error factors that may cause an accident, ranging from the manager's personality and training issues to organisation's policies and events that occur the day of the accident. Reviewing the cause of accident using HFFM conceptual format can pinpoint the role of individual and organisational deficiencies. HFFM is well-suited as an active and proactive investigation model. Based on the mixture of ingredients in the funnel, outcomes will either meet or not meet intended safety objectives. The key here is to focus on the "big picture" in terms of what organisational and/or individual elements may be responsible in error causation so that future unsafe practices and incidents can be avoided.

2.6.2 Systemic Approach to HOF

HOFs are the individual's action on himself or his environment together with the effect of the organisational measures on the individual, on other environment aspects as well as on themselves, which is illustrated in Fig. 3.

General systemic approach to HF and HOF

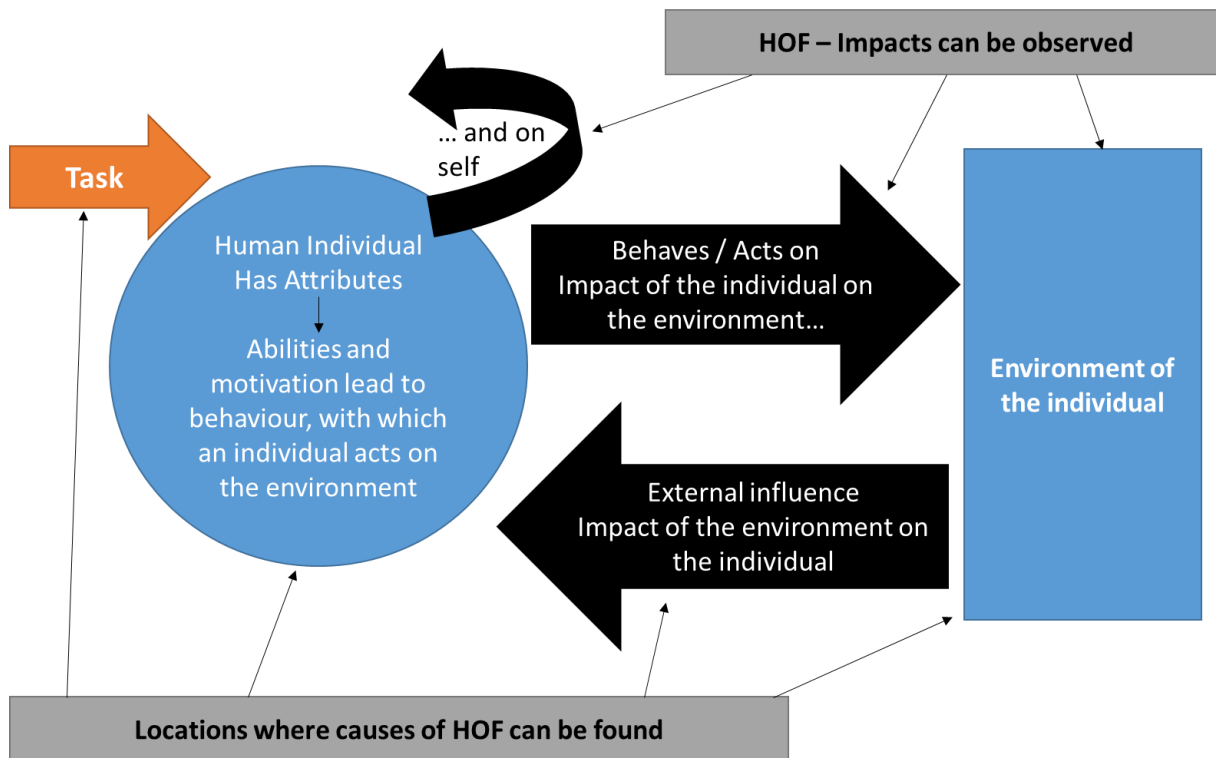


Fig.3: Systemic Approach to HOF

2.6.3 Swiss-Cheese Safety Model

The Swiss cheese model of accident causation equates human systems to multiple slices of Swiss cheese, stacked side by side, in which the risk of a threat becoming a reality is mitigated by the differing layers and types of defences which are "layered" behind each other. Therefore, in theory, lapses and weaknesses in one defence do not allow a risk to materialize, since other defences also exist, to prevent a single point of weakness. It is sometimes called the cumulative act effect. Although the Swiss cheese model is considered to be a useful method of relating concepts however, it has been criticised for its over-broadly use and lack of support by other models.

In this model, the initial error will only result in an undesirable event if all the barriers have been breached. The accident analysis is therefore supposed to understand not only the initial event, but also the way in which all the barriers were defective. This model remains important, but it is insufficient.

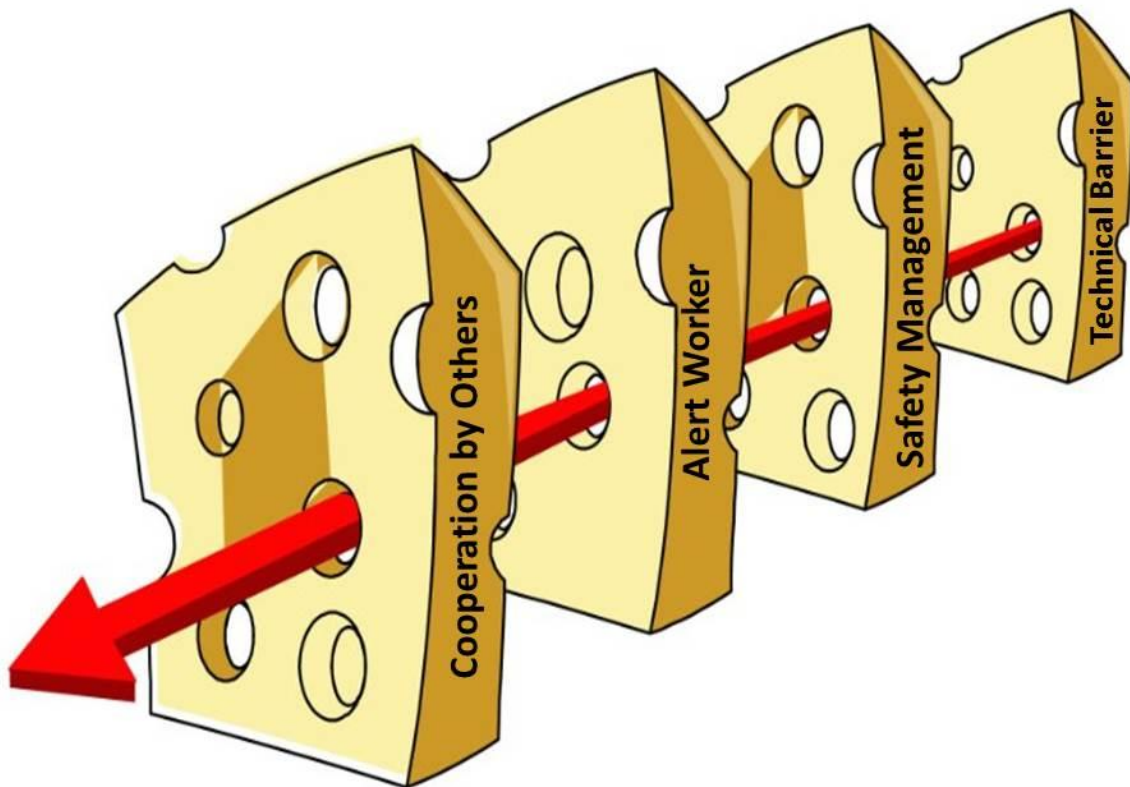


Fig.4 : Swiss –Cheese Safety Model

2.7 HOT-Factor Programme

Human, organisation and technology and their interaction is considered in an integrated manner during the planning and execution of the HFE programme, during HMI design and resource allocation for all plant states. The HFE programme applies a questioning and learning attitude to accepted design methods and solutions, taking newly developed information, analysis methods, knowledge and features of new technology into account. The HFE programme follows an appropriate approach in order to identify the appropriate level of rigor, resources, and detail to be applied.

The HOT Factor programme outlines the HFE processes as well as inputs and outputs for these processes. The HFE processes include analyses, design of human machine interfaces, and evaluation such as verification and validation.

HOT factor programme

- Identifies the integration of HFE with other plant design or modification activities.

- Identifies the coordination required between responsible personnel, project and design authorities, and different disciplines in order to perform HFE activities.
- Documents the process for communicating outputs of analyses to the responsible engineering disciplines and ensuring that the outputs have been addressed.
- Identifies the organisation and competence requirements for integrating human factors engineering into the design.
- Provides a framework for documenting and tracking HFE issues that are identified by the HFE processes.

3.0 ANALYSIS FOR HOT-FACTORS

3.1 Analysis on Lessons Learned

Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organisational factors.

HFE uses the experience data and conclusions from event analyses as a basis for design of the new plant or modification of operating plants. The review of operating experience provides information regarding current work practices for the following purposes:

- i) to assess the potential impact of planned changes
- ii) to evaluate operational problems and issues in current designs that may be addressed during plant modernization; and
- iii) to evaluate relevant industry experience with the selected approaches to instrumentation and control systems and HMI technology for their potential to improve plant efficiency and safety.

Operating experience review analysis includes both positive and negative aspects of performance and design. The operating experience review provides the following:

- Applicable HFE issues identified in review of plant operating experience;
- Issues identified from applicable predecessor designs
- Experience insights identified by plant personnel
- Operating experience from other nuclear power plants and high technology industries.

HFE also considers operating experience data for any of the following:

- Minor problems that are often precursors or contributors to more significant events
- Trends that deviate from reliability
- Existence of root cause data that could point out improvements in design

- Evidence of culture influences and trends that could prove problematic for future operations
- Corrective actions identification and implementation
- Recurring events
- Review of maintenance practices.

3.2 Analysis for Functional Requirement

Functional requirements analysis and allocation of functions are conducted to ensure that the functions necessary to accomplish safe operation of the nuclear power plant are sufficiently defined and analysed. Human, organisation and technology factors are considered when performing the functional requirements analysis and function allocation. Functional requirements analysis help in identifying high level acceptance criteria associated with maintaining safe operation of the plant.

As part of the functional requirements analysis process, the following are analysed and documented:

- High level functions that ensure safe operation of the plant
- Relationships between high level functions and the plant's systems (e.g. plant configurations or success paths) responsible for performing the functions
- Higher level functions should be divided into lower level functions that can be mapped to tasks to be performed by plant automation or by human, or human and automation jointly
- A framework for determining the roles and responsibilities of personnel and automation

3.3 Analysis for Tasks

The task analysis considers all plant states, all plant operating modes and all groups of operating personnel. Human, technological and organisational factors are considered while performing the task analysis. Task analysis is conducted to analyse and document physical and cognitive activities associated with performing tasks to which personnel have been assigned.

Task analysis aims to analyse the context (e.g. HMI, procedures and organisational arrangements) used to accomplish the task from the standpoint of its users. Tasks that might concern safety, e.g. latent errors, initiators, are analysed based on the following:

- Occupational risks for the personnel (contamination, radiation exposure and conventional);
- Risks to the personnel and public due to human error
- Task complexity which increases difficulties for task completion owing to the multiple resources, multiple human system interactions, working environments, and competences needed to meet human and system performance requirements
- Past experience (operating experience review)

- The judgement of plant personnel (operators or maintainers) who will have to perform the task, e.g. function analysis indicating the task is demanding for personnel but will not be automated.

The results from this analysis are used to identify the following:

- Expectations on conducting each task and its outcome
- Human reliability and error prevention factors in place of critical tasks involving safety
- Impacted safety functions, initiating conditions and terminating conditions of each task
- Expected human tasks and potential human errors which have an impact on safety demonstration
- Order for implementing tasks and subtasks
- Personnel needs (e.g. organisational aspects, staffing, qualification, training), the equipment needs (e.g. HMI elements, special tools and protective clothing), and documentation needs (e.g. procedures, processes, instructions)
- Human performance requirements and constraints (e.g. time, precision, independent verification)
- Required communication systems and access to those systems

To conduct a task analysis, information from the following sources are considered:

- Documentation (supplier documentation, technical specifications, existing procedures, manuals, training materials)
- Knowledgeable personnel from the design team, stakeholders and experts
- Walk-through and talk-through to analyse previous activities and to analyse the predecessor system's task activities and tasks from similar plants
- Data from the operating experience review (e.g. note differences from the reference design);
- Data from the customer requirements
- Data from other analyses that are inputs to the HFE design process (e.g. functional requirements analysis and allocation, human reliability analysis)
- Data from simulator studies
- International HFE standards

The impact of task performance requirements on human reliability is evaluated. The process for collecting, tabulating, and analysing the inputs for the task analysis are documented. The task analysis is a collaborative activity and involves a multidisciplinary team with HFE and operations expertise. The results of the task analysis is communicated to the disciplines participating in the design. The results of

the task analysis is directly used to estimate the human error and probabilities used within the probabilistic safety assessment.

Task analysis is particularly performed in instances where cognitive processes, such as decision-making, problem-solving, memory, attention and judgement, are important to tasks. A list of all tasks performed upon system hardware by operations, maintenance, and support personnel is maintained. Table top analysis of documentation (e.g. procedures) alone is not sufficient for determining that task can be performed or not. Simulations by mock-up, field walk down, part task simulator, or full scope simulators are performed to confirm applicability in real scenarios.

Task analysis contains error taxonomy that at a minimum, captures the following:

- Improper sequencing of equipment or misalignments
- Actions taken too soon or too late
- Actions omitted
- Actions out of sequence
- Wrong actions
- Failures in communication
- Failures in decision making.

3.4 Staffing and Organisation Structure

Staffing, organisation and qualification is analysed for all tasks impacting safety to ensure that the required number of personnel, organisational interactions and qualification of personnel are sufficient for task performance. Staffing, organisation and qualification analysis covers all the working groups that carry out tasks with a safety impact. It includes all operating, service support, emergency preparedness and response teams.

Staffing, organisation and qualification analysis takes into account any change in relation to reference plants, which may impact on:

- The safe completion of the operator tasks
- The workload of the members of a team
- The ability to synchronize the contribution of each team member to the task
- The independence and coordination of the individuals responsible for checking (for example actions taken in the control room and locally by the operators)
- The perception of the task, its benefits, and its acceptability for the personnel.

The analysis identifies and evaluates the needs of these working groups in terms of staffing, organisation and qualification. Staffing, organisation and qualifications analysis evaluate the impacts

of the organisational and technological changes with respect to reference plant. The inputs of the staffing, organisation and qualifications analysis includes:

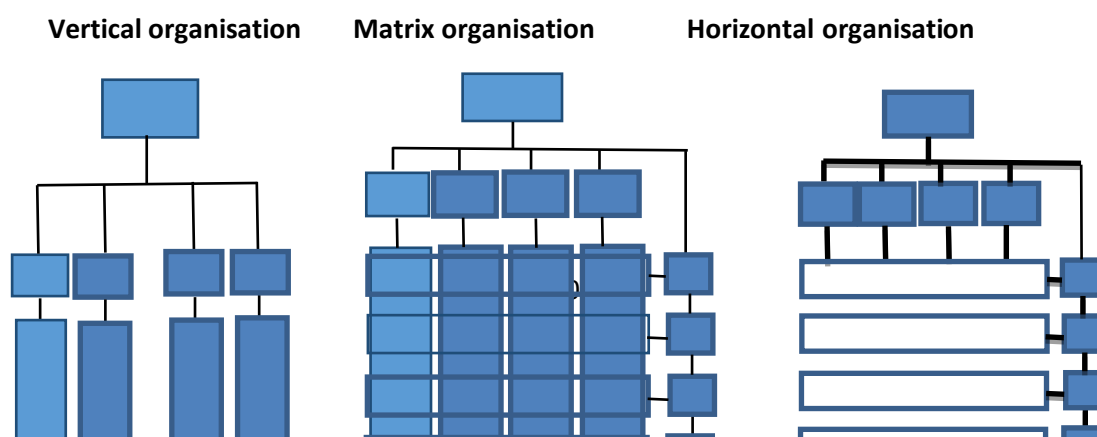
- Operation concept in normal, incident and accident condition
- Task requirements
- Regulatory requirements
- Operating experience
- Human reliability analysis

Task analysis is used in support of defining roles, requirements and responsibilities of the working group. The following are considered while assigning individual tasks to working group members:

- The tasks assigned to each member are clearly described
- The basis for task distribution is determined and justified
- The workload of each team member is reasonable in all operational and accident scenarios
- The human performance impact is assessed when distributing the tasks between teams working day and night
- The tasks required in various operating situations are assigned to working group members in order to ensure continuity of responsibilities.

Any reduction of staffing is evaluated for its potential impact on safety by simulations or full scope simulator tests.

Organisation Structure Models: The different organisational models give a good indication of the options that are favoured. Thus a vertical model (model A) favours an organisation divided into different functional departments, where the coordination is centralized within a powerful management structure that applies a top-down planning strategy. This type of structure values the reduction of uncertainties and the coordination and regularisation of work, mainly through rules and a hierarchy. It is suited to an environment that is quite stable, in which priority is given to the mass production of a clearly defined product.



(A)

(B)

(C)

Fig.5: Different organisation model

To the opposite extreme, a horizontal organisation (model C) favours the division of work based on customer-focused processes or according to projects. The goal of this type of transverse structure is to encourage responsiveness and innovation in a competitive and fast-changing environment. The strength of each model is the weakness of the other: a vertical structure is inflexible and struggles to adapt quickly to changes in market conditions; the horizontal structure is more flexible, but coordinating everyone involved is often difficult since there is no well-established hierarchy. Hence the advent of a more recent third model, a matrix structure (model B), with a dual line of authority: a horizontal reporting line in charge of coordinating the project/process and a vertical line of authority in charge of managing the teams.

4.0 IMPLEMENTATION OF HOT FACTORS

4.1 Human Machine Interaction (HMI)

The human machine interaction is designed through a structured methodology that starts from conceptual design for identification and selection of HMI approaches, detailed design, to the performance of HMI tests and evaluations. The concept of defence in depth is considered during HMI design, as applied to all safety activities, whether organisational, behavioural or design related and is ensured that if a failure were to occur, it would be detected and compensated for or corrected by appropriate measures. The human aspects, the machine (hardware and software), the work environment, and the control, operation and management is harmoniously integrated during all phases of the design process (human-centred design approach).

Designers consider how information relayed by the HMI will be communicated, exchanged and used across an organisation. They also consider the constraints and flexibility in the design to adopt different control or operational strategies across the different plant states and plant operating modes.

Design considerations provide for operator and organisational resilience, for example:

- Whether automatic actions are properly allocated to respond to a postulated initiating event
- Whether HMI can support anticipation and response to an unexpected event

- Whether HMI provides information on incremental changes in anticipation of sudden disruptions or fault conditions (e.g. predictive displays)
- Whether provisions and locations for additional tools and equipment are available
- Whether implementation of 'stress tests' related to human and organisational factors may provide insights on how equipment may be used in unexpected ways
- Whether implementation of different operational strategies may have to be adopted in order to achieve a safe state as an event unfolds
- Whether equipment could be used out of its design function support, a different strategy (e.g. use of fire protection system to provide cooling)

4.2 Accessibility

The design of workplaces and the working environment of the operating personnel is in accordance with ergonomic concepts. In areas where operating personnel are expected to monitor and control plant systems, the necessary provisions are made to ensure suitable conditions in the working environment and to protect against hazardous conditions. Normal aspects of the working environment considered include lighting, temperature, humidity, noise and vibration. Hazards considered include radiation, smoke and toxic substances in the atmosphere.

With respect to nuclear plants one way of establishing suitable means of access is to provide a qualified route that is protected against potential internal hazards or external hazards to supplementary control points and other field locations where operator actions are expected to occur.

4.3 Ergonomics

Ergonomics is the science of designing the workplace, keeping in mind the capabilities and limitations of the operating personnel. Poor worksite design, leads to fatigued, frustrated and ill-affected operators. This rarely leads to the most productive operator. More likely, it leads to a painful and costly injury, lower productivity and poor product quality. A systematic ergonomics improvement process removes risk factors that lead to musculoskeletal injuries and allows for improved human performance and productivity. By making improvements to the work process, barriers to maximum safe work performance are removed. The operators are provided with a job that is within their body's capabilities and limitations. Done well, an ergonomics improvement process can be a key contributor to your facility's competitiveness and provide a better work experience the operators.

4.4 Procedure Development & its Implementation

Human tasks needed for safe operation as identified for example, in deterministic safety analysis, probabilistic safety analysis and hazard analysis, are covered in procedures. Both the operating

personnel and training personnel should participate during the development of procedures. Procedures are verified to confirm their technical accuracy and that document development and document management processes have been adhered to. The procedures that outline important human tasks as identified by safety analysis are validated periodically to confirm the:

- Availability and status of equipment needed to successfully complete the procedure
- Validity of any assumptions or claims made in safety analysis about tasks performed by human that are related to safety.

Procedures are validated to ensure its proper execution as specified for intended results or outputs. The assumptions that support the basis of the procedures are documented in order to identify whether changes to the assumptions may affect the procedure. The basis for the procedure does not have to be included as part of the procedure, but is documented and the association with the procedure should be clear.

Procedure development considers inputs from task analysis to:

- Identify potential errors that should be highlighted in the procedure
- Provide required flow of information, actions, and feedback necessary for successful completion of a task
- Identify links between tasks and personnel
- Provide preliminary timing information.

The expected outcome of an action (or group of actions) identified in a procedure is clear, understandable and verifiable. Development of plant procedure considers that the format and content are commensurate with the category of procedure (e.g. emergency operating procedure, maintenance and test procedures). Safety critical tasks, complex tasks, and rarely performed tasks are detailed step by step. The procedure may provide guidance for safe contingent actions if the actions specified cannot be achieved or guidance for terminating the procedure safely. Where a transition may be required from one procedure to another, information and support is provided within that procedure to unequivocal transition from one document to another document (or sets of documents).

4.5 Training

The training programme for operating personnel should be consistent with HMI design, the systems functions, current plant configuration and the operating procedures and emergency procedures. The HFE task analysis provides a basis for determining training requirements for the system being designed. The training programme specifies the knowledge, skills and abilities that the operating personnel need to be able to use and understand the information provided through HMI design.

Operating personnel are trained on the relationship between the display form and the plant states it is intended to represent, including failure modes and their effect and appearance on display representation. They are also trained in navigation within and between displays, manipulation of on-screen features such as windows, and use of other functionalities within the HMI. It is ensured that operating personnel are proficient with graphic displays, including those infrequently used.

The training plan is reviewed and modified periodically according to the evolutions of the design. Training associated with modifications or modernizations, is completed prior to operation. Simulations by mock-up, field walk down, part task simulator, or full scope simulators is used in the training programme for operating personnel.

4.6 Human Error & Behaviour Based Safety (BBS)

Human error is often invoked as a factor that caused or contributed to an accident. Yet often errors are the consequence of the characteristics of the situation, which have not allowed operators or groups to use their skills in a relevant way. Operators detect and manage a number of high-risk situations which would not have been detected or correctly dealt with by an automated device.

Human activity corrects many errors, either individually or collectively. Human beings learn from experience, and develop their individual and collective ability to cope with similar situations.

The error led to an accident only because, on this particular day, the error was not corrected. The same erroneous action may have occurred a number of times previously without serious consequences if the technological and organisation barriers were working properly. The fact that the accident occurred demonstrates a failure of the set of barriers. Operator error can only cause an accident if it is combined with a number of other technological and organisational factors, some of which are permanent. Design errors should be thought of as “latent errors”, i.e. configurations where it is highly likely that an operational error will occur one day.

4.7 Safety Culture

Safety culture is the assembly of characteristics and attitudes in organisation and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance. A strong safety culture is promoted and supported by:

- ensuring a common understanding of the key aspects of the safety culture within the organisation
- providing the means by which the organisation supports individuals and teams to carry out their tasks safely and successfully, taking into account the interactions between individuals, technology and organisations

- reinforcing a learning and questioning attitude at all levels of the organisation, and
- providing the means by which organisation continually seeks to develop and improve its safety culture.

Adequate resources are allocated for promotion of safety culture. It is ensured that sufficient experienced staff is available, so that duties relevant to safety are carried out effectively without undue haste or pressure. Training is the foundation in developing and creating the organisation's values and practices and contributes to develop safety awareness, safety culture and skills. Hence, training of staff is recognized as vital and necessary resources are devoted to it. Availability of adequate and competent staff at each level ensures that a good safety culture always prevails

4.8 Alarm Management & Response Facilities

Suitable alarm systems and means of communication are provided so that all persons present at the nuclear facility can be given warnings and instructions, in operational states and in accident conditions.

Alarms or other devices indicate deviations of conditions from normal operation. When this occurs, the operators should be provided with the information necessary to:

- Identify the actions being taken by automatic systems
- Perform any necessary manual counteractions
- Follow the course of the plant's behaviour or response.

An alarm provides information about abnormal conditions such as:

- Parameter or rate of change deviations from control or protection setpoints
- Equipment failures, anomalies or discrepancies
- Incomplete or failed automatic actions.

Conditions that do not require any operator action do not result in alarms. Data derived from planned situations that do not indicate abnormalities but are rather messages from expected system response are assimilated to status information. Alarms are defined primarily from an operational perspective considering system designer's point of view. All alarms are clearly documented and their management is carefully specified. The system has a sufficient number of alarms with an appropriate operational coverage and aretechnologically consistent.

HFE is applied when designing emergency response facilities on the site technical support centres to provide for optimal layout of individual workplaces and data and information needed to perform the activities required for the implementation of accident management strategies. Accident monitoring

displays in emergency response facilities supporting situation awareness are designed through application of accepted human factors engineering methods and principles. These include illumination, size, geometry, display and control layouts, available content, suitable format and standardization of the displays, and fundamentally consider the task to be performed with the information provided by the display. The emergency response facilities staff are trained on the identification and use of the instruments to support implementation of severe accident management procedures or guidelines.

5.0 INTEGRATION OF HOT-FACTORS

5.1 Integration of HOT-factors in Safety Process

The content of the HFE chapter in safety analysis report describes the HFE programme and its application to the specific plant design. HFE considerations present in the safety analysis report cover at minimum the following:

- HFE programme management, including the authority and oversight in the design process;
- The human factors analysis methods applied
- Assumptions for the choice of HMI design taking into account HFE
- Human factors verification and validations including identification and resolution of HFE issues identified during the design project and assumptions made during analysis
- Description of how HMI design has been implemented in the overall plant design
- Description of human performance monitoring strategy for safety critical tasks

HFE review is conducted to determine and verify whether the acceptable HFE practices and guidelines are incorporated into design and safety analysis. HFE analysis is considered whenever manual actions are credited to backup automatic actions in the design analysis as part of diversity. Modernizations and modifications of HFE design is documented in safety analysis report.

The periodic safety review confirms whether the following continue to be valid:

- The most resource intensive conditions feasible in each operational mode / plant state
- The division and coordination of work in the most resource intensive conditions is feasible, through assessing function allocation, task analyses, and workload analyses.

The periodic safety review considers whether the staffing, organisation, system design, training, procedures, tools, equipment and other resources needed for successful human performance during the most resource intensive conditions are suitable and sufficient. The periodic safety review considers whether HFE verification and validation activities used to confirm assumptions and claims surrounding human tasks identified in safety analyses, continue to be valid. It also considers whether

the expectations of staff competencies align with human limitations and capabilities, task requirements, and regulatory requirements. The periodic safety review identifies reasonably practicable improvements in managing human and organisational factors to ensure that desired human performance is achieved, including through the HFE programme.

5.2 HOT-Factors in Plant Modification and Modernization

Consequences of the modification for human tasks and performance is systematically analysed. For all plant modifications, human and organisational factors are adequately considered.

HFE review is conducted whenever modification of operator actions results from modernizations, small or large, to identify a potential risk impact. HFE is conducted whenever changes (sequencing, timing, and workload) are made to procedures for which credit is taken in the safety analysis. The effect of the plant modification and modernization on human tasks is reviewed. The HFE programme on plant modification and modernization uses a graded approach. Any modification and modernization involving HFE solutions is transferred to plant controls before being put in operation (e.g. documentation, procedures, layout, and administrative controls, training).

5.3 HOT-Factors in Accident Management

The likelihood of human error increases during severe accident situations because of the increased stress, uncertainty due to novel or unknown situations, transition from emergency operating procedures to severe accident management guides, fear of the potential accident outcomes, and the harsh environmental conditions associated with the event. Operating experience reviews, including emergency exercises combined with functional requirements analysis and task analysis provides the basis for identifying the human performance-related requirements for accident monitoring and operation of severe accident mitigation equipment. HFE considers resource allocation strategies (e.g. staffing), the physical conditions of a facility (e.g. power supply, accessibility, environmental and radiological conditions), exacerbating factors, such as weather conditions (extreme heat, cold, or precipitation) and technology selection in relation to human performance under emergency conditions. HFE is also considered when personnel are required to operate the mobile accident mitigation equipment and the additional equipment credited during severe accident management. This includes safe access to locally and externally controlled equipment. HFE considers the range of internal and external interaction of individuals and interested parties at all levels with the emergency organisation for severe accidents. It also considers the level of stress and workload that can exist during accident management situations. The technical support centre staff is trained on the identification and use of the instruments to support implementation of severe accident management guidelines.

5.4 Interaction with Computerized Process System

In most scenarios, computerized procedures assist personnel by transforming paper based procedures into digital form that provides different levels of functionality including varying levels of automation. The computerized procedures are used to support the operating personnel in monitoring and detection, situation assessment, response planning and response implementation tasks. In particular, the computerised operating system allow the operating team members to have consistent, clear and shared situation awareness of the plant.

HFE ensures that the use of computerized procedures enhances the safety of nuclear facilities, minimizing human errors and helping operators to be more efficient. The computerized procedures presented to the operator on a display device or set of visual display devices which show the needed information for the operator to accomplish all the tasks defined in the procedure being executed. When computerized procedures are implemented at existing plant, the HFE programme considers how they would be introduced, in order to ensure proper functionality and consistency with operator expectations and experience.

Computerized procedures are included in the plant configuration management programme and administration. The design of computerized procedures considers the practical feasibility of authoring, quality assurance, review, verification, validation, control and updating the procedures.

5.5 Personal Protective Equipment (PPEs)

Personal protective equipment and their characteristics is selected and compatible with the users' anthropometry, the tasks performed while wearing it, and the range of environments in which the users are expected to work. HFE design criteria that relate to the use of personal protective equipment is applied to the anticipated use of systems, tools and job aids that may be used while wearing it. Personal protective equipment do not significantly affect reliability of the task.

HFE analysis determine that the task can be carried out whilst using protective equipment, which may affect the users' vision, hearing dexterity, mobility and abilities to work in extreme temperatures. Personal protective equipment are verified and validated related to their intended use across various plant conditions (e.g. during drills and emergency exercises). This verification and validation consider the full range of body sizes of the user population to be accommodated.

6.0 ASSESSMENT OF HOT-FACTORS

6.1 Planning for verification

Confirmation by examination and by provision of objective evidence that the HMI system meets the design specifications, requirements and provides the support needed to accomplish tasks, as intended is known as verification. The criteria applied for the verification include HFE standards and guidelines used in the design. The selection of standards and guidelines (HFE guideline) used in the review depends upon the characteristics of the HMI components included in the scope of the evaluation. Verification of HMI design are also performed to identify whether task requirements that were identified in the HFE task analysis have been met.

6.2 Safety Sampling

Safety sampling is a technique performed in a workplace or hazardous area that is used to measure potential for accidents. Safety sampling is performed by routine checks or inspections. It is a repeatable process designed to ensure compliance to safe practices and regulatory requirements over a long term basis and to keep safety levels high consistently. A qualified safety coordinator who has experience in creating, reviewing and maintaining standard operating procedures and their documentation, as well as perform safety inspections and help staff to comply with statutory and regulatory requirements through staff training procedures is usually the one who conducts the safety sampling.

6.3 Assessment Methods

Probabilistic Safety Assessment (PSA) is increasingly used in the nuclear industry in a complementary manner to the traditional deterministic analysis, as part of the decision making process to assess the level of safety. PSA provides a comprehensive, structured approach to identify accident scenarios and deriving numerical estimates of risks. The reliability experience, mainly derived from operational experience of all safety relevant features of the plant, are brought together, compared and evaluated. Human performance may substantially influence the reliability and safety level of all safety relevant components of the plant. Therefore human reliability analysis (HRA) constitutes an important part of PSA.

Another simple tool to assess the impact of Human, Organisational and Technological factors on the process is through check lists. A typical checklist for assessment of HOT factors is enclosed as Annexure-I, which may be used during the assessment of Nuclear and Radiation Facilities (NRF). The assessment of the utility is carried out either during Regulatory inspection or team visit constituted for this purpose. Frequency of assessment of the particular facility is once in a year.

6.4 Data Collection & Analysis

The means of collecting data are deployed in the course of the tests on mock-up, field part task simulator, or full scope simulators in order to detect, for example:

- The actions taken by the test participants (automatic archiving and manual collection by observers during each test)
- Communication between the test participants in the control room and communication between the control room and other teams involved in the operation of the plant and the crisis management.

The means of collecting data during the tests is used to collect deficiencies, i.e. the detected difficulties and mistakes made by the test participants and, on the other hand, to collect data on the ease of use when using the tools anticipated by the design. Consequently, the validation tests identify the resources that provide support for operator actions for safety purposes and those for which improvements are necessary, for example:

- To facilitate the surveillance of the installation and the understanding of the situation;
- To optimise the workload of the personnel;
- To encourage coordination and communications amongst the personnel.

The means of collecting data in validation tests are capable of making both objective measurements (e.g. the time taken to perform an action) and subjective measurements (a subjective questionnaire on the workload as perceived by the personnel, for example). The collected data allow for an in-depth analysis of every tested situation, for example:

- The chronology of the actions;
- The identification of tasks that were performed consistently well and without issues;
- The identification and analysis of remarkable facts in the execution of the scenario (e.g. any difficulties encountered by the personnel, hesitations about how to proceed, misunderstandings between the members of the control room team about the status of the systems or the equipment, etc.).

The analysis of the verification and validation tests requires an in depth examination of the collected data. It covers both the mistakes made by the test participants as well as human activities that were performed successfully. Furthermore, in all the tested operating situations the analysis highlight:

- The systems that were used efficiently by the test participants and that meet their needs;
- The systems that were difficult to use;
- The implied safety significance of the test results
- Suggestions for improved design (e.g. made by analyst and users).

The HFE issues are systematically documented and tracked. The corresponding mitigation solutions and their effectiveness are also documented, evaluated and monitored.

6.5 Validation of results

Confirmation by examination and by provision of objective evidence to ensure that the HMI system, including the user, can successfully accomplish that systems intended use, goals, and objectives in the particular operational environment is known as validation. The results of each verification and validation test campaign are documented. A report on the performed verification and validation is produced that summarizes the test plan, test findings, suggestions for improvements and conclusions. Any gaps with the HFE standards and the safety objectives are investigated, resolved, and documented. Any aspect which is not addressed in the verification and validation tests, and that must be validated on site after the installation enters operation, is also specified.

6.6 Human Performance Monitoring (HPM)

The monitoring of human performance is an active and ongoing process to evaluate the continuing effectiveness of the design to properly support people to carry out their work tasks safely and effectively. It provides insight into:

- Whether the HMI design meets (and continues to meet) the original safety, operability and performance assumptions;
- Whether the HMI design can be effectively used by operating personnel to conduct their tasks in the main control room, supplementary control room, local control stations and emergency response facilities;
- Whether changes made to the HMI design, procedures and training have any adverse effects on how operators carry out their work tasks;
- Whether human tasks can be accomplished within time response and performance criteria;
- Whether the level of performance established during the system validation is maintained over the plant life.

Human performance monitoring considers the following:

- All administrators of human performance monitoring and the users of its outputs are adequately trained;
- The administrators are suitably qualified and experienced in the domains of human and organisational factors, systemic approaches, and root cause analysis methods, to ensure that the causes and significance of deficient human performance are comprehensively understood and the suitable paths to performance improvement are identified and implemented;

- The effective use of issue reporting by system users in monitoring human performance needs a culture of open and honest reporting;
- Individual and team performance is directly affected by all levels within the organisation and therefore effective human performance monitoring should capture data from all levels;
- A sufficient flexibility is applied proportionate to the risk presented by the deviation in acceptable human performance;
- Progress in responding to and resolving degraded human performance is monitored to ensure that the response is within appropriate timescales.

Plant exercises and drills provide an important opportunity to gather information during a wide range of plant responses in all plant states. Where reasonably practicable, high level of trustworthiness is used to approximate the conditions faced during a real event.

6.7 Feedback & Improvement

Periodic feedback is obtained from the operators regarding the implementation of the HOT-Factors using a feedback form. The feedback form may contain information on improvement areas related to accessibility to workplace, work environment, ergonomics, procedural lapses, design deficiencies, suggestions etc. The feedback thus obtained is analysed for identification of areas of improvement.

7.0 CASE STUDIES

7.1 Fatal accident in a plant: Knocking down by Forklift Truck While Crossing the Road

A fatal accident occurred in a plant premises. The accident was due to hitting by a forklift truck while the victim was crossing the road.

On the date of accident, the victim was engaged in a file despatch job by HR section. He was going to board a parked tempo traveller near main gate of the plant for a scheduled trip to an adjoining another plant. Same time, a cask was being transported from the Rad-waste building of the plant to the Solid Waste Management Facility (SWMF) which is at about 2 km distance. This was a routine work and normally carried with a standard operating procedure. The fork lift loaded with the cask was moving through main road. For the forklift driver, some portion of the road was blind because of the loaded cask. A branch road from Administration Building joins the main road. At this time, the victim came from administration building side branch road and was crossing the main road to board the tempo traveller. The victim crossed the road without paying attention to vehicle movement and came in close contact with the Forklift body and fell down. The right side front and back tyres of the forklift ran over the victim. His body and head got crushed due to the accident.

First Aid staff was informed by CISF. The first Aid staff immediately reported the incident spot and confirmed the death of victim in spot. Thereafter, Medical officer assessed the condition and completed Medico- legal formalities. Subsequently the information was passed to Police and other authorities as per norms.

What went wrong?

There was a latent weakness of the system. Movement of Cask was being done since long with such blocked vision without envisaging what could go wrong. Procedure did not specify the requirement of pilot, speed limit etc. On the day of accident, when the inattentive employee was crossing the road, he was knocked out by forklift truck and the fatality occurred.

Human, Organisational and Technological (HOT) factors:

The Fatal accident asks for a re-examination of existing practice at the facilities. Clearly understanding of all the issues will help in making/implementing the Guidelines/ Procedures. The lessons learned and operating experiences must be incorporated in the training. Additionally, a systematic approach to safety requires the integration of all the prospects that need to be taken into account in light of the Human, Organisational and Technological factors.

Human factors:

This accident is a result of human related weakness. When this accident took place, the victim was crossing the road without paying any attention to the vehicle movement on the road. The loaded forklift engine had sound level even up to 85 dBA. But he did not notice it. As per the basic road rule, one individual should see both sides before crossing the road.

The speed of the forklift was more while this incident. The Forklift driver shall operate the Fork lift in slow speed, especially when the portion of road before him is not in visible range. The Forklift operation guide for training purpose specifies a speed limit of 8 km/hr.

At the earlier occasions, over the long years of the activities, even though knowing the blocked vision of about 25 feet, the operators became habitual of this way of forklift operation and they did not point out this constraint for any corrective action.

Organisational Factors

- ***Procedure Weakness:***

The standard operating procedure for Transportation of cask having filter sludge and other solid Rad-waste states that “While movement of cask, it should be escorted for handling emergency condition in case of any eventualities”. However, job responsibility of the escort accompanying the forklift during transportation of forklift was not clearly defined. Inclusion of the deployment of a pilot/escort for the

purpose of alerting the pedestrians and other vehicles during the transportation of cask by forklift would have cautioned the victim before crossing the road and prevented the accident.

- ***Role of Training***

Training is having an important role for safe handling all type of material handling equipment. The forklift operators training was not effective. The forklift operator must be aware the movements that can be happened in the blind zone. Application of pilot person is very important to overcome the anticipations in blind zone.

- ***Use of Permit System***

The practice of Industrial Safety Permit was not there. The Cask movement is a work with accidental potential due to heavy material movement. So the application of Industrial Safety Permit is very much essential. Job Hazard analysis of Cask movement was not carried out.

- ***Lack of Communication***

Safety Guide for Training mentions speed limit of 8 km/hr for loaded conditions but the procedure did not have precautionary information about the speed limit. The mandatory safety instructions shall be incorporated in training as well as in operating procedures and enforced at all levels and at all places.

Technological Factors

- ***Inadequate signalling system***

In the Forklift model used in Station, the provision of siren and blinking lights were not there. To overcome the blind zone uncertainties, provision of siren and blinking lights will be effective to achieve safe material transportation.

- ***Speed Control of Fork lift***

On the day of accident, the forklift was driven at a speed of about 15 km/hr. The procedure for transportation of cask did not specify slow speed operation of forklift in loaded condition. Limiting values and regulation on speeds at which the forklift can be driven at HI and LO position of the speed selector lever was not available in this model of forklift.

7.2 Importance of selection of Process Technology

Introduction:

H₂S-H₂O exchange process is used for producing Heavy water. H₂S gas is required to be generated to provide the make up to maintain the system pressure and purity. H₂S gas is produced in situ by reacting Sodium Sulphide with Sulphuric Acid. Operational data have established that 30 MT of liquid effluent containing about 14% Sodium Sulphate is generated for production of each MT of H₂S gas. Thus, the total liquid effluent generation for say 150 MT H₂S gas translates to 4500 MT liquid effluent per annum.

Sodium Sulphate effluent has been traditionally processed by concentrating from 14% to 25% using steam / hot liquid effluent from Exchange Unit before feeding to solar evaporation tanks. In the solar evaporation tanks, the solution gets concentrated leading to crystallization of Glauber Salt ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$). This Glauber Salt contains nearly 56% water together with various other impurities present in the effluent. Earlier, reasonable market existed for the Glauber Salt and as such the same could be disposed off by sale. However, as technologies progressed, high moisture containing Glauber Salt is not being accepted in the market as dry Sodium Sulphate is getting available and as such it is becoming increasingly difficult to dispose off this Glauber Salt. This situation became critical on account of piling up of this material due to non-disposal and was a bottleneck in plant operation. In order to overcome the constraint arising out of disposal difficulties connected with Glauber Salt, another process was adopted to generate anhydrous Sodium Sulphate by spray drying of Sodium Sulphate solution. While this process generates saleable dry powder, it is highly energy intensive. The process flow diagram is given in Fig.6.

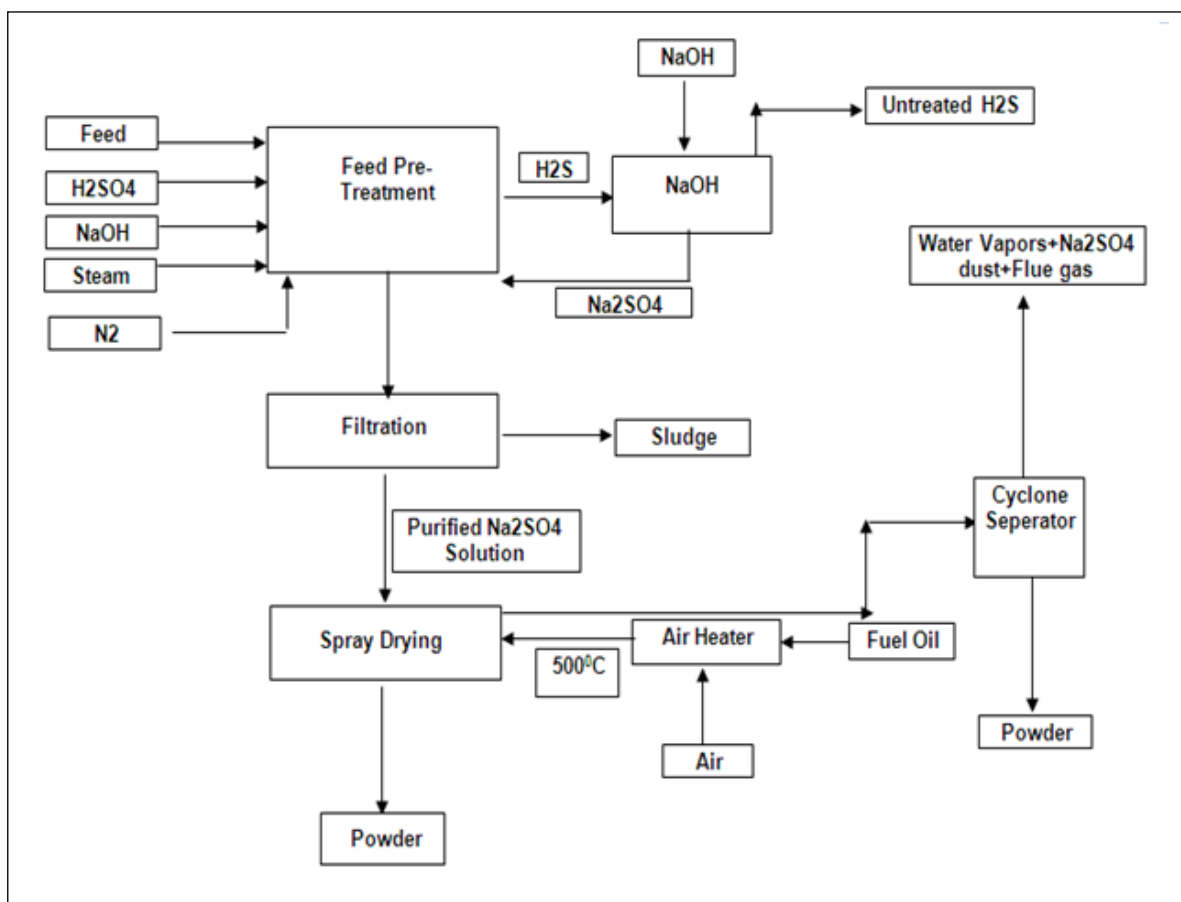


Fig.6: Process flow diagram of Sodium Sulphate Spray Drying Plant

This process involves pre-treatment of the feed solution to remove Na_2S as it catches fire during spray drying & also acts as an impurity in the finished product. Thus this process involves handling and consumption of acid, alkali & absorbing H_2S generated in NaOH . Secondly, spray drying is done at

500°C temp which is achieved by burning LDO & mixing air in the flue gas. The flue gas is released to atmosphere at 110°C as shown in Fig.7. Thus the process is not only very costly but also hazardous from the point of fire, explosion & chemicals.

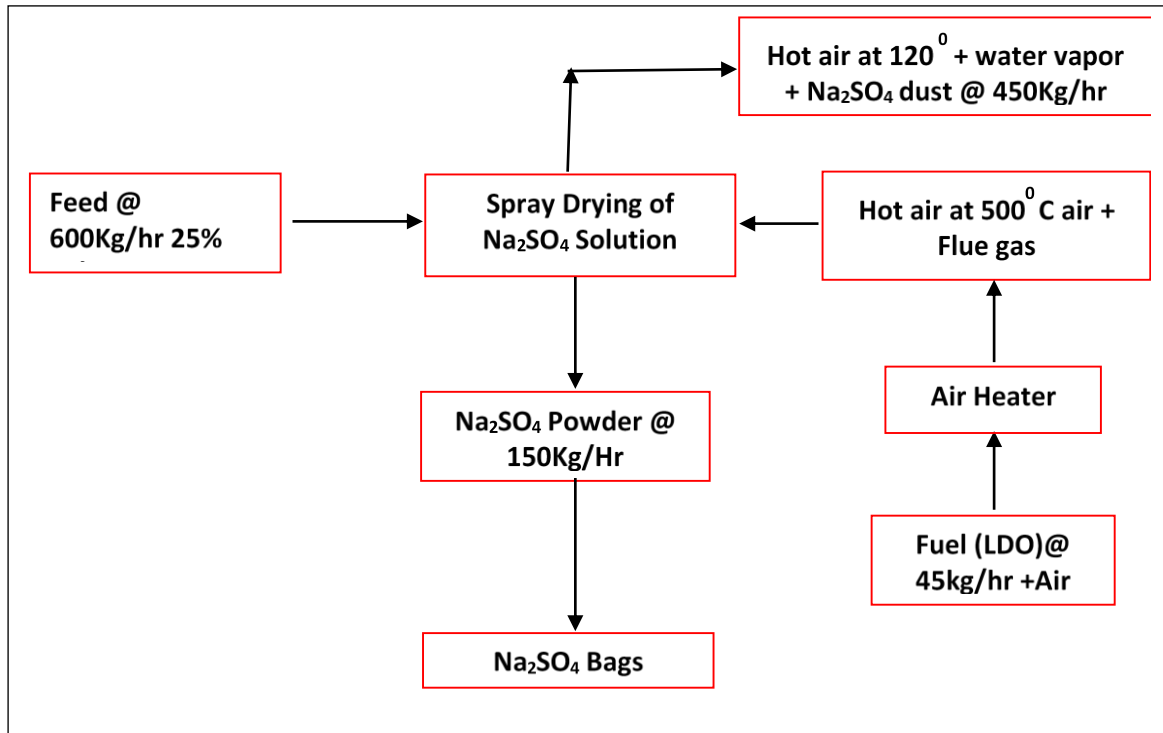


Fig.7: Process flow diagram of Sodium Sulphate Spray Drying Plant

Thus a need was felt to develop an alternate cheaper, simpler & eco-friendly process to facilitate recovery of such a large volume of Sodium Sulphate effluent.

Brief Process Description:

The separation of Na₂SO₄ by crystallization is possible due to the solubility difference between the impurities & Na₂SO₄. Secondly, anhydrous crystals of Na₂SO₄ are formed when evaporation is carried out at higher temperature. Therefore, the crystallization is proposed to be carried out at 80-90°C. The process, therefore, envisages preheating the Na₂SO₄ solution with liquid effluent of exchange unit, crystallization of Na₂SO₄ in multiple effect evaporator, separation of Na₂SO₄ crystals by centrifuging, drying of crystals in rotary drier & bagging.

The mother liquor, rich in impurities Na₂S₂O₇, Na₂S can be further concentrated in the evaporator where most of the Na₂S₂O₇ will get separated & it will be centrifuged & dried. The balance mother liquor with Na₂S and some Na₂S₂O₇ will be recycled to generate H₂S in H₂S generation plant.

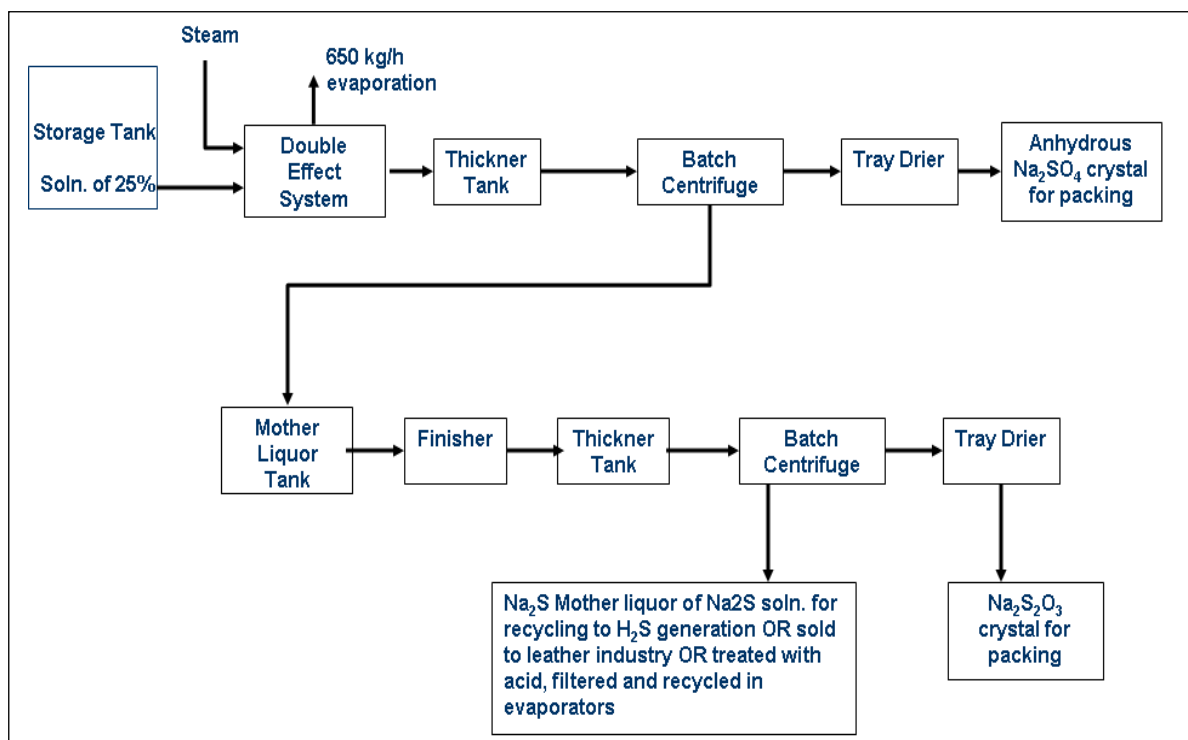


Fig.8: Process Flow Diagram of Sodium Sulphate Crystallizer Unit

Major benefits of the project:

- Reduction in fire, explosion and chemical hazards.
- Zero effluent from Sodium Sulphate laden streams which is converted to a saleable product.
- Generation of pure Sodium Sulphate and Sodium thio-sulphate will fetch reasonable price to partly cover the cost of effluent management.
- Recycling of mother liquor to utilize un-reacted Sodium Sulphide for production of H₂S gas.
- Cleaner Technology as no fuel consumption.
- Chemicals are not consumed to remove the impurities & impurities are recovered.

Human organisation and technological factors

I. Human Factors

- a. Lower the hazards easier is the operation of the plant. This technology does not have flammable and toxic chemicals. Therefore operation of the plant is easy and simple.
- b. Use of personal protective equipment is very less as hazards are insignificant.
- c. Plant monitoring and trouble shooting is easy.

II. Organisational Factors

- a. Training requirements are not stringent and easy to develop competency.
- b. Plant design is simple and capital and operational costs are lower.
- c. Sophisticated control systems are not required.

III. Technological Factors

- a. To design and maintain the plant is simpler as compared to earlier technology.
- b. No chemical consumption and all the impurities are recovered and reused.
- c. Pollution is minimal.

Conclusion :

Selection of technology has bearing on cost, safety, environment & operation. The second process was found to be cheaper, simpler, safer & more eco-friendly

7.3 Fukushima Daiichi Nuclear Power Plant Accident

The Great East Japan Earthquake occurred on 11 March 2011. It was caused by a sudden release of energy at the interface where the Pacific tectonic plate forces its way under the North American tectonic plate. The earthquake and tsunami caused great loss of life and widespread devastation in Japan.

At the Fukushima Daiichi nuclear power plant, operated by the Tokyo Electric Power Company (TEPCO), the earthquake caused damage to the electric power supply lines to the site, and the tsunami caused substantial destruction of the operational and safety infrastructure on the site. The combined effect led to the loss of off-site and on-site electrical power. This resulted in the loss of the cooling function at the three operating reactors as well as at the spent fuel pools. The four other nuclear power plants along the coast were also affected to different degrees by the earthquake and tsunami. However, all operating reactor units at these plants were safely shut down.

Despite the efforts of the operators at the Fukushima Daiichi nuclear power plant to maintain control, the reactor cores in Units 1–3 overheated, the nuclear fuel melted and the three containment vessels were breached. Hydrogen was released from the reactor pressure vessels, leading to explosions inside the reactor buildings in Units 1, 3 and 4 that damaged structures and equipment and injured personnel. Radionuclides were released from the plant to the atmosphere and were deposited on land and on the ocean. There were also direct releases into the sea. People within a radius of 20 km of the site and in other designated areas were evacuated, and those within a radius of 20–30 km were instructed to shelter before later being advised to voluntarily evacuate. Restrictions were placed on the distribution and consumption of food and the consumption of drinking water.

Safety Functions

The three fundamental safety functions important for ensuring safety are: the control of reactivity in the nuclear fuel; the removal of heat from the reactor core and spent fuel pool; and the confinement of radioactive material.

Following the earthquake, the first fundamental safety function — control of reactivity — was fulfilled in all six units at the Fukushima Daiichi nuclear power plant.

The second fundamental safety function — removing heat from the reactor core and the spent fuel pool — could not be maintained because the operators were deprived of almost all means of control over the reactors of Units 1, 2 and 3 and the spent fuel pools as a result of the loss of most of the AC and DC electrical systems. The loss of the second fundamental safety function was, in part, due to the failure to implement alternative water injection because of delays in depressurizing the reactor pressure vessels. Loss of cooling led to overheating and melting of the fuel in the reactors.

The confinement function was lost as a result of the loss of AC and DC power, which rendered the cooling systems unavailable and made it difficult for the operators to use the containment venting system. Venting of the containment was necessary to relieve pressure and prevent its failure. The operators were able to vent Units 1 and 3 to reduce the pressure in the primary containment vessels. However, this resulted in radioactive releases to the environment. Even though the containment vents for Units 1 and 3 were opened, the primary containment vessels for Units 1 and 3 eventually failed. Containment venting for Unit 2 was not successful, and the containment failed, resulting in radioactive releases.

Human organisational and Technological factors:

The Fukushima Daiichi accident revealed the need for a re-examination of some of the key elements of emergency preparedness and response and the scope of related training. In particular, it again was evident that the roles and responsibilities of the various stakeholders need to be clearly defined and well communicated. Issues between the operating organisation, the regulatory body, the government and the public had an impact on the emergency response to the accident. To ensure the effectiveness of well-defined roles and responsibilities, an integrated approach to training in emergency preparedness and response becomes critical. The use of lessons learned and operating experience must be incorporated into the training. Additionally, a systemic approach to safety requires the integration of all the factors that need to be considered for human, organisational and technological factors.

Human Factors

- 1) Operators' lack of knowledge about and practice with the emergency systems.
- 2) Emergency Response centre (ERC) support was more difficult to provide than expected due to the conditions of the emergency.
- 3) The ERC had difficulty in managing the supervision of the three reactors simultaneously.
- 4) The idea of using fire trucks came up early, but its implementation was delayed while attempting the other possibilities and understanding the procedures.
- 5) The uncertainty and the lack of foresight about this specific accident were also highlighted in the number of decisions that had to be made during the emergency response because they had not been considered beforehand.
- 6) Those farther away from the danger, in the TEPCO headquarters and in the Prime Minister's office, seemed to have greater difficulty dealing with uncertainty.
- 7) Lack of Training, exercises and drills to include postulated severe accident conditions to ensure that operators are as well prepared as possible. They need to include the simulated use of actual equipment that would be deployed in the management of a severe accident.

Organisational Factors

Responsibility gap during Crisis management:

Role and responsibility for decision making concerning the emergency situation was not clear. During the Fukushima Daiichi accident, this was an issue between the operator, the regulator and, eventually, the Government. The prime responsibility for safety must rest with the operator. In some Member States, there is a belief that the regulatory body should have the authority to take the final decisions; in other Member States this is not the case. There is a clear need for well defined roles and responsibilities for decision making among the regulatory body, the operator and any other stakeholders that may be involved during an emergency situation. These responsibilities and the authority for decision making in an emergency need to be agreed and exercised at the preparedness stage to allow for an effective response once an emergency occurs. A key lesson learned from the Fukushima Daiichi accident was that, as the decision making responsibilities and authority had not been clarified, individuals who did not have the appropriate technical expertise or complete information about the situation were making significant decisions that in some cases were inappropriate or incorrect.

Role of Training

The lessons learned from the Fukushima Daiichi accident indicate that the highest ranking individuals may be involved in the emergency response and therefore need to be part of the emergency preparedness arrangements for such an event. Drills and training exercises are an essential mechanism for training staff to deal with emergency situations. However, it was noted that drills and

training exercises are usually pre-planned and announced, and use expected rather than unexpected scenarios. These drills and training exercises also need to cover beyond design basis events and to include all responsible parties; they may also involve multiple countries.

Use of Operating Experience

Fukushima Daiichi accident could contribute to learning within the new safety paradigm is the success experienced at the Fukushima Daini nuclear power plant. The key elements of this success identified by the experts were the establishment of a well prioritized and clear strategy by the management of the Fukushima Daini nuclear power plant and communication of that strategy to all personnel. This allowed the organisation to move directly to achieving the goals of the strategy during the emergency situation. Additionally, organisational integrity was maintained during the emergency situation by using a command and control structure to deal with the simultaneous damage of multiple units. The presence of a large number of individuals from the operating staff who had worked at the plant during the construction and commissioning stages and who had a better knowledge of the plant than their counterparts were utilised in handling the emergency situation in Fukushima Daiichi. The operating experience feedback were found extremely valuable. Most importantly, good teamwork had already been developed prior to the accident.

Lack of regulatory Independence

In order to ensure effective regulatory oversight of the safety of nuclear installations, it is essential that the regulatory body is independent and possesses legal authority, technical competence and a strong safety culture

Technological Factors

Inadequate assessment of natural hazard

The assessment of natural hazards needs to be sufficiently conservative. The consideration of mainly historical data in the establishment of the design basis of NPPs is not sufficient to characterize the risks of extreme natural hazards. Even when comprehensive data are available, due to the relatively short observation periods, large uncertainties remain in the prediction of natural hazards.

Lack of instrumentation and control systems during BDBA

Instrumentation and control systems that are necessary during beyond design basis accidents need to remain operable in order to monitor essential plant safety parameters and to facilitate plant operations

BIBLIOGRAPHY:

1. IAEA Draft Safety Guide on “*Human Factors Engineering in the Design of Nuclear Power Plants*”, September 2016.
2. “*Human and Organisational Factors of Safety*” by François Daniellou et al, 2009

Annexure –I

Typical Checklist for Assessment of HOT Factors						
Part I: Human Factors						
	Not Appli- cable	Strongly Disagree	Disagree	Cannot Decide	Agree	Strongly Agree
1. Safety aspects are covered in the Job specific Training given to the employees.	N/A	1	2	3	4	5
2. Periodic Medical examination is conducted as per - a) Atomic Energy Factories Rules 1996 b) Radiation Protection Rules 2004	N/A	1	2	3	4	5
3. All the employees at work meet minimum cognitive capability standards (e.g. Memory, drive to completion) for their respective assigned job. This is required to avoid poor judgment/ decision making errors. (Based on field observations, field discussions, filled-in log-sheets & checklists, work-permits, SOP/EOPs etc.)	N/A	1	2	3	4	5
4. Whether the mechanism is available to check the <i>Fitness for duty</i> of employees. (W.r.t. distraction, situation awareness, mental / physical fatigue and stress, long working hours, excessive overtime etc.)	N/A	1	2	3	4	5
5. Mechanism is in place to verify that the employee possesses technical Skills for the assigned job.	N/A	1	2	3	4	5
6. Mechanism is in place to verify that the concerned employee possesses observation, coaching and supervision skills for the assigned job and responsibilities.	N/A	1	2	3	4	5
7. Whether the employee is sensitive towards reasoning based decisions, positive towards checklist discipline, and capable of minimizing procedural error tendency.	N/A	1	2	3	4	5
8. Accountability of employee is evident towards application of existing Rules/ procedure, Risk Assessment, Recognition of changes, Relying on Memory, Frustration and Complacency	N/A	1	2	3	4	5
Part II: Organisational Factors						
9. Documents such as SOPs, Manuals, Procedures related to safety are used in principle and are easily retrievable for future use and reference.	N/A	1	2	3	4	5
10. Mechanism of sharing Information exists among different departments (horizontally) and from top management to the lower levels (vertically).	N/A	1	2	3	4	5

11. Whether Statutory Posts such as competent person, Safety officer, Welfare officer, Occupier / Licensee, Certifying Surgeon, Radiological Safety Officer (RSO) are filled as per the requirement under Atomic Energy Factories Rules 1996 and Radiation Protection Rules, 2004.	N/A	1	2	3	4	5
12. It is evident that officers holding statutory posts have been delegated authority and empowered by the management.	N/A	1	2	3	4	5
13. Evidence that safety issues are discussed in section, plant and apex level safety committee (Management Level)	N/A	1	2	3	4	5
14. Whether recommendations of the Regulatory inspections and Safety committee meetings are complied with stipulated time period.	N/A	1	2	3	4	5
15. Whether workers / supervisors are encouraged to ask questions, raising issues and making suggestions during meetings, training sessions, safety survey etc.	N/A	1	2	3	4	5
16. Evidence of proper communication and information flow in the organisation	N/A	1	2	3	4	5
17. Scheme of Knowledge transfer mechanism (vertically and horizontally both) is available and followed in the organisation	N/A	1	2	3	4	5
18. Does the facility conduct an internal audit / review on performance of industrial and fire standards?	N/A	1	2	3	4	5
19. Whether operations are identified for which Licensing / Authorisation of operational personnel is carried out.	N/A	1	2	3	4	5
20. Does the facility follow work permit system for hazardous jobs.	N/A	1	2	3	4	5
Part III: Technological Factors						
21. Methodology and Procedures clarity regarding the operation to the employees at work (e.g. operator & maintenance manual, ISI, QA & QC manual etc.)	N/A	1	2	3	4	5
22. Approved Technical Specification of the plant/ facility is available and being used.	N/A	1	2	3	4	5
23. Evidence of systematic analysis of a specific job in a specific location to identify and diagnose potential hazards and determine the controls (e.g. JHA, HAZOP & FHA etc.)	N/A	1	2	3	4	5
24. Integration of human factors at various stages of design incorporating probable human error in operation or maintenance. (Ergonomics aspects)	N/A	1	2	3	4	5

25. Whether examination and testing of lifting equipment and pressure vessels are being done as per Atomic Energy factories Rules 1996 requirements?	N/A	1	2	3	4	5
Part IV: Safety Culture Evaluation						
26. Evidence of good practices related to safety conscious work environment being followed	N/A	1	2	3	4	5
27. Implementation of industrial, fire and radiological safety policy are visible during inspection	N/A	1	2	3	4	5
28. Evidence of leadership commitment to safety management systems (such as discipline, rewards and recognition, observation and feedback, safety communication, safety accountability, audits and inspections and incident reporting and investigation)	N/A	1	2	3	4	5
29. Whether defined management structure with authority and accountability is in place to implement safety policies.	N/A	1	2	3	4	5
30. Evidence that adequate resources (i.e. sufficient experienced and trained staff, funding, necessary equipment, facilities and supporting technical infrastructure) are devoted to safety.	N/A	1	2	3	4	5
31. Whether plant/ facility advocates self-regulation by arranging regular review of those practices that contribute to plant safety.	N/A	1	2	3	4	5
32. Whether responsibilities assigned to individuals are defined and documented in sufficient details to prevent ambiguity.	N/A	1	2	3	4	5
33. Whether thought process is developed among employees through advocating questioning attitude environment.	N/A	1	2	3	4	5
34. Evidence that Top management are informed about outcome of internal assessments of the safety performance parameters / indicators.	N/A	1	2	3	4	5
35. Remarks:						

Part-B:
Lifestyle Diseases –
Silent Killer of the Millennium

Contributors:

Dr. D. S. Kathuria, NPCIL

Dr. Hemant Haldavnekar, BARC

Dr. Ajay Dubey, KKNPP

Dr. Preeti Dubey, KKNPP

Shri S. R. Bhave, AERB

Shri Vishvajit Bhatkhande, AERB

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1.0 INTRODUCTION

The world has come a long way in the last say 100 years or since the beginning of industrialization, not just in terms of economic advancements and blurring geographies for trade, but also in the field of science, specifically medicine. As developments in businesses occurred, there was an implicit effect on the pace of lifestyles of the people involved. Although field of medicine has evolved extensively and has eradicated quite a few deadly diseases till now, the next generation has been plagued with a fresh set of diseases, creatively called as “**lifestyle diseases**”. These diseases, as the name suggests, are the result of fast-paced lifestyle that necessarily accompanies the developments over the years and have become a major threat to health in the present era.

Today, the biggest killer in the world, accounting for almost 80% deaths worldwide is not war, disease, natural calamities or accidents; but the “lifestyle diseases”. These diseases are now the leading cause of death around the world with developing countries hit hardest. These diseases better known as **Non-Communicable Diseases (NCDs)**, characterize those diseases whose occurrence is primarily based on the daily habits of people and also a result of an inappropriate relationship of people with their environment. *It is a medical condition or disease which is non-infectious and non-transmissible, but is likely to continue progressively.* According to World Health Organization (WHO), lifestyle diseases may be chronic diseases of long duration and slow progression or they may result in more rapid death. Bad food habits, physical inactivity, wrong body posture, disturbed biological clock and addictions are the major factors found to influence susceptibility to many diseases.

NCDs are often associated with older age groups, but recent evidence shows that more than 9 million of all deaths attributed to NCDs occur before the age of 60. The WHO has estimated that by 2020, two-thirds of the global burden of diseases

will be attributable to chronic NCDs, most of them strongly associated with life style.

The four main types of lifestyle diseases are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases and diabetes. The other lifestyle diseases include hypertension, obesity, osteoporosis, Alzheimer's disease, arthritis, atherosclerosis, chronic liver disease or cirrhosis and so on.

Obesity, lack of physical activity and exercise, mental stresses and tension, pollution, addictions (alcohol, and smoking) negligence/ ignorance / overconfidence are the major lifestyle culprits. They manifest themselves innocently as high blood pressure, diabetes or hyperlipidemia, and then without warning strike fatally as heart attacks, cancer, HIV/AIDS & cerebrovascular accidents (CVA). Earlier known to strike in old age the biggest killer in the world, the heart attack now strikes as early as in age 40 years, & with each passing decade is attacking younger age groups.

Certainly, there are amazing instruments that identify blood pressure, blood sugar, blood lipids, artery blockage, irregular electrical stimulus of the heart and bizarre brain waves, etc. But it is a need of hour to know, how do we get to these states of high blood pressure, high blood sugar or fats? How do our arteries get clogged? How do our heart rates and brain waves get distorted? It is the prerequisite of this millennium to identify the lifestyle risk factors that cause these maladies. It then goes one step further. To attain positive and total health is the only remedy against these maladies.

2.0 Bio-Medical Lifestyle Risk Factors

Lifestyle related diseases are often associated with genetic factors and other common, modifiable lifestyle risks, including obesity, physical inactivity, unhealthy diet, tobacco smoking, risky alcohol consumption, unhealthy diet habits and high cholesterol. Chronic diseases or Non-communicable diseases (NCDs), usually emerge in middle age after long exposure to an unhealthy lifestyle also involving above factors, known as **“risk factors”**. *Risk factors are conditions that increase risk of developing any lifestyle disease.* The risk factors are frequently undiagnosed or inadequately managed in health services designed to treat acute conditions. Unhealthy lifestyle results in higher levels of risk factors, such as hypertension, dyslipidemia, diabetes, and obesity that act independently and synergistically.

A broad range of risk factors for chronic disease has been identified. These can be demographic, behavioral, biomedical, genetic, environmental, social or other factors, which can act independently or in combination, and some of which can be modified to reduce the risk of developing a chronic condition. It is widely acknowledged that many chronic diseases not only share common risk factors, but can also be risk factors for each other.

While the presence of a single risk factor can lead to illness, there is an increasing danger of developing chronic disease when more than one risk factor is present. The effects of multiple risk factors can manifest in the earlier development of a condition, in an increased burden and need for management of a condition, in greater health care costs and ultimately in reduced life expectancy.

Across all ages, changes in health behaviors can reduce the incidence and impact of chronic diseases.

2.1 Risk Factors

Risk factors are often classified into **“modifiable”** & **“non-modifiable”** risk factors.

2.1.1 Modifiable risk factors

Some risk factors are called as **“modifiable”** because they can be changed or treated. Common modifiable risk factors include tobacco smoking, harmful use of alcohol, overweight and obesity, physical inactivity and poor nutrition. Such modifiable risk factors can lead to overweight and obesity, high blood pressure and high cholesterol levels, which in turn can lead to chronic disease and conditions such as cardiovascular disease, diabetes, cancer and mental health issues.

High blood pressure

Blood pressure is recorded as a ratio, like 120/80 mmHg. The numerator, called systolic blood pressure, measures the pressure in the arteries when the heart beats. The denominator, called diastolic blood pressure, measures the pressure in the arteries between the heartbeats. High blood pressure (HBP) is defined as pressure above **140/90 mmHg** on at least two separate occasions on separate days. Target blood pressure is 120/80 mmHg regardless of age. Many people have high blood pressure (HBP) for years. If left untreated, it can lead to coronary heart disease, heart attack or stroke. A higher percentage of men than women have HBP until age 45. From ages 45–64, the percentage of men and women is similar. After that, a much higher percentage of women have HBP than men. High blood pressure is estimated to cause 7.5 million deaths, about 12.8% of all deaths. It is a major risk factor for cardiovascular disease.

Smoking (addiction)

Smoking is the most **preventable** risk factor. Smokers have more than twice the risk of developing cardiovascular disease. On average, smoking costs 13 years to a male smoker and 14 years to a female smoker.

Almost 6 million people die from tobacco use each year, both from active and passive smoking. By 2020, this number will increase to 7.5 million, accounting for 10% of all deaths. Smoking is estimated to cause about 71% of lung cancer, 42% of chronic respiratory disease and nearly 10% of cardiovascular disease.

Insufficient Physical Activity

Approximately 3.2 million people die each year due to physical inactivity. Regular physical activity reduces the risk of cardiovascular disease, including high blood pressure, diabetes, breast and colon cancer and depression.

Harmful use of alcohol (excessive intake of alcohol)

Approximately 2.3 million die each year from the harmful use of alcohol, accounting for about 3.8% of all deaths in the world. More than half of these deaths occur from NCDs including cancers, cardiovascular disease and liver cirrhosis.

Unhealthy diet

Unhealthy diet and inappropriate timings of taking diet are major concerns for most of the working individuals. Healthy diet at right time is a key to good health e.g. adequate consumption of fruit and vegetables reduces the risk for cardiovascular diseases, stomach cancer and colorectal cancer. For disease prevention; high salt consumption is an important determinant of high blood pressure and cardiovascular risk. High consumption of saturated fats and Trans-fatty acids is linked to heart disease.

Overweight and Obesity

At least 2.8 million people die each year as a result of being overweight or obese. Risks of heart disease, stroke and diabetes increase steadily with increasing body mass index (BMI). Raised BMI also increases the risk of certain cancers.

Cholesterol

Raised cholesterol is estimated to cause 2.6 million deaths annually; it increases the risk of heart disease and stroke. The cholesterol profile includes LDL (bad) cholesterol, HDL (good) cholesterol, triglycerides and total cholesterol.

A. LDL cholesterol (low density lipoprotein) contributes to the artery blockages (plaques). Most people should aim at an LDL cholesterol level of 100 mg/dL or lower. If you have a very high risk of developing cardiovascular disease, or if you already had a heart attack, you may need to aim at an LDL level below 70 mg/dL.

B. HDL Cholesterol (high density lipoprotein) is a reverse-transport protein; it removes cholesterol from the arteries and takes it to the liver where it can be passed out of the body. High levels of HDL cholesterol lower your risk of developing cardiovascular disease. An HDL level of 60 mg/dL and over is considered excellent, providing you optimal protection.

Total cholesterol is a measure of LDL cholesterol, HDL cholesterol and other lipids. The desirable level of total cholesterol is less than 200mg/dL.

Triglyceride is the most common type of fat in the body. Many people who have heart disease or diabetes, have high triglyceride levels. Normal triglyceride level is less than 150 mg/dL.

Cancer – Associated infections as modifiable risk factor

At least 2 million cancer cases per year, 18% of the global cancer burden, are attributable to a few specific chronic infections, and this fraction is substantially larger in low-income countries. The principal infectious agents are human papillomavirus, Hepatitis B virus, Hepatitis C virus and Helicobacter pylori. These infections are largely preventable through vaccinations and measures to avoid transmission, or treatable.

Environmental Risk Factors

Occupational Hazards, air and water pollution poses a significant risk in causing and aggravating many lifestyle diseases predominantly Heart Disease.

2.1.2 Non-Modifiable Risk Factors includes

Some risk factors are called "non-modifiable" because nobody can change them and these risk factors include:

Age

According to American Heart Association computations, about 80 percent of people who die from cardiovascular disease are 65 years and older. Age itself increases risk of developing heart disease.

Gender

Heart disease has long been considered to be primarily men's disease. Although women tend to develop cardiovascular disease about 10 years later in life than men, the outcome for women is often worse. Following statistics highlight the same,

- 2/3 of women have at least 1 risk factor.
- More than 60% are overweight or obese.
- 25% have almost NO physical activity.
- More than 50% of women over 45 years old have hypertension.
- 40% of women over 55 years old have elevated cholesterol.
- Low HDL (Less than 40mg) is a stronger risk factor for older women than older men.
- Diabetes increases relative risk 3-7 fold for women.

Family history

Risk for developing heart disease increases if anybody has a relative who developed heart disease at an early age (before 55 years old). If parents developed heart disease later in life, it may be age-related rather than genetic. While nobody can change genes, it is important to know the family medical history and share it with family doctor.

3.0 Why we need lifestyle management?

India is the seventh largest and the second most populous country in the world. Currently India is dealing with triple disease burden that is non-communicable disease, communicable disease and violence & injuries. Out of 57 million global deaths in 2008, 36 million or 63 percent (INDIA 53 %) were due to non-communicable diseases (NCDs). By cause, **cardiovascular diseases** were responsible for the largest proportion of NCD deaths 47.9 per cent (INDIA 24%) followed by **cancers** 21 per cent (INDIA 6%), **chronic respiratory diseases** 11.72 per cent (INDIA 11%), **digestive diseases** 6.1 per cent, diabetes 3.5 per cent (INDIA 2%), and rest of the NCDs were responsible for 9.78 per cent of deaths (INDIA 10%). As population will increase, annual NCD deaths are projected to rise substantially to 52 million in 2030. Annual cardiovascular disease mortality is projected to increase by 6 million and cancer mortality by 4 million (INDIA 2.8 million). In low-and-middle income countries NCDs will be responsible for three times and nearly five times as many deaths as communicable diseases, maternal, perinatal and nutritional conditions combined.

India is experiencing a rapid health transition with a rising burden of NCDs causing significant morbidity and mortality, both in urban and rural population, with considerable loss in potentially productive years (age 35 – 64 years) of life.

In one of the study on lifestyle and non-communicable diseases: a double edged sword for future India, showed that in India 53% of the death in 2008, were due to NCDs (WHO). The anticipated cumulative loss of national income due to NCDs mortality for India for 2006-2015 was USD237 billion. By, 2030, this productivity loss is expected to double.

THE MAJOR NCDS CAN BE PREVENTED THROUGH EFFECTIVE INTERVENTIONS BY UNDERTAKING THE LIFESTYLE RELATED MODIFIABLE RISKFACTORS.

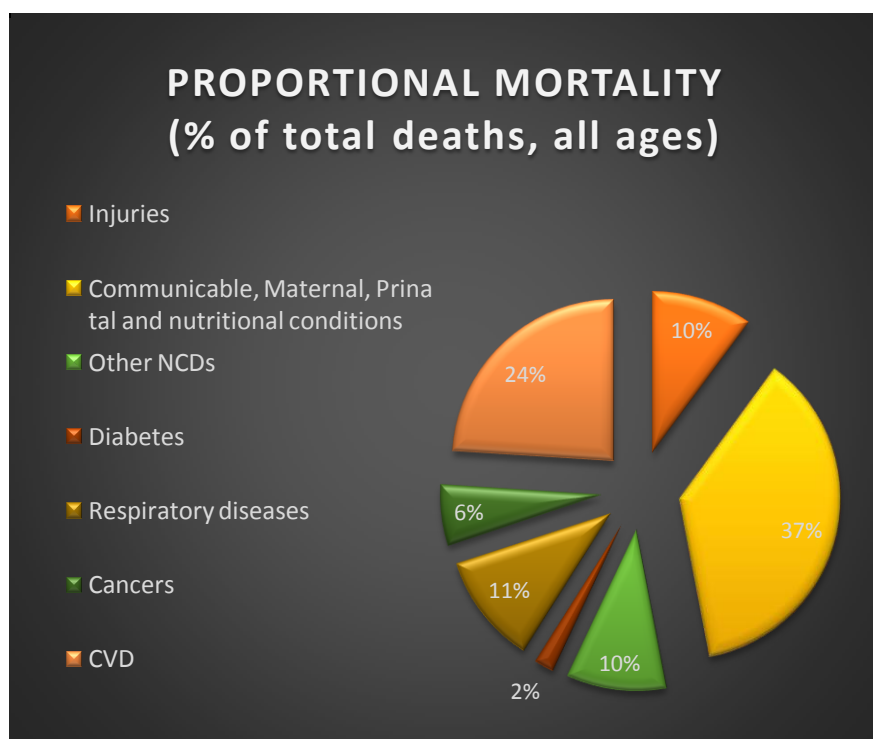


TABLE 1: Behavioral risk factors for Non – Communicable Disease (WHO-2008 estimates)–

The Indian Scenario

S.No.	Risk factor	Total (%)
1.	Current daily tobacco smoking	13.9
2.	Physical inactivity	14.0

Table 2: Metabolic risk factors of Non – Communicable Disease (WHO-2008 estimates)

S.No.	Risk factor	Total (%)
1.	Raised blood pressure	32.5
2.	Raised blood glucose	10.0
3.	Overweight	11.0
4.	Obesity	1.9
5.	Raised cholesterol	27.1

4.0 Major Lifestyle Diseases

4.1 HYPERTENSION

Blood pressure is the force exerted by the blood against the walls of blood vessels, and the magnitude of this force depends on the cardiac output and the resistance of the blood vessels. Hypertension is a chronic condition of concern due to its role in the causation of coronary heart disease, stroke and other vascular complications.

TYPES OF HYPERTENSION

i) PRIMARY HYPERTENSION (ESSENTIAL HYPERTENSION)

Hypertension is classified as "essential" when the causes are generally unknown. About 90–95% of cases are primary, defined as high blood pressure due to nonspecific lifestyle and genetic factors.

ii) SECONDARY HYPERTENSION (NON-ESSENTIAL HYPERTENSION)

The remaining 5–10% of cases is categorized as secondary high blood pressure, defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the kidney arteries, an endocrine disorder, or the use of birth control pills.

RISK FACTORS

- ❖ Obesity
- ❖ Saturated Fat
- ❖ Alcohol
- ❖ Physical Inactivity
- ❖ Salt Intake (High salt intake (i.e., 7-8 g per day))
- ❖ Low Dietary Fiber
- ❖ Tobacco
- ❖ Stress

EFFECTS OF HYPERTENSION

Organ Damage - Although the extent of organ damage often correlates with the level of blood pressure, it is not always the case. The affected organs are heart, brain and kidney.

High pressures may be seen without organ damage and, conversely, organ damage may be present with only moderate elevation of blood pressure.

Damage to your arteries - Healthy arteries are flexible, strong and elastic. Their inner lining is smooth so that blood flows freely, supplying vital organs and tissues with nutrients and oxygen. Hypertension gradually increases the pressure of blood flowing through your arteries. As a result, you might experience:

- ✓ **Damaged and narrowed arteries** - High blood pressure can damage the cells of your arteries' inner lining. When fats from your diet enter your bloodstream, they can accumulate in the damaged arteries. Eventually, your artery walls become less elastic, limiting blood flow throughout your body.

- ✓ **Aneurysm** - Over time, the constant pressure of blood moving through a weakened artery can cause a section of its wall to enlarge and form a bulge (aneurysm). An aneurysm can potentially rupture and cause life-threatening internal bleeding. Aneurysms can form in any artery throughout your body, but they're most common in your body's largest artery (aorta).

Damage to your heart - Your heart pumps blood to your entire body. Uncontrolled high blood pressure can damage your heart in a number of ways, such as:

- **Coronary artery disease** - Coronary artery disease affects the arteries that supply blood to your heart muscle. Arteries narrowed by coronary artery disease don't allow blood to flow freely through your arteries. When blood can't flow freely to your heart, you can experience chest pain, a heart attack or irregular heart rhythms (arrhythmias).
- **Enlarged left heart** - High blood pressure forces your heart to work harder than necessary in order to pump blood to the rest of your body. This causes the left ventricle to thicken or stiffen (left ventricular hypertrophy). These changes limit the ventricle's ability to pump blood to your body. This condition increases your risk of heart attack, heart failure and sudden cardiac death.
- **Heart failure** - Over time, the strain on your heart caused by high blood pressure can cause your heart muscle to weaken and work less efficiently. Eventually, your overwhelmed heart simply begins to wear out and fail. Damage from heart attacks adds to this problem.

Damage to your brain - Just like your heart, your brain depends on a nourishing blood supply to work properly and survive. But high blood pressure can cause several problems, including:

- **Transient ischemic attack (TIA)** - Sometimes called a ministroke, a transient ischemic (is-KEE-mik) attack is a brief, temporary disruption of blood supply to your brain. It's often caused by atherosclerosis or a blood clot - both of which can arise

from high blood pressure. A transient ischemic attack is often a warning that you're at risk of a full-blown stroke.

- **Stroke** - A stroke occurs when part of your brain is deprived of oxygen and nutrients, causing brain cells to die. Uncontrolled high blood pressure can lead to stroke by damaging and weakening your brain's blood vessels, causing them to narrow, rupture or leak. High blood pressure can also cause blood clots to form in the arteries leading to your brain, blocking blood flow and potentially causing a stroke.
- **Dementia** - Dementia is a brain disease resulting in problems with thinking, speaking, reasoning, memory, vision and movement. There are a number of causes of dementia. One cause, vascular dementia, can result from narrowing and blockage of the arteries that supply blood to the brain. It can also result from strokes caused by an interruption of blood flow to the brain. In either case, high blood pressure may be the culprit.
- **Mild cognitive impairment** - Mild cognitive impairment is a transition stage between the changes in understanding and memory that come with aging and the more-serious problems caused by Alzheimer's disease. Like dementia, it can result from blocked blood flow to the brain when high blood pressure damages arteries.

Damage to your kidneys - Your kidneys filter excess fluid and waste from your blood — a process that depends on healthy blood vessels. High blood pressure can injure both the blood vessels in and leading to your kidneys, causing several types of kidney disease (nephropathy). Having diabetes in addition to high blood pressure can worsen the damage.

- **Kidney failure.** High blood pressure is one of the most common causes of kidney failure. That's because it can damage both the large arteries leading to your kidneys and the tiny blood vessels (glomeruli) within the kidneys. Damage to either makes it so your kidneys can't effectively filter waste from your blood. As a result,

dangerous levels of fluid and waste can accumulate. You might ultimately require dialysis or kidney transplantation.

- **Kidney scarring (glomerulosclerosis)** - Glomerulosclerosis (gloe-mer-u-loe-skluh-ROE-sis) is a type of kidney damage caused by scarring of the glomeruli (gloe-MER-u-li). The glomeruli are tiny clusters of blood vessels within your kidneys that filter fluid and waste from your blood. Glomerulosclerosis can leave your kidneys unable to filter waste effectively, leading to kidney failure.
- **Kidney artery aneurysm.** An aneurysm is a bulge in the wall of a blood vessel. When it occurs in an artery leading to the kidney, it's known as a kidney (renal) artery aneurysm. One potential cause is atherosclerosis, which weakens and damages the artery wall. Over time, high blood pressure in a weakened artery can cause a section to enlarge and form a bulge - the aneurysm. Aneurysms can rupture and cause life-threatening internal bleeding.

LIFESTYLE MODIFICATIONS TO MANAGE HYPERTENSION

MODIFICATION	RECOMMENDATION
Weight reduction	Maintain normal body weight. Ideal BMI 18.5-25 kg/meter square.
Adopt DASH** eating plan	Consume a diet rich fruits, vegetables and low-fat dairy products with a reduce content of saturated fat and total fat.
Dietary sodium reduction	Reduce dietary sodium intake to no more than 100 mEq/d (2.4 g sodium or 6 g sodium chloride).It ensures approximate SBP reduction of 2-8 mmHg.World Health Organization recommends 5 gm salt which is equal to 1tsf per day.
Physical Activity	Engage in regular aerobic physical activity such as brisk walking (at least 30 minutes per day, most days of the week) it reduces diastolic pressure 15-20 mmHg.
Moderation of alcohol	Limit consumption to no more than two drinks per day.

consumption	
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** - DASH is DIETARY APPROACHES TO STOP HYPERTENSION.

- ✚ Moderate sodium intake(2 to 3gm per day) decreases diastolic blood pressure by 6-10 mm Hg.
- ✚ Apricots, tomato, chickoo, watermelon, banana, leafy vegetables, bitter gourd, brinjal and potato should be included in the daily diet since they contain low sodium and high potassium.
- ✚ Hypertensive patients with kidney disease should avoid a high intake of potassium as it puts an excessive load on the kidney. Another good source of potassium is celery and it also contains a compound (3 n-butyl phthalide) which acts as a sedative and lowers blood pressure.
- ✚ Poultry without skin are better than other type of meat.
- ✚ If overweight; avoid dried fruits, fried fruits sweets and cakes.
- ✚ Increase fiber in the diet in the form of cereals, vegetables and fruits.

GOALS OF THERAPY

The primary goal is to achieve target BP usually less than 140/90mm Hg. by non-pharmacological or pharmacological intervention.

How to reduce salt intake: A practical advice

- Use pepper, garlic, lemon and herbs
- Use lemon or vinegar, ginger, chilies and onion as garnishing agents
- Avoid baking powder and soda
- Avoid canned and tinned food
- Avoid salted butter and cheese
- Avoid sea fish, dried fish and salted meat
- Avoid chips, pickles and pappad

It is advisable to reduce the fat consumption since hypertension has greater risk of arteriosclerosis. It is better to avoid high intake of animal fat or hydrogenated oils,

which contain saturated fatty acids. The cholesterol rich foods such as meat, organ meat, egg yolk, lobster, crab and prawns should be minimized in the diet. The dietary fats should consist of vegetable oil like corn oil, olive oil and sunflower oil.

4.2 CORONARY HEART DISEASE (CHD)

Coronary heart disease has been defined as “impairment of heart function due to inadequate blood flow to the heart compared to its needs, caused by obstructive changes in the coronary circulation to the heart”.

The arteries, which start out smooth and elastic, get plaque on their inner walls, which can make them more rigid and narrowed. This restricts blood flow to the heart, which can then become starved of oxygen. The plaque could rupture, leading to a heart attack or sudden cardiac death.

The underlying mechanism involves atherosclerosis of the arteries of the heart. It may be diagnosed with a number of tests including: electrocardiogram, cardiac stress testing, coronary computed tomographic angiography and coronary angiogram.

CHD may manifest itself in many presentations

- a. Angina pectoris of effort
- b. Myocardial infarction
- c. Irregularities of the heart
- d. Cardiac failure
- e. Sudden death

RISK FACTORS

1. Smoking
2. Hypertension
3. Serum Cholesterol
4. Other Risk Factors
 - Diabetes
 - Genetic Factors

- Physical Activity
- Type A personality
- Oral Contraceptives
- Hormones
- Alcohol

LIFESTYLE MODIFICATIONS TO MANAGE CHD

Dietary modification is the principal preventive strategy.

- ❖ Reduction of fat intake to 20-30 per cent of total energy intake.
- ❖ Consumption of saturated fats must be limited to less than 10 per cent of total energy intake; some of the reduction in saturated fat may be made up by mono and poly-unsaturated fats.
- ❖ A reduction of dietary cholesterol to below 100 mg per 1000 kcal per day.
- ❖ An increase in complex carbohydrate consumption (i.e. Vegetables, fruits, whole grains and legumes)
- ❖ Avoidance of alcohol consumption; reduction of salt intake to 5 g daily or less.
- ❖ **FATS:** Type of dietary fat is important; there are three kinds saturated, monounsaturated, and omega-3 and omega-6 PUFAs. Diets high in saturated fats are clearly atherogenic, and those high in mono-unsaturates or omega-3 oils are less so. For patients at high risk of CAD and especially for those with evidence of CAD, it is reasonable to recommend a 20h per day fat diet consisting of 6-10g of PUFAs with equal proportion of omega-6 and omega-3 oils, <=2g of saturated fat, and the remainder of monounsaturated.
- ❖ One group of phytochemical called flavonoids (found in red and purple grapes, red wine black teas and dark beers) appears particularly protective against CAD. High intake of flavonoids in red wine may help explain why French populations have a relatively low incidence of CAD.

4.3 OBESITY

Obesity is a [medical condition](#) in which excess [body fat](#) has accumulated to the extent that it may have a negative effect on health. People are generally considered obese

when their [body mass index](#) (BMI), a measurement obtained by dividing a person's weight by the square of the person's height is in excess to the normal value.

$$\text{BMI} = \text{Weight in kg} / (\text{Height in meters})^2$$

Classification of adults based on obesity as per WHO

Classification	BMI	Risk Of Co morbidities
Underweight	<18.50	Low (but risk of other clinical problems increased)
Normal Range	18.50-24.99	Average
Over weight	\geq 25.00	
Pre-obese	25.00-29.99	Increased
Obese Class I	30.00-34.99	Moderate
Obese Class II	35.00-39.99	Severe
Obese Class III	\geq 40.00	Very Severe

ASSESSMENT OF OBESITY

[Body Weight](#): BMI and Brocca index widely used.

[Brocca index](#) = Height (cm) minus 100

For example, if a person's height is 160 cm, his ideal weight is (160-100) =60 kg

[Skin folds Thickness](#): Less than 40 mm in boys and 50 mm in girls

[Waist Circumference and Waist: HIP Ratio \(WHR\)](#): There is an increased risk of metabolic complications for men with a waist circumference \geq 102 cm, and women with a waist circumference \geq 88 cm.

Over the past 10 years or so, it has become accepted that a high WHR ($>$ 1.0 in men and $>$ 0.85 in women) indicates abdominal fat accumulation.

RISK FACTORS

- ✓ Age
- ✓ Genetic Factors
- ✓ Eating Habits
- ✓ Endocrine Factors
- ✓ Smoking
- ✓ Sex
- ✓ Physical Inactivity
- ✓ Psychosocial Factors
- ✓ Alcohol

RELATIVE RISK OF HEALTH PROBLEMS ASSOCIATED WITH OBESITY:

Greatly increased	Moderately increased	Slightly increased
a) Type 2 diabetes b) Gallbladder disease c) Dyslipidemia d) Insulin Resistance e) Breathlessness f) Sleep Apnea	1. CHD 2. Hypertension 3. Osteoarthritis (knees) 4. Hyperuricaemia and gout	i) Cancer (breast cancer in postmenopausal woman, endometrial cancer, colon cancer) ii) Reproductive hormone abnormalities iii) Polycystic ovary syndrome iv) Impaired fertility v) Low back pain due to obesity vi) Increased risk of an aesthesia complications vii) Fetal defects associated with maternal obesity.

Does it matter where body fat is located? (Is it worse to be an 'apple' or a 'pear'?)

Concern is directed not only at how much fat a person has but also where that fat is located on the body. The pattern of body fat distribution tends to differ in men and women. Women typically collect fat in their hips and buttocks, giving their figures a "pear" shape. Men, on the other hand, usually collect fat around the belly, giving them more of an "apple" shape. (This is not a hard and fast rule, some men are pear-shaped and some women become apple-shaped, particularly after menopause). Apple-shaped people whose fat is concentrated mostly in the abdomen are more likely to develop many of the health problems associated with obesity. They are at increased health risk because of their fat distribution. While obesity of any kind is a health risk-yes, it is better to be apear than an apple. In order to sort the types of fruit, doctors have

developed a simple way to determine whether someone is an apple or a pear. The measurement is called waist-to-hip ratio. To find out a person's waist-to-hip ratio, measure the waist at its narrowest point, and then measure the hips at the widest point. Divide the waist measurement by the hip measurement, for example, a woman with a 35-inch waist and 46-inch hips would have a waist-to-hip ratios of more than 0.8 and men with waist-to-hip ratios of more than 1.0 are "apples".

Another rough way of estimating the amount of a person's abdominal fat is by measuring the waist circumference. Men with waist circumference of 40 inches or greater and women with waist circumference of 35 inches or greater are considered to have increased health risks related to obesity.

4.4 HYPERLIPIDEMIA / DYSLIPIDEMIA

Hyperlipidemia / Dyslipidemia is elevation of plasma cholesterol, triglycerides (TGs), or both, or a low high-density lipoprotein level that contributes to the development of atherosclerosis. Causes may be primary (genetic) or secondary. Diagnosis is made by measuring plasma levels of total cholesterol, TGs, and individual lipoproteins. Treatment involves dietary changes, exercise, and lipid-lowering drugs.

Primary causes are single or multiple gene mutations that result in either overproduction or defective clearance of TG and LDL cholesterol, or in underproduction or excessive clearance of HDL. Secondary causes contribute to many cases of dyslipidemia in adults. The most important secondary cause in developed countries are:

- A sedentary lifestyle with excessive dietary intake of saturated fat, cholesterol and trans-fats.
- Trans-fats are polyunsaturated or monounsaturated fatty acids to which hydrogen atoms have been added; they are used in many processed foods and are as atherogenic as saturated fat.
- Other common secondary causes include

- Diabetes mellitus
 - Alcohol overuse
 - Chronic kidney disease
 - Hypothyroidism
 - Primary biliary cirrhosis and other cholestasis liver diseases
 - Drugs, such as thiazides, β -blockers, highly active antiretroviral agents, cyclosporine, tacrolimus, estrogen and progestin, and glucocorticoids
- Secondary causes of low levels of HDL cholesterol include cigarette smoking, anabolic steroids, HIV infection, and nephrotic syndrome.

4.5 DIABETES MELLITUS

Diabetes is an “iceberg” disease. Diabetes is defined as “A disease characterized by chronic Hyperglycemia (raised levels of blood sugar) with disturbances of Carbohydrate, Fat and Protein metabolism resulting from either an ‘absolute’ or ‘relative’ deficiency of insulin secretion and/or action”.

Symptoms of diabetes: Symptoms or in other words the presenting features of diabetes which the person himself will or can notice are:

- a) **Polydipsia** which means excessive thirst.
- b) **Polyphagia** which means excessive appetite or hunger.
- c) **Polyuria** which means excessive urination.

Signs of diabetes – Signs observed on examination in diabetes are:

- a. Weight loss,
- b. weight gain,
- c. non healing ulcers and
- d. Diminished peripheral sensation

Blood sugar is the level of sugar or glucose in the blood measured in mg per deciliter.

Sugar or glucose is formed from principally two factors:

- (a) From the metabolism of food that we eat, and
- (b) By generation in the liver, by a process called Gluconeogenesis.

Human body has an organ called the Pancreas, which is located in the abdomen. The pancreas has special kind of cells, called the Beta cells, located in the tail of the pancreas. These beta cells secrete insulin which acts on the target cells and lowers the blood sugar. A normal pancreas has about 100 000 Islets of Langerhans, and each islet has 80 to 100 beta cells. These cells can measure the blood glucose every few seconds to within a range of 2 milligrams per cent. The beta cells can deliver the exact amount of insulin, within a minute, needed to keep blood sugar normal. When there is imbalance between the insulin levels and the blood sugar i.e. a) insulin is not adequate, b) efficacy of insulin is not adequate and c) target cells have resistance against insulin, the blood glucose level rises.

Clinical manifestation of Diabetes mellitus

The classification of diabetes mellitus as adopted by WHO is as follows:

1. Primary Diabetes Mellitus
 - a) Type I or Insulin Dependent Diabetes Mellitus (IDDM)
 - b) Type II or Non-Insulin Diabetes Mellitus (NIDDM)
2. Secondary Diabetes Mellitus : which is secondary to:
 - a) Pancreatic disease
 - b) Hormonal disturbances viz. Cushing's syndrome, Pheochromocytoma etc.
 - c) Drug induced or chemical induced
 - d) Insulin receptor abnormalities
 - e) Genetic Syndromes
3. Impaired Glucose Tolerance
4. Gestational Diabetes Mellitus, i.e. Diabetes in Pregnancy

RISK FACTORS

- A. AGE:** Although diabetes may occur at any age, surveys indicate that prevalence rises steeply with age. Type-II diabetes usually comes to light in the middle years of life and thereafter begins to rise in frequency.
- B. SEX:** This is open to question.
- C. GENETIC MARKERS:** Type-I diabetes is associated with HLA-B8 and B15, and more powerful with HLA-DR3 and DR4. The highest risk of type 1 diabetes is carried by individual with both DR3 and DR4.
- D. IMMUNE MECHANISMS:** There is some evidence of both cell-mediated and of humoral activity against islet cells.
- E. OBESITY:** Obesity particularly central adiposity has long been accepted as a risk factor for type-II diabetes and the risk is related to both the duration and degree of obesity.

ENVIRONMENTAL RISK FACTORS

1. SEDENTARY LIFE

- 2. DIET:** A high saturated fat intake has been associated with higher fasting glucose and insulin levels.
- 3. DIETARY FIBRE:** In many controlled experimental studies, high intakes of dietary fiber have been shown to result in reduced blood glucose and insulin levels.
- 4. MALNUTRITION:** Malnutrition (PEM) in early infancy and childhood may result in partial failure of beta-cells function.
- 5. ALCOHOL:** Excessive intake of alcohol can increase the risk of diabetes by damaging the pancreas and liver and by promoting obesity.
- 6. VIRAL INFECTIONS:** Among the viruses that have been implicated are rubella, mumps, and human Coxsackie virus B4.
- 7. CHEMICAL AGENTS:** A number of chemical agents are known to be toxic to beta cells, e.g., alloxan, streptozotocin, the rodenticide VOLCOR etc. A high intake of cyanide producing foods (e.g., cassava and certain beans) may also have toxic effects on beta cells.

8. **STRESS:** Surgery, trauma, and stress of situations, internal or external, may “bring out” the disease.

Summary of strength of evidence on lifestyle factors and risk of developing type-II diabetes

Evidence	Decreased risk	Increased risk
Convincing	Voluntary weight loss in Overweight and obese people Physical activity	Overweight and obesity Abdominal obesity Physical inactivity Maternal diabetes
Probable	NSP (NSP=non-starchpolysaccharides)	Saturated fats Intrauterine Growth retardation
Possible	Omega 3 fatty acids. Low glycemic index foods Exclusive breast-feeding	Total fat intake Trans –fatty acids
Insufficient	Vitamin E Chromium Magnesium Moderate alcohol	Excess alcohol

Other effects of diabetes mellitus:

- Insulin Resistance Syndrome (Syndrome X)

In obese patients with type-II diabetes, there is association of hyperglycemia, hyperinsulinaemia, dyslipidemia and hypertension, which lead to coronary artery disease and stroke. It is seen that insulin resistance predisposes to

hyperglycemia, which results in hyperinsulinaemia and this excessive insulin level then contributes to high levels of triglycerides and increased hypertension.

PREVENTIVE MEASURES AGAINST DIABETES MELLITUS

1. PRIMARY PREVENTION

The primary prevention measures comprise of maintenance of normal body weight through adoption of healthy nutritional habits and physical exercise.

2. SECONDARY PREVENTION

When diabetes is detected, it must be adequately treated. The aims of treatment are to maintain blood glucose levels as close within the normal limits and to maintain ideal body weight. Treatment is based on (a) diet alone – small balanced meals more frequently, (b) diet and oral anti-diabetic drugs or (c) diet and insulin.

Glycosylated hemoglobin: There should be an estimation of glycated (glycosylated) hemoglobin at half –yearly intervals. This test provides a long-term index of glucose control.

Self-care– E.g. adherence to diet and drug regimens, examination of his own urine and where possible blood glucose monitoring; self-administration of insulin, abstinence from alcohol, maintenance of optimum weight, attending periodic check-ups, recognition of symptoms associated with glycosuria and hypoglycemia, etc.

Home blood glucose monitoring: Assessment of control has been greatly aided by the many meters now available or the direct reading Haemoglukotest strips.

The patient should carry an identification card showing his name, address, telephone number (if any) and the details of treatment he is receiving.

4.6 MUSCULOSKELETAL DISORDER

Musculoskeletal disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back.

Work-related musculoskeletal disorders (MSDs) cover a broad range of health problems associated with repetitive and strenuous work. These health problems range from discomfort, minor aches and pains, to more serious medical conditions which can lead to permanent disability.

Every year millions of workers are affected by MSDs. The most well-known MSDs are low back pain and work-related upper limb disorders. The first is mainly associated with manual handling while the main risk factors for the latter are associated with task repetition and awkward work postures.

Nowadays lower limb work-related MSDs are also been recognized as disorders that may be associated with occupational activity. Most of the recorded work related MSD affect the lower back, neck, shoulders and upper limbs.

MSD affect less often the lower limbs. It is important to recognize however that not all MSDs are caused by work, although work may provoke symptoms and the problem may prevent a person from working, or make it more difficult. For example, a recent study found that age, gender and BMI made a bigger proportional contribution to developing carpal tunnel syndrome (CTS) than work-related factors.

Lower limb MSDs is a problem in many workplaces and they tend to be related with conditions in other areas of the body. Lower Limb Disorders affect the hips, knees and legs and usually happen because of overuse.

Acute injury caused by a violent impact or extreme force is less common. Workers working over a long period in a standing or kneeling position are most at risk. The most common risk factors at work are: repetitive kneeling and/or squatting, fixed postures such as standing for more than two hours without a break, frequent jumping from a height.

4.7 PSYCHOSOMATIC DISORDER

A psychosomatic disorder is a disease which involves both mind and body. Some physical diseases are thought to be particularly prone to be made worse by mental factors such as stress and anxiety.

Psychosomatic medicine emphasizes the influence of the mind on the body (Psycho + Somatic). Psychosomatic medicine was defined in 1978 by the National Academy of Science India as "the field concerned with the development and integration of behavior and biomedical science, knowledge and techniques relevant to health and illness and the application of this knowledge and these techniques to prevention, diagnosis and rehabilitation.

For at least 100 years now physicians and Psychiatrists have both agreed that some disorders have an emotional overlay. Mentioned below is a list of psychosomatic disorders currently accepted by Diagnostic and Statistical Manual of Mental Disorders (DSM):

SOME PSYCHOSOMATIC DISORDERS

- Allergic reactions
- Angina pectoris
- Asthmatic Wheezing
- Bronchial asthma
- Chronic pain syndromes
- Coronary heart disease
- Diabetes mellitus
- Essential hypertension
- Headache
- Hypoglycemia
- Immune diseases
- Irritable colon
- Migraine
- Nausea
- Obesity
- Painful Menstruation
- Rheumatoid arthritis
- Skin diseases, such as Psoriasis
- Tension headache
- Tuberculosis
- Urticaria
- Vomiting
- Warts

RISK FACTORS

- Having anxiety or depression
- Having a medical condition or recovering from one
- Being at risk of developing a medical condition, such as having a strong family history of a disease
- Experiencing stressful life events, trauma or violence
- Having experienced past trauma, such as childhood sexual abuse
- Having a lower level of education and socio-economic status

LIFESTYLE AND HOME REMEDIES

While somatic symptom disorder benefits from professional treatment, you can take some lifestyle and self-care steps, including these:

- **Work with your doctor** - Work with your doctor to determine a regular schedule for visits to discuss your concerns and build a trusting relationship. Also discuss setting reasonable limits on tests, evaluations and specialist referrals. Avoid seeking advice from multiple doctors or emergency room visits that can make your care more difficult to coordinate and may subject you to duplicate testing.
- **Practice stress management and relaxation techniques** - Learning stress management and relaxation techniques, such as progressive muscle relaxation, may help improve symptoms.
- **Get physically active** - A graduated activity program may have a calming effect on your mood, improve your physical symptoms and help improve your physical function.
- **Participate in activities** - Stay involved in work, social and family activities. Don't wait until your symptoms are resolved to participate.

- **Avoid alcohol and recreational drugs** - Substance use can make your care more difficult. Talk to your health care provider if you need help quitting.

PREVENTION

Little is known about how to prevent somatic symptom disorder. However, these recommendations may help.

- **If you have problems with anxiety or depression, seek professional help as soon as possible.**
- **Learn to recognize when you're stressed and how this affects your body — and regularly practice stress management and relaxation techniques.**
- **If you think you have somatic symptom disorder, get treatment early to help stop symptoms from getting worse and impairing your quality of life.**
- **Stick with your treatment plan to help prevent relapses or worsening of symptom.**

4.8 **ERGONOMICS**

The term "ergonomics" is derived from two Greek words "ergon," meaning work, and "nomoi," meaning natural laws.

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

All of us could significantly reduce our risk of injury if we could adhere to the following ergonomic principles:

- All work activities should permit the worker to adopt several different, but equally healthy and safe postures.

- Where muscular force has to be exerted it should be done by the largest appropriate muscle groups available.
- Work activities should be performed with the joints at about mid-point of their range of movement. This applies particularly to the head, trunk, and upper limbs.

Proper ergonomic design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which can develop over time and can lead to long-term disability.

Human factors and ergonomics is concerned with the "fit" between the user, equipment and their environments. It takes account of the user's capabilities and limitations in seeking to ensure that tasks, functions, information and the environment suit each user.

Ergonomists study human capabilities in relationship to work demands. In recent years, ergonomists have attempted to define postures which minimize unnecessary static work and reduce the forces acting on the body. To achieve best practice design, ergonomists use the data and techniques of several disciplines:

- anthropometry: body sizes, shapes; populations and variations
- biomechanics: muscles, levers, forces, strength
- environmental physics: noise, light, heat, cold, radiation, vibration
- body systems: hearing, vision, sensations
- applied psychology: skill, learning, errors, differences
- Social psychology: groups, communication, learning, behaviors.

WHY ERGONOMICS?

Definition: Ergonomics discovers and applies information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, tasks, jobs, and environments for productive, safe, comfortable human use.

Ergonomics promotes and requires a multidisciplinary approach to design, that may draw upon knowledge of biology, anthropology, psychology, engineering, physiology and statistics.

Application of Ergonomics

Computers provide a good example of this. The first personal computers were units with the display screen directly connected to the keyboard, and eventually to a central processing unit (CPU) also. They were placed on existing office furniture.

The result of this was widespread reports of discomfort among users. This eventually resulted in the separation of the display, keyboard, and CPU, and the introduction of adjustable furniture specifically designed to support the various components of the computer at component-specific appropriate heights.

Work systems are made up of more than just the physical components (tools, equipment, workstation, and production materials) with which people work.

Other key elements of a work system are the work environment (physical, cultural, and social), work organization (work hours, pay system, assembly line etc.), work methods (how the steps in the production process are performed) and tasks performed.

The effects of all of these, and how they might interact, should be considered when a system is developed. For example, height adjustability becomes a more important feature for a computer workstation when the computer will be used for extended periods of time by more than one user, and becomes a less important feature if each user only uses the computer for a few minutes during the day.

Ergonomists are trained to take a "total view" towards systems design.

Basic Body Mechanics: It is essential to have a basic understanding of the physical construction, physiology, and capabilities of humans in order to design systems, tools, and jobs in which human users will be safe, comfortable, and most productive.

Muscle exertion is the basis for all of our physical activitiese.g. manipulating small objects in our hands, lifting heavy boxes with our bodies, walking, or positioning ourselves for work at a desk.

Muscles are attached to bones via tendons. Muscles contract and the bones to which they are attached move relative to each other by rotating about the joint. For example, the right index finger flexes to press on the “j” key of a keyboard due to the contraction of the finger flexor muscles. In order to release the “j” key and raise the finger, the finger extensor muscle is activated.

This arrangement of muscles, in pairs, is common throughout the body because muscles can only exert contracting forces that pull on bones, yet joints need to move in more than one direction (flex and extend, for example).

The muscles that control the elbow are another familiar example of a pair of muscles. The biceps muscle flexes the elbow and the triceps muscle extends the elbow. Generally speaking, neutral joint postures are those positions in which pairs of muscles are in balance when gravity is not a factor.

When the arm is allowed to hang by the side, the wrist is in a neutral position — it is not bent toward the palm or the back of the hand, nor toward the thumb or little finger. Extending the wrist, while the arm is at the side, requires contraction of the wrist extensor muscles.

When the hands float above the keyboard when typing, the wrist extensor muscles are also active, even if the wrist is in a neutral position. This is because gravity exerts a downward force on the hand when the forearm is positioned horizontally.

The wrist tends to flex due to the pull of gravity on the hand. In order to keep the wrist straight, the wrist extensor muscles must contract to counteract the gravitational force on the hands.

Holding such a position becomes uncomfortable after a time. This is because the muscles are being asked to exert force continuously, which does not allow them to operate in their most efficient manner.

Blood flows best through muscles as they alternate between contraction and relaxation. Blood flow within a muscle may be impeded during sustained contractions. Because blood flow is a key metabolic process (the means by which energy is transferred from the foods we eat to chemicals and energy muscles use to function), if the blood flow is reduced, then eventually the muscle will fatigue.

Muscle fatigue is associated with discomfort and reduction in the ability to control the muscle (e.g. to position a limb precisely where desired or exert a specific desired amount of force). Fatigue effects can be short or long term, depending on the pattern of development (one-time event or prolonged or repeated development). Long-term effects can include damage or destruction of some of the individual muscle fibers that make up a muscle.

External supports, such as the seat pan of a chair, forearm supports and back rest have been shown to be effective in alleviating fatigue and reducing discomfort in workers.

USE OF ERGONOMICS IN PREVENTION OF MUSCULOSKELETAL DISORDERS

Ergonomics is increasingly becoming more important for prevention of musculoskeletal disorders and repetitive strain injuries and a good ergonomics program can benefit the employer by preventing injury, promoting early returns to work, reducing absenteeism and in turn decreasing cost.

Maintaining a proper work-life balance is essential. [When the home front is taken care of, we are less distracted at work. Similarly, when our work is well managed, we are happier at home.](#)

Some of the common sources of workplace stress may be work overload, long working hours, strained relationship and conflicting job demands. For most people workplace is literally a “home away from home”. The time spend at work place may be more than what we spend at home in the waking state. Hence, what we eat and do at the workplace affects us profoundly. The success of any organization depends on having a motivated and healthy workforce.

Employees should be encouraged to bring meals prepared at home as these tend to be lower in fat, sugar and calories. If it is not feasible, the canteen food can be suitably modified to make it healthier.

Physical activity, apart from providing health benefits, also helps beat the afternoon drowsiness. Using the stairs instead of elevators, walking in a group outside the office building and having ‘walking meetings’ is very refreshing and stimulating.

4.9 REPETITIVE STRESS INJURIES (RSI)

Prevention and Exercises

Modern day urban life is mostly inactive. Physical activity is limited, while mental activity is hectic. Most work is done sitting, putting most stress on the back and spine.

Practice these RSI exercise to prevent injury to your joints. These exercises are very relevant for all those who work long hours on the computer or for that matter also sitting at a table and chair and also for those with very sedentary work and a lot of stress.

RSI Prevention:

- Get up from your desk and move around every ½ - 1 hour. Stay aware of your posture while you are sitting at your desk.

- Don't slouch or recline too much.
- Sit back such that the major part of your back is supported by your seat back. Do not eat your lunch at your desk.
- During lunch break do some physical activity.
- Include full body stretches in your daily activity, emphasizing the upper body.
- Observe your sleeping position. Don't curl up too much.
- The neck should be supported, with pillows in line with the rest of the spine when you sleep.
- Check that your workstation is set up correctly.
- Your monitor screen should be at eye level or below eye level. New keyboards and mouse designs that support the wrist can help prevent strain.

RSI Stretch Exercises

Here are some yoga- based exercise (predominantly following **18 exercises**) which one can do in the office during the course of the day to help prevent carpal tunnel and repetitive stress injuries.

Hold the positions for a few breaths and let the stretch increase but do not force it.

- 1. Eye exercise** – Keep your arm extended and thumb out. Let your eyes follow your thumb. Rotate left to right, right to left, then diagonally left bottom to right top and vice versa, move eyes around in circles or diagonal.
- 2. Neck exercise** – Point Chin to the sky then tuck chin into your chest. Head tilt to left shoulder then right. Chin point to left shoulder then right. Neck rotation left to right and viceversa. There are four different neck movements.
- 3. Shoulder rotation** – Forward rotation and backwards. Arms up clasp hands together and stretch skywards. Repeat same with arms stretching to left side then to right.
- 4. Chest release** – Hold hands behind your back and rise up as much as possible.
- 5. Hug yourself** – Tightly cross arms across your chest with hands touching your upper back. Then reverse with the opposite arm up. This releases your upper back.

- 6. Side stretch** – Sitting straight in chair twist body to left side as much as possible. Repeat on right side. Same thing can be standing.
- 7. Toe touch** – Keeping legs close together stretch arms up and then bend forward to toes or as close as possible without bending knees.
- 8. Knees up** – Standing straight bring one knee up to chest and hug close to chest. Repeat with other leg.
- 9. Knees back** – Standing straight bend knee back with foot heel touching buttocks. Repeat with other leg.
- 10. Ankle rotation** – Sitting or standing stretch leg out and rotate ankle in both directions. Then repeat with other leg.
- 11. Namaste** – Bring arms across chest with hands touching in Namaste. Then make sure that fingers and palm above wrist are flat and touching and lower this right up to elbow level if possible.
- 12. Finger stretch** – Clench fists tight then open and stretch your fingers out and stretch thumbs up.
- 13. Standing up** – Place both hands flat on the table and press palms down.
- 14. Wrist rotation** – Rotate wrist in one direction and then opposite.
- 15. Thumbs up** – Place both fists on the table with thumbs side up. Move both fists outwards and then inwards keeping wrist in the same place.
- 16. Palms up** – Stretch arms out, palm facing down. Now move hands up and down to stretch wrist.
- 17. Deep breathing** – Breathe in from the nose and out from mouth, 5 – 10 times.
- 18. Finally shake arms out** – Shake legs out one at a time and do the skeletal dance (dance as if you are completely loose).

4.10 STRESS AND ITS MANAGEMENT

Lifestyle can be major source of stress.

Definition: Stress is the neuro-muscular endocrine response of the body to a demand, mental or physical and results in psychosomatic ailments. Stress is an arousal response, the body makes, when a situation is perceived as being stressful.

STRESS MANAGEMENT

Managing Stress

The first step in managing stress is to develop a stress free personality. A high self-esteem, assertive behavior and a positive attitude help in building stress free perception. It also helps to focus on areas where control and change are possible, thereby reducing stress.

Any exercise programme done regularly utilizes excess stress hormones present in body. Exercise not only makes the body fit, but it also acclimatizes the heart and lungs to increased activity, as in stressful situations.

Exercise is physical management of stress. It burns the biochemical product of the stress response. Research shows the regular exercise reduces hostility by 60% nearly and depression by 30%. Exercise raises the body to an arousal state similar to stress and benefit is similar to relaxation techniques. Heart rate comes down, breathing is calmer and brain waves move from alert beta brain waves to relaxed alpha waves.

Stamina Exercises

Walking: Excellent cardiovascular benefits for the advanced age groups. Should be done briskly with swinging of the arms. Comfortable shoes need to be worn. May be done in the mornings or evenings for between 30-60 minutes.

Jogging: Suitable for younger age group below 50 years. 30 minutes is all that is required and may be done continuously, or jog and walk in between when fatigued. The pace of jogging is equal to that of a brisk walk. Preferably use thick solid comfortable shoes and run on soft or grassy surfaces. Wear comfortable clothes and breathe freely.

Swimming: For those who know how to swim, 20 minutes of continuous swimming are sufficient. Alternatively swim the length of a pool, rest at the end for 30 seconds and swim back. Ten such lengths are good. Use any stroke you know. They are all of almost equal cardiovascular and muscular benefit.

Cycling: For any age group. Minimum time 45-60 minutes of continuous controlled fast cycling. Cycling up slopes gives added benefit. Ordinary cycles are good enough and indoor stationary exercises may also be used at low resistance for 45 minutes.

Games: For the fitter younger age group. Get fit first before playing games such as squash, badminton, tennis, handball, basketball, football etc. Warm up before the games. 30-45 minutes of the game is sufficient. Weekend or once a week games is to be avoided unless other fitness programmes are done on other days. Play within your capacity.

Relaxation and meditation techniques result in calming brain waves and reducing the effects of stress. This is especially effective with stress related ailments.

The easiest way to meditate is by lying down, sitting on the ground or sitting on a chair in a comfortable position. Eyes should be closed and noise eliminated to reduce internal stimulation. Soft music aids in relaxation.

A **few tips** to change stressful behavior:

- ✓ Plan a little idleness each day.
- ✓ Listen without interruption.
- ✓ Compartmentalize.
- ✓ Make your home a retreat.
- ✓ Know your stress points.
- ✓ Enrich & update yourself.
- ✓ Seek humor in life.
- ✓ Prioritize jointly with significant persons.
- ✓ Plan time & activities.

- ✓ Delegate & support.
- ✓ Maintain a detached overview.
- ✓ Nurture a support group.
- ✓ One task at a time – slow down.

Meditation(A natural and powerful stress healer):In simple terms, meditation can also be defined as the “art of living in the present moment.” We hardly live the present moment. Our mind almost and always dwells in the past or future. It is really very strange that all our stress is rooted either in the past or the future. Relaxation can be achieved by living in the present moment.

The experience of deep relaxation or the art living in the present moment creates the required deep silent mind to know our real self, the spiritual dimension. Until and unless we experience the spiritual dimension which is beyond the body mind, we cannot be called healthy. Hence, WHO defines Health as the well-being of physical, mental, social & spiritual dimensions.

Healing effects of meditation

Health is the balance, harmony, rhythm and natural flow or pulsation of life energy, through every part of our body. Diseases occur when this joyful flow is interrupted. Poor lifestyle, emotional conflict, mental tension with consequent energy depletion or inherited predispositions is the main causes of poor health. A number of physical diseases are often related to these subtle problems. Meditation is very helpful in overcoming these problems. Medication heals the body from outside, whereas meditation heals it from inside.

Regular meditation helps to overcome addictions to tranquillizers, reduce hypertension, insomnia, migraine, depression, anxiety and other psychosomatic illness.

It also expands brain function by enhancing a balance between the two separate hemispheres of the brain, promoting creativity, love, compassion etc.

4.11 ACCELERATED AGEING SYNDROME

There are several factors which cause the body to age prematurely. The **age accelerating factors** are

1. Respiratory ailments
2. Cardiac problem
3. Elevated blood pressure
4. Elevated blood sugar
5. Elevated blood lipids
6. Poor Activity levels
7. High abdominal fat
8. Poor muscular capacity
9. Poor spinal flexibility
10. Obesity
11. High overall Stress
12. Alcohol
13. Smoking
14. Drugs/Medication
15. Cancer Risk

5. Evaluating Risk Factors to Save Lives (A case study)

THE FRAMINGHAM HEART STUDY

A Brief Description: Franklin Delano Roosevelt (FDR), President of the United States, 1933-1945, was longest-serving president who led country through Great Depression. He was commander in chief of U.S. military in World War II. He died while president on April 12, 1945. His medical condition was studied which is as under:

- ✚ FDR's Blood Pressure before presidency was 140/100 mm of Hg. Today, this is already considered **high blood pressure** as normal blood pressure is less than 120/80 mm of Hg.
- ✚ One year before death, 210/120 mm of Hg. Today, this is called **Hypertensive Crisis**, and emergency care is needed.
- ✚ FDR's personal physician: "A moderate degree of arteriosclerosis, although no more than normal for a man of his age".
- ✚ Two months before death: 260/150 mm of Hg.
- ✚ Day of death: 300/190 mm of Hg.

How did we learn?

In late 1940s, U.S. Government set out to better understand cardiovascular disease (CVD) and hence started beginning of Framingham Heart Study in 1948 in City of Framingham.

How does this Framingham risk score calculator work?

This is a health tool designed to estimate heart disease risk in individuals in a period of 10-years especially that of coronary heart disease, based on a series of factors identified as cardiovascular risk factors in the Framingham Heart Study. It comprises of age, gender and whether the person scored is a smoker or not or under treatment for hypertension; plus three clinical determinations important in assessing cardiovascular function risks: total cholesterol, HDL cholesterol and systolic blood pressure.

The criteria considered in this *Framingham risk score calculator* are detailed below:

- Gender - Male/Female, this factor is taken in consideration as the points in the following criteria are segmented by gender.
- Age – this health calculator permits ages starting from 20 to ensure most individual cases of importance are covered, not only elderly people in which, of course, the heart disease risk is proportional to age.
- Total cholesterol (mg/dL) – a lower TC than 200 mg/dL is considered low risk while 200 to 239 mg/dL is borderline high and everything above 240 mg/dL is high risk.
- HDL cholesterol (mg/dL) – contrary to the general belief, not all cholesterol is bad cholesterol. HDL is considered the good one as it consists of high density lipoproteins that don't stick to the arteries forming plaque and leading to atherosclerosis like LDL. Plus, HDL is also able to remove part of LDL, the bad cholesterol away from the arteries and is said to protect against heart attack and stroke when in levels higher than 60 mg/dL. Everything under 40mg/dL HDL is considered high risk for cardiovascular disease.
- Under hypertension treatment - Yes/No – people with high blood pressure are at risk of coronary artery disease (atherosclerosis) and hypertension treatment can help lower the risk.
- Systolic blood pressure (mmHg) - This is the first number in the blood pressure reading with the normal range between 90 and 120 mmHg and corresponds to the force with which the contraction of the heart pushes blood in circulation.
- Smoker - Yes/No – smoking increases heart disease risk by damaging the arterial lining, leading to atheromas which are buildups narrowing the arteries, leading on the long term to very high risk of angina, heart attack or stroke.

The following tables are presenting the breakdown of criteria and points in the Framingham scoring model according to gender:

Age	Female pts	Male pts
20 - 34	-7	-9

35 - 39	-3	-4
40 - 44	0	0
45 - 49	3	3
50 - 54	6	6
55 - 59	8	8
60 - 64	10	10
65 - 69	12	11
70 - 74	14	12
>75	16	13
Total cholesterol mg/dL		
Value	Female pts	Male pts
Age interval: 20 - 39		
<160	0	0
160 - 199	4	4
200 - 239	8	7
240 - 279	11	9
>=280	13	11
Age interval: 40 - 49		
<160	0	0
160 - 199	3	3
200 - 239	6	5
240 - 279	8	6
>=280	10	8
Age interval: 50 - 59		
<160	0	0
160 - 199	2	2
200 - 239	4	3
240 - 279	5	4
>=280	7	5

Age interval: 60 - 69		
<160	0	0
160 - 199	1	1
200 - 239	2	1
240 - 279	3	2
>=280	4	3
Age interval: >70		
<160	0	0
160 - 199	1	0
200 - 239	1	0
240 - 279	2	1
>=280	2	1
HDL cholesterol mg/dL		
Value	Female pts	Male pts
>=60	-1	-1
50 - 59	0	0
40 - 49	1	1
<40	2	2
SBP mmHg / treated		
Value	Female pts	Male pts
<120	0	0
120 - 129	3	1
130 - 139	4	2
140 -159	5	2
>=160	6	3

6. Nutrition and Diet

Understanding some common terms

Sedentary Metabolic Rate (SMR) is the amount of Calorie used by a person when sedentary or not active. This is calculated as $24 \times \text{weight in kilograms per day}$. The calorie intake for all three situations is

Correct weight same as SMR

Over weight (i.e. when you are to lose weight) then your intake of food allowed will be 500 calories less than SMR per day.

Under weight, (when you are to gain weight) then your intake of food allowed will be 500 calories more than SMR per day.

HEALTHY FOODS		
Eat foods from each of these groups daily		
a) Fruits	-	Apple, Banana, Papaya, Mango, Guava, Pear, Bel, Amla, Grape, Orange, Watermelon
b) Vegetables	-	Potato, Onion, Ginger, Garlic, Beetroot, Tomato, Lime, Radish, Turnip, Cabbage, Cauliflower, Lettuce, Cucumber, Asparagus, Spinach, Saag, Coconut, Carrot, Karela
c) Grains & Pulses	-	Beans, Peas, Gram, Dhal, Wheat, Rice, Nuts
d) Dairy Products	-	Skimmed Milk Curd
e) Miscellaneous	-	Honey, Dry fruits, Vegetable Oils
f) Fluids	-	Water, juices, Lassi

Benefits of eating fruits (A few examples)



Benefits:

Asthma prevention/ Lowers Blood Pressure/ Prevents Cancer/ Helps Digestion and Hydration.



Benefits:

Protects against Diabetic Neuropathy and Retinopathy/ Beneficial for treating Alzheimer's disease/ Relieves hot flashes and mood swings associated with menopause/ Anti-inflammatory/ Preservation of Bone Mineral Density/ Reduction in the formation of kidney Stones.



Benefits:

Strengthens Immune System/ Protects against Cancer/ Maintains Healthy Eye and Skin/ Lowers High Blood Pressure/ Controls Asthma/ Prevents Anemia/ Maintains a Healthy Thyroid.



Benefits:

Supports Immune system/ Strengthens Bones Anti-inflammatory/ Helps in Fertility/ Blood Clot reduction/ Alleviates Common Cold and Sinus inflammation.



Benefits:

Fights Cancer/ Keeps Cholesterol in check
Skin Cleanser/ Weight Loss/ Eye care/
Strengthens Immune System Reduces
Kidney Stones/ Stomach Tonic.



Benefits:

Immune supporting effects/ inhibits
abnormal platelet aggregation/ lowers
blood pressure and cholesterol/ relieves or
protects against depression and
osteoporosis.



Benefits:

Reduces the risk of a heart attack and stroke/ alleviates symptoms of allergies/ protects against neural tube defects in infants.



Benefits:

Immune system booster/ osteoporosis prevention/ increased energy levels/ digestive health cancer prevention/ healthy pregnancy less allergenic/ good for weaning.



Benefits:

Beneficial in treating Gout/ helps in treating Rheumatism/ Prevents liver problems/ Lessens the chances of developing skin diseases/ purify the blood/ Improves appetite.



Benefits:

Boosts Immune System / Lowers Blood Pressure / Prevents Anemia / Boosts Bone Strength/ Prevents Cancer/ Protects Heart health/ Aids in Weight loss/ Boosts Oral and Dental health.



Benefits:

Enhance mood / Antibacterial /Antioxidant / Strengthens Immune System / Cleanses Stomach.



Benefits:

Treatment for Diarrhea, Dysentery, Constipation, Cough, Cold, Skin problems, High Blood pressure, Weight loss, Scurvy etc.

CALORIE-SHEET					
Item	Quality	Caloric Value (apx.)	Item	Quality	Caloric Value (apx.)
Break fast			Beverages		
Egg boiled	1	80	Tea, black, without sugar	1 cup	10
Egg poached	1	80	Coffee, black, without sugar	1 cup	10
Egg fried	1	110	Tea with milk and sugar	1 cup	45
Egg omelette	1	120	Coffee with milk and sugar	1 cup	45
Bread slice	1	45	Milk without sugar	1 cup	60
Bread slice with Butter	1	90	Milk with sugar	1 cup	75
Chapati	1	60	Horlicks	1 cup	120
Puri	1	75	Fruit juice, concentrated	1 cup	120
Paratha	1	150	Soft drinks (Thums Up,etc.)	1 bottle	90

Subji	1cup	150	Beer	1 bottle	200
Idli	1	100	Soda	1 bottle	10
Dosa plain	1	120	Alcohol neat	1peg,small	75
Dosa masala	1	250	Miscellaneous and Non-Indian		
Sambhar	1cup	150	Porridge	1 cup	150
Lunch / Dinner			Jam	1 tsp	30
Cooked rice,plain	1cup	120	Butter	1 tsp	50
Cooked rice, fried	1cup	150	Ghee	1 tsp	50
Chapati	1	60	Sugar	1 tsp	30
Puri	1	75	Biscuit	1	30
Paratha	1	150	Fried nuts	1 cup	300
Nan	1	150	Puddings	1 cup	200
Dal	1cup	150	Ice-cream	1 cup	200
Sambhar	1cup	150	Milk-Shake	1 glass	200
Curd	1cup	100	Wafers	1 pkt	120
Curry, Vegetable	1cup	150	Samosa	1	100
Curry, meat	1cup	175	Bhel puri/pani puri	1 helping	150
Salad	1cup	100	Kabab	1 plate	150
Papad	1	45	Indian sweet/mithai	1 pc	150
Cutlet	1	75	Pickle	1tsp	30
Pickle	1	30	Soup,clear	1 cup	75
Soup,clear	1cup	75	Soup, heavy	1 cup	150
Soup, heavy	1cup	150	Fruit	1 helping	75
Fruit	1helping	75			

FAT & FIBRE CONTENT IN DAILY FOODS

Item	Fat (gms)	Fiber (gms)	Item	Fat (gms)	Fiber (gms)
Almonds 1 Cup	72	16	Cream 1tbsp	5	0
Apple 1 Cup	0	8	Cucumber 1 cup	0	2
Apple juice 1 Cup	0	0	Dates 1 cup	0	8
Banana	0	2	Egg 1Pc	5	0
Beans Baked 1 cup	1	10	Bacon (1strip)	2	0
Beans Cooked 1 cup	0	12	Tomato(1 pc)	0	2
Beef Lean 1 cup	32	0	Tomato Juice(1 cup)	0	1
Beef Medium 1 cup(60z)	50	0	Walnuts(1 cup)	64	8
Beer 1 Glass	0	0	Water melon (1cup)	0	4
Beet Root 1 cup	0	6	Wine(1 cup)	0	0

Biscuit 1 Pc	5	1	Yoghurt(1 cup)	8	0
Bread White 1 Pc	1	1	Vegetable Salad Mixed(1 cup)	0	8
Bread Wheat 1 Pc	1	3	Egg white	0	0
Vegetable Clear Soup 1cup	0	0	Brinjal(1 cup)	0	4
Soup Non-Veg Clear 1 cup	1	0	Flour Wheat(1 cup)	0	18
Soup Thick Veg 1 cup	0	2	Flour White(1 cup)	0	4
Soup Thick Non-Veg 1 cup	5	0	Fruit Cocktail(1 cup)	0	8
Butter 1 tsp	5	0	Fruit Juice(1 cup)	0	0
Butter Multi Whole 1 cup	8	0	Grapes(1 cup)	0	4
Butter Low Fat 1 cup	2	0	Greens(1 cup)	0	8
Cabbage 1 cup	0	4	Ham(1 cup)(60z)	26	0
Carrot 1 cup	0	4	Honey(1tsp)	0	0
Cashewnut 1 cup	32	4	Ice Cream(regular)	16	0
Cauliflower 1 cup	2	2	Jam(1 tsp)	0	0
Cereal Bran 1 cup	2	22	Jelly(1tsp)	0	0
Cereal Flatus 1 cup	0	6	Lamb Lean(1cup)(60z)	24	0
Cheese Cottage 1 cup	8	0	Lamb Medium(1cup)(60z)	50	0
Cheese Whole 1 Cup	36	0	Lettuce(1 cup)	0	4
Chicken with skin 1 cup(60z)	20	0	Liquor(Rum/Whisky/Gin)(1peg)	0	0
Chicken No Skin 1 cup(60z)	6	0	Nuts	60	9
Chocolate 1pc	18	0	Mango 1 Piece	0	6
Chili/Tomato Sauce 1 tbsp.	0	1	Fish(1cup)(60z)	24	0
Corn 1 cup	0	4	Margarine(1tsp)	4	0
Crab Meat 1 cup(60z)	20	0	Mayonnaise(1tsp)	4	0
Milk Whole(1 cup)	5	0	Peas(1cup)	0	10
Milk skimmed(1 cup)	1	0	Pine apple(1cup)	0	4
Mushroom(1 cup)	0	8	Pork Lean(1cup)(60z)	16	0
Noodles(1 cup)	2	3	Pork Medium(1cup)(60z)	46	0
Oil Vegetables(1 tsp)	5	0	Potato(1 cup)	0	12

Onion(1 cup)	0	8	Rice(Brown)(1 cup)	0	6
Orange(1 pc)	0	4	Rice(White)(1 cup)	0	2
Orange juice(1 cup)	0	0	Sausage(1cup)(60z)	36	0
Papaya(1 cup)	0	2	Soya bean(1 cup)	6	12
Peanut butter(1 tsp)	8	1	Spinach(1cup)	0	4
Peanuts(1 cup)	72	12	Sugar(1tsp)	0	0
Pear(1 pc)	1	4			

SOME INTERNATIONAL FOOD CALAORIE VALUES					
Item	Quantity	Caloric Value (apx.)	Item	Quantity	Caloric Value (apx.)
Bread slice with butter & Jam/Cheese, etc.	1	120	Sandwich large	1 pcs	250
Breakfast cereal with milk	1	100	Hamburger	1 pcs	250
Breakfast cereal with milk sweetened	1 cup	130	Steak & Salad	1 plate	300
Porridge & milk	1 cup	120	Fish& Chips	1 plate	400
Sweetened	1 cup	150	Spaghetti & meat Sauce, etc.	1 plate	450
Baked Beans in sauce	1 cup	200	Baked dish	1 helping	400
Sausage, bacon, Ham, etc. fried	1 helping	120	Fried chicken	1 helping	200
Potato Mash	1 cup	100	Chinese noodles	1 plate	450
Potato fried	1 cup	200	Chinese fried rice	1 plate	450
Pizza	1 plate	400	Chinese side dish	1 plate	250

SAMPLE DIET (INDIAN) LOW FAT HIGH FIBRE

Meal	Item	Fat (gm)	Fibre (gm)
Early Morning	One cup Juice	0	0
Break fast	Two chapatis	0	6
	One cup vegetables	0	8
	One cup milk	1	0
Lunch	One cup cooked rice	0	6
	One cup lentils	0	10
	One cup curry(veg.)	0	8
	One cup Salad	0	8
	One fruit	0	8
Tea	One cup tea	1	0
Dinner	Two chapatis	0	6
	One cup Dal	0	10
	One Meat curry	10	0
	One cup salad	0	8
	One cup curd	8	0
	*Two spoons oil for cooking	10	0
(Total)		30	78

SAMPLE DIET (INDIAN)

Meal	Item	Total Calories
BED TEA	1 cup tea with milk no sugar	20
BREAK FAST	Two chapatis One Katori curry or	275

	One masala dosa/2 idlis	
LUNCH	One cup cooked rice or three chapatis One cup dal/sambhar One cup curry One cup salad/curd, One fruit	600
EVENING TEA	One cup tea with milk no sugar	20
DINNER	One cup cooked rice or three chapatis One cup dal or Sambhar One cup curry, One cup salad/Curd	500
NIGHT CAP	One cup milk	75

7. Conclusion

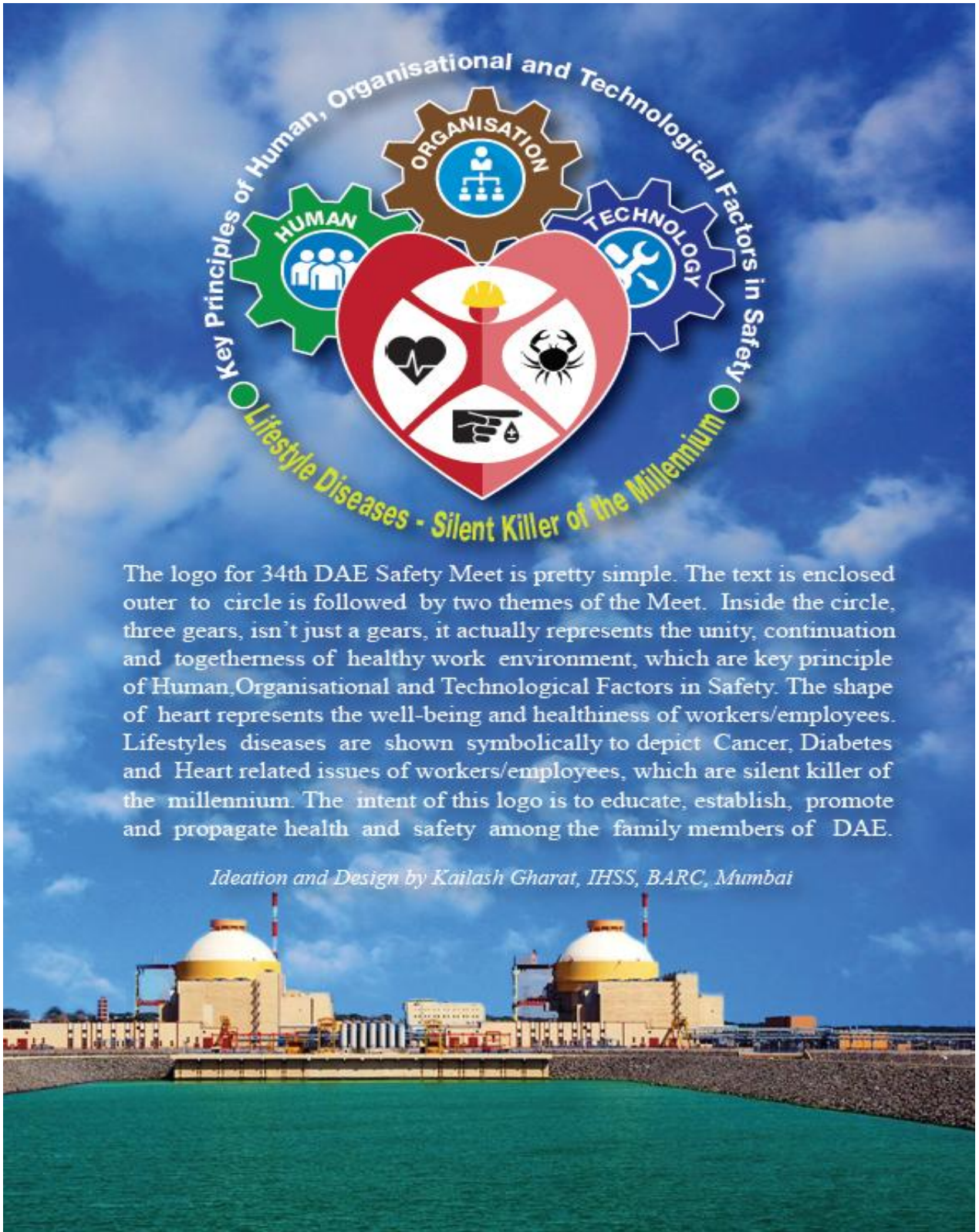
A particular lifestyle of person is a cumulative product of his/her physical capacity coordinated with psychological functioning displayed in the form of habits, behaviors, dietary and living patterns. A healthy lifestyle which includes a proper balanced diet, physical activity and giving due respect to biological clock, must be adopted to combat these life threatening diseases.

On the part of medical science, contemporary medicine is no longer solely an art and science for the diagnosis and treatment of disease through medicines. It should also be the science for the prevention of disease and promotion of good health. This expansion of the scope of medicine has emphasized on a redefinition of its goals and objectives, which aims at not only stopping the progression of disease with medicine and therapeutic treatment but also prevention at the outset with a comprehensive lifestyle modification.

To defeat the slogan of “Life Style Diseases – The silent killer of millennium” it is high time that everyone should join hands together and adopt a healthy lifestyle that include- healthy eating, regular exercise, avoiding addictions (smoking and alcohol), “no fasting and no feasting”, taking competitive environment coolly to keep our self-stress free and last but not the least **“Keep Smiling”!!!**

BIBLIOGRAPHY:

1. Parks text book of Preventive and Social Medicine – 23rd Edition
2. Handbook on “Preventive Health Care in exercise and nutrition” by Apollo Hospitals
3. D’Agostino RB, Sr Vasan RS, Pencina M J, Wolf PA, Cobain M, Massaro JM, Kannel WB (2008) - General cardiovascular risk profile for use in primary care: The Framingham Heart Study.
4. Wilson PW, Dr Agostino RB, Levy D, Belanger AM, Sibershatz H, Kannel WB (1998)- Prediction of coronary heart diseases using risk factor categories
5. Introduction to Ergonomics, OSHAcademy Course 711 Study Guide
6. Risk Factors contributing to chronic diseases - Australian Institute of Health & Welfare



The logo for 34th DAE Safety Meet is pretty simple. The text is enclosed outer to circle is followed by two themes of the Meet. Inside the circle, three gears, isn't just a gears, it actually represents the unity, continuation and togetherness of healthy work environment, which are key principle of Human, Organisational and Technological Factors in Safety. The shape of heart represents the well-being and healthiness of workers/employees. Lifestyles diseases are shown symbolically to depict Cancer, Diabetes and Heart related issues of workers/employees, which are silent killer of the millennium. The intent of this logo is to educate, establish, promote and propagate health and safety among the family members of DAE.

Ideation and Design by Kailash Gharat, IHSS, BARC, Mumbai