CHAPTER 2

LITERATURE SURVEY
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2.1 INDUSTRIAL ACCIDENT PREVENTION THEORIES AND APPROACHES.

ACCIDENT PREVENTION THEOREM BY H.W. HEINRICH.

As per H.W. Heinrich an Accident Prevention represents above all other things, control – control of worker performance, machine performance, and physical environment. The word “control” is used advisedly because it connotes prevention as well as correction of unsafe conditions and circumstances. As thus defined accident prevention is a vital factor in every industrial enterprise, one which if ignored or practiced unskillfully, leads to needless human suffering and business bankruptcy. The “domino sequence” theorem shows that (1) industrial injuries result only from accidents, (2) accidents are caused directly only by (a) the unsafe acts of persons or (b) exposure to unsafe mechanical conditions, (3) unsafe actions and conditions are caused only by faults of persons, and (4) faults of persons are created by environment or acquired by inheritance. Thus accident prevention may be defined as an integrated program, a series of coordinated activities, directed to the control of unsafe personal performance and unsafe mechanical conditions, and based on certain knowledge, attitudes, and abilities. In this text these several steps or factors in the program are given identifying names, defined and illustrated by examples of application.
AN UPDATED DOMINO SEQUENCE BY FRANK BIRD, JR.

LACK OF CONTROL – MANAGEMENT.

The word “control” in this factor refers to the function of professional management (PLANNING – ORGANISING – LEADING – CONTROLLING). In its generic usage, as related to “loss control”, the word “control” refers broadly to the general regulation, curbing, restraining or holding back of losses. CONTROL as a function of professional management is optimized through five established steps that systematically produce desired results. Simply stated, loss control management involves (1) the identification of the WORK activities in the program that management must engage into produce desired results at an existing stage of the program’s development (i.e., accident investigation, facility inspection, job analysis, personal communications, supervisory training, hiring and selection, design engineering, etc.) (2) the establishment of STANDARDS for management’s performance in each work activity identified, (3) MEASURING management performance by the established standards in each of its work activities, and (4) CORRECTING performance by improving the existing program (see maintenance loop on chart) and/or expanding the existing program.

BASIC CAUSE – ORIGINS (ETIOLOGY)

Since the path to achieving a highly reliable safety/loss control system involves a developmental growth process, there will probably be management work activities that have not been identified at any given time, and, therefore, standards, measurement, evaluation and correction systems not yet established. In effect, the absence of a highly reliable loss control system will permit the existence of personal and job-related factors referred to as the basic or underlying causes of
accidents or downgrading incidents. Personal factors would include lack of knowledge or skill, improper motivation, and physical or mental problems. Job factors would include inadequate work standards, inadequate purchasing standards, normal wear-and-tear and abnormal usage. The professional manager realizes that only by identifying these basic causes can be really establish a system of effective control. ORIGINS (Etiology) refers to the sources, and its appropriate identification with the basic or underlying cause serves to reinforce our desire to achieve more effective control by getting at the root cause, rather than simply treating the symptoms of the problem.

IMMEDIATE CAUSES – SYMPTOMS
These are the factors in the accident/incident sequence that have historically been called the most important ones to attack. The safety manager most frequently refers to these causes as unsafe acts or conditions (i.e., operating without authority, nullifying safety devices, taking unsafe positions, inadequate guards, poor housekeeping, etc.). The production or quality control manager could also refer to immediate causes of his problem (downgraded production) as substandard acts or conditions. In reality, the immediate cause is usually only a symptom of the deeper underlying program.

ACCIDENT – CONTACT
For practical purposes, the accident might be described as an undesired event that results in physical harm, injury, property damage. The word "accident" itself is purely descriptive, and has no real etiological connotation. While words such as "error" or "mistake" have been suggested as more indicative of an underlying
management deficiency, they are also descriptive and would serve no more significant value in loss control than the word "accident".

INJURY – DAMAGE – LOSS

To the early safety practitioner, the terms "accident" and "traumatic injury" were almost synonymous. While occupational disease, fire and property damage were philosophically associated with industrial safety, actual accident prevention practices through the years have largely been devoid of these considerations and are quite injury-oriented. Thus, the word "injury" has been most frequently used to mean bodily damage or harm through traumatic accident. While occupational diseases have historically been counted in disabling injury rates, their cause and control have not until recently had their rightful inclusion in the accident prevention program.

THE FERRELL THEORY OF ACCIDENT PREVENTION

One theory of accident causation in this category comes from Dr. Russell Ferrell, professor of human factors at the University of Arizona. The theory states that accidents are the result of a causal chain (as in the multiple-causation theory), one or more of the causes being human error. Behind all initiating incidents of accidents is human error. Human error is in turn caused by one of three situations: (1) overload which is the mismatch of a human's capacity and the load to which he is subjected in a motivational and arousal state; (2) incorrect response by the person in the situation which is due to a basic incompatibility to which he is subjected; and (3) an improper activity that he performs either because he didn't know any better or because he deliberately took a risk. since this is basically a human factors
model, greater emphasis is then placed on the first two causes of human error, overload and incompatibility. Overload can be examined in the model by looking at the sources of load; task load (physical requirements or information processing requirements); environmental load (amount of illumination, noise, distraction, etc); internal load (amount of worry, stress, etc.); and situational load (ambiguity of the situation, interpersonal problems, danger, etc). The sources of load can be compared to the sources of capacity. These are a person’s natural endowments, his physical condition, his state of mind, his training level, whether or not there is a drug or pollutant influence, the amount of pressure, and fatigue. And all this takes place when a person is in a certain arousal and motivational state.

THE PETERSEN ACCIDENT-INCIDENT CAUSATION MODEL

An adaptation of the Ferrell human factors model of causation is the Petersen model. This model differs from the Ferrell model in that it allows two possible causes for accidents much as the original Heinrich domino theory did: human error and/or systems failure. Causes of accidents and/or incidents can be from either or both. This model suggests that behind human error are three broad categories: overload, traps and decision to err. Overload approximates the Ferrell model very closely, and is again defined as a mismatch of capacity with load in a state. Items under each are slightly different, however, with the load category including the concept of Life Change Units, the job hazard situation, etc., and with the state category including four classes: motivational, arousal, attitudinal, and biorhythmic.
Like the epidemiological model, a systems model recognizes the inseparable ties between individuals, their tools and machines, and their general work environment.

Bob Firenze illustrates this with his model as:

Each worker, whether he be a machinist, chemist, foundry worker, etc., performs his job as part of a network called a man-machine system. Such a system is composed of the physical equipment, the man or men who perform functions with the equipment, and the environment where the process takes place. This integrated group of components is designed to bring about a desired end - a product or task within the limits of its environment, and within an acceptable period of time. Providing that the system functions as planned, the expected result is usually obtained. However, a failure - whether it be human, equipment, or environmental - will invariably detract from the efficient accomplishment of the operation. In some instances, it wipes out the operation, resulting in a total failure or catastrophic situation. The match of human and equipment functions in a given environment are critical to a system's effectiveness and its capacity to perform as it was designed to.

There exists a void between a man-machine system and its task. The process that takes place in this space holds one of the keys to understanding the man-failure-accident problem. In order for the system to move towards its objective, a series of sequential processes must take place. First, the human element must make decisions. Based on these decisions, the human component will take certain risks in an effort to reach his objective. In each case, the man needs information upon which to base his decisions. The better his information, the better his decision, and,
subsequently, the more calculable the risk becomes. The poorer his information, the greater the chance for bad decisions, bad risks, and failures that may be responsible for accidents. Secondly, the equipment in the system must function effectively without failure. Poorly designed equipment or tools – or those poorly maintained – may, in themselves, be the trigger mechanism that leads to an accident. Thirdly, the environment plays a significant role in the system. A failure in the environment may affect either the man, his machine, or both, thus setting up an accident situation (e.g. toxic atmospheres, glare, etc.) Before decisions are made, a man seeks information that serves to remove some or all of the uncertainty involving his task. The uncertainty centers around two major areas: the requirements of the task; the nature of the harmful consequences. If his "information bank" is adequate, the ultimate risk resulting from his decisions will be within calculable limits of risk taking, and the chance of his failing will be lessened. For that reason, one of the primary efforts must be to equip workers with as much information as possible through training, so that their decision-making is facilitated, their actions are effective, and their chance for human failure is minimised. There is, however, an exception to the rule that a man with full knowledge of his job will always make wise, calculated decisions. Variables known as "stressors", or blocks to a man’s decision-making capability, often appear in the decision process and cloud his ability to make sound, rational decisions. These stressors can be of psychological, physiological, or physical origin. They act to distort and, sometimes, prevent the decision-making process from taking place. Narcotics and alcohol are examples of physiological stressors that have an effect upon the organism. Each type of stressor has the capacity by itself or in
combination with other factors to cause otherwise safe behaviour to be faulty. It is often during the period when the man is distracted that he makes an error. The error often times is primarily responsible for an accident. Accident causation involves consideration of as many of the variables that affect the system as possible. The design of tools and equipment must be considered as must be elements in the environment that may detract from the successful completion of the operation. Lastly, but ever so important, it must be considered that the human variable in the system is a non-perfect entity subject to many forces in his environment. With this in mind, it must be understood that no matter how intelligent the man is, how much he is trained, or how much information he possesses, he will still – under certain circumstances – make errors. Some of these errors will lead him into an accident situation. This is not to imply that trying to improve the man’s knowledge of his tasks should be abandoned. Chances are that if his decision-making ability is sufficiently developed, along with his comprehension of the hazards connected with his job, and his ability to anticipate and counter accident situations, he stands a better chance of surviving without injuries than if he had no comprehension of the problem at all.

2.2 STATISTICS OF INDUSTRIAL ACCIDENTS / INJURIES COVERING INDIAN INDUSTRIES:
In spite of the best legislative law the Factories Act, 1948, industrial accidents occurring year by year are very significant there by causing injury to persons in the work place, causing property damage, polluting the surroundings, contracting with occupational diseases by the employees working in the factory etc. The statistics to the extent available from various sources related to number of working factories,
estimated average daily employment, the number of industrial injuries state-wise, major industry classification-wise and their respective Frequency rate and Incident rates are placed at Annexure – I to Annexure –IV of this Report. The statistics are related to factories as defined under the Factories Act 1948. The Act covers factories employing 10 or more workers and using power, factories employing 20 or more workers and not using power and the factories specially brought under the purview of the Act by the State Government under the section 85 of the Act. The statistics are related to the persons employed, directly or through any agency including contractors in any manufacturing process (whether for wages or not) or in any cleaning any part of the machinery or premises used for a manufacturing process or any other kind of work identical to or connected with the manufacturing process thus, the definition of workers as laid down in the Act does not cover manual workers alone but some clerical and supervisory personnel as well. The employment figures relate to all working factories including estimated employment of factories not submitting the returns to the Government. The average daily employment figure is arrived by dividing the total attendance (man days worked) during the year by the total number of working days during the same year, not on the basis of number of persons working. Under the Factories Act, 1948, statistics of injuries resulting from Industrial Accidents by reasons of which persons affected are prevented from attending work for a period of 48 hours or more immediately following the injury, are required to be reported to the Factory Inspectors. For statistical purposes the number of injuries is given by the number of persons receiving injuries as a result of accident and this number can be more than the actual number of accidents because one accident may result in injuries to more than
one person. The data on injuries presented in the enclosed Annexure I to IV relate only to the factories submitting returns to the Government in time. The frequency rate of injuries is calculated by dividing the total number of injuries by the corresponding man-days worked in lakhs. The incidence rates in terms of injuries per 1000 persons employed have also been presented in the Annexures I to IV.

2.3 ANALYSIS OF INDUSTRIAL ACCIDENTS / INJURIES IN INDIAN INDUSTRIES:

2.3.1 ANALYSIS OF INDUSTRIAL ACCIDENTS / INJURY RATES IN FACTORIES.
As seen from the figures placed at Annexure-I, the number of working Factories in the year 1995 were reported as 2,34,867 when compared to 1971 figures as 81,078 which shows a considerable increase in number of working factories. There was a significant increase in the estimated average employment from 93,63,000 in 1995 when compared to 50,85,000 in 1971. The range of industrial injuries from 1971 to 1988 varied from 2,00,258 to a peak of 3,33,572. Whereas the figures for the fatal for the same period showed variation from 456 fatalities to a peak of 924 fatalities which is a matter of concern. Similarly the total frequency rate showed a cyclic variation from 1971 to 1996. However the fatality frequency rate showed more or less uniform trend barring few years. The trend in respect of incidence rates is also having a cyclic variation since 1971 to 1996 but on decline trend from 75.67 in 1971 to 17.02 in 1995. The quantum of improvement shown since 1987 was attributed to the amendments in the Factories Act (provisions related to Hazardous processes) and compulsory appointment of safety officer with requisite qualification. However there is still scope to reduce the industrial accidents/injuries.
2.3.2 ANALYSIS OF STATE WISE INDUSTRIAL INJURIES IN FACTORIES:
The type of industries and the density of operations are not uniformly distributed among all states in the country. The details available from various sources regarding the number of industrial injuries/fatalities and the injury rates since 1986 to 1996 among different states are placed at Annexure II & III. As per the full details available up to 1988 from major states, west Bengal, Maharasra, Gujarart, Tamilnadu, Madhya Pradesh, Karnataka contribute to almost 85% of total number of industrial injuries including the number of fatal accidents. The incidence rate and frequency rate of total number of injuries and rate of fatalities are showing mixed trend. Many important states did not make their statistics available for further analysis. However, the trend is alarming to take corrective steps to prevent industrial accidents/incidence.

2.3.3 ANALYSIS OF INDUSTRIAL INJURIES IN MAJOR GROUP OF INDUSTRIES
The details of total number of injuries fatalities and the Incident Rate of some major group of industries since 1986 to 1995 through available source of information, is placed at Annexure IV of this Report. As seen from the Annexure, the textile, basic metal and alloys, machining and machinery tools, transport and
equipment parts constitute major portion of industrial injuries. Whereas, the chemical and chemical products contribute to the next. The occupational diseases arising out of them are not recorded as the data is not available immediately. It is stated in the recent ILO conference (Dec. 1999) that "More than 3000 people die per day because of the work they do for a living throughout the world. Workers worldwide suffer 250 million accidents every year and 160 millions diseases caused by their Jobs. The economic losses are equivalent to 4% of world’s gross National product. In terms of shattered families and communities, the damage is irreparable. The safe work programme of the ILO reaches out to people in the most hazardous occupations to help them, make their workplace a safe and decent place to work."