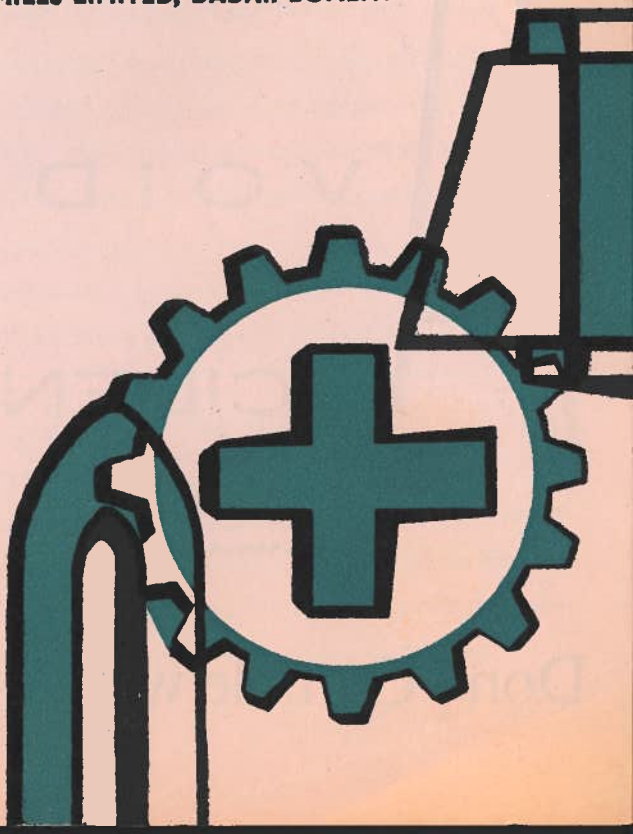
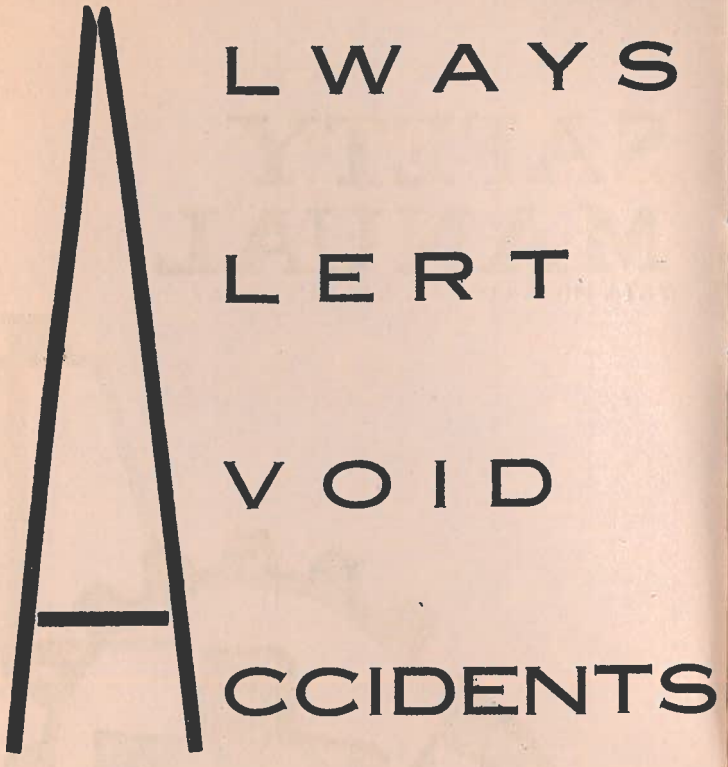
SAFETY MANUAL

TATA MILLS LIMITED, DADAR BOMBAY





Don't Gamble with Safety

A MESSAGE FROM YOUR WORKS MANAGER

Accidents not only cause needless human suffering and in some cases loss of life, they also result in economic and social loss, impair productivity, cause inefficiency and retard the development of good personnel relationship. Each one of us, therefore, bears a moral responsibility for the prevention of accidents. A well thought-out safety programme is essential for achieving this objective. I, therefore, welcome the publication of the Safety Manual as a valuable adjunct to such a programme. It is meant primarily for the supervisors who are the key persons in any safety programme and I, therefore, appeal to you to make a close study of these rules and recommendations and ensure their implementation through your own efforts and through the active co-operation of the employees working under you.

SAFETY FIRST

SAFETY LAST

LET THAT BE

A DAILY TASK

There is no Substitute

for

SAFETY

GENERAL SAFETY RULES

It is the responsibility of Departmental Heads to ensure that copies of these rules applicable to their own department are prominently displayed in English and vernacular in the department and are readily available to workers at all times.

1. Whenever any unsafe and dangerous condition is noted, it should be reported immediately to the Assistant in charge and/or the Safety Department.

2. Any injury, no matter how slight, must be reported to the Assistant in charge immediately who will arrange for your treatment at the Ambulance Room by issuing a permit.

3. Drums or other make-shifts should not be used in place of ladders or as work benches or supports for any job.

4. Excavations inside the compound or departments must be properly fenced and marked with suitable warning sign boards at all times. This also applies to any trench or drain which has a cover removed. If ladders or handrails are removed, safety ropes must be

placed around to eliminate the danger of falls.

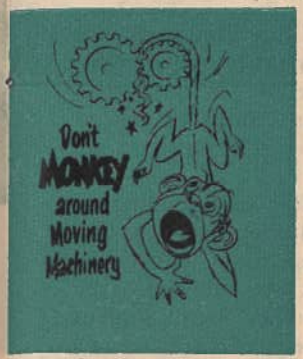
5. Goggles or face shields must be used when working on emery wheels or chipping metal etc., or any other job where there are possible eye hazards.

6. Gloves must never be worn while grinding materials on an emery wheel. Gloves should not be used when operating machinery except with the permission of the Departmental Head.

7. Ladders with broken or missing rungs or split side rails or otherwise defective or without safety shoes or hooks must not be used. Ladders when erected must be tied at the top with a rope.

8. Before any person is allowed to work on a roof or in an enclosed place or in a manhole, or any hazardous place permission for doing such job there must be obtained from the management who will ask the Safety Department or the Departmental Head concerned to take such precautions as he may deem fit.

9. When working on asbestos covered roofs, proper boards like crawling boards or cat ladder must be used to support your weight.



10. Before any work is commenced in an enclosed place or in a manhole, such a place must be kept open for at least two hours.

11. When working in an enclosed place or in a man-hole, wear a rope or belt around the waist or a belt with one end of the rope or belt held outside the manhole by one or more standby personnel who will keep a watch in order to pull out the worker should he be in difficulty or overcome by gas.

12. You must use the wastebins provided for all waste and rubbish.

13. Dumping of refuse near incinerator should be done during the specified hours and only within the fenced area. It is prohibited to dump refuse outside the fenced area.

14. Defective tools e. g. chisels with mushroom heads, spanners with worn jaws, broken file handles, hammers with broken shaft, etc. must be brought to the notice of the Assistant in charge immediately.

15. Drivers must use the horn at all intersections and blind corners and while reversing.

16. You should note that unauthorised riding on trucks and

unauthorised climbing on trees are not allowed and that horseplay of any kind is prohibited inside the mills.

17. It is prohibited to sleep or sit on the roads inside the mills at any time.

RULES FOR MATERIAL HANDLING

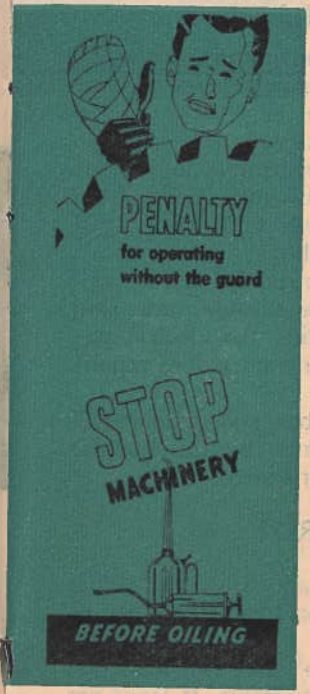
1. Materials of any kind must not be thrown from or to any height. If such a procedure is necessary, the particular area must be fenced to keep others in the clear.

2. The unloading and loading of gas cylinders, drums, carboys, etc. must be carried out with care. These should not be allowed to be dropped or come into violent contact with one another.

3. Materials should be stacked carefully, tidily and up to a safe height and should be properly secured.

4. All drums, casks, etc. should be stacked horizontally during monsoons so as to prevent accumulation of rain water and breeding of mosquitoes therein.

RULES FOR MACHINE HAZARDS



1. All guards on the machines and rollers must be in position before starting any machine.

2. See that everybody and everything is clear before starting up machine. Make sure no one is in a position to be injured as a result of your act.

3. Stop machine before oiling, adjusting, inspecting or cleaning it.

4. When working on grinding wheels: (i) Check that the safety shield is correctly set. (ii) Ensure that the wheel is running true. (iii) See that the tool rest is fixed within one inch from the wheel.

5. When repairing a machine, keep all small machine parts etc. in trays and not on the floor.

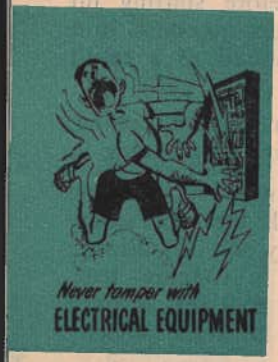
6. Use goggles or face shields provided while grinding or machining cast iron or brass etc. to protect your eyes.

7. Do not tamper or interfere with any machinery that you are not operating or repairing.

8. Do not attempt to operate or set in motion any machine or equipment to which you are not assigned.

9. Use machines, guards and other equipment with care. Report at once to your supervisor any damage or fault or any sound.

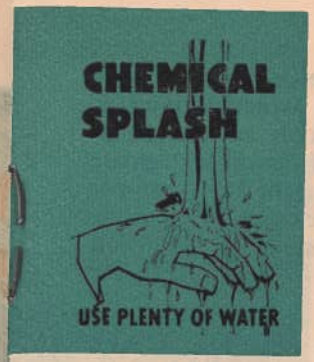
RULES FOR ELECTRIC HAZARDS



1. Unskilled men must never be allowed to attempt repairs to electrical apparatus.
2. Only authorised persons from the Electric Department may operate any switch gear apart from routine stopping and starting of motors and lighting.
3. When electrically driven machines and apparatus are shut down for repairs, the electric circuit must be isolated before repairs commence. .
4. Lights, globes and bulbs must be renewed only by the Electric Department personnel.

RULES FOR CHEMICAL HAZARDS

1. Any leakage observed from drums, jars, packages, carboys or cylinders, etc. must be reported immediately to the Departmental Head or his Assistants. If leaks are from packages containing acid, caustic soda or other corrosives, steps must be taken to stop other persons approaching the location.



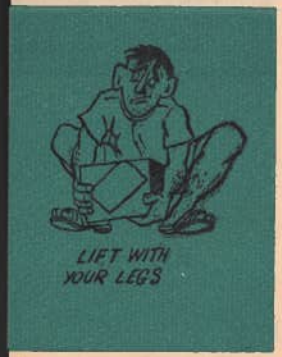
2. Should you be splashed with acid, caustic or other chemicals, wash yourself with water, flooding the affected part of the body and immediately report to the Ambulance Room for attention.

Day Dreaming

INVITES

ACCIDENTS

GENERAL SAFETY RECOMMENDATIONS



1. Good house-keeping will save you from many avoidable injuries. (i) Keep your tools and surroundings clean, free from oil and grease and your equipment in its proper place. (ii) Be careful to clean up a job after finishing it. All left over junk is to be removed to the proper place.

2. Be sure you know how to do a job before you start it. If in doubt, consult your superior.

3. Never look directly into the arc produced during welding without proper eye protection.

4. Protruding nails should be pulled out or bent over or knocked down before you throw anything out for scrap or pass material on. Look out for sharp edges and splinters.

5. Do not over-reach when working on a ladder.

6. When ascending or descending a ladder, face the ladder and obtain a firm grip with both hands. Carry tools or materials in such a way so as to provide free use of your hands.

7. Use your tools with care. Do not put them to use they are not meant for, e.g. using spanner as a hammer or a knife as a screwdriver.

8. Do not throw tools from one man to another. Instead, hand them over.

9. Place tools and materials securely on benches.

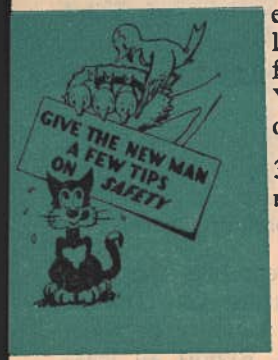
10. Keep aisles free of fallen articles like bobbins, pirns, springs, nuts and bolts to avoid slipping over them.

11. Please use spitoons while spitting. Indiscriminate spitting inside the departments or the compounds is spreading germs.

12. Please use carefully the toilet facilities provided for you. Do not tamper with any sanitary or water pipe connections. Report all leakages promptly to your Departmental Supervisors or to the Safety Department. Pull flushing chains gently.

13. Keeping of pets inside the mills can lead to cases of dog bite resulting in rabies.

RECOMENDATIONS FOR MATERIAL HAZARDS



1. Learn the right way to lift weight so as to avoid strain. Bend your knees, keep back straight, lift with your legs. If you feel a strain, stop.

2. Get help, if an object is too heavy for you. Team lifting of heavy objects is dangerous—it must be effectively supervised. See that the load is not too heavy or awkward for the men detailed for the job. You are responsible for the safety of the man working under you.

3. When loading or unloading materials:

(i) Start unloading from the top of the load.

(ii) Do not needlessly throw objects to the ground.

(iii) Watch your footing.

(iv) Arrange materials in orderly piles.

(v) Do not stack materials in passage ways.

4. Do not carry or push a load you cannot see over.

5. Take care you do not get your finger crushed or pinched while handling materials. (Use gloves whenever directed or necessary).

6. Never pull a hand truck. Push it always. While pushing a truck through a door way, keep your hands within the width of the truck.

7. When working aloft, secure your gear and tools etc., because a hammer falls like a thunderbolt into the shop below.

RECOMMENDATIONS FOR MACHINE HAZARDS

1. Do not wear finger rings near moving machinery because many machinists have had fingers injured through wearing rings.

2. Do not use gloves when actually working machinery.

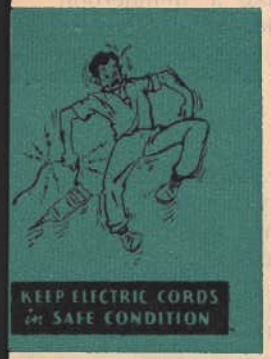
3. Use a brush or hook for removing cutting chips or fluff. Do not use your fingers nor blow filings with your breath.

4. Never leave your machine unattended while in motion.

5. Never reach across the exposed moving parts of a machine.

6. Where machine weights are provided with safety clips, adjust weights with care. See the hooks to which weights are suspended are in order, because weights can hurt your toes.

RECOMENDATIONS FOR ELECTRIC HARARDS



1. Knowledge of how to give Artificial Respiration is very useful to all workers. Instructions and lessons in Artificial Respiration can be obtained from the Safety and/or Medical Department.

2. Never use water for extinguishing electrical fires. Use always CO_2 type or CTC type of fire extinguisher for extinguishing electric fires.

3. Do not use any grade of petrol or turpentine oil or any other inflammable liquid or corrosive chemical for cleaning purposes.

4. Report all skin irritations to the Ambulance Room immediately.

RULES FOR THE PREVENTION OF FIRE HAZARDS

1. Smoking is not allowed inside any Department and near the cotton bale godowns.

2. Fire-fighting equipment is not to be put to other uses except fire-fighting. Fire buckets are not to be misused.

3. The Safety Department must be informed early when any fire equipment has been used or misused so that replacement could be effected early.

4. Deposit all oily rags in containers provided. Do not throw them about thoughtlessly.

5. Complete precautions against fire must be taken before doing any welding or cutting work inside the department. The Safety Department must be given advance intimation of such operation.

FIRE -> EASY TO START
-> HARD TO STOP

ANY JOB

BIG or SMALL

SAFETY FIRST

APPLIES TO ALL

HE WHO BELIEVES

IN SAFETY FIRST

—LASTS !

Safety—TO-DAY,

Tomorrow May be Too Late

LITTLE DRIPS

Cause

BIG SLIPS

CHANCE TAKERS

are

ACCIDENT MAKERS

Put your Eye in your Job
Let not your Job get into your Eye

IF YOU CAN AVOID YOUR

FIRST ACCIDENT

YOU WILL NEVER GET THE

SECOND

This booklet is issued by the
Personnel Division of Tata Mills Limited.
(Managing Agents Tata Industries Private Limited)

ORGANISATION INTERNATIONALE DU TRAVAIL

L'HOMME AU TRAVAIL

(ETUDE SUCCINCTE DE PHYSIOLOGIE APPLIQUEE AUX CONDITIONS DE TRAVAIL DANS UN PAYS SUBTROPICAL.)

par

E. HOHWÜ CHRISTENSEN

SERIE SECURITE, HYGIENE
ET MEDECINE DU TRAVAIL
No. 4

BUREAU INTERNATIONAL DU TRAVAIL
GENEVE
1964

ORGANISATION INTERNATIONALE DU TRAVAIL

"L'HOMME AU TRAVAIL"

(Etude succincte de physiologie appliquée aux conditions de travail dans un pays subtropical.)

par

E. Hohwü Christensen

Série Sécurité, Hygiène et Médecine du Travail
n° 4

Bureau international du Travail

Genève

1964

TABLE DES MATIERES

PREFACE

L'objet de la présente étude est de mettre en relief certains principes de la physiologie de l'homme au travail en se référant spécialement aux conditions existant en Inde.

Cette étude a été faite par le professeur E. Hohwü Christensen, expert en physiologie du travail du B.I.T., à la suite d'une mission d'assistance technique en Inde. Cependant, les principes discutés et les expériences rapportées s'appliquent à des conditions de travail tellement fondamentales que leur diffusion revêt une importance exceptionnelle, en particulier pour les régions subtropicales et dans les pays en cours de développement industriel.

Bien qu'il traite de problèmes de physiologie très avancés, le professeur Christensen a écrit ce document dans une forme qui le rende accessible non seulement aux médecins et aux physiologistes, mais à tous ceux qui possèdent un petit bagage scientifique. Il sera utile à tous ceux qui assument une responsabilité dans la protection de la santé des travailleurs et dans la productivité, dans toutes les branches économiques.

I. INTRODUCTION

Bien que cette étude succincte porte essentiellement sur les aspects physiologiques de "L'homme au travail", je me suis efforcé de ne pas négliger pour autant quelques problèmes connexes plus généraux que soulève le travail humain. Plutôt que de m'étendre sur les détails, j'ai voulu, parfois en m'inspirant de conditions particulières à l'Inde, dégager certains principes pouvant servir de base à de futures discussions.

Les recherches dans ce domaine entreprises depuis plusieurs années dans ce pays ont abouti à des résultats partiels qu'il serait possible d'exploiter dès maintenant, mais j'éviterai de les récapituler, de même que je m'abstiendrai d'en examiner la valeur, car tel n'est pas mon propos. D'autres devront s'atteler à la tâche non seulement pour permettre à l'industrie de tirer un meilleur parti de ces données, mais encore pour éviter autant que possible, au stade de l'élaboration des études nouvelles, que les mêmes recherches soient entreprises par des spécialistes différents.

D'innombrables problèmes se posent, dont la solution, le fait mérite d'être souligné car il revêt une importance primordiale, pourra être trouvée sans qu'il faille utiliser des appareils scientifiques complexes et onéreux ou appliquer des méthodes compliquées. Le bon sens, une connaissance suffisante de la physiologie et surtout la volonté de faire du lieu de travail dans l'industrie et du travailleur lui-même l'objet principal des recherches, sont des éléments bien plus indispensables.

La physiologie du travail est une discipline scientifique qui a pour objet l'étude de l'homme en tant qu'être "travaillant". Elle comporte une partie fondamentale, qui est une branche de la biologie, et une partie appliquée que nous pouvons appeler physiologie industrielle. Cette dernière ne peut se justifier que par l'utilité qu'elle présente pour l'industrie. Elle doit avoir pour objectif d'obtenir, en mettant en oeuvre des méthodes de recherche physiologique, des renseignements utiles sur les conditions de travail actuelles et sur les possibilités de les améliorer pour rendre le travail plus humain et accroître la productivité sans imposer d'efforts excessifs aux travailleurs.

L'Inde, qui est un pays en voie de développement, possède des entreprises où l'aménagement des postes et les conditions de travail peuvent soutenir la comparaison avec les entreprises ultra-modernes des pays occidentaux, ainsi que

des entreprises où règnent des conditions de travail très inférieures aux normes acceptables. Dans ce pays, l'une des tâches principales de l'avenir consistera à convaincre en particulier les dirigeants des entreprises arriérées que de mauvaises conditions de travail se révèlent à la longue très onéreuses.

La physiologie du travail est l'une des nombreuses disciplines scientifiques qui seront représentées à l'Institut central du travail de l'Inde. Associer ces différentes disciplines à un effort commun pour résoudre les problèmes présents et futurs sera une tâche des plus difficiles, mais aussi des plus stimulantes. Chacune de ces disciplines a sa technique propre, ses conceptions, sa propre échelle des valeurs pour déterminer ce qui est important et ce qui ne l'est pas, etc. Il arrive même, ce qui est pire, qu'elles se servent des mêmes termes en leur prêtant un sens entièrement différent. Il n'en reste pas moins que cette conjugaison des efforts est rationnelle. Pour ma part, je suis convaincu que la création de l'Institut central du travail à Bombay et d'Instituts régionaux du travail à Calcutta, Kampur et Madras constitue un grand progrès dans le domaine des sciences du travail, même en dehors de l'Inde.

Nombreux sont les problèmes importants concernant la physiologie du travail que nous passerons sous silence. Malgré cela, j'espère que cette étude succincte contribuera à mieux faire comprendre tant aux employeurs qu'aux travailleurs l'importance des problèmes soulevés. J'estime, s'il en est ainsi, que l'une des tâches essentielles de ma mission auprès du ministère du Travail et de l'Emploi, que j'ai été appelé à conseiller en ma qualité d'expert du B.I.T., aura été remplie.

Bombay, juillet 1962.

E. Hohwü Christensen,
Expert en physiologie du travail du B.I.T.

II. PHYSIOLOGIE DU TRAVAIL

Il est utile d'avoir une connaissance suffisante de la physiologie du travail pour pouvoir adapter le travail au travailleur et affecter celui-ci à un poste correspondant à ses capacités physiologiques. Cette connaissance est un gage d'objectivité dans les études de postes et nous permet également de soumettre aux employeurs et travailleurs des propositions en vue de l'amélioration des conditions de travail. Grâce à cette amélioration, il est possible d'atteindre un niveau de production identique ou même supérieur avec une moindre fatigue pour le travailleur, dans l'intérêt évident de la direction et du personnel.

Il s'ensuit que la connaissance de "L'homme au travail" constitue un élément fondamental de la productivité, dont il faudrait tenir compte partout et notamment dans un pays comme l'Inde où, en raison des conditions climatiques, le travailleur doit fournir un effort plus intensif. De plus, le rythme accéléré de l'industrialisation ne manquera pas, au cours de la prochaine décennie, d'entraîner une modification du mode de vie et des habitudes de travail de millions de personnes. Des problèmes entièrement nouveaux risquent de se poser et le travailleur rural indien, que l'expérience transmise par les générations précédentes a sans doute conduit à adopter un rythme et un volume de travail déterminés, conformes à ses exigences et à ses possibilités, devra s'adapter au milieu nouveau et au rythme de travail différent de l'industrie moderne, où les conditions de travail ne sont pas les mêmes et où les machines peuvent exercer une influence marquée sur sa cadence.

Il n'est guère possible, en l'état actuel des choses, d'évaluer objectivement l'effort physiologique demandé au travailleur indien par rapport à celui que fournit un travailleur affecté à un poste analogue dans un pays occidental aux conditions climatiques plus favorables. Le jour où des méthodes d'étude du travail plus objectives seront couramment appliquées, nous pourrons comparer les résultats obtenus dans des entreprises indiennes avec ceux d'entreprises situées, par exemple, aux Etats-Unis ou en Europe. Toutefois, il ne faut pas s'attendre à ce que l'ouvrier indien travaillant dans des conditions climatiques défavorables puisse, dès lors que le procédé de fabrication implique un effort physique intensif, atteindre le rendement élevé du travailleur américain ou européen.

La physiologie du travail ne s'intéresse pas tant à la productivité des travailleurs pris en groupe qu'à la charge physiologique supportée par un sujet effectuant un travail déterminé. Le travailleur européen et son homologue indien peuvent certes atteindre un niveau de production égal

lorsqu'ils sont placés dans des conditions identiques, mais au prix d'un effort physiologique sans doute très inégal. Le premier peut tabler sur une marge de sécurité plus grande en raison de sa constitution plus robuste, d'une meilleure alimentation, d'une formation professionnelle plus systématique, etc. alors que le second risque de travailler à la limite de ses possibilités.

Le premier objectif du physiologiste du travail pourrait être le suivant : tout faire pour éviter qu'il y ait des sujets présentant des différences biologiques trop grandes dans un groupe donné de travailleurs exerçant la même activité. Pour cela, il faudrait autant que possible procéder à un examen approfondi d'embauchage et de sélection. En outre, le spécialiste de l'étude du travail et le physiologiste du travail devraient conjuguer leurs efforts pour étudier de manière plus détaillée les différents postes et supprimer autant que possible les conditions de travail défavorables. Les mauvaises postures de travail, le levage de charges trop lourdes, un mauvais éclairage, des conditions climatiques défavorables, un niveau élevé de bruit, etc. ne devraient pas être considérés comme des éléments inéluctables du travail.

Il se peut qu'il nous faille admettre dans certains secteurs industriels un niveau élevé de bruit, une haute température et une forte humidité, parce qu'ils sont inséparables du procédé de fabrication, mais il ne faut en aucun cas se résoudre à tenir ces conditions pour immuables ou croire qu'il suffit d'augmenter les pauses pour surmonter les difficultés.

Dans le cas des procédés de fabrication très bruyants, il faut lutter contre le bruit à la source même afin de l'empêcher de se propager dans toute l'usine. De même, un fort rayonnement calorifique peut être neutralisé ou atténué au moyen d'écrans appropriés. L'objectif final devrait être de ramener la charge imposée à l'ouvrier du fait de son travail au niveau strictement nécessaire pour assurer la production, et de remédier au maximum aux conditions de travail défavorables.

L'industrie a pour objet, le fait est connu, de fabriquer des marchandises et de les produire au prix de revient le plus bas. Pour cette raison, ni le physiologiste du travail ni le psychologue du travail ne doivent être investis d'un droit de veto en matière d'organisation ou d'exploitation de l'entreprise. Ils doivent être intégrés en revanche à l'équipe composée de représentants des employeurs et des syndicats, de médecins du travail, de spécialistes de l'étude du travail, de spécialistes de la productivité et d'économistes dont les efforts doivent tendre conjointement vers un but unique : une production maximale fondée sur une utilisation optimale non seulement du capital et des machines, mais encore de la main-d'oeuvre engagée dans le circuit de production, ce terme s'entendant au sens le plus large.

III. ETUDES DE POSTES

L'étude de poste doit être aussi objective et quantitative que possible. Tout appréciation subjective telle que "pénible", "fatigant", etc. est à proscrire, car l'effort et la sollicitation, ou l'effet fatigant d'un travail, ne sont pas uniquement fonction des caractéristiques essentielles de ce dernier, mais dépendent aussi des possibilités du candidat au poste. Un travail peut être pénible et fatigant pour tel travailleur et facile pour tel autre, plus robuste et parfois plus jeune.

Le physiologiste du travail dans son laboratoire et à l'aide d'appareils de type normalisé est en mesure d'évaluer le travail avec toute l'objectivité voulue. Il peut par exemple se servir d'une bicyclette ergométrique pour astreindre le sujet à un effort physique mesurable, exprimé en kgp.m[1] par minute ou par seconde ou encore en fractions de cheval-vapeur (CV). Le rendement mécanique du sujet qui pédale varie très peu d'une personne à l'autre; de plus, il est indépendant du milieu de travail et reste constant malgré des variations assez importantes dans l'intensité de l'effort; le physiologiste peut donc prévoir le coût métabolique du travail et démontrer que, pour fournir un travail mécanique équivalant à 427 kgp.m, le sujet doit dépenser approximativement cinq fois plus d'énergie, ou 5 kcal environ. Le rendement mécanique s'établit ainsi à près de 20 pour cent. Le physiologiste peut également déterminer la consommation d'oxygène en litres et, en multipliant le résultat par 5 environ, exprimer en grandes calories le coût métabolique du travail.

Cette méthode de calcul de la dépense de calories est encore et toujours une des plus utiles pour l'étude quantitative et objective des postes, cela non seulement en laboratoire, mais aussi dans l'industrie, l'agriculture et la sylviculture. Toutefois, lorsqu'il s'agit d'exercices consistant à pédaler sur une bicyclette ergométrique ou à monter un escalier, il n'est guère possible de prévoir le coût métabolique du travail effectué et il faut le calculer en partant de la consommation d'oxygène mesurée.

La consommation d'oxygène par minute ou la consommation de calories par minute peut servir de base à la classification du travail. C'est ainsi qu'un travail "très léger"

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[1] Kgp.m = kilo-poids-mètre; 1 kgp. correspond à la force agissant sur une masse de 1 kg soumise à une accélération de 1 g (accélération normale de gravité).

correspond à une consommation d'oxygène inférieure à 0,5 litre par minute (ou moins de 2,5 kcal/mn), un travail "lourd" à une consommation de 1,5 à 2 litres par minute, etc. (voir tableau 1, p. 11).

Il faut préciser que, dans cette classification fondée sur la dépense de calories, les mots "léger", "lourd", "extrêmement lourd", etc. se rapportent à la consommation d'oxygène ou de calories, c'est-à-dire à une donnée pouvant être mesurée objectivement et exprimée quantitativement. Il peut n'y avoir qu'un lien ténu entre le qualificatif employé et l'effort ressenti par le sujet, car il s'agit en fait d'une appréciation objective.

Cette classification, il convient de le signaler aussi, n'est pas fondée sur la consommation totale d'oxygène ou la dépense totale de calories enregistrées au cours d'une journée de travail de huit heures. En fait, elle a pour objet en premier lieu d'évaluer les efforts de pointe déployés pendant une journée de travail normale. Ces efforts de pointe risquent de constituer de sérieux obstacles à l'embauchage des travailleurs, aussi présentent-ils un intérêt primordial pour le personnel technique lorsqu'on envisage de mécaniser davantage les opérations, ou pour le médecin du travail et le chef du personnel chargés de sélectionner les travailleurs pour différents postes.

Nous savons que la dépense moyenne d'énergie atteint, chez les travailleurs des exploitations forestières, une valeur élevée pour la durée de la journée de travail; ils devront donc se nourrir en conséquence. Dans d'autres métiers, la durée réelle du travail intensif est parfois assez limitée, ne correspondant qu'à 20 pour cent ou même moins de la journée de travail. Il n'empêche que le travail sera considéré comme lourd en raison des efforts de pointe qu'il comporte. Dans certains cas, la mécanisation permet de diminuer ces efforts de pointe et un travail lourd pourra être reclassé dans la catégorie des travaux légers sans que la consommation totale de calories durant les huit heures de travail de la journée fléchisse autant que le laisserait supposer ce changement de catégorie.

Il ne faut en aucun cas se fonder sur cette classification du travail pour calculer les besoins normaux du travailleur en calories ou en aliments, car les chiffres obtenus sont souvent trop élevés et ne correspondent guère à la réalité.

Pour déterminer les besoins totaux de calories, il est préférable d'avoir recours à une méthode simple qui consiste à peser et à analyser tous les aliments absorbés au cours d'une période allant de plusieurs semaines à quelques mois; la quantité de calories consommées pourra être calculée avec une précision

suffisante à partir de ces données. Bien entendu, le poids du sujet ne doit subir aucune modification sensible pendant toute cette période et son activité physique doit être réduite durant les heures de loisir, à moins qu'il n'en soit tenu dûment compte dans les calculs.

L'application de cette méthode risque de soulever quelques difficultés particulières dans les pays où certains travailleurs sont sous-alimentés. Elle n'en présente pas moins un grand intérêt, des études antérieures ayant montré que la productivité des travailleurs sous-alimentés peut baisser fortement et subir des fluctuations étroitement liées à la quantité de calories disponibles lorsque la consommation alimentaire totale reste pendant un certain temps en dessous d'un niveau déterminé. Un travailleur bien nourri a, du fait de ses réserves de graisse qui représentent quelque 10 pour cent de son poids total, des quantités d'énergie disponibles relativement importantes. Il est en mesure de maintenir sa productivité à un niveau normal pendant plusieurs semaines, même si sa ration journalière d'aliments est déficiente en calories.

On peut admettre que les besoins minimaux en calories d'un travailleur adulte, même sous-alimenté, qui ne fait aucun travail physique spécial sans être pour autant au repos physiologique complet, sont de l'ordre de 1 kcal par minute ou de 1 440 kcal par 24 heures. En tablant sur une consommation totale de 2 000 kcal par 24 heures, chiffre que certains peuvent considérer comme excessif, il disposerait de 560 kcal par jour pour le travail physique. Même dans les industries dites légères, il arrive qu'il faille 2 kcal supplémentaires par minute pour le travail physique. Or l'équilibre entre la dépense d'énergie et la consommation de calories n'est assuré que pendant 280 minutes ou 4 h 1/2, sur 8 heures ou 480 minutes de travail quotidien. Il suffit de porter la consommation de 2 000 à 2 400 kcal, c'est-à-dire de l'augmenter de 20 pour cent seulement, pour que la durée possible du travail effectif soit presque doublée et portée à 8 heures par journée de travail. Cet apport supplémentaire de calories peut se faire sous la forme de subvention pour repas ou même d'un repas gratuit fourni par la cantine de l'entreprise, solution qui présente un intérêt certain au point de vue de la productivité. On peut certes survivre avec une consommation moindre de calories, mais il est impossible dans ces conditions d'atteindre une productivité normale. Un déficit de 200 à 300 kcal par jour dans l'alimentation des travailleurs entraîne une baisse de la production qui peut se révéler très coûteuse sur le plan de la rentabilité de l'industrie légère d'un pays. Dans tous les cas, il faut fournir les calories basales qui sont entièrement improductives.

Dans les travaux agricoles ou forestiers, ainsi que dans les travaux de manutention dans l'industrie, les besoins supplémentaires découlant du travail physique peuvent atteindre 5 kcal par minute. Cela signifie que la durée possible du travail effectif est réduite à 112 minutes, ou moins de 2 heures par journée de travail, lorsque la consommation totale est de 2 000 kcal par jour.

Un travailleur forestier suédois arrive à consommer près de 5 000 kcal par jour, ou même davantage. Admettons qu'il consomme 5 440 kcal et qu'il lui en faille 1 440 par 24 heures lorsqu'il ne travaille pas. Il dispose en conséquence de 4 000 kcal pour le travail physique, soit 500 par heure pour une journée de travail de 8 heures, ou 8,3 kcal par minute. Ces chiffres sont très proches de ceux qui ont été déterminés dans la pratique.

En ce qui concerne l'Inde, on peut fixer à 5 kcal supplémentaires par minute la limite supérieure en cas de travail soutenu, en tenant compte du fait que des efforts de pointe peuvent être exigés de temps à autre. Nous avons retenu ce chiffre plus bas du fait que le travailleur indien est généralement moins corpulent (ce qui fait de lui une "machine" plus petite ayant en conséquence un rendement maximal plus faible), du fait aussi que les conditions climatiques sont moins favorables à l'élimination de la chaleur en Inde que dans les pays nordiques. Même en dépensant davantage de calories, le travailleur suédois bénéficie d'une grande marge de sécurité en ce qui concerne l'élimination de la chaleur. Au contraire, pour le travailleur indien appelé à déployer un effort intensif, l'insuffisance de l'élimination de la chaleur est un facteur susceptible de limiter son rendement. En tablant sur 5 kcal supplémentaires par minute, ou 300 kcal par heure, le travailleur doit disposer de 2 400 kcal supplémentaires pour un travail continu étalé sur 8 heures et la consommation journalière totale devrait être de 1 440 + 2 400 = 3 840 kcal; si la durée du travail effectif est ramenée à 6 heures par journée, par suite de pauses, etc., la consommation quotidienne devrait être de 1 440 + 1 800 = 3 240 kcal. Il est certain que, pour pouvoir augmenter le volume de travail ou la durée du travail effectif, il est indispensable d'augmenter la consommation de calories dans la même proportion.

Il peut être intéressant de nous écarter légèrement de notre sujet principal, l'étude de postes, et d'examiner la question fondamentale de l'organisme humain considéré comme une machine par rapport à d'autres machines.

On dit souvent que le rendement de l'homme est relativement élevé dans certaines activités telles que l'exercice consistant à pédaler sur une bicyclette ergométrique ou à monter des escaliers, où il atteint 20 pour cent ou plus et peut se comparer avantageusement à celui de la machine à vapeur. Toutefois, ce chiffre s'applique uniquement à la période de travail effectif et ne tient pas compte du fait que la machine à vapeur, contrairement à l'homme, ne consomme aucune énergie au repos.

Il vaut la peine de préciser également que le rendement relativement élevé de 20 pour cent, atteint par le sujet qui monte l'escalier, et qui "impressionne" le physiologiste, doit être accueilli avec réserve car le travailleur se contente de soulever son propre poids à ce "prix". Lorsque le sujet fait office de véhicule de transport, le poids supplémentaire ou "charge effective transportée" qu'il peut véhiculer en fournissant un travail continu correspond approximativement à 20 ou 25 pour cent de son propre poids. Le rendement réel sera donc très faible sur le plan de la productivité, la majeure partie du travail improductif fourni par le travailleur consistant à soulever son propre poids.

Dans les exercices à rendement élevé, comme c'est le cas lorsque le travailleur monte en escalier, on admet que l'intensité d'un travail physique soutenu correspond à 0,1 CV environ chez un sujet en bonne condition physique, ce qui équivaut à 7,5 kgp.m/s ou 450 kgp.m/mn. De ce fait, un travailleur qui pèse, y compris sa charge, 75 kg, peut soulever de 6 m par minute une "charge effective" d'une vingtaine de kg. Ce rendement est manifestement très faible si on le considère du point de vue technique.

Le chiffre de 0,1 CV par travailleur a été obtenu à partir de données valables pour l'Europe et s'applique à un travailleur pesant 70 kg. Dans l'exemple ci-dessous, ce poids a été fixé à 55 kg, ce qui paraît mieux correspondre au poids réel d'un travailleur indien des transports. Toutefois, si nous admettons ce chiffre de 0,1 CV par 70 kg, cela signifie que la "machine humaine" devrait peser 700 kg pour pouvoir développer 1 CV. Lorsqu'il s'agit d'un moteur à combustion, un poids de 7 kg environ pour produire 1 CV est déjà large. Il est donc certain que l'organisme humain est un bien mauvais substitut au moteur mécanique.

Il faut également tenir compte d'un autre facteur, le prix du combustible, lorsqu'on compare le travail mécanique de l'homme à celui de la machine, en particulier dans les

activités de transport où les besoins d'énergie sont importants. Ce combustible est fourni à la "machine humaine" par les différentes denrées alimentaires. Or les calories présentes dans les aliments sont beaucoup plus onéreuses que celles contenues dans le charbon ou le pétrole et peuvent coûter jusqu'à 50 fois plus cher. A cela s'ajoute le fait que la "machine humaine" a de grands besoins d'énergie même au repos.

A un point de vue strictement technique et économique, il est évident que les travailleurs devraient être remplacés autant que possible, en particulier dans les transports qui constituent souvent le travail le plus lourd, par des appareils et installations mécaniques. L'emploi de travailleurs en guise de véhicules revient presque toujours plus cher que la mise en oeuvre de moyens mécaniques.

Il serait possible, sans même aller jusqu'à acquérir des machines coûteuses, d'utiliser plus efficacement l'homme dans les transports, dans l'industrie de la construction, dans la construction des routes, etc., simplement en mettant à sa disposition une brouette, véhicule dont l'usage semble, pour des raisons obscures, presque inconnu dans ces secteurs de l'industrie indienne.

L'Inde doit actuellement résoudre deux problèmes très importants, le chômage d'une part, et le manque de calories alimentaires, de l'autre. Il n'est pas du tout certain que le gaspillage en matière de main-d'oeuvre présente un intérêt quelconque, même si l'on admet la théorie selon laquelle l'industrie indienne ne doit pas être gérée suivant des principes strictement rationnels, mais doit contribuer au bien-être général de la collectivité. Il serait peut-être plus rationnel, même au point de vue du bien-être, d'employer plus efficacement les ressources humaines et les denrées alimentaires disponibles.

Ces considérations générales au sujet de l'étude des postes de travail ont pour objet de mieux faire comprendre les répercussions du travail et l'utilisation de la main-d'oeuvre aux cadres de direction et au personnel technique. Lorsqu'on passe rapidement de l'artisanat à l'industrie moderne, il ne suffit pas de conserver les postes tels qu'ils se présentent actuellement et de poser en principe général que, pour réduire le chômage, il faut mettre au travail autant d'hommes que possible. Une utilisation plus rationnelle de la main-d'oeuvre peut se traduire à la longue par une augmentation du nombre de travailleurs employés grâce à une exploitation plus rationnelle du capital et des autres ressources.

Revenons-en maintenant au problème de la classification du travail fondée sur des données physiologiques. Ainsi qu'il ressort du tableau 1, ces données ne concernent pas seulement la consommation d'oxygène et la dépense correspondante de calories par minute, mais aussi le rythme cardiaque, la température rectale et le taux de sudation.

Tableau 1

Variables physiologiques	Effort physiologique					
	Très léger	Léger	Modéré	Lourd	Très lourd	Extrêmement lourd
Consommation d'oxygène en litres par minute	0,5	0,5-1,0	1,0-1,5	1,5-2,0	2,0-2,5	> 2,5
Kilocalories par minute	2,5	2,5-5,0	5,0-7,5	7,5-10,0	10,0-12,5	>12,5
Rythme cardiaque (battements par minute)		75-100	100-125	125-150	150-175	> 175
Température rectale, °C			37,5-38,0	38,0-38,5	38,5-39,0	>39,0
Taux de sudation, ml/h, moyenne pour poste de 8 h			200-400	400-600	600-800	> 800

Tout d'abord, voyons à quoi se rapportent les termes "léger", "lourd", etc. employés pour classifier l'effort physiologique. Cette terminologie se fonde sur l'expérience, et concerne en premier lieu des données applicables aux travailleurs forestiers et aux travailleurs de l'industrie lourde en Suède. Au terme de "travailleur moyen" employé par les spécialistes de l'étude du travail, nous préférons celui de "travailleur standard", aux caractéristiques physiologiques nettement définies, qui nous servira d'"étalon".

Le "travailleur standard" est un homme âgé de 20 à 30 ans environ et ayant une capacité maximale d'oxygénation de 4 l/mn environ*.

Si nous soumettons notre "travailleur standard" à un effort "lourd" tel que défini au tableau 1, sa consommation d'oxygène se situera entre 1,5 et 2 l/mn, sa consommation de calories sera de 7,5 à 10 par minute et, dans une ambiance tempérée (10 à 20° C environ), son rythme cardiaque se situera entre 125 et 150, sa température rectale sera de l'ordre de 38° C et le taux moyen de sudation pendant un poste de 8 heures sera proche de 0,5 l/h.

En ce qui concerne l'aptitude physiologique, ce "travailleur standard" manifestera très probablement une certaine supériorité par rapport au "travailleur moyen" des spécialistes de l'étude du travail. Toutefois, ses capacités sont nettement définies et l'on dispose également des moyens nécessaires pour déterminer dans quelle mesure les possibilités de tel ou tel ouvrier diffèrent de celles du "travailleur standard".

Il pourrait sembler plus logique, au point de vue technique, d'exprimer la charge de travail en watts, en kgp.m/mn ou en fraction de CV et d'établir la classification du travail sur ces bases. Toutefois, il serait impossible dans la plupart des cas de mesurer la charge de travail physique en unités physiques, d'autant plus que le rendement mécanique dans différents emplois varie dans des proportions telles que, même s'il était possible de déterminer cette charge, l'effort physiologique correspondant n'en resterait pas moins inconnu.

La raison pour laquelle un travail exigeant une consommation d'oxygène de 0,5 à 1 litre est qualifié de "léger" est que le système d'oxygénation du travailleur standard (dont la consommation d'oxygène atteint au maximum 4 l/mn), c'est-à-dire son système cardio-respiratoire, sera relativement peu sollicité. Il disposera donc d'une très grande marge de sécurité. Lorsque le travail est "lourd", c'est-à-dire que l'effort physiologique est intensif, le système d'oxygénation du "travailleur standard" sera sollicité à près de 50 pour cent de sa capacité

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* En admettant qu'un travailleur indien en bonne condition physique (pesant 50 kg) consomme la même quantité d'oxygène, de 55 ml par kg et par minute, que le "travailleur standard" suédois (pesant 72 kg), la consommation maximale d'oxygène du premier devrait s'établir à 2,8 l/mn.

maximale. Or nous savons d'expérience qu'un travail continu à cette cadence peut conduire à une sensation subjective de fatigue et que des pauses seront souhaitables ou nécessaires. Lorsque le travail est "très lourd" ou "extrêmement lourd", des signes objectifs et mesurables de fatigue apparaîtront même chez le "travailleur standard". Bien que les besoins totaux d'oxygène soient toujours nettement inférieurs à la capacité maximale d'oxygénation, la quantité d'oxygène amenée à certains tissus, parmi lesquels figurent en premier lieu les muscles les plus sollicités, sera insuffisante. La libération d'énergie ne sera plus intégralement aérobie, c'est-à-dire liée à des phénomènes d'oxydation, car une partie de cette énergie devra être obtenue par dégradation de substances riches en énergie, se traduisant par une accumulation d'acide lactique au niveau des muscles et dans le sang. Le taux de concentration plus élevé de l'acide lactique servira d'étalon objectif pour mesurer la fatigue. Si la charge de travail atteint cette valeur élevée, il sera toujours nécessaire d'instaurer des pauses.

Si un travailleur moins "apte", c'est-à-dire un sujet dont la capacité maximale d'oxygénation est nettement inférieure à 4 l/mn, effectue un travail qualifié de "modéré" (exigeant une consommation de 1 à 1,5 l d'oxygène ou de 5 à 7,5 kcal/mn), la concentration d'acide lactique dans le sang risque d'augmenter, indiquant ainsi que cette charge de travail "modéré", eu égard aux besoins d'énergie, est subjectivement "lourde" ou même "extrêmement lourde" pour ce travailleur.

Pour en revenir au tableau 1, remarquons une fois de plus que le rythme cardiaque du "travailleur standard" exécutant un travail "lourd" se situe entre 125 et 150 et que sa température rectale atteint 38° C environ lorsqu'il travaille dans une ambiance tempérée. Il s'ensuit que notre classification du travail pourrait également se fonder sur ces deux fonctions physiologiques qui, dans ce cas précis, nous indiqueraient automatiquement que le travail est "lourd" sur le plan énergétique. Il existe un rapport direct entre la consommation d'oxygène, d'une part, et le rythme cardiaque et la température rectale, de l'autre. De ce fait, et pour autant que notre "travailleur standard" s'active dans des conditions climatiques favorables, nous pouvons déduire avec un certain degré de précision, à partir du rythme cardiaque ou de la température rectale, sa consommation d'oxygène ou la quantité de calories dépensées. Cette méthode est d'un usage courant dans les recherches qui se poursuivent actuellement dans la sylviculture et l'industrie suédoise.

Toutefois, lorsque le travail "lourd" doit être exécuté dans des conditions climatiques défavorables, le rapport entre la consommation d'oxygène ou de calories et le rythme cardiaque ou la température est complètement faussé. La consommation d'oxygène continuera de correspondre à un travail "lourd", mais le rythme cardiaque et la température atteindront les valeurs associées (voir tableau 1) à un effort "très intensif" ou même "extrêmement intensif".

Cette variation du rapport entre consommation d'oxygène et rythme cardiaque enregistrée dans des conditions climatiques défavorables s'explique par le fait que celles-ci freinent l'élimination de la chaleur et que le coeur est ainsi plus fortement sollicité. La charge "normale", qui a pour corollaire un certain rythme cardiaque, découle principalement de la fonction d'oxygénation dévolue au coeur; tout ralentissement du processus d'élimination de la chaleur se traduit par une charge supplémentaire imposée au coeur. La charge totale supportée par le système circulatoire sera donc supérieure à celle qui correspondrait à la consommation d'oxygène; la marge de sécurité de ce système se trouvant de ce fait réduite, le sujet risquera de travailler à la limite de ses possibilités bien que la dépense de calories ne se situe nullement à un niveau extrême.

La relation faussée entre la consommation de calories et la température rectale peut s'expliquer d'une manière analogue. La chaleur engendrée par le processus métabolique associé au travail "lourd" ne s'élimine plus au rythme normal et s'accumule en quantités croissantes dans l'organisme, la température rectale monte et la marge de sécurité est réduite en ce qui concerne la thermorégulation.

Ainsi, nous sommes amenés à décider si nous continuerons d'utiliser une classification fondée uniquement sur la consommation d'oxygène ou de calories par minute, ou s'il vaut mieux adopter une classification double, tenant compte en plus du rythme cardiaque et de la température rectale, pour les travaux effectués dans des conditions climatiques défavorables. C'est évidemment cette dernière solution qu'il faudra choisir, faute de quoi les mots "léger", "lourd", etc. seront en contradiction trop flagrante avec la capacité de travail réelle de notre "travailleur standard".

Cette classification double présente, pour diverses raisons, un grand intérêt pratique dans l'industrie. Admettons à titre d'exemple qu'un certain travail soit, de par le besoin de calories qu'il implique, classé comme "léger", mais que les conditions climatiques défavorables nous obligent à le reclasser dans la catégorie des travaux "lourds" ou "extrêmement lourds". Dans ce cas, nous pouvons faire appel à la classification double

pour mieux faire comprendre à la direction toutes les conséquences qui découlent des conditions de travail défavorables, conséquences qui se font sentir non seulement dans le domaine du confort, mais encore et surtout dans celui de la productivité. Un travail "lourd" ou "extrêmement lourd" doit être entrecoupé de pauses prolongées et coûteuses, alors qu'un travail "léger" peut être fait plus ou moins sans interruption.

L'utilisation du rythme cardiaque comme critère de l'effort physiologique présente divers avantages : il suffit d'un simple chronomètre pour déterminer ce rythme; l'information recherchée nous est directement accessible; il est possible de le mesurer plusieurs fois au cours d'une période de travail sans trop gêner le travailleur dans l'accomplissement de sa tâche. De plus, il existe maintenant des appareils relativement sûrs qui permettent d'enregistrer le rythme cardiaque en continu et pendant des laps de temps déterminés.

Les fluctuations soudaines de la charge de travail ne se répercutent pas immédiatement sur la température du sujet. Il faut parfois de 30 à 40 minutes avant que le nouveau "réglage" du thermostat de l'organisme se traduise par une modification de la température rectale correspondant à la charge métabolique "moyenne" engendrée au cours de la période considérée. Ce fait s'explique en partie par la chaleur spécifique relativement élevée de l'organisme humain. Dans des conditions climatiques défavorables, la température rectale risque de monter de plus en plus et des pauses devront être aménagées pour permettre au travailleur de se rafraîchir. La température rectale peut être prise pendant les pauses qui entrecoupent le poste normal, car il importe peu qu'elle soit mesurée quelques minutes après l'arrêt du travail. A défaut de température rectale, on prendra la température buccale dans les pays où la première méthode risque de susciter une opposition de la part des travailleurs.

Il existe un autre critère, le taux de sudation, qui tient également compte de l'influence exercée, pendant une période de travail prolongée, par la charge énergétique due au travail et par les conditions climatiques. Les valeurs figurant au tableau 1 ont été déterminées par N. Lundgren sur la base de ses recherches dans l'industrie et la sylviculture suédoises. Etant donné des conditions climatiques défavorables, un taux de sudation disproportionné à la consommation de calories afférente à un certain travail permet de mieux déterminer l'effort physiologique total. Pour calculer le taux de sudation avec une précision suffisante, on mesure la quantité de liquides absorbés pendant le poste et on pèse le travailleur au début et à la fin du poste; la quantité d'urine émise devrait être mesurée également.

La pesée du travailleur permet de contrôler dans quelle mesure celui-ci est capable d'adapter sa consommation en boissons à ses déperditions liquides. L'on sait que le sujet qui transpire abondamment risque de "sous-estimer" ses besoins en liquides, la sensation de soif ne dépassant pas le niveau normal, et de se déshydrater. Cette déshydratation peut atteindre un point tel qu'il n'y aurait rien d'étonnant à ce qu'elle provoque la "fatigue" du travailleur occupé dans une ambiance chaude. Il faut apprendre au travailleur à surveiller son poids pour qu'il varie le moins possible pendant toute la durée du poste. La quantité de liquides absorbés doit être augmentée dès que des pertes supérieures à 1 ou 2 pour cent sont régulièrement observées. Il incombe à la direction de mettre à la disposition des travailleurs de l'eau potable de bonne qualité. Dans certains cas, un appoint de sel est à conseiller. Une partie du sel s'élimine par la sueur et lorsque la transpiration est trop abondante (plus de 0,5 litre par heure), le sel perdu doit être remplacé pendant le travail pour éviter les "crampes de chaleur". De plus, cet appoint de sel stimule la sensation de soif et incite le sujet à absorber plus de liquides. Les travailleurs ingurgitent normalement une quantité suffisante de sel avec leurs repas, mais, comme nous l'avons signalé plus haut, il leur en faut davantage lorsqu'ils transpirent abondamment.

Les limites supérieures admissibles pour un travail soutenu dans des conditions climatiques défavorables sont parfois d'un très grand intérêt, tant pour l'employeur que pour le travailleur, lorsqu'il s'agit d'étudier certains postes. Cette question a fait l'objet en Inde d'une étude relativement récente dont les résultats sont consignés dans un ouvrage, "Thermal Stress in the Textile Industry"*, publié en 1957 par le Conseiller principal des fabriques. Ce travail de recherche fondamentale, détaillé et complet, a porté sur 15 volontaires qui ont travaillé pendant 4 heures d'affilée dans des conditions climatiques très rigoureuses et en partie insoutenables, avec une dépense d'énergie qui se situait entre 235 et 330 kcal par heure, soit de 3,92 à 5,50 kcal par minute. Ils marchaient tous à la même vitesse de 5,6 km/h et les variations assez importantes de la dépense métabolique qui ont été enregistrées étaient certainement dues à des différences de poids des sujets, qui pesaient entre 42,6 et 60,3 kg. L'énergie dépensée par le volontaire le plus lourd était supérieure de 40 pour cent à celle du sujet le moins lourd. Ces deux travailleurs accusaient une différence de poids de 41,5 pour cent. Bien qu'ils marchassent à la même vitesse, il y avait une différence allant

* "L'agression thermique dans l'industrie textile".

jusqu'à 40 pour cent entre les deux charges métaboliques. Or c'est justement l'élimination de cette charge thermique découlant du métabolisme qui est contrariée par les conditions climatiques défavorables. De ce fait, les résultats enregistrés montrent que le stress thermique associé au travail doit être rapporté non à la charge métabolique absolue, mais à la charge relative supportée par le travailleur. Il est fort probable que le travailleur le plus lourd sera également le plus "apte", celui qui, pour une dépense d'énergie déterminée, pourra supporter la charge thermique la plus élevée. Dans sa thèse qui a été récemment publiée (1960), I. Astrand aboutit à une conclusion analogue : "la température du sujet qui exerce une activité est essentiellement fonction de la dépense relative d'énergie et non de la dépense absolue "Aerobic Work Capacity in Men and Women with Special Reference to Age"*. D'autres recherches seront nécessaires pour approfondir cette importante question.

Il ressort de l'équation de la thermorégulation

$$M + S - E + C + R = 0$$

que le dégagement de chaleur provoqué par le métabolisme M doit être compensé positivement ou négativement par la chaleur accumulée dans l'organisme S, par les déperditions de chaleur dues à l'évaporation E, par la chaleur perdue ou absorbée par convection C ou par rayonnement R. Dans cette équation, M est fonction de la charge métabolique due au travail, E se rapporte à l'évaporation de la sueur à la surface du corps, qui dépend du taux de sudation et des conditions climatiques (notamment de la tension de vapeur d'eau et de la vitesse de l'air en mouvement), C et R sont naturellement déterminés par les conditions climatiques. On peut considérer que S est égal à zéro, c'est-à-dire que la température du sujet et la chaleur accumulée dans l'organisme sont constantes après une demi-heure environ de travail, et que M est compensé par E, C et R lorsque le sujet effectue un travail soutenu dans un microclimat tempéré. Dans une ambiance chaude et relativement sèche, C et R peuvent être compensés par E tandis que S ne varie pas. En admettant que C et R soient tous deux égaux à zéro, le dégagement de chaleur occasionné par le métabolisme doit être compensé uniquement par l'évaporation E. Si nous fixons arbitrairement la charge métabolique due au travail à 5 kcal/mn, soit 300 kcal/h, il faut que le sujet élimine un demi-litre de sueur par heure (un litre de sueur évaporée correspond à quelque 560 kcal) pour maintenir sa température à un chiffre constant.

* "Capacité de travail aérobie de l'homme et de la femme, compte tenu de leur âge."

Le physiologiste, le médecin du travail et le personnel technique ont recours, naturellement, à des données météorologiques pour déterminer les répercussions physiologiques du milieu de travail sur le sujet. C'est ainsi qu'ils utilisent les températures relevées avec le thermomètre sec ou mouillé, le thermomètre à réservoir noir ou le katathermomètre, les chiffres ainsi obtenus pouvant leur servir également à calculer différents indices, tels que la température effective, la température effective corrigée, etc., au moyen desquels ils définissent les diverses ambiances de travail. Toutefois, quel que soit l'intérêt de ces chiffres, une grande incertitude règne en ce qui concerne leur utilité générale dans des conditions climatiques différentes, avec des charges de travail variables et pour des travailleurs plus ou moins acclimatés dont la condition physique n'est pas la même. R.L. Lind, dans une étude critique publiée récemment (1960), donne des renseignements valables sur l'emploi de différents indices d'agression thermique dans l'étude de poste. D'autre part, le Conseil britannique de la recherche médicale a publié un rapport n° 298 très complet, intitulé "Physical Response to Hot Environments"*, dans lequel sont passés en revue tous les travaux de recherche fondamentale faits dans ce domaine à Singapour et à Londres.

L'un des indices les plus généralement admis pour la détermination de l'influence combinée de la charge métabolique due au travail et de la charge thermique découlant des conditions climatiques est celui du taux de sudation présumé pour quatre heures (Predicted Four-Hour Sweat Rate, ou P4SR). Le taux de sudation maximal admissible pour une période de travail de quatre heures s'établit à près d'un litre par heure; pour une journée de huit heures de travail, cette limite ne doit pas être atteinte.

Dans le cadre de nos recherches dans l'industrie suédoise, nous avons appliqué une méthode pratique pour nous renseigner sur la charge supplémentaire à laquelle l'ouvrier travaillant dans des conditions climatiques défavorables est exposé. Nous déterminons d'abord M, la dépense métabolique de l'ouvrier occupé à son travail courant. Ensuite, nous imposons à notre "travailleur standard", sur la bicyclette ergométrique, une charge correspondant à un "M" identique; le travail est effectué une première fois dans un climat frais servant de référence et ensuite dans le milieu de travail réel "inconnu", à l'usine ou dans la mine. Toute variation marquée du rythme cardiaque, de la température, etc. du sujet faisant son travail dans le milieu de l'usine nous fournit un renseignement important sur la charge

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* "Réaction physiologique aux ambiances chaudes".

supplémentaire imposée à l'ouvrier travaillant à un rythme normal dans ce milieu. Cette méthode relativement simple, dans laquelle le travailleur fait office d'"instrument" de mesure, nous permet de dégager les données dont nous avons besoin. Une autre raison milite en faveur de son adoption : dans certains secteurs industriels, fonderie et laminage à chaud par exemple, la charge thermique associée au milieu et due principalement à la chaleur rayonnante varie avec une telle rapidité qu'aucune des données météorologiques dont nous pouvons actuellement disposer ne saurait nous renseigner avec précision sur la charge thermique réelle. Les résultats figurant au tableau 2 ont été enregistrés dans une entreprise suédoise de laminage à chaud :

Tableau 2

Effort physique sur bicyclette ergométrique kgp.m/mn	Tempér. de l'air (thermomètre au mercure non protégé) °C	Température rectale maximale °C	Température max. moyenne de la peau °C	Rythme cardiaque max. (battements par minute)	Litres d'O_2 ou kcal par minute	Perte de poids kg	Durée totale du travail mn	Conditions de travail
600	19-20	37,8	32,8	104	1,4 (7)	0,25	45	aucune charge therm.
600	32-44	38,8	37,6	166	1,4 (7)	1,15	45	forte charge therm. due à rayonnement intense.

Des chercheurs américains ("Physiology of Heat Regulation and the Science of Clothing")* sont parvenus à établir qu'un travailleur en bonne condition physique, accoutumé au travail dans une ambiance chaude, peut éliminer environ 80 kcal par m^2 de surface du corps et par °C de différence entre la température rectale et la température moyenne de la peau. Cette constatation illustre le fait que la capacité de transport de chaleur de l'appareil circulatoire est fonction de l'ampleur du refroidissement subi par le sang lors de son passage dans les vaisseaux de la peau. En appliquant ces données aux cas pratiques

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* "Physiologie de la thermo-régulation et science de l'habillement".

cité au tableau 2, nous nous apercevons que le travailleur pourrait éliminer 380 kcal par m^2 et par heure lorsqu'il travaille dans une ambiance tempérée et que, du fait de la consommation d'oxygène par minute et du rendement du travail, la quantité de chaleur métabolique qu'il doit dissiper pour rétablir l'équilibre thermique s'établit à 160 kcal par m^2 et par heure. Il dispose en conséquence d'une bonne marge de sécurité en ce qui concerne l'élimination de la chaleur. Dans une ambiance chaude, la valeur de "M" est la même et, du fait que l'écart entre la température rectale et la température de la peau est beaucoup plus faible, le sujet ne peut éliminer qu'environ 70 kcal par m^2 et par heure et, comme "S" augmente rapidement, il est complètement épuisé après 45 minutes de travail continu. Alors qu'il faut 104 pulsations par minute pour atteindre un certain niveau de productivité dans une ambiance tempérée, 62 pulsations supplémentaires par minute sont nécessaires dans le milieu réel de travail pour assurer le transport de la chaleur en supplément. Pourtant, ce n'était pas encore suffisant pour assurer l'équilibre thermique.

Si nous admettons un chiffre modéré de 120 battements cardiaques par minute pour une journée de travail de 8 heures, il reste à décider combien de battements il faut pour la "production" et combien il serait possible d'en "gaspiller" pour neutraliser les conditions de travail défavorables.

Les températures rectale et buccale servent encore et toujours à indiquer les limites supérieures admissibles de l'"effort" thermique. L'expérience acquise dans les mines sud-africaines a démontré l'utilité de ces mesures. La limite supérieure admissible pour la température buccale (ou rectale) est de 38,3 à 38,9° C. Il existe toutefois certains inconvénients. Un sujet apte et expérimenté, qui travaille dans une ambiance fraîche et sous une charge de travail élevée peut se sentir tout à fait à son aise lorsque sa température est de 38,3 ou 38,9° C; au contraire, lorsqu'il s'active dans une ambiance chaude et humide, à un niveau métabolique beaucoup plus bas, cette même température peut se révéler très critique, en particulier s'il n'est pas acclimaté à la chaleur. La température qui revêt le plus d'importance n'est pas la rectale ou la buccale, mais la température cutanée. Dès que la température cutanée moyenne dépasse un certain niveau, ce qui signifie que l'action rafraîchissante du sang qui a passé dans les capillaires de la peau perd de son efficacité, le sujet risque d'être victime d'un coup de chaleur dans les quelques minutes qui suivent. La température moyenne de la peau est toutefois difficile à déterminer.

Rythme cardiaque de récupération. Pour évaluer l'effort physiologique, on se sert non seulement du rythme cardiaque enregistré au cours du travail ou dans les 10 secondes qui suivent l'arrêt du travail, mais encore et dans une large mesure du rythme cardiaque observé pendant la période de récupération. Cette méthode a été appliquée en particulier par le physiologiste allemand du travail E.A. Muller, de l'Institut de physiologie du travail de Dortmund. L. Brouha, de son côté, en a démontré l'utilité pour l'évaluation pratique de l'effort dû au travail dans son ouvrage "Physiologie et Industrie" récemment publié. Cette méthode se fonde essentiellement sur le fait que, pour une activité déployée dans des conditions favorables, les processus physiologiques qu'implique un travail pas trop intensif se trouvent en état d'équilibre et que, après l'arrêt du travail, il suffit de quelques minutes de récupération pour revenir à l'état de repos. Cependant, en cas de "surcharge" provoquée par un besoin excessif d'oxygène ou par l'action combinée du besoin d'oxygène et de conditions climatiques défavorables, l'équilibre est dérangé, ce qui se traduit par une longue période de récupération.

La méthode choisie par Brouha est simple. Il prend le pouls pendant trois périodes distinctes : de 30 secondes à une minute, de 1 1/2 à 2 minutes et de 2 1/2 à 3 minutes après l'arrêt du travail. Il trace d'après les résultats obtenus par ces comptages une "courbe de récupération cardiaque". Il résume ainsi ses conclusions : "L'expérience acquise (au cours des 15 dernières années) par l'étude de nombreuses opérations industrielles a montré que quand la valeur moyenne du premier pouls de récupération ne dépasse pas 110 pulsations par minute et quand la décélération entre la première et la troisième mesure est d'au moins 10 battements par minute, on n'observe pas d'accroissement de l'effort cardiovasculaire au cours de la journée de travail. Que ces réactions soient produites par le travail seul ou par l'effet combiné du travail et de l'environnement, il semble que l'effort puisse se poursuivre tout en maintenant un état physiologique stable à condition, bien entendu, que périodes de travail et pauses de repos soient convenablement organisées." (Physiologie et Industrie, p. 125).

Dans quelle mesure les données physiologiques permettent-elles d'évaluer plus objectivement le travail lorsque ni le coût métabolique de ce dernier ni les conditions climatiques ne jouent un rôle essentiel ?

Les arguments exposés et la classification du travail dont il est question plus haut n'ont parfois qu'une valeur limitée lorsqu'il s'agit du travail dans une entreprise très mécanisée. Notre classification du travail est fondée sur l'hypothèse que le poste étudié implique la mise en oeuvre

plus ou moins simultanée de groupes musculaires relativement importants tels que ceux des jambes, du torse et des bras. Toutefois, lorsque le travail est très spécialisé et que seuls de petits groupes de muscles sont sollicités, comme c'est le cas pour les travaux extrêmement répétitifs, nous pouvons qualifier ce travail, au point de vue énergétique, de "très léger" du fait qu'il n'entraîne qu'une consommation d'oxygène de 0,5 litres par minute, bien que ce travail soit néanmoins astreignant pour le travailleur par suite des efforts localisés des muscles, jointures et ligaments en cause. Nous savons que la capacité d'oxygénation de notre "travailleur standard" peut atteindre 4 litres par minute lorsque ses puissants muscles des jambes travaillent sur la bicyclette ergométrique; nous savons aussi que son rendement maximal et sa consommation maximale d'oxygène sont réduits de 40 pour cent environ lorsque les muscles des bras sont seuls à travailler. Ce maximum sera nettement plus bas encore si le travail doit être effectué uniquement par les muscles des avant-bras et des doigts. Il s'ensuit que ni le coût métabolique total du travail ni l'élimination de la chaleur ne jouent un rôle primordial dans le travail en cause. Il n'en reste pas moins que les modifications du rythme cardiaque au cours d'une journée de 8 heures de travail, ainsi que le rythme cardiaque rapporté au coût énergétique du travail peuvent cependant nous fournir des renseignements semi-quantitatifs de valeur.

Postures de travail de l'ouvrier debout ou assis. On admet généralement qu'il faut, dans toute la mesure du possible, permettre à l'ouvrier de travailler assis, la position debout ayant toujours pour effet d'imposer une charge supplémentaire à l'organisme humain. Le coût métabolique de la position debout immobile peut être d'environ 10 pour cent supérieur à celui de la position assise. Ce fait ne revêt cependant qu'une importance minime par rapport à l'augmentation de l'effort circulatoire qu'implique la position debout et la charge localisée supportée par certains petits groupes de muscles dans cette position. L'effort circulatoire supplémentaire est dû au fait que la pesanteur entraîne une augmentation du volume sanguin à un niveau inférieur à celui du coeur; la quantité de sang renvoyée au coeur est plus faible, le coeur se remplit moins complètement et doit travailler à un rythme plus rapide. Ce rythme cardiaque, plus rapide en position debout qu'en position assise, fournit certaines indications quantitatives au sujet de l'effort supplémentaire découlant de la position debout et de l'amélioration que le passage à la position assise permet de réaliser.

Travail statique - travail dynamique. Le coût métabolique de l'activité déployée à l'occasion de divers exercices consistant à marcher, à courir, à pédaler, à monter des escaliers, etc.

est à imputer presque en totalité au travail dynamique. Les muscles mis en oeuvre se contractent et se relâchent de façon rythmique. Pendant la période de contraction, le flux sanguin passant dans les muscles peut être passagèrement réduit, mais la période de relâchement qui suit s'accompagne d'une augmentation de ce flux et d'une circulation sanguine d'un volume suffisant pour évacuer l'anhydride carbonique et les autres déchets. L'équilibre interne sera maintenu à un niveau "normal" et le travail pourra se poursuivre. Le flux sanguin ne sera insuffisant et, de ce fait, l'équilibre ne sera dérangé que si la charge de travail dépasse une certaine limite. Dans le travail industriel normal, cette limite sera uniquement atteinte par notre "travailleur standard" lorsque le travail sera qualifié de "très lourd" ou d'"extrêmement lourd".

La contraction et le relâchement des muscles ne s'effectuent pas de la même manière rythmique dans le travail statique que dans le travail dynamique. Le but à atteindre dans le premier cas consiste à neutraliser la tendance manifestée par la charge à déplacer une certaine partie du corps. Si la charge est relativement légère par rapport à la force globale du groupe musculaire actif, il est possible de faire même un travail statique en continu sans pour autant déranger l'équilibre interne, du fait qu'un groupe musculaire se compose d'un grand nombre de muscles fonctionnant plus ou moins indépendamment les uns des autres. Ainsi, dans le cas d'une charge relativement légère, certains muscles seront actifs tandis que les autres resteront inactifs et pourront se reposer de leur activité précédente, la pression interne n'étant alors pas suffisante pour gêner la circulation du sang vers les muscles et au retour. Toutefois, dès que la charge totale dépasse une certaine limite, la plupart des muscles devront travailler simultanément, le flux sanguin ne sera pas suffisant par suite de la pression interne plus forte du muscle et la récupération intégrale ne pourra se faire pendant la contraction statique. L'équilibre interne sera perturbé et, selon les physiologistes du travail allemands, ce dérangement interne, ou état de "fatigue", se traduira par une accélération du rythme cardiaque, disproportionnée à la consommation d'oxygène. D'autres recherches seront nécessaires dans ce domaine.

Postures de travail inconfortables. Ces postures, souvent associées à un travail statique, peuvent également se traduire par un rythme cardiaque disproportionné au coût métabolique du travail. Il en est de même lorsque, à cause de postures de travail anormales, des groupes musculaires relativement faibles doivent déployer un effort assez intensif, comme c'est parfois le cas dans l'industrie minière où le travail se fait souvent dans des lieux resserrés et où il arrive que le mineur manie la pelle, etc. couché sur le dos.

Conditions de travail défavorables en raison d'un niveau élevé de bruit, d'un mauvais éclairage, etc. Nous ne traiterons pas en détail de ces problèmes, en dépit de leur importance certaine. Signalons simplement que ces conditions défavorables ne doivent jamais être acceptées comme étant des éléments inséparables d'un lieu de travail, quel qu'il soit, et qu'il faut faire tous les efforts nécessaires pour y remédier autant que possible. Qu'il s'agisse du niveau de bruit ou de la nature du bruit, nous disposons d'appareils de mesure qui nous permettent de les déterminer quantitativement et qualitativement et nous trouvons dans les travaux publiés certaines valeurs critiques. Il faut poser en principe que l'intensité du bruit doit être atténuée à la source même et que les travaux bruyants doivent être isolés dans toute la mesure du possible des autres lieux de travail. La protection personnelle du travailleur doit être assurée lorsque le niveau de bruit reste élevé en dépit des mesures prises. Il est certain qu'un niveau élevé de bruit est "fatigant" et qu'il affecte la sécurité du travail, puisqu'il gêne les communications. On sait aussi que les ouvriers qui travaillent dans une ambiance très bruyante se plaignent souvent de troubles non spécifiés et fréquemment sans fondement.

Les outils pneumatiques engendrent un niveau élevé de bruit et, de surcroît, exposent souvent le travailleur à des vibrations mécaniques qui risquent de provoquer une fatigue localisée et même des lésions de certains tissus. L'organisme réagit aux vibrations par des contractions involontaires des muscles qui imposent toujours un effort supplémentaire au travailleur.

En ce qui concerne l'éclairage, il existe également des instruments permettant de mesurer l'éclairement; la littérature spécialisée (par exemple le Tableau 2, à la page 63 de l'"introduction à l'étude du travail", B.I.T., 1959) nous renseigne, d'autre part, sur les niveaux d'éclairement préconisés pour différents lieux de travail. Les travailleurs âgés, en particulier, risquent d'être gravement handicapés lorsque le niveau d'éclairement est trop bas, ce qui a pour effet de leur imposer un effort supplémentaire qui pourrait être évité dans la plupart des cas. Un mauvais éclairage ne devrait jamais, ne serait-ce que du point de vue de la sécurité, être accepté comme une caractéristique normale d'un travail quelconque.

Equipements de protection individuelle. Le port d'équipements de protection individuelle, tels que les masques respiratoires, rendu nécessaire par les fumées ou les poussières auxquelles le travailleur est exposé, constitue une charge supplémentaire dont l'accélération du rythme cardiaque est un indice probant. Il en est de même lorsque le travailleur doit être entièrement protégé par des vêtements imperméables.

Echelles semi-quantitatives établies en fonction des exigences du travail. L'évaluation quantitative de la charge de travail selon les principes exposés ici constitue et constituera, on ne saurait le nier, un objectif plus ou moins utopique que la plupart des entreprises ne pourront atteindre. Il est possible, cependant, de réaliser de grands progrès avec des méthodes plus simples et dans un esprit scientifique moins rigoureux. Différentes échelles semi-quantitatives ont été élaborées, auxquelles le médecin du travail et le chef du personnel peuvent se référer pour choisir les travailleurs qu'ils affecteront à différents postes.

C'est ainsi que N. Lundgren propose d'adopter une échelle à trois degrés adaptée aux différentes exigences des postes étudiés. Le premier degré se rapporte à un travail peu intensif, le second à un travail modéré et le troisième à un travail intensif. Aux termes de cette classification de Lundgren, un travailleur expérimenté et en bonne santé, ayant reçu une formation professionnelle et âgé de soixante ans environ devrait être capable de satisfaire aux exigences du deuxième degré; cela revient à dire, en fait, qu'il ne sera pas nécessaire de remplacer, pour des raisons d'âge, un travailleur affecté à un poste conforme à ses possibilités.

Cette classification tient compte des facteurs suivants : Force musculaire, endurance physique, sollicitations auxquelles sont exposés le dos, les jambes, les pieds, les mains et les doigts; charge thermique, froid, courants d'air et humidité, notamment dans les travaux à l'air libre ou dans les mines; critères de vision, niveau de bruit, poussières, fumées et gaz, vibrations, exposition de la peau à des substances irritantes. Si le travail s'effectue par équipes alternantes, il en sera tenu compte. Les risques pour les yeux et les oreilles, ainsi que les risques de chute en cas de travail à une certaine hauteur seront également pris en considération. Enfin, il faudra préciser si le rythme de travail est "libre" ou réglé par la cadence d'une machine.

Le chef du personnel ou le médecin du travail utilisera une échelle à trois degrés d'un type analogue pour juger des aptitudes des candidats à certains postes ou de celles d'ouvriers qui doivent être mutés à un autre poste dans une même entreprise.

On peut affirmer, sans craindre de se tromper, que même une méthode aussi simple s'est révélée utile lorsqu'il s'agit d'affecter le travailleur à un poste qui lui convient. Toutefois, et c'est là l'un des postulats les plus importants, il faut que le chef du personnel et le médecin du travail soient parfaitement familiarisés avec les divers aspects du travail.

IV. EVALUATION DE L'APTITUDE PHYSIQUE

Il devrait être possible, en théorie du moins, lorsqu'on a procédé à une évaluation quantitative approfondie des différents postes, de sélectionner des travailleurs particulièrement adaptés à ces postes et d'écarter ceux qui ne le sont pas. Cette méthode de présélection devrait avoir pour résultat idéal la constitution d'un groupe relativement uniforme de travailleurs effectuant le même travail. Ainsi, le terme de statistique "travailleur moyen" employé pour le spécialiste de l'étude du travail aurait un sens très précis, et d'autres termes tels que "charge de travail modérée", "effort modéré", "pauses" et "fatigue" auraient la même signification tant pour le spécialiste de l'étude du travail que pour le physiologiste du travail ou le médecin du travail. Il est possible que ce but ne soit jamais atteint entièrement, mais une méthode de présélection minutieuse et rationnelle permettrait fort probablement de réduire les divergences qui existent actuellement entre ces spécialistes, dont les uns s'intéressent principalement à des chiffres moyens tandis que les autres se préoccupent de la santé et du bien-être du travailleur.

J'aimerais, une fois de plus, attirer l'attention sur une affirmation de ce physiologiste du travail et médecin du travail très expérimenté qu'est L. Brouha :

"Quand ceux qui ne sont pas physiquement aptes à un certain travail sont éliminés, ceux qui restent ont un bon rendement pour un coût physiologique minimum. Il arrive fréquemment que l'élimination des moins aptes a une influence heureuse sur le moral des autres; il faut réaliser qu'un individu qui se fatigue en faisant son métier blâme le travail plutôt que son manque d'aptitude et peut influencer l'attitude de ses compagnons par ses récriminations. Aussi bien du point de vue de l'ouvrier que de celui de l'employeur, il importe de sélectionner les individus de telle sorte qu'ils puissent accomplir leur tâche quotidienne sans devoir fournir un effort physiologique disproportionné."

Si nous admettons, avec L. Brouha, que l'ouvrier physiquemment inapte est celui qui accuse un coût physiologique trop grand pour le travail effectué, il nous faut préciser le sens de ce coût physiologique. Cela signifie, à notre avis, que cet ouvrier doit faire appel à un pourcentage trop élevé de ses capacités pour satisfaire aux exigences du travail.

Il s'ensuit non pas que le travailleur peu apte devra nécessairement dépenser plus d'énergie que l'ouvrier apte pour faire le même travail, mais qu'il sera plus près de la limite supérieure de sa capacité et qu'il disposera d'une marge de sécurité réduite par rapport à celle du sujet plus apte.

"Aptitude" est un mot aussi ambigu que "fatigue" et il nous faudra préciser, dans chaque cas, à quel type d'aptitude nous nous référons. Cela ne manque pas de soulever certaines difficultés lorsqu'il s'agit de choisir des travailleurs aptes à certains travaux et d'écarter les inaptes. Nous disposons cependant de méthodes relativement simples et précises qui nous permettent de choisir les travailleurs pour des postes impliquant une dépense énergétique relativement élevée où ils devront effectuer un travail qualifié plus haut de "modéré", "lourd" ou "extrêmement lourd", ou encore pour sélectionner des travailleurs aptes au travail musculaire dans les conditions défavorables d'un climat chaud et humide.

Cette "aptitude physiologique" se confond avec la "capacité maximale d'oxygénation". Pour évaluer l'"aptitude physique" du travailleur, nous vérifions en fait dans quelle mesure son système pulmonaire et circulatoire est capable d'alimenter en oxygène les muscles actifs. Au sens de cette définition, il sera d'autant plus apte que la quantité d'oxygène amenée par minute à ses muscles sera plus grande. Un travailleur dont la capacité maximale d'oxygénation s'établit à 4 litres par minute sera physiquement plus apte que celui dont la capacité n'est que de 3 litres par minute. Toutefois, il faut faire preuve de discernement dans l'application de notre définition. L'"aptitude physique" sera naturellement différente selon qu'il s'agit d'hommes, de femmes ou d'enfants n'ayant pas du tout la même corpulence, car la petite "machine" a évidemment un rendement maximal plus faible. De ce fait, nous ne pouvons nous contenter de dire que l'aptitude est uniquement fonction de la consommation maximale d'oxygène par minute; il nous faut également tenir compte du poids du sujet. Nous calculerons la consommation maximale d'oxygène par minute et par kg. de poids du sujet. En effet, pour un sujet qui porte son propre poids, qui marche ou court, par exemple, le facteur déterminant de l'aptitude n'est peut-être pas tant la consommation totale d'oxygène par minute que la consommation par kg. de sujet.

Toutefois, dans la sélection des travailleurs pour des emplois industriels ou forestiers, impliquant une forte dépense énergétique, comme c'est le cas pour les travaux "lourds" ou "extrêmement lourds", c'est bien la consommation totale possible

d'oxygène par minute ou la dépense énergétique maximale possible par minute qui constituera le facteur décisif. Même si la consommation possible par kg de sujet est très élevée, le travailleur ne sera pas pour autant apte si son poids total est faible : la "machine" qu'il représente n'est pas assez puissante pour ce type de travail.

Nous pouvons déterminer la consommation maximale d'oxygène par minute en laboratoire. La méthode est compliquée et exige beaucoup de temps, aussi, ne saurait-on recommander d'en normaliser l'usage pour la sélection et l'affectation des travailleurs aux divers emplois industriels. Dans ce dernier cas, il faut avoir recours à des méthodes plus simples, mais d'une précision suffisante, qui ont essentiellement pour objet de soumettre le candidat à une charge de travail mesurable et d'enregistrer ses réactions physiologiques. Pour reprendre la terminologie de Brouha, disons que l'essai entraînera pour le travailleur inapte, "un effort physiologique disproportionné" par rapport à un ouvrier plus apte.

Différents tests d'effort sont utilisés par les chercheurs dans le cadre de leur méthode. La plus simple est celle du "test de l'escabeau" dans lequel le sujet monte sur un escabeau d'une certaine hauteur et en descend un certain nombre de fois par minute. Il soulève son propre poids d'une hauteur déterminée, ses réactions physiologiques étant notées. Une autre méthode, très employée dans différents laboratoires et en particulier aux Etats-Unis, consiste à faire marcher ou courir le sujet à une vitesse donnée sur un tapis roulant ayant une inclinaison déterminée; là encore, le sujet soulève son propre poids sur une certaine distance. Il est évident que, dans les deux cas, la charge d'épreuve ne sera pas constante, mais qu'elle <u>variera en fonction du poids</u> des sujets.

En Europe, et plus particulièrement en Allemagne et dans les pays scandinaves, l'appareil le plus utilisé est la bicyclette ergométrique. Il en existe différents modèles qui remplissent tous, en principe, une fonction identique consistant à imposer un effort physique connu au sujet. L'un des principaux avantage de la bicyclette ergométrique réside dans le fait que l'effort physique peut être exprimé en unités physiques (kgp.m par minute). Le rendement du travail ne varie que légèrement d'un sujet à l'autre. Le sujet est assis, et facilement accessible lorsqu'on veut effectuer certaines mesures ou prélever un échantillon de sang en cours d'exercice. En outre, <u>la charge de travail imposée ne dépend pas du poids du sujet</u>. Pour diverses raisons pratiques (étalonnage facile), une bicyclette ergométrique

permettant de mesurer directement par pesage la force de freinage présente des avantages certains. Il en va de même pour le cycle ergométrique qui fonctionne sans alimentation extérieure en énergie électrique. D'autre part, la bicyclette ergométrique destinée à être utilisée dans l'industrie doit être légère et facile à transporter d'un endroit à un autre. Il en existe divers modèles et en particulier la bicyclette ergométrique suédoise, conçue par von Döbeln.

<u>La réaction physiologique à la charge d'épreuve qui s'est révélée la plus utile est la modification du rythme cardiaque</u>. Comme nous l'avons signalé plus haut, il existe une relation linéaire entre la consommation d'oxygène et le rythme cardiaque. Il y a aussi, du fait que le rendement du sujet qui pédale est relativement constant à des allures très variables et pour différentes charges, une relation linéaire entre l'effort exprimé en kgp.m par minute, d'une part, et le rythme cardiaque, de l'autre. L'accélération du rythme cardiaque accompagnant une certaine augmentation de l'effort est moins rapide chez le travailleur apte que chez l'inapte. Le "Leistungspulsindex" utilisé par Müller et d'autres physiologistes allemands du travail pour caractériser l'aptitude des travailleurs, est fondé sur cette constatation.

On peut faire appel au même principe en soumettant le candidat à une charge de travail normalisée, par exemple de 600 kgp.m par minute, et en comparant son rythme cardiaque à celui de notre "travailleur standard" supportant la même charge. La raison essentielle de la légère accélération du rythme cardiaque observée chez le travailleur apte pour une augmentation déterminée de la charge est qu'à chaque contraction de son coeur volumineux et puissant correspond une oxygénation comparativement élevée, que nous pouvons qualifier d'"oxygénation par pulsation élevée". L'oxygénation maximale par pulsation de l'ouvrier inapte peut s'établir à 10 ml au travail, alors que celle de l'athlète en excellente condition physique peut atteindre 25 ml ou même davantage. Il s'ensuit que le nombre des battements nécessaires pour un même travail est moins grand chez le travailleur apte que chez l'inapte.

Cette réaction du rythme cardiaque à une charge de travail sous-maximale peut servir non seulement à établir une comparaison entre différents travailleurs, mais encore à prévoir la capacité maximale d'oxygénation du sujet.

Cette méthode prévisionnelle est fondée en principe sur la constatation que des sujets jeunes et en bonne santé, âgés de 20 à 30 ans, ont en général un rythme cardiaque maximal proche de 200 par minute lorsqu'ils déploient un effort qu'ils peuvent "supporter" pendant 4 à 6 minutes avant épuisement total. Chez un sujet (moyennement apte) ce maximum sera atteint lorsque la charge de travail sera de 900 kgp.m par minute, alors que chez un autre (très apte) la charge de travail critique peut être de 1 800 kgp.m par minute. On s'est également aperçu qu'en imposant à ces deux sujets une charge égale à 50 pour cent de leur charge maximale respectives, leur rythme cardiaque est proche de 130 par minute. I. et P.O. Astrand, s'appuyant sur des constatations analogues, ont élaboré un abaque permettant de prévoir la consommation maximale d'oxygène en partant de résultats de tests sur le travail sous-maximal. Lorsqu'on applique cette méthode à des sujets âgés de plus de 30 ans, il faut introduire un correctif, variant avec l'âge, cité également par Astrand dans sa brochure, du fait que le rythme cardiaque maximal baisse avec l'âge. Cela entraîne également des répercussions pratiques lorsque le rythme cardiaque sert d'étalon de la charge relative à laquelle l'ouvrier est soumis à l'occasion de son travail quotidien dans l'industrie. Ainsi qu'il a été dit plus haut, un rythme cardiaque de 130 par minute indique que le travailleur jeune supporte une charge proche de 50 pour cent de sa capacité maximale. Il ressort des recherches de I. Astrand, portant sur 66 travailleurs du sexe masculin âgés de 50 à 59 ans, que leur rythme cardiaque moyen est proche de 100 par minute lorsque la charge s'établit à 50 pour cent du maximum. L'extrait de l'article consacré par I. Astrand à la capacité maximale d'oxygénation et l'âge, reproduit ci-après, renseignera le lecteur sur l'état actuel de nos connaissances en cette matière.

"Cette étude a permis d'établir que la capacité maximale d'oxygénation diminue à mesure que le sujet avance en âge. En ce qui concerne les sujets de sexe féminin, la capacité maximale d'oxygénation a baissé de 17 pour cent (28 pour cent lorsqu'on la rapporte au kg de poids du sujet), tombant de 2,23 à 1,85 l/mn pour un âge échelonné de 25 à 55 ans. Dans le cas de sujets de sexe masculin âgés de 25 à 50 ans environ, elle a baissé de 26 pour cent (21 pour cent lorsqu'elle est rapportée au kg de sujet), passant de 3,01 à 2,23 l/mn. La baisse est de 30 pour cent entre 35 et 63 ans environ (de 3,42 à 2,25 l/mn) (20 pour cent lorsqu'elle est rapportée au kg de sujet). Divers auteurs ont signalé des modifications analogues pour d'autres fonctions biologiques. C'est ainsi que la force musculaire développée par le biceps baisse de

32 pour cent environ entre 25 et 55 ans, et celle des muscles dorsaux de 28 pour cent environ (Ufland, 1933). Pour ce qui est de la fonction pulmonaire, signalons que la capacité vitale, le volume expiratoire maximum-seconde et la capacité de diffusion diminuent, tandis que le volume d'air résiduel augmente. Cowdry (1952) a étudié en détail les modifications fonctionnelles des divers organes. En ce qui concerne le vieillissement et les fonctions psychiques, le lecteur pourra se reporter utilement à Welford (1958).

En règle générale, lorsqu'on compare les moyennes de différents groupes d'âge, on observe que la capacité fonctionnelle des divers organes diminue avec l'âge, l'écart normal entre les valeurs notées étant généralement plus grand dans le groupe le plus âgé que dans l'autre. Nombreux sont les sujets âgés dont la capacité ne le cède en rien à celle d'un sujet moyen plus jeune. Nous en avons plusieurs exemples dans ces groupes. C'est ainsi qu'une femme de 57 ans avait une consommation maximale d'oxygène de 2,33 l/mn et s'est ainsi classée cinquième sur 44 femmes âgées de 20 à 65 ans. La question est de savoir si le groupe le plus âgé ne se composerait pas pour partie de sujets ayant vieilli relativement plus vite et pour partie de sujets ayant relativement peu vieilli, ou encore dans quelle mesure l'âge chronologique et l'âge psychologique correspondent. Tant que cette question n'aura pas été éclaircie, il faudra être très circonspect dans l'interprétation des valeurs moyennes obtenues. Il importe au premier chef de contrôler la capacité du sujet lorsqu'on sélectionne des travailleurs pour certains postes ou des postes pour certains travailleurs."

Il convient de faire ressortir que l'aptitude physique n'est pas un état statique et qu'elle varie non seulement avec l'âge mais dépend également de l'état général de santé du travailleur. Une légère infection de la gorge ou un vulgaire rhume suffit parfois pour porter atteinte à l'aptitude physique, atteinte qui se manifeste par une accélération du rythme cardiaque pour une charge de travail normalisé. Le travailleur risque aussi de perdre son aptitude s'il n'exerce aucune activité physique pendant un certain temps. Des expériences ont permis de démontrer que l'aptitude physique de sujets jeunes et en bonne santé se détériore rapidement, malgré leur bon état de santé, lorsqu'ils sont obligés de rester couchés pendant plusieurs semaines; il leur faut, après ce repos forcé, prendre de l'exercice pendant plusieurs semaines avant de

recouvrer leur niveau normal d'aptitude. Il ne faut pas ouvrier non plus qu'un ouvrier effectuant un travail "léger" s'adaptera de lui-même à un bas niveau d'aptitude physique s'il n'exerce pas une activité physique plus grande pendant ses loisirs. Un travailleur jeune et en bonne santé, mais physiquement inapte, affecté à un emploi exigeant une dépense énergétique relativement élevée, peut s'adapter graduellement à son nouveau travail. Toutefois, la prudence s'impose en cette matière et le chef du personnel doit savoir que toute mutation d'un travail "léger" à un travail "lourd" doit être obligatoirement précédée d'une période de formation et qu'elle exige un effort supplémentaire de la part du travailleur. Il faut s'entourer de grandes précautions pour muter un ouvrier d'un travail léger à un travail lourd surtout si le travailleur a un certain âge ou si son état physique n'est pas tout à fait satisfaisant, sinon sa santé risquerait d'en pâtir.

Dans le cas de femmes devant faire un travail physique, il faut tenir compte du fait qu'elles constituent des "machines" plus petites. Selon les conclusions de P.O. Astrand, des femmes jeunes, en bonne santé et physiquement bien entraînées ont, dans l'ensemble, une capacité d'oxygénation égale à 70 pour cent de celle de sujets du sexe masculin. Cela s'explique, d'une part, parce qu'elles sont moins corpulentes et, d'autre part, par le fait que le corps féminin contient une proportion plus grande de tissus lipidiques. Toutefois, à corpulence égale et compte tenu du "poids corporel sans lipides" (au lieu du poids corporel total) la comparaison révèle, ainsi que von Döbeln l'a noté, que la capacité maximale d'oxygénation de la femme n'est inférieure que de 5 pour cent à celle de l'homme.

En Inde, l'Européen est stupéfait de voir combien souvent les femmes sont occupées à des travaux physiques lourds alors que des hommes robustes et en bonne santé font un travail léger, lequel serait certainement confié à des femmes dans les pays occidentaux, alors que les hommes seraient chargés du travail lourd.

Toujours selon les conclusions de P.O. Astrand, il existe une corrélation étroite entre la capacité de travail d'hommes jeunes et en bonne santé et leur poids corporel. La proportion de graisse représentait en moyenne 10 pour cent du poids corporel des volontaires de sexe masculin qui se sont prêtés aux épreuves entreprises dans le cadre de ces recherches, alors que cette proportion était de 20 pour cent chez les sujets de sexe féminin.

Le poids total des muscles est un élément important qu'il nous faut déterminer lorsque nous étudions les fondements physiologiques de l'aptitude physique. Nos muscles sont toujours sollicités lorsque nous faisons un travail physique et il est certain que le poids total des muscles constitue un élément important de l'aptitude physique. Des méthodes permettant de déterminer le poids total des muscles ont été mises au point très récemment. Elles sont fondées sur le fait que la plus forte proportion de potassium contenu dans le corps se trouve dans les muscles; la teneur totale en potassium peut être évaluée maintenant au moyen du "compteur de charge corporelle radioactive du sujet".

Ces mesures présenteraient certainement un grand intérêt pour comparer des travailleurs bien nourris à des ouvriers sous-alimentés. Il existe un "compteur de la charge corporelle radioactive du sujet" dans la région de Bombay et l'on espère qu'il sera possible de s'attaquer, dans quelque temps, à ce problème. Les résultats auront au moins une grande valeur théorique et peut-être même des applications pratiques lorsqu'il faudra évaluer l'importance d'une alimentation appropriée pour les travailleurs.

Il est possible que, pour la plupart des entreprises, l'évaluation quantitative de tous les travailleurs lors des examens d'embauchage ou en cas de transfert d'un travail léger à un travail lourd, ou encore avant la reprise du travail après un congé de maladie, constitue un objectif idéal aussi difficile à atteindre que l'évaluation quantitative du travail est elle-même difficile à exécuter. Un chef du personnel familiarisé avec les problèmes qui se posent, dont certains ont été évoqués dans ce chapitre, peut contribuer pour beaucoup à nous rapprocher de ce but. Pour autant que les capacités du candidat puissent être évaluées en fonction de l'échelle à trois degrés préconisée par Lundgren (voir "Etudes de postes") et que son "aptitude" à divers égards soit rapportée aux critères de travail afférents à ces trois degrés, de grands progrès pourront être réalisés dans l'affectation des travailleurs aux postes qui leur conviennent le mieux. Cela permettra d'éviter de placer les travailleurs dans des emplois auxquels ils ne sont pas aptes par suite de l'effort physiologique disproportionné que ces emplois exigent.

On ne saurait surestimer l'importance du rôle dévolu au médecin du travail, à condition qu'il s'intéresse à ces problèmes et soit familiarisé avec eux. Dépassant le rôle du "médecin" au sens ordinaire du mot, il peut contribuer puissamment à améliorer le rendement et la productivité de l'entreprise à laquelle il est attaché.

Je terminerai ce chapitre en citant le dernier paragraphe de "Physiologie et industrie" (p. 177), dans lequel Brouha déclare : "Ni patience, ni temps, ni argent ne doivent être économisés pour établir sur des bases solides la sélection, le placement et l'entraînement des travailleurs, aussi bien normaux que physiquement handicapés. Dans tous les cas, le but est d'atteindre une productivité élevée pour un coût physiologique minimum."

V. FATIGUE

Tous les physiologistes qui s'intéressent aux problèmes de la fatigue physique, de même que les psychologues préoccupés par les problèmes de fatigue mentale, savent que le mot fatigue est très ambigu et combien il est difficile de mesurer cette fatigue.

En règle générale, il faudrait renoncer à tous les tests de fatigue qui tiennent compte de la motivation du sujet ou du travailleur. En effet, une motivation puissante ainsi que l'absence de toute motivation sont susceptibles d'enlever toute leur valeur à ces tests.

Nous pouvons cependant définir la fatigue physique comme étant un état d'équilibre interne perturbé par l'effort, ce qui nous permet d'évaluer au moins semi-quantitativement la fatigue physique. En conséquence, nous nous attacherons à déterminer certaines fonctions physiologiques pouvant être mesurées et comparées dans trois états différents :

1. à l'état de repos;

2. à l'état d'activité;

3. à l'état de récupération.

A cet effet, nous pouvons retenir par exemple les fonctions suivantes : rythme cardiaque, pression sanguine, rythme respiratoire, ventilation pulmonaire, consommation d'oxygène, température corporelle, température de la peau, taux de glycémie, taux de concentration de l'acide lactique dans le sang, teneur du sang en oxygène, volume du sang, rapport volume du plasma - volume du sang total, taux de concentration des protéines dans le plasma; nous pouvons même avoir recours à une donnée simple telle que le poids du sujet.

La plupart de ces fonctions présentent des différences, le fait est connu, selon que le sujet est au repos, en activité ou en période de récupération. Toutefois, et dans la plupart des cas, cela ne signifie pas qu'il ressent de la fatigue. N'oublions pas que l'organisme humain qui passe du repos à l'activité s'adapte à cette situation nouvelle et à ses exigences. Dès que la période d'adaptation est terminée, l'état de repos et son

équilibre spécifique sont remplacés par l'état d'activité et son équilibre propre. Le travailleur se trouvera dans un nouvel "état stable" où le besoin et l'approvisionnement s'équilibreront, mais à un niveau différent de celui de l'état de repos. De même, l'arrêt du travail est suivi d'une période de récupération qui se termine lorsque l'état de repos est atteint. La récupération peut se ramener, en fait, à une certaine "inertie" dans les modifications des fonctions organiques qui déterminent l'adaptation au travail.

Toutefois, il faut bien comprendre que ni l'état de repos, ni l'état d'activité équilibrée ne constituent à tous les points de vue un "état stable" intégral, car il se produit invariablement une dépense d'énergie et des pertes de liquides aussi bien au repos qu'au travail. L'organisme est néanmoins en mesure de subvenir à certains besoins, dépense énergétique et perte de liquide, sans que l'état normal d'équilibre soit troublé. Lorsque la dépense énergétique est trop grande et que les pertes d'énergie et de liquide ne sont pas compensées suffisamment entre les postes ou lors des pauses, le travailleur en subit le contre coup assez rapidement et nous avons alors ce qu'il est convenu d'appeler un état de fatigue chronique.

Un rythme cardiaque relativement élevé n'est pas nécessairement un indice de fatigue; au contraire, une accélération croissante de ce rythme alors que le rendement reste constant, ou un ralentissement très peu marqué du rythme pendant la période des récupérations, sont bel et bien des indices de fatigue. Il en est de même lorsque, pour un travail donné, le rythme cardiaque est nettement plus élevé vers la fin du poste que pendant les premières heures de travail. Nous pouvons utiliser une fois de plus la bicyclette ergométrique pour nous assurer que les écarts enregistrés pendant le poste ne sont pas le résultat de variation du rendement réel. Pour cela, on impose au travailleur un effort normalisé au début et vers la fin du poste et on mesure ses réactions. L'expérience acquise dans l'industrie suédoise avec ce type de test montre que le rythme cardiaque ne s'accélère nettement que lorsque le travailleur est vraiment fatigué, ce qui ne saurait être considéré comme le résultat normal d'une journée de travail. Nous pouvons également conclur à la fatigue lorsque le rythme cardiaque de récupération s'accélère après un certain nombre de cycles de travail au cours de la journée de travail.

Une accélération marquée du rythme cardiaque lorsque le sujet passe de la position horizontale à la verticale est souvent un signe de fatigue, notamment lorsqu'il travaille dans une ambiance chaude et humide et que les pertes de liquide ne sont pas suffisamment compensées.

L'augmentation du rythme respiratoire ou de la ventilation pulmonaire pour un rendement constant, ou celle de la consommation d'oxygène pour un rythme de travail constant, sont des indices de fatigue.

Rares sont les modifications importantes de la pression sanguine au cours de périodes prolongées de travail; lorsqu'elles se produisent et surtout si la tension artérielle baisse brusquement, cela veut signifier que le sujet est surchargé.

Une élévation de la température corporelle disproportionnée au coût métabolique du travail décèle une perturbation de la thermorégulation et, en conséquence, un état de fatigue. Une élévation de la température de la peau peut présenter un caractère de gravité encore plus accentué.

Le taux de glycémie se maintient généralement à près de 100 mg pour cent et ne varie que dans d'étroites limites. Une augmentation marquée de ce taux, sauf lorsqu'elle se produit à la suite d'un repas riche en hydrates de carbone, indique que l'équilibre est perturbé par suite d'une surexcitation de la sécrétion hormonale; sa diminution au cours d'un travail prolongé dénote une insuffisance des réserves d'hydrates de carbone accompagnée d'une sensation suggestive de fatigue et de lassitude. Cet état de fatigue peut être combattu par des collations prises entre les heures normales de repas ou même par des pauses café ou thé. Le petit déjeuner du travailleur mérite d'être particulièrement surveillé; en effet, il faut qu'il prenne un petit déjeuner suffisamment copieux avant de se rendre au travail. Signalons qu'à la suite d'un repas très riche en hydrates de carbone faciles à digérer et très pauvre en protéines, il est possible qu'on observe un faible taux de glycémie deux ou trois heures après le repas. Ce taux est élevé pendant l'heure qui suit le repas, ce qui active la production d'insuline; le sucre est rapidement éliminé du sang et accumulé sous forme insoluble dans le foie et dans les muscles. En cas d'augmentation simultanée de la consommation d'hydrates de carbone, due au travail, il peut s'ensuivre une hypoglycémie (diminution de la concentration de sucre dans le sang) aboutissant à un état de fatigue. Les "pauses café" peuvent être utiles pour rétablir la glycémie au taux normal.

La concentration d'acide lactique dans le sang est normalement proche de 10 mg pour cent au repos et en période d'activité. Une nette augmentation de cette concentration indique toujours une fatigue musculaire localisée ou générale. Son augmentation s'accompagne d'une diminution correspondante de la teneur en CO_2 du sang.

D'autres modifications telles qu'une diminution du volume du sang total ou du volume du plasma, ou encore une augmentation du taux de concentration de protéines au cours d'un travail prolongé, sont des indices sérieux d'une perturbation de l'équilibre hydrique (déshydratation) et donc de fatigue. Ces modifications sont plus ou moins associées à des variations du poids du sujet. Il convient de toujours prévenir les modifications importantes de ce poids au cours de la période de travail.

La première mesure à prendre pour lutter contre la fatigue dans l'industrie ne devrait pas consister à réduire la dépense énergétique en ralentissant le rythme de travail ou en aménageant des pauses plus longues et plus nombreuses, mais à mieux sélectionner les travailleurs pour les différents postes et à éliminer les conditions de travail défavorables. Les habitudes du travailleur en matière d'alimentation et de boisson devraient être mieux surveillées. En outre, il faudrait supprimer, grâce à une mécanisation plus poussée, les efforts de pointe et les difficultés qu'ils soulèvent. C'est seulement après avoir examiné toutes les possibilités qu'il faut se résoudre à baisser le rendement et à augmenter les temps de repos, car c'est toujours la solution la plus coûteuse et souvent aussi la plus difficile à appliquer rationnellement pour qu'en bénéficie le travailleur qui a le plus besoin d'un changement.

Les pauses constituent cependant un des points essentiels de toute étude consacrée à la fatigue dans l'industrie et nous traiterons, dans le chapitre suivant, de certains aspects physiologiques de cette question.

VI. PAUSES ET REPOS INTERCALAIRES

L'une des nombreuses questions difficiles qui se posent dans l'analyse de la charge de travail et la capacité de travail dans l'industrie est la suivante : "Qu'est-ce qu'une charge de travail acceptable et une charge de travail inacceptable ?" Même après avoir soigneusement sélectionné les travailleurs pour les différents postes, et bien que connaissant suffisamment bien les exigences physiologiques de ces postes, il nous est impossible de définir avec certitude une charge acceptable de travail pour une journée de huit heures, une semaine ou une année.

Le professeur G. Lehmann, spécialiste allemand qui a une très grande expérience de la physiologie du travail, estime que la limite supérieure admissible pour la dépense d'énergie s'établit à 4.800 kcal par 24 heures. En conséquence, la limite supérieure pour un travail soutenu serait d'environ 250 kcal par heure de "travail", soit près de 4 kcal par minute de "travail" (plus une kcal pour le métabolisme de repos).

L'un des collaborateurs de Lehmann, Spitzer, s'est fondé sur ces chiffres pour élaborer une formule qui permet de calculer les pauses de repos pour des ouvriers effectuant un travail à forte dépense énergétique :

$$\text{Pauses pour cent} = \left(\frac{\text{kcal par minute}}{4} - 1\right) \times 100$$

Si l'on admet une moyenne de 6 kcal de "travail" par minute, la pause correspondra à 50 pour cent, et à 100 pour cent pour 8 kcal. Dans ce dernier cas, une heure de travail sera divisée en deux parts égales, une demi-heure de travail et une demi-heure de repos.

Les chiffres de Lehmann ont été établis sur la base d'enquêtes sur l'alimentation de sujets effectuant un travail à forte dépense énergétique; ce sont des chiffres moyens. Or, ainsi qu'il ressort de tout notre exposé, c'est avec la plus grande circonspection qu'il faut accueillir les chiffres moyens lorsqu'il s'agit de la santé et du bien-être du travailleur. En se fiant à ces chiffres moyens, il se peut que le travailleur peu apte et dont la dépense de calories ne doit pas dépasser un niveau assez bas ne soit pas convenablement prémuni contre le surmenage, alors que le travailleur apte dont la capacité physique dépasse la moyenne risque d'être freiné et de ne pas pouvoir faire le travail qu'il pourrait effectuer sans surmenage.

Lundgren, dans son étude très complète intitulée "The Physiological Effects of Time Schedule Work on Lumber-Workers"*, a observé presque journellement, pendant une période allant de 9 à 14,5 mois, 5 ouvriers expérimentés âgés de 26, 28, 40, 41 et 55 ans. Malgré une dépense énergétique extrêmement élevée, aucun indice de fatigue chronique ou de diminution de la capacité de travail n'a été décelé. Des enquêtes sur l'alimentation de groupes comparables de travailleurs suédois ont révélé qu'à la "saison claire", pendant laquelle ils travaillent effectivement sept heures environ par jour, la dépense totale de calories atteignait jusqu'à 5.900 kcal par jour alors qu'elle n'était que de 4.500 kcal durant la "saison sombre" avec sa durée de travail réduite. La dépense énergique totale afférante au travail effectif était proche, en moyenne, de 10 kcal par minute pour la plupart des opérations. Ces chiffres et ceux qui ont été établis plus récemment en Suède ne corroborent pas le temps de pause calculée par Spitzer sur la base des chiffres moyens cités par Lehmann pour la consommation d'aliments. A l'époque où Lundgren a fait sa première étude, l'examen d'embauchage n'existait pas encore. Les travailleurs étaient recrutés sur place et il se produisait indubitablement une sélection naturelle, car ceux qui faisaient preuve d'une certaine aptitude physique (correspondant à environ 4 litres d'oxygène par minute) étaient capables de faire le travail et d'en retirer un salaire convenable, calculé aux pièces.

Nous fondant sur l'expérience, acquise principalement dans les exploitations forestières par N. Lundgren et au laboratoire par P.O. Astrand, nous partirons de l'hypothèse que la <u>limite supérieure acceptable pour un travail soutenu correspond à 50 pour cent au maximum de la capacité maximale d'oxygénation du travailleur</u>. Pour une capacité maximale d'oxygénation de 4 litres par minute (ou 20 kcal), il ne devrait pas effectuer un travail soutenu exigeant plus de deux litres d'oxygène par minute, ou 10 kcal par minute.

I. Astrand, travaillant à sa thèse intitulée "Aerobic Work Capacity in Men and Women with special reference to Age", a récemment vérifié le bien-fondé de l'hypothèse de la "limite de 50 pour cent" pour un travail continu d'une durée d'une heure. Son étude a porté sur 18 volontaires du sexe féminin, âgés de 40 à 65 ans, qui devaient marcher pendant une heure et

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* "Effets physiologiques du travail chronométré sur les bûcherons."

à une vitesse de 5 km/h sur un tapis roulant horizontal. Diverses fonctions importantes ont été évaluées pendant cet exercice entre la cinquième et la douzième minute et, de nouveau, entre la 50me et la 60me minute. La consommation d'oxygène, le rythme cardiaque et la ventilation pulmonaire n'ont pour ainsi dire pas varié pendant toute la durée de l'exercice (une heure) et la concentration de l'acide lactique dans le sang n'a pas dépassé les valeurs normales au repos. <u>Il en ressort que la marge de sécurité n'est nullement entamée lorsque la charge est de 50 pour cent et que le travail dure au total une heure</u>. La capacité moyenne d'oxygénation des 18 sujets s'établissait à 1,99 (± 0,04) litre par minute, la consommation moyenne d'oxygène a été de 1,04 (± 0,04) litre par minute pendant la première période de l'exercice et de 0,98 (± 0,04) pendant la dernière partie. Le rythme cardiaque moyen était de 112 par minute pendant la première partie et de 108 dans la seconde; la concentration d'acide lactique dans le sang était respectivement de 14mg pour cent et de 9 mg pour cent.

Une seconde série d'expériences a permis à I. Astrand de vérifier la justesse de la "limite de 50 pour cent" pour une journée entière de travail. Quatre sujets en bonne santé, deux femmes et deux hommes, âgés de 24 à 35 ans, ont été soumis à ces expériences qui avaient pour but de vérifier leur capacité maximale d'oxygénation (consommation maximale d'oxygène par minute). Ils ont marché sur un tapis roulant et pédalé sur une bicyclette ergométrique, sous une charge correspondant à 50 pour cent de leur capacité individuelle. L'exercice consistait en périodes de 50 minutes d'activité entrecoupées de périodes de 10 minutes de repos. Une pause d'une heure pour le déjeûner leur était accordée après 4 heures d'exercice; ensuite, ils faisaient de nouveau 3 heures d'exercice.

La consommation moyenne d'oxygène du sujet le plus apte, ayant une consommation maximale d'oxygène de 5,60 litres par minute, a été de 2,74 litres par minute; celle du sujet féminin le moins apte, dont la consommation maximale d'oxygène était de 2,25 litres par minute, a été de 1,15 litre par minute. Les volontaires ont été capables tous les quatre d'accomplir la tâche fixée, c'est-à-dire les 7 périodes de 50 minutes de travail continu, mais tous présentaient des symptômes de fatigue. Chez trois d'entre eux, le rythme cardiaque, sous la charge imposée, avait augmenté, par rapport aux deux premières périodes d'exercice, de 10 battements au cours des deux dernières périodes. En ce qui concerne le quatrième sujet, une augmentation de 17 pulsations par minute a été observée; c'est lui

aussi qui avait perdu le plus de poids au cours de cette journée d'exercice, perte qui était 1,95 kg ou 2,7 pour cent de son poids.

La dépense totale de calories de ces quatre sujets s'est établie à 2 000, 2 300, 4 250 et 4 750 kcal. Aucun d'entre eux ne présentait de symptômes subjectifs ou objectifs de fatigue après une heure d'exercice; à la fin de la septième heure, les deux sujets les moins aptes (femmes) éprouvaient des douleurs musculaires et articulaires, tandis que l'un des hommes se sentait fatigué et avait faim. Le volontaire masculin le plus apte, qui avait dépensé 4 750 kcal, était le moins affecté malgré son énorme rendement.

I. Astrand déduit de ces résultats que la limite de 50 pour cent ne devrait sans doute pas être dépassée lorsque le travail s'étend sur une journée entière.

Lundgren, dans son étude sur les bûcherons, a également observé une tendance à l'accélération du rythme cardiaque, sous une charge normalisée, à la fin de la journée normale de travail. Cette accélération était provoquée en partie par des facteurs hydrostatiques associés à la répartition du sang dans les jambes; il était possible de la supprimer en bandant les jambes.

Des écarts de l'ordre de ± 25 pour cent ne sont pas rares dans un groupe d'ouvriers faisant un travail identique, même si, par suite de la "sélection naturelle", des différences d'aptitude physique aussi importantes que celles relevées dans l'expérience finale de I. Astrand, ne se manifestent qu'exceptionnellement. Il s'ensuit qu'il serait difficile, au point de vue médical ou sanitaire, de justifier l'aménagement de pauses fixes sur la base de chiffres moyens. En effet, elles ne protégeraient pas de la fatigue et du surmenage le travailleur peu apte et seraient donc plus ou moins irrationnelles.

Toutefois, sur le plan physiologique, l'objection la plus grave que l'on peut opposer à l'instauration de pauses fixes déterminées sur la base de la charge énergétique découlant du travail se fonde sur le fait que les répercussions de ces pauses peuvent être très dissemblables dans des situations différentes. Il se peut que la durée totale de la pause par heure de travail ne joue qu'un rôle assez insignifiant par rapport à la répartition des pauses au cours de l'heure de travail. Cet

aspect du problème a été mis en relief par Lehmann lui-même, qui affirme que des pauses courtes et nombreuses peuvent permettre de prévenir l'apparition de la fatigue alors que des pauses plus rares et plus longues, mais d'une durée totale égale, seraient inefficaces. Muller est également d'avis que la fatigue augmente plus rapidement que la longueur de la période de travail; en conséquence, on peut admettre que la fatigue moins grande découlant d'un travail de courte durée explique le fait que le travailleur récupère mieux lorsque les pauses sont courtes et répétées.

Les résultats obtenus par des chercheurs suédois à la suite d'expériences récentes offrent de l'intérêt à cet égard. Ils expliquent, dans une certaine mesure, l'influence bénéfique de pauses courtes et nombreuses ou, pour être plus précis, les effets bénéfiques de la répartition d'un effort intensif sur de courtes périodes de travail entrecoupées de courtes pauses.

Il y a peu de temps encore, les physiologistes concentraient leurs recherches sur les répercussions physiologiques du travail continu, alors que, dans l'industrie, l'effort musculaire intensif est le plus souvent intermittent et non pas continu. Comme nous l'avons signalé plus haut, au cours d'une même journée de travail, l'effort imposé aux travailleurs peut varier dans une large mesure, allant d'un travail léger à un travail extrêmement lourd; les périodes de travail et les pauses peuvent se suivre et modifier de manière imprévisible la charge physiologique supportée pendant la journée de travail.

Deux exemples tirés de recherches suédoises récentes sur la physiologie du travail intermittent permettent d'illustrer les différences fondamentales qui existent sur le plan de la charge physiologique entre le travail continu et le travail intermittent, et de montrer le rôle extrêmement important que joue la répartition des périodes de travail et de repos.

Le premier exemple nous est fourni par une série d'expériences dans le cadre desquelles un sujet physiquement bien entraîné (capacité maximale d'oxygénation, 4,6 litres par minute) a déployé sur une bicyclette ergométrique un effort physique extrêmement intensif égal à 2 520 kgp.m par minute, ce qui correspond à un peu plus de 0,5 CV. Cet effort l'aurait amené en 3 ou 4 minutes à un état d'épuisement total s'il avait été fourni sans interruption. Au contraire, en alternant des périodes d'exercice d'une minute et des pauses de deux minutes, il a pu poursuivre son effort pendant 24 minutes avant d'être totalement épuisé, la concentration d'acide

lactique dans le sang atteignant alors 150 mg pour cent. Avec des périodes alternées de 0,5 minute d'exercice et d'une minute de repos, il a pu accomplir l'effort pendant une demi-heure et produire un travail physique égal à 25 200 kgp.m. Toutefois, au bout d'une demi-heure d'exercice, il était très fatigué et la concentration d'acide lactique dans le sang atteignait un niveau élevé, (60 mg pour cent), pendant les 20 dernières minutes d'exercice. Pour la troisième expérience de la série, les périodes d'activité étaient réduites à 10 secondes et les pauses à 20 secondes. Dans ces conditions, le sujet a produit dans une demi-heure les 25 200 kgp.m prévus sans éprouver de forte sensation subjective de tension ou de fatigue. La concentration d'acide lactique dans le sang est restée constante à environ 20 mg pour cent, indiquant ainsi que la quantité d'oxygène fournie à l'organisme correspondait à la charge importante supportée par les muscles. Dans les trois cas, l'effort physique était identique de 2 520 kgp.m par minute, de même que le rapport entre travail et repos était toujours de 1:2. En revanche, l'effort physiologique supporté par le sujet et l'effet fatiguant étaient entièrement différents.

Le même sujet a été soumis à une seconde série d'expériences avec un effort de travail physique identique, mais avec un rapport travail-repos de 1:4, avec des périodes alternées d'une minute de travail et de quatre minutes de repos ou d'une demi-minute de travail suivie de deux minutes de repos, ou encore, pour la troisième expérience, de dix secondes de travail suivies de 40 secondes de repos. Le sujet éprouvait de grandes difficultés à finir sa tâche d'une demi-heure lorsque les périodes de travail étaient d'une minute; la concentration d'acide lactique dans le sang augmentait continuellement pour atteindre finalement 110 mg pour cent, indice d'une grande fatigue. Cette concentration se maintenait aussi à un niveau relativement élevé, de quelque 50 mg pour cent, pendant la demi-heure, lorsque les périodes de travail étaient d'une demi-minute, alors qu'elle restait constante et ne dépassait que de 5 mg pour cent environ la valeur normale au repos lorsque les périodes de travail étaien de dix secondes. Dans ce dernier cas, la quantité d'oxygène était suffisante malgré un effort physique important, égal à 2 520 kgp.m par minute. Dans cette série d'expériences, la productivité a été ramenée à 15 120 kgp.m par demi-heure du fait que les pauses avaient été doublées. Cette augmentation des pauses et la réduction du rendement n'ont cependant eu qu'un effet bénéfique infime sur le plan de la diminution de la fatigue. L'élément le plus important était manifestement la longueur des périodes de travail, alors que la longueur des pauses et la durée totale du repos au cours de la demi-heure de travail ne jouaient qu'un rôle nettement secondaire.

La deuxième expérience a été faite sur un sujet extrêmement apte (consommation maximale d'oxygène par minute, 5,6 litres); il a couru sur le tapis roulant horizontal à une vitesse de 20 km/h, qu'il pouvait soutenir pendant quatre minutes avant d'être complètement épuisé. La distance totale parcourue était d'environ 2,5 km. La concentration d'acide lactique dans le sang observée en fin de course atteignait également dans ce cas le niveau critique d'environ 150 mg pour cent. En alternant des périodes de 10 secondes de course et de 5 secondes de repos, il pouvait "tenir" pendant une demi-heure, soit une durée de travail effectif de 20 minutes et un repos de 10 minutes au total. Pendant cette demi-heure, sa consommation totale d'oxygène était de 150 litres, soit en moyenne cinq litres par minute. Une analyse détaillée a permis d'établir que la consommation d'oxygène pendant les 20 minutes de travail effectif a été au total de 101 litres, les 49 autres litres ayant été consommés pendant les 10 minutes de récupération ou de repos qui entrecoupaient les périodes d'exercice.

Les expériences classiques de A.V. Hill et de ses collaborateurs nous ont appris qu'en cas de course sans interruption, une "dette d'oxygène" d'environ 15 litres peut être considérée comme la limite maximale supérieure et qu'il faut une heure ou davantage pour "éponger" cette dette et rétablir la concentration d'acide lactique à son niveau normal dans le sang. Dans le cas du sujet cité plus haut, la "dette d'oxygène", c'est-à-dire la quantité supplémentaire d'oxygène consommée en dehors de la période de travail effectif, atteignait presque 50 litres au bout d'une demi-heure. Pourtant, le sujet n'était pas épuisé et la concentration en acide lactique n'avait pas atteint une valeur extrême, loin de là.

La seule explication possible que nous puissions donner de ces résultats imprévus est la suivante : lorsque le sujet travaille pendant de courtes périodes avec une dépense énergétique extrêmement élevée, la quantité d'oxygène disponible est suffisante bien que l'oxygénation des muscles en activité soit très insuffisante. Le faible taux de libération d'acide lactique tend à prouver que la quantité d'oxygène disponible est suffisante ou presque. Cela signifie qu'au début de chaque période de travail les muscles doivent avoir une certaine quantité d'oxygène à leur disposition. Il nous faut partir de l'hypothèse que l'oxygène associé à la myoglobine constitue une réserve d'oxygène qui est utilisée durant les premières phases du travail, avant que la circulation et la respiration puissent éventuellement fournir une quantité suffisante d'oxygène. Dans l'exemple, cité ci-dessus, de périodes alternées de 10 secondes

d'exercice et de 5 secondes de repos, les deux tiers de l'oxygène nécessaire étaient fournis par le sang pendant les périodes de travail, l'autre tiers provenait des réserves d'oxygène stockées dans les muscles, réserves qui étaient à leur tour complétées pendant les périodes de 5 secondes de repos qui suivaient.

En fait, l'effet amortissant de cette réserve hypothétique d'oxygène permet, en instaurant des périodes de travail et de repos de courte durée, d'obtenir avec une charge maximale relativement faible pour les systèmes circulatoire et respiratoire, une grande quantité de travail impliquant un effort physique extrêmement intensif. Cela peut expliquer en partie pourquoi un aussi grand nombre de travailleurs âgés continuent, malgré une capacité d'oxygénation réduite, d'occuper des postes exigeant un effort physique intensif, dans la sylviculture et l'agriculture par exemple. En effet, les charges imposées à leurs systèmes respiratoire et circulatoire ne dépassent pas les limites de leur capacité réduite lorsqu'ils choisissent "spontanément" des périodes de travail et de repos de la longueur voulue. Au contraire, lorsque la cadence de travail est déterminée par une machine, il suffit d'une charge moins lourde, même associée à des périodes de travail relativement longues, pour éliminer les travailleurs âgés.

Les résultats cités ici peuvent également expliquer les conclusions auxquelles l'expérience a permis aux physiologistes allemands du travail d'aboutir en ce qui concerne l'influence bénéfique des pauses de courte durée, tant pour le travail dynamique que pour le travail statique.

On pourrait objecter, en se plaçant à un point de vue "pratique", que les résultats obtenus récemment en Suède l'ont été avec des charges de travail tellement élevées qu'elles ne risquent guère d'être acceptées dans l'industrie et que, de ce fait, ils sont peu concluants en ce qui concerne cette dernière. Il est peu probable, cependant, que cette objection soit valable. Même avec des charges totales de travail bien plus faibles, l'effort localisé imposé aux muscles actifs peut être tel que la quantité d'oxygène fournie pendant la période d'activité soit insuffisante. L'oxygène "stocké" exercera alors l'influence bénéfique déjà mentionnée, et l'importance de ce facteur sera fonction, dans la même mesure, de la durée des différentes périodes de travail. Toutefois, ce problème est toujours à l'étude et d'autres recherches seront nécessaires pour le résoudre.

Si les hypothèses exposées ici se justifient, il faudra peut-être que le spécialiste de l'étude du travail aborde la question sous un autre angle. Une analyse plus détaillée de la séquence de travail, une "micro-étude", sera peut-être nécessaire pour évaluer le travail si l'on veut se fonder sur cette évaluation pour déterminer les pauses, les efforts acceptables, etc.

Les pauses pour les repas et les interruptions plus longues du travail, permettant à l'ouvrier de se détendre dans une ambiance moins pénible que le milieu de travail, doivent varier en fonction de la charge énergétique et des conditions de travail.

Le travailleur forestier suédois peut servir d'exemple d'une situation dans laquelle un besoin énergétique important détermine dans une large mesure l'horaire de travail et les pauses pour les repas. Pendant la "saison claire", cet ouvrier, après avoir pris un petit déjeuner copieux chez lui, commence son travail à 7 heures. Il s'arrête à 9 heures pour son deuxième petit déjeuner. La seconde période de travail va de 9 h 30 à 12 h. De 12 h à 12 h 45, il prend son déjeuner. La troisième période s'étend de 12 h 45 à 14 h 45; la pause café dure de 14 h 45 à 15 h, et la quatrième période de travail de 15 h à 17 h. Il passe donc 10 heures dans la forêt, avec une durée de travail effectif de 7,5 heures. Durant la "saison obscure", le temps total passé dans la forêt peut se réduire à 7,25 heures, et la durée du travail effectif à 5,1 heures; bien qu'il passe moins de temps à son poste de travail, l'ouvrier forestier suédois n'en a pas moins besoin de ses trois pauses pour les repas; les jours étant moins longs, le travail ne peut commencer avant 8 h 15 et doit s'arrêter à 15 h 30 ("The Physiological Effects of Time Schedule Work on Lunber-Workers", Lundgren).

Dans l'industrie de la plupart des pays occidentaux on tend malheureusement de plus en plus à réduire le temps alloué pour ces pauses, temps qui n'est pas rétribué par l'employeur. Dans de nombreuses entreprises suédoises, et sur les instances des travailleurs, la pause pour le déjeuner ne dépasser pas 20 minutes en dépit du fait que les médecins du travail, les physiologistes du travail et les employeurs savent parfaitement qu'il serait préférable de fixer à une heure la durée de l'interruption qui coupe en deux la journée de travail de 8 heures. L'ouvrier désire rester aussi peu de temps que possible à l'usine, même si la conséquence doit en être un horaire de travail peu conforme aux critères d'hygiène. Ce sont en particulier les travailleurs âgés qui risquent de pâtir d'un tel horaire. C'est

ainsi qu'on a pu démontrer, dans une entreprise où les travailleurs transpiraient abondamment par suite de conditions climatiques défavorables, que pendant les 20 minutes de repos accordées pour le déjeuner les travailleurs absorbaient une quantité insuffisante d'aliments solides et liquides et risquaient davantage de se déshydrater pendant leurs journées de travail. Les travailleurs qui bénéficiaient d'une période de repos "normale" d'une heure pour déjeuner et qui prenaient un repas normal à la maison ou à la cantine de l'usine, présentaient à la fin du poste une perte de poids nettement moins grande. Les médecins du travail et les employeurs devraient se préoccuper des habitudes des travailleurs en matière d'alimentation, notamment en ce qui concerne les ouvriers travaillant de nuit. Les troubles de la digestion et les ulcères d'estomac sont loin d'être rares chez les ouvriers des pays occidentaux travaillant par équipe. Le travail par équipe se complique sérieusement par suite d'un autre facteur, la difficulté pour le travailleur de dormir suffisamment et de se reposer convenablement pendant le jour lorsqu'il travaille de nuit.

Pour évaluer l'effort total découlant d'une journée de 8 heures de travail pour les travailleurs de l'industrie, il faut également tenir compte du trajet parcouru pour se rendre au lieu de travail et en revenir, et de la durée de ce trajet. Il n'est pas rare, dans l'industrie des pays occidentaux, que l'ouvrier doive passer de deux à trois heures par jour en trajet; même en Inde, ce problème peut revêtir une certaine importance.

Souvent, les pauses sont absolument nécessaires pour prévenir tout effort exagéré de l'ouvrier travaillant dans des conditions climatiques défavorables. L'ouvrier soumis à une forte charge de travail dans une ambiance chaude et humide doit pouvoir se "rafraîchir" entre deux périodes limitées de travail. Ce "rafraîchissement" sera indubitablement plus rapide et plus efficace si l'ouvrier peut se reposer dans une ambiance fraîche, non loin de son lieu de travail (voir étude de Brouha).

Il faudrait se préoccuper davantage, en général, de l'ambiance dans laquelle le travailleur est censé passer ses périodes de repos à l'usine. Si, par exemple, il prend son déjeuner à la cantine de l'usine, il faut tout faire pour en rendre l'ambiance agréable. Une ambiance fraîche, à faible niveau de bruit, lui permet de récupérer vraiement, tandis qu'une ambiance chaude et bruyante ne soulage que très peu des fatigues dues à l'ambiance du travail.

L'intérêt que des entreprises à la pointe du progrès témoignent pour les possibilités de distraction et les activités de loisirs de leurs travailleurs, n'est pas seulement bénéfique

au point de vue humanitaire, mais peut également constituer un investissement utile sur le plan de la santé, du bien-être et du rendement. L'activité physique déployée durant les loisirs peut être un moyen efficace de délassement et peut même permettre au travailleur de mieux s'adapter à son travail et d'être moins exposé à la fatigue.

Je ne voudrais pas terminer ce chapitre consacré aux pauses et repos intercalaires sans donner un avis personnel quant au rôle actuellement dévolu au physiologiste du travail qui traite de ces problèmes. Je doute fort, en toute sincérité, qu'en l'état actuel de nos connaissances limitées le physiologiste du travail puisse donner valablement des conseils quant à l'"effort acceptable", aux "pauses acceptables" etc., à moins qu'une étude sérieuse des travailleurs et du travail ait été faite au préalable. Le physiologiste peut exprimer certains avis susceptibles d'éclairer les employeurs et les travailleurs au sujet des problèmes qui se posent, mais c'est du jugement des deux parties en cause que dépendront les mesures concrètes prises. Les employeurs éclairés et animés d'esprit de progrès, d'une part, et les travailleurs dignes de confiance et conscients de leurs responsabilités, de l'autre, devront s'accorder sur ce qui est acceptable et faisable et sur ce qui ne l'est pas. Dans un pays en voie de développement, chaque entreprise nouvelle peut soulever de nouveaux problèmes et constituer une expérience sans équivalent. C'est dans de telles circonstances que la nature des rapports entre employeurs et travailleurs revêt une importance primordiale. Le succès futur de l'entreprise est davantage fonction des bonnes relations au sein de l'entreprise même, que des conseils donnés par des personnes étrangères à cette dernière.

VII. DISCUSSION GENERALE

Les chapitres qui précèdent auront permis au lecteur de comprendre certaines des possibilités et des limites des méthodes de recherche physiologique et du raisonnement biologique appliqués au travail industriel. De nombreux et importants problèmes tels que l'utilisation d'outils appropriés, l'application de l'ergonomie à l'aménagement du poste, etc., n'ont pas été évoqués. Ces sujets ont été, pour la plupart, étudiés dans la littérature spécialisée et les données qui les concernent devraient être exploitées non seulement par le physiologiste et le psychologue du travail, mais encore et surtout par les spécialistes de l'étude du travail. Il importe au plus haut point de rechercher l'intérêt que certaines des données disponibles peuvent présenter dans les conditions particulières à d'autres pays tels que l'Inde. La corpulence de l'ouvrier indien n'est généralement pas la même que celle de ses homologues occidentaux, et certaines dimensions anthropométriques peuvent constituer des facteurs critiques lorsqu'il s'agit de donner un avis, quant à l'outillage approprié, au spécialiste de l'étude des machines, des chaises et des tables, etc.

Pour terminer cette étude succincte, dans laquelle je me suis efforcé de mettre l'accent sur l'intérêt que présente une collaboration entre diverses disciplines ayant pour objet l'étude du travail, j'aimerais signaler une étude internationale récente qui portait sur l'abattage des arbres par un seul homme. Les résultats de cette étude ont été publiés dans un ouvrage rédigé en allemand et intitulé : "Arbeitstechnische und Arbeitsphysiologische Studien über Einmannarbeit im Hauungsbetrieb*" Lundgren a de son côté publié dans un rapport un résumé en anglais de ces études (rapport no 13 de l'Institut de recherche forestière de Suède, Département du rendement pratique, 1961).

Le passage suivant est extrait de ce rapport :

"Les pays qui ont collaboré à cette étude - l'Allemagne, l'Autriche et la Suède - sont depuis de nombreuses années en contact étroit pour tout ce qui concerne le rendement des travaux forestiers. On s'est aperçu à ce propos qu'il existe dans ces pays des différences en ce qui concerne les méthodes de travail,

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*"Etude technique et physiologie du travail individuel dans l'abattage".

l'outillage utilisé dans les travaux forestiers et les résultats obtenus en matière de production. Il est cependant très difficile d'analyser les raisons de ces différences du fait que les méthodes d'étude du travail appliquées dans ces pays ne sont pas les mêmes, du fait aussi qu'il n'est pas facile de faire la discrimination entre les divers facteurs susceptibles d'influer sur les résultats de la production. En conséquence, on a estimé que la méthode la plus pratique et la plus efficace pour résoudre ces problèmes consisterait à entreprendre des études comparatives directes dans lesquelles les méthodes de travail et l'outillage, ainsi que les méthodes scientifiques, seraient soumis corrélativement à des essais dans des conditions identiques. Ces intentions ont été mises à exécution dans la présente étude. Certaines des études ont porté sur l'abattage pratiqué, tant en terrain plat qu'en terrain montagneux (6 jours), dans le cadre du travail normal et courant, alors que d'autres consistaient en essais particuliers - faits plus ou moins dans les conditions de laboratoire - et concernaient le tronçonnage, la coupe, l'ébranchage et l'écorçage (3 jours).

Dans ces recherches figuraient des études des temps et de la production, des études de méthodes de travail (à l'aide de films, etc.) ainsi que des études médicales et physiologiques".

Deux volontaires (des ouvriers forestiers très expérimentés) de chacun des trois pays intéressés participaient à ces recherches. Chacun d'eux utilisait les outils dont il avait l'habitude et organisait son travail comme à l'accoutumée. La production des travailleurs suédois par unité de temps a été supérieure à celle des autres. Cette différence était encore accentuée par le fait que les ouvriers suédois avaient une journée de travail légèrement plus longue et aussi que le pourcentage de leur temps de travail effectif était plus élevé. Dans l'ensemble, il est ressorti de ces essais que le trajet parcouru à pied par les travailleurs suédois était fréquemment plus court, qu'ils disposaient avec plus d'efficacité leurs divers outils et qu'ils organisaient leur travail plus efficacement. Le rendement comparable, ou "productivité", exprimé en m^3 par heure effective du meilleur des deux ouvriers suédois était 195 pour cent en terrain plat et de 200 pour cent en terrain alpestre, le chiffre de 100 pour cent ayant été retenu pour celui des sujets du groupe dont le rendement était le plus faible. Même le second travailleur suédois arrivait aux chiffres élevés de 169 et 175 pour cent respectivement. Au point de vue de l'aptitude physique, il n'y avait aucune différence sensible entre les travailleurs des trois

pays. L'effort physiologique des Suédois était légèrement plus important, ils atteignaient un pourcentage plus élevé de leur capacité maximale et, rappelons-le, un pourcentage plus grand en ce qui concerne la durée du travail effectif.

Je considère personnellement que cette étude est des plus intéressantes, car on s'est efforcé d'allier les méthodes courantes du spécialiste de l'étude du travail à celles du physiologiste du travail.

J'aimerais évoquer enfin le problème de l'absentéisme. Ayant pu observer les conditions qui règnent dans l'industrie de l'Inde, j'ai été très surpris de constater l'extrême gravité de l'absentéisme, cela, en dépit d'un important chômage. La raison de ce pourcentage élevé d'absentéisme et les moyens permettant d'y remédier devraient constituer, pour les spécialistes des diverses disciplines du travail, des sujets d'études auxquels il faudrait s'attaquer avec tous les moyens possibles.

Il est possible que cet absentéisme s'explique avant tout par des raisons d'ordre sociologique. Le travailleur indien de l'industrie est peut-être demeuré, dans une certaine mesure, un travailleur agricole "déplacé" qui plonge ses racines dans la glèbe et dont la famille habite peut-être la campagne, aussi désire-t-il y retourner aussi souvent que possible au risque même de perdre le salaire journalier qu'il gagne dans l'industrie. Peut-être même est-ce un paysan "à temps partiel" qui veut retourner chez lui à la saison des travaux des champs.

Toutefois, il semble que ce pourcentage élevé d'absentéisme, qui coûte extrêmement cher tant à l'industrie qu'à l'ensemble du pays, s'explique également par des raisons physiologiques. Lorsque les conditions de travail sont mauvaises, que l'ouvrier est mal équipé pour son travail, qui exige peut-être de lui plus qu'il ne peut donner dans les limites d'un "effort acceptable", lorsque le travailleur est sous-alimenté, une absence de courte durée est peut-être la seule solution rationnelle qui lui permette "d'économiser des calories". Le fait qu'il travaille "au ralenti" et que ses pauses soient "excessivement" longues peut éventuellement s'expliquer de la même façon, ou encore par des conditions de travail extrêmement défavorables, un mauvais état de santé, etc.

Pour exprimer une opinion plus générale, je dirai que le travailleur indien soutient la comparaison avec ses homologues occidentaux lorsqu'il est convenablement sélectionné, formé et

alimenté. On ne saurait tenir le travailleur pour seul responsable de cet absentéisme, car la faute en incombe autant sinon davantage à la direction. L'employeur des pays occidentaux qui prend soin de ses ouvriers, les fait travailler dans des conditions favorables et procure au travailleur et à sa famille un logement convenable, etc. n'est pas forcément plus philanthrope qu'un employeur éclairé de l'Inde. Il est bien plus probable qu'il s'est rendu compte qu'un ouvrier qualifié est un élément précieux au point de vue économique, et qu'une instabilité trop grande du personnel ou un fort pourcentage d'absentéisme constitue une menace grave pour la productivité.

VIII. BIBLIOGRAPHIE

Les références bibliographiques citées ci-après, bien qu'elles ne puissent être considérées comme complètes constituent cependant des repères utiles en matière de physiologie du travail. On y trouvera une documentation relativement complète et détaillée.

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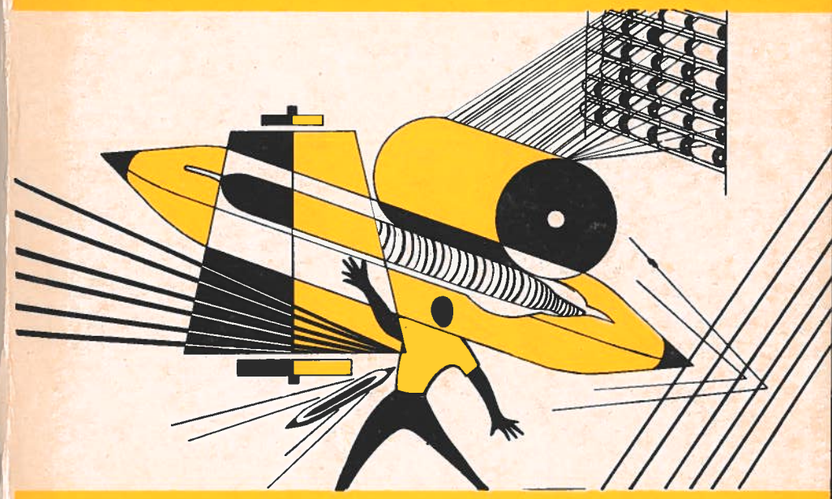
PROCEEDINGS OF NATIONAL SEMINAR

SAFETY AND HEALTH IN TEXTILE INDUSTRY



CENTRAL LABOUR INSTITUTE, BOMBAY-400 022

Proceedings of
The National Seminar on
SAFETY AND HEALTH
IN TEXTILE INDUSTRY

Held at Jaipur
10th November, 1975

Organised Jointly by
Central Labour Institute
Inspectorate of Factories, Rajasthan
Rajasthan Textile Mills Association

Central Labour Institute, Sion, Bombay-400 022.

Edited by
P. R. Surendranathan
H. N. Gupta
and
G. Vaidyanathan

Published by the Central Labour Institute, Bombay,
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of the Seminar.

PREFACE

Textile industry employing about one-fourth of the total work force accounts for over 45 per cent of the total accidents in factories. The rate of accidents in this industry has been the highest among all the manufacturing industries. The National Seminar, the proceedings of which are reported in this publication, was organised to highlight the need for intensifying efforts for prevention of accidents and occupational diseases in this industry and providing a forum for discussing the ways and means of bringing about improvements.

It is hoped that the proceedings would be useful to all those concerned with the prevention of accidents and ill health in textile industry.

The organisers wish to gratefully acknowledge the help and support received from many individuals and organisations in organising the Seminar and publishing these proceedings.

Bombay,
7th January, 1976.

Brig. G. R. CHAINANI
Director General

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NATIONAL SEMINAR ON SAFETY AND HEALTH IN TEXTILE INDUSTRY

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How to Vitalise Safety in Textile Industry
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Promoting Industrial Safety
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Deputy Director (Medical), Central Labour Institute,
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GOVINDJEE MISHRA

Welcome Address

It is my proud privilege to welcome you all to this National Seminar on Industrial Safety and Occupational Health in Textile Industry. We are indeed fortunate in having in our midst His Excellency the Governor of Rajasthan who has very kindly accepted our invitation to be with us this morning and inaugurate this important seminar. I am sure, Sir, that your presence here will not only enhance the importance of this function, but also help the cause of industrial safety and health in textile industry.

I am also very grateful to our Hon'ble Minister of Labour for presiding over today's function. Your presence here, Sir, is a source of inspiration and encouragement to all of us.

As you know, the Indian textile industry which is the fore-runner of industrialisation in our country, continues to occupy a prominent position in our national economy. It employs a little over 25% of our work force. But unfortunately about 50% of the total industrial accidents occur in the textile mills. Another disturbing feature is that during the last few years, the rate of accidents has shown appreciable decline in all other industries except the textile industry. To focus the attention of all those concerned and to do something positive to prevent accidents and improve the health of the workers in textile mills, 1975 is being observed as the safety in textile industry year.

This Seminar, which precedes the Annual Conference of the Chief Inspectors of Factories which this State is privileged to host this year, therefore, has been organised not a day too soon.

It is fortunate that two senior labour leaders, Smt. Parvathi Krishnan, M.P., Secretary, All India Trade Union Congress and

Shri Arvind Buch, Secretary, Textile Labour Association, Ahmedabad would also be talking to us on ways and means of promoting safety in the textile industry. I am sure, with their vast experience, the suggestions which they are going to give us would be extremely practicable and useful.

From the employers' side, we have Shri Kantikumar R. Podar, President, All India Organisation of Employers and Shri Mohan Lal Gupta, President, Rajasthan Textile Mills Association. We are grateful to them that inspite of their various engagements and responsibilities, they could be present at this function. Their experience in promotion of safety would be enlightening to all of us.

The Seminar has two Technical Sessions, one on Industrial Safety which will be chaired by Shri H. C. Jain, Controller, Textile Division, Delhi Cloth and General Mills Limited, Delhi, and the other on Occupational Health which will be chaired by Dr. Pitamber Dayal Mathur, Director of Medical and Health Services, Rajasthan. I welcome both these gentlemen and the various speakers who are going to talk to us in the Technical Sessions.

In organising this Seminar, we have received whole-hearted co-operation of the Director General, Factory Advice Service & Labour Institutes and his officers.

I have also great pleasure in welcoming all the distinguished guests, other invitees and delegates who have gathered here today to participate in this Seminar and I have no doubt that their contribution would make its deliberations purposeful and interesting.

MOHAN CHHANGANI

Presidential Address

I am happy that the All India Conference of the Chief Inspectors of Factories and also this National Seminar on Industrial Safety and Occupational Health arranged to coincide with the Conference are being held in Jaipur. The decision to hold a National Safety Seminar preceding each Conference of the Chief Inspectors of Factories is, I feel, a step in the right direction.

Textile Industry occupies a very important position in our national economy. Taking the employment and accident figures for the period 1968 to 1972 it is seen that among the registered factories, the textile factories employ on the average about 27% of the total working force in all the factories. But it is sad to note that the textile factories have had a disproportionately high share of the accidents, the number of accidents in these factories during the same 5 years period being as large as 49.8% of the total accidents in all factories. The rate of accidents in this industry during 1971 the latest year for which published statistics of rate of accidents is available was 154.6 for every 1000 workers employed. The rate per 1000 workers employed in textile factories in U. K. during the same year was only 25.0. The rate in the U.S.A. was considerably less. Also a very striking point when comparing the rate of accidents in textile factories in India with those in U.K. and U.S.A. is that the rate in textile factories in the latter two countries is considerably less than the rate for all the factories. In U.K., the rate of accidents per 1000 workers in textile factories during 1971 was only 75% of the rate in all factories. In U.S.A., the corres-

ponding figures was as small as only 34% These figures by themselves speak much. The main conclusion which can be drawn is that the rate of accidents in textile industry in India is very high compared to those in other industries as well as the rates in textile industry in U.K. and U.S.A.

The last time the Conference of the Chief Inspectors of Factories was held in this State was in 1963, Since then, considerable changes have taken place on matters related to prevention of accidents and ill health in Industries. The most significant change, to my mind, is in the approach to prevention of accidents and ill health on the part of the management, authorities like the Chief Inspectors of Factories and the Inspectors of Factories and also the Governments, both in this country as well as abroad. There has been a growing awareness in this country and abroad that very little can be achieved by mere enforcement or compliance with the statutory provisions. On the other hand, for achieving worthwhile results, co-operative efforts on the part of the managements and workers for determining the various measures for prevention of accidents and launching such measures are essential. Safety education and training is also recognised as a key factor in successfully launching of such preventive programmes. In U.K. and U.S.A. new safety legislations have been introduced and among the new features, these laws provide for measures to be taken by the managements and workers to promote these activities.

In India too, these aspects have increasingly been recognised which is reflected in the various activities of the Central and State Governments. The Ministry of Labour have strengthened the staff and facilities in the Central Labour Institute so as to provide service to the industry in the field of industrial safety and health. Also, to enable providing more specialised services, specialist cells are being set up in the Central Labour Institite. A Mobile Safety Exhibition has been organised by the Central Labour Institute for the purpose of taking the safety message to the door step of the factories. I understand that three more

such Mobile Exhibition Units are planned to be set up for allocation to the three Regional Labour Institutes.

The State Government too have been concerned with the increasing rate of accidents and the emerging picture of increasing health hazards in industries. Looking at the accident rate per 1000 workers employed in Rajasthan during the last 10 years, it reveals that there has been a rising trend of accident till 1972 when the rate was as high as 79. But subsequently the rate has shown a declining trend with the rate being 68 in 1973 and 56 in 1974. This is a happy sign, and the Factories Inspectorate with the active co-operation of the managements and workers should try hard to bring it down still further. The inspecting staff in this State has also been gradually augmented and we now have 4 Senior Inspectors and 14 Inspectors of Factories with the Chief Inspector of Factories as head of the department. We shall try to augment the inspecting staff further so as to achieve the accepted norm of 150 factories per Inspector.

The work of the Inspectorate is primarily that of advising the Industry to provide guidance on ways and means of securing good working conditions in factories free from accidents and ill health, rather than being mere enforcement officers. The Inspectorate with the help of the organisation of the Director General Factory Advice Service and Labour Institutes has organised many safety courses for the supervisory staff in industries during the last two years. This year, the Inspectorate is trying to organise detailed studies of accidents in 4 textile units which have large incidence of accidents with the co-operation and help of the Central Labour Institute. Some of the textile mills in Rajasthan have shown good performance by reducing the rate of accidents considerably. The rates in such units are about 40 per 1000 workers employed. While I compliment the management of these factories on the reduction achieved by them, I feel that further reduction is possible by better efforts, But more attention is required in the case of some mills where the rate of accidents is as high as 300 per 1000 workers employed.

A point which I would like to stress even at the risk of repetition is that besides the roles which the managements, workers, the Factory Inspectors and other bodies have to play in the task of preventing accidents and ill health in Industry, the trade unions can indeed make an effective contribution. With their influence on the employees by virtue of their inherent position as leaders of employees, the unions can play an effective role in developing the correct perspective towards safety in the employees and guiding them on their responsibilities.

With joint efforts by the managements, workers and trade unions supported and guided by other agencies like the Factory Inspectorates, the Central and Regional Labour Institutes and the National Safety Council, it is certainly possible to bring down the accident rate to negligible levels as illustrated by the accident records of the firms which win the National Safety Awards every year. The technology as well as the machinery, equipment and processes of these factories are quite comparable with those of several factories where the rate of accidents is many times higher, but the essential difference is in the approach and leadership of the managements concerned.

It is our good fortune that the Governor has very kindly agreed to inaugurate this Seminar. We are equally fortunate to have at this Session many distinguished persons who would speak on the different aspects of the theme of the Seminar. The words of wisdom from the Chief Guest and the able expositions from the other speakers would provide a fitting start to this Seminar.

I would conclude by wishing every success to all those engaged in the task of prevention of accidents and ill health in textile industry which has always projected India with distinction in the world market.

I now request the Governor to kindly inaugurate the Seminar.

DR. JOGENDAR SINGH

Inaugural Address

It gives me great pleasure to be with you this morning to participate in this Seminar. It is heartening to see the large number of delegates assembled here, for it shows the interest and determination of industrialists, trade union officials and others concerned with prevention of accidents and ill health in textile industry.

Considering the high rate of accidents in textile industry, there is urgent need for taking all possible measures to drastically cut down the incidence of accidents. The importance of this becomes quite evident when one considers the serious consequences of such large annual toll of accidents. These accidents cause not only financial loss, but untold misery, pain and agony to the employees and their families. Besides the suffering of the injured employees, we can ill afford the economic burden caused by these accidents.

I firmly believe that it is essentially the responsibility of the managements to ensure the safety and health of the persons employed by them. Of course, there are many others who have their own responsibilities like the trade unions, workers and the Governments. Indeed, the co-operative efforts of all such parties concerned are very essential for the success of accident prevention efforts.

The advantages of the practice of participative management have well been demonstrated by progressive industrial organisations both in this country and abroad. The days of the authoritative type of management are over; it is only by involving the

employees and getting their willing co-operation and participation that managements can achieve their targets whether they be for better safety or higher productivity. The workers should be treated with respect and honour for they make sacrifices to make others rich and prosperous. The management should pay full attention to remove their grievances, who in their turn should also work hard to augment production.

I am very happy to see the active participation of renowned trade union leaders in this Seminar. As safety has a direct bearing on workers, trade unions have to play a vital role. They direct their attention on many other matters. Let them also concentrate on accident prevention and ensure that employees are protected from accidents and ill health.

I would like to refer to the recent proclaimation of emergency. It has done lot of good to people. It has acquinted them of the rules and regulations. The daily occurrence of hartals, lockouts etc., causes tremendous losses to the individual managements but the loss to the country is still greater. Prices go up whenever there is scarcity of commodities and these come down whenever there is abundance. I would urge our friends to work with full dedication, only then we can catch up with the advanced countries like U.S.A., U.S.S.R. and the United Kingdom.

I understand that as a part of the various efforts, the Directorate General Factory Advice Service and Labour Institutes with the co-operation of the Factory Inspectorates are undertaking detailed safety studies in textile mills. The results of these studies could form a sound foundation for planning preventive efforts. I also learn that a large number of seminars and training programmes for personnel from textile industry are being organised by these and other organisations concerned with prevention of accidents and ill health in industry. I hope these efforts will not only achieve short term results but also lay a firm foundation for continued future efforts.

It is very appropriate that you propose to discuss at this seminar, not only accidents but also the health hazards. I consider that the health aspects of the working man have not received the required attention yet. In textile industry, there are harmful environmental agents which need to be carefully controlled for protecting the health of the employees. With more research and judicious application of the principles of engineering control measures, I am confident that we could do a great deal to make the working environment far more comfortable and free from health hazards than it is today. Improvement of the working environment would greatly contribute to better productivity.

Looking at the programme, I have no doubt that the deliberations at this Seminar would not only be interesting but also useful in providing guidelines for future action.

I have great pleasure in inaugurating this Seminar.

BRIG. G. R. CHAINANI

A Perspective of Accidents and Ill-Health in Textile Industry

The Conference of the Chief Inspectors of Factories decided that 1975 be observed as the Textile Safety Year, because this industry employing one-fourth of the total work force accounts for over 45% of the accidents. This is apparent from the following figures for 1973 :—

State	Total Accidents	Textile Accidents
1. Maharashtra	55,018	29,827
2. Gujarat	27,065	18,536
3. West Bengal	74,266	40,164 (Jute)
		5,761 (Cotton textile)

We know that the textile industry is the forerunner of our industries and occupies an eminent position in our industrial development contributing substantially to our national economy. We are aware that the textile industry is old. It has had ad hoc growth. The conditions of work are difficult and on top of them, workers are subject to heat, humidity and noise. But do we have to accept these accidents as inevitable ? All safety experts believe that 98% of the accidents are due to human failure which have led to unsafe acts and unsafe conditions, and that these can be controlled and substantially reduced. It is our responsibility to protect the workers. Accidents are not mere figures on the statistics book, but should trigger in our

mind pictures of workers killed or maimed or in agony and pain, houses broken up, bread winners without jobs, widowed women and children without means of support or subsistence.

Accident is not a disease. It is symptom of something wrong in the system. We have, therefore, to undertake thorough investigations to localise the cause. We have to undertake surveys and research to assess the hazards so as to be able to organise better for safety and health. We have to create safety consciousness through propaganda, training, seminars and other promotional activities. Finally, we have to involve the workers and the trade unions in safety. Government has laid great emphasis on participation of employees in management. Why not we make a beginning of participation in protectivity of the people in the plant ?

We undertook a survey of 2200 accidents in cotton textile industry all over the country and we found that 46% of accidents were due to unsafe acts and 54% due to unsafe conditions. A study of 964 accidents in jute mills in West Bengal, however, showed that nearly 66% were due to unsafe acts and 34% due to unsafe conditions. The survey further shows that accidents per 1000 workers in the sample mills vary from 15 to 297. Against this it is known that the textile factory, which has won the latest National Safety Award for the lowest frequency rate has an accident rate as low as 1/60th of the average.

I firmly believe that safety is productivity. It is our experience that reduction in accidents has invariably led to increase in productivity. Many factories have reaped this benefit and it is now upto the textile industry to follow this lead. In this connection, I would like to mention that an ILO study reveals that as much as 5% of the working days in industry are lost due to accidents. A recent report from USA indicates that out of 12% of inflation, 1/6th is attributable to accidents.

Let me tell you that the Central Labour Institute and the Regional Labour Institutes with the co-operation of the Chief

Inspectors of Factories are constantly engaged in seeking ways and means of promoting safety and health in industries. We concentrate on education, propaganda and in depth surveys of factories having high incidence rate of accidents. Over the last 4 years, it has paid handsome dividends. In some cases, in the first year the reduction in accidents has been upto 45%. The all India accidents in factories have progressively dropped as under :—

1971	..	3,25,000
1972	..	2,85,000
1973	..	2,78,000
1974	..	2,37,000
1975	..	The trend is very encouraging.

But this is possible where industries have shown the will. Once they accept safety, we are there to show them the way. I urge the industry to tune their mind to safety. I would like them to create a culture of safety, a culture of compassion and protection. We can then help them to build a bridge of safety with the following 8 pillars, for promoting protectivity, productivity, prosperity and progress :

1. Identify mills/plants/departments with high accidents.
2. Survey and appraise the conditions.
3. Analyse the data and accident statistics.
4. Develop safety codes and procedures.
5. Organise tailor made safety programmes.,
6. Arrange safety training and education for all tiers
7. Measure/assess effectiveness and modify by critical check.
8. Reach the pillar of zero-accident.

What is said for safety equally applies to health except that new technology brings in new health hazards which often manifest after a long period. The same drive for safety is applicable to health except that we need many doctors and hygienists to assist and join in the crusade against occupational diseases.

We are always there to render any assistance. In fact, we

have now added a Mobile Safety Exhibition which takes the message to every factory. Our motto is " Man is Precious : Don't cripple him ". We always recommend that machines be designed to suit the man, and the environment be controlled to enable the worker to operate with ease and comfort. In fact we recommend that industry be humanised for protectivity, participation and productivity. In all these, our guide is " an injury prevented is a benefaction ; an injury compensation is an apology."

Here is a challenge for managements and trade unions. Let us hope that their joint efforts will succeed and bring about substantial reduction in accidents in the textile industry.

Before I conclude, I would leave a thought for your consideration. Textile production is estimated to be of the value of Rs. 2,000 crores per year, apart from 1.2 million tons of jute with a current selling price of Rs. 5,200 per tonne. Would it be too much to suggest that a fraction of 1% be earmarked as a ' Safety and Health Cess ' so that this amount could be utilised for these activities.

PARVATHI KRISHNAN

How to Vitalise Safety in Industry

The subject for discussion in this Seminar is safety and health in textile industry. Why is it that so much attention to textile industry ? Firstly, the textile industry is one of the major and oldest of industries in our country. Secondly, as pointed out by Brig. Chainani, this industry has the highest rate of accidents. How are we to prevent these accidents ? I do not think that the approach is quite different from the approach that is to be adopted for ensuring safety and health in industry in general. Because, after all, when accidents take place in any enterprise or in any industry, what does it really mean ? It means immediately a loss of one of the major resources of our country, i.e. the resource of man-power. It affects production of the enterprise or the industry. But even more significant is the fact that the sum total of the losses both direct and indirect due to the large number of accidents could be very substantial, which is an avoidable waste. This is not to speak of the misery and the sufferings to the workers which the accidents cause.

Now, as far as the question of attitude to safety is concerned, we, in the trade union movement, are always being told that the workers do not take it seriously enough ; that the approach of the workers is not dynamic enough towards co-operation in seeing that the various safety devices which are there are properly used or operated. That surely is one aspect of it. And we have never denied the fact that the trade unions have a very special role to play on this. Shri Arvind Buch will be speaking on that, so I do not want to go into that aspect. But I would like to point out that before you expect the worker to participate in the

effort of bringing down the accident rate in the textile industry, particularly, it is extremely important that the wherewithal should be there. First and foremost comes the responsibility of the management to see that all the requirements and facilities are provided at the place of work to enable the worker to carry out his work safely. This aspect has been pointed out in the report of the National Commission on Labour.

Another comment by the Commission was that " the social distance between the senior managements and Inspector of Factories is widening." In other words, though the Inspectorates have been set up for the purpose of securing safe and suitable conditions of work in industry, the Inspectorates cannot really fulfill their job, unless the managements also gets involved in this whole process. The National Commission on Labour pointed out after their investigations that this gap is widening and therefore, one of the first tasks before us is to narrow the gap which exists between the enforcing authority and the management on the one hand, and the implementing authority and the workers on the other. This is something that is extremely important. I think we are all concerned with bringing about closer co-operation between the three forces that exist in industry in order to see that the accident rate comes down.

Again, the National Commission on Labour commented on various other aspects besides the precautions for prevention of accidents. For instance, the Commission pointed out that there is a tendency on the part of the managements to " ignore certain broader elements that are necessary such as good ventilation, reasonable thermal conditions, adequate lighting " and so on. And, it is strange that when they come to write their report in the sixties they quote from the Report of the Bombay Textile Labour Enquiry Committee of 1940 and point out that 20 years later, very little had changed. Now we have got here amongst us representatives of those sections of our managements, which are termed as enlightened managements. I hope I am not treading on any one's corns. While we consider certain recent reports

which give a picture of the present conditions in the industry, it is evident that there is considerable room for improvement of the working and safety conditions. Therefore, when you come to the question of making the workers aware of the need for safety, this can only be done if one deals with it also in its wider aspect.

Safety does not mean merely providing guards to machines or providing certain facilities. I have heard employers say to me that even when we give the workers the safety devices, they do not utilise them properly. Then how do we get the workers to utilise them properly ? That cannot be achieved unless and until the workers are actively involved in the safety programme. This is one side of it ; that is, the total involvement of the workers and their representatives in the whole process of safety.

Secondly, there are other intangible factors which also need careful consideration. One of the factors, for instance, is industrial noise. Noise is recognised as a factor that affects the hearing mechanism and behaviour of individuals. It also interferes with communication. What is being done about this ? Are the managements adopting appropriate control measures to ensure that the noise levels at the place of work are kept well below the acceptable level. I do not know how many of the honourable ladies and gentlemen who are here have visited any textile factory or gone from one department to another and felt the effect of noise even in the brief period of the visit. This is just one example.

Similarly, there is the question whether the nutrition that the worker has is sufficient for him to be able to withstand the work-load particularly in heavy tasks and be free from undue fatigue. The health status of the workers is equally relevant. Within the limited time available, I do not propose to go into various other factors which are all relevant to safety. My purpose in giving these examples is to illustrate that there are several factors which need careful attention, if our efforts to prevent accidents and ill health at work are to be successful.

I think a tendency is there amongst us more and more to rely only upon the law to bring about social changes. Firstly, as has been pointed out earlier, implementation of a law is never automatic. This has been the history not only in this country but in all countries. For implementation of the law, all the forces have to co-operate. It is a matter of changing one's whole outlook, one's whole social attitude. Here in our country we have got many laws — some laws that are favourable to labour and some favourable to the managements. Why then is there the gap between the law and the implementation of it ? The gap is there because, I think, we have not tackled the aspects associated with the implementation. For example, when there is an accident, immediately each one is trying to blame the other, instead of going down to what is really the cause of the accident. Sometimes, the accident may be due to some totally extraneous factor such as fatigue caused by poor nutrition. This may not be the responsibility of the management or the Factory Inspector. But it comes out of the wider social and economic conditions that exist in our country today. Thus, some of the factors which are linked to causation of accidents could well span beyond the factory premises or environment.

Sometimes, you find that the worker himself is not aware of how or where an accident took place. That is where it becomes a psychological or a medical problem. Such a problem cannot be dealt with by law nor can it be dealt with only by the physical devices that are being provided. Therefore, I would plead that in this whole approach to safety in industry, one has to understand that factors such as habits, customs, behaviour and attitudes and so also the general standard of living play as important a part as the fulfilment of the legal requirements. Only by taking a total integrated approach would it be possible to make worthwhile progress in the matter of preventing accidents and ill health.

The figures that have been given to us from time to time by the Government departments and by the National Safety

Council show that the accident rate have been steadily going up for some years and then from 1970–71 we find that it is gradually coming down. But that should not give any room for complacency or make us feel that the battle is over. For, it is obvious that all the factors are still not under control. In spite of the present downward trend, you will find that you will reach a certain point beyond which further improvement cannot be made unless and until a total integral approach is evolved and adopted. We have a long way to go. Safety in industry like productivity is a national task. A national approach to safety is necessary.

A. N. BUCH

Role of Trade Unions In Safety In Textiles Industry

IMAGE OF TRADE UNIONS

Image of trade unions in India is much more damaged during the last twenty years as the responsible trade union movement is being neglected at every stage and irresponsible trade union movement mainly led by politicians of various parties is given much more weightage than the membership they represent in the national field of labour movement.

ECONOMIC AND SOCIAL WELFARE

Today, the emphasis is laid on trade unions' neglect of efficiency, productivity and lack of community welfare outlook and especially towards the rural poor. This is a controversial subject and this place being not the right forum, the subject can be expanded elsewhere. Trade unions' main function is economic and social welfare for its members and unless this is faithfully and loyally attempted by trade union leaders, they will carry no voice if certain other aspects of industrial problems are taken up by them.

WELFARE AT LABOUR LOCALITY

Trade unions are basically bodies representing their members in particular and working class in general and they have to function in its own orbit of economic and social welfare of the industrial workers. In a socialist country, welfare of workers has to be shifted from factory premises to labour locality and its implementation can certainly be done with the assistance of the State

and through the joint agency of trade unions and managements' Foundations and Trusts.

THE CAUSES MAY BE MANY MORE

It is not possible for trade unions to set aside issues like wage rise, dearness allowance related to consumer price index, annual bonus, paid leave and better conditions of work and living. If this leads to inflation, the causes may be many more related to Government and management policy, rather than trade unions' role to augment the income of industrial workers. If this philosophy is accepted, trade unions' role in small savings, family planning, industrial health, hygiene, safety and other related problems can further be discussed.

TERROR IS NOT FELT

It is true that trade unions basing their structure on fiscal demands do not survive long and it is essential that trade union membership and leadership is made conscious on all the aspects that arise from the working of industrial units. Loss of lives due to fighting between two or more countries has not been a new feature but one can understand that in a war there is likely to be a damage to life or limb as the very nature of involvement in a fight predetermines loss on either side. Loss of life or limb in a production or servicing process is very difficult to understand ; however, there are large number of accidents which lead to loss of life and limbs even much more than war casuality and damages and its terror is not felt in the society.

TEXTILE LABOUR ASSOCIATION WILL COOPERATE

Safety legislation in India is age-old and Safety First Association of India was formed in the year 1931. If International Labour Organization reports of earlier years are referred to, it will be seen that the role of the Ahmedabad Textile Labour Association on safety is taken note of, and even today the Textile Labour Association, Ahmedabad, and the affiliates of the National Labour Organization in Gujarat are prepared to extend their cooperation to the National Safety Council and its tributories

and even spare personnel and finances to accelerate the velocity of safety movement in Gujarat and elsewhere.

TRAINING, EDUCATION & PERSUASION

As the Textile Labour Association, we are opposed to man-days loss in production process to solve the industrials grievances and the Textile Labour Association is known for its emphasis on negotiations and voluntary arbitration and if both are not acceptable to management, then justice through adjudication of industrial tribunal and courts is demanded. The Textile Labour Association is now furthering its policy that loss of working days due to death of leaders of management, labour, Government and political parties should end as it is not necessary to disrupt production and employment on emotional grounds and find out alternative methods of expressing sorrow and erecting memorials may be differently worked out. If this is done, our advice to continue production to workers wherever industrial accidents occur will be more effective. Total damage to human life and property cannot be eliminated as we have seen that heavy floods and cyclones have done irreparable damage in various parts of our country but wherever possible, attempt should be continued to save human life and limb through the process of training, education and persuasion.

SAFETY DEVICE NOT REQUIRED

Textile industry, as is said, has remained totally careless in reducing industrial accidents and textile managements have no spare finances to attend this job. Every Government and management in our country is complaining about high cost of production and trade unions in turn level the charge that higher taxation and higher profit making are two causes for the higher cost of production. If the rate of interest of investment is very high, who are the recipients of dividend and heavy rate of interest paid to investors of Banks and other financial institutions ? Poor people of India ! Certainly not. Those who are earning higher profits are, on the other hand, earning higher rate of interest. Working class of India has invested Rs. 5,000 crores

through Provident Fund at only 6¼%, the cheapest rate of interest in the country. This matter is focussed here for the reason that managements in India consider that investments on safety devices and guarding equipment is not required and what is their loss if a human being is lost or limb is broken from the vast ocean of toiling millions in the country.

DAMAGING INTEREST OF SOCIETY

Is it possible to correct the accident schedule through prosecution ? The answer is in negative. The Factory Inspectorate and the judiciary have proved to be incapable of bringing erring managements to the right track. This is not to doubt their intention but the whole atmosphere is such that everyone in charge of position and power to prosecute would prefer method of education and generosity towards those who are damaging interest of society and the common man. A few points suggested below may be useful to create greater consciousness and involvement of trade unions even though some of the managements may remain inactive, inert and ignorant of their role to play in safety and other similar welfare measures.

1. Cash Compensation in terms of financial aid to the heirs of those who die in industrial accidents or sustain loss of limb may be revised, even reduced but compulsion on management to continue such workers on the muster roll without reducing their wage rate, offer life time pensions to heirs of deceased workers in accident till a member in the family is employable should be devised. This will bring about social responsibility of the industry and the managements will not have to preserve statistics in their books but from the muster roll one will be able to find out what is the ratio of industrial accidents in the unit.

2. Higher the rate of accident, higher the rate of premium be worked out and applied to managements which are careless.

3. National Safety Councils at the local level should be authorised to prosecute the recalcitrant elements in management. Functions of prosecution should be extended from Factory

Inspectorate staff to trade unions and National Safety Council of a unit or a industry.

4. Prosecutions on accidents etc. should be tried by labour courts, industrial courts, rather than civil and criminal courts as they exist today. Specification in prosecution is necessary to curb those who are inattentive and carefree.

5. Workers not putting on safety equipment or dress or removing guards should also be punished through such courts where persuasion fails and is treated as weakness of the management. Trade Unions should assist management in correcting such workers.

6. National Safety Councils at regional level should organize training programme for workers at unit level. Those workers who attend the programme may be given certificates. Some fringe benefits to such trainees can be worked out to enthuse them to join such programmes.

7. Fines levied by courts should be made available to National Safety Council to undertake training programmes at various levels. Forfeiture fund of Provident Fund which is to be used for workers' welfare and which is now being used for payment on behalf of defaulting managements should be requested to spare finances to execute training programmes for safety etc. Some of the State Governments have levied welfare cess on workers and transferred collections to Labour Welfare Boards. Some claim should be raised before Labour Welfare Boards to strengthen national safety movement. Some portion of unpaid wages, bonus and leave can also be taken away from management to finance safety movement. Safety movement cannot be worked for all time on donations and collection through advertisements.

8. Trade Unions sparing finances on safety programmes can be extended by a matching grant by safety councils provided trade unions conduct such programmes and they accept supervision of the council.

9. Booklets in regional language and pamphlets on accidents in that particular town or city should be published to create consciousness amongst the workers.

10. Assistance from the All India Radio and Television Units can be taken to widely publicize the programmes of safety.

11. If it is possible, Workers Education Directorate be approached to incorporate safety programmes in its course. The Worker-teacher may be asked to be the President of Safety Council and he may nominate representatives of managements and trade unions after consulting respective parties.

Over and above what has been said, steps should be taken to push the programmes of safety through the National Safety Council by organising talks, Unit Level Classes and other audio vision aids. While emphasizing need of safety consciousness in management and trade unions no figures of accidents have been quoted as the record is very dirty, far from satisfaction and the idea is let us look ahead after fully knowing that the performance of management, Government and trade unions is very poor. It may also be taken note that only managements can initiate programme, invite involvement of trade unions, and seek co-operation from workers and if the reverse is expected there is not likely to be any progress than where we are. However, trade union conniving at safety in industry will also be missing its job in the direction of welfare of its members.

KANTIKUMAR R. PODAR

Our Experience in Promotion of Safety

Hazards to life perhaps are as old as life itself. As a matter of fact, risks and accidents have been necessary accompaniments of man's struggle, not only for survival but for making life more comfortable and to achieve what is best. Every phase of social evolution of man, from paleolathic to modern through pastoral and agricultural, reveals man's increasing grip over his immediate surroundings and his intense desire to experiment with the novel, and face the unknown risk in his this quest. Yet, there has been simultaneous urge to develop safe conditions of work and make living as risk free as possible. If industrial revolution has been a turning point in our social and economic history, this also marked the beginning of heightened use of technology and greater exposure of men to unheard of risks and accidents. And to this very cut off point can be traced the aetiology of institutionalised concern of society for occupational health and safety.

The present technological sophistication and accelerated tempo of economic development have at the same time underlined the importance of preventive measures against industrial accidents and undertaking of ecological studies to avoid pollution resulting from industrial wastes and effluents. No doubt, occupational accidents and diseases remain one of the most appalling tragedies of modern industry. According to an ILO estimates, nearly 1.5 crores occupational accidents take place through out the world every year, out of which more than 1 lakh are fatal and nearly 15 lakhs resuit in permanent disability. Figures available for India show that out of 2.81 lakhs accidents in factories,

647 were fatal in 1972. In mines 319 were fatal accidents as against 2,691 non-fatal in 1973. Indian Railways, employing over 14 lakhs employees, lost 279 workers while 26,600 were involved in non-fatal accidents in 1973.

The software cost apart, the community pays heavily in the loss of production, disruption of production schedules, damage to equipments and in certain cases, in terms of major social dislocations. It is difficult to assess the economic loss accurately. However, even a conservative estimate places the cost of each lost-time accident in USA, at $ 1800 to one employer. Therefore, those engaged in the use of machinery and chemicals in industry, agriculture, forestry, health and other social services are becoming aware of their primary responsibility to ensure safety for human life and a cleaner environment. Yet, the fact remains that vast uncharted areas remain and all of us owe it to society at large to do our best to create congenial and safe work conditions.

An analysis of the causes of accidents discloses that all industrial accidents — directly or indirectly — are attributable to human failings. Man is not infallible and does commit mistakes. These mistakes may be of the architect who designed the factory, the contractor who built it, the machine designer, the manager, the engineer, the foreman, the operator or maintenance personnel — in fact, by anyone who has something to do with the design, construction, installation, supervision, management and use of anything in a factory complex.

Accidents can occur in almost any situation, even with a carefully guarded machine, the non-slip floor, or a completely enclosed switch gear. Guards and covers may be removed, safety devices may be out of action, people may try out equipments which they are not supposed to. They may be partly due to worry, illness, bad temper, frustration, exuberance, intoxication or other physical and mental states which may or may not have any bearing on an establishment. However, the most common causes of accidents are not to be found in dangerous machines

or dangerous substances, but in ordinary acts like stumbling, falling, faulty handling of goods or hand-tools, or being struck by falling objects. Nearly 30% of the industrial accidents are caused by mis-handling and this can be traced to factors like faulty lifting techniques, lifting very heavy loads and failure to wear protective gear.

One important accident factor which has been brought to light by statistical analysis is that nearly 85% of the accidents are caused due to factors such as absent-mindedness, negligence, foolhardiness and ignorance of risks involved. Another revealation is that for every lost time accident, there are 29 minor accidents and 300 near-accidents. It is these near-accidents that require greater attention. A timely investigation of the causes of this large number of near-accidents would go a long way in preventing serious accidents in future.

In any scheme of accident prevention a scientific, proper and objective investigation is a must. Accidents may be investigated for pruposes of ascertaining who is responsible for them, or to find out how similar accidents can be prevented, and to disseminate information about the inherent dangers in the machine operations. Often accident investigations is concerned with both responsibility and prevention. In accident investigation, however, it should always be borne in mind that prevention of accidents is much more important than mere apportionment of the blame. It is imperative that workers' attitude should be reoriented to make them more safety conscious and then alone shall it be possible to conduct successful investigations.

Results of investigations have thrown up rather amazing ideas. For instance some of the workers consider unsafe ways easier, less troublesome or faster even though a lot of risk is involved and they know it by precept. Often, they are convinced that safety precautions are unnecessary because they can look after themselves in all circumstances. They may object to interference in personal matters, even to orders given in their own interests. This attitude can and does lead to accidents and

should be taken care of by providing pre-employment vocational training. In most cases it is ignorance of safe working methods. It must be conceded the best method for accident prevention is to make workers aware of the pitfalls in industrial operations and using machines as they aught to be used. Workers can be properly educated by arranging educational programmes to make them familiar with accident prevention systems.

There are three main types of educational measures ; propaganda, educational and training. Propaganda is usually through using stickers and posters, and organising film shows, talks, competitions, safety weeks and exhibitions. Safety education could begin in the elementary schools and be continued in higher institutions, including trade schools, and colleges. Practical training can also be given through various channels in trade and technical schools, apprenticeship courses, and on the job, to keep the workers' interest alive and make them safety minded.

Training of job instructors, job setters and supervisors is equally important. They must be trained in methodology of teaching safe practices to new comers. Individual undertakings or industrial associations could usefully organise safety discussion groups for their supervisors, where the responsibilities of instructors, charge-hands, supervisors and other staff in charge of the work of others, are underlined and where case studies are made of accidents occurring in the plant. The training of middle management personnel, comprising department heads, engineers etc. should include instructions in regard to the occupational safety and health in industry and also their functions and responsibilities. Top management, of course, has to set the pace in promoting and maintaining high safety standards. The management has to show by words and deeds that it is particularly concerned with prevention of accidents. After a serious accident, a manager should not only look at the accident report but obtain first-hand information about its cause from the victim, the foreman and the department manager. This will reinforce the primary responsibility which a foreman and the

department manager owe to the safety of the employees in their charge.

The management must ensure that the plant is properly maintained by periodical checks, proper lubrication and replacement of worn out parts. In this connection, it would be necessary to give up the notion of treating the maintenance department as a breakdown squad and continuous steps should be taken to maintain all machines in perfect working condition.

The Joint Safety Committees at shop floor level can really play an important role in organising programmes for making the workers safety mind. The workers' representatives on such safety committees also need to be educated in regard to the laws, regulations and practices obtaining in the industries concerned.

Last but not the least, the workers' unions have a distinct interest and responsibility in promoting safety. There are many ways in which they can contribute to safety and in fact, they can take direct action to ensure high standards. It is the duty of the trade unions that the solidarity, often shown by workers in times of trouble, gets manifest in the field of safety. Every workman is duty bound to protect his fellow workers from accidents. Cooperation between unions and employers is essential for smooth and efficient functioning of safety committees. In Sweden, for instance, the unions take the view that safety cannot be ensured by legislation alone and that the latter must be supplemented by cooperation between employers and workers at all levels — from national to local. The National Safety Council has an important role in promoting bipartite safety committees at shop floor level throughout the country.

A great deal will have been achieved when all workers make a positive contribution to safety by obeying safety rules and applying safety principles. But the safety movement will not be a complete success unless every worker puts his heart and soul into the task of preventing accidents. In the war the humanity wages against accidents, all conceivable weapons should be used. Though it is not possible to completely eli-

minate accidents from our industrial life, there is wide measure of agreement that most accidents can be prevented. In fact, companies with good safety organisations have proved that this is so in large number of cases. Let us not spare any efforts in our campaign to make the industrial world as safe as possible to live in.

M. L. GUPTA

Our Experience in Promotion of Safety

This Seminar about Safety measures in industrial undertakings is most opportune and is welcome. This State has an industrial labour force which is still predominently rural and uneducated. Uneducated people are very much more daring and prone to take risks and are less calculative and cautious than the educated people. It is for this reason that the industrial labour force needs to be educated towards industrial safety and made more and more cautious of risks which are unnecessary and which can easily be avoided with a little more caution. I am of the view that there should be some conventions, evolved and laid down so that the unions involve themselves in promoting safety consciousness amongst the work force so that the values are changed & the workers may not feel that the safety measures are unnecessary or wasteful of time and are thrust upon them. For example, there is a convention that the people who want to travel by a bus, should stand in a queue at the bus stand and get in the bus one by one rather than gang up and in the process of boarding the bus injure somebody or get injured themselves. In all parts of the world we find such healthy conventions. In India we find such conventions in Bombay and some other cities but in the cities of Rajasthan or in Calcutta a traveller has to literally struggle to get himself into a bus. Situations like these have to be eliminated and orderliness inculcated which by itself will prevent several accidents.

Conventions need also be established for putting the right thing at the right place and for picking up any article out of

place and for placing it at the right place. If a bobbin is lying on the floor of a textile mill department, and the supervisor picks it up and places it at the proper place, it will set an example for the workers. The workers will then emulate the example and thus prevent accidents. The burden of my argument is for good house keeping. The importance of good housekeeping is well known to everybody. The major portion of the problem of industrial safety will be solved if the union leaders, supervisors and educated workers start following such conventions and setting examples.

Gentlemen, conventions are not to be taught by preaching or by delivering lectures, but by ourselves doing things in a correct way. These conventions will help in developing right attitudes and healthy habits amongst the industrial workers as well as in developing interest in their own safety. Safety consciousness in a man can neither be ordered nor can it be enforced by command because man is sensitive and reactive but it can be easily developed by setting example. We should create the circumstances and the environment which can encourage the formation of right attitudes.

I do not mean to say that chivalry and boldness are not to be encouraged, but that taking unnecessary and avoidable risks purposelessly are neither chivalrous nor courageous. Obviously fool hardy and careless acts deserve no praise.

I am also of the opinion that the technical training institutes like the Industrial Training Institutes should impart safety training to their students besides the professional or technical training, so that the trainees may become aware of the industrial hazards and risks as well as safety measures to be adopted in the various tasks. Thus, these institutes will be helpful in creating and developing safety consciousness amongst the trainees.

I take this opportunity to request the Hon'ble Minister Shreeman Chhangani Saheb that some textile trades like that of spinner and weaver may be introduced in the Industrial Training

Institutes. The persons who are trained in the textile trades as well as in safety will do their jobs safely and efficiently and also set good example to others. In this connection I would also like to mention that long back I offered to donate some machines to the Industrial Training Institute, Pali, for starting courses on spinning trades but the same were not accepted for want of accommodation and adequate funds. I feel that the Industrial Training Institutes could play a useful role by training students in textile trades.

I am sure that this Seminar will educate all of us on improving the safety measures in the textile factories.

B. K. GANDHI

Promoting Industrial Safety

You have heard views from the Government side, from the trade union side and from the management side. I do not belong to any of these. I am from between the management and the workers, i.e., the middle cadre. Actually the responsibility for ensuring safety greatly depend upon the middle men and how best they can convey the orders of the management to the workers. One could realise the difficulties of these middle men in implementation of the various safety measures. During my course of employment, I have come across certain factors which have not been referred to by any of the speakers here. These, I consider, are very important factors.

The first factor which I came across while dealing with certain accidents was that when a worker is happy at his home due to very good homely atmosphere, he is in a position to prevent accidents. But when he is not happy at home, and he is tensed with whatever problems he have carried with him from his home to the factory, his performance is affected. In such a mental condition, even if we provide him with good machines and proper facilities, he is not in a position to use them in the manner in which they are expected to be used. He may even utterly disregard the safe procedures. So, let us recognise this important aspect and try to do something to tackle this causative factor.

Another factor which I have noticed is that in order to gain the benefits of ESIC and other schemes, workers have a tendency to work hurriedly and cause accidents. The middle men cannot

do anything to stop this. I request the different agencies to consider seriously how this tendency can be stopped.

The third aspect which I would like to point out is intoxication among workers, particularly in textile industry. Many accidents are caused due to intoxication. It is for the Government and social organisations to consider how this can be stopped.

These are the three points which I wanted to refer to.

H. R. PABUWAL

Vote of Thanks

It is my proud privilege to propose a hearty vote of thanks to the respected Governor, Labour Minister and other guests who have kindly responded to our invitation at the inaugural function of this National Seminar. The presence of the Governor at the inaugural function signifies the importance which both the Government and himself attaches to the subject of the Seminar. Inspite of his busy schedule, he has graced this function to inaugurate this Seminar, for which we are extremely grateful to him. The philosophy and principles given by him in his illuminating address should form the firm guidelines for our future actions.

Our Labour Minister Shri Chhangani, has always been a guiding spirit in all matters affecting health and welfare of labour. To him, we owe a deep sense of gratitude for presiding over this inaugural function and giving us guidance and encouragement in our work. This Seminar has been arranged with the collaboration of the Directorate General Factory Advice Service and Labour Institutes, Bombay. Brigadier Chainani and his officers have helped us in a big way in organising the Seminar for which we are greatly indebted to them.

The Rajasthan Textile Mills Association has also collaborated in organising this Seminar. I am grateful to the President of the Association, Shri Mohan Lal Gupta and his officers for their untiring efforts in making this Seminar a success.

We have been fortunate to have eminent speakers from the side of employers and trade unions to speak on the various

aspects of the problem or safety with special reference to textile industry. Though they are all very busy persons, they have very kindly made it possible to come to Jaipur to speak at this Seminar. We are highly obliged to Smt. Parvathi Krishnan, Shri Buch and Shri Kanti Kumar R. Podar for sparing their valuable time and for their excellent contributions to this session.

Shri Hem Chand Jain and Dr. P. D. Mathur have kindly agreed to be the Chairmen of the two technical sessions to be held in the afternoon. We shall be much benefitted by their views on this important subject, as they are persons with long experience in administration of industrial safety and health.

This Seminar is being held preceding the All India Conference of Chief Inspectors of Factories. This has given us the benefit of the presence of the Chief Inspectors of Factories of almost all the States in the country. We are grateful to them for their presence here at this function.

I am also grateful to the Press and the All India Radio for covering the proceedings of this Seminar.

Lastly, I am grateful to all the guests who have graced the occasion by their presence.

TECHNICAL SESSION

Industrial Safety

P. R. SURENDRANATHAN

Accidents in Spinning Preparatory And Spinning Process

INTRODUCTION

It is the objective of this paper to highlight the important types of accidents in the spinning preparatory and spinning processes and to discuss the measures for controlling them. I intend to do this by presenting the important findings of a recent study, *carried out by the Regional Labour Institute, of accidents in the above mentioned processes in cotton textile factories. The study covered a sample of 838 accidents from 5 textile mills in Madras.

MAJOR CAUSES

An examination of the major causes of these accidents by assigning one major cause for each accident, in terms of an unsafe physical condition or an unsafe act, revealed that in 60.5% of the accidents, unsafe physical conditions including systems of work were the cause in as large as 60.5% of the accidents. This indicates the considerable scope for improvement of the mechanical or physical conditions, by far a surer method of prevention of accidents. It is also noteworthy that

*Murashetty, M., Surendranathan, P. R., "Accidents in Cotton Textile Factories—Part 1— Spinning Preparatory and Spinning Processess", Regional Labour Institute, Madras, 1975.

nearly 85% of the accidents in which unsafe conditions were the major cause, were caused by the following two types of unsafe conditions :

i) Defective condition in agency 55.6%
ii) Hazardous arrangement, procedure, method, inherent hazard in the job, etc. 29.2%

This highlights the necessity to give due weightage in accident prevention programmes to introduce and sustain adequate systems to have (i) proper maintenance of machinery, equipment and tools, (ii) the methods of work properly studied, to detect the hazards involved and to introduce appropriate measures to control the risk of accidents, in various operations.

AGENCIES CAUSING ACCIDENTS

The distribution of accidents according to the agencies causing them, is given in Table.

TABLE

Agency	Number of Accidents	Per-centage
A. MACHINERY		
1. Opening and blow room machinery	29	3.5
2. Carding machines ..	64	7.6
3. Sliver and ribbon lap machine	8	0.9
4. Combers and draw frames ..	30	3.6
5. Roving frames	43	5.1
6. Ring spinning frames ..	364	43.5
7. Other machines	2	0.2
B. AGENCIES OTHER THAN MACHINERY		
8. Materials handled	113	13.5
9. Working conditions ..	101	12.1
10. Hand tools	40	4.8
11. Hand trucks	36	4.3
12. Others	8	0.9
Total	838	100.0

It would be seen that 90% of the accidents were caused by the three agencies machinery, materials handled and working conditions. Machinery caused 64.4% of the total accidents, materials handled and working conditions causing 13.5% and 12.1% respectively of the total. It should be clarified that accidents in operations associated with machinery have also been included under this classification. For example, while trying to take out bobbins from the creel top of an inter frame, if a bobbin falls and injures an employee, the accident would be classified as due to inter frame (bobbin falling). Of machinery, ring frames alone contributed as large as 43.5% of the total accidents.

In terms of severity, grinding machines topped the list with an average number of man-days lost of 79.5. The other agencies which caused high loss of man-days are opening and blow room machinery, carding machines, sliver and ribbon lap machines, roving frames and combers and draw frames, the man-days lost per accident being 36.3, 24.6, 19.5, 19.1 and 18.1 respectively.

CAUSES OF ACCIDENTS AND CONTROL MEASURES

Time permits only a few of the important agencies to be discussed and those have been selected from considerations of frequency of occurrence and the severity of accidents. The sequence as given in the table has been followed.

1. Opening and Blow Room Machinery

These contributed 3.5% of the total sample. Transmission machinery parts caused 8 accidents, i.e. 27.5% of the accidents due to this agency. Six were due to not guarding these parts and 2 due to lack of sufficient care on the part of the employees.

Absence of interlocked guard at the doors giving access to beaters in these machinery, caused 4 serious accidents (including one case in which a permanent disablement of 5% of the earning

capacity was caused), the average man-days lost being 151.8. The employees were either removing chocked cotton or dirt when the accidents took place. In 3 cases, the beaters had not come to rest and in the other, the beater moved while the above operations were carried on. The imperative need for providing interlocked guards to such doors giving access to beaters on other dangerous parts of these categories of machines which is a legal requirement, is brought out clearly by these accidents.

Three accidents which involved persons falling from heights were due to lack of suitable means of access to locations at heights on the machines where certain jobs had to be performed. It is necessary to provide safe means of access to all locations to which employees are required to go in the course of work.

2. Carding Machines

Accidents due to carding machines constituted 7.6% of the total sample. Here again, transmission machinery constituted a high percentage — nearly 33% of the total accidents on these machines. Twelve of these were due to lack of sufficient care in mounting or dismounting belts or ropes on or from pulleys. Employees clearing transmission machinery parts without switching off power caused 3 accidents, while lack of care in removing fluff from between the side shaft wheel and end plate wheel which were not power driven caused 2 more accidents. Four accidents (6.2%) were due to absence of adequate guards for these parts.

Cylinder, licker-in and doffer together caused 13 accidents, i.e. 20.3% of the accidents on carding machines. That accidents due to these parts could be quite serious is proved by 4 accidents in the sample caused by contact with wire clothing of the cylinder. The average man-days lost per accident was as high as 62.5%. Two of these were due to absence of locking arrangement at the cylinder door. Gauging of the clearance between the cylinder wire clothing and the flats with the card in motion resulted in the other two accidents involving contact with wire

clothing. Gauging should have been done with the cylinder stationary. Also, use of an angular gauge would facilitate the operation. Inadequate guarding of the licker-in caused two accidents. The remaining 7 accidents were due to unsafe actions on the part of employees.

Coilers requires constant attention and it is necessary to maintain the coiler covers in good condition. Defective condition of the covers caused 3 accidents in which the covers fell and injured the fingers. The unguarded gears of the coiler box caused 2 accidents while fingers came in contact with them during operations close to them. Inadequate care caused 4 more accidents involving the coiler, making a total of 9 (14% of the total accidents on carding machines).

The other accidents on the carding machines were mostly due to lack of sufficient care on the part of the employees in various operations.

3. Roving Frames

5.1% of the sample were accidents due to roving frames. Bobbins falling while placing them on or removing them from creel top or due to vibrations caused 14 accidents, i.e. 32.6% of the accidents on roving machines. The investigation of these accidents revealed a glaring mis-match between the machine and the employees who is to work on it. In many cases, the creel top was too high for the employees to reach it easily. There was also no suitable and safe means of reaching the creel top. This led to adopting several unsafe means of placing and taking out bobbins on and from creel top which resulted in these accidents. It is necessary to provide suitable foot boards and hand holds on the frames. Also, not more than one row of bobbins should be stacked on the creel top.

There is an inherent risk at these machines of contact with flyers which rotate at high speed. Twelve accidents, i.e. 27.9% of the total on roving frames were caused due to contact with moving flyers while employees were attending to different

operations. Operations such as cleaning fluff should not be carried out in close proximity to the rotating flyers without stopping the machine.

4. Ring Frames

364 accidents, i.e. 43.5% of the total sample occurred on ring frames. Of these, 51.1% (186 accidents) were due to damaged metallic shield of bobbins. Judicious selection and adoption of the control measures recommended in the report of the study namely, of inspection and rejection of bobbins with damaged shields, substitution of wooden bobbins with plastic ones and use of knee brakes could prevent such accidents.

77 accidents, i.e. 21.2% of the accidents on ring frames were due to fall of rollers or being hit against or caught between various parts of the frame while attending to different types of operations. Except in very few cases where the sharp edges of machinery parts injured the employees on contact, or there were defects in the mechanisms holding the rollers, all the accidents were due to lack of exercise of proper care by employees while attending to various operations. However, this is not to rule out the possibilities of reducing certain types of these accidents by improved machine design and better layout.

There were 44 accidents due to fall of bobbins from creel tops. These accidents occurred in similar circumstances as described earlier in the case of this category of accidents on roving frames and hence the control measures are not repeated here.

That there is hazard particularly to the eye from travellers which may fly off is confirmed from 12 accidents in the sample in which employees were injured in different parts of the body by flying travellers. One occurred while removing a traveller. While pulling out the traveller, it came off with force and hit the eye of the employee. Use of good quality travellers, fitting them properly and an effective system of periodical replacement after determining the periodicity would minimise the chances of

travellers flying. Also, the persons replacing travellers should wear goggles.

5. Materials Handled

13.5% of the accidents were due to materials handled. Operations involving elements of handling, but which could be conveniently treated as a process associated with other agencies like machines are excluded from the group of accidents discussed in this section. Fifty percent of these accidents were in handling of cans and skips. That nearly three-fourths of the accidents while handling cans and skips were caused due to sharp or protruding portions of damaged cans and skips, brings out clearly the need for introduction of an effective system of inspection and maintenance of these containers. The study also highlights the importance of exercise of due care in handling of materials, particularly heavy objects like bales, machinery parts and loaded cans and skips.

6. Working Conditions

This agency contributed 12.1% of the sample and these were caused largely by what is generally termed as bad house-keeping. Objects such as nails, hoop iron, metal pieces, ring travellers, glass pieces, bobbins, cans and skips, machinery and machinery parts lying about on the floor and damaged or slippery condition of the floor were the causes of accidents in nearly three-fourth of these accidents. The working space around machinery and fixtures in textile mills generally being already limited, it is very important that the free and safe movement of men and materials are not hampered by bad house-keeping. Since workers normally work bare footed or with unsuitable type of foot wear, the need for maintaining a high level of house-keeping is all the more relevant.

CONCLUSION

It will be noticed that the above discussion places much emphasis on controlling physical conditions and methods of work as a means of achieving freedom from accidents. This

must be so not only because in the processes dealt with in this paper the major causes of accidents in over 60% of the cases were due to unsafe physical conditions and systems of work, but also because as a basic principle the first and most important step in accident prevention is to remove as far as possible all the hazards in the job. Obviously, behaviour of persons is more difficult to be achieved then controlling the physical conditions. However, since every risk in the job cannot be removed, it is necessary to lay down safe procedures of work for the various tasks to ensure that employees conform to them, through training and education and motivation of the employees.

That the available techniques and methods can effectively be employed in textile industry, provided there is the necessary support and load from the top managements and cooperation from the employees has been proved by the performance of the textile factories winning the National Safety Awards yearly. It has been possible to control accidents in these factories to almost negligible levels.

M. K. PATANKAR

Accidents in Weaving and Weaving Preparatory Processes

INTRODUCTION

Accidents in the weaving department, can be conveniently discussed under three main headings, namely, (i) shuttle flying (ii) beam weights and (iii) miscellaneous. But before taking up that discussion, I would like to ask the question as to who is responsible for these accidents. The ultimate responsibility for prevention of accidents both legally and morally should undoubtedly, be that of the management. But in actual operations at the shops floor, this responsibility will have to be assigned to or shared by different levels.

Based on my observations in these matters, my comments about the failure to carry out the responsibilities so assignable are as follows : In certain types of accidents, major responsibility is that of management ; in another lot the responsibility equally rests with workers and management ; and only in a very small number, it can be attributed entirely to incorrect way of working on the part of the workers.

SHUTTLE FLYING

The shuttle flying accidents constitute a large number of accidents in textile industry. In Maharashtra with 78303 looms in textile industry the number of accidents due to shuttle flying in 1974 was about 2,000, which is roughly about 10% of the total accidents in textile industry. For every injury producing shuttle flying accident, there are 2 or 3 shuttle flying accidents

without injury. Taking an average of 2.5 shuttle flights per reported shuttle flying injury accident, the 2,000 accidents referred to above results in 5,000 smashes. In terms of loss of production, it means about 20,000 meters of cloth and in terms of rupees it would be in lakhs.

This is just to stress the point that accident prevention work, at least so far as shuttle flying accidents are concerned, is called for not only from legal and philanthropic considerations but also from point of view of productivity. If a detailed study of the total cost of a shuttle flying accident is carried out, I have no doubt, that the management would feel better convinced about the need for preventing such accidents.

From my experience, I can say with conviction that most of the shuttle flying accidents are preventable. This is supported by the views of many senior personnel of textile mills with whom I have discussed this matter. To cite only one example, a cotton textile mill in Bombay has been able to achieve spectacular reduction in shuttle flying accidents by systematic and sustained efforts. The success of the efforts in this mill could be judged from the results achieved. The mill which had 1,800 looms worked 300 days with two shifts on each day had only 7 shuttle flying accidents.

If the control measures are to be successful, they have to be integrated into operational procedures. Some of the important measures are indicated below :—

The Weaving Master should ensure that the loom is properly tuned. Care and discipeine is required at the different stages of the setting up and operation to ensure that the proper angle of the shuttle, balancing the shuttle and the angle of the reed to the race board are maintained. It is equally important that the weaver should keep an alert watch for warp breakages and promptly repair such breakages. 'Play' in the brackets and cups and in spindles and spindle stud in the box should be checked. Correct setting of spindle stud is very important.

Similarly, at every beam full, the condition of the slay should be checked for concavity and curvature and also the physical condition of parts such as race board and slay cap. Further, shedding should be checked at the time of beam gaiting.

BEAM WEIGHTS

Another typical accident, so far as weaving section is concerned, is due to loom weights. The looms are provided with horizontal beam over which weights can be moved to give proper tension. The hazard lies when the worker tries to shift the weight. The opening on the weight being longer than the height of the beam, sometimes, the weight falls off the beam on the foot of the worker. Suitable change in the design of the weights could prevent their fall while shifting. Alternatively, adoption of the spring loaded mechanism for beam weighing could eliminate such accidents.

MISCELLANEOUS

A danger which immediately comes to attention under this category, is from bursting of sizing cylinders. The most common reasons for this are improper maintenance, failure to have periodic examinations carried out and applying steam at a higher pressure than what is safe, either due to an error in operation or due to failure to specify permissible safe working pressure on the basis of careful examination. We find, at times, a sizing cylinder of about 4 ft. diameter used along with drying range cylinders having about 2' 6" diameter. That the safe working pressures of the sizing cylinder and the drying cylinders are different, itself has been a factor in causation of accidents involving working of the sizing cylinders at pressures higher than permissible.

In late fifties and early sixties, the slasher type sizing machine was being replaced by hot air sizing like Ruty, Hubert and similar machines. We were happy that one hazard was slowly diminishing but again these days, we find the slasher sizing being introduced. The only augury from safety point of view is introduction of multi-cylinder stainless steel sizing machines. These are

safer on account of small diameters and high tensile strength of steel.

Even in the case of conventional slashers, if proper measures are taken such as provision of pressure guage, safety valve and reducing valve for steam and proper examination maintenance of the parts as well as the cylinder themselves, near complete safety can be ensured.

There are many other types of accidents, all of which, it is not possible to deal with within the short time at my disposal. The most common among them are caused due to (a) contact with broken edges of pirns, cans and skips, (*b*) stepping on objects like nails, bobbins scrap, or machinery parts lying about haphazardly, (*c*) inadequacy of space, (*d*) defective tools, (*e*) hands or fingers being caught between parts of the loom, and (*f*) being hit by the picking stick. Better attention to house-keeping and maintenance and to providing safety education and training to employees are called for to prevent such accidents.

Lastly, I am not under any mis-apprehension, that whatever I have mentioned is anything new to majority of you. All that I have done is to put the facts before you in a particular manner.

P. T. SHAH

Accidents in Finishing Processes

In this talk I propose to deal with only the common hazards in the finishing department of textile mills.

For successfully tackling the problem of accidents, the causes and circumstances of such accidents should be analysed so that appropriate solutions could be considered. Analysis of accidents often reveals that in majority of the accidents, the main cause is the human failure. However, rectification of unsafe conditions should receive the first priority since many of the human failures can be traced to unsafe physical conditions including unsafe systems of work.

The main activities of the finishing department could be classified into the following major heads :

1. Calendering
2. Bleaching
3. Dyeing, Printing and Drying.

CALENDERING

When the textile mills were originally established, most of them were producing only grey cloth. The grey cloth was bleached at dhobi ghats and then sent to the finishing department for calendering and packing. As such, the machinery in the finishing department consisted mainly of calendering machines. The main types of accidents on this machine are trapping of

fingers between the nips on the in-running end of the bowls, gears and transmission machinery. The accidents on gears and the parts of transmission machinery could be prevented by providing suitable fixed guards.

The in-running nips of bowls forms a highly dangerous zone and can cause disastrous accidents if not properly guarded. As such, special provision should be made to provide nip guards for such nips. The nip guards needs a constant maintenance, otherwise it would be ineffective at any time due to displacement from the tension of the cloth passing through, adjustment of pressures on rolls, etc. The accidents normally occur while threading, cleaning or scraping of bowls. To prevent such accidents, threading should be entrusted, only to specially trained workers. Also, inching mechanism should be provided and used during the work. The cleaning and scrapping should be done after releasing the pressure of the bowls and on the out-going sides of the bowls. Some calenders are of reversible type and in such types, nip guards should be provided for the nips on both sides of the bowls. For cleaning purposes, a special type of hand brush having the same curvature as that of the rolls with handle should be used. The use of rags or cloth for cleaning should be prohibited.

Even after taking all such precautions accident occur sometimes on this machine, during cleaning, threading, etc. due to unexpected reversal of the direction of rotation of the bowls. Such accidents occur in the first shift after the weekly holiday during which the maintenance work is carried out. Investigations have revealed that the phase connections of the electrical motor driving such machine were interchanged unknowingly, which regulated in reversal of the direction of rotation of the bowls. The workers who attend to the machine in the normal manner are caught unaware. It is, therefore, imperative that the maintenance staff check up the direction of rotation of the motor and the machine after the maintenance work is over. Here comes the responsibility of the supervisory staff. It is

also desirable to mark the correct direction of motion of the motor for each calendering machine.

Some accidents have also occurred due to trapping of fingers or hands between the end collars of the bowls. It is, therefore, desirable to provide proper cover guards at the end of each nip guard to properly cover the intake end of the collars.

BLEACHING

The advancing technology subsequently added host of present day machines which have created complex problems of safety in the finishing department. Many of the common accidents in the bleaching process, occur in use of chemicing, souring and washing machines and the Kiers.

1. The Chemicing And Washing Machine

The chemicing and washing machines pose the danger from trapping between rolls of the machines. Normally, nip guards are not possible on these machines, and therefore, 'positional guards' are the commonly accepted solution. These machines have liquor or water tanks below them and the walls of such tanks act as positional guards, but there were instances when workers are found attending to certain operation by standing on the walls of such tanks. While doing this, the worker sometimes, get entangled with the cloth resulting in serious accidents. It is, therefore, necessary to provide strong rail guards of at least 3'6" high fixed on the inside edge of the tanks which could serve both the purposes of preventing access to the above said nips, running cloth as well as tanks when the machines are working. Operations requiring working close to the dangerous parts of machinery or dangerous zones should be done only after stopping the machine. Inching arrangement should be provided for facilitating threading operations.

2. Kiers

The Kier is a potential source of danger ; if proper care is not taken. A worker has to enter the Kier for piling of cloth

and while he is piling the cloth, if through mistake, the liquor pump is started, hot liquor would fall on the worker. In such instances, only when the screams of the worker is heard, it is realised that there has been a mistake in opening the inlet valve and starting the pump. By then it is too late. Locking the inlet valve alone is not sufficient as a solution, since the valve could be defective and could leak. The remedy is to lock the electrical switch and the suction and delivery valves by a double locking arrangement. Both the men entering the Kier and the supervisor should lock the switch and the valves by means of separate set of locks and carry the keys with them.

Where more than one Kier is installed, and the discharge pipes from them are connected to a common discharge pipe, there is a possibility of the hot liquor flowing back to the individual discharge pipes and falling into any Kier, if by chance its discharge valve is not closed. To prevent such accident, there should be a separate pipe from each Kier.

The Kiers are pressure vessels and there is a potential danger of their bursting if the normal precautions of periodic inspections and maintenance are not adopted. There are instances of the top end shell plate of the Kier having been sheared off at the circumference and thrown up breaking open the roof, then travelling about 100' horizontally and falling down like an inverted basket. Such incidents have very high potential to cause injuries and damage and call for strict adoption of control measures. Even though Kiers are not directly connected with any high pressure steam lines, still such mishaps have occurred. In a Kier installation, normally, the live steam line is connected to the jacket of the pre-heaters through reducing valves and the liquor passing through the tubes of the pre-heater are heated. The pressure normally existing in a Kier is very small and this is due to the steam generated by the heat transfer in the pre-heater and this is not likely to be high enough to shear off the Kier shell. It is found in such accidents that either the reducing valve on

the steam line to the pre-heater is not provided or is out of order and the tubes or tube plates of pre-heater are corroded and leaky. Such conditions allow leak of steam and consequently the build up of steam at the boiler pressure within the Kier, causing the explosion. To prevent such accidents, thorough examination of the Kier and its various parts particularly the pre-heaters and pressure tests should be carried out periodically.

3. Shearing, Cropping and Singeing Machines

These are another group of dangerous machines used to give further finish to the cloth.

The shearing and cropping machine can shear off anybody's finger or hand which comes within the reach of its revolving blades. The blades are therefore to be covered with an enclosure having either mechanical or electrical interlocking arrangements.

In the case of singeing machine, a possible hazard is fire or explosion. In this machine flame is used to burn the furs on the cloth. In the burners, petrol gas is normally used. For this purpose, petrol gas generators are installed to produce petrol gas. In such generators, liquid petrol is converted into gas by passing steam in the jacket or coils of the vessel containing petrol. The gas so generated is stored in gas holders and supplied to the burners. It is normally found that flames traps and non return valves are provided at the gas generating unit. Still, there are instances of fires and explosions. Sometimes, the flame travels back from the burners through the air pipes and comes out at the suction end of the air blower causing serious burn injuries to workers working nearby. To prevent such accidents, it is necessary to provide flame traps and non return valves on both the gas and air lines. They should be located both near the burner end and the gas generating plant ends. Gas singeing machines having carburators eliminate such dangers.

DYEING, PRINTING AND DRYING

After bleaching, the cloth is either dyed or printed. Batch process of dyeing is carried out on machines called jiggers in which the main hazard in that of splash of hot liquids. It is necessary to provide suitable splash guards to control splashing to the extent possible end to supply personal protective equipment such as apron, gloves, gum boots and face shield to the operators.

1. Printing Machines

In case of printing machines, the danger is more due to trapping of fingers between the pressure and the printing rolls near the doctor blades. This can be prevented by providing proper nip-guards or slit guards. In respect of printing done by certain types of colours, ageing or polymerising is required to be done to fix the colours. This is done by passing the cloth through ageing or curing machine, also called polymerising machine. Kerosene or other solvent is normally used in preparing the paste of such colours and when the printed cloth is passed through the polymerising machine, there is a possibility of formation of an explosive mixture of kerosene vapour with air, if proper exhaust arrangement is not provided. Serious explosions have taken place in the past in polymerising machines and therefore, measures for preventing such accidents need serious consideration and priority.

The most essential step to prevent such explosion is to ensure that the cloth is dried sufficiently before feeding into the polymerising machine. Exhaust fans of adequate capacity should be provided and installed in such a manner that the concentration of the solvent in the air in the chamber of the machine is kept well below the recommended level. The feeding mechanism should be so interlocked with the fans that the former would not work without the fans having been switched on. Also suitable safe working procedures should be drawn up and

adhered to strictly. Further, explosion vents should be provided in the machine as per recommended standard.

2. Drying

After bleaching, dyeing and printing processes, the cloth is required to be dried. This is normally done on vertical or horizontal drying ranges. These drying ranges are made up of copper or stainless steel cylinders which are heated by passing steam at reduced pressure. The main hazard is bursting of cylinders due to high pressure steam entering the cylinders. Such accidents could be prevented by ensuring that the required normal precautions in operating such "pressure vessels" as required by the Factories Rules are strictly followed.

MISCELLANEOUS

In addition to the dangers on machines, there are chances of accidents due to sources such as chemicals and acids, slippery floors, handling of materials, etc. Great care is required while handling acids and other chemicals. Suitable containers should be used for carrying them. Personal protective equipment like aprons, gloves, face shields and gum boots should be used while handling acids and other chemicals. There should be a continuous system of safety education to ensure that workers use such safety equipment and adopt the safe procedures.

I may mention at the end, that safety cannot be achieved unless everyone concerned co-operate and work together. It is no good just having safety devices. It should be ensured that they are in good working order. Rather than providing a safety device which does not work, it is better not to have it at all. Any warning device must be reliable, if it has to serve its purpose of providing timely warning, but its reliability will finally depend on its good maintenance. Maintenance and inspections are therefore an essential part of safety. It is no good to have a safety device if people on shop floor would not use it. You have to convince them and get them to use it and to understand

how to use it. The human factor, which is often neglected is a vital link in prevention of accidents. It is only through integration of measures for control of the physical or mechanical conditions with those for control of the human factor that safety can be achieved.

B. RAMACHANDRAN

Prevention of Accidents Caused by Metal Shields of Paper Ring Tubes

It has often been reported that many accidents involving injuries to fingers have been caused by the metal shields fitted to the bottom of the wooden bobbins or to the ring paper tubes used in spinning in the textile industry. Since we have been interested in this problem not only by virtue of our being the suppliers of paper ring tubes but also because of our association with the Indian Standards Institution in evolution of proper standards for paper tubes and aluminium plug type spindles. We have studied this problem at the mills and also conducted detailed experiments in our factory in consultation with our collaborators M/s. T. P. T. Limited, ROMILEY, U.K. We also had the benefit of active guidance from several Spinning Masters of Textile mills. The factors which had struck us as significant during our study are mentioned in this paper.

Metal Shields are provided to bakelised paper tubes in order that the edges may be protected from premature wear and tear and its life consequently prolonged, particularly where water or steam conditioning is involved. In cases where yarn is not conditioned, the life of bakelised paper tubes fitted with shields can be as long as six years. In other cases, a life of two to three years under normal handling could be expected.

When the problem of cracking of ferrules with consequent injury to the fingers of operatives on the spinning frames came to our notice, in a few cases, we studied the behaviour of our

tubes as well as those supplied in India in general. We felt that one of the reasons might be due to the fact that ferrules particularly made out of tin sheets were annealed before they were fixed to the paper tubes. This was done to avoid steps inside the tube at the base edge and to make ferrules flush with the body of the tubes. Annealing, however, had its own problems and in view of these, we took a decision not to have any annealed ferrules. Further, tin sheets particularly those used by outside suppliers, that is, when we were drawing our requirements from outside sources, were varying in gauge ; and when they were unduly thin, tended to give way under repeated use. Effect of water with high salinity is also a factor contributing to rusting and peeling of ferrules but this is not an exclusive feature on tin ferrules alone as water with such high salinity has affected even ferrules made of brass, galvanised iron etc.

It was, therefore, decided by us that we should manufacture ferrules ourselves and fit them to tubes without annealing. We have also evolved special processes to ensure that the ferrules are fitted properly minimising the chances of getting distorted or cracked. We have found during the past two years since we started making ourselves the bulk of our requirements of ferrules that wherever we have supplied tubes with tin ferrules manufactured by ourselves, there have been very few accidents due to cracks.

On a study of the operations in the spinning frames it was found that piecing of yarn is done by the worker first by stopping the running spindle with the index finger and then piecing the yarn when the spindle comes to a halt. The spindle has an acorn which is fairly long e.g. about 1" to 1½" and this provides enough space for the finger of the operative to be encircled around the spindle. However, such a procedure causes burns to the finger due to heat generated by friction though the worker in course of time would get used to it by repeated operations. Even so, he tends to avoid this by stopping the spindle above

the acorn. When the finger is held around the lower portion of the yarn wound on the paper tubes no heat is generated and it is, therefore, much more comfortable for the worker to stop the spindle at the base of the portion of the spindle with yarn wound on it than on the acorn. The workers are, however, not allowed to touch yarn as the package gets soiled with oil and grease smeared in their fingers. With this constraint, when the worker tries to stop the bobbin holding the acorn with his fingers, his fingers are likely to come down to the portions having the metal shield, when any broken edge of the shield is likely to cause an injury. The obvious course is, therefore, to see that the worker is encouraged to use the acorn avoiding slipping of his fingers down to the area of the metal shield. Also, bobbins with damaged metal shield should be discarded.

Use of knee brakes is another effective remedy for avoidance of injuries due to cracked ferrules. Under this method, the spindle is stopped by a brake operated by the knee which gives freedom to both the hands for piecing. In the initial stage when the worker is not conversant with the use of knee brakes, he may be reluctant to use them, but with training, use of these brakes would facilitate doing the piecing operation quickly and safely. Also, there would be no possibility of injury either by heat generated by spindles at the acorn or by metal ferrules piercing the fingers. We would, therefore, suggest that the seminar should give due consideration to this method of controlling accidents from damaged metal ferrules and seek ways and means of promoting the provision and use of knee brakes on spinning frames.

This suggestion does not preclude the necessity for ensuring that metal shields of bobbins are of good quality and that they are fixed to the tubes properly. As stated earlier, our efforts in improving the quality of the metal ferrules and the method of fitting them have helped in reducing the accidents from broken ferrules considerably. We trust that these methods will also be adopted with advantage not only by other manufacturers of paper tubes but also the manufacturers of wooden bobbins as well.

Discussion

PAPER I

Q. While feeding the lap at the feeding end of the carding machine, there is a chance of the fingers being injured by the licker-in as the licker-in could be reached from this end also. I have known of a few accidents from such contact with licker-in. How to prevent such accidents ?

A. I do not think that the licker-in can be reached while feeding the lap. Probably, the accidents referred to have happened only at the nip between the feed table and the fluted feed roller. During the normal operations, an operator need not bring his fingers to the close proximity of the nip between the feed table and the feed roller, since the lap end of the new lap roll would automatically be taken in by the machine if the lap end is placed over the tail end of the lap which is already within the machine. The danger arises while feeding the initial lap when the fingers have to be brought close to the nip. Since guard is difficult to be provided, the remedy lies in ensuring that this operation should be done only by sufficiently trained workers.

PAPER II

Q. The contention that shuttle flying causes work smashes and thereby production lose, is not correct because shuttle flying will never cause smash. The speaker has held the management responsible for accidents due to shuttle

flying, which is also wrong because shuttle flying is due to entanglement of broken ends in the shed or presence of some foreign matter in the shed for which weaver's vigilance is very essential. The negligence of the weaver in not attending to those and rectifying them immediately causes shuttle flying. Similarly, tempering with the shuttle guard is also common. The weaver lifts the guard for easy shuttling. Hence the weaver is more responsible for shuttle flying accidents.

A. : As regards "work smashes", I think the confusion is because of the different meanings attributed by me and Shri Singh who asked the question. The word smash is used in our area when a large number of threads are broken on account of shuttle flying. If only one or two threads are broken, it is not considered as a "smash". In an isolated case, shuttle may fly without creating a smash as mentioned. But by and large, every shuttle flying creates a smash.

As regards the other part of the question, it cannot be denied that workers sometimes are not careful enough, but the overall responsibility for preventing accidents is that of the management. If proper maintenance is not done, I think the responsibility should be entirely that of the management. Further, though the management could assign responsibilities, it cannot abdicate the overall responsibilities for carrying out the various operations in a safe manner. I would also like to clarify that all causes for shuttles flying cannot be controlled by the worker.

Chairman : The management fail many times. Vigilance should be there on the part of supervisors. Correct type of guard should be provided. Regular checks should be made at the time of weaving.

Q. Environment at home affects the mind of the worker and his performance in the factory. There is also a marked

tendency seen on the part of the workers to work in a hurried or careless manner and take undue advantage of the ESI and other benefits.

Intoxication is another factor in accident causation. Again, there is the important question of providing proper training to workers before entering the factory. In Rajasthan, the persons available for recruitment are not educated. How could this problem be solved ?

Chairman : Pre-employment training should be given by the industry. I feel that it is not important whether the worker is a matriculate or having similar educational qualifications. Proper job training is what is necessary, so that he can do his job effectively.

Q. We do not have a suitable cadre to give them training and put them to work. When we have workers, we have such type of workers who do not want to go for training. In industry, admittedly, training and retraining is essential. This has to be done by the Government. A partidular level fo education is also necessary.

A. Training within the industry will be the best solution.

Chairman : I do not think that it is important that all workers are highly educated. I consider that even a person knowing how to write or has passed the 5th Standard and has been given proper training would be a very good weaver or a spinner. We should not confuse skills and abilities to do a job with literacy.

Q. If a man has passed only 5th Standard, he is not suitable enough for the job.

Chairman : It is a question of opinion. There are people who may be matriculates or even graduates but not doing the work upto the standard. Aptitude and training are the essential ingredients. If you go to Bombay or Ahmedabad

you would come across very good weavers among certain communities. They are hard working and have acquired this skill, so to say, as a tradition. There are other examples too. It is not necessary that training can be given only if. a worker is educated.

PAPER III

Q. While threading cloth on a felt calendering machine, fingers get caught between the guide roller and the main cylinder. What should be the remedy ?

A. A suitable nip guard can prevent such accidents. If the nip guard presents difficulty in threading of cloth, it could be overcome by sticking the cloth end on the main roll and not attempting to feed the end to the nip directly by using fingers.

Q. In the processing department, threading should be done while the machine is in motion. How are accidents to be avoided ?

A. The machine should be stopped for doing this operation. Inching arrangement should be provided to facilitate the work. Also, the worker should be a fully trained person.

H. C. JAIN

Summing up

The papers presented in this session relate to the typical accidents that take place in the various departments of the textile industry, right from the spinning preparatory to the finishing processes. I must indeed congratulate the authors for their painstaking collection and analysis of data with respect to the various types of accidents and suggesting appropriate control measures for minimising accidents as far as possible. I do not want to go into the details of the figures as it has already been ably dealt with by the speakers. But one thing I would like to remark by way of summing up is about the method of approach in tackling this problem of accidents which is evidenced by these presentations. In trying to seek solutions, it is extremely important that appropriate techniques are used. For example it is essential that all accidents that take place are analysed and the causes in terms of unsafe physical conditions and unsafe actions assigned. So also, the other factors such as " agencies " responsible for the accidents are to be identified, so that appropriate control measures can be devised and adopted.

I would also like to refer to two of the most common types of accidents. These are accidents due to broken or damaged shields of bobbins in the spinning process and due to flying shuttles in the weaving process. I have no doubt that sustained efforts by managements with the co-operation of the employees and trade unions could positively achieve the desired reduction in accidents. Although the textile industry is more than 100 years old, serious efforts, in my opinion, have not been made by the managements, workers and labour unions for the prevention

of accidents. We are not putting in this direction even a small fraction of the efforts that we put in for achieving better quality, efficiency and productivity.

In the morning session, Shri Buch stressed the value of penal action as a remedy. There I would not agree with him. I would, on the other hand, suggest a suitably worked out weightage in E.S.I. contribution so that there will be an incentive to those factories which take measure to control accidents. I would also suggest that the best mills with excellent safety records be spotted by the Safety Councils and visits to these mills arranged so that those interested could be benefited by studying the techniques being followed successfully by the former.

Another important point brought out by the speakers is that besides the various physical safeguards to be provided, it is equally important that the management establishes the appropriate and safe procedures of working and that it is ensured that these procedures are followed in actual practice. The need for effective supervision as well as education and motivation was also rightly stressed.

Various investigations have clearly indicated that in controlling accidents, the following measures are basic ingredients for building up a good safety organisation.

1. A clearly defined policy to make known the top management's interest and intentions. Assignment of responsibilities to be departmental heads and operating personnel.

2. A qualified and competent safety officer with requisite status, staff and authority to enable him to function effectively.

3. A properly drawn up system of accident investigation, reporting and plant inspection to discover the potential

causes of accidents, followed by appropriate remedial measures.

4. Continuous promotional activities aimed at involving employees and supervisors in effective accident prevention efforts.

With efforts organised appropriately, it is definitely possible to drastically out down accidents.

TECHNICAL SESSION

Occupational Health

DR. HARWANT SINGH

Health Hazards In Textile Industry

The textile industry is one of the largest employers of labour, not only in India but throughout the world. Out of the many health hazards that exist in the textile industry, the important ones arise from cotton dust, noise, toxic substances, excessive temperature and humidity, poor ventilation and lighting, scalds and drowning from bleaching Kiers and cross infection from "shuttle kissing". Of these, those subjects which would be dealt with by other speakers are not discussed in this paper.

COTTON DUST

1. Mill Fever (Cotton Cold)

Almost all workers suffer from mill fever or cotton cold, when they begin to work in the cotton mills and who have not previously been exposed to the dust. Tolerance is developed usually within a few days. Symptoms may reappear following an absence from work for 2 to 4 weeks. No specific cause has been found.

Workers complain of dryness of the throat, headache, sense of feeling ill all over, with slight rise of temperature. Attacks of sneezing some times occur. In a few cases an urticarial rash appears.

2. Byssinosis

It is a progressive respiratory functional disability resulting

in total disablement, if exposure to cotton dust continues. It is characterised by a sensation of tightness of the chest and is experienced principally on the first working day of the week after the week-end's leave or after periods of absence from the work spot. It is associated with a significant fall in the ventilatory capacity and a progressive increase in airways resistance during the course of the day. The disease may progress to emphysema and corpulmonale and is usually reversible during its early stages or removal from the dusty atmosphere, but may not be so after long periods of exposure.

Four stages are recognised in the development of this disease.

Grade ½ — Occasional chest tightness on the first day of working week. (Monday — Europe and India, Saturday — Arab countries).

Grade 1 — Regular chest tightness on the first day of working week.

Grade 2 — Chest tightness on first and other days of working week.

Grade 3 — Grade 2 symptoms accompanied by permanent incapacity from diminished effort, intolerance and/or reduced ventilatory capacity.

3. Weaver's Cough

It is out-break of an acute respiratory illness, occurring from time to time and varying in severity from dry cough (weaver's cough) to severe asthma occurring in cotton weaving sheds.

Here also no specific cause has been found but the dust from the size applied to cotton yarn is held responsible. The sizing materials used are kernal of tamarind seed, sago, maize, potato starch, etc. About 1/20 of the size gets removed during

weaving, out of which some remain floating in the air and the rest falls on the floor.

4. Acute Respiratory Illness from contaminated cotton

Acute illness can break-out among people handling dusty, low-grade, stained cotton.

Symptoms usually begins within the first 6 hours of exposure. There is fatigue and generalised aching, anorexia, headache, nausea followed by vomitting and vigors with a temperature of 102°F. Some may complain of abdominal pain and retrosternal discomfort on taking deep breath. Symptoms last from 2 to 5 days.

This illness is a distinct clinical entity not connected with byssinosis.

NOISE

The noise in a weaving shed is a continuous roar and clatter, the composite result of a number of sounds of considerable intensity generated usually by various parts of a large number of looms.

Gears, cams and picking mechanism are mainly responsible for the noise, the intensity level of which, in a shed of medium size, is about 96 decibels (dB).

As you all know, the excessive noise is definitely harmful. Therefore, the remedy should, if possible, be found in the modification of noise generators, thus suppressing or reducing noise at its source, rather than in equipping persons exposed to excessive noise with some noise screening or damping device.

The method adopted to alter the normal noise environment of the weavers is to equip them with ear defenders — special plugs and muffs. The object is to reduce the noise level by about 15 dB.

Tolerance to noise in some measure can chiefly be in the psychological sense. Thus, it is possible to become so accustomed or acclimatised to noise that consciousness of its subjective effects — irritaton, annoyance, distraction — ceases to become less acute, but its deleterious effects remain and are revealed only by objective measurements.

Excessive noise is to the human organism very much as excessive friction is to the machine — it wastes energy.

TOXIC SUSTANCES

Toxic substances are encountered in
(a) manufacture of artificial and synthetic fibre, and
(b) in dyeing, bleaching, finishing and printing sections.

Depending on the type of chemical to which persons may be exposed to and to the extent of exposure, acute or chronic effects may result. It may lead to systemic poisoning or give rise to local conditions such as eczema and dermatitis.

Care must be taken that bleaches, acids, solvents, dyes and other chemicals do not come in contact with the skin. For this purpose, necessary personal protective equipment should be used, wherever necessary.

Also, it is necessary that wherever the hazard arises from inhalation of toxic substances, appropriate well known control measures should be adopted to reduce the concentration of these agents in the environment. Good house-keeping of the plant is equally important.

DERMATITIS

Since mostly, dermatitis is produced by long continued intimate contact with chemicals or mineral oils, personal cleanliness to reduce the duration of contact with such materials is a most important factor in any pervention programme.

Oil dermatitis is found in fitters, jobbers and oilers of various departments. This skin condition results from contact with cutting oils. It starts with irritation of the skin by continuous contact with oil leading to the formation of black heads or commedones. This then gets infected to form oil acne. Oil dermatitis always results from dirty workman in dirty oil. Individuals vary in susceptibility but given sufficient exposure and time any one will develop the condition.

ATHLETE'S FOOT

Dermatophyte infection of feet is found in Bleaching Department due to continuous contact with wet floor. The infection is transmitted to the webs of the toes and gets a chance to grow if the toes are not kept clean and dry.

EYE STRAIN

This hazard is commonly found in Drawing-in department. The operation of drawing-in is a skilled job wherein the design of cloth is determined by adjusting every thread individually on a beam. Consequently, during the course of years they develop asthenopic symptoms. Periodic eye check up is done for the early detection of cases. It is equally important that adequate illumination is provided at this task to prevent eye strain.

SHUTTLE KISSING

The weft cop or bobbin of a non-automatic loom shuttle has to be replenished every 4 – 5 minutes and this is done by placing the lips against the shuttle eye and sucking up the thread The operation of 'shuttle kissing' is done a few hundred times. a day by each weaver. This practice is unhygienic becuase fibre dust from the wet yarn is drawn into the mouth. Also, in shift work, 3 different weavers use the same shuttle resulting in cross infection.

CONCLUSION

In conclusion, I would say that proper handling of materials, regular maintenance of the machinery, educative training to workers and regular periodic medical check-up will reduce the hazards to health.

R. G. KULKARNI

Dust Control in Textile Processes

Environmental planning in textile mills relates to three separate units ; dust, noise and safety. Today, we are concerned with the first namely dust, and the related issues are :

i) Why is it necessary to control dust in textile mills ?
ii) What generates dust ?
iii) How to control dust ?

WHY DUST CONTROL

Clean pleasant and safe conditions of work are not only desirable but essential to the efficient and profitable running of a progressive textile mill.

One of the main reasons that prompted the U.S. legislators to enact the Occupational Safety and Health Act (OSHA) and U.K. to enact the " Health and Safety at Work Act 1974 ", was the predominance of byssinosis, the respiratory disease found among textile workers. Byssinosis may be one of the most important problems facing textile mills in India during the coming years. Recent findings about byssinosis have jolted textile men and in a somewhat characteristic reaction, the industry is trying to hide the problem, hoping that it will go away. In our country, very little or no information is available on the prevalence of this disease among our textile workers. However, judging from the mass of information available from the textile industry abroad and knowing the very poor conditions of work prevalent in our

textile mills, one would shudder at even the thought of the health of our textile workers. Our legislators do not seem to have applied their minds to this problem when reports and surveys on byssinosis are pointing to a prevalence of the disease among textile workers. One doctor in the U.S.A.. has publicly stated that, if a textile worker suffered from any chest complaint, or symptoms common to bronchitis and byssisnosis, he would diagnose the worker as byssinotic. Such medical diagnosis would clear the way for the workmen's compensation claim. A 54 year old textile worker in U.S.A. who filed for workmen's compensation claiming that he contracted byssinosis, reportedly received $ 10,000 in out-of-court settlement from his firm's insurance company.

Findings have revealed that some seven different types of enzyme found in cotton waste, which enter the lungs of the workers by way of inhaled dust, are responsible for the disease.

WHAT GENERATES DUST

For the past 30 years, textile industry all over the world, like all manufacturing industries, has worked on a schedule to increase output per man hour. Employee machine assignments and machine speeds have zoomed over the past few years. Draw frames that ran at 36 mpm (120 fpm) in the late 1950's have been out-dated by speeds of 430 mpm (1400 fpm) on today's machines. Cards that produced 2.7 kg/hr (6 lb/hr) during the same period now work upto 45 kg/hr (100 lb/hr). This boom was possible by equipping older cards with individual high speed drives, high speed ball bearings at cylinder and doffer and using metallic wire on both. Roving frames that ran at 400 to 600 flyer rpm have been shot down by frames with flyer speed upto 1400 flyer rpm. These production increases have been a key factor in the survival of the textile industry. But there have been consequences. Over the years, dust and the number of disabling injuries per million employee hours have risen along with productivity in the manufacturing industries.

Increases in machine speeds and productivity have also resulted in obvious increase in noise levels.

Stack emission from drying and dyeing of many fabrics is recognised as a source of air pollution. There are many dye houses whose stacks emit a bluish odourous haze generally caused by the drying and heat setting of man-mades. The problem appears to be the emission of oily effluents with some or the material particularly broken down by the heat in the stenters. Installation of mist eliminator is one of the ways of overcoming this problem. The demister unit used for this purpose, comprises of a number of vertically packed beds of fine fibrous material. As an oily mist passes through the demister, it is coalesced to form larger droplets and get collected and drained by gravity with 99.7% removal efficiency.

Cropping and shearing machine used in the finishing department is another machine where quite a lot of dust generation takes place.

It has been found that when the installation of dust collection units on machines in a mill is complete, the improvement in working conditions and the quality of cotton, wool, their blends with man-made fibres, or cloth processed is very marked.

CONTROL OF DUST

There is a clear distinction between the process dust which is continualy generated during processing of fibre and the local dust clouds formed during the intermittent processes of grinding and cleaning of the machines. The local exhaust appliances which I shall describe are designed to remove only the process dust and I wish to emphasise again that the use of the suction stripping apparatus by application of exhaust draught during grinding, cleaning, brushing etc. and the use of pneumatic systems for the removal of waste are all of the greatest importance in maintaining a dust free atmosphere in any department.

Control of dust in opening and blowing rooms should receive the most careful consideration in every mill not only because it reduces the amount of dust sent forward to the cards and thereby assists in maintaining a dust free card room but also because it reduces the amount of dust to which the workers in the opening processes are exposed. Oiling the cotton is no longer considered as a satisfactory method of dust control as was originally thought.

Of all the machines that rank near the top in producing dust in a cotton mill, the card is the leading culprit. The card is responsible for removing fine non-lint materials from the fibres and it is difficult to keep some of these materials from getting into the air. By its location in the processing chain-carding is only a couple of steps from the gin — the card processes stock still near its virgin state.

Dust is generated in many processes in a textile mill and the largest amount is evolved in the spinning department, that is, from the blow room to the ring frame, as cotton and other fibres are almost in a dry state when being processed by the machines in the spinning department. Development of dust collection devices has therefore to be concentrated on spinning machine.

MAINTENANCE

The importance of good maintenance if dust collection equipment is to be kept at full efficiency, has to be emphasised If the devices are to perform satisfactorily year after year, it is essential that they, and all the equipments associated with them should be kept in first class condition and that the flow of air in the ducts should at all times be maintained at the recommended levels. This can be ensured only if maintenance is systematic and is carried out by persons specially qualified and appointed for the task. To provide for routine tests at regular intervals, it will be necessary to make provision in the ducting for the use of suitable instruments.

It is also essential that the workers should co-operate in ensuring proper maintenance of the devices. The removal of large volumes of air from any department by the use of exhaust ventilating equipment will obviously create problems about the maintenance of the correct temperature and humidity. Extracted air must either be filtered and recirculated or it must be replaced by fresh air which may have to be cooled and/or humidified. The returned air should be free of dust.

MACHINES AND EQUIPMENTS

There are many devices available for application on different machines and I shall now describe some of the equipments that we manufacture.

1. Rotary Filter : This equipment can be fitted to a blow room line or can also be used as a central dust collection unit for a group of cards. The equipment essentially consists of a primary filter comprising of a perforated drum, rotating at a speed of about 1 to 3 rpm on which dust from the blow room line or a group of cards is deposited after being drawn through exhaust ducting by a powerful material handling fan. The dust is then delivered in the form of a mat or sheet into a trolley. The very low speed of the rotating cylinder allows accumulation of dust on it to form a mat. The exhaust air passes through a filter bag arrangement known as a secondary filter and clean filtered respirable air can then be circulated back to the department or discharged into the atmosphere as may be desired. Installation of a Rotary Filter in the blow room line will do away with the requirement of a cellar for deposition of dust.

2. Dust Collection unit for Cards : This is available as an individual unit for application on each card with a filter box, plenums and individual drive. Suction is applied at the points at which dust originates. A carding engine basically comprises of three large rotating cylinders, the licker-in, the cylinder and the doffer. When these cylinders rotate at high speeds, dust is generated. The equipment that we make provides for collection of dust :

i) between licker-in and cylinder,
ii) cylinder and doffer,
iii) doffer comb,
iv) calender roller, and
v) underneath the flats.

However location of the suction pipes or the plenums depends on the type of carding engine and its construction. The suction ones are common to the individual or central collection system. In the individual system the filter box to collect the dust is located at the top of each card whereas in the centralised system, the location of the collection chamber is at a remote place.

3. Draw Frame : On the draw frame suction system is similarly applied for collection of dust generated within the drafting zone by provision of hoods connected to an exhaust system, comprising of a filter box, a filter and a drive system.

4. Speed Frame : Here too we offer a suction system designed for collection of fly and broken roving.

5. Ring Frame : The system of broken end collection on the ring frame comprises of a filter box with filter, drive system ducting, flutes and accessories. This system is known by the common name of pneumafil and is widely accepted.

Similarly, the provision of overhead travelling clearners of the suction and blowing type, as offered by us, will help in removal of dust and mechanised cleaning of machines.

6. Winding Machine : On this machine also, we have designed and supplied suction equipment and overhead travelling cleaners which have considerably added to the efficiency of the operation and the quality of the yarn package. This has substantially increased the efficiency of the subsequent processes.

7. Cropping and Shearing Machine : This machine also, generates a lot of dust. For this machine, we provide along with

the machine, a set of filter bags and blowers by which the dust created during the cropping and shearing on the cloth is collected in the filter bags and clean dust free air exhausted through filter bags.

CONCLUSION

Our experience with textile industry in particular, forces us to conclude that unless environmental control measures are enforced through legislation and penalties imposed for non-compliance of regulations very few textile mills will, of their own accord, invest in dust control equipment which is looked upon as a luxury to be indulged in only by the prosperous textile mills.

Textile mills should realise that provision of better working conditions will pay for the funds invested through greater out-put by workers per man-hour, less absenteeism on account of ill health, value realised through better quality of products, sale or re-use of some of the waste collected, etc. Mills should thus voluntarily come forward to seek advice from experts in environmental planning, and provide all co-operation and facilities to design dust control equipments and to evaluate their efficiencies and towards development of new facilities and equipments. Government should also permit import of prototype instruments and gadgets that have been developed successfully abroad to carry out tests and experimentation. Similarly, there should be suitable industrial medical facilities available in the mills both to look after the health of the textile workers as well as collect statistical data. In all these matters, the Factory Inspectorate can provide great influence and assistance.

In this matter, the following suggestions if implemented will provide great relief to workers.

i) Provision of respirators to workers exposed to dust.

ii) Collection and analysis of data in order to improve control measures.

iii) Use of suction instead of air pressure in removing dust and lint from floors and machines.

iv) Avoiding use of compressed air at more than 30 psi for cleaning purposes.

v) Provision of proper ventilation and adequate number of air changes in all rooms.

iv) Provisions for collection of dust at the source of dust generation.

L. G. BARTAKE

Maintaining Desirable Thermal Condition in Textile Mills —Methods & Limitations

BASIC THEORETICS

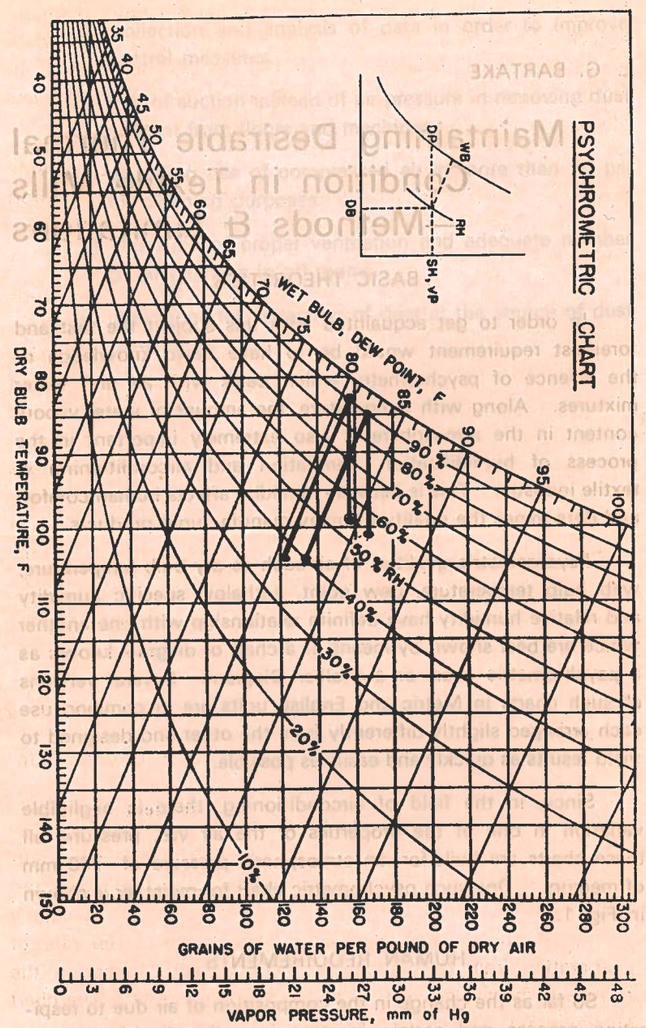
In order to get acquainted with this subject the first and foremost requirement would be to have basic knowledge of the science of psychrometry which deals with air and water mixtures. Along with temperature, the amount of water vapour content in the atmosphere is also extremely important in the process of humidification, ventilation and airconditioning in textile industry. This is because humidity affects human comfort and determines the quality of many manufactured products.

Psychrometric qualities of air such as dry bulb temperature, web bulb temperature, dew point, enthalpy, specific humidity and relative humidity have definite relationship with one another which are best shown by means of a chart or diagram known as a psychrometric chart or a Mollier Diagram. Several versions of such charts in Metric and English units are in common use each arranged slightly differently from the other and designed to yield results as quickly and easily as possible.

Since, in the field of airconditioning, there is negligible variation in one of the properties of the air viz., pressure, all these charts are built for an atmospheric pressure of 760 mm of mercury. One such psychometric chart for moist air is shown in Fig. 1.

HUMAN REQUIREMENTS

So far as the change in the composition of air due to respiration process and certain increase in carbondioxide content



Psychrometric Chart For Moist Air
Fig. 1

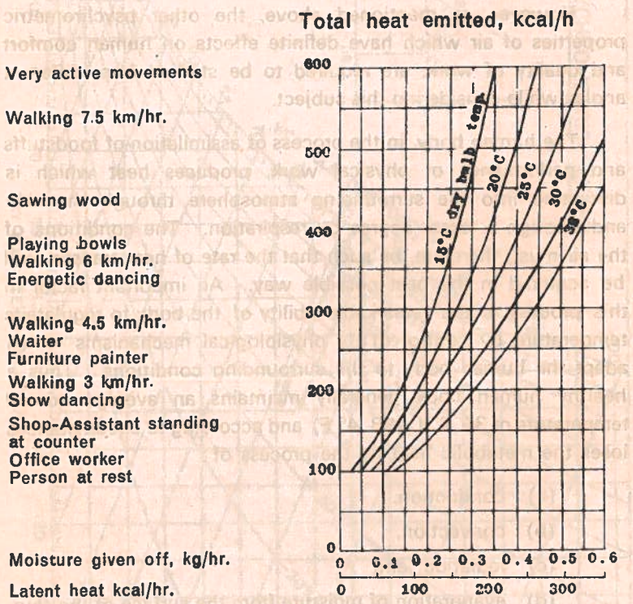
brought about by it is concerned, the investigations of many hygienists have revealed that this is an insignificant factor while considering environments in industrial environments, and, in particular, in textile mills where the room volume per worker is always quite large.

However, as mentioned above, the other psychrometric properties of air which have definite effects on human comfort and quality of work, are required to be studied from different angles while considering this subject.

The human body, in the process of assimilation of foodstuffs and performance of physical work, produces heat which is dissipated into the surrounding atmosphere through the skin and through a lesser degree by respiration. The conditions of the air must, therefore, be such that the rate of heat transfer will be acquired in the best possible way. An important factor in this process is the remarkable ability of the body to regulateits temperature by control of its physiological mechanisms which adapt the human body to the surrounding conditions. Thus a healthy human body generally maintains an average normal temperature of 36 . 8° C (98 . 4° F) and according to circumstances loses the metabolic heat by the process of :

(a) conduction,
(b) convection,
(c) radiation, and
(d) evaporation of moisture from the surface of the skin.

If the air temperature is less than that of the skin, this regulation occurs primarily through the first three means viz., conduction, convection and radiation. However, when the skin and surrounding air are at the same temperature and also when the skin has a lower temperature, thermo-regulation occurs by means of the fourth available means, i.e., evaporation. The rate of evaporation from the surface of the skin will depend on the relative humidity and velocity of the surrounding air. The chart shown in Fig. 2 indicates the details in this respect.



Heat and moisture emitted by humans

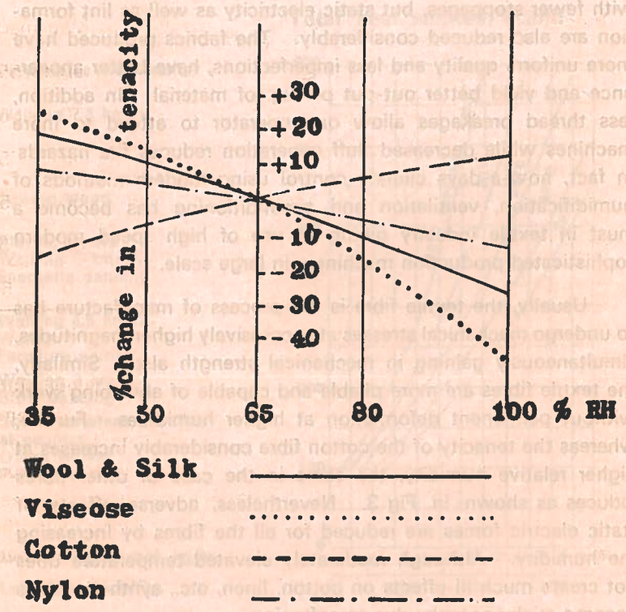
Fig. 2

PROCESS REQUIREMENTS

As far as various production processes are concerned, the benefits of humidification, ventilation and airconditioning in textile industry are well known. Not only does thread gets stronger allowing closer machine adjustment and higher speed with fewer stoppages, but static electricity as well as lint formation are also reduced considerably. The fabrics produced have more uniform quality and less imperfections, have better appearance and yield better out-put per kg. of material. In addition, less thread breakages allow one operator to attend to more machines while decreased fluff generation reduces fire hazards. In fact, now-a-days climate control using modern methods of humidification, ventilation and airconditioning has become a must in textile industry owing to use of high speed modern sophisticated production machinery in large scale.

Usually, the textile fibre is the process of manufacture has to undergo mechanical stresses at successively higher magnitudes, simultaneously gaining in mechanical strength also. Similarly, the textile fibres are more pliable and capable of absorbing work without permanent deformation at higher humidities. Further, whereas the tenacity of the cotton fibre considerably increases at higher relative humidity, the same in the case of other fibres reduces as shown in Fig 3. Nevertheless, adverse effects of static electric forces are reduced for all the fibres by increasing the humidity. Although moderately elevated temperature does not create much ill-effects on cotton, linen, etc., synthetic fibres become sticky or tacky due to softening.

Taking into account all these factors and the experience accumulated over several years in this field, the required relative humidity conditions for different textile operations could generally be recommended as indicated in Table 1. These limits are to be taken as general recommendations only, since continuous improvements in machinery and environmental control systems may suggest adoption of standards somewhat different from those once considered optimum for a particular process or fibre.



Effect of Humidity on Tenacity of Various Textile Fibres.

Fig. 3

TABLE 1

RECOMMENDED RELATIVE HUMIDITY LEVELS FOR SPECIFIC TEXTILE OPERATIONS ON DIFFERENT FIBRES.

	Relative Humidity in percentage		
Process	Cotton	Wool	Man-made
Opening and	50 to 55	65 to 70	50 to 55
Carding	50 to 55	65 to 70	50 to 55
Spinning Preparatory	55 ± 5	55 ± 5	55 ± 5
Spinning	60 ± 5	55 ± 5	60 ± 5
Weaving Preparatory	65 ± 5	55 ± 5	60 ± 5
Weaving	80 ± 5	60 ± 5	60 ± 5

HUMAN-CUM-PROCESS REQUIREMENTS

As mentioned above, due to ill-effects of high temperature on synthetic fibres, it is necessary to control the dry bulb temperature at the requisite level inside the departments where these fibres are processed. Generally, the recommended temperature range is from 26° C to 28° C, for all spinning processes whereas for weaving the same is 24 to 26° C, which along with the recommended percentage relative humidities as given above, automatically meet the human comfort requirements also.

However, in other cases such as in cotton textile mills where the manufacturing process does not call for rigid control of temperature but requires only a specific relative humidity at fairly constant level for the required process, an evaporative cooling plant alone is quite sufficient in most cases to obtain the desired results. These plants have the advantage of economy in the initial and running costs. The only snag with the use of such plants would be that the indoor temperature would rise and fall with the outside wet bulb temperature as shown in Table 2.

TABLE 2

RISE IN INDOOR DB TEMPERATURE OVER OUTSIDE WB TEMPERATURE WHILE USING EVAPORATIVE COOLING PLANT

Relative humidity inside the department In Percentage	Indoor dry bulb temperature in ° C above outside wet bulb temperature (approx.)
50	9 to 11
55	8 to 10
60	7 to 9
65	6 to 8
70	5 to 7
75	3 to 5
80	2.5 to 3.5
85	1.5 to 2.5

Therefore, during certain periods of the hot season when wet bulb temperature of the outside atmosphere is high, inside conditions would not permit human comfort. During such periods the body heat dissipation due to the processes of conduction, convection and radiation comes practically to a standstill ; hence all the metabolic heat has to be lost by the process of evaporation only. Due to requirements of elevated relative humidities for efficient production, the evaporation process is also unsatisfactory. The only remedy, therefore, is that the velocity of the air surrounding the human body is to be sufficiently increased to mitigate the heat stress. However, it has to be ensured that unduly high velocities are not created which would disturb the process, particularly in carding and ring frame sections. This could be achieved by adopting suitable air distribution methods.

The required air circulation rate under such circumstances, considering the recommended upper limits of effective temperature as shown in Table 3 could be found out by referring to the

basic scale of Corrected Effective Temperature chart (Fig. 4) in conjunction with a Psychrometric Chart (Fig. 1) in the following manner:

(a) Plot certain departmental conditions i.e. dry bulb temperature, wet bulb temperature, percentage relative humidity, etc., as maintained by an adequate evaporative cooling plant working for this department in a Psychrometric Chart, Fig. 1.

(b) Having obtained departmental dry bulb and wet bulb temperatures as above, jot these figures on the Corrected Effective Temperature Chart (Fig. 4) to obtain required air velocity for different effective tempratures upto the upper limits as given in Table 3.

Table 3

RECOMMENDED UPPER LIMITING VALUES OF EFFECTIVE TEMPERATURES

Conserations	Recommended Effective/ Corrected Effective Temperature °C.
1. Safe Tolerable limits for every day work :	
(a) Light work (energy consumption rate upto 150 K cal/hr.)	32.0 (89.6°F)
(b) Moderate work .. (energy consumption rate from 150 to 250 K cal/hr.) ..	29.4 (84.9°F)
2. Prevention of Steep fall in production. ..	28.9 (84°F)
3. For efficient production ..	26.7 (80°F)
4. For thermal comfort in light/ sedentary work ..	20 to 24.7 (68 to 76.5°F)

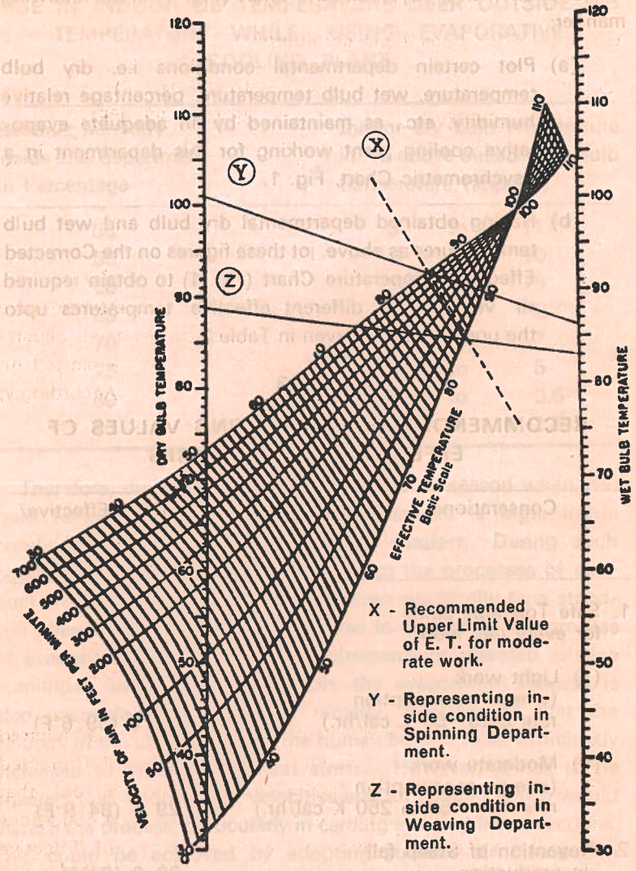


Chart Showing Basic Scale of Corrected Effective (or Effective) Temperature.

Fig. 4

For example, let us consider the case of a cotton textile mill with :

Given outside atmospheric conditions :

DB Temperature . .	40°C (104°F)
WB Temperature . .	28°C (82.4°F)

Required inside conditions

Spinning Section . .	55% RH
Weaving Section . .	80% RH

Considering that this mill is equipped with adequate evaporative cooling plant, the cooling process together with inside departmental conditions maintained by the same could be plotted on the Psychrometric Chart as indicated in Fig. 1. Accordingly, the inside departmental conditions will be for :

Spinning Section with 55% RH :

DB Temperature . .	38°C (100.4°F)
WB Temperature . .	30°C (86°F)

Weaving Section with 80% RH :

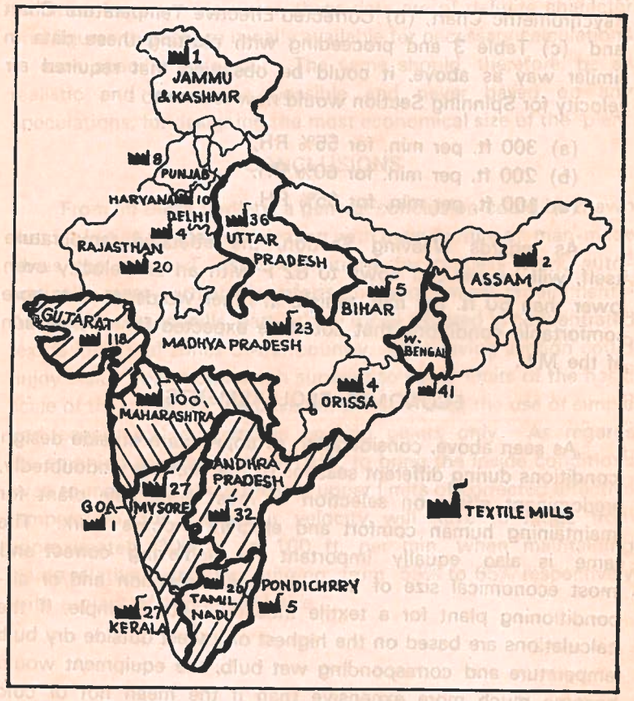
DB Temperature . .	31.5°C (88.7°F)
WB Temperature . .	28.4°C (83.1°F)

After obtaining possible departmental conditions as referred above, same could be again plotted in the chart of Corrected Effective Temperature as shown in Fig. 4 to find out that as far as Weaving Department is concerned the inside conditions are well within the recommended upper limits of Effective Temperature even with the lowest air velocity, range as given therein. However, for Spinning Section, the inside conditions do not meet the recommended upper limits even with the highest velocity range of 700 ft. per minute as given therein. Likewise for some other intermediate figures of departmental relative

humidities of say 60% to 65%, it could be observed that the air velocity requirements drop down to 400 ft. per minute and 200 ft. per minute for 60% RH respectively.

One of the remedies for obtaining low effective temperatures within such section of textile factories requiring low relative humidities for process work could be that the evaporative cooling plant is to be operated with partial water spray say with only one spray bank at low water pressure while drawing in 100% fresh air. If we consider under such conditions that the air produced by a plant is at 70% RH, this air when circulated through the department will maintain the department conditions of 37°C DB (98.6°F) and 28.8°C WB (83.8°F) with 55% R.H. Referring back these conditions to the Corrected Effective Temperature chart, it could be observed that the required maximum air velocity would now be reduced down to 300 ft. per minute only. Likewise for other higher relative humidities of say 60% and 65% the required velocity will drop down to 200 ft. per min. and 100 ft. per min. respectively. However, the volumetric capacity of the plant under such conditions will have to be double that of the plant referred in the first case for obtaining the required relative humidity inside the department. This may not be economical both from the capital as well as running cost point of view, particularly in view of that such abnormal conditions are never prevailing for long durations in the year, not even during hot or wet seasons and that for required process work elevated DB/WB temperatures maintained by low capacity economical plant although unfavourable to a worker do not seriously affect the production.

If we study the year-round weather conditions in different States of India where in the Textile Industry has been set up on a large scale, for example places within and around Ahmedabad, Bombay, Calcutta, Coimbatore, Hyderabad, Madras Madurai, Nagpur, Salem, Surat, etc. (Please refer Map as per Fig. 5 with concerned territories covered within thick border lines), it could be observed that during hot and dry seasons, the wet bulb temperatures at these places could be ranging from



Approximate Distribution of Textile Mills in India.

Fig. 5

about 26°C to 28°C. Whereas during hot and wet seasons the same could be lower than the figures given above. Therefore, considering 27°C as a representative average wet bulb temperature to cover all these Zones and referring back to (a) Psychrometric Chart, (b) Corrected Effective Temperature Chart and (c) Table 3 and proceeding with plotting these data in similar way as above, it could be observed that required air velocity for Spinning Section would now reduce to :

(a) 300 ft. per min. for 55% RH,
(b) 200 ft. per min. for 60% RH,
(c) 100 ft. per min. for 65% RH.

As regards Weaving Section, the effective temperature itself, will be reduced down to 82°F with an air velocity even lower than 50 ft. per min. which, in other words, means more comfortable conditions that could be expected for this section of the Mill.

ECONOMIC REQUIREMENTS

As seen above, consideration of appropriate outside design conditions during different seasons of the year has undoubtedly, predominant effect on selection of most applicable plant for maintaining human comfort and efficient process work. The same is also equally important for achieving correct and most economical size of humidification/ventilation and/or air-conditioning plant for a textile industry. For example, if the calculations are based on the highest or lowest outside dry bulb temperature and corresponding wet bulb, the equipment would become much more expensive than if the mean hot or cold weather conditions are considered. With the selection based on highest or lowest conditions, it is more probable that a plant will be called upon to give its full rated capacity not even for a few days during the year and this is obviously uneconomical. The calculations must, therefore, be based on conditions which will maintain the greatest economy both in initial as well as operational cost. They should, therefore, be those which are likely to apply for long periods of the year to be of importance.

The other factors influencing the selection and size of the plant are the amount of heat generated in various departments of the Mills due to services such as machinery, light, workers, etc., the heat transmission through roof, windows, walls, etc. and the radiation factors. However, these data are of definite character and figures thereof are usually available for necessary calculations in each specific instance. The same should, therefore, be as realistic and correct as possible and never based on any speculations, for designing the most economical size of the plant.

CONCLUSIONS

From all these findings a general conclusion could be drawn that for Indian textile mills dealing with manufacture of man-made fibres the required inside conditions for process work automatically meet with the comforts and economical requirements. As regards cotton mills, particularly those situated in concentrated textile industrial zones of our country, the weaving section could enjoy inside conditions much superior to upper limits of the basic scale of the corrected effective temperature with the use of simple and economical evaporative cooling plants only. As regards the spinning section of these mills, to bring the inside conditions even to meet with the aforesaid upper limits of corrected effective temperature, the inside air velocity will have to range from approximately 300 ft. to 100 ft. per min. when maintaining inside relative humidities ranging from 55% to 65% respectively with a plant of economical size.

Discussion

PAPER I

Q. The author mentioned about the illumination levels. What should be the illumination level to be maintained in the various sections of a textile mill ?

A. The illumination to be provided would depend upon the visual demands of the concerned tasks. The ISI Standard No. 3646 would provide guidance on this matter.

PAPER II

Q. Have you any idea of how air sampling can be undertaken to determine dust concentrations in the air ?

A. The ' hexlet ' sampler is suitable for collecting samples of cotton dust.

Q. What kind of help are you ready to render ? Is it possible to make the managements agree to install dust collection units without a legislation ?

A. A number of mills have installed dust collection units without any legislation. This may be prosperous mills processing synthetics where the generation of dust is much less than what it is in ordinary cotton mills particularly those in which processing of low varieties of cotton is done. Unfortunately, it is the latter mills which need the equipment but whose financial position is not sound.

Q. Is an underground cellar a necessity while providing dust extracting system ?

A. Dust is collected in filter bags which lets out only filtered air. Different varieties of cloth are used for filter bags. We have developed a rotary filter comprising primary filter unit for coarse filtration and secondary filter unit for fine filtration. In the primary filter the coarse dust with cotton is thrown out in the form of a mat or sheet whereas in the secondary filter fine filtration takes place through filter bags.

Remarks by Dr. Harwant Singh

Talking about dust, I would like to mention about a study carried out under the auspices of the Council of Medical Research which brings out the importance of adopting measures to control cotton dust. It is seen that the incidence of byssinosis in spinning preparatory and spinning sections of mills having modern machinery is about 5%, where as in the mills with older type of machinery, , the incidence of the disease ranged from about 35 to 40 per cent.

Remarks by Dr. S. S. Ramaswamy

I just want to add a few points to what Dr. Singh has very ably put across. Only last week we happened to hear about a study carried out in France. They were experimenting on the simultaneous effect of noise and alcohol. In the morning we heard that alcoholism is a problem in our country also, particularly among workers. The result of their study obtained on the animals is yet to be confirmed as to the validity on the human beings. The study shows that the behavioural change or attitude change due to the combined effects of exposure to noise and of alcohol is not simply additive of the changes effected separated by noise and alcohol but much more than that. Their results were very convincing. Productivity will go down not in an additive way but much more than that. If it is so, then we have to think of having compartmental control measures. Sup-

posing due to economic or technological reasons, we are not able to bring down noise levels, can we devote our attention on alcoholoism ?

The second point is about heat stress. Mr. Bartake was mentioning about this. We often see that technical requirements stipulate certain percentage of relative humidity and the temperature is very high. It is not always possible to increase the ventilation. It has some side effects also. Can we devote a little more attention on this and look at it from all prespectives. Another point which I would like to submit to my friends, Shri Kulkarni and Bartake, is whether we can have some idea. about the cost aspect, because management's convincing logic will be this. Can we establish cost benefit ratios ? Fo example, there was a query as to whether temperature conditions can be brought down to the permissible level or threshold limit level ? Will it be possible for us to work out and say that for such and such a plant capacity, this would be the cost involved ? This will give us a yardstick to establish the cost benefit ratio. Unless and until one is convinced either in physical terms or biological terms, I think nobody will agree. These are some of the points I wanted to mention. Even about byssinossis, our approach need not be a scared one. There are certain things with which we have to live. No doubt, we have to identify the problems and take proper steps. Let us not be scared by certain exaggerated reports which happens to go round at times.

Q. I would like to know whether you have developed any masks for distribution?

A. We are thinking of developing suitable masks. The problem is that the mills have very little facility to make experimentation. Mills feel that any control measure will cost them much and, therefore, unless there is legal pressure, mills may be reluctant to adapt any control measures. In such a situation, it is going to be difficult to make improvements in the matter of control of dust.

Q. Dust collection units will take lot of money and time also. If good masks are provided, will it not be better?

Dr. Harvant Singh Masks should be the last resort. I n weather conditions like ours, nobody would like to put on a mask. Workers have objections from other considerations too. They say that they look like monkeys when they put on the mask. It is a fact. I have heard from them. I have been a Medical Inspector of Factories for some time. If one puts on a mask which is tightly fitting, there is a risk of dermatitis along the area where it is in contact. Further if the filters are not cleaned or changed as required, they will get chocked and this would increase the breathing resistance making it difficult to wear the mask. Considering all these difficulties, masks should be the last resort.

PAPER III

Q. While maintaining air velocity at 300 fpm as suggested by you, will it be possible to maintain thermal conditions in the work environments within the permissible limits with particular reference to physiological considerations, on all the days of the year ; or are you making exceptions of a few days in the year which may be particularly hot ?

A. As I have mentioned in the paper, considering the areas in which our textile industry is concentrated, the average wet bulb temperature calculated from the meteorological data works out to about 27°C. By use of the psychrometric chart and the nomogram for calculating effective temperature, it can be shown that the conditions within the factory should be maintained within the permissible levels. We do not take into consideration expectionally hot days.

P. D. MATHUR

Summing up

The subjects discussed at this session are extremely important ones particularly in the context of our rapid progress in industrialisation. The health hazards or deleterious effects from cotton dust, chemicals and other physical agents like noise and heat as well as the different methods for controlling the hazards were very ably discussed by the experts who presented the papers. Most of the hazards are controllable provided the managements adopts a positive policy and follows up with vigour. Knowledge gained from science and technology and observations are there to guide us. But the vital prerequisite is that managements should give this matter of protecting the health of the workers due priority.

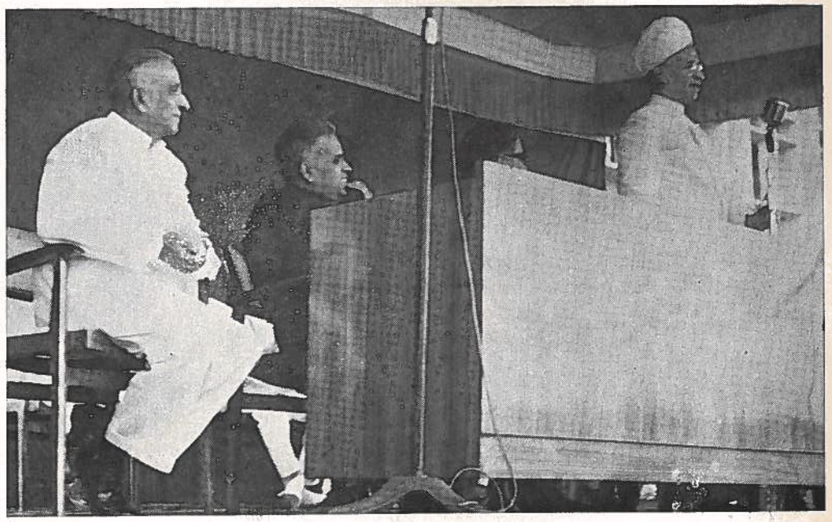
It is indeed very appropriate that the organisers of this seminar thought of arranging a discussion on this very important subject.

The President of India, Shri Fakhruddin Ali Ahmed, presenting National Safety and Shram Vir wards

CENTRAL LABOUR INSTITUTE

BOMBAY

Late Prime Minister Jawaharlal Nehru laying the foundation stone for the Institute building



The Institute being inaugurated by the then President Dr. S. Radhakrishnan

CENTRAL LABOUR INSTITUTE

The Central Labour Institute at Sion, Bombay is one of the four Labour Institutes in the country under the Directorate General of Factory Advice Service & Labour Institutes (DGFASLI).

The Institute was established during the first five year plan to function as a socioeconomic laboratory and a national institute dealing with the scientific study of all aspects of Industrial development as relating to human factor.

The Institute's objective is to promote safe and healthy working conditions in the factories and docks and thereby assist in the achievement of improved work environment, better motivation, higher productivity, etc. The Institute is thus concerned with humanisation of work and improving the quality of working life.

The Institute consists of four wings viz. Safety, Research, Training and Ergonomics under which ten divisions are grouped as follws :

1 Safety Wing
- i) Industrial Safety Health & Welfare Centre
- ii) Training & Service Centre
- iii) Library-cum-information Service.

2. Research Wing
- iv) Industrial Hygiene Laboratory
- v) Industrial Medicine Centre
- iv) Industrial Physiology Division

3. Training wing
- vii) Productivity Division
- viii) Saff Training Centre
- ix) Industrial Psychology Division

4. Ergonomics
- Ergonomics Laboratory

TRAINING PROGRAMMES OFFERED

One of the main activities of the institute is to offer training programmes in various specialised areas. The unique feature of the Institute is the multi-disciplinary approach to problems. Services of highly qualified and experienced engineers, doctors, chemists, physiologists and psychologists all under one roof are available for conducting training programmes and carrying out projects.

Training programmes are arranged in English, Hindi or regional languages as required.

The Institute also offers training in the various disciplines for overseas trainees.

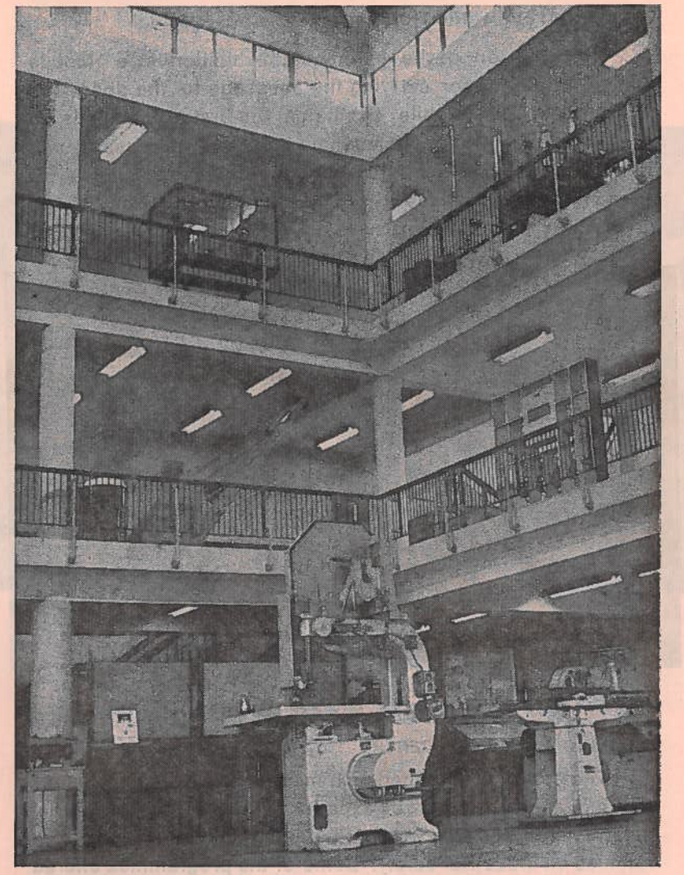
SAFETY WING

The functions of the Safety Wing are :

1. to educate managements, employees, trade union leaders and others on industrial safety and occupational health for prevention of accidents and safeguarding the health of workers in factories and on the means of achieving good working conditions.
2. to provide authentic and up to-date imformation and technical advice on various aspects relating to industrial safety.
3. to prepare training aids such as slides, film strips, films, posters, safety graphs, booklets, etc. for safety education.
4. to promote and propagate improvements for prevention of accidents and ill-health.
5. to undertake comprehensive survey in high-accident-rate industries and provide know-how and guidance for safety.
6. to carry out research in relation to prevention of accidents and injury to health in industrial operations and improvement of working conditions.

INDUSTRIAL SAFETY HEALTH & WELFARE CENTRE

The Safety Wing maintains a display centre demonstrate methods, arrangements and appliances for promoting safety and health of workers as well as for providing good working

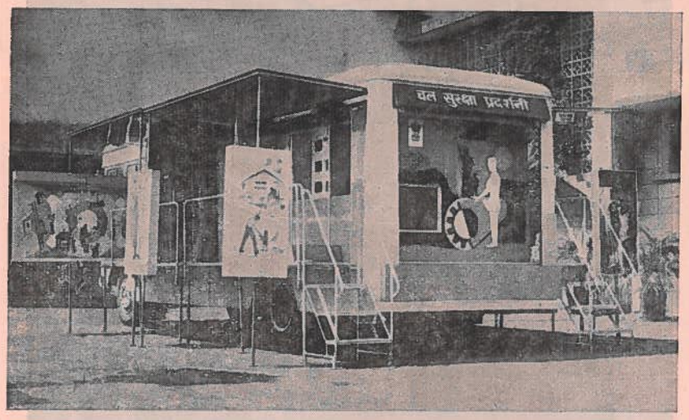


A View of the Safety Centre

conditions. It illustrates the dangers to life, limb and health incidental to industrial processes and demonstrates the most effective methods of safeguarding against such hazards. The exhibits cover a wide range of such practices and methods in different industries. The Centre has a Section devoted to safety in Docks. The exhibition is open to the public.

MOBILE SAFETY EXHIBITION

An extension of the permanent exhibition is a Mobile Safety Exhibition for carrying the message to the doorsteps of factories. The Mobile Exhibition, the first of its kinds in Asia, highlights the hazards in industrial processes and demonstrates the safeguards which should be followed to prevent industrial accidents. The exhibition is equipped with a daylight film projection system.

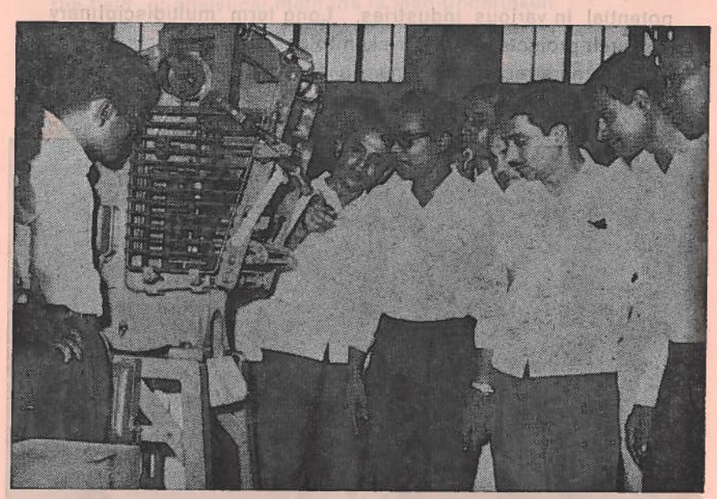


Mobile Safety Exhibition

TRAINING & SERVICES CENTRE

The centre is equipped with modern audiovisual aids for training and is staffed by experts in the field of industrial safety. it organizes a variety of training and education programmes on industrial safety. Some of the programmes offered by the Safety Wing are :

1. Course for Senior management personnel
2. Courses for middle management personnel
3. In-plant programmes
4. Courses on specific safety subjects
5. Course for workers in regional languages
6. Diploma Course on Industrial Safety (one year).



Salient features of the guard being explained during a safety training programme

LIBRARY-CUM-INFORMATION SERVICE

The Centre maintains an up-to-date library of 16,000 volumes of books and 200 journals on the various subjects related to the disciplines dealt with by the Institute. It provides an integrated information service, the requests for information received by the centre being processed with the assistance of specialists of the different disciplines.

RESEARCH WING

The insidious effects of air contaminants and the stress caused by heat, noise, vibration, etc. on the health of the workers are increasingly being recognised by industry and Government. Of late, managements have shown themselves to be anxious to improve the environmental conditions inside factories.

The Research Wing is principally responsible for assessing the environmental and occupational health hazard potential in various industries. Long term multidisciplinary research projects are undertaken to assess the effects of environmental stress/conditions on the health of workers in various industries.

Air Sampling in an industrial working environment using Midget Impinger

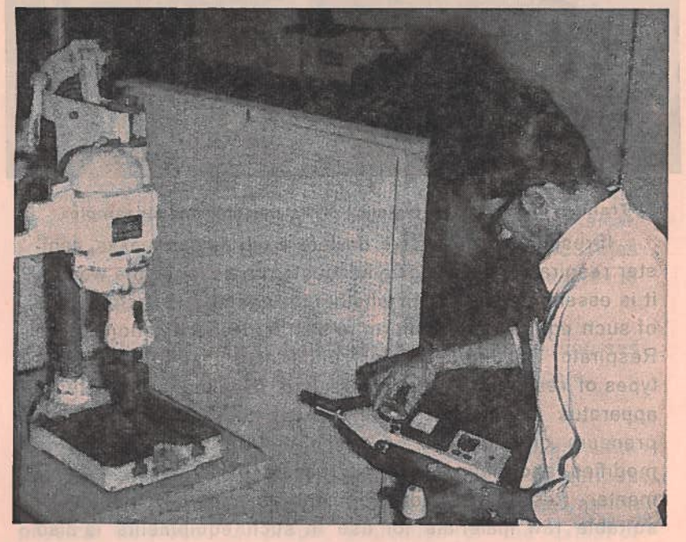
INDUSTRIAL HYGIENE LABORATORY

The work environment gets contaminated with toxic and hazardous materials because of the various processes carried out in the industry. The evaluation of the degree of contamination is essential for identifying potential problem areas for providing technical control measures as well as for evaluation of performance of existing control measures.

The Industrial Hygiene Laboratory which is well-equipped with trained personnel and modern equipments for environmental monitoring, carries out industrial hygiene studies. Analysis of biological samples from workers exposed to toxic chemicals is also undertaken for ascertaining the severity of exposure/indicaton of early exposure. Developmental work in the field of analytical methods is also undertaken.

Industrial Hygiene Laboratory in collaboration with Safety and other departments of the Institute provides the following services :

i) conduction environmental studies to assess the levels of harmful agents such as air contaminants, heat and noise in the work environment



Noise level assessment in a workshop

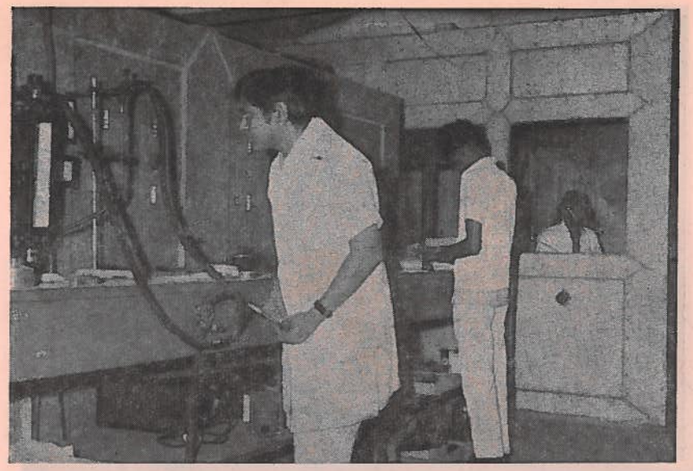
ii) undertaking appraisals of ventilation systems.

iii) advising on the methods of control for improving the environment.

iv) providing training to managers, designers, plant engineers, etc. to educate them on the ill-effects of these environmental factors and on the methods and techniques of improving the environment.

Trainees of Industrial Hygiene Workshop analysing air samples

If respiratory protective devices such as gas masks, canister respirators have to give adequate protection to the wearer, it is essential to ascertain whether the quality and performance of such equipments conform to standard specifications. The Respirator Testing Laboratory undertakes testing of different types of respirators, gas masks and supplied air breathing apparatus manufactured indigenously and advises the enterpreneurs on the lines on which their products should be modified and improved to meet basic performance requirements. Research and development work for development of suitable raw materials for use in such equipments is also undertaken for helping the indigenous manufacturers.



Testing respirator and gas mask in a simulated environment

INDUSTRIAL MEDICINE DIVISION

Exposure to adverse environmental conditions can affect health and well-being of the workers. To ensure that the health is not affected requires periodic medical examination keeping in view the nature of environmental factors. The Industrial Medicine Division carries out studies for assessment of occupational health status of workers exposed to physical, chemical and biological hazards in various types of industries and renders advice to those concerned about the measures to be taken for health protection.

The Division also conducts Refresher Training courses in Occupational Health for the benifit of Medical Officers.

INDUSTRIAL PHYSIOLOGY DIVISION

Efficiency and productivity of industrial workers are influenced by the extent of fatigue due to exposure to various environmental stress factors on the shop floor as well as the physical workload. A proper evaluation of the extent of physiological responses due to exposure to these factors will

Medical examination of a worker during occupational health investigations

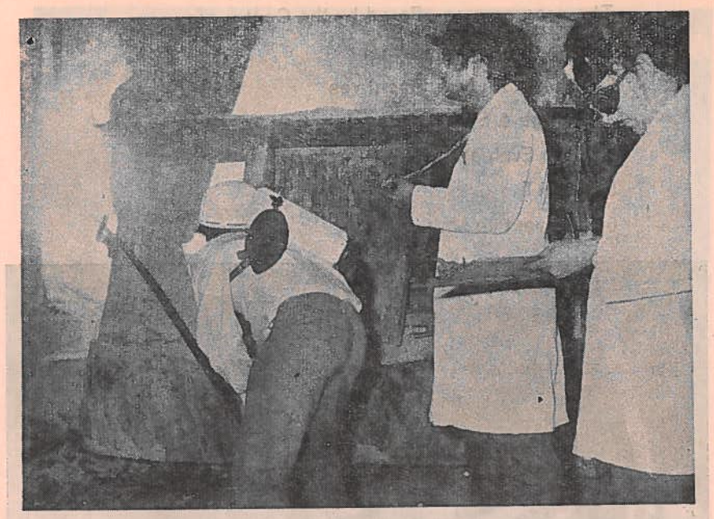
facilitate devising the optimal conditions of work. Evaluation of the physiological cost of the different types of jobs on the shop floor will help in working out a proper system of work and rest schedule so that at the end of the shift fatigue will be minimal.

The Division carries out research in Occupational Physiology as outlined below :

(i) Work Physiology : Physical work and its effects on man; evaluation of Jobs; assessment of physical fitness of industrial workers; selection of workers from the physiological point of view; permissible limits for continuous work; optimum duration of work cycles and rest pauses, etc.

(ii) Environmental Physiology : Effects of heat, humidity and related environmental stresses in industry, thermal limits for day-to-day industrial work.

(iii) Respiratory Physiology : Effects of dust, fumes and toxic gases on the pulmonary functions of the industrial works.



Works Scientists taking physiolog'cal measurements of fettling operation in a steel melting shop.

The Division also conducts specialised training programmes on various aspects such as industrial Fatigue, Rest Pauses etc.

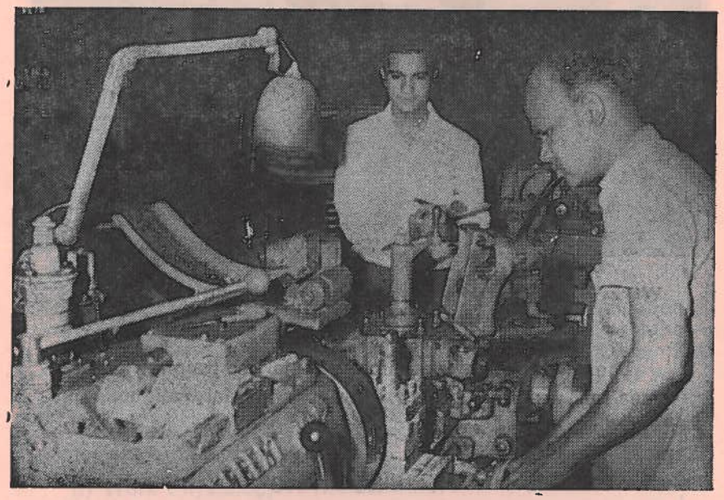
TRAINING WING

PRODUCTIVITY CENTRE

The Centre is engaged in conducting training programmes for technical personnel at various levels in the field of Industrial Engineering and other elated productivity techniques. The Centre also undertakes field projects and investigations in various areas such as Job Evaluation, Incentive Schemes, Improvement of Layouts, Resource & Capacity Utilisation etc. Through this, the Centre attempts to raise the productivity of the units as well as the workers' earnings and also improve conditions of work.

The programmes offered by the Centre are :

1. Materials Management
2. Work Study & Incentives
3. Wage & Salary Administration
4. Job Evaluation
5. PERT
6. Preventive Maintenance



Study of a job

STAFF TRAINING CENTRE

The Centre offers guidance and assistance on all aspects of staff training in industry. Its special bias is on supervisory development and modern methods of training.

Training Programmes for Trainers :

1. Comprehensive Supervisory Trainer's Project.
2. Organisation & Administration of Training.
3. Job Safety Institute for Safety Officers
4. Office Supervision for Administrative Trainer

Management programme in action

Training Programmes for Management :

1. Managerial Excellence
2. Result Oriented Leadership
3. Human Problems at Works
4. Communication and Human Relations
5. Conference Leading.
6. Communication Skill Development.

Training Programmes for Supervisors :

1. Shop-floor Management for Results
2. Basic Principles of Supervision

Training Programmes for Trade Union Leaders :

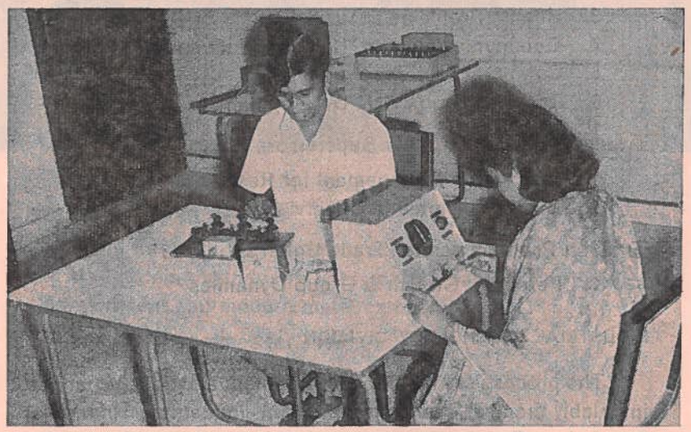
1. Personal Growth & Group Dynamics

INDUSTRIAL PSYCHOLOGY DIVISION

The process of industrial development and social changes invariably creates human problems in industries. Industrial Psychology Division is concerned with monitoring the quality of working life through research, training and consultancy

activities in the areas of employees' attitudes, aspirations, values and their adjustment to and satisfaction in work organisation. The major areas of coverage are :

1. Studies on organisation climate, work organisation, management system, etc.
2. Personnel selection, appraisal and counselling.
3. Attitude surveys,Job satisfaction, and Job enrichment
4. Studying the causes of lost time, viz. accidents. absenteeism etc.
5. Experimental interdisciplinary studies on the psychic effect of working condition and environmental hazards.
6. Specific training programmes in human relation areas viz. Transactional Analysis, Sensitivity training. Counselling, etc.



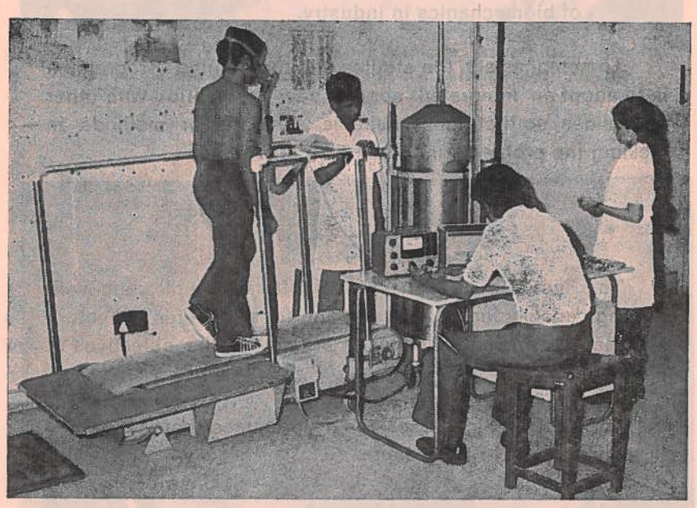
Psychological reactions being studied

ERGONOMICS

ERGONOMICS LABORATORY

Highly complex manufacturing processes, plant and equipment and high speeds of working are characteristic of industry today. Trying to adapt to the demands of such an industrial environment having improperly adjusted man-machine inter faces, could create considerable stress in the worker leading to loss of efficiency, accidents and impaired health.

Human factors engineering (Ergonomics) enables us, among other things, to study man-machine systems with a view to matching the machine and the environments to the man or making the best mutual adjustment between them.



Tread mill experiment for determination of optimum work rate

The Ergonomics Laboratory is equipped to :

1. carry out research to make the best adjustment between man and machine.

2. educate manufacturers of plant, machinery and equipment in applying the ergonomics approach.
3. provide a consultancy service to industry to rectify unsatisfactory situations.
4. establish anthropometric data relating to industrial employees of different regions, as also other principles and standards for the design of equipment, work space, and motion.
5. educate Designers, Engineers and Managers on the advantages of and on the application of the principles of biomechanics in industry.

The emphasis in the studies and the training pr. gramme is to adopt an integrated approach in association with other disciplines, so that most suitable solutions or methods in tackling the problems in industry are arrived at.

OTHER FACILITIES

The Institute has an Air-conditioned Auditorium with seating capacity for 300 persons and four Conference Lecture Halls, all of which are helpful in promoting the objectives of the Institute.

For the participants of the programmes there is a well-furnished hostel in the campus.

Shri Bal Govind Verma, Dy. Labour Minister, Government of India, delivering the inaugural address at the Seminar on 'Industry, Environment & Man'

The section of audience at the Colloquium on 'Industrial Carcinogens'

industry, environment and man

PROCEEDINGS OF NATIONAL SEMINAR

held at

CENTRAL LABOUR INSTITUTE, BOMBAY-22

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PROCEEDINGS OF

THE NATIONAL SEMINAR

ON

"INDUSTRY, ENVIRONMENT & MAN"

8-9 February, 1975

Organised by

THE CENTRAL LABOUR INSTITUTE, BOMBAY-400 022

AND

THE SOCIETY FOR CLEAN ENVIRONMENT

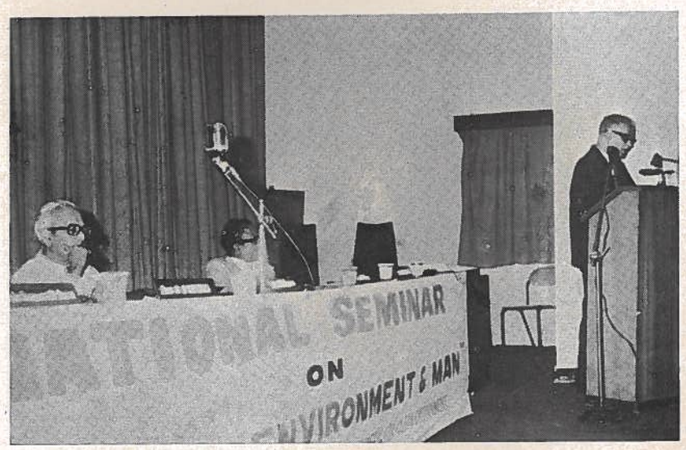
BOMBAY-400 071

1975

Inaugural session of the Seminar. Seated from L. to R.: Shri V. B. Karnik, Shri Vijay Merchant, Brig. G. R. Chainani, Hon'ble Shri Ramnath Pande, Hon'ble Shri Bal Govind Verma, Prof. Nitish De, Dr. P. J. Deoras and Dr. S. S. Ramaswamy.

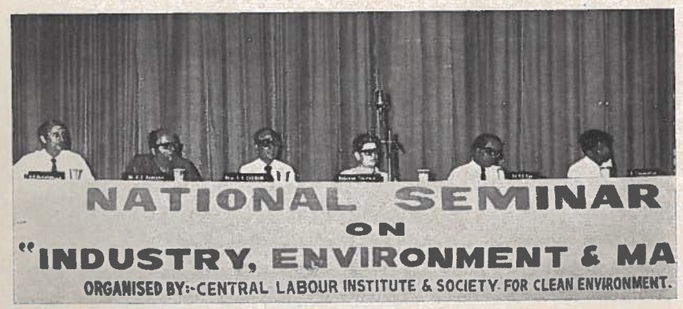
Hon'ble Shri Bal Govind Verma, Dy. Labour Minister, Govt. of India delivering the inaugural address.

Hon'ble Shri Ramnath Pande, Minister of State for Labour, Government of Maharashtra delivering the Presidential Address.



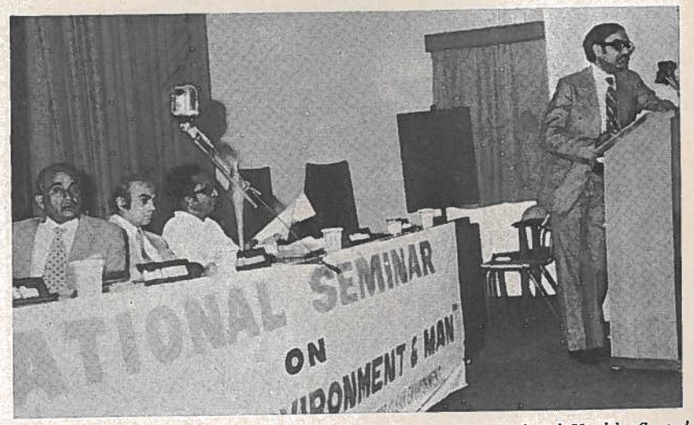
Prof. M. S. Gore addressing the Technical Session on Social Environment. Seated from L. to R.: Dr. P. H. Prabhu and Shri S. B. Hegde Patil.

A section of the audience.



At the Session on Protectivity in Indian Industry. Seated from L. to R.: Shri M. R. Nagarwalla, Dr. M. S. Nadkarni, Brig. G. R. Chainani, Shri Bagaram Tulpule, Dr. R. K. Rao and Shri D. Thankappan.

Dr. Ram S. Tarneja introducing the Technical Session on Quality of Working Life & Environment. Seated from L. to R.: Brig. G. R. Chainani, Dr. A. K. Ganguly and Dr. J. M. Dave.



Dr. K. G. Nair addressing the Technical Session on Occupational Health. Seated from L. to R.: Dr. J. B. Shrivastava, Dr. J. C. Kothari and Dr. Shanti Patel.

Contents

INAUGURAL SESSION

Welcome Address

BRIG. G. R. CHAINANI

On behalf of the Central Labour Institute and the Society for Clean Environment, it is my privilege to welcome you all to this Seminar. We are really encouraged by your response and the presence in our midst of such a galaxy of distinguished personalities, speakers and guests—to mention a few of them, our Deputy Labour Minister, the State Labour Minister of Maharashtra, renowned thinkers and delegates with a large slice from the trade unions.

Every year, on our institute day, we organise a National Seminar on a thought-provoking subject. Last year, we had a Seminar on "Humanisation of Industry". This year, it pertains to "Industry, Environment and Man".

Modern technology has to be employed for the good of the country. But must we accept the ills experienced by others? It is for us to ensure that we so deploy the technological innovations as to supplement and not to suppress or supplant the human creativity.

I am reminded of the saying by Dr. S. Radhakrishnan—"Life is a game of bridge. We did not frame the Rules and we cannot control the dealing. The cards are dealt to us whether they be good or bad. We can play the game well or play badly. A skilful player may have a poor hand, yet win the game. A bad player may have a good hand and yet make a mess of it. Our life is a mixture of necessity and freedom, chance and choice. We may not change events but we can change the approach to events". I think he has a vital precept for us. It calls for a proper introspection. Let us play our part skilfully and well. Let us strive to change our approach for the better. I say this, because I am convinced that our people are industrious as well as ambitious, intelligent as well as imaginative. They are capable of assuming responsibility and developing their

ability for achieving the desired goals. We have, therefore, selected four areas in this Seminar. I think each one of them has a message for every one of us, individually as well as collectively because we all have to play an important role in the attainment of socialism including social security in the real sense.

Once again I heartily welcome one and all and I do hope the deliberations will offer new approaches, or new avenues in our fight to usher in better environment free of poverty, pollution and with adequate protectivity.

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Inaugural Address

HON'BLE SHRI BALGOVIND VERMA

I am very happy to be with you this morning for this important national seminar on 'Industry, Environment and Man.' Our country or more correctly the whole world is passing through a crisis which has economic, political, social, spiritual and moral ramifications. These aspects are closely intertwined and each exerts a profound influence on the other. Economic and social forces will continue to influence the material structure and march of human civilisation. It is our principal task to strengthen and build up a social order for the whole country. Today's seminar gives us an opportunity to focus our attention on industry and the worker.

When we became independent we took a pledge to improve by following the goal of socialistic society built on equality and welfare of one and all. We realised that our march for progress and our goal of economic and social upliftment could only be achieved through planned industrialisation and improvement in agricultural production. The last 27½ years have seen a lot of development in these areas and our future plans envisage substantial increase in the production in our basic and allied industries. While we can be proud of our achievements in industrial production and must welcome the move towards our socio-economic aspirations, can we say that this has eradicated or helped to eradicate poverty and improve the basic needs of the poor man?

Talking of social environment, the migration of the rural labour from their traditional homes to urban areas, quite often in the slums, has tremendous psychological influence on their outlook and personality. Have we given enough thought to this problem, particularly as they have shifted from the calm and clean rural environment to the overcrowded and polluted sur-

roundings with the added stress on working with modern machinery and plant?

As regards Protectivity, our reports and statistics show that the industrial accident rates are comparatively higher than those of the developed countries. Is this to be accepted as an essential by-product of industrialisation? Would it not be wise to follow the foot-steps of the developed countries also and adopt adequate safety measures to bring down the high rates of accidents and thereby reduce unnecessary suffering and pain? Our salvation lies not only in industrialisation and economic development but also in making sure that the worker is protected from machines and his environment is kept congenial and free from pollution.

You will be deliberating on working conditions and environment. Modern technology has necessarily to be employed to produce goods to satisfy the needs of the growing population. But is it not necessary to exercise far-sighted vision to ensure that technology does not lead to pollution of ecology and environment? While nobody is opposed to industrialisation, certainly we can learn from the experience of other countries and ensure that we do not suffer the ill-effects of industrialisation that have been successfully tackled and overcome by them.

Legislation on Factories Act has been in existence for many years and there is already provision for welfare and health measures for workmen inside the factory premises. With the fast changing production techniques, the workmen have also to be safeguarded against atmospheric pollution, including dust, radiation, toxic substances, noise and vibration. You are also aware that the Government has enacted legislation on Water Pollution and soon control will be exercised on Air Pollution. The Government also will have to exert their energies to cut down the menace of noise pollution as well. But can legislation alone achieve the desired results? I submit that it is only the realisation, by the industry of the social responsibilities and their determination to solve these problems to make our life happier and free from health hazards, that will bring about the desired effects.

We know of the immense problems of inflation. We know that people are reeling through one of the most unpleasant periods, and what is needed is not talks but positive results. The current economic and social crisis is grave and demands drastic and unprecedented remedies. We all have a role to play because in

a democracy it is the will of the people that counts. We know we have to increase both production and productivity to meet the increasing needs of our growing population. Can this be achieved through workers' participation in the management? Will this help to bring the changes in the personality and attitude of the worker? Will it be possible to opt for participation so that we can change from alienation in industrial relations to alliance and from conflicts to cooperation so that disputes can be overcome through discussions and dialogue? This may call for adjustment in our management system. After all, man has to be the focus of all developments. The Prime Minister recently said, "The individual counts, not only in the sense that his vote counts, but his freedom and responsibility to shape his future himself. He should not become merely a cog in the machine. My whole endeavour is to strengthen the human being. If he has more self-confidence, then the country as a whole is stronger". Is it not the time that we should devote special attention towards him by humanising the whole process of the industry? Is it not necessary to carefully study the behavioural responses of the employees and then suitably mould the management techniques?

We are the biggest democracy in the world. A democratic form of Government guarantees freedom of man and in turn this pre-supposes certain duties and obligations. There cannot be rights without certain obligations and vice versa. Let us therefore not only opt for having further rights but also opt for acceptance of responsibility. I appeal to my trade union friends to be guided by an ideology that can create inspiration to work for the good of the masses as a whole; because trade union movement cannot be satisfied merely with materialistic gains. It has to aim for the upliftment of the common man. This was visualised many years ago when it was ordained that trade unions must involve themselves immensely in social responsibilities. Mahatma Gandhi, Father of the Nation, always campaigned for the betterment of the worker. Let us be guided by his sayings and philosophy.

It is very appropriate that the Central Labour Institute and the Society for Clean Environment have chosen to organise this two-day seminar to deliberate on some of the intricate problems. I am sure that these deliberations will bring forth certain positive recommendations. I for one welcome this seminar as it talks

of humanisation in the four spheres of social environment, protectivity, quality of working life and health hazards in industry. Let us work for the growth of the country and let us tackle the problem we are faced with, in all aspects viz. alienation of human mind, pollution of air, pollution of water, noise pollution and lack of protectivity and also the biggest pollutant namely poverty. Let us cooperate and team-up to transform poverty to prosperity. Let 'humanisation' be the key for our industrial growth.

Lastly I thank you all and take pleasure in inaugurating the Seminar.

★

Quality of Working Life and Work Environment

PROF. NITISH R. DE

From the theme "Quality of Working Life and Work Environment", I select three words—'work', 'life' and 'environment'. It is not an amazing discovery but a reality, that there exist three very thick walls between work, life and environment. They coexist; but they do not exist together; they exist separately. And at the same time, this has been happening in the industrial culture when a very impressive advancement in the natural sciences, technology and the knowledge about man has been taking place. So, on the one hand, we have an impressive record of achievement and, on the other, divorcement between work, life and environment. This to me is the central problem that the civilisation is confronted with today.

This divorcement of the three basic elements has created a series of folklore and beliefs, some of which I mention by way of illustration. First one: the belief that work life and social life are two distinct entities. One may be unhappy in work, but one may be happy in social life. Harvard technology projects carried over a large number of years suggest that this is but a myth. A worker or an employee who is dissatisfied and unhappy in his work tends to have unhappy social life, family life and emotional life. Drunkenness, indebtedness, brawls and fights and unsocial activities have often close correlation with the unhappiness in work life. The suicide rates in Scandinavian countries, which are perhaps the highest in the world is another indication that work life and social life cannot be divorced.

The second folklore that amusement, entertainment and various forms of excitement, whether through TV or otherwise are a compensation for work. 'Work' has to be suffered in any case and, therefore, it has to be compensated for by multi-million dollar

amusement and entertainment in industry. True, this is the western reality. If one looks at the social cost of crime control, then it may not be impossible to come to a statistical correlation that as the expenses on the entertainment industries are going up, the social cost of crime control may also be going up.

The third folklore is that the production of material goods and services is the key to the resolution of all human problems. More the GNP and more the per capita distribution of wealth, more is the human happiness. What do we find? A total mishap to the ecology, the great lakes bordering Canada in the United States had been rendered a cess-pool of disgrace. If one reads Geoffrey Vickers' book, *Freedom On a Rocking Boat,* one will find that men have played 'monkey' with the river Thames with the result that London and the adjoining areas are an hazard today. In other words, tempering with the climate, tempering with the balance of nature, tempering with the habitation that makes human life worthwhile seems to have almost an indirect correlation with the growth in GNP.

Essentially, however, the issue is that we have worked out a wonderful device since the industrial civilisation had dawned, a device called "division of labour" which means, first that work is to be controlled by organiser of work; may he be the entrepreneur or the manager or whoever. Secondly, that life is to be controlled by the man himself—that is his area of autonomy, and the third, that the environment is to be controlled either by a supernatural power like God or by a more secular power, namely, by the State. Now, this is human ingenuity that has fashioned this device, the division of labour between work, life and environment. Now this is a reality in all the three worlds. First is the world of plenty; they have this problem. Second is the world of adequacy—this is mostly the socialist countries. They are not affluent, but certainly they have adequacy and, the third, the world of poverty, of which India is one. Now, the basic problem of the divorcement between work, life and environment is common in all the three worlds. This is the capsule way I see the problem.

So, what is the challenge? The challenge lies in the formulation of the problem itself, that is, in bringing about an integration of work, life and environment without the sacrifice of the march of sciences, technology and knowledge about man. We

do not have to sacrifice our achievements in sciences and technology but at the same time we have to reverse the gear and bring about an integration between work, life and environment.

This formulation calls for a meta-ecological balance of six functions. First, man-nature balance. You do not have to go back to Thoreau's concept of going to the forest but certainly a man-nature balance has to be restored. Second, nation-nation balance. The whole concept of competitive, confrontation culture that exists between a nation and another, unless that is also resolved, I do not think we will be able to achieve the meta-balance of human systems. Third, man-technology balance. Fourth, man-organisation balance. Fifth, man and his group balance—primary group or secondary, viz., family, social group, work group and so on, and lastly, the man-man balance between one person and another. I may quote here from one of my papers:

> "Man depends on nature for resources and nature depends on man for its definition. One nation depends on another for exchange of ideas, products, men and services. Man depends on technology for 'comfort' and technology can only be enhanced by man. Man depends on organisations for achieving purposes and organisations depend on man for resources and skills. Man depends on human groups for the satisfaction of certain needs; groups depend on man for membership and contribution. Man depends on man for self-definition, self-esteem and self-growth."*

So, the challenge is to design social arrangements and work systems which will permit (a) the human use of human beings as Norbert Weiner said and (b) establishment of human relations with a view to providing the liberation of man from myths, fictions and inhibitions of all kinds.

What is the way out? Now the basic premise for the way out lies in the ideal that the society has to be free from exploitation of man. The meta-balance that we are talking about, the meta-ecological balance between work, life and environment cannot be conceived so long as the exploitation of man by man exists. Indeed, it is an ideal but an ideal that cannot be set aside. Accepting that premise, I think, our attention should be to

* "Social Context of Work and Drop-out From Work" a paper to be Published by the Centre for Continuing Education, Australian National University, Canberra, 1975.

debureaucratise the work culture, whether it is in administration or whether it is implicit in industrial engineering systems by adopting a few steps. First, we have to adapt technology to organisational needs and human requirements instead of what we have been doing all the while by squeezing human beings to fit the technology. Technology has become the God and man has been made to subserve technology. That process has to be reversed by (a) variation and meaningful tasks for one and all, sweeper upwards; (b) by creating opportunities for learning and continuous and permanent education; (c) by providing increased autonomy; (d) by augmenting social support in collaborative work groups instead of establishment of fierce competition, as has been the contribution of some cultures; (e) bringing about meaningful relations between job and the social environment and (f) provision of desirable career patterns for one and all and not only for managers.

Second, utilisation of information system in a consultative way rather than using information for a postaudit culture which is one of the great contributions of the British administration of India. Third, establishment of medium-sized units with higher degree of flexibility. There was a time when size of an organisation was determined by the size of the technology and the availability of financial resources. Time has come to subordinate technology and financial resources to the number of people in an organisation. One of the predictions of Europe of tomorrow is that in the twenty-first century no organisation, by and large, is going to have more than 500 to 2000 employees. If necessary, they will create a series of organisations rather than having 40-50 thousand people. Now a word of caution. You can't think of probably an integrated Steel Plant with 500 people. Now, accepting these limitations, the basic premise is that the most valuable resources is not the technology or the financial resources or capital goods but the human beings. Next, organisations are to accept the value to learn and to operate different roles and arrange structures according to task variations. In other words, building up of the capability in the employees so that they can operate all the "four gears" of the automobile. It is not merely to make people, in a technical sense, multi-skilled but to make people to accept skills and knowledge and abilities as a part of life. And lastly, to make people to work in autonomous groups rather than

the tradition of one job-one man. I wish I could develop the theme but my objective here is to highlight the basic premise.

What are the assumptions behind this kind of work design? First, the chances of survival; I mean that the chances of human survival are increased by adaptiveness of human beings. Why is it that the Dinosaurs did not survive and they do not live today? We should ask this question and we will find out the answer that the Dinosaur could not adapt itself to the changes in environment and in the process it became extinct. Increasing the redundancy of functions of individuals rather than the redundancy of individuals will be a goal. Increase the number of challenges, the number of opportunities for a man instead of increasing the number of men and limiting their opportunities and growth. Now, I am not arguing in favour of the classic case for rationalisation of employees, the way it has been done in some industries. My argument is more basic. I think, it is Ashby, an authority on cybernatics, in his book, *The Design of Brain,* said that more the variety of experiences for a man, more is the adaptability of that man. Less is the variety of experience for a man, less is the adaptability of that man. That is why, we find that a problem worker behaves in a narrow range of way simply because the variety of experiences that the industry has provided to him is so limited that his way of coping with something that he does not like, is very limited.

Thirdly, the need for development of effective control mechanism within a work group rather than increase in the cost of supervision. I shall argue that lesser is the cost of supervision, better would be the work climate which, however, means that the entire internal control system has to be more sophisticated and response oriented. Lastly, I think; it is our experience that responsive environment creates responsive behaviour. Example is the well-known movie, "My Fair Lady"—Professor Higgins and the flower girl. It is the responsive environment that Higgins could create that made the flower girl what she could become.

Now, in conclusion, I would like to mention that let us not confuse among three work issues and one global issue. There is a word of caution. That in the work area or in industry there are three levels of relationship—(i) intergroup democracy, what we call the culture of collective bargaining; the right of the union and the management to bargain with certain degree of freedom

depending upon the State Policy; (ii) representative democracy—the acceptance of the reality that the trade union is a representative body; it represents worker in certain aspects of his work life just as the management is accountable to the worker in certain other aspects of his work life. So, management is also a part of representative democracy just as the trade union is; (iii) work-linked democracy where manager, worker and supervisor all are linked by the centrality of work; and the responsibility for it becomes a collective task. Now what is important is to have all the three types of democracy and not one as a substitute for another. I have heard umpteen debates where people see participative management at times as a clever manipulative device of weakening the representative democracy, namely, the role of the Trade Union. Now, this is the caution, that all the three will have to go together and not one against the other.

In the end, the global issue I intend to mention: What is the global issue? The argument that one faces is something like this. Our problem is one of poverty, backwardness, misery and the greed. And, therefore, to talk about improvement of the quality of work life is irrelevant, unnecessary, diversionary. Our problem is to solve the poverty, etc. Now this is not an argument I subscribe to. My reason is that if the protagonists who believe that the problem of poverty and backwardness is to be solved, what they really mean is that environment has to be changed first. Now in order to change the environment one has to change one's own work habit and life style. Therefore, coming back to my main theme, even if one wants to change the environment either by a revolutionary process or by an evolutionary process he could not divorce the work habit of himself and his life style from his mission. There is the example of Gandhiji. In order to change the environment that was India in his days, he had to give up a lucrative legal practice. He had to give up his life style and had to take up a different work style. The same happened to Lenin who changed the environment of the Czarist Russia; he had to take the life style of a fugitive and the work style of a revolutionary. Then only he could change the environment. Another person not so well-known is Dr. Albert Shcweitzer. A brilliant musician visiting the best cities of Europe, he gave up his profession and the life style at a fairly advanced age, took up the studentship in a medical college so that he could become

a doctor and then go to tropical, inhospitable climate of West Africa and fight the curse of leprosy and other diseases among the tribals thereby changing the environment then in existence.

So, friends, my argument would be that let us not advance a linear logic that refers to our backwardness in many areas and relegate the quality of work life to secondary importance. My apprehension is that those who take up that argument often seek to use the argument as a substitute for human action. After all, human liberation can come only through the interplay of action and reflection.

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Employees' Participation in Practice—Some Reflections

VIJAY MERCHANT

I would like to mention, my friends, about cricket on the wider field of life. Cricket is one game that teaches you how you have to play in life, it is one game where the better batsman takes care of the lesser batsman so that the team may win. In life it is those who 'have' that must protest and take care of those who 'have not', in order that the society may flourish and the country may prosper. That is the cricket I understand and that is the cricket I play, now that my active cricketing days are over.

For the last 10 years, I have been trying out an experiment in humanity with labour. We have heard so much about participation of labour in management. What does the labour want through participation? A place on the Board of Directors? What will be the labour do there? The participation that he wants is a patient hearing; he wants justice, above all he wants understanding and a little love. That is my experiment in humanity. Whether I have succeeded or failed is not relevant. I am not a disappointed man, because I do not link up my experiment in humanity with production or anything else. I do it because I owe it to labour, I owe it to those who have made my industry prosperous, to those who work with me and who work under me. I am interested in making my worker feel that he is a part of me and that I am a part of him. There is no format and there is no policy. I am a cricketeer who plays every ball on its own merits. I don't decide before the ball is bowled I should play my stroke.

I will only give you two instances in the limited time at my disposal to give you an idea about my deep involvement with labour. Give me the honour of taking you round the Hindoostan Mills, where we have a small Health Centre, small in size, but

very big in heart. A worker came to my Health Officer, a young lady, and said, 'my wife has got a tummy ache, will you kindly get her examined by the Doctor?'. The worker was sent back to the department. My Health Officer who is a para-medical person, B.Sc. with nursing, had a look at the wife before the Doctor could come and she could make out that she was expecting a baby. Nothing wrong in that, is not it? But two years earlier her husband had undergone vasectomy. My Health Officer came to me, 'Vijay Bhai, what do I do? Not my problem'. In other words, not a medical problem—a social problem. I said, 'my dear, give me two days to think it over'. Very innocently she said, 'What is there to think over Vijay Bhai?'. I said, 'my dear, you are still young'. Sometimes, my friends, it is the easiest thing to say the truth and get away from a problem. Two days later I was ready with my answer. I called the Health Officer and told her to get the worker's wife before me. She sat across the table from me and I told her, my dear, I know what has happened. Let us not discuss it. We have now to decide about you; get your husband here tomorrow. I shall apologise to your husband in the presence of my Health Officer and Gynaecologist and say, "I am extremely sorry to put you in this embarrassing position—something went wrong with your operation". Right or wrong, do not ask me. What may be right in one set of circumstances may be wrong in another. My Health Officer was flabbergasted, "Sir, you are involving our Doctor". I said, 'don't worry for a good cause everyone cooperates'. I picked up the telephone explained the situation and solicited his help. He wanted to know how. I said, "just sit by my side and don't say a word—"Narowa —Kunjarowa". I want your presence and not your voice. I am prepared to take the responsibility for what I am doing. Doctor said, "Vijay Bhai, I will be there". Tears tickled out of the woman's eyes. She who was prepared to bear the guilt of another man's baby in her womb was not prepared to bear the guilt of Vijay Bhai having to say a lie on her behalf. She went home. Next morning at 7.00 O'clock her husband called me and said, "Vijay Bhai, that meeting will not be necessary. My wife has told me the truth". This is character as I understand it, my good friends, and there is more character amongst the poor people than among the rich. That is my experience of life. The husband was pleased that in spite of the protection offered by me

she had the moral courage to admit the truth. I sent for the couple, complimented the man and made him promise not to bring up this matter ever again. It is a twelve year old story. The man has kept his word so far. My innings No. 1.

Now my innings No. 2. What do we do with that unborn child? I called the young lady and told her to get rid of the child. She demurred at first. I explained to her how the child will be a permanent reminder of her infidelity and how the child might suffer for no fault of its own. An abortion was arranged and it cost me Rs. 500.00. I did what I thought was best for her and the family without a thought about personal consequences.

Now my third innings. Service must be absolute and total and involvement must be absolute also. What about the man who was the culprit? He might again create trouble for the family. So my Labour Officer threatened that man with the criminal consequences for seducing a married lady, unless he left the neighbourhood for food. On the 17th day after this threat he left that neighbourhood and in the last 12 years nobody has seen him.

This is the type of service that I want to render to my workers and their families. It is not only the worker who has got a claim on me, but it is the entire family that has got a claim on me. And very recently the daughter of a worker who died 20 years back came and said, "Sir, I have got a claim on you". One of the finest and sweetest compliments that can ever be paid to an employer. This is the experiment in humanity which I am carrying on. You will naturally ask me what do I get there from—higher production, better quality or less waste percentage? As I said earlier my experiment is not linked with production. What I get is the tremendous internal satisfaction of having played with a straight bat. One thing I have certainly got out of this human relationship with labour it has enabled me to keep my industry going even when somebody dies inside the mill. When my good mother died about 7 years back the workers wanted to stop the mill. The officers tried to explain to the workmen that Vijay Bhai's philosophy is that work should not stop for anybody. But they remonstrated "Vijay Bhaichi Ayi amchi ayi". What a sweet compliment! I called six of them and explained my philosophy. I told them that this was the philosophy of my mother also. They were not satisfied, so I played my trump card. I

said, "if you feel that I want to work the industry today because of the profit I get there from, you name the charity and today's average profit will be handed over to that charity in the name of workers of the Hindoostan Mills". My workers were satisfied. They went back to work. At 11.00 o'clock I was present at the joint prayers held by the workers. This was repeated in the second and third shift also. Since then the mill has not stopped for any death in the family or even on the death of any officer. That has been my tremendous gain but that philosophy will be complete, when the last ball is bowled in when I am gone and my mill still works. When they keep the mill going the widow is helped in every possible sense of the term either through a job or a suitable pension.

How do I get on with my union? In one of the meetings with the workers and the union representatives one of them just came up and said to me, "Vijay Bhai do you need a union in your mill?" What a great compliment from a worker to an employer! I said, "yes, I need a union very badly in my mill because then the union representatives and my labour will know that I am playing with a very straight bat". Every 15 days a meeting is held with the union representatives to straighten out any matter at unit level that may crop up. In other words there is a continuous dialogue with the union representatives apart from workers who have individual problems. We have come to a stage where we settle their domestic quarrels also. We have prevented four of the workers from having a second marriage when the first wife is alive. In one case we failed—the fault was of the wife's people who spread the rumour that her husband was impotent. So he had to prove his potency by marrying another lady.

My good friends, out of these experiments in humanity, I get tremendous satisfaction, a sense of oneness with my workers and their families. What they give back to me cannot be put down in any score book. But I am sure it will go down in the greatest score book of them all. It is credited into the greatest bank of all, the bank of humanity which no Government can ever nationalise!

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Industrial Worker—His Safety & Health

V. B. KARNIK

I note that the theme of the seminar is Industry, Environment and Man. I would have liked it to begin with Man—Man, Industry and Environment. We want industry for the welfare of man. We need control over the environment for the benefit and welfare of man. I know the organisers of the seminar are of the view that man should be given the central place in all activities. Man should be the centre around which everything should roll, industry, agriculture, political, and economic administration. Prof. De has talked about the necessity of changing environment. Trade unions are trying to change the social and economic environment. They try from time to time to get concessions for the worker. Many a time they are monetory concessions, but they also try to change the conditions of work. I attach much greater importance to the role of the trade unions in changing concepts of social justice than securing economic concessions for their men.

I have been asked to make a few observations on the workers' health and safety. I am sure everybody will agree that proper steps should be taken to protect the health and safety of the workers. I mean not merely the absence of disease but the full enjoyment of all faculties by the workers. I would like the worker to be vigorous, enthusiastic and able to do all his work in a proper manner. It is this type of health that we want in our factory, our industrial units, where the worker will be able to apply his whole mind to his work and to give a good account of himself? If proper arrangements are made to look after his health in this wider meaning, I am sure, the production in the factories will be much better than what it is today. The axiom that 'health is wealth' is nowhere more true than in an industrial society and industrial unit. If the worker is healthy, enthusiastic

and vigorous, the production will increase and with increase in production the wealth of the industrial unit also improve. Therefore, I would like the employer, more particularly the Supervisors and Managers to keep in mind the fact that the health of the worker is as important as production.

Similarly, safety is essential because without safety and prevention of accidents, production cannot go on in the usual manner. Many a time production stops because of accidents. The statistics on man days lost due to accidents and sickness indicate that more working days are lost as a result of accidents and sickness than as a result of strikes. When strikes take place there is usually an uproar that so much of working hours are lost, but nobody pays the necessary attention to the loss of working time as a result of illness of workers and accidents. I am sure that if proper arrangements are made, this loss can be considerably reduced.

Employees State Insurance Corporation is providing medicine and some sort of a cash allowance for the days that a worker is ill. But after all it is curative treatment, what is much more important is the preventive treatment and this preventive treatment can be suggested by the Doctors in various industrial establishments. I would submit that the work of these doctors should not merely be confined to giving medicine or suggesting tonic, but they should take upon themselves the responsibility of advising the workers with regard to the type of balanced diet that they should have, and proper hygienic and sanitary arrangements in their homes. In this manner, if a broad outlook is taken of the health of the worker, I believe, quite a lot of infirmity that exist today amongst the workers can be easily removed. I would like to suggest to Brig. Chainani and to his organisation to organise a survey of various industrial establishments to find out how many workers live upto the retirement age and after retirement in what condition of health. I believe such a survey will be very useful and will also show us the points that require attention. I am sure trade unions would be glad to cooperate with such a project.

Before I end, let me again emphasise the fact that though we have the Factories Act, and various other legislations which provide for the safety and health of the worker, many of these legislations cannot be properly implemented with the small staff of Factory Inspectors. I would suggest that every Factory In-

spector or every person concerned with the prevention of ill-health and the prevention of accidents should make it a point to consult the Union before he visits the factories and makes a report under the Factories Act or other relevant legislation. And if in this manner the cooperation of the trade union is sought, I am sure, that the implementation of all these legislations will be much more effective. I admit that the trade unions are not paying as much attention to the problems of health and safety of workers as they should. Their attention is still concentrated mostly on wages and allowances and similar economic advantages. I am sure in course of time our trade unions, will widen their outlook and will come to look upon the questions of health and safety as much more important than the increase of a few rupees in wages and allowances. I submit to the Trade Unions who are participating in the seminar and others pay attention to this necessary duty of the trade unions and try to develop the social outlook amongst trade unions.

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Presidential Address

HON'BLE SHRI RAMNATH PANDE

I am very happy to be invited, this morning, to preside over the Inaugural Session of the 2-Day National Seminar on "Industry, Environment & Man". I must congratulate the Central Labour Institute, both for selecting the appropriate location as well as the topic of intimate interest. I also think that, this Seminar is organised not a day soon in industrial history of our country.

Looking back, as we do, over the last hundred or more years of economic development, it is abundantly clear that speedy industrialization has had tremendous impact on Environment and Man. Rapid progresses in science and technology have made possible, man's continuous search for the new sources of energy and power generation, raw materials and consumer products, means of modern transport and communication. The resulting growth of a wide variety of industries and manufacturing processes have not merely altered the economic conditions of many nations, but also affected the work environment and the quality of peoples' life.

While thinking of man in relation to industry and its consequential environment, we are required to pay attention to the demographic aspects of employment and work environment, job requirements and organizational behaviour, occupational health, industrial safety and social security, enjoyment of leisure and the general improvement in the quality of his work-life. We have also to be aware of the fact that, industrialization demands in the work-people the development of discipline in the context of factory conditions, urban living, formalised rule-making and adjustment to the industrial environment and way of life.

Technological advance and economic progress, through industrialization, have not proved to be unmixed blessings. In the process, they have gravely disturbed the ecological equilibrium and exposed industrial societies to many an environmental hazard by cutting of forests, spoiling of water, polluting of air and above

all by misutilising of space. Vast belts of virgin lands and large areas of green jungles have been converted into numerous industrial estates and careless human habitations. Consequently, they have ravaged the beauties of nature and degraded the quality of work environment and life of millions of people.

With rapid industrialization, environmental pollution has been making its onslaught at an alarming speed. Where huge quantities of industrial waste and refuse are generated, junk-yards grow on heaps, destroy vegetation, breed pests and give out gases harmful to life. Hundreds of tonnes of lubricating and other industrial oils find their way into waterways. The vast clouds of smoke and noxious fumes have polluted the industrial regions. In short, clean water and fresh air, clear sky and sparkling sunshine, natural greenery and thrilling seasons are, as if, lost to the human race.

The health hazards of environmental pollution have in fact, severe effects on living being: Thus *firstly,* the accumulation of peat, coal, oil, shale and other deposits of organic origin—in the absence of recycling by Nature—have harmed the very existence of life on earth. Very often, they cause deterioration and destruction of living creatures, vegetation and plant life. Secondly, water pollution can be the cause of biological infirmities and even death of normal acquatic life. When industrial waste in the form of chemicals, fertilizers and dye-stuff, along with untreated sewage, are deposited in water, it can result in cholera, typhoid and such other epidemics. It is estimated that in India, more than 2 million people die due to water-borne disease and over 50 million persons are partially incapacitated every year.

Thirdly, air-pollution resulting from the smoke of factory chimneys, and exhaust from the automobiles it yet another menace to health. Its extent in India has perhaps increased by 300 per cent over last 20 years. With the growth and expansion of heavy chemical industry, the main industrial air pollutant now is sulphur dioxide. Huge quantities are entitled by chemical plants, oil refineries, power stations and fertilizer plants, resulting in respiratory diseases. Besides, they cause irritation of eyes, nose and throat. Over and above, is noise pollution, which sometimes, leads to the dialation of the pupils, paling of skin, drying of mucous membranes, intestinal spasms and the like.

While environmental pollution presents a more serious and urgent problem in industrially advanced countries like U.S.A.,

Japan, Britain, Germany and others, its potential dangers are no less serious for developing countries like India. The problem is grave enough in some of our big cities like Bombay, Calcutta, Madras, Kanpur, Delhi and Ahmedabad. Besides, these cities have inevitably inadequate road areas, and usually heavy traffic of variety of vehicles. And these have added further to the trouble.

The continued proliferation of the human race is perhaps at the root of environmental problems. In a sense, poverty causes as serious a threat to ecological balance as industrial development. In cities with huge population, vast heaps of people are clinging tenaciously to life in conditions so crowded and so-unhumane—and all this within yards of sky-scrapers and other symbols of present day economic advancement.

It is being realised that, rapid industrialization without adequate environmental planning has created the problems of pollution and ecological imbalance; and that, disaster looms large ahead, for our densely populated industrial centres, if immediate steps are not taken to clean its increasingly polluted environment. Our national concern for environmental protection is, therefore, obvious.

Fighting pollution and creation of pollution-free environment should be our major objective. It involves the highly complex problem of geo-hygiene, which is closely tied to economic and social problems. It also implies the maintenance of certain standard of pollution-free-control mechanism within the plant premises.

Sanitary land filling, formation of compost and incineration would perhaps provide a partial answer to industrial waste and refuse utilization. On a broader plane, however, city planning land use, mass transport and planning and resource management should receive our priority attention.

In this context, I should like to lay stress on self-reliance, through indigenous development of pollution control methods and equipment, tailor-made to our own particular requirements. Besides, these devices should be technically reliable, economically feasible and administratively effective. In this respect, the activities and work of the National Environmental Engineering Research Institute, Nagpur, and Indian Standards Institution, Delhi, deserve a special mention.

On the other hand, while evolving the standards of environmental protection it will be desirable to keep it in mind the necessity of more imaginative adaptation of life to the environment. In fact, it will have to be a continuous process of adaptation, conciliation and adjustment between industry, environment and man, as also between man-made and natural systems. Realising this, our Fifth Five Year Plan has set its attention on this problem with a view to developing a complex and multi-faced strategy which will meet our national requirements. Protective legislation against environmental pollution is also passed by Maharashtra as well as by the Central Government. The Bombay Smoke Nuisance Act, Maharashtra Water Pollution Prevention Act, and Water (Prevention and Control of Pollution) Act of Central Government merit our attention. It is further necessary to formulate a national environmental policy for the country as a whole. I consider that the recent Report of the National Committee on Environment, Planning and Coordination (NCEPC) would be found to be a very useful and relevant document.

It is also considered that, while embarking upon the projects of speedy industrialization in the country, we should direct our efforts towards the search for such technology which will avoid or minimise environmental pollution and still provide better standards of life. *Progress without Pollution* should be the main criterion. Our scientists and experts will have to develop the standards for what may be called, *Preventive Environmental Equilibrium,* in order to preserve a certain quality of human life.

Ultimately, to achieve a continuous improvement in the quality of the environment demands perception, education, economic strength, research and, above all, policies and administration geared to the right aims—especially in such a fast changing world *where every solution of a problem is a new problem itself.*

I am aware that there is no magic detergent for all environmental messes; but the deliberations of this Seminar should go a long way in providing a framework in which we can assess our problems and search suitable solutions within the reach of our national financial and technical resources. And in this search, we have to involve Industry, Trade Unions, Local Authorities, Governmental Administration, Research Institutions, and above all, expert Environmentalists. In short, this should be the business of everybody and of all, individually and collectively.

Address

DR P. J. DEORAS

It is indeed a good augury that we are having a Seminar on Industry, Environment & Man. The theme address of Prof. De has brought to light that the environment has been degraded for some time. It was the Stockholm Conference that made the world aware of this problem of biodegradation.

We want industries because without industry we cannot prosper but industrial development should be without pollution. Attempts are being made to recycle pollutants or do something to wipe out the after-effects of technological developments. But while doing this, very little attention has been paid to the ecological aspects.

The environment on this earth is shared by all the life forces, be it a plant, be it an animal, be it a micro organism. Man is only a very very small part of this environment of the animal kingdom. So unless we take the whole concept of this environment in which all life forces exist, it is very difficult for us to understand the environment and the pollution problem.

Secondly, the natural or the ecological balance is so made that each live force depends on the other. The animals take in the carbo-hydrates and oxygen prepared by the plants and in turn release carbon-dioxide and waste which the plants absorb. There is a very intimate balance between the two. The upsetting of this balance causes pollution. This fact is very little understood. The world has changed many times. 40 million years ago on this earth lived enormous animals like some of the triceratops that were 40 to 60 ft. long, but had a brain of only 4". When the atmosphere changed, they could not stand the changes and were destroyed. Later on new anthropoid came here. When the atmosphere changed, with the glacier ages, the anthropoid migrated, survived and we have homosapiens today trying to master the whole world.

Changes brought about by nature is gradual and nature balances itself. But technology is ushering chances so fast that it is very difficult for nature to adjust or balance the defects. There are nearly half a million man-made chemicals in the world today and it is very difficult to predict their behaviour. Their destructive qualities are jeopardising the very survival of nearly 280 species of mammals, 350 species of birds, 20,000 species of plants in a very few countries alone. Industrial man in the world today is like a bull in a China shop. If he understands half of the ecology he will adapt himself to the behaviour of the environment. Unfortunately the man seems to expect that the China shop will adapt itself and tolerate his behaviour. The scare of food shortage is driving experts to convert the ecosphere into a food factory for man. It is ridiculous to think of the world consisting only of man and his favourite food plants. This earth is a world of diversity. Man has to decide whether to live entirely by technology or to keep the biological experience of millions of years intact.

Pollution may be attributed to scientific development, but it is primarily a socio-economic problem mainly in the realm, of mal-distribution of resources and benefits. In the rush to industrialise, we destroy vegetation and break up communities, so that the controls which formerly regulated behaviour are destroyed before alternatives can be provided. The urban drift is one result of this process with a consequent rise in antisocial practices, crime and delinquency that is so costly to society in terms of both money and well-being. The main problems in environment do not arise from temporary or accidental malfunctioning of existing socio-economic systems. They are the warning signs of a profound incompatibility between deeply-rooted belief in industry's continuous growth on the one hand, and recognition of the fact that this earth is a spaceship with limited resources and vulnerable to thoughtless manhandling by tinkers.

We must respond to the challenge and act, otherwise the result would be catastrophic. A sane society would lay the conditions whereby there would be minimum destruction of ecological process and maximum conservation of material energy. Pollution is an attitude of mind; we must realise that the cost of reduction of effluents would be cheaper on the whole compared to the cost of morbidity and mortality in the society at large. Precious

water needs recycling for crop protection and water can be recycled into energy. The dispersal of industry would prevent multiple pollutants and give equal benefits to all regions. Towns in India are crowded but not that the country is over-populated. Frogs consume 3,000 pests per day and cause less pollution. So they could be considered as a pesticide. In these days of energy shortage, let earthworms give us 15 tons of humus per acre per year and let us not bemoan the shortage of fertilizers.

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Vote of Thanks

DR. S. S. RAMASWAMY

Hon'ble Shri Balgovind Verma, Hon'ble Shri Ramnath Pande, learned speakers, distinguished guests, delegates and friends,

We, from the Central Labour Institute and the Society for Clean Environment, are greatly indebted to all of you for gracing the occasion with your presence. In particular, I would like to convey our deep sense of gratitude to Shri Balgovind Verma, for sparing his valuable time amidst his pre-occupations in Delhi and coming over here to encourage us in our deliberations. Recently the International Labour Organisation observed that even in advanced countries until and unless an attitude to fully appreciate the problem and exhibit a keen sense of involvement in tackling the same, is developed by one and all starting from the topmost executives to the lowermost, nothing much can be achieved in our efforts in the field of Occupational Health and Safety. In this context, Sir, the many ideas which you have put before us in your inaugural address will form the basis for guidance and encouragement in our efforts. As is well-known in any endeavour to solve problems if adequate care is taken to clearly define the objective in the beginning itself, it can be deemed that half the solution is already achieved. We are happy that your address has highlighted many points which may have to be given serious thought of, during the course of the seminar.

While considering such a problem of national importance which is before us, it is essential to have a close rapport between the Centre and the States, to achieve results. In this regard we are fortunate to have also Shri Ramnath Pande, Maharashtra State Minister for Labour, with us this morning. We are grateful to him for his thought provoking presidenitial address which has covered all the problems to be dealt with in the various sessions of the Seminar.

In their key note addresses, the distinguished speakers have developed the various themes with clarity, going deep into the subject matter. Their analysis has provided food for thought to the various speakers in the different technical sessions to follow. I would like to express our grateful thanks to Prof. De, Shri Vijaybhai, Shri Karnik and Dr. Deoras, for the troubles they have taken.

In his inaugural speech, the Hon'ble Deputy Labour Minister was aptly mentioning that in these days of democracy until and unless the common man is also got involved, nothing much can be achieved. In our efforts to communicate the message of this Seminar to the public, we received unstinted cooperation and help from the Press Information Bureau and the Press. We express our appreciation and thanks to these agencies.

The Seminar could not be a success had it not been for the keen participation of the delegates. To you all, and to the managements who have sponsored you, we express our sincere thanks.

Two of the local managements, M/s. Indian Smelting and Refining, Thana and M/s. Kamani Tubes have extended some courtesies to the delegates. For this I would like to express our sincere thanks and appreciation to them.

Finally, I shall be failing in my duty if I do not acknowledge the wonderful help and assistance rendered by the members of the SOCLEEN as well as the officers and staff of the CLI to my colleague Shri B.B. Mathur, who has shouldered the responsibility of the organisation of the Seminar.

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Technical Session

SOCIAL ENVIRONMENT

Introductory Remarks

DR. P. H. PRABHU

The theme of this session of the Seminar is Social Environment, and we have three speakers who will read their papers and present their views on different aspects of the subject. I hope we will have enough time for questions from members of the audience and for discussion on the issues raised by these three speakers.

I cannot help making certain observations stemming from our experience of this morning's papers and speeches. One of the strange things that sometimes surprises me is that we often become aware that we have a problem in this country when in some other advanced country people start talking seriously about the problem in their country! It seems we have a tendency sometimes to import even the awareness of some problems from elsewhere. And as a natural follow-up of this, we also import the techniques, the methodologies, the ideologies, the jargons and the systems that have grown around the "foreign" problem and are developed there to solve the problems. I particularly feel that the imported mass of meaningless jargon may "sound" and "read" scholarly without having any value for correcting local maladies and miseries, whether in the area of man-environment system or any other. Further, sometimes we feel we have a problem where there is none, just because somewhere else that kind of problem exists, and we believe that we must be having it and in fact we have to have it otherwise we would not be rated as "civilized" and "developing" people. This is one way in which the some of us believe that we can "catch up" with the advanced countries: By believing that we have the same difficulties and problems which they have recognised and vocalised as theirs. I think this is not conducive to a healthy progress to our Society.

And that is why I would like to draw your attention to one of the speeches of this morning, as a striking contrast to this

general tendency, namely, the informative speech full of first hand experince of Mr. Vijay Merchant. He gave us description of some of the excellent humanistic work that he has been doing for some years in his industry almost entirely on the basis of fairly and squarely facing problems as they arise and generating spontaneous solutions suited to the context without seeking any standardized or text-book formula of aids and ideas imported from elsewhere. Mr. Merchant found himself face-to-face directly with certain problems as they actually arose out of a complex of circumstances which got entangled into each other. He went into the details and carefully analysed the whole situation and looked at the matter as an interrelated whole and not as several bits of problems bundled together into one. He held dialogues with his senior staff concerned, the actual parties concerned and gave his own thought to the problems. And he then took step after step in a carefully organised series as each step emerged from out of the attempts to disentangle the mass of intermixed data involving the job, duties on the job, professional career and life, moral, personal and social values, economic factors, conjugal harmony and happiness, future of the persons individually and of the family and children, professional ethics living with grace and dignity in society, and a host of other intricately interrelated aspects involved in the totality of the problem. At one point he felt that the current law may not be particularly helpful or may not support him, but his conscience and strong humanism became his main guiding forces and gave him the necessary strength to surmound the difficulties and to face possible adverse consequences, if any, for him in the interest of careful worked out, humane, and genuine solution. In this, he felt further fortified by his own sense of values cultivated by his own study of the Mahabharata, among other studies,—he even quoted a saying from the Mahabharata and felt so strong in his conviction that he firmly asserted that he would face even God on the Day of Judgement on the issue because his conscience was clear. In all this, he was not guided by any cook-book approach of steps to be taken borrowed from books written in other contexts than Indian. And he finally emerged out with a success that all parties liked sincerely, and what was more, the healthy effects of the solutions did not remain specific to the problem but had long range beneficial effects as shown by several subsequent events.

I am not suggesting that you cannot learn from the experience elsewhere of facing a problem and solutions developed there. Such experiences are often useful. What I am concerned with is the tendency of blindly apeing other advanced countries not only in regard to solutions of a problem but even in regard to believing that there is a problem where really there may be none, or may be there is a similar problem but with very different complexion.

Take this problem of man, machine and environment: The advanced countries had concentrated far more on the manufacture and improvement of the machine with a minimum consideration to man for several decades in the past. And it took many generations for them to discover that this has created a number of evil consequences for man whose interests the machines were primarily meant to serve. And so during the very recent decades they have tried to shift the emphasis of their attention to man. It is because of this shift in their attention from machine to man that they have discovered that there is a third vital aspect in the trio, viz. environment, which also needs a much closer look because many of the evil consequences of mechanization have affected and are deeply saturated in the environment, and the consequences environmental imbalance has added further to man's miseries. Thus the advanced countries have recently directed the focus of their attention to looking at man as the centre in the triangle of man-machine-environment system.

However, I notice a certain tendency in the American and other investigations on the subject which makes me unhappy. Ostensibly, man is now an important focal point, far more so now than he was ever before. But the approaches made to study the problem seem to me to reduce man himself to a machine, like an instrumentality or a mixture of structures. He is looked upon as a bundle of any number of concomitant features put into a bag. And supposedly he could be understood by atomizing him into discrete elementary units, and examining these units and pooling together our understanding of the functioning of these separate units. This overlooks the basic fact that man is not just the sum total of these units. He is not only an integration of these units but is much more and over and above the sum total of these analysable and laboratory scrutinizable units. I will illustrate the

importance of this point by a Canadian experimental study in a psychiatric hospital in Saskatchewan.

Dr. Humphry Osmond, a physician who was the Director of the health and research centre of this hospital noticed certain disturbing features in the hospital. For example, its new female geriatrics ward was considered to be a model ward. Everything in and about it was neat, clean and shiny. There was ample space. The colours were cheerful. And yet, the longer the patients stayed in the ward, the less they seemed to talk to each other. Gradually "they were becoming like furniture, permanently and silently glued to the walls at regular intervals between the beds. In addition, they all seemed depressed. Osmond distinguished between two kinds of spaces: *Sociofugal spaces,* such as the railway waiting rooms, which tend to keep people apart, and *sociopetal spaces* "which tend to bring people together, such as the tables at a French sidewalk cafe." His hospital was full of sociofugal spaces and very few sociopetal spaces. Osmond then put Robert Sommer, a psychologist, to find out as much as he could about the relationship of furniture to conversations. Sommer used many ingenious devices including studying natural settings which offered a number of different situations in which people could be observed in conversations, such as the hospital cafeteria. The point here is, that the frequencies of conversation and quantitative measurements of similar phenomena would not necessarily provide a reliable indication of increased or decreased friendliness, affinity or distance, conduciveness of the environment to sociability or otherwise, and so forth of the people concerned. We must always distinguish between physical space and psychological space, physical distance and psychological distance. Two individuals, for instance, may be far away from each other in physical distance but rather close to each other in terms of psychological distance or *vice versa.* Communication is not only a physical, verbal overt phenomenon but comprises many other non-tangible features than mere talking. And sometimes what the speaker feels he has communicated by words is not being communicated to the listener, and at other times communication is effected even without talking and without gestures. Thus, it seems to me that while ostensibly the attention is recently focussed on man, man himself has come to be looked upon as if he and his behaviour are made up of mechanical components such

as physically measurable distances, frequencies of verbal communications, the number of times a person approaches the other person, and so forth.

If we bear in mind the danger of studying man as a collection of bits or pieces of covert behaviour and approach man in environment or in space with his aspirations and hopes and expectations, his perceptions, values and outlooks and views of the world, we should be able to find worthwhile and genuine solutions to our problems. And, of course, before that we must also carefully discover true problems; and not imported or sham ideas of problems! And we must avoid magnifying minor problems by being vocal about them, or minimize major problems by overlooking them because they are not vocalized in the advanced countries of world.

Edward T. Hall has observed: "Man's feeling about being properly oriented in space runs deep. Such knowledge is ultimately linked to survival and sanity. To be disoriented in space is to be psychotic. The difference between acting with reflex speed and having to stop to think in an emergency may mean the difference between life and death—a rule which applies equally to the driver negotiating freeway traffic and the rodent dodging predators.

It seems some interesting work is being done now to study and bring man and environment closer to each other by understanding both. Hall, for instance, has been critical about the preoccupation of the architects with the visual patterns of structure, i.e. what one sees. They are unaware of the fact that people carry around with them internationalization of fixed-feature space learned early in life. Fixed-feature space is the mould into which a great deal of our behaviour is cast. It is one of the basic ways of organising the activities of individuals and groups. For example, buildings, rooms for special function such as food preparation (kitchen), eating (dining room), entertaining, socializing, sleeping, sanitation, the layout of villages, towns, cities, etc. An individual used to one kind of cultural fixed-feature space patterns gets lost and may get highly disoriented in a different fixed-feature space pattern. The Arab feels depressed unless he has enough space with large rooms and high ceilings. In regard to the layout of a city, the European systems stress the lines, which they name as streets or roads. The Japanese name the

intersecting points and forget about the lines. The streets are not named. Houses are numbered in the order of time in which they are built, and not in the order in space; and so forth. Therefore, Japan has problems integrating the automobile into a culture in which the lines between point (highways) receive less attention than the points. Some of the world's greatest traffic jams occur in Tokyo. India has her own problems too in this connection. Hall remarks: "Unless Indian engineers can design roads that will separate slow pedestrains from fast-moving vehicles, the class-conscious driver's lack of consideration for the poor will continue to breed disaster. Even Le Corbusier's great buildings at Chandigarh, capital of Punjab, had to be modified by the residents to make them habitable. The Indians walled up Corbusier's balconies, converting them into kitchens! Similarly, Arabs coming to the United States find that their own internalized fixed-feature patterns do not fit American housing. Arabs feel oppressed by it—the ceiling are too low, the rooms too small, privacy from the outside inadequate, and views non-existent."

I believe that the man-environment system with which this session is concerned needs to make a good case for a very careful, penetrative and perceptive analysis in order to understand the entire complex as a whole, unified and interacting situation in the Indian context of values and ways of life. And I feel sure that if this is seriously done, and if the findings are then seriously put into action by the powers-that-be, we will be able to overcome the present problems and march ahead towards health and prosperity for the country.

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Social Environment

PROF. N. S. GORE

I have been asked to speak on the subject of the problems relating to industrialising the rural worker. When we speak of the rural environment and the rural worker and then the demands of industry made upon him, inevitably we are speaking in stereotypes.

The rural worker can be described from many points of view. First, he is a person probably without many education. He is a person who is not likely to possess at the point where he starts any industrial skills, though we may find that as a result of the establishment of ITIs and Polytechnics some of the persons who come from rural areas and more particularly from small towns, have some education and may also have some industrial skill. Then there are certain social and psychological characteristics that we associate with the rural worker. One would assume that he does not have an efficiency or productivity orientation, unless again he happens to be from the fertile and irrigated areas of Punjab or the sugarcane areas of Maharashtra.

By and large, the rural worker, particularly the non-land-owning worker and a worker from the dry farming areas, is only oriented to subsistence in the practice of his occupation. This fact may have some implications for his attitudes to his work in industry. Following the premise of subsistence orientation we would assume that he is not really used to thinking in terms of monthly incomes and the planned use of these incomes over a period of time. The idea of savings, accumulation of such savings over a period of time, the investment of these savings, are ideas that are not part of his way of thinking when he comes to work. The rural worker again is rooted in his family in the sense that he is bound by the traditions of his family, of his caste and of his village. He is emotionally tied to the family and to the people or to the group from which he comes. We

may find that this dependence upon the group is an important characteristic which affects his functioning in the city as well.

A rural worker will probably find his life in the urban areas literally too fast in terms of time. He may find it too impersonal in so far as he moves from the primary groups to which he has been used and has now to live an environment dominated by secondary groups. The environment is too impersonal at his work place and even in the place where he lives. Even in the urban areas, the workers may seek to recreate the kind of primary groups to which he belonged in his village. In so far as possible he prefers to live in areas of the city where other migrants from his part of the country have come to live. He may seek to find linguistic or regional or both affinities in choosing his place of residence. In fact, he will try to find as close a kinship group as he possibly can, and it is not uncommon to find that a rural worker with some 'bhai' or the other. The 'bhai' may not literally mean a brother but only a person from his village or someone known to him. This meets the need to establish primary ties in an otherwise impersonal environment.

He may find that unlike in his village where his work is allocated to him by the fact that he belongs to a particular family, his work in the urban environment is something that he has to compete for. He has to get used to this competitive environment of the city, particularly of industry. He may also find the urban environment too heterogenous. Though the Indian village is characterised by a multiplicity of caste and differences in levels of economic well-being, the heterogenity of the city is very different from anything that he is likely to have experienced earlier particularly the heterogenity of metropolitan cities like Bombay and Calcutta.

He may also find that it is a strain to adjust to the formal control mechanism of industry, the control exercised through the time office, and supervisors at various points. This is a control exercised in terms of written rules to which strict adherence is required. He may find that this supervision is different from the very but personally more responsive supervision exercised by his village boss. He will take time to get used to the mechanism of formal control. He is conditioned to define his social context in terms of group affiliations and family affiliations rather than in terms of individual achievement or individual choice. This is

important to understand for those who have to deal with workers from rural areas. When, for instance, a new rural worker asks for a particular thing to be done for him on grounds other than those of merit he is not seeking an unfair gain. It happens that this is the only system he has worked in and he tries to establish relationships through primary affiliations to which he is used. He may find that in order to make life possible in the urban areas, he has to live in some kind of clusters which he can understand and to which he can relate. Thus, in older metropolitan cities, particularly in their neighbourhood arrangements there is a tendency on the part of the workers from particular parts of the country to live together almost like a village group. You can, in fact, identify villages from Konkan lane by lane in some of the labour areas. This is in a way an effort to continue the network of village relationships in the absence of which he would find it difficult to function.

Obviously, these different characteristics are undergoing change as the rural environment itself is undergoing change. But the pace of this change has been somewhat slow and the chances are that these generalisations based upon old studies are still probably not invalid.

Now what are the demands that we make on such a worker in terms of his work situation as also the situation of life in which he finds himself. The first demand is for a certain measure of technical skill. The degree of skill required will vary but to an extent possible, industry will try to grade and match the worker in terms of what he is able to give and what the job demands. But very often when an industry is established in an entirely new area, industry does not have a choice and a very large proportion of the workers are necessarily drawn from among those who are first generation industrial workers. In this case, the demand made upon them by industry is not likely to be adequately met and industry will have to find ways by which these shortcomings in the worker can make up. The worker is not likely to be production or efficiency oriented and this may reflect on his performance in a wide variety of ways. He is also not thinking necessarily in terms of progressively building up a career. The idea of a career does not often figure in the calculations of this person. He is quite happy to begin with to be able to make both ends meet.

If this worker is to think in terms of a permanent job, of progress in his job, of working up from his current lack of skill to a semi-skilled and a skilled worker, there is a new input required. Every worker who comes from the rural area may not be so oriented.

For every industrial centre there are certain rural areas from which industrial workers have been traditionally drawn. Bombay and Calcutta have such areas. In these rural areas, it is possible that the culture of industry has spread — at least in the sense that individual think in terms of making a career, of a progression in terms of one's skill and emoluments. But to the extent that industry-drawn workers from an entirely new rural area, we would find this orientation is absent. The assumption that every person must respond and will respond to monetary incentives is valid not within limits and it may be that there is no one correlation between the effort that the worker puts in and the emoluments that he is promised.

The rural worker experiences a conflict in terms of the demands that are made upon him by industry in terms of the regularity and punctuality of attendance at work and the demands made on him by his family, his village and so on. The extreme cases, of course, are those of the tribal workers where the worker works for 5 or 6 days and then does not appear on the scene on the next working day after the wages are paid. This is less and less true of the rural worker.

As an institutional administrator, it is my experience to find that workers go on leave, some time in May and then do not return to work for 3 months. They are trying to accommodate the demands of the small farm at home during the rainy season, the demands of their families in terms of weddings in family, etc. within the formal limits imposed by the institution. Since he has to retain his job, he asks for an extension of leave on some ground or the other and, if he is skilled in the workings of bureaucracy, he will duly send a medical certificate which will enable him to get sick leave or some other kind of leave to which he is entitled. If he is not fully familiar with these mechanisms, he may not write at all, and then turn up suddenly at the end of 3 months. If the post has not been filled, he gets his job back again. If it has been filled, he gets his first experience of how the office procedures operate.

Industry demands that the workers should be quick at adaptation; a worker who is able to change from one job to another, is likely to do better in industry than a worker who can only perform one type of an operation. This is not entirely consistent with the demands that traditional agriculture has made upon him. The new kind of agriculture may make demands which are more like the demands that industry makes.

The capacity to cope with and to manipulate the rule-bound organisational relationships in which he finds himself, does not come naturally to the worker. There are all kinds of rules in which he has to function and interact with individuals in various statutes.

This is a different environment from the one which he has been used to. The worker may find it difficult to meet these demands and experience many problems of adjustment.

Industry could minimise some of these problems and the adjustment. I would like just to point here about the role of social services and of better conditions of work, of simple things like housing, community facilities, health etc. as also the role of formal, informal education structures relating to his job, to his life in the urban areas, the role of training and retraining opportunities on work. These various facilities can help reduce the strains and problems rural workers face. We have to enable this worker to first feel secure in a new environment so as to be able to make the necessary adjustments and enable him to gain a new kind of individuality, autonomy and identity.

When I speak of an adjusted worker, I am not necessarily speaking of a worker who is more manageable or conforming. You may find that after providing the various facilities, industry succeeds in getting a more independence, a more self-respecting and, may be a more educable and more efficient worker, but he may also be a more difficult worker to manipulate. This is sometimes not realised and industrial management complain that despite all the facilities they provide the worker is not grateful and compliant.

What I have tried to do is to indicate the kind of an environment from which the rural worker comes, the kind of problems that he is likely to face in the urban situation and the kind of objectives that we may reasonably set for ourselves and yet not be disillusioned. ★

Behavioural Dynamics in Industry

DR. JASWANT M. SINGH

If I cannot bend the Gods above, I shall move the underworld.
—Virgil

We shall not cease from exploration, and the end of all our exploration will be to arrive where we stated and know the place for the first time.—T. S. Eliot

Seventeenth century is known as the age of enlightenment, eigheeenth the age of reason, nineteenth age of progress and twentieth the age of anxiety. Down the history man has found solutions to problems as they have presented themselves. And in the process man learnt to create. Man creates to protect and prolong his own existence. In the process of creation man has been discovering his own self. Discovery of self through various disciplines has been man's greatest achievement. However, creativity and self discovery have presented man with it's own peculiar humanistic problems.

Human interactions carry within them potential problems. A closer look will reveal that any interaction with external environment has a built-in probability for creating stress or anxiety within the individual. Noise in the factory, unsympathetic supervisor, meeting dead lines, leaky roof, traffic on the roads, rising prices and innumerable other situations generate stress and anxiety in people. For some it is not necessary to have other people around to make them anxious, they have mastered the art of becoming anxious by pressing certain buttons in their own heads. It almost appears that people are addicted to anxiety. Absence of anxiety has demotivating effect on them. According to his ingenuity each individual determines the quantum of anxiety necessary to maintain his* addiction. The addictive nature of anxiety, perhaps motivated thinkers to call twentieth century the age of anxiety.

* The pronoun 'his' in this paper is used to indicate both masculine and feminine genders.

Possibly twenty-first century will be the age of awareness, in which direction, man has already started moving.

Anxiety can reach critically destructive dimensions. It can cause critical accidents, bankruptcy, unrealistic planning, or a style of management which would lead to sure destruction. The ravages of anxiety are not only visible in individuals locked up in institutions for mentally sick but also in, so to say, sane individuals holding the destinies of others in their hands. This makes it worth our while to examine the dynamics of anxiety or in more general terms, the dynamics of human behaviour in order to relieve man from the oppression of 'anxiety'. A humble beginning need to be made and what is being done here may be infinitly insignificant, but it is a beginning.

Critical analysis of any situation will make it amply clear that its nucleus is communication. A subordinate is not anxious about getting late, but how will he explain it to his superior. Management is not anxious about the rising cost of production, but how will they explain it to their customers. A salesman is not anxious about losing a deal but how will he explain to his employer, wife and creditors.

Communication, therefore, is the single important problem that people face today. Earlier anthropological as well as political and social history amply verifies the problem of communication that man has faced from time immemorial. Lack of, or broken communication have resulted in wars, social upheavels, revolutions, etc., and even today man has not mastered the art of communication. Those men who attained certain degree of fluency have left their mark on the history of mankind. We have produced our share of such men and Gandhi was one of them.

All along man has spoken in search of himself; to discover his own self; to find reason and answer to his being and existence man evolved ways and means of expression. To this end some have spoken eloquently, some disjointedly, some haltingly while some incoherently, but man's search of self and it's effective expression continues.

Man has communicated through art, sculpture, letters, word of mouth etc. but in all it's forms it has opened the inner sanctums of man, as any communication is a blend of the communicators physiology, biology, anatomy, neurology, biochemistry, developmental processes, social environment, religion, culture and edu-

cational level. Therefore, in order to be able to understand man and his internal processes his communication need to be examined and understood. Transactional theory concerns itself with the understanding and prediction of behaviour through the study of communication.

Conceptual Frame Work

The empirical foundation of transactional theory of personality is based on observable constructs; what can be seen, heard or experienced; provides the framework for the study of behaviour. Externally behaviour may be observed by tone of voice, facial expressions, gestures, postures and the use of words. These external manifestations of behaviour may be correlated with internal nervous tissue functioning, even though it is not known uptil now how the mind is connected with body. However, Penfield[1] demonstrated that stimulation of certain brain centres activate a specified behaviour. He further demonstrated that such stimulation brings back forgotten expriences to awareness. These experiments remonstrate that memory function which is commonly known as psychological phenomenon, also the biological determinants.

Penfield's studies prove that people carry within their heads "programmed" patterns which formulates internal system or environment for the individual. This leads us to the conclusion that each individual has two environments to reckon with — the internal and the external. Simply stating — internal environment influences behaviour when one wants to (feels like) and/or does not want to (don't feel like), while external environment influences behaviour by placing demands such as "should" and/or "should not". The nervous tissues incorporate part of the external environment as it's own and at times influence behaviour on the basis of this external learning or influence.

Experience shows that all behaviour may be categorized as 1-rational, 2 non-rational** based on feeling and 3 non-rational based on learning. After intensive study, Berne[2] concluded that

** The term non-rational was suggested by one of my therapy group members. Prior to this I was using the term 'irrational', which is both anti-therapeutic as well as derogatory.

1. Penfield, "Memory Mechanism". A.M.A. Archives of Neurology and Psychiatry, 67 (1952); 178-198.
2. E. Berne, Transactional Analysis in Psychotherapy. Grove Press, NY.

every person carries inside his head three personalities based on the above three categories. This was the beginning of Berne's new theory of personality and in order to keep the vocabulary simple and non-technical he called the rational part "Adult" the non-rational part based on feelings the "Child" and the non-rational part based on learning the "Parent". These are not only theoretical concepts by phenomenonlogical facts, with names, identities, likes, dislikes, idiosyncracies, impressions, diction and vocabulary. At any given point in time, a person's behaviour is operated by one of these three personalities. In essence a person when operated by his Parent is being very much like his natural parents or when operated by his Child is being very much the child he was.

Ego State

Ego is described as "Self" or "I". The "Self" or "I" shifts from moment to moment from Parent, Adult or Child. At a given moment when a person's behaviour is controlled by his internal Adult the "Self" or "I" at that point in time is located in the Adult and the person experiences "Self" in the Adult part. Thus we conclude that the person's ego or "Self" is in the Adult state. Similarly, the ego or "self" may shift to Parent or Child and the person is said to be in Parent-ego-State or Child-ego-state.

Here it would be in order to distinguish between the transactional analysis ego states and the psychoanalytic concept of "Id", "Ego" and "Superego". From psychoanalytic approach personality is viewed as a composite of biological aspects, represented by Id, psychological aspects represented by ego, social aspects represented by superego[3]. This concept provides a frame work within which personality can be explained and behaviour transfixed, however, it lacks in providing tools to explain and predict behaviour. While on other hand ego states are realities which may be observed as ego functions in the form of behaviour. This gives rise to the concept of ego state content which in turn provides pragmatic approach to understanding and prediction of behaviour. Therefore, even though Id, Ego and Superego may appear similar in their apparent content and structure to ego states, however, in fact, as is obvious they are quite different in their basic approach and functions.

3. Sigmund Freud: Introductory Lectures on Psychoanalysis.

Parent Ego State

From the time he is born, a human infant starts getting messages. During infancy, the messages came from his natural parents, while later, also from the 'big' people around him. He gets these messages verbally as well as through gestures, facial expressions, tone of voice and the way he is handled. These messages from the 'big' people are recorded in the child's head as they are received. There are two reasons why this happens. First of all, the child's own "Adult" is not experienced enough to sort out and reason out these messages. Secondly, the child is dependent upon the "big" people for his physical as well as psychological survival and therefore, takes these messages without questioning. These messages also contain opinions, prejudices, superstitions, do's and don'ts ethical and moral values and form the Parent-ego-state in the head of the child.

Parent messages can be supportive or nurturing as well as non-supportive or punitive. Supportive messages will give the child permission to try out, experiment, take risk and learn through experience and express real feelings. A supportive message will convey to the child that he is accepted for what 'he is' and not for what 'he does'. Supportive messages stroke the child and give him necessary protection. They allow the child to decide for himself. Supportive messages make a child feel good about himself.

Non-supportive messages inhibit the child with "do's" and "don'ts". They are loaded with canned opinions and prejudices. Non-supportive messages make prophesies for the child, such as "you will never be anything", "you never hear", "you are stupid", "you are always late", "you can never get along with anyone", etc., which the child records in his Parent ego state and makes them come true in his life.

Adult Ego State

Sometime people find themselves trapped in distasteful and unpleasant situations and take it for granted that there is nothing they can do about it. They are not able to see alternative options or obvious solutions. They limit their perception of the problem and leave no option for themselves but to repeat unsuccessful steps over and over again.

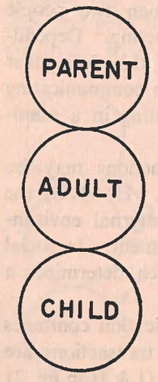
Everyone has a system to evaluate or sort out data. This system can be used to reason, evaluate data, gather information and also to store it for future reference. Its function can be compared with that of a computer which, given a certain data, processes it objectively. This part also has mechanism to reality test a given data by examining whether it is a fact, a fantasy, and opinion, tradition or some prejudice.

Adult examines a given data, considers the Child (internal) feelings, weighs Parent (internal) messages and makes an objective decision. By providing alternatives and options, the Adult in a person ensures his independent survival.

The correctness of a decision is not necessarily the measure of ones functioning from his Adult ego state. The criterion of ones using his Adult ego depends upon the process by which the decision is made. The quality of decision will depend on how well the Adult is informed and how freely he is able to select information from his Parent and Child and how objectively he can really test and evaluate a given data.

Child Ego State

The third part in a person is his internal Child which records and stores all the feelings that he goes through as a child. It



Nurturing and Punitive.

Perceptions, problems solving, memory, thinking.

Feelings, needs adaptive behaviour, fun loving, intuitive, creative, makes guesses.

Fig. 1.—Personality structure.

is reasonably accurate to say that a part of his child (chronological) is fixated inside his head to form the Child ego state. Chronologically, this part remains in him a child even in adulthood.

This part is also intuitive and makes guesses. It contains all the impulses that come naturally to an infant. It also contains the recordings of his early experiences. When a person responds as he did in childhood—inquisitive, affectionate, selfish, mean, playful, whinning, manipulative—he is responding from his Child part. To the internal nurturing Parent the most important part is the internal Child.

Depending upon the quality of Parent messages and Child feelings, the child charts the course of his life. While still young and not armed with adequate information, a child makes a plan for his life to which he is committed for the rest of his life.

Transactions[4]

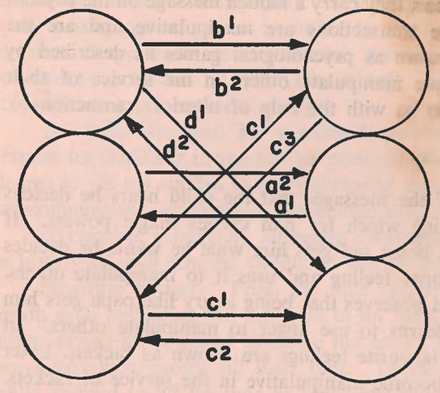
In terms of transactional analysis (TA), a unit of communication is called a transaction. A transaction therefore consists of one stimulus followed by one response. For instance "have you finished the Jogin report?" is a stimulus and "I submitted it last Monday" is the response, together they make a unit of transactions can be verbal as well as non-verbal and form the basis of all social interaction. As is obvious in all social interactions, total personality is involved, that is to say when two people interact a total number of six ego states are interacting. Depending upon the ego states they engage in interacting they will either continue communicating and making sense or stop communicating with residual ill feelings or continue communicating in a manipulative way.

On the basis of these considerations transactions may be classified as complimentary, crossed and ulterior. However, the quality of communication is influenced by the internal environment and in effect influences the external environment. In social aggregate this is a single dynamic force which determines a person's social and psychological well being.

Complimentary transactions: When communication continues along parallel lines between two individuals the transactions are called complimentary. In such transactions vectors (I & II in fig. 2)

4. Berne, E. Structure and Dynamics of Groups and Organisations.

run parallel without crossing each other. Theoretically complimentary transactions can continue indefinitely.



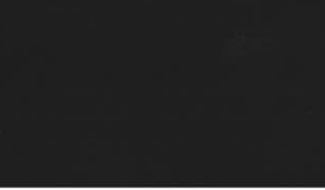
a1: Do you have the Gopal case?
a2: No. I think it's with the boss.

b1: You must have the Gopal case.
b2: You are the one who should have it.

c1: I don't know where that Gopal case has gone.
c2: Nothing remains in place here.

Fig. 2.—Complimentary transactions.

Crossed transactions: In this type of communication the vectors cross and the communication ceases at that point in time. The thread may be picked up by one or the other individual and communication continued, however, crossed transaction leaves residual bad feeling which remain stored until such time when they find guilt free social interaction. Crossed transactions inhibit creativity, free thinking and social interaction.



a1: Have you seen my application?
a2: Don't discuss that with me.

a1: Have you seen my application?
a3: Why do I have to deal with such things.

Fig. 3.—Crossed transactions.

Ulterior transactions: These communications have double meaning. On the social level or on the surface they have a clear adult message, whereas, they carry a hidden message on the psychological level. These transactions are manipulative and are the basis if what are known as psychological games as described by Berne[5]. When people manipulate others in the service of their own feelings they do so with the help of ulterior transactions.

Magic Feelings

On the basis of the messages that the child hears he decides upon a certain feeling which for him carries magic powers. If the child learns that being sad gets him what he wants he decides sadness as his favourite feeling and uses it to manipulate others. Similarly if the child observes that being angry like papa gets him what he wants he learns to use anger to manipulate others. In TA language these favourite feelings are known as rackets. Later in life transactions become manipulative in the service of rackets.

Basic Needs

Apart from need for food, water and air which are essential for physical survival of man, there are certain psychological needs which are equally essential for his survival. In the absence of adequate resource to fulfil his psychological needs human organism becomes less productive, withers and is extreme cases actually dies. These basic needs are known as hungers and are seen as stroke hunger, structure hunger and position hunger.

Stroke hunger: Spitz[6] in his studies showed that human infant dies (merasmus) due to lack of touch or contact. He discovered that inadequate handling in children caused dehydration and nervous tissue shrinking. This led to the concept of stroke hunger.

It is a common experience that every one needs and seeks recognition. In the language of transactional theory, this recognition is called "stroking" which, literally means touching or patting. A child's primary language of love is touch.

Human contact, therefore, is essential for total development. If a Child is not recognized and stroked for what he is, he learns

5. E. Berne: Games People Play.
6. R. Spitz; "Hospitalism; Genesis of Psychiatric Conditions in Early Childhood".

to collect his strokes by manipulating the environment. Sometime a Child settles for a slap, which is a negative stroke than to have no strokes at all. Subsequently, the Child learns to innovate and play psychological games in order to ensure a fair supply of strokes. Experience shows that such game playing in the service of strokes, continues in adult life as well, unless the person becomes aware and makes a change.

In adults the need for stroking is still there, however, the means for fulfilling it are not as primitive as in childhood. He learns to get his strokes in a sophisticated way; such as by means of compliments, acceptance, recognition etc.

A creative, intelligent, authentic person is so because he has a history of well stroked childhood behind him.

Structure hunger: From the time of birth until the time of death each individual has the need to fill his time. This need for filling ones time is called structure hunger. There are six known ways in which people fill their time. Depending upon how the child learned to fill his time he will chart the course of his social interaction. One of the ways people fill their time is by Withdrawing from threatening environment. Some people fill their time by engaging in Rituals very similar to religious, social and cultural. Another time people engage themselves in Activities such as repairing a car or planning an expansion programme or balancing household budget. Activity and goal oriented and the communication is maintained until the same is accomplished. Another way of structuring time is in engaging Pastime. Which consists of complimentry transactions however, in the process nothing is accomplished. Gossip, talking about the neighbour, office politics, inefficient government policies fall in the category of pastimes. Fifth way of structuring time is playing psychological Games. Games are played in the service of reinforcing favourite feeling, reinforce one's own self worth and maintain the supply of strokes. Finally people structure their time by being Intimate. Intimacy is a state being where a person is real. He doesn't manipulate others neither does he allow others to manipulate him. He enjoys what he does and is in-charge if his feelings and responsible of his actions. Intimacy is the state of optimum creativity and self satisfaction.

Position hunger: Very early in life depending upon the quality of messages, the Child decides upon his own self worth

as against those around him.[7] This is known as the basic position, and the individual continues to reinforce his earlier stance by manipulating the environment around him. The basic position that the child is born with is I'm OK, you are OK (as opposed to Hariss stand of I'm not OK, you are OK). As the child grows he may change his basic position to any of the following three: (1) I'm OK, your are not OK, (2) I'm not OK, you are Ok, and (3) I'm not Ok, you are not OK. Accordingly, the child learns to relate and communicate with his external environment.

An individual who has received positive strokes, is an intimate person and communicates on the basis of I'm OK you are OK.

Organisation Script

On the basis, external messages the Child decides upon his favourite ego state and also how he will live and organize the rest of his life. This is known as life plan or life script.[8] Some studies show that life plan or life script is decided upon by a child as early as between fifth to seventh year of his life. Whatever the age of the child might be when he decides upon his life plan, the fact remains that he does so without adequate and accurate information about self as well as others and is forced to persue it to it's tragic end or predetermined conclusion.

People are propelled to communicate from their favourite ego state as well as manipulate their environment in furthering and fulfilling their life script. For instance if a person has Parent as his favourite ego state and has a message to be success and make money, he will carve out his life to become chairman of an organization and make a good deal of money. Messages can also be destructive in content. For example, be a success message may be enjoined with 'you are stupid' message, in which case the person may become a success and end up in an asylum or blow up the whole thing, both in the service of being a success and stupid as well.

Scripts influence families, social interactions as well as work situations. In the larger context families, organizations, cultural and ethenic groups, even nations have scripts. Statements such as 'A' people are hard working, 'B' people are hot headed, and

7. Thomas Harris: I'm OK, You are OK.
8. James and D. Jongeward: "Born to win."

'C' people are lazy, is actually reference to the script people live by. Similarly organizations, especially family owned, have script similar to that of the top man. If the top man is Parent oriented he makes the organization dependent and non-creative his verbal and non- verbal messages are "don't think", and is likely to run an efficient non-threatening organization by gathering complaint Child people around him.

On the other hand the top man may have Child as his favourite Ego state and may run the organization from the feeling level. He may be a popular happy-go-lucky man in the organization and may also lead the organization to sporadic successes, but the fate of the organization is similar to that of a ship commendeered by a seven year old. He is likely to run the organization of hunches, gusses, and feelings, without reality testing the given data.

When there is harmony among the ego states, life becomes a symphony. Self shifts from one ego state to the other according to given situation. Communication is meaningful and creative and non-manipulative.

People have options to operate from the ego state they want to, change about themselves what they want to and alter loosing into a winning script.

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Job Enrichment & Humanisation

S. B. HEGDE PATIL

Introduction

I have to deal with the subject under constraint. They emanate from the inadequate number of studies on Job Enrichment carried out in India. However, organisational studies done by the Central Labour Institute and others amply show the need for evaluating the existing job structure in terms of motivational requirements.

In this paper, we shall consider:

1. Some salient features of job enrichment and its logical base, against motivational problems;
2. The steps and principles involved in redesigning the job; and,
3. Managerial implications in terms of participative approach education and training, and personal policies.

Motivational Problems

The concept of Job Enrichment should be viewed in the context of today's industrial relations' climate. Apart from resorting to strike and the like, blue and white collar employees and to some extent middle managers increasingly tend to surreptitiously challenge authority, resent their bosses and show dissatisfaction about their union. These symptoms of relational problems are not peculiar to industrially advanced countries. The studies carried out by the Industrial Psychology Division of the Central Labour Institute and other researchers show that this is true of India also. Alienation of employees as expressed by passive withdrawal, tardiness, absenteeism or active attacks, deliberate waste and other disruption of work routines are common experience.

Results of the attitude surveys carried out by us indicate that such passive and active reactions are overt manifestations of a conflict between changing employee needs and attitudes and the organisation's incapacity to meet them. There is a conflict between work with ever less human content and people with ever-increasing human aspirations and expectations from the work organisation. In this social order, the traditional management approach of direction and control are increasingly found to be useless in motivating people because social and egoistic needs have become important to them.

From this background, let us examine some salient features of 'Job Enrichment'.

Job Enrichment Theory

Job Enrichment Theory of Dr. Fredrick Herzberg states that employees are motivated positively by challenging jobs which provide them with a sense of achievement, advancement, recognition, responsibility and growth. Whereas, they are affected little by job peripheral factors such as company policy, supervisory character, working conditions and fringe benefits, wages and welfare, etc.

Herzberg points out that satisfiers or motivators which will enrich the job are associated with the work itself and are part of the job content. Whereas, dissatisfiers are the factors external to the job and are found in job context. Hence he calls job context factors 'maintenance' or 'hygiene' factors.

Herzberg further emphasises that job satisfaction and dissatisfaction are two distinct experiences. The improvement in hygiene factors such as pay and working conditions removes dissatisfaction. But it does not necessarily lead to satisfaction and hence job motivation. He, therefore, suggests that job dissatisfiers have to be removed in order to remove dissatisfaction but by mere removal of such factors we should not expect job satisfaction. We managers, therefore, besides improving on hygiene factors must introduce motivators in the job to make it satisfying and enriching.

It is found that when there are fewer opportunities to meet motivational demands managers tend to offer greater hygiene to make the situation tolerable. But this is not the panacea for lack

of motivational aspects. Herzberg, therefore, suggests redesigning the job to make it more challenging, creative and hence interesting and satisfying. He calls it vertical job loading. It contradicts the efforts of industrial engineers to rationalise the jobs or personnel managers' efforts to load it horizontally.

Herzberg's job enrichment seeks to improve both task efficiency and human satisfaction by building into the job motivating attributes, viz. greater scope for personal achievement and its recognition, more challenging and responsible work and more opportunity for individual advancement and growth.

Job Redesign

The following steps need to be taken in order to redesign the job so as to bring about enrichment.

(a) analyse how the job is now done;
(b) examine how far this falls short of meeting the human requirements;
(c) redesign for a better way of doing the job (if such one is felt to be needed) and,
(d) work out how the new design could be implemented.

All actions taken in pursuance of these steps should be governed by the following principles:—

(i) Giving a person a complete natural unit of work; (Module) by putting prework, auxiliary and later work activites into longer work cycle for meaningfulness;
(ii) Creating jobs having discretionary content of thinking and decision making;
(iii) Assigning special and creative tasks with ample opportunities to innovate, to change, to renew so as to demonstrate personal capacities and potential;
(iv) Granting adequate authority, accountability for results and freedom of expression, association and organising etc. within the job responsibility;
(v) Creating communication system to provide clear standards and regular feed back on performance for self monitoring.

The jobs which are inter-related could be redesigned by:—

(i) Laying out the work area to facilitate group interaction;
(ii) Designing work modules which will help make a natural

group with inbuilt mutual dependence for providing a service or meeting the needs of a customer/client/whole task;
(iii) Forming autonomous work groups which allow its members to share and allocate amongst themselves the requirements for control and coordination of their task-related activities with task interdependencies in mind. The group thus shares the task of monitoring and controlling the contributions of its own members and organising their mutual support to cope with individual and task variations.

Management Implications

While effecting the required changes we should also consider organisational climate. Under organizational climate, I shall limit myself to three aspects viz.:—

(i) quality of participation in decision making;
(ii) investment in education and training; and,
(iii) re-orientation of personnel policies.

(1) *Participation*: The studies carried out by our Industrial Psychology Division (following Likert's Model) suggest that Indian Managers want to move towards a more particpative system of Management. It also showed that the degree of participation, in terms of quality and quantity of participation based on the task and technology used, is important for employee satisfaction and performance.

The quality of participation is the degree of subordinate's involvement in view of the purpose of participatin, viz. job redesign for enriching it. For improving the quality of participation, the Manager should cultivate confidence in his subordinate's abilities to handle problems. Improving the quality of participation also implies, acknowledging personality and capacity differences among his subordinates by the manager. He recognises that individuals should move towards the free inter-change of ideas, suggestions, and criticisms for bringing about improved job content.

The process of working together on problems of common concern about job content increases communication, understanding and confidence between the manager and the managed. The interaction of two-way communication helps establish cooperation for

a common goal of improved job content. It also serves as a base for sound industrial peace and progress.

(2) *Education & Training*: It is needless to emphasise that an adequate investment in education and training only will pave the way towards job enrichment. Here my concern is towards effectiveness in training rather than efficiency in training. What I mean is that education and training should be with objective of doing the right things, producing creative alternatives, optimising use of resources, realising learning objectives and developing training needs on a continuous basis rather than following only efficiency criteria, viz. do things right, solve problems, safeguard resources, follow duties, and cost of training. We can very well realise how the alternative propositions which come under efficiency approach are not in tune with its innovative elements involved in job enrichment.

From this perspective of innovative education and training for organizational effectiveness, I would like to dwell upon two training models we made for two specific organisations:

(a) possible enrichment of supervisory jobs
(b) evdving training needs at the managerial level.

(a) *Encircement of Supervisory Job*:

The aimof the programme was (1) to help the first-time supervisors to think and act positively and constructively on their day-to-day organisational problems of utilising human and physical resources by dentifying new areas of responsibility and (2) to suggest ways and means for their optimum contribution to organisational effectiveness.

The strategy adopted was—

(i) Top management was apprised of the need for collaborative effort and whole-hearted support in encouraging and implementing the change in supervisory job content.
(ii) A four-day Seminar for Middle Management personnel was organised to develop concepts and approaches for colaborative effort and supportive attitude and follow up responsibilities.
(iii) A basic course on supervision was conducted for the first line supervisors (target group) in which technical and company subjects were covered by company officials

and social and psychological requirements of supervisory job by Institute faculty. About 75% of the supervisors were exposed to this training.
(iv) Afterwards they were exposed to problem solving workshops of two days' duration. Exercises were designed to help discover problems and invent solutions. These programmes were concluded after formulating a number of practical suggestions.
(v) A Committee was formed from amongst the departmental heads to discuss the suggestions given by the first line supervisors and facilitate application and follow up of results. The Committee under the Chairmanship of General Manager used to meet once in a month to see the progress regarding the implementation of the suggestions.

(b) *Evolving Training Needs*:

The project was based on the assumption that the organisation will benefit from developing methods to deal with such problems as identification of training needs, so that the organisation as a whole would become a more adaptative and self-independent task force.

Through separate and joint group meetings of Managers, Department Heads, Engineers and Supervisors (category personnel) with the Institute faculty the following approaches/strategies were formulated.

(i) Evolving an effective system of training was the responsibility of the organisation and the Institute faculty would help the organisation in this process.
(ii) Data on organisational problems were collected by the faculty through questionnaire and interview method and were fed back to the members in homogeneous groups.
(iii) As an outcome of feed back based on work problems as perceived and dealt by members and as revealed through questionnaire and interview data, a task force nominated by groups was formed to analyse in depth the causes of the problems and suggest solutions.
(iv) The task force being a decision making group the members learned to participate effectively in group decision making. The faculty facilitated the process by provid-

ing a broad knowledge of human factors relating to work problems.

(v) The suggestions of the task force was not in terms of a list of demands or a mandate but in terms of an agenda for meaningful discussion with all concerned for arriving at an agreed course of action to which all were committed.

(vi) The suggested course of action was not intended for solutions of the problems in totality (as they are complicated by human, technical and organisational variables within the organisation and the forces of the external environment that effect the internal organisation). Instead the suggested actions were considered as purposeful interventions based on clear hypothesis and objectives agreed by all so as to enable the organisation to evaluate the effect of these purposeful actions at a later stage and continue the process of change in the right directions.

As a result of these exercises group needs or organisational training needs emerged. Questions were raised again and again at feed back sessions about individual training needs by the members. Problems involved in this were also discussed.

This is not the place to list down the training needs the organisation so evolved. But, however, I should add that one of the training needs they identified viz., communication gap between top executives and middle managers could be bridged by their participating in a joint Human Interaction Workshop. Because the members worked through their own problems and identified their training needs by collaborative approach, there was total commitment to the training activity which was intended to meet that need.

Job reduction or enrichment being a collaborative exercise, rather than a management technique, the need for following participative training strategy as a continuous process for its implementation need not be emphasised.

(3) *Personnel Policies*: Personnel policies should support Job Enrichment concept and practice. It is, therefore, appropriate to examine what is presently happening.

Personnel policies in most firms remain confined to three areas; Labour Relations, Recruitment & Selection, Training and Welfare. Within these areas, personnel work tends to be oriented exclusively towards people *per-se* in terms of their abilities, satisfaction and welfare and away from the work of the enterprise in terms of how it should be changed to meet the requirements of people. Job Enrichment concept and practice cannot be effective with such an orientation to personnel policies. What is required is a balanced shift to people-in-relation-to-work and its organisation, that is to say, to the people work relationship.

In this shifting of emphasis, I do not mean to ignore the importance of welfare activities or pay. However, all welfare activities and compensation must be tuned to the changing needs of people-work-relationship which has to be perceived through a common frame of reference by the people concerned. This common frame of reference can be brought about only by educating people about work and its meaning to them and society and by a continuing dialogue on what constitutes individual aspirations and oraganisation/union goals.

Before I conclude my remarks on Personnel Policies, it is relevant to touch upon the problem of wage payment in the context of job enrichment because it is a sensitive area. Here, I can only share with you the conclusions of case studies of successful and unsuccessful job enrichment programmes carried out abroad. It is observed that the forms of wages payment such as incentive scheme based on finely detailed job specification and paid on individual basis or for a particular kind of narrow specialisation inhibit team working and individual growth and satisfaction which go against the principles of job enrichment. Case studies of successful programmes indicate that it is necessary to evolve forms of payment based on following criteria.

1. A fixed salary for the individual norm based on his proportional contribution to the total group task.
2. A multi-factor incentive bonus scheme for the factors related to the task objective.

Summary

The concept of Job Enrichment should be viewed in the context of today's industrial relations climate. The passive and

active reactions are overt manifestations of a conflict between changing employee needs and attitudes and organisation's incapacity to meet them. The traditional management approach of direction and control are increasingly found to be inadequate in motivating people because social and egoistic needs have become important to people.

Herzberg suggests redesigning the job to bring about job enrichment. Job enrichment seeks to improve both task efficiency and human satisfaction by building motivating attributes into jobs. Individual jobs could be redesigned with a view to improving social and psychic content of the job. Whereas, the jobs which are inter-related could be redesigned with a view to promoting autonomous teakwork.

Organisational climate must support the new pattern of work organisation. The degree of participation in terms of quality and quantity of participation based on the task and technology used and individuality of persons are important for employee satisfaction and performance.

As adequate investment is called for in education and training of the members of the organisation to pave the way towards job enrichment. Only effectiveness in training with innovative elements in it will help bring about a climate of collaboration and commitment which is necessary for organisational growth.

Personal policies should be supportive to Job Enrichment concept and practice. Its orientation must change from people and away from the work to that of people-in-relation-to-work and its organisation and thereby coming into contact with the dynamics of work and seeking its relevance to welfare and wage payments.

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Summing up

DR. P. H. PRABHU

We had three papers presented during this session, by Dr. Gore, Dr. Jaswant Singh and Mr. Hegde Patil. Dr. Gore's paper on "Industrialising the Rural Worker" has conceptualised some of the major issues relating to the theme of the seminar during the course of which we have considered the question of migration of large population as workers in the city. This is an immensely large population which brings with it to the cities the rural ways of life, of thinking, of attitudes, of values, of habit modes etc., and this has a considerable influence on industrial productivity, labour climate and many urban conditions just as the urban conditions have an influence on the rural migrants. Some studies made in this connection, including the one we made in Bombay for the UNESCO (1957)*, have found that men as well as women workers have great difficulties in adjusting themselves to the urban conditions and demands, several of which were highly exacting on them. Among the many difficulties that one can mention is the sense of time. From an environment where time scheduling for completion of a work or an assignment has much less importance to an environment where being late by a few minutes in starting work suddenly becomes extremely important is a great leap to get accustomed to, and to act up to, create tension in the minds of the rural workers. One can mention numerous other problems of adjustment which create stresses and strains often very hard to cope with for the rural workers.

During the question hour somebody suggested that perhaps it would be desirable to prefer for industrial employment workers as far as possible who are born and bred up in the city. In this

* Pandharinath H. Prabhu : A study of the Social Effect of Urbanization of Industrial Workers Migrating from Rural Areas to the City of Bombay (Published in Five Studies in Asia), New Delhi : UNESCO Research Centre, 1975.

connection, however one must ask the following question: Is it not true that hundreds of people who have been migrating from rural places for several decades in the past have been working in urban conditions, that may have some how got fairly well adjusted and that several have risen to positions of higher and higher levels in the industry including? Although several workers of today who are around the age of forty or fifty can be considered to be more or less urban because they were born and bred up in the cities, there is still a continuing exodus of rural workers migrating to the cities who come for the first time to the cities to begin their life career. The question, therefore, actually is not whether the rural workers are fit or unfit for urban work and living because of adjustment or its lack, but the question should be raised in a very different way. The question is: While the rural migrants are doing their very best to adjust themselves to the stressful and demanding conditions of the urban life and are able to attain good success in most cases, what are the urbanites the industry, the civic government, the state government and various other agencies of the cities doing on their part to facilitate the adjustment of the workers to the city? If a rural migrant does not have a keen sense of time, what have the urban organisations been doing to inculcate a strong sense of time in them? If the rural migrants don't seem to enjoy work but take it as a kind of drudgery with disinterest in it and even apathy towards it, what have these organisations and agencies being doing to infuse in them the spirit of enjoying work? What is being done to help the rural migrant to utilise his leisure time to his advantage, to his own growth as a person to derive the benefits of rest and recreation so that he feels more invigorated with greater energy to do his work?

I sometimes like to classify people into two classes: workers, and shirkers. Man seems to be naturally born with strong tendencies toward working and not toward shirking. Anybody who observers a growing infant must readily notice the extraordinary activity of the entire body and limbs and eyes of the infant. As the infant grows into child, he would far often be engaged, during his waking hours, in running, jumping and related activities rather than sitting idly and doing nothing. He would not even be doing things in a leisurely manner but must do them with speed. All this is universal of all infants and children. As the child grows

into an adult it becomes more activity-minded or activity avoiding, work-minded or work-shunning, largely due to cultural influence. Thus, on an average, the American and the Japanese adult seem to be far more wrok-minded than some of their counterparts in India and in some other countries. In India there has been a kind of general outlook developed that work is for the lowly, the under-privileged, the inferior and it is a sign of one's belonging to a higher status to get work done for him by others which he can do himself. And at home you begin with ordering about your juniors because they are younger, or your servants to do work for you if you have them, even work which you can do yourself very easily, more quickly and more efficiently. It is necessary to inculcate from early childhood the values of work as indicated in "work is worship", of enjoyment in work, avoidance of remaining idle or inactive as disgraceful to human being, of postponement of assignment on work, of having too much interruption in the work process by so-called holidays, and the like. Although there are good reasons to believe that Indian thinking and preaching has stressed the value of work (*udyogam purusha-lakshanam*=industriousness is a sign of manliness; *udyoginam purusha-simhamupapaiti lakshmih*=prosperity approaches the lion-like man who is industrious: etc.) the influence of forces including feudalistic elements in the history of Indian have contributed to the development of the retrogressive value of avoidance of work. Looking down upon work has gained the upperhand in the lives and practices from early childhood of hundreds of men and women growing in India. And so when work is done it is done out of sheer necessity, because it has to be done somehow for earning salary any other benefit, and never for the pleasure of it.

All these question are related to the nourturing of certain basic values during the course of the development of the individual from early childhood. In this connection one is reminded of the work of McClelland of Harvard and his associates on the achievement motivation in different parts of the world. However, it should be remembered that achievement means different things for different human groups in different parts of the world in terms of its operational goals. For one human group "achievement" may mean earning money, position, comforts, power, having a house, a bunglow, a mansion or more than one of these, a cook,

a servant, one or more cars, a chauffer, a television and so forth. For another human group, just to take an extreme possibility, "achievement may mean renunciation of all pleasures, comforts and material acquisition, a life of devotion to selfless work, (like Gandhi or Schwitzer), pursuit of an art or a science for its own sake, mountain-climbing, or anything else which does not have the meaning of achievement that McClelland and his colleagues have in view. What is more basic than achievement, that from which the acts of achievement really spring, is probably the value desire or need of "accomplishment". The sanyasin, the ascetic, the selfless social worker, each pursues the value of accomplishing his ideal or goal which he cherishes even at the cost of money, comfort, position and the like just as the business man, the builder of an industry or the banker pursues his value of "accomplishment" by achieving money, position etc.

Similar observation could be made about Herzberg's studies on motivation in the United States which have resulted in a two-factor theory of motivators and hygiene factors. The motivators are those which have the intrinsic power to egg on people to work. Hygiene factors are those that will cause dissatisfaction if they are not satisfied, but by being satisfied will not act as motivators or instigators to work by themselves. Hereto we must remember that what is the motivator or a hygiene factor in one culture may not be a motivator or hygiene factor necessarily in another culture.

Dr. Jaswant Singh has brought to bear the implications of transactional psychology on the subject through his paper on "Behavioural Dynamics in Industry". He has dealt with the question of anxiety, communication, the psychological development of the individual into an adult person and his later life how the work of Eric Berne and Thomas Harris has given us significant insights that can contribute to individual as well as organizational development. Mr. Hegde Patil has discussed some salient features of job enrichment and their motivational basis in which he has used Herzberg's theory. And he proposes that jobs could be redesigned and enriched with a view to improving sense of achievement, new learning and meaningful work by taking certain steps in that direction. One of the things that would strike all of us, among other things, is that sociologists like Dr. Gore, transactional psychologists like Dr. Jaswant Singh, specialists in engi-

neering and industrial management like Mr. Hegde Patil and students of psychology like me seem to be generally coming to conclusions that are consonant with each other, all reaching the same general points of agreement through different approaches.

I would like to draw your attention to the fact that the term "environment" itself is often used in an ambiguous sense. The same apparently objective environment is really different environments to different people. Several years ago Henry Ford introduced one of the earliest plans of providing special welfare amenities to his workers. The labourers, however, actually accused him as trying to be charitable and paternalistic to the workers by these actions whereas in their view what he was doing was what the workers had a right to get from his company. The workers seemed to say: "Why is this man trying to show that he is nice and kind to us while he owes us these welfare amenities and many more as our legitimate dues from him? We are sweating while he is only collecting the benefits and profits from our hard work without himself sweating like us! We must have a strong union to wrench out many more benefits for us from him because he owes them to us!" On the other hand, in a culture where paternalism has become a part of the growth and development of a man, the company boss's "charitable" and "nice" and "sympathetic" actions towards the labour may be highly appreciated and may act as strong motivators in the workers. This, again, brings out the importance of how environment has a context which is a part and parcel of the total man-mahcine-environment system rather than an isolated piece of action and behaviour.

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Technical Session

PROTECTIVITY

Our Efforts in Accident Prevention

DR. M. S. NADKARNI

I have been closely associated with accident prevention programme in Petroleum industry and most of the points I will present during this session are based on my experience in this area during the past few years.

Before we started the Accident Prevention programme at the Madras Refinery, our frequency and severity rates for lost-time accident were extremely high. In 1971, our frequency rate was 15 and severity rate 294. With the accident prevention programme, we brought these rates down to 0.9 and 8.1 respectively in 1973. The corresponding man-days lost was reduced from 313 in 1971 to 9 in 1973.

HOW DID WE ACHIEVE THIS?

Is there any magic formula? Good on-the-job accident prevention programmes don't just happen; they are made it takes positive action to achieve these goals.

The first step in any such programme is an involvement of top management. It has been found by experience that so many programmes fail because they do not have the active support from the top management. The top man must declare himself positively and follow up to see that every individual in the organization, regardless of title or rank, complies with overall safety policy. At Madras Refinery, the top man presides over the meetings of the Central Safety Committee consisting of functional Managers, wherein unsafe acts and conditions are continually analysed and corrective actions taken. All accidents, both minor and lost-time, are to be reported to the top management. The top management also presides over plant safety functions. All these indicate strong support and involvement of top management in the safety programme.

Second only to this support is employee awareness and participation. Safety specialists claim that 80% of the on the-job accidents can be traced to human factor and 20% to solely unsafe conditions. The human factors which contribute to unsafe acts or behaviour include:

mental and bodily characteristics;
violation of safety rules and procedures;
inadequate skills and training;
using improper tools; and
failure to use personal protection equipment and lack of safety consciousness.

Since 'human factor' is a single major contributor in the accidents, the Safety Programme in any organization must be principally directed to get employee participation without which the safety programme may not succeed.

At the Madras Refinery, safety is everybody's business, and we try to keep our men aware of this in every possible way we can. Safety must be sold and our safety programme has been implemented in a number of ways.

We have pre-placement and annual medical examination of all employees. This annual check-up gives a timely warning of any ailment to take corrective steps. A pre-placement examination prevents employing sick people who are prone to get hurt on the job. This can lead to inefficiency and affect the production.

In the Madras Refinery, the frequency rate (number of man-hours lost per million man-hours) and the severity rate (number of lost-time accidents per million man-hours) of accidents were brought down from 19.38 and 328 in 1971 to 0.91 and 0.07 respectively in 1973. I am proud to say that the refinery completed its first million man-hours without a lost-time accident in Febtuary, 1973, and a second million man-hours in March, 1974. For this the refinery received three National Safety Awards for the highest percentage reduction in frequency rate (90.74%) and for the lowest frequency rate (1.794) in the petroleum refining industry. This award winning safety performance reflects planning and support of management so much necessary for any successful safety programme. The programme at the refinery has been implemented in various ways:

1. To encourage employee participation in the safety programme, we carry out the following promotional activities:

(a) Safety information is passed on to our employees through the Safety News Bulletin on a regular basis.

(b) Safety posters are located at strategic place and miniature printed posters placed in monthly pay packets.

(c) Safety score board with a safety flag is provided at the entrance of the Refinery.

(d) Safety slogan contests and suggestions are organised to inculcate safety consciousness and motivate employees.

(e) Area/shop level Safety Committees are formed and they meet monthly to discuss safety activities, hazards, accidents, etc. The recommendations of these Committees are reviewed by the Central Safety Committee headed by the Chief Executive and implemented.

(f) Individual and group safety awards are given after completion of set safety targets.

2. All the accidents—minor or major—are investigated and corrective actions are taken to prevent recurrence.

3. Regular on-the-job training is provided. This generally directed towards the use of equipment such as fire extinguishers, emergency breathing equipment, fire hose and other fire fighting equipments, rendering first-aid, etc. Training is also provided to improve the knowledge on safety procedures and practices. This results in more efficient operation, improved attitude and confidence.

4. Importance is given to good housekeeping. This is encouraged by competition between different plant areas. Good housekeeping eliminates unsafe conditions and develops good work habits. The efficiency improves with the orderly use and storage of equipment.

To conclude, Safety is a prime function of management. It is an integral part of production and employee productivity. The success of any safety programme depends on the following vital elements:

(a) Attitude of top management,

(b) Management support to provide healthy and safe place to work,

(c) Management's ability to sell "Safety" by publicity, motivation, etc.,

(d) Regular on-the-job training programmes on Safety, fire fighting, first-aid, etc.,

(e) Enforcement of good housekeeping practices.

(f) Creating sense of participation and involvement in the safety programme.

I believe that the thoughts I have presented herein, will stimulate others to consider introduction of similar safety programmes in their organizations to improve Safety.

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Observations

DR. RAMCHANDAR

Beautiful data have been presented by the speakers. Taking one example, Mr. Nadkarni has quoted statistics of no lost-time accidents for impressively long periods. Wonderful! but I would like to point out that it is largely a question of interpretation. The basic question should be whether in the factories which are quoting statistics of excellent performance, there is real reduction in accidents. So also, are the statistics on which we rely so much, really reliable?

I mean that factors like availability of facilities for medical treatment of injuries within the plant, increased tendency to avail of E.S.I.C. benefits where proper medical facilities do not exist in the plants, the stipulation of waiting period in the Workmen's Compensation Act, leniency on the part of the E.S.I.C. Doctors, etc. can make the comparison of statistics unreliable. I would suggest that this aspect would need detailed study.

The second point I would like to make is that a good planned medical service can provide excellent support in an accident prevention programme and thus programmes of occupational health and safety should be properly integrated.

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Getting Employees' Participation in Safety

DR. K. R. RAO

"People are our most important asset—their safety is our greatest responsibility".

This I quote from the President Charter of Union Carbide Corporation, U.S.A. This SAFETY FIRST attitude of our Company has been one of the factors contributing to its growth. Carbide has found that efficiency, production and safety are synonymous.

Safety Pays: This is an experience and not just an empty slogan, a FACT and not just an assumption.

Once an organisation accepts SAFETY as a policy and not just as an imposed Factory Act obligation then the formulation of a practical safety policy does not represent a painful hindrance in its efforts to increase production but rather as an added lever in that direction.

Safety is non-controversial: Safety is everybody's business and management accepts this responsibility today as an integral function of industrial production. The Government accepts safety as a social responsibility. Most responsible trade unions accept that they too have an important role to play in promoting industrial safety for the workers, whom they represent. It is then an accepted all round fact that safety is everybody's business.

Analysis of industrial accidents, time and again show that there is a "human element" that is nearly always the weak link. The "human element" is the man on the job whom every section of the Factories Act rightly seeks to protect. Strangely very little is said about the responsibilities of a worker to protect himself.

Industry will gladly provide the employees with protective "safety" equipment: safety glasses, helmets, gloves, aprons, safety shoes, gas masks, respirators, etc., to protect him from every con-

ceivable hazard, but usually when an accident is investigated it reveals that the safety equipment provided was not used.

Why is it that an employee refuses or is reluctant to wear personal protective equipment? It is not because he is unaware of the hazards. Surely it is not because the protective equipment is so cumbersome as to risk a painful injury. Why then does he risk so much for so little? I suspect that deep down, an employee convinces himself that he will not be the next victim of an accident, even when the hazard is obvious and so is tempted to ignore the means of protection that is designed for him.

Every employee, technician or worker, who takes a risk to increase production or to "earn" an extra 15 minutes of rest risks his own safety or the safety of the plant. These risks are frowned upon by management and ignored by himself and his colleagues until his luck runs out.

CENTRAL SAFETY COMMITTEE

It is also reflected in the composition of the Central Safety Committee which directs and formulates the safety programme of the organisation. Its members are the Works Manager and workers, department heads and supervisors, managers and foremen, artisans and technicians: every facet of the family of Carbide Chemicals. It is heartening to experience the sincere efforts made by all levels in this committee in improving the overall safety performance of this plant.

We have a very senior engineer as Department Head for Safety and an experienced operating foreman with several years' experience as the Safety Officer of the Company.

The plant is divided into departments according to the functions. It is here that work is done and hazards encountered where safety is most important, i.e. in the field of operation. Every department has a departmenal Safety Committee. This is the "down to earth" safety committee which meets every month to examine all unsafe conditions in the area and to eliminate them.

SAFETY TOURS

Every fortnight the Head of the Safety Department, with an inspection team, inspects one department without prior information and notes all unsafe acts or conditions in the area. All

such unsafe and hazardous conditions must be eliminated within a period of thirty days.

SAFETY SUGGESTION SCHEME

To motivate every employee to work for safety, a safety suggestion scheme was formulated. Any employee can point out a hazard in any department with a suggestion of how to correct the unsafe condition. Many a hazard has been eliminated by this channel of communication. All suggestions accepted by the management are rewarded with a gift and a commendation letter inserted in the personal file.

INDIVIDUAL AND GROUP INCENTIVE AWARDS

To encourage entire departments to strive as teams for a better safety performance, target days are set for each department, according to the hazards involved. On achieving these target days worked without a disabling injury, every individual in the department receives a gift in appreciation.

The department also receives a rotating shield in appreciation. Every individual in the plant was presented a gift on achieving a million man-hours worked and on being awarded a National Safety Award.

ANNUAL SAFETY WEEKS are organised. Zonal competition, individual safety contests, safety talks and quizes and safety films are organised. Safety lucky prizes are also given to renew the safety habit in employees.

Display of safety posters keeps hazards and their solutions more clearly in the mind. Safety posters and films show much more than what words can tell. The visual impact lingers when words are forgotten.

SAFETY NEWSLETTER

A Safety Newsletter is published to highlight our safety performance: the achievements and failures. Also unsafe incidents occurring in other UCC plants are widely publicised to avoid such recurrences.

SAFETY EQUIPMENT

The Materials Department stock as regular items such protective equipment as safety glasses, helmets, safety shoes that are

issued to all employees and so also gloves, gas masks, aprons, etc. that are issued to personnel who may need them.

Gas masks, eye-baths, safety showers, benzene detectors, self-contained air masks, explosimeters, safety air-blowers-cum-masks, etc. are available at locations where they are needed.

ACCIDENT INVESTIGATION

If inspite of all our efforts an accident does occur, it is reported in an Incident Report and a monthly summary is widely circulated—others will learn from somebody else's mistake!

Every injury that results (or could have resulted) in a disabling injury has to be inquired into by a Manager personally, primarily to find out how it happened so as to avoid a repetition. Appropriating blame is never the purpose of these inquiries.

This safety programme is designed to ensure that every employee—at all levels—has an effective role to play not only to ensure his own safety but that of his colleagues as well.

From its very inception, Carbide Chemicals Company has had a very clear concept of its safety obligation towards its employees and society and we have come a long way from 1963 when our frequency rate was 50 to the lowest of only 2 in 1972.

The effectiveness of the Company's safety efforts is reflected in the nationally acclaimed results. Carbide Chemicals can be justifiably proud of the laurels it has received at the hands of the President of India in recognition of the successful achievement of its goal of making the plant a safe place to work in:

(i) In 1972 Carbide Chemicals Company received a National Safety Award "for outstanding performance in Industrial Safety in achieving the Highest Percentage Reduction in Frequency Rate during 1971", i.e. an improvement of 104.4% over two years.

(ii) A similar National Safety Award was received in 1973 also for improvement of 130% over two years together with.

(iii) A National Safety Award "for meritorious performance in Industrial Safety in achieving Longest Accident Free Period during 1972".

On the State level, Carbide Chemicals Company is in the front rank in the field of industrial safety. In 1966, a certificate was awarded for the highest percentage reduction in frequency

rate. The Council of Industrial Safety, Maharashtra State Branch of National Safety Council awarded the Company a certificate "for outstanding performance in Industrial Safety for achieving 107% reduction in frequency rate over two years, 1970-1972".

Carbide Chemicals Company's Safety Programme is acclaimed by sister industries, but the greatest satisfaction is in the service this programme does for the employees' physical and mental health. SAFETY is an investment today for our happiness tomorrow.

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What is Lacking in Safety: Workers' View

Y. V. CHAVAN

Safety movement is on for several years past in our country. Enlightened employers, officers entrusted with safety work and trade union leaders have been doing their utmost possible to make conditions of work safer for the worker. Yet, everyone has a feeling that safety has not become anywhere a continuous and constant concern of all those connected with production, namely, the workers, the supervisors and the managements. There are spells of enthusiasm for safety work for punctuating long periods of sullen despondency. The workmen feel that the management can never really be serious about their safety and the managements feel that on 99 out of 100 occasions workers' complaints, suggestions and demands are frivolous, if not false, and an attempt to exploit the good intentions of the management. Therefore, one need not be surprised if in the result there is a feeling of frustration among safety workers.

The organizers of the seminar have definitely pinpointed this situation by calling upon safety workers to discuss what is lacking in safety work. Each one of us, I am sure, will make suggestions emerging from his personal experience. I would confine myself to two points. First, one very important aspect bearing on safety work, namely, the way accidents are looked upon and dealt with and the second, the main enemy of safety work—the monstrous dehumanizing system.

There is a general tendency in the supervisory cadres to look upon every accident either as really accidental or a result of some mistake or negligence on the part of the workman. Secondly, we rarely have a real thorough investigation of any accident. In most cases, the investigation is left to the Factory Inspector who does it in a formal cursory way to satisfy the purpose of law.

Investigation may in some cases be carried out by officers in charge of the department without any real participation of the workmen, who in my opinion, should be vitally concerned with the investigation. I have had occasions to demand investigation of fatal accidents by joint committees of management and worker representatives and in most cases the request has been turned down even by managements who are, to all appearances, concerned and paternalistic. Their reasoning is, what can workers or worker representatives contribute to such a highly technical investigation and that investigation of any accident happening in the factory is a prerogative of the management and cannot be allowed to be encroached upon by the workmen. I know of cases where almost exactly similar accidents have taken place after some lapse of time. If the previous accident had been thoroughly investigated jointly by the workmen and the management and in that course they had been educated into the do's and don'ts emerging from such investigation, I am sure the subsequent accidents could definitely have been avoided.

In my opinion, there are few real accidents in the sense that they cannot be avoided by normal precautions on the part of persons involved. An investigation of an accident with the help of all the persons around in the department should really become a process of education in taking preventive measures. But, what is usually done is exactly the contrary. Attempts are made to hush up, explain away, put the responsibility on the worker's negligence and in all possible ways try to prove that the management was not to be blamed in any way. The reaction of the workers to this attitude is mainly to become accusative and to demand dismissal of those officers whom they consider responsible for the accident. However, justified this reaction may be, I must acknowledge that it misses the main point of utilizing the learning from the accident for preventing recurrence.

Management's attitude towards smaller injuries to workmen while at work is even more surprising. It is argued that workers deliberately inflict small injuries on their persons to get an excuse to have an off day to attend cinema appointment or some other personal work. Many officers have seriously argued this point with me but have never convinced me about it. They only convinced me about their perverted relationship with their workers.

I have, time and again, advocated that a workman who suffers

injury while at work must be paid full wages for the whole period for which he is required to be on accident leave. This is the period when the worker's costs go up and for him to have to go without pay or even with half pay, surely drives him into debts and unbalances the family finances for years to come. Yet will you believe that this suggestion has been adamantly opposed by the managements on the grounds that the workmen will inflict injuries on themselves to enjoy such accident leave with full pay?

Being sincerely interested in safety work, I am sure, all of you may have had occasions to reach workers to hospitals when met with accidents, I mean Government or Corporation or E.S.I.C. Hospitals. I hope you do not consider this point as irrelevant to our subject of safety work. I think, just as safety work should cover the pre-accident period, it must also cover the post-accident situation if safety workers are to be concerned about saving human life and not merely about being absolved of their part of the responsibility. In a serious accident, immediate availability of a doctor and transport is highly necessary and in most work-places both of these are absent, except for what is known as first aid. We all know that private doctors refuse to treat serious accident cases out of fear of involvement into legalities. At the hospital, it has been my experience in several cases that a patient, unconscious or in extreme pain, will lie at the gate unadmitted for hours before the doctor in-charge arrives and the formalities are completed and the patient is ultimately admitted. A patient would be fortunate if he gets a bed on a cot, because as you know in most of our hospitals, a large number of patients are laid on the floor between and around the cots and then begins the experience of neglect, indifference, arrogance, and irritation of the hospital staff. At night you will never get a doctor to attend you even though you may be knocking at the gates of death. I am recalling all this callous indifference to human pain and life that we experience in every day life because I believe the basis of safety work is the sensitivity to human life. The way the overwhelming majority of our people are living and working in our country this sensitivity is a casualty every hour, every minute, even every second. A very common experience occurs to my mind. Everyone who travels by the local trains in Bombay in the morning or evening rush hours by the second class has had the experience of being brutalized to human pain and life. The

conditions are so created that men are turned into brutes who can with least compunction push or hit his neighbour to severe injury or even to death either to get into the carriage or out of it. The whole life of the common men is full of such experiences.

I recently read in an issue of 'Guardian' about the conditions prevailing in the Nursing Home Industry in the United States. To my mind, it appears that in respect of medical care of poor, they are no way better than us. A United States Senate sub-committee began hearing on January 21st at New York City where 16 separate investigations are now under way. Of all the abuses now being discovered have a familiar ring. Patients beaten, drugged, patients lying or sitting in their own wastes for hours at times, including the entire night, patients falling on the floor with calls for help ignored or unheard, patients tied to bed or chair with sheets, starved patients who fight with each other for food, patients in shock from cold, dehydration or improper medicines, patients with bedsores that have penetrated to the bone, causing disease and death.

Whether in poor countries or in rich countries these are the surroundings in which we have to work and these surroundings are not accidental or local, but they are persistent and universal. They are not created by freaks of individuals, but they are the result of the basic law of our social system. Our social system is based on individual profit and this basic law governing every social transaction commercialises and dehumanises every human relation. The efforts of well-intentioned individuals to awaken sensitivity to human pain and life are like drops in the ocean of brutality that is perpetrated by this system and it is no wonder that while in small islands of activity the result for some time may appear positive, on the whole the picture is of regression. There are times in the process of human social development when fundamental changes are called for and in the absence of fundamental changes all good activity is negatived.

I am sorry if I have appeared a bit pessimistic to you, but I am not at all pessimistic. Actually, I have only tried to express the need that is felt all over the country among the masses of common people for a fundamental change in the basic law of our system, the substitution of the individual profit law by the principle of well-being of the society. The safety workers, while working hard in their own field, cannot be blind to the general

crisis that is developing in our country, an all-sided crisis, and the need for a basic change of values which alone can carry forward our people to a better and safer life and work.

DISCUSSION:

Q. Majority of the fatal accidents occur in the construction industry. Safety of these workers is rarely ensured. What efforts are made by the Unions for construction workers?

A. Those who are familiar with the construction industry know that most of the workers in the industry are unorganised. These workers are also without much experience in the industry. The employers are mostly contractors. The safety of these workers who are unorganised should be the joint responsibility of the employers and the organised workers.

Q. Mostly, factories in Bombay do not provide accommodation to workers. Hence most of the workers have to come from long distances in overcrowded trains. The worker who attend his duties after such hard travel is more likely to commit accidents. What efforts are being made by the Trade Unions to bargain with the management to provide accommodation near the factories?

A. This is a big problem. Unions are putting up demand for housing near the factories, but as there is no priority for housing these demands are not attended to or are overlooked. National Labour Commission in its report have also suggested that the employers should provide housing to the workers near the place of work. The unions will have to organise themselves for this, because lack of proper housing near the factory has a bearing on the working environment of the Worker. Employers, government and the unions should all look into this aspect.

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Accident Rates and Operational Efficiency

M. R. NAGARWALLA

INTRODUCTION

The topic I am going to deal with is "Accident Rates and Operational Efficiency". On the face of it, the inter-relation seems so obvious that one would imagine I can present a graph showing accident rates going down with relative increase in operational efficiency, and another graph highlighting the converse.

I must, however, disappoint you by saying that I have no such ready made answer, which shows a direct statistical relationship of this type. Nevertheless, there is a distinct and definite relationship which comes through in qualitative terms. I, therefore, intend to share my experience with you and hope that I can stimulate thoughts, which may prove of benefit to you in your own environment.

FIRE INCIDENTS

The major hazard in any oil refinery, is that of an explosion and fire accidents. Even though these are not measureable in the same manner as Injury rates, it may be of help to examine the statistics in this respect.

The Chart-I, shows the number of fires recorded in the refinery from its inception until today. It will be noticed that the incidence of fires were quite high in the early years of operation but rapidly came down within a few years to about one third of the original level.

During these years, i.e. 1955 to 1958, we recorded every incident, however minor it may have been (e.g. a piece of cotton waste catching fire). From 1959, we altered our reporting procedures to include only fires of significance irrespective of whether

they were very minor or otherwise. This was done to ensure that lessons learnt from these incidents could be given wider publicity and thereby improve our fire protection machinery. Reporting all fires tended to distract us from this objective at this phase of our operational experience.

CHART I

BSR FIRE INCIDENTS

Year	No. of Incidents (Total)	Year	No. of Incidents (Total)
1955 ..	53	1965 ..	5
1956 ..	37	1966 ..	20
1957 ..	22	1967 ..	27
1958 ..	18	1968 ..	17
1959 ..	2	1969 ..	27
1960 ..	8	1970 ..	31
1961 ..	4	1971 ..	10
1962 ..	8	1972 ..	12
1963 ..	20	1973 ..	6
1964 ..	6	1974 ..	10

During this period, the 1963 figure stands out as the highest in the group. This was due to a particular problem that we were experiencing with gasketed joints and the correction of this very certainly improved the operational efficiency of the particular plant. From 1966 onwards, we have once again been recording and analysing every incident, however, minor it might be. This led us to a renewed attack on reducing the total number and one can see a basic change from 1971 onwards, when the efforts began to pay out.

While it is impossible to quantify what loss/damage to equipment and injury to personnel has been avoided over the years, there is no doubt, that the preventive efforts have contributed to the high "On-Stream" time of our plants and equipment.

INJURY RATES

Coming now to the injury rates proper, Chart No. II shows the statistics from 1955 to 1974, in regard to Manhours Worked and the Lost Time Injury Frequency Rate.

The injury rates in the first two years were high, mainly because of the general lack of experience in what was then a new industry. The Safety Programme also was in its infancy and had

yet to take root. As experience and familiarisation was built-up by personnel at all levels, and with the growth in safety consciousness, injury rates came down sharply; by 1959, we were down to one fifth of the initial level. Between 1959 to 1970 the injury rates remained at a good—but not an exceptionally good—level. Our safety efforts continued vigorously, with courses, training sessions, safety 'observers', safety meetings at all levels, and etc. During these years, we did achieve the coveted "million manhours without a lost time injury" on two occasions. Despite the considerable safety efforts that were exercised during this period, we could not break the " million" barrier at that time. In fact after a very good performance in 1969, there was a reverse trend in 1970. At this time the safety programme was intensified, particularly in terms of communication to and POSITIVE involvement at all levels, and in terms of Sections & Departments setting up their own targets for safety performance. The programme had immediate results, and with further adaptation, a break through was achieved in 1973, by working "Two Million Manhours" without a Lost Time Injury. The psychological impact of having

CHART II

B. S. R. INJURY DATA

Year	Total Man-hours worked	Frequency
1955	29,70,000	40.05
1956	42,48,530	26.82
1957	44,15,000	9.75
1958	45,08,480	8.40
1959	43,44,320	7.40
1960	40,43,620	5.20
1961	39,80,640	4.70
1962	38,03,040	7.80
1963	37,84,710	5.80
1964	36,87,425	7.30
1965	35,54,550	6.50
1966	33,91,320	7.10
1967	33,16,940	6.63
1968	32,44,560	5.55
1969	31,73,840	4.09
1970	31,75,900	5.03
1971	31,63,300	2.52
1972	30,59,976	3.26
1973	30,40,183	0.33
1974	27,00,200	ZERO

achieved a self set target, which was previously felt to be near impossible, was tremendous. Personal involvement and dedication to safe working increased even more—no man wanted to be the one who let the side down. This momentum has carried us through to over "FIVE MILLION" now, having broken all Shell world-wide refinery records, and we are still going strong setting new records.

From the above two charts, one can reasonably establish only two or three aspects as follows:-

(a) The initial two years were a period of rapid improvements in term of reduction in hazardous incidents as well as injury rates.
(b) The years 1959 to 1970 were basically of a steady nature with expected variations within a narrow range.
(c) From 1971, there has been a remarkable improvements in injury rates to the extent of achieving "perfection" in 1974. (Fire incident statistics not "zeroed" yet).

OPERATIONAL EFFICIENCY

At this stage, I would have liked to put up a chart which showed that our operational efficiency improved rapidly in the very early years, remained steadily good for many years upto 1970, and that we are now 100 per cent efficient in 1974!

CHART III

OPERATIONAL EFFICIENCY

(a) Total Operating Cost
(b) Cost/Unit processed
(c) Manpower/Unit processed
(d) Profits.

Highest processing rate
Highest yield of product
Highest Energy Utilisation

Tone of Organisation for Achievement

operational efficiency, a little more closely. Injury rates are measured by a standard procedure, and a standard yardstick which is common throughtout the world. For operational efficiency, however, there are many variables and many aspects are to be

considered. In looking for a co-relation with the injury statistics I examined:-

(a) Total operating costs.
(b) The cost per unit processed
(c) Manpower utilization per unit processed
(d) Annual profits,
and some other data.

All of these yardsticks have proved to be invalid as a consistent, simple measure of operational efficiency over the years. All of these measures have so many other influencing factors, such as inflation in materials, wages, Government controls on prices and operating levels, variation in product demands, and so on, that they required a complicated analysis for their own interpretation, and could, therefore, be hardly co-related directly with statistics such as injury data.

CONCLUSION

Should we, therefore, conclude that there is no reflection of the injury performance on operational performance? In my view that would be a very wrong conclusion.

Despite not being able to establish a direct co-relationship on an overall basis, there are certain aspects of operation which can be good indicators. For example, during this period of high safety peformance, we have also achieved the highest rate of processing, the highest yield of valuable product from our raw material, the best utilisation of energy. Is that just a co-incidence? Certainly not.

Whereever strong and SINCERE efforts are put in towards the improvement of safety, the tone of the whole organization is affected in such a manner has to have a sustained benefit in closely linked areas, such as operational efficiency.

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DISCUSSION

D. Ramanujam

Q. For any worker, his domestic environment, family responsibilities and pressures as well, have got a direct bearing to his industrial work and his safety from accidents — What is the responsibility of management to his problem?

M. R. Nagarwalla

A. This is a question which could merit a session on its own but let me attempt an answer.

To give a straight answer, I would say that management has no direct responsibility towards this problem. Since domestic environment, responsibilities, external emotional pressures, etc. are outside the control of management, it is obviously unfair and impractical for management to carry any direct responsibility. However, we are all aware that these factors do exist, and therefore any enlightened management will not ignore these factors but cater to the fact that individuals do carry their mental tensions into the factory environment. To reduce the effect of these tensions, the man's relationships with his supervisors, and his co-workers, the procedures for his work, the ready availability of protective equipment, adequacy of instruction, and so on become important and it is in these areas that management can have effect.

In short, without being made responsible for a worker's condition of mind, a good management could and would arrange circumstances and environment within the factory to reduce the effects of these external disturbances.

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Observations

SHRI K. C. GUPTA

I have to make three observations which are based on our experience of the safety projects that we undertake in some of the organisations.

My first observation is, it is difficult to correlate statistically the operational efficiency with the accident rates, as no single parameter can measure the operational efficiency. I, therefore, agree with the facts presented by Mr. Nagarwala. The paramount difficulty in safety projects is to sell the idea of safety to the top management and for this we have to fall back upon the knowledge of behavioural sciences rather than that of technology. However, once these efforts succeed, the indirect benefits of safety —improvement in the overall climate in the industry can be fully realised.

My second observation is, once the top management is convinced and has accepted the idea of safety, we have to achieve a total commitment or involvement of the people right from the shop-floor to the managerial level. This involvement can only come out of the realisation of the need for safety. Though the need for safety is based on a number of considerations including the effect of safety on production. We should always stress upon the humanitarian considerations. Our experience has shown that this is the only approach on which a safety programme can be successfully implemented. If an attempt is made to relate the safety with the operational efficiency at the shop floor level, the programme of achieving safe conditions of work cannot succeed in the desired measure.

My third observation is, there is a lot of helplessness prevailing at the middle management level. The first line supervisors, the foreman and others upto the level of departmental heads often find themselves in a helpless situation as regards safety and also

sometimes as regards production. It seems as if they lack conviction that they will be supported in their efforts by the top management. At the same time they do not have the faith that they will be able to carry with them the workers. So development of conviction or faith on the part of the middle management will be a problem area in organising for safety. Without tackling this problem successfully, the success of a safety programme can be completely jeopardised. How to bring about the development of middle management in this area? The Labour Institutes are making endeavour in this field. We would like to share the experience of other successful organizations in developing the requisite attitude towards safety at the middle management level.

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Summing Up

SHRI BAGARAM TULPULE

Ever since I got actively involved with the safety movement in industry several years ago, I have been conscious of a certain riddle. The riddle is that nobody wants accidents, the know-how of preventing accidents is available, the protective appliances are fairly well developed, safety organizations exist and yet we have a large number of accidents, and what is worse, the accident frequency has been going up, except perhaps in the last year or two. We do not know the latest figures. Now this is something which I have found very difficult to understand. Both the managements and the unions would certainly like to be without accidents, most of the things that are necessary to promote safety are within reach and yet we have accidents. When one tries to understand this situation, one does not get a really convincing answer, but certain aspects of it come to the fore. Some of them have been touched upon by the speakers. Top management has to be genuinely interested in safety. Yes. But is that enough? I found in my organization that this is not. Not that the safety record of the steel industry is bad; in fact, it is quite good. But I would like to judge the performance by how many avoidable accidents have been permitted to take place and when I judge it from this criterion, I do not feel very satisfied about our performance. Now this is not because the top management is not interested. It is because, firstly, this interest is difficult to communicate to different levels of the organisations. The executives and the supervisors still feel that their accountability in relation to production is the primary accountability, their accountability in respect of safety is only incidental. We, of course, have safety officers, safety managers and the approved kind of interaction between the line managers even at the top level, and the safety department. But yet, safety does not really get inte-

grated into the total management system. The approach is one of fire fighting which is quite different from the systems approach which management now adopts in dealing with most of its other functions. For instance, control of costs is not left to any isolated off-the-cuff decisions as and when the problems comes up. This is built into systems of management so that when anything goes wrong, the system itself sets in motion processes which are calculated to reassert control and get total cost performance in line with what the management want. Such is the case with other functions like quality, personnel etc. also I have yet to find an organisation where safety is viewed in this sense. I agree that there are conspicuous instances of organisations which have shown a very high performance in safety. Performances which have been pointed out, have set records all over the world. I submit that these continue to be islands of conspicuous achievement in a vast sea of mediocre or no achievement at all. What I am saying is that no conscious, deliberate, determined, systematic effort is made to control the working conditions, working environment, work habits, so that work may be safe for the individual and for the organisation. I believe this is a challenge to the management scientist and to the top management.

Now I shall give some indication of what induces me to think so. We find that large majority of accidents are caused not because there are major hazards, but either by people knocking against objects or by falling bodies. In a general way, we can say that it is due to bad housekeeping. Even with good housekeeping such accidents may occur—now this is the view that we are inclined to take. Where they know that a serious or major hazard is likely, the management makes all possible efforts to ensure that the hazard is eliminated and therefore, such accidents are relatively few. Last year, we planned to undertake in my plant a major repair to a blast furnace, while the blast furnace was still hot. A hot blast furnace emanates carbon monoxide which is a deadly poisonous gas and this operation had to be done on the top of the furnace where carbon monoxide concentration could be expected to be high. It was a very major job. Hundred people had to be working there round the clock. Now, we knew that a very serious hazard existed and therefore, before any body was permitted to approach the workplace all possible tests were carried out to ensure that gas concentration was within tolerable

limits. Here I would like to refer to a point which Dr. Deoras raised, whether we have any animal models I do not know, what he meant exactly by an 'animal model'. Apart from the instruments and other things one of the live tests which we carried out to determine whether the gas concentration was high or not was by means of a canary bird. A canary bird is the first to succumb to even a slight increase in the gas concentration beyond the tolerance limits. Two or three canary birds were kept there all the time till the whole job was completed which took about 22 days. Everybody, safety officers and other officers, were on the job all 24 hours in order to ensure that gas level was kept below the threshold. Now here, we knew that a serious hazard was likely and hence management did every thing possible to ensure that that hazard was effectively removed and we could complete the entire job without any mishap.

Now this is something which leads me to believe that if management will develop some system by which hazards can be continuously monitored and remedied, accidents can be controlled. Otherwise, I think we have no hope of controlling these, because then we will be always acting after the accident has occurred.

I would also like to refer to one or two other points. There is a lot about accidents which we do not yet know. Although technologically perhaps we know quite a bit, I believe, from the point of view of the worker himself, there is quite a bit which we still don't know. For instance, Dr. Deoras referred to the factors of environment, vegetation, and temperature variations. Do they have any correlation to accident frequency? This probably will need lot of collection of data and research. There are simpler aspects which could be more readily investigated. Some of them are being investigated no doubt; for instance, the age distribution among the victims of accidents. I do not know whether this is a general situation, but in my plant I have found that the accident frequency is highest among the employees in the age group of 30-35, the next group is 25-30, and above the age of 35 years accident frequency drops very sharply. If this is generally true of other factories also, then why people below 35 are less susceptible to accidents, deserves to be investigated.

I am sure the concentration, the attention, the reflexes of a man vary from hour to hour within a shift, and there may be variations from shift to shift. If the data of accidents are analysed

according to shifts, and also according to the hours within a shift, it should certainly throw up some interesting facts which could be utilised to control behaviour and minimise accidents.

I would like to go back to the point which I referred to earlier, namely the communication of top management interest to lower rungs. One of the speakers said that many of the accidents are due to non-usage of safety equipments by the workers. May I request you to tell me whether the supervisors and foremen concerned take the workers to task for not using safty equipment, as they would normally have done if the worker did not do his work. Now the question answers itself really. The very fact that the workers are allowed to work without using the safety equipment shows that they are not taken to task.

I want to put one more question. If in the course of his work a worker continuously gave poor performance or bad quality and if the supervisor or foreman did not take him to task then the top management would take the foreman to task. Does the top management deal in the same way with a foreman who does not enforce the necessary safe norms of behaviour on his workers? Again, I believe, that the answer is 'NO'. If the foreman falls conspicuously below in his performance in regard to quantity or quality of production that foreman would certainly be hauled up. But if the accident frequency in his department is higher than what it should be, I do not think the management, by and large, would haul him up. But this really means that the interest the top management takes does not go to the extent of creating unpleasant situations over the enforcement of safety. If we can achieve safety without being unpleasant—Fine. We will try to do that. But if the price to be paid is creating an unpleasant situation, then we would rather not, even if conditions remain unsafe. It is too bad but we will have to bear with it. I think this is the attitude we frequently find in top management and very much more so among the middle management and lower management.

If I may venture to say so, this is also the attitude among the trade unions. I am not saying this because I am not a trade unionist now. I have been saying this even when I was a trade unionist. And this is also seen from the fact that while trade unions would not like accidents to occur, they also do not say,

"All right, if the worker ignores safety precaution or he does not use safety equipment, then the management would be free to take action against him; the unions will not interfere". I do not expect the unions to come forward and force the workers to use protective equipment. But I think, the unions owe it to the workmen to tell them, "Look, you are sticking your neck out; don't do it. If you stick your neck out, we will not be able to protect you." This would show that the unions too, have a more live interest in safety. In Madras at the time of our National Conference on Safety we had invited one of the most senior trade unionists of our country, Shri Anthony Pillai, to deliver one of the key-note addresses. He was frank enough to admit that the unions' interest in safety was only lukewarm and to underline this point he asked, "Have you come across any charter of demands put forward by a union, where one of the demands was the elimination of hazards, or else they would go on strike?" At least in my career of 25 years as a trade unionist, I never gave a charter of demands like that. And I am not aware of any other union who has done it either. This would be a test, I am not saying that they should go on strike all the time. May be a strike would be justified if they find that the management was conniving at a really serious hazard which it could rectify.

I would therefore, submit that we do have a situation where although we do not want accidents, we want safe work places, we are not sufficiently intensely committed to put ourselves out, and I say this both for management and the trade unions, to accept possible consequences and conflicts, in not tolerating unsafe conditions. That degree of urgent involvement does not seem to be there. And at the same time there are areas of safety so far as human behaviour is concerned, which probably we have not investigated fully yet.

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Technical Session

QUALITY OF WORKING LIFE AND ENVIRONMENT

Introductory Remarks

DR. RAM TARNEJA

The subject for discussion this morning is "Quality of Working Life and Environment". As we become more and more industrialised, we have to ask ourselves a basic question. What is the end or what is the objective of industrialisation that we are seeking? Is it that we want to prove to the rest of the world that we are capable of manufacturing any ware from a sewing needle to a sophisticated aeroplane? Or is it that we feel that by the process of industrialisation, we as a nation, stand to gain which, in turn, means that we as individual citizen of the country also stand to gain? My interpretation of industrialisation is obviously of this nature—that we are doing it for ourself, for our own interest and therefore the efforts that we are putting must be rewarded.

But in process of industrialisation whatever be its objectives including one I have just stated, one thing that becomes very obvious is the fact that it is the entire work group, it is the team work that matters most when we talk of the working life. Accordingly, we are concerned with all of us, as if we were a team, as if we are all workers when we say that we would like to live in cleaner surroundings or better environment.

Another observation I would like to make is that primarily even today, after almost seventy five years of industrialisation out of which more than twenty five years are of intensive industrialisation, we are primarily a rural economy. More than half of Gross National Product (GNP) in this country is still from agricultural goods. It is not the industry, the chimneys that you see, but the farmer that we do not see, who contributes more to the GNP than all the industries put together. Since we are primarily a rural society, bulk of us, certainly very large bulk of our working classes, comes from an environment which is far more

pure than the environment of cities like Bombay, Calcutta and Madras. When it becomes to realise that the same inputs, for instance, food intake does not necessarily permit him to remain in the same state of health. He begins to wonder. Two things happen. One is that if you eat the same rich food that we would be in rural areas we cannot digest it not because of environment or pollution but because of our working habits. The other part of it is that when we adjust ourselves to food intake of the urban type, then environment, pollution and the other things begin to play, their role on our day to day lives.

The fact that the bulk of our working population with its rural background itself requires a large degree of involvement and adjustment because it is environment apart from many other things to which we have to get adjusted to. This environment is not merely concerned as having physical characteristics, but also social characteristics which form very much the part of the environment. The social characteristics are not merely the group with which we work, not merely the group with which we live but also the overall population to which we are exposed. The typical man, when he leaves for his work in the morning, if he is living half a dozen miles away from his workplace which is not unusual in cities like Bombay, and Calcutta, starts his morning with the environment of his family. He then goes and commutes by public transport, be it a bus, be it another means of transportation like cycle, riksha. He, in the process of doing it, mixes with the other group, a diverse group, because not every passenger in the bus either works in the same factory or from the same locality or in the same profession. And then he goes to his workplace and so goes the circus of life. Therefore, if in a span of 16 hours, let us say out of 24 hours, if we all sleep a minimum of expected 8 hours, probably we easily have to adjust ourselves to 4 or 5 social patterns or social groups. Likewise during the same course of the day, we also have to adjust ourselves to varying physical environments. Physical environment of the house is quite different from the physical environment of the office or the factory where we work. It is still different from the streets on which we walk or to the bazars we go. So all these put together has both the quantitative and qualitative aspects.

I am reminded of an incident when I went to the United

States as a student in the year 1953. During the winter vacation I was on the way to Chicago and I spent a night in the city of Pittusburgh which, as you know, is the steel capital of the world. I distinctly remember that a white shirt I was wearing got dirty in less than one hour just by walking in the city. Seven years later, after obtaining my degree, I was to start my first job in the same city and the shirt no longer got dirty. On my enquiries I was told that the corporation of Pittsburgh has passed a law which requires every steel mill to pass the fumes that comes out of the furnace through an electrostatic tunnel, before it is expelled to mix with the city air. The investment, was enormous which ran into millions of dollars. But that one step converted Pitusburgh from the dirty city into one of the cleanest cities of the United States. While one cannot say that this is the kind of thing that should happen at this stage of our history in this country, the fact is that if we do not start thinking and exercising our mind at this stage when we are still new, in our industrialisation, we would land ourselves with the kind of problems that Pitusburgh had and many other cities still have.

In Calcutta, within our own country, we have the problem. What do we do then? We did take preventive steps to the extent possible. We try to locate industries in areas which are freer, which have larger infra-structure, locate our housing colonies in such a way that they are not near the path of the polluted air. The first question is who is actually going to do it? The second question is can we afford it? Now I am not going to answer these questions because there are experts coming a little later to touch on these individual aspects. But, may I merely say this: I think time has come that all of us should try to build a longing, a feeling, an opinion and a belief that it is the responsibility of large industries, large industrial plants, whether they are in the public sector, private sector or joint sector to see that right from the stage of project development, this problem forms a part of their capital expenditure and not after 10-20 years when suddenly some one gets up to bring about new laws or new measures. An example is Cement industry. The cement industry can be the dirtiest industries one can come across, because lime stone is ground and fed into kiln where clinkers are produced. At the kiln, lot of dust is exhausted. Years ago, cement plants

were not many, but it was felt that within the cement industry, itself these problems have to be taken care of. It is the only industry, I know where through exercising self restraint this problem today does not exist in that industry. I do not feel that I can say the same about steel, another major industry like cement having a basic process, despite the fact that after the independence, substantial investment in steel has been in steel plants in the public sector.

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Environmental Quality Control in Industry–Lessons from Nuclear Industry

DR. A. K. GANGULY

1. Introduction

Safety aspects in design, operation and maintenance of an industrial production unit may be categorised as:

Conventional industrial safety, against physical injuries and toxicological hazards,

Safety of the public and maintenance/enchancement of the quality of environment, and

Systems Safety.

When dealing with a major radioactive installation, there is an additional one viz. Radiation safety of occupational workers.

Towards this end, the designer, the operator as well as the safety scientist are required to be guided by some basic criteria.

Where radiation safety is involved, the criteria are in terms of risk and damage and can be quantified through the parameters of permissible radiation dose, which are also used for planning. Similarly conventional industrial safety against toxicological hazards can also be quantified through the parameter of concentrations in air and water in the working and public environment, if we can spell out risk and damage criteria. On the other hand, in the case of conventional safety against physical injuries, no quantitative parameters are spelt out and safety of a system are being assessed a *posteriori* through parameters like "man-days lost". Some of these problems vis-a-vis radiation safety in power reactors—we shall discuss in this paper.

2. Radiltion Safety—Criteria for Occupat.onal Wobkers

The maximum permissible doses recommended by International Commission on Radiological Protection (ICRP) such as

whole body exposure average of 3 R in 13 weeks and 5 R in one year (ICRP 1966) etc., are universally adopted and practical control of exposure is achieved by enforcing:

(a) access control to the radioactive areas, area and personnel monitoring,
(b) use of protective clothing and equipment,
(c) prescribed permissible occupancy period for workers, and
(d) backfitting or modifying the inbuilt engineered safety in an existing plant.

The permissible exposures mentioned above are the total exposures and include dose from internally deposited radionuclides as well. The latter is indirectly estimated through air sampling, bioassay and whole body counting. To allow for internal dose on the basis of the experience to date—only 4.5 R annual external exposure limit is used instead of 5R/year in the external exposure planning and 0.5 R/year is reserved to account for the internal exposure.

3. Experience

Radiation exposure experiences at BARC and Tarapur Atomic Power Station (TAPS) are summarised in Tables I & II respectively (Tirupatiah 1972, Patnaik 1973).

Table I

*NO. OF PEOPLE EXPOSED IN DIFFERENT DOSE INTERVALS IN BARC**

1961-71

Year	No. of radiation workers	O.5-R.	0.5-2R	2-4R	4-5R	5 R	Largest individual exposure (R)
1961 ..	2,059	1,120	104	26	1	2	6.0
1962 ..	2,228	1,265	121	37	4	3	26.6
1963 ..	2,206	1,231	61	3	0	2	5.2
1964 ..	2,551	1,401	220	8	0	1	7.8
1965 ..	2,830	1,521	455	79	12	6	8.4
1966 ..	2,951	1,580	578	169	31	16	6.0
1967 ..	3,067	1,571	710	168	4	5	23.6
1968 ..	3,082	1,624	554	177	15	6	8.0
1969 ..	3,102	1,529	566	195	38	15	6.2
1970 ..	3,295	1,522	896	250	33	5	5.5
1971 ..	3,476	1,814	537	96	17	2	6.3

*Soman et al 1969, Wattamwar et al, 1968, 1969, 1971a, 1971b, 1971c.

TABLE II

RADIATION EXPOSURE EXPERIENCE AT TARAPUR—NUMBER OF PEOPLE IN VARIOUS EXPOSURE INTERVALS

Year	No. of workers	0.5R	0.5-2R	2-4R	4-5R	5R	Highest over-exposure	Remarks
1969* ..	554	542	12	—	—	—		
1970* ..	670	569	100	1	—	—		
1971* ..	622	327	252	43	—	—		(*a*) TAPS employees including work charged
1972** ..	@510	87	97	115	191	30	6.4R	personnel.
	(*a*) 248	118	103	25	1	1		(*b*) Temporary workers including contract workers
	(*c*) 746	241	435	69	1	—		(*c*) Other DAE units BARC MAPP etc.

*Tirupattaiah 1972 **Patnaik 1973

In BARC, the number of radiation workers has been steadily increasing over the last two decades. Almost all the over-exposures occurred in the highly active areas of fuel reprocessing plant and CIRUS reactor.

The trend at TAPS has been similar. The man-rems used up during maintenance and refuelling work have been found to be more than that during the operating phase. Tables have an important bearing on man-rem management and conservation to meet the contingencies. Proper training and rehearsals with scaled model job mockups form an integral part of radiation safety and optimum utilisation of man-rem. Economics of the situation also demands such an approach e.g., consumption by a radiation workers of the annual permissible dose in the first quarter of a year, require possibly a highly skilled and essential supervisor or worker to be laid off for 270 days from radiation work. Such incidents are amenable to quantification in terms of man-days lost for radiation work. Then the same person needs to be fitted appropriately in non-radiation work to avoid a nine months complete lay off.

4. Conventional Safety

4.1 *Injuries, Fatalities and Man-days lost:*

There is a significant difference in the nature of risk involved in the radiation exposure and conventional injuries or accidents. Immediate somatic injury is not apparent in the case of radiation exposure below about 100 R and the lethal dose is apparently beyond about 450 R (USAEC 1957). The injuries from exposures lower than 25 R have a latent period of 10 years or more for manifestation. On the other hand, in the case of conventional hazards or accidents, the injuries looked for are somewhat immediate or acute, including those of fatalities i.e. at equivalent of radiation exposure levels above 100 R.

Table III (Abraham et al 1973) shows the disabling injuries and man-days lost at Tarapur. As far as the plant is concerned, the man-days lost due to radiation would exceed those due to the conventional accidents in 1972. The statistics for BRAC is shown in Table IV (Somayaji 1973).

In respect of disabling injury to an occupational worker, which may affect his immediate or future livelihood, the injuries temporary or otherwise, are always significant to the person involved. In radiation protection, safety standards are set to plan against disabling injuries or any kind in a life time, the standards in conventional injuries or toxicological effects are set at a much higher level of recognisable effects. In the field of toxicological effects, perhaps for judicious setting up of standards, principles parallel to the radiation safety principles should be propounded. However, it would be very difficult to evolve such a concept for physical damages from conventional sources.

TABLE III

*CONVENTIONAL SAFETY RECORD AT TAPS** — 1969-72

Year	No. of disabling Injuries	No. of man-days lost	Fatalities
1970 ..	19	75	1
1971 ..	10	36	0
1972 ..	20	108	0

*Abraham et al 1973

TABLE IV

*INJURY STATISTICS IN BARC***

Year	No. of persons	No. of disabling injuries	No. of mendays lost	FR	SR	Fatalities
1962* ..	5,700	33	504	7.2	110	1
1963 ..	6,600	89	842	7.1	67	0
1964 ..	7,900	159	1,932	10.4	128	1
1965 ..	8,800	91	866	5.4	51	3
1966 ..	9,500	85	963	4.7	53	0
1967 ..	9,800	53	903	2.8	48	0
1968 ..	10,110	45	866	2.3	45	1
1969 ..	10,540	58	844	2.9	42	0
1970 ..	10,727	55	743	2.7	36	1
1971 ..	10,968	41	603	2.0	29	1
1972 ..	11,142	60	1,007	2.8	47	0

**Somayaji (1973)

*August—December only

F.R. = Frequency Rate = $\frac{\text{No. of disabling injuries} \times 10^6}{\text{No. of man-hours worked}}$

S.R. = Severity Rate = $\frac{\text{No. of days lost} \times 10^6}{\text{No. of man-hours worked}}$

The present trend in health and safety practices in nuclear industry is to take cognisance of the totality of safety problems including the total environmental impact. In view of the above, there exists in practice multiple standards of safety in the nuclear industry; where stringent quantitative standards are used to control radiation exposure, whereas well defined standards or safety criteria are not available for conventional safety. This is a dichotomy in which health and safety workers find themselves in, in nuclear industry or in power reactor safety management.

4.2 *Working Environment*:

The working environment implies—the conditions obtained in respect of: toxins in the atmosphere, temperature, humidity, noise, equipment and its layout in the working areas, which affect the efficiency and well being of the workers. The criteria to noise, equipment and its layout in the working areas, which affect the efficiency and well being of the workers. The criteria to "Threshold Limit Values" (TLV) or "Ceiling limits". Equipment and layout problems have to be essentially handled at the design and planning stage with considerable imagination, foresight and coordination, to realise the prescribed performance standards and safety standards.

The areas in nuclear industry where such controls are required are radwaste system, ore treatment, nuclear fuel complex and heavy water plants where toxic substances such as F, Cl, NH_3, H_2S, MnO etc. are used or produced.

5. Approach to Environmental Safety

Safety criteria for the public in the environs outside of the nuclear installations were spelt out differently from the occupational workers because:

(i) the public domain also includes old and ill people, children and child bearing mothers,

(ii) health standards of the inhabitants are different from the people recruited for radiation work after appropriate medical screening, and

(iii) exposure to large population group entails genetic risks.

On these basis ICRP recommends, somewhat arbitrarily, permissible dose value at least one order of magnitude lower than those for occupational workers.

The prime concern of ICRP (ICRP 1965) has been the protection of man viz. "assessment of the actual or potential exposure of man" and not so much the other life forms in the environment. Permissible environmental radioactivity levels were evolved in different countries from the considerations of irradiation of man externally and internally through intake via his food and living habits. However, environmental protection has been indirectly accomplished in our efforts of safeguarding man, his interests and his safety. Experience to date with peaceful operations of atomic energy indicates that in their efforts to protect man as the user and recepient of environmental products, the safety standards are stringent enough for protection of the other living system valued by man, viz. deleterious effects of the permissible low levels of radiation on other life forms in the environment could not be unequivocally established in the light of the experience of the nuclear operations during the last three decades. However, certain profound controversies still exist on this issue.

For conventional toxins and pollutants such considerations are now being formulated. In these, however, the genetic risk aspect is not very explicit.

Working standards for environmental radiation safety are in terms of:

(i) separation distance of population from the reactor (population distance criteria) and
(ii) effluent discharge limits.

5.1 *Population Distance Limits:*

An exclusion distance of 1.6 Km. has been recommended for a power reactor at the siting stage itself, to ensure that in normal operations and as well as in the case of a severe accident the public does not receive doses in excess of acceptable limits. Based on the analysis of design basis accidents, containment requirements are prescribed to ensure that acceptable emergency dose is not exceeded, in worst meterological conditions, beyond the exclusion distance. Also effluent discharge limits under normal operations are so specified as not to cause unacceptable radiation exposure to a public individual at or beyond the station boundary (exclusion distance).

5.2 *Effluent Discharge Limits:*

ICRP recommends a dose of 0.5 R/year to a public individual as maximum allowable exposure from all sources due to nuclear operations at and beyond the site boundary. The dose would arise from the gaseous and liquid effluent releases. In certain cases, a contribution to dose may also arise from land operations e.g. waste burial and transport of irradiated fuel or radiation sources. In order to keep the total dose around a power station site within the prescribed limit it is necessary to:

(a) apportion dose limits to each of the routes viz. air, water and land. The total should not exceed 0.5 R/year,
(b) apportion further, fractions of these apportioned limits to each plant taking into account the nature of the effluents from each, and
(c) derive effluent discharge limits for each plant based upon the limits in (b).

The situation is further complicated by the fact that in making these appointments, it is necessary to keep in view the future expansion possibilities of the nuclear facilities at a site.

We have been confronted from time to time with this problem in all the three power reactor sites in the country.

STUDIES FOR ENVIRONMENTAL SAFETY CRITERIA

Setting up of discharge limits for the radioactive effluents require a proper foundation of environmental investigations covering micrometeorology, acquatic and micropopulation studies. Environmental conditions change from site to site and each site most often requires independent studies over a minimum period of one year (to cover the seasonal variations) in the preoperational stage and some continuing studies in the operational phase to examine the environmental impact of an operating station. As illustrative examples, we cite the following:

6.1 *Tarapur*:

Liquid Effluents:

Basic discharge limit was set by the designer at 10^{-7} uci/cc in the discharge water. The concentration is intended to be obtained by mixing the radioactive wastes with condenser coolant which is then led to the sea via a 1.5 km. long northern canal during high tide and southern canal of similar length in low tide. The intake is located in between the two at 1 fathom line in the sea.

Studies by the Environmental Survey Laboratory (ESL) on the movement of water using floats and dye tracers have shown that wastes would accumulate on shore through siltation and that during spring tide, the incoming tidal waters made the north discharge canal ineffective in leading the condenser discharge into the sea. On the basis of this information, augmentation of waste treatment facility has been undertaken by the station as one of the remedial actions in this regard.

Atmospheric Effluents:

Designer's specifications or annual average gaseous discharge rate through the 110 m stack is 580 mci/sec. This limit is based upon the calculated dose at the nearest site boundary in the most frequent wind direction (from SSW taking effluents to NNE). The dose, as calculated from the preoperational micrometerological data collected at the site, is 500 mR/year for 580 mic/sec dis-

charge limit. It thus appeared that the site radiological burden could be fully utilised by the air route exposure alone. However, operational surveillance and monitoring show that the limit set as above has never been exceeded by the station. The Tarapur station complex operates on the basis of some apportionment of release through air and water routes viz. apportionment of 250 mR each for air and water routes. Of the air route apportionment, 10% is allotted to Power Reactor Fuel Reprocessing Plant. Based on the remaining 225 mR/year value at 1.6 km, TAPS may release 246 mci/sec as the annual average discharge limit. Any further expansion of facility at the site can only be made through reduction of this appointment.

6.2 *Rajasthan*

Aquatic:

The reactor uses lake water as condenser coolant in its once-through system. The intake and discharge structure was based on model studies to minimise thermal recycling.

Two series of further studies were made by the ESL in these waters. The first was to establish the maximum permissible concentration in the lake waters through the analysis of acquatic fauna and considering the reconcentration factors of individual elements by these (Pillai et al 1966). The second was to follow the movement of coolant discharge in the lake (Kamath 1973). The observations served as a feed back information for the project for relocation of the intake points.

Gaseous Efficient:

Preoperational meteorological and smoke diffusion studies made since 1964 (Shirvaikar et al 1970) in the region have been used as input information to derive the maximum permissible discharge limits.

Such analysis also gives the maximum admissible reactor power at the site and gives guidelines for design modifications.

Analysis of the doses under accident conditions and normal operations have led to design modifications in successive CANDU type stations. At Kalpakkam, containment has been modified to double containment system with a modified pressure suppression system whereas in the proposed U.P. reactor, trends are

towards eliminating the production of A-41 (which is the main contributor to the environmental dose) by changing the calandria peripheral cooling system (Kati 1972).

6.3 *Kalpakkam*

Aquatic and micropopulation studies have been started in the newly built environmental survey laboratory. Continuous meteorological data generated at the site has been used as input to stack design, discharge limits of gaseous effluents etc. both for the MAPP (CANDU reactors) as well as for (Fast reactor) FBTR. Unlike at the earlier sities, air route dose appointment could be made at an early stage at Kalpakkam.

7. Conventional Pollutants

Concern shown for radioactive pollutants in the nuclear industry, far outweights that shown for conventional ones in the same industry. Such pollutants include H_2S, chlorine, fluorine etc. air and a host of chemicals in water. For inland stations, quantities of lubricating oil are such that it could pose some pollution problem if discharged to water body.

A number of toxic corrosion products e.g. Fe, Cr, Mn, Ni, Cu, Zn, Co etc. are discharged with the condenser coolant into the surface waters. Tables V and VI compare the permissible elemental concentrations for the active and inactive isotopes of

Table V

COMPARISON OF $(MPC)_w$ FOR RADIOACTIVE AND STABLE ELEMENTS

Element	MPCs in drinking water		Tolerances for irrigation water** mg/l
	Radionuclide* mg/l	Stable isotope** mg/l	
Chromium	2.1×10^{-8} (^{51}Cr)	5×10^{-2}	5.0
Manganese	1.2×10^{-8} (^{54}Mn)	5×10^{-2}	2.0
Iron	1.2×10^{-9} (^{59}Fe)	3×10^{-1}	—
Cobalt	4.4×10^{-8} (^{60}Co)	—	0.2
Nickel	4.2×10^{-7} (^{63}Ni)	—	0.5
Copper	7.8×10^{-11} (^{64}Cu)	1	0.2
Zinc	1.2×10^{-8} (^{65}Zn)	5	5.0
Molybdneum	4.2×10^{-10} (^{99}Mo)	—	0.005

*Derived from ICRP MPC_w

**From 'Water Quality Criteria', Federal Water Pollution Control Administration, USA (1968) and International Standards for Drinking Water, W.H.O. (1963).

some elements. The MPC for radioactive elements are lower by several orders of magnitudes, still, efforts are made to chemically or physically decontaminate these, a practice that can be extended with more ease for the non-radioactive isotopes of the metals. Such an effort is necessitated by the fact that the elements cited are all biologically significant and a large number of organisms concentrate these to very large extent from ambient media.

TABLE VI

COMPARISON OF MPC's IN THE AIR FOR RADIONUCLIDE AND STABLE IOSTOPE

	Radionuclide	Stable isotope**
Mercury	1.76×10^{-10}	3×10^{-4}
Manganese ..	1.48×10^{-10}	1×10^{-3}
Lead	4.85×10^{-11}	7×10^{-4}

(**Air quality standards : USSR)

Safety analysis and hazarls evaluation at various stages between design and operation are exercises to which all the power reactors are subjected to prior to their clearance for operation. This type of disciplined approach for sitting and operation of conventional power plants or chemical plants are not yet in vogue. Such stipulations in sitting a conventional power plant are now only being thought of. Although there exists for some time the ambient air quality—criteria for different toxic gases and pollutants, it has not been a practice so far in our country to plan and demarcate the plant boundary where such air quality in respect of the toxins released by the plants, are to be realised, though in some states in U.S., the system exists as part of legislative code (Stern 1968).

8. SYSTEM SAFETY

A power reactor has to be inherently safe if it has to deliver the power with efficiency. We have concerned ourselves here only with those aspects of safety which would generate radiation fields or radioactive wastes or release these to the environment. There are two ways to achieve the objective. The first is to

follow the stringent standards for design, construction, operation and maintenance. The second is to have sufficient buffer capacity to hold the wastes so that the reactor operation and maintenance are not hampered due to non-compliance with the specifications. By and large, the first approach is the commendable one, for it controls the generation of wastes at the source. The second approach amounts to operating at the expense of the systems.

Continued enforcement of the standards requires technically sound operations policy and resupposes and extremely efficient management cadre. When this is assured, the system must also be equipped for the second approach and must also provide for unforeseen performance problems.

Note:—This talk is an adaptation from an earlier paper by V. V. Shirvaikar and A. K. Ganguly on the subject matter of this address. The subject matter and the conclusions are not out of date yet.

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Working Environment and the Worker

RAJA KULKARNI

These days we cannot discuss health and safety standards inside a factory in isolation to the notions of health and safety of the people living in the surrounding area. The concept of environment is of recent origin. Twenty years ago the word 'environment' was not so much used. The word was not used in the industrial language or in the language of health and safety. Twenty years ago I would have taken the word to embrace such things as ventilation, cleanliness of the rooms, the layout of the machinery, the lighting system, the provision of clean water, the W.C and all these things which are in the Factories Act. Then both public policy as well as attention of the industry were focussed on that aspect, which was known as physical working conditions and we used to use the word 'physical working conditions' for a number of years and that was the assumption on which the Factories Act was formulated. Even then we found that all these provisions of the Factories Act were inadequate to solve the problems, even industry found that was not enough so they made their own efforts and the govt. also thought something should be done outside the Factories Act.

We have economic development and yet the people of India feel that we are not making any progress economically or socially similarly, even inside the industry though efforts have been made to improve the physical working conditions the problem is as acute as it was 20-30 years ago. We do see the difference between factories which were established 50 years ago and those established 15-20 years ago in the suburbs of Bombay. The latter have good appearance, ventilation is quite all right, lighting is good, layout is not bad, the provision of drinking water is there. Well, outside the four walls you have the beautiful gardens sur-

rounding the factories and yet the question of working environment is as acute a problem whether they are old factories or new factories. The working environment concept has exceeded far beyond its original definition. The social environment is now considered a part of the working environment. I am now taking the question of housing. If a man has no family life, no house to stay how can he work efficiently, even if you have given him a very good garden like factory to work in? So this is the social aspect. To-day the worker is looking at the working environment not only as an employee during the 8 hours he works inside, but also a citizen. The traditional walls between the people outside the premises of the factories and the physical environment within the premises are broken especially, the conceptual walls and therefore the whole thing stands as wholly integrated. Therefore, we are looking at the relationship of working environment and the workers as an integrated process. Environment today is an outgrowth of the new type of industrial development that we have, the nuclear industry as Dr. Ganguly has pointed out to you and the development of petroleum and petro-chemical and chemical industries. The Government policy lays down that these chemical industrial complexes will be located somewhere away from the city—Kalyan, Belapur, Vashi in New Bombay. Chembur was selected 15-20 years ago. They had certain notions when they selected Chembur. Those days nobody was worried about sending the effluent into the sea. Whether it is water pollution or air pollution, there is civic life pollution. All these problems have come because particular type of industries are coming up.

I do not know, you might be able to give the answer whether pollution is inevitable with the growth of technology that we have. 'We' means not only India, but the world. That is the main problem and the workers are also looking at it from the same angle. 14,000 workers at the Fertilizer factory at Chembur are in my union. They spend 8 hours inside. During the 16 hours of the day when they are in their house, or on the road, they are in the vicinity of the factory. They reside in the housing colony of the Fertilizers which is only a few yards away from the factory. So this working environment affects a worker not only as worker for 8 hours of his daily life, but for all the 24 hours. Now that is the one problem that requires to be resol-

ved. Well, sitting in Sion, you are affected with pollution. We have seen the same problem in other industrial cities too, such as Durgapur and Asansol, the Vapi chemical complexes in Gujarat. Look at the Kalyan chemical complexes. It is not only the Ulhas river that is polluted but the surrounding villages too.

I am the elected member of the parliament from Chembur. Twenty-five years ago Chembur was a small cluster of villages. Fishery was the main industry. But today, after the development of chemical industries complex, Chembur is known as polluted area of Bombay. We have at Chembur the BARC, petro-chemical industries, two refineries, and the fertilizer factory. I had brought this to the attention of the Government. Can we say, let the industries grow and at the same time people can stay on without the fear of any pollution. That reply in positive terms cannot be given as yet. We are taking precaution, preventive measure so that the people will not be affected. There is no demand to take away the industry from here. Industries have also not made demands that all residential quarters would be shifted from Chembur and the whole area should be a no man's land. That stage has not come as yet. Remedial measures are taken so far as workers safety and health inside the premises are concerned. Now, for the last 5-6 years the problem of people outside the premises have come up which is an integral part of the working environment which an industry has to consider. Well, then what should do about it? That is the problem we are facing today. I wanted to form a housing Society in Chembur for industrial workers. They did not encourage me to buy land in Chembur. They say, we do not want a permanant house of our own in Chembur area. Industrial workers in large numbers have come to live during the last 5-6 years outside the factories in Chembur. But it is the population of the slum areas in Chembur that has gone up. Decent colonies of middle class are no longer coming up.

Providing a garden like factory is not enough for good efficiency and health and safety. In the earlier notions it was the connection of man with industry—man with machines, man to man, man to different hierarchy in income, the supervisor to workers, were not brought in relation with working environment.

They were taken as separate subjects to be dealt with differently, they were not integrated together. Now I know the workers are studied as human being, they are studied as citizens, they are studied as family members, they are studied as employees when we put all these together it is working environment concept integrated. The integrated approach has brought together people outside the factory and the people inside the factory in one concept. Just as the computer integrates into one business organisation, the factory, the head office and sales offices scattered in different locations. And I feel that if the problem is looked at from this point of view it can alone be resolved. In 1969 for the first time the parliament took cognizance of this question of pollution. And that came as a result of what happened in Calcutta, Bihar and Bombay, especially what happened in Bihar when the waters of the Ganga caught fire near Barauni Refineries. Parliament thought this is a public problem and there should be public policy on this. The first systematized, organised attempt at public or Govt. level came in 1970, the bill was drawn up, it went to the select committee and the evidence was taken, the committee went to these industrial complexes throughout the country. But on air pollution nothing has come so far in the form of a bill though there are various expert committee reports. It might take little time to enact the Bill. But the difficulty is as to how to implement it. Water pollution and air pollution has also an effect on civic life. A solution will have to be sought with the cooperation of statutory, non-statutory measures, experts and others, I think it is only in giving up the traditional notions on different aspects some solution can be found in establishing a harmonious relationship between working environment and the worker.

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Pollution Control

DR. J.M DAVE

We want to understand the effects the industry has caused on our environment due to the pollutants it releases during the manufacturing process and what should be done for protection of our environment. Let us project this problem of environmental pollution as it stands today in a systematic way. Here we refer to the total environment.

Earlier you heard that due to uncontrolled effluent discharge, the Great Lakes in America have become huge cesspools. I may give a few more examples. In the river Rhine, the bacterial count of 30 to 100 ml. at the source in Switzerland goes to about 2000 ml. at Boden sea (lake constant) and reaches the one million mark in Holland.

In Green land level of lead in ice was 18 ng/kg. 200 years ago. In 1953, this level was 80 ng/kg. and in 1965 it reached 200 ng/kg. The level increased 4 times in 200 years and almost three times in only 10 years.

Pollution which is physical and chemical is not limited to water alone. It is present in soil and in the atmosphere.

For instance, our surroundings are now full of noise. The overall noise levels in many European cities have considerably gone up during the last few years.

The total solid waste has reached abnormal proportions. In USA, it is about 15,000 million tonnes per year (industrial) and 2,800 million tonnes (domestics). The disposal problem is enormous.

Here we must also realise that the phenomenon is reversible. The overall picture is, therefore, not so discouraging. The nature herself is trying to change the things.

In London they have seen salmons in the river Thames after a gap of almost 100 years.

Let us look back home to find out our position and what we are doing.

In urban areas we produce about 1,500 million tonnes of solid wastes per year.

The Damodar river with severe pollution has a B.O.D. of 300 mg/l. and practically no dissolved oxygen.

Cities like Delhi, Bombay and Calcutta have SO_2 levels of about 100 mcg/m^3.

The overall noise level in Delhi is 70 dB.

Now why is this so? Man is himself responsible for the present state of affairs.

Man is an evolutionary animal. With his intelligence he has gained superiority over the nature, over animals and managed protection against various odds. He has halted diseases, preventent starvation, succeeded in securing food, shelter and the material needs. But in this progress he has also changed himself. He has organised himself into various groups, such as teachers, farmers, doctors and finally the most important—the technologists and scientists.

The technologists developed fertilisers to produce more food, pesticides to protect these crops, materials for better housing facilities. He also produced medicines and drugs for better health protection from weather and other elements. He has created industries and helped the society. But these factories and processes have brought with them the problem of waste and its disposal. We cannot blame the technologist for this. The technologist has not been irresponsible.

Dr. Ganguly described the development of nuclear energy industry and the preventive and protective measures being taken. In fact, the technologist has never been so involved than today for protecting man from his own waste. For this he has created systems for domestic waste disposal, safe water supply, protection from weather and even the utmost element of space. It is a challenge which we have tried to meet and still we are facing the situation as it is today. Why? Let us understand the reasons for this.

The general awareness about environmental pollution and the need for its control was not aroused as a result of the 1972 Stockholm Conference. Technologists have been working for

pollution control from time immemorial. The technologists in UK in 1913 told the British Parliament to pass the Smoke Nuisance Act. The technologists stressed that water got degraded if undesirable components are added to it. The concept of BOD and dissolved oxygen was introduced by them way back in 1929.

Waste is produced by production and consumers processes. Some portion causes water pollution and some portion causes air pollution. Hence we introduce the system for purification of water and conservation of air. But what about the solid waste? Are we to treat it or just go in dumping it? And if so, how much waste can we dump? We have to maintain a balance in the echo system. And hence we have to find a solution for reducing waste and pollution.

Before doing so, we have to consider different aspects of the problem. Foremost is the consideration of economics of pollution control. The industrialists did not create pollution because they wanted to do so. They are interested to see that the production runs smoothly and while doing so they incidentally created the pollution problems.

The manufacturers of soft drinks in USA found it cheaper to have throwaway bottle than bring it back, clean and refill. They therefore discarded rebottling. It is sheer and simple economics. They did not care for the impact of such a change.

Second aspect is economy in production technology. If sulphur produced from a smelter has no commercial value what should we do with it? We may as well release it to the atmosphere. This was the case of Anaconda Mines on the Canada and USA border. They were thus ruining the forests for over 30 years, quite unknowingly, because the idea was quite economical.

Third factor is the socio-economic cost. For economic development of our country we need more production. We have to establish certain industries. This may bring with it the problem of pollution and waste disposal. What should we do?

Let us illustrate this with the Trombay case. What are the socio-economic benefits from this Fertilizer factory? It helps produce food for a million people by production of important fertilisers. If this factory creates pollution, 10 or 20 thousand people in the vicinity may suffer. The question is that just because this factory produces food for a million, are we justified in making 10

or 20 thousand people suffer? A decision has, therefore, to be taken as to who should pay for the treatment of those affected. What would be the socio-economic cost and who would bear it? Should we close down this factory? Who would suffer from this? One has to make a decision and it is a political decision. How are we going to decide this and similar issues?

The problem of socio-economic cost is not restricted to our country alone, it is a problem faced by many other countries. The 1972 Conference was a political one and not technological. They wanted to decide who would share the cost and how. They were not concerned whether the control technology was available or not.

Environmental scientists have been aware of these problems. The technologists have pointed out dangers of uncontrolled industrial activity. It is not the negligence on the part of the technologists. Socio-economic issues are involved which need simultaneous consideration.

There is a point beyond which the industry cannot control emissions. For this they will have to spend some funds. The economics of running an industry and expenditure on air pollution control measures are inter-related in a logarithmic manner. If you want to remove 80% of the pollutants you pay, say X, but if you want to remove the balance 20% pollutants, you may have to pay 20 X. Who would bear this 20 X cost? Would the benefits accrued justify this expenditure? This is an issue which is to be decided upon.

It is not possible to precisely determine the benefits the society will derive in terms of better health of the people as a result of controlling the pollutants. Some of these things are intangible.

The other constraint on the problem of pollution control is resources. We cannot think of pollution control without proper resources.

Government has decided that all power stations should work with coal. Our coal is furtunately low in sulphur but its ash content is very high. So, when all power generating stations are converted to work with coal, the fly ash discharge would be about 100 tonnes per day. What are we going to do about it? Where are we going to dump this ash? It has to be decided right now. We cannot remove all the fly ash. In fact, beyond a cer-

tain point, we cannot achieve better performance of the control equipment. Electrostatic Precipitator may remove 99% fly ash. The problem is critical only due to 0.5, 0.7 or 0.9% ash which is bound to escape. We have to decide on priorities and we have to decide how we are going to spend the resources.

We have no sulphur in our country. We may find it cheaper to recover sulphur from some industries which Eurpoean countries find very expensive. The technology is available for this and it plays an important role in the economy.

I would like to mention something about the intangible damage to our culture due to pollution. The case in point is of the Taj Mahal. A refinery is being built not far away from this monument. We have to decide which is precious to us. Should we go ahead with industrial progress or should we go on preserving our monuments? These are confliting questions and the society has to find some solution.

We forget all along that nature is on our side. The nature has tremendous capacity to accommodate. Even since man invented fire, he is dumping carbon dioxide into the environment for over 600 years and according to some calculations its present level should have gone up by 25%. However, the level is reasonably constant. Where has the gas gone? What happens to the tonnes of hydrocarbon vapour released in the air? Where does it go? The nature breaks it down. We do not know the capacity of nature and should therefore make the best use of this tremendous capacity.

Same is the case of the soil. It can assimilate carbon dioxide, hydrocarbons, sulphur dioxide, organic compounds and cyanides. We yet do not know its total capacity and how we can use at least a part of it for the making of a better environment.

Tress and plants have tremendous capacity to absorb sulphur dioxide and other pollutants and particulates. If therefore we have proper zoning of industrial and residential areas-inlaid with green belts we could use the nature's capacity to our advantage. For this purpose proper planning is necessary.

Finally, about the control technology, What is the extent to which the pollution can be controlled? When fertilizer and pesticides were being produced by the new technology, the seas and oceans were flooded with them. This was rather ignorantly done

but that should not be the limit of our intelligence. The technology has to meet any challenge the environment poses.

First and foremost we must have the will of the people to improve the environment. The next requirement is prescribing standards and introducing legal measures. The industry says it will put water of certain quality into the stream. The naturalists may insist that the water stream should be maintained clean and without pollution. This gives rise to the conflicts. A balance has to be struck and people can play an important role. The people should decide the limits to which the wastes must be treated before being discharged as mandates. The technologists has this capacity but he requires a mandate from the society.

While framing laws and prescribing standards, however, the approach should be rationalised. For instance, a country may not be able to accept a WHO prescribed level of 66 mg/m^3 for a pollutant due to various problems. This ultimate goal may be achieved in stages. Let the standards be set temporarily at 130 mg. and try to achieve it.

We cannot stop at passing laws and prescribing standards. We have also to meet our social responsibilities. We should assist technologists in developing control measures and convince the industries to adopt these technologies.

Let us again examine the Trombay case. The question is of an investment of Rs. 10 crore to provide food for a million people which may cause suffering for about 20,000 people. What we could do is place the responsibility for welfare of the people on the society. This means the Government should subsidize. If the industry is not in a position to protect the 20,000 people, somebody has to bear the burden in between. The society benefits from the food and therefore it should provide financial subsidy in the form of funds. This again has to come out of the will of the people.

It is not the industry alone which causes pollution, it is also the mankind. In fact, almost 80% of river pollution problems in the country are caused by our people and not by our industry. We have to look into this aspect, provide required facilities and educate people to change their habits.

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Technical Session

OCCUPATIONAL HEALTH

Family Health and its Importance to Industrial Workers

DR. (MRS.) USHA R. KRISHNA

Social environment, working environment, pollution control etc. have been dealt with in previous sessions. Let us now think of how family health problems affect a worker's environment and thus his work efficiency, concentration and safety.

When we make efforts to improve the environment, these efforts have to be multi-dimensional. A great deal is being done to improve the environment in the factory where the worker spends 8 hours of the day. But what about the effects of the environment that surrounds him for the remaining hours? Dirt, poor hygiene, malnutrition, social evils, alcoholism, indebtedness etc. are factors that influence the physical, mental and emotional health of the worker and his family.

If we want productivity and safety, we want the worker not just to use his hands on the machine but to put his heart and mind in the work. To have the "total worker" with us in the factory, we have to improve the "total environment". Studies have shown that the majority of accidents are avoidable, as lack of concentration and negligence are important causative factors. Worries due to ill-health in the family and domestic problems could be lessened by paying attention to the health of the worker's family.

We cannot eradicate tuberculosis, infectious diseases or venereal diseases from workers unless they are treated and eradicated from the families as well. A worker cannot be well nourished when his family is malnourished. The majority of the employers as well as the Government are now convinced about the need for Family Planning. Disease, malnutrition, infant morality as well as social evils are more difficult to tackle in larger families. Yet family planning will be welcome by workers only

if it is part and parcel of integrated health care of the families. Facilities for treating pediatric, gynaec and general health problems, antenatal and post-natal care, immunisation of children etc. are some necessary facilities to create a climate in which we can achieve good results in Family Planning. Sustained motivation of workers is one of the most difficult problems. Therefore, it is extremely important to make the workers adopt the family health programme as their own programme.

Exhibitions on health care, Bal Melas entertainments, healthy baby shows, nutrition classes, sewing classes, etc. as well periodic leaflets and booklets are certainly helpful in generating worker's interest in health programmes. Voluntary health visitors can be created from among the workers and their wives and they can be very effective.

Health education is extremely important to spread the Preventive Medicine Programme. The agony of polio affliction, for instance, can be avoided if by health education the worker can be made to get his children immunised. Similarly, the problem of pregnancy in unmarried girls can be prevented by family health education (sex education).

In conclusion, it must be said that the efforts to maintain a good standard of the worker's health will succeed in the long run only if a corresponding effort is made to maintain the worker's family in good health.

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Hazards of Noise in Industry

DR. K. G. NAIR

The subject of my choice today is Hazards of Noise in Industry. I am going to talk on a subject which is very dear to my heart, because it concerns an important form of pollution that we are all adhered to. Now, sound can be very disturbing to the human environment, it is not only the sound that we hear but also infrasonic vibrations that can disturb man's performance. Perhaps, some of you are aware of this feature. Vibrations and noise which is not detectable by the ear can also influence human behaviour. Sound energy is expressed as sound unit area, and the unit of the sound is decibel (dB), which is the intensity in measure with respect to the reference intensity in a lowest make ratio. Now these words may have little meaning unless I give you the intensity levels of certain well known sounds in dB as shown below:

Approximate Sound Pressure (decibels)	*Source and Location*
200	— Saturn rocket at lift off 300 m. away
160	— Peak level, 0.303 rifle
140	— Jet Aircraft (take off) at 25 metres
120	— Submarine Engine room
100	— Noisy factory
90	— Road drill at 7 metres
65	— Busy office with typewriters

Some types of noise:

First of all noise may be defined as a public nuisance. But against this kind of nuisance you may not be able to take any legislative effect. Then there is a type of noise which is called statutory noise and for this offence the persons may be punished, for example, bursting of crackers and other such noises could be

made offences under law. Then, of course, noise can be a private nuisance. The neighbour happened to have a rather wild party and it can be a sort of a private source of noise.

A noise of course, can be a form of protest. We read of instance where clashing of cymbals and beating of drums and other instruments have been used as a form of protest.

Now it is not that noise only cause annoyance and disturb human conduct. But noise may cause selective deafness which is well known to everyone in industry. It can cause audio-genic stress and it is now well known that audio-genic stress can produce or can be conducive to infection. In other words, if you are harbouring an infection at the same time subjected to loud noises where the chances of having bad infection or higher. This has been proved experimentally. For example, by giving 2 sets of mice, one identically versus and having one subjected to noise signals. Loud sound can also affect the endocrinal system, various hormone level may be affected and various cyclically events may be disturbed and so on.

Noise of course can be conducive to peptic ulcer. A group in Russia-Systalove Systanon Glutto studied 300 workers exposed to noise. And also a group in Czechoslavakia—Sakoda and Premorova works—They studied 969 workers exposed to noise greater than 85 dB and found higher incidence of peptic ulcer among the workers.

Various people have observed that continuous noise, let us say at the level of 95 dB or so can affect blood pressure adversely. So hyper-tension can occur among people. Curiously also, fall in blood pressure is also noted in individual people. A Russian group also found that there may be bradycardia. Now if you are prone to coronary after disease, noise can be certainly aggravating. Peripheral vascular systems can be influenced by noise particularly peripheral vascular resistance. The blood cholesterol level may be elevated if you are living in a noisy environment. And we have done this experiment. This is called an experimental cardiac hyper trophy, where continuous subjection of rats to noise can cause left ventricle enlargement due to audiogenic stimulus. So here are many bad effects of noise which may occur in industrial environment.

Noise of course may affect the reproductory system and in one experiment in animal, a large number of still births were

recorded. So it may be adversely influencing the foetus. Whether it causes foetus deformity or not is not quite clear, although one worker did try by sending out noisy signals through the uterus to foetus and found that high incidence of foetus deformity particularly hair-lips, cleft palate and so on.

Loud sound can cause vertigo. This is known as Tullio phenominon. Loud sound may also cause a change in the skin resistance—the galvanic skin resistance known as Fer Effect. Noise, of course, every one knows causes sleeplessness. Now, the older you are the more difficult to get sleep. Thus people near the air port—such people have been studied and it has been found that those people who are 60 and above hardly get any sleep and young people somehow manage to sleep soundly through aircraft noise.

Sound may induce epilepsy. Actually there is a kind of epilepsy called musio-genic epilepsy where a person hearing certain types of knocks or sound can go into an epileptic fit. Audiogenic epilepsy of course is more inducible in rats and mice and low forms of life. Man is not as susceptible unless he is already an epilepsy subject.

Now, ship's noise can have a very important role, and doctors working on ships must be aware of this. Those who are working in gun-deck, those who are working in engine room, those who are near the aircraft carrier, and those who are on the aircraft carriers are constantly subjected to noise. The people who are on duty on the aircraft carrier for 3 to 4 years in succession suffer from nervousness, insomnia, hypertension and are possible candidates for heart disease. In submarine wherein very noisy environment adversely affect the cardiac function. In other words, you will find that in naval environment there is lot of audiogenic stress. I also said earlier about infra-sonic vibration. We do not hear vibration, but because of the instability of ship or submarine, infra-sonic vibration can also disturb human behaviour. For any navy personnel behaving peculiarly he should be kept away from the noisy sources and if he had tendency towards neurosis, then noise certainly aggrevates. Now, for guns that fire explosively, a lot of research abroad and in this country and the Navy has developed a device for reducing the stress on the ear drum by putting an object through the ear drum with perforation

in the ear drum. This prevents the ear drum from being shattered and thus the gun can be fired at close quarters.

Noise induces psychopharmacologic change in the CNS levels of serotonin, nor-epinephrine and Gama Amino Butric Acid (GAMA). These are of two different types of neuro-transmitters. Human behaviour is influenced by what is known as amino-organic transmitters that certain transmitters in the brain can affect CNS functions particularly behaviour and irrelevant behaviour, neurotic behaviour. All of these may result from a sleepless individual who is continuously disturbed by noise, not only does he perform inefficiently but he may perform in a very peculiar way. So these problems can incur particularly in the army, navy and Air Force.

The turbo jet engine causes extra amount of noise on take off. Some of you know that you are going from one city to another and from that city back again and perhaps you are shuttling back and forth you do not have much sleeps and then you are caught on such a plane with turbo-jet making loud noise and is going to disturb your performance profoundly. It may affect your endocrine function, your cerebral function. It may affect your blood pressure, if you are prone to it. It may cause peptic ulcer so and so. Air Force has been constantly trying to reduce aircraft noise and it has many problems to overcome in this regard.

It has been estimated that in USA if they really have the super-sonic aircraft as many as 50 million people may be involved in sonic boom by one single flight. There is lot of protest by citizens against this and therefore, the supersonic flights have not yet come to stay. But it has been observed that supersonic flights with the sonic boom induced over the people not only shatters windows and glassware but can also shatter human personality.

Noise can be reduced by insulation. Rock wool, on perforated metal facing suspended fissure mineral fibre tiles on the perforated plaster board or perforated wood fibre tile are used to reduce noise level. If these kinds of tiles are put on your roof and inside the walls and if you have a fairly thick carpet then you can cut down the noise extensively and it is not always possible in the factory environment to introduce the tiles at all the junctions. But certainly certain noise areas you can use this sound

proofing and you will have a very much happier worker free from some of these ills that is due to noise.

I have told you about the various types of noise and how they may definitely influence human behaviour. We have not yet done much to eradicate noise from the human environment. Perhaps we are a race of noisy people, I do not know about this. But it is important that for the industrial health of your worker the doctor concerned make a deep analysis into the sources of noise in the environment for the worker, if we want a fitter worker and more well slept and more peaceful kind of worker. I have given you this brief outline what can be done about noise in the factory.

(Extracts from the talk)

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DISCUSSION:

K. C. Gupta:

Can you please suggest some of the practical ways of reducing noise in the loom sheds?

Dr. Nair:

Efforts should be made to locate the points at which impact noise is produced and to take control measures, such as providing cushioning material at the points where impact between parts take place and also to choke the vibration.

K. C. Gupta:

How can we deal with the noise of rivetting or use of other pneumatic tools during fabrication of ship laid on her kneel?

Dr. Nair:

This is a problem of vibration. If you can devise a silencer for rivetting gun on the lines of the silence for the gun, you will get away the noise. Silencer for the rivetting gun has not been yet designed. Of course, the simplest method would be for the workers to wear ear protectors for audiogenic stress. Indian workers do not like ear masks, because they cannot talk to each other at work. This is a social problem. The next best is to wear ear plugs. I would suggest ear plugs for the rivettors.

Dr. S. K. Chatterji:

I shall be thankful for your expert views on attenuation level expected at the ear drum in relation to noise level recorded outside.

Dr. Nair:

I am not an ear, nose and throat specialist, but I am sure some dB of attenuation do take place at the level of ear drum. It is in terms of the intensity and the duration of noise level outside that the present standard on allowable noise levels are fixed.

Dr. Sachdev:

Would you elaborate as to how many places in our country have adequate facilities for studying scientifically the effect of noise on life in general?

Dr. Nair:

I know of no such centre with adequate facilities. Institutes like the National Physical Laboratory, Central Labour Institute, National Institute of Occupational Health can, I believe, take up such studies.

J. Adhia:

Would you recommend ear protection for workers exposed to higher sound level? If yes, whether ear plugs, or ear muffs?

Dr. Nair:

I think ear plug is the simplest. A suitable ear muff or ear plug has to be so designed that it will prevent noise but will at the same time, allow the workers to communicate with each other. The gunnary people have devised an ear protection device, which is excellent. They can fire the rifles without affecting the ear drums.

Dr. S. S. Ramaswamy:

A number of people seem to be blissfully unaware of the noise and also its hazards and are apparently hale and hearty. Are there factors which render them 'immune' just as some people do not contact respiratory diseases even after prolonged exposure? Do diseases caused by noise also have long latent periods? Have any steps been taken in any industry towards noise abatement below the hazardous levels?

Dr. Nair:

The various aspects referred in the first part of his question has not received the required attention. These require detailed study. As regards the last part of his question I am afraid we have been paying very little attention to the question of abating noise in industry to acceptable levels.

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Lung Diseases in Industry

DR. J. C. KOTHARI

INTRODUCTION

It is a group of diseases that affect the lung as a result of inhalation of dusts, gases, fumes or infectious agents at the work site or in the environment as a whole. Hence, it may, broadly speaking, be proper to define them as environmental lung diseases.

Physicians practicing in areas, where such occupational hazards exist, are usually prompt in detecting these cases. In non-industrial areas, physicians are not well aware of these problems and many cases with history of occupational exposure in the past may not be recognised. Gaensler[1] has reported an incidence of 5.8% primary occupational pulmonary disease.

In the middle of the 16th century, Agricola[2] gave a detailed account of the working conditions in mines in a treatise "De Re Metallica". He noted that miners had a shorter life due to lung disease. He makes the following observation: "In the mines of the Carpathian mountains, women were found who have married seven husbands, all of whom this terrible consumption has carried off to a premature death". He advocated preventive measures by adequate ventilation and use of loose veils over the face. In England, Charles Thackrah in the 19th century surveyed the health hazards in various industries then existing in the country.

History

A thorough history of the patient's present occupation, his work environment, details of raw materials and products handled by him are very important. Of equal importance is a history of all his past occupations. Very often, the present illness may be a result of exposures to material handled in a previous occupation several years ago. As a rule it takes several years exposure to a

toxic substance before the disease manifests itself. Besides, this, the bronchial clearing mechanism, enzyme deficiencies and hypersensitivity can influence the occurrence of lung lesions.

Classification

There is an infinite variety of substances that can cause occupational lung disorders. Many of the disorders are non-specific in nature and are diagnosed by history of occupational exposure, symptoms and pulmonary manifestations. The following is a broad classification suggested by Fitzerald Carrington and Gaensler:[3]

Inorganic Dusts

1. *Free Silica:* (a) Crystalline—quartz, trydymite, cristobalite. (b) Amorphous—diatomaceous earth, silica gel.
2. *Silicates:* (a) Fibrous—asbestos, sillamanite, talc, sericite. (b) Other—mica, Fuller's earth, kaolin, cement dust.
3. *Carbon:* coal, graphite, carbon black, soot, charcoal.
4. *"Inert" metals:* Iron, barium, tin.

Biological "Dust"

1. *Vegetable:* monthly hay (Farmer's lung) mushroom compost, bagasse, maple bark B. subtilis enzyme (detergents), malt, grain-weevil, cork, roof-thatch, lycopodium.
2. *Animal:* Pigeons, parrots, budgeringars, hens, pitutary snuff.

Toxic Chemicals

1. *Irritant gases:* Oxides of nitrogen, sulphur dioxide, ammonia, chlorine, ozone, phosgene, carbon tetrachloride, hydrogen chloride etc.
2. *Metallic fumes:* Vapours, oxides and salts: beryllium, silicides, mercury, cadmium, platinum, manganese, zinc, vanadium prutoxide, nickel, osmium.
3. *Plastics:* Polyatrafluroethylene, toleune diisocyanide (TDI).
4. *Aerosoles:* Mineral oils "cutting" oils, $CuSO_4$.

Occupational Respiratory Infections

1. *Bacteria:* Tuberculosis (miners, nurses, pathologists), anthrax, glanders.
2. *Virus/rickettsial:* Psittacosis.
3. *Fungi:* Coccidiomyocosis (irrigation, farm work, archeology), histoplasmosis (poultry, pigeons) cryptococcosis (pigeons).

Occupational Respiratory Carcinogens

Arsenic, cobalt, nickel haematite, uranium, chromates, asbestos, talc etc.

Silicosis

It is probable that Silicosis existed in prehistoric times. Hippocrates observed "the difficult breathing of miners".

It occurs in workers engaged in the following occupations—industries: ceramics, potteries, granite, sandstone, flint, abrasive, gold mines, tin, copper, silver, zinc, iron ore, coal; graphite; metal grinding, iron and steel foundries, sandblasting, tunneling, glass manufacture. The causative factors are: (1) particle size of the dust, (2) duration of exposure, (3) concentration of dust in air.

(1) Any dust particles 710 micron in size and filtered out in the nose and upper naso-respiratory passage and removed by the ciliary action of the bronchial lining. There is no ciliary epithelium in the alveoli. Here the phagocytes come into play. Dust particles less than 5 microns in size are deposited in the terminal bronchioles and alveoli. The optimum size for retention is 1 micron. Continuous and prolonged exposure leads to breakdown of the natural defence mechanism and eventually nodular fibrosis develops.

(2) An exposure period of 2 to 10 years is necessary to produce disease. Often, the disease may appear long after exposure has ceased and the patient has changed to a different occupation. Individual immunological mechanism may also play an important role. Therefore, a small minority of workers may not get the disease even after many years of heavy exposure. Occasionally the disease may appear after a short exposure and in an epidemic form.

(3) Concentration of silica dust greater than 5 p.p.m. per c.ft. of air are highly injurious.

Pathogenesis: It is the silicon dioxide (SiO_2) which is capable of producing fibrosis. Silicates are not able to produce the lesion. There are several theories of the mechanism of causation—mechanical, chemical and immunological.

Pathology: The characteristic lesions are numerous silicotic nodules 2 to 5 mm in size. In severe forms of the disease, several nodules form large massive nodules by coalescene—the massive fibrosis. Histologically the silicotic nodule is seen as whorls of concentrically laminated fibrous tissue. Cavitation occurs due to ischemic necrosis or supervening tuberculosis infection.

Incidence: In India, several surveys have been carried out by the Ministry of Labour, to determine the incidence of Silicosis. In potteries and ceramic industry, it was found that 15.7 per cent had X-ray evidence of Silicosis.[4] In coal mines in Bihar, 18.8 per cent incidence has been reported.[5] In mica mines, 34.1 per cent incidence has been reported.[6]

Clinical picture: There may not be any symptoms for many years. However, a chest radiography may show abnormality long before symptoms develop. Shortness of breath, cough with expectoration may be the first symptoms. They are progressive unless the person is removed from further exposure. If exposure continues, complications eventually develop. They are pulmonary tuberculosis, pneumonia and corpulmonale. Physical signs are not specific. There are signs of emphysema. More than 20 per cent of silicosis patients eventually develop pulmonary tuberculosis.

Diagnosis: The following broad guidelines are applicable to the whole group of disorders. References will be made in appropriate disease conditions to specfic criteria.

General diagnostic criteria: A thorough history of occupational exposure should be obtained. This has been discussed earlier.

Chest Roentgenogram: Almost always shows evidence of fibrosis and specific characteristic lesion of individual toxic agents.

Lung Biopsy: For the purpose of differentiating obscure conditions from occupational diseases.

Physical signs are not specific. Rales may be present. Clubbing, cyanosis signify complications like Cor Pulmonale. There

may be extra-pulmonary manifestations e.g. ascitis in asbestosis, extra-pyranidal signs in manganese toxicity, and multisystem involvement in berylliosis.

Pulmonary function: (1) Are of no diagnostic value to detect specific disorder. They serve to quantitate the severity of malfunction and to follow the course of the disease, using the patient as his own control.

(2) Correlation of lung function with radiological abnormalities is poor. Severe functional disturbances may be found in patients with normal radiograms. Reverse situations are not uncommon. Therefore, chest X-ray alone should not be used for disability evaluation.

(3) Obstructive syndromes generally lead to dyspnoea. Dyspnoea generally correlates well with objectively measured lung function.

(4) In certain entities e.g. asbestosis, berylliosis, there is impairment of gas exchange. The arterial 02 tension, A-a gradient and diffusing capacity are abnormal. They, however, correlate poorly with dyspnoea.

(5) Impairment of lung function is not synonymous with disability. Disability occurs when the worker's performance is less than that of a group of normal individuals of the same age, sex and stature. Quite often, function may be markedly reduced without corresponding impairment of work performance and conversely without significant impairment of function a worker may be severely disabled because of cough, generalised toxicity or recurring respiratory infections.

Radiological classification—Terminology: The ILO classification has recently been expanded and more precise terminology has been included in the UICC/Cincinati classification (Illustration of Radiograms).

Associated disease and complications: Routine tuberculin testing of all individuals at risk should be done. A reaction more than 10 mm to a .0001 mg. PPD indicates infection with tubercule bacilli. The chest X-ray may not show evidence in early stages. These persons should receive prophylactic INH therapy for one year. Conglomerate shadows on X-rays and positive sputum culture establish diagnosis. Cavities on X-rays may also be due to ischaemic necrosis without tuberculous infection.

Treatment: There is no effective therapy for Silicosis. In-

halation of aluminium dust has been advocated to retard fibrosis. Recently Schlipkoher[7] has shown that Polyvinylpridine — N-oxide (PVNO) is effective in animals to diminish fibrosis. This study has not yet been confirmed by other workers.

Therefore, the main treatment consists in prevention. Proper dust control measures, environmental hygiene, protective masks and industrial engineering can go a long way in controlling this disease. Respiratory infections, bacterial or viral, must be promtly treated. Smoking should be discouraged.

Other occupational lung disorders are:

Coal Workers Pneumoconiosis (CWP): Exposure to coal dust particles more than 5 microns can cause Coal Workers Pneumoconiosis. In the simple form of the disease, the X-ray shows a fine reticular pattern. In the complicated form the X-ray shows nodularity progressing to massive fibrosis. This is usually due to secondary infection especially with micobacteria. Capalan described the association of rheumatoid arthritis and progressive massive fibrosis. This is thought to be due to immune response. In the terminal stage, mortality is due to fibrosis, Cor Pulmonic and tuberculosis.

Asbestosis: More than 2,000 years ago, the Romans and Egyptians were known to use asbestos textiles for cremation attire.

Asbestos is used as insulating material in electrical wiring, heat insulation, brake lining, heat resistant textiles, fire-proofing etc. Asbestos fibres 20-30 microns in length, when inhaled lodge in respiratory bronchioles. The characteristic pathonomonic feature is the asbestos body which may be found in sputum. It resembles a drumstick. It appears as brown or black fibres upto 75 microns in length. The patient presents with a history of cough and dyspnoea. In advanced cases there may be clubbing and cyanosis. X-ray shows diffuse fibrosis, with pleural thickening and calcification, more at the bases. Pleural effusions may also occur. Asbestos is carcinogenic. Mesothelima and bronchogenic carcinoma occur more frequently in asbestos workers. Peritoneal mesotheliomas and ascitis also occur.

Lung function studies are characterized by impaired gas exchange and alveolar capillary block. Treatment is symptomatic.

Beryllium Disease: Several years ago the commonest exposure to beryllium occurred in fluorescent light industry. Now the use of beryliium in this industry has been discontinued. Ex-

posure can occur during its extraction from ore. Industrial uses of beryllium include making berillium copper alloys and solid fuel rockets. Particles larger than 10 microns in size are injurious. It is characterized by low incidence in exposed workers and long latent interval. It can manifest in acute or chronic form. The acute form is characterized by fever, dyspnoea, cough and weight loss. X-ray shows patchy pneumonitis. Recovery occurs in 1-4 months. In the chronic variety, the disease develops incidiously, after a latent period of weeks to several years. The symptoms are chronic cough, dyspnoea and weight loss. Chest X-ray shows fine miliary nodulation with diffuse fibrosis. The characteristic lesion is a granuloma resembling Sarcoidosis. The liver spleen, kidney, heart and skeletal muscles may be involved. At times diagnosis from Sarcoidosis is difficult.

Treatment: Steroids have been found beneficial.

Biological 'Dusts'

Byssinosis: It is a chronic lung disease occurring in textile workers engaged in carding and spinning room as a result of inhalation of cotton dust. The cotton dust is a complex mixture of cotton fibres and fungi. In the early stages of exposure the worker experiences only a slight cough and tightness in the chest which may be regarded as bronchitis. Following a weekend without exposure, these symptoms develop on the Monday on return to work. This may be accompanied by fever — "Monday morning fever". After several years, these symptoms become chronic and are present throughout the week. Dyspnoea and asthma may be progressive. The physical findings are those of chronic bronchitis and emphysema.

Incidence: In USA, 25% of carders and 12% of spinners have airway obstruction, indicating that upto 17,000 textile workers may be affected.[8] In UK it is 63%, in West Germany 62% and 27% in Egypt. In India several studies in the textile centres like Bombay, Ahmedabad, Kanpur and Madras were carried out by using the questionnaire method recommended by Schilling. From these studies it is apparent that the incidence in our country is lower than in the West. It varies from 3.8% to 8.4% in various centres. No plausible explanation is available.

Causation: It is likely that Byssinosis may be due to an

allergic response of the bronchial mucosa to one or more unidentified allergen in the cotton dust. A positive skin test to extracts of cotton dust is found only in a small proportion of workers. It is also found positive in co-workers of patients who have no symptoms and also in persons who have never worked in textile mills. Recently it has been shown that the disease correlates more closely with enzyme levels in the dust than with dust levels themselves.

Diagnosis: The diagnosis mainly rests on a history of occupational exposure and the characteristic symptoms. X ray picture may be normal in early stages and in later stages may show nonspecific changes of bronchitis and emphysema. The FEV tested before the work shift and at the end shows a significant drop. For survey work a combination of questionnaire method of Schilling[10] and Timed Vital Capacity tests are employed. Schilling has stressed the importance of pre-employment and periodic examination of textile workers. People with pre-existing lung disease must not be recruited and those with progressive impairment of lung function must be removed from further dust exposure.

Farmer's Lung: It is a disorder of agricultural workers who store hay in moist conditions whereby the hay becomes mouldy. Recently a thermophilic actinomycete has been identified as the causative agent. Campbell in England and Towey in USA[11] first reported several cases of farmer's lung. The illness may be acute or insidious in onset. In the acute form, it is characterised by chills, fever, cough and dyspnoea occurring within a few hours of exposure to mouldy farm dust. Occasionally dyspnoea may predominate the clinical picture and fever may be absent. The symptoms disappear on cessation of exposure and repeat on further exposure. Repeated exposure may lead to insidious chronic illness resulting in progressive pulmonary insufficiency. It has been estimated that a farmer working with a moderately dusty hay retains 750,000 spores per minute in his lungs.

Chest X-ray shows a fine granular pattern, linear striation and patchy areas of conglomerate densities.

Pulmonary function studies reveal, reduced diffusing capacity, uneven distribution of ventilation and perfusion, but no significant airway obstruction.

Lung biopsy shows granulomatous interstitial pneumonitis. It is thought that the disease is due to an acquired hypersensitivity to

moulds or fungi. The sera of farmers exposed to mouldy hay have shown specific antibodies.

Treatment: Treatment of acute episodes is symptomatic. Steroids are helpful. Further exposure shall be prevented otherwise crippling pulmonary disease may develop.

Silo Filler's Disease: It is also a disease of agricultural workers engaged in Silos. In poorly ventilated or closed silos, nitrogen oxide is generated which on inhalation leads to acute chemical pneumonitis. In several exposure there may be pulmonary oedema and death. It is important to remember that only a recently filled silo may be the cause of disease.

Bagassosis: It is a disease of sugarcane workers arising from exposure to fibrous residue to sugarcane, after sugar has been extracted. It leads to fever, cough and dyspnoea. Most workers recover spontaneously but a few may progress to pulmonary fibrosis and insufficiency.

Fumes and Gases: There is a variety of fumes and gases which can cause chemical pneumonitis e.g. SO_2 NO_2 Cadmium Oxide etc. Besides, gases the fumes there is a miscellaneous group of compounds which can produce sensitization e.g. Toleune Diisocyanate (TDI) and proteolytic enzymes used in detergent industry.

There is also a greater risk of lung cancer in uranium workers, nickle and chromate workers and asbestos industry.

Conclusion

A variety of well recognised occupational lung disorders is receiving attention of industrial physicians. The list is ever-increasing. A few important entities have been discussed. The significance of a thorough history as an important tool in diagnosis is emphasised. Prevention lies mainly in a proper environmental hygiene. It may be pointed out that certain synergistic factors may aggravate the course or indirectly contribute to the causation of industrial lung disease. These are: Tobacco, Alpha-1, Antrypsin deficiency, Infection, Allergy and Bronchitis.[12]

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DISCUSSION

Observations by a delegate:

I would like to add something to the industrial diseases told by Dr. Kothari. There is one hard metal pneumoconiosis observed by me in two cases in the Defence Metallurgical Institute, Hyderabad. They used tungsten carbide with copper though the size ranges within 10 mu, the weight of the tungsten carbide is heavy from gramme to gramme when you compared with that of silica. X-rays were taken and some of the X-ray reveals there is a slight cardiomegaly. Further research is in progress. Regarding the mica, mica pneumoconiosis has also been reported from Hyderabad when a joint venture survey was done with TV Director and myself in mica mines at Gudu. Eight to 9 per cent incidents were reported. These two things I want to add to his list.

Dr. C. K. Ramchander:

Every industry is normally associated with a disease. Ceramic industry is associated with silicosis; but this is not axiomatic. In South India, where good ventilation due to open shops are common, in a sanitary-wares factory 500 X-ray studies during a 20-year period suggest that conditions are different.

Dr. J. C. Kothari:

I only wanted to emphasise that there is always an occupational hazard associated with certain industries. This is not tantamount to saying that in every industry people will develop that disease. In an industry, like the one the question is referring to, where adequate ventilation is available and if adequate measures are taken to see that the dust is not generated or if it is generated, it is effectively cleared up, I am sure, the incidence of occupational disease will be very low.

Dr. C. K. Ramchander:

You have said that 15 per cent cases were found in potteries

and ceramic industries. This does not seem to be a general picture and may give a wrong impression about incidence af silicosis in the pottery industries.

Dr. J. C. Kothari:

The source of my information was a study conducted by the Ministry of Labour and published with the collaboration of the Central Labour Institute. The study was based on an all-India survey in several industries and my statistics are pertaining to that sample of industries. I am sure that not all factories will have that average incidents rate; some will have low and some may have even high rates of incidents.

Dr. P. V. Thacker:

To what extent would nutritional status of the worker will be responsible or contributory in the incidence of silicosis or byssinosis among the appropriate industrial workers?

Dr. J. C. Kothari:

At least one respiratory disease is somehow connected with nutrition, viz. pulmonary tuberculosis. We all know that people with under nourished physical status are more liable to infection with tuberculosis than people with a better state of health.

The question as to whether byssinosis or silicosis will develop in only poorly nourished people is very difficult to answer. It has been established that there is a small percentage of workers both in textile industry as well as in industries where silicosis is a hazard, who do not develop silicosis or byssinosis despite having the same working conditions. This is attributed to some form of immunity. But, how far immunity is linked with nutrition is a very moot problem to give a definite answer. For example, it is known that in some people with high status of immunity, cancer can be arrested or even cured. Nutrition may have something to do with immunity and in that case, to that extent, a worker may be immune to that disease.

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Industrial Worker & His Health

DR. SHANTI PATEL

Friends, the subject on which I am required to speak is a very wide one. But, may I say that, when we talk of industrial worker and health particularly the health part of it should be very clear. Generally, our attention is diverted towards what is happening at or on the job, what are his surroundings, what are his environments. In simple language we say, whether he is working in an atmosphere where an ordinary human being can work efficiently and whether he can satisfy the aspirations of the employer, who wants him to produce more and more for less and less wages. Well, that is the experience we are faced with. Now this is one part of it. The second part on which I would like to put all the emphasis is when he is off the job. Is it going to be the responsibility of the employer or the society at large as to how and where he is living. How much time is he spending in coming and going from his residence to the workplace. I believe these are equally important issues and need to be attended to. More so, in industrial cities like Bombay where there is a concentration of industries or where the surroundings are such, that the workers cannot be physiologically fit to put in their best at the workplace. When we think of the health of the worker on the job it is said that prevention is the primary concern, that unless you look to this aspect, nothing could be done in this particular sphere.

May I ask in humility, Sir, particularly of those who belong to the employing class and of those who are concerned with the inspectorate division of the Government of India or Government of Maharashtra or any other State as to what they have been doing. I would like to quote a very concrete instance. I am connected with the industry of port and docks. I would like to ask the Chief Inspector of Factories as to whether he has bothered to visit the Indira Dock and study the surroundings in which machinery worth crores of rupees are being repaired. I am not

alone in saying this. This is also what the National Commission on Labour has said, that our Inspectorate, whatever the reasons may be, are not prompt enough to go into this aspect and take necessary steps. So, they have been talking a lot about prevention but when it comes to implementation we are found lacking.

Then the next part is the care or treatment of a person, who has become a victim, may be of an illness, or an injury which is caused due to his occupation. There also now the care is becoming less. We have a number of schemes like the Government sponsored ESI Scheme. The ordinary sense of responsibility starts and ends with working within the legal frame work. We have various laws, the Factories Act, the Mines Act and a number of other legislations, but as I pointed out a little earlier, even what is mentioned in these legislations are not being done. Also, let us not forget that the law lays down the minimum requirements and that something more needs to be done. How many of us are aware of it? Of course, the learned Lady Doctor has rightly referred to another aspect that is of family planning and I was very happy to hear that 97% of the employees in that concern are covered by this particular welfare. So this is another aspect which needs to be taken care of and tackled in a more humane way.

We feel and also economists tell us that unless we industrialise and that too rapidly, we cannot solve the ills of the society. That may or may not be true. But one thing is certain, when we try to do this, we also invite certain ill-effects which we do not take care of. Because when we look through the ESIC or Labour Bureau reports, we find that the number of accidents and cases of illness in our country is quite large compared to other countries. This only shows that in trying to make human beings happy, and make their life worth living through rapid industrialisation, we are, may be unconsciously, making their life rather not liveable. Another aspect that I would like to refer to is how many employers or those who are expected to take care of those unfortunate victims try to see that they are made able again? What we should aim at is the rehabilitation of a person who has become a victim of unfortunate circumstances while trying to serve the society at large, a very laudable cause? But does the society take care when it becomes a matter of curing or rehabilitating him?

If we really mean business, let us get on with this aspect of prevention, cure and rehabilitation. I would like to ask you,

how many employers are prepared to take back those persons who have been disabled? But I may tell you that there are a number of instances where these people who could have been reemployed, have been thrown out mercilessly to become beggars on the streets of Bombay and other cities. What answer has the society, the country, got to this problem? These workers have been working day and night for the good of the country. Let the country also look to the human, the moral aspect of the whole problem. Should we condemn the worker to a state of perpetual anxiety about what would happen to him and his family in case he were disabled. I would request all the employers to be a little humanitarian and take care of this man instead of accumulating and then building big temples and big hospitals in the name of their houses.

Another aspect to which I would like to draw your pointed attention is that you must take interest in the maintenance and promotion of health before it deteriorates. Is it difficult for the employers to provide the worker a nourishing meal in the factory? Mind you, when we talk of the wonders in Germany they were not brought about just because the Germans are nationalists; probably that may be one of the factors. But I have seen German factory workers being fed by the employers. I have taken that very meal myself and I know how delicious and how good it is. Are we prepared to provide such meals? Oh no! then we talk of profits. But may I again humbly invite the attention of these employers that it is one of the items of permissible expenditure. You may call it welfare or whatever you want to call it, but if you invest your money in this manner, I am sure it will give you better dividends than what you could get by paying one or two rupees more. So let us also try to treat human beings as human beings and not as machines. Unless we really feel concerned not merely because certain laws made by the Government compel us, any number of seminars are not going to do any good. At least they are not going to bring the desired results. Our whole approach to the problem has to be changed. Here are the workers who produce for the world, for Human happiness, for the good of this country and it is our responsibility to look after them in that particular perspective.

DISCUSSION:

Dr. C. K. Ramchander:

What is your experience and opinion about Doctors in industry?

Dr. Shanti Patel:

I would like to ask them whether they are able to carry out whatever they would like to in the matter of industrial health service. Are they free to prescribe something which may not be in the approved list of medicines? It is my experience that there are a number of well meaning doctors, but I know their limitations.

Dr. C. K. Ramchander:

Dr. Shanti Patel, I would like to narrate my experience as a Doctor working in industry for the past 27 years. We think we are serving the workers and they think, as euphemistically put by Dr. Shanti Patel that we are so fettered that we cannot do anything. So long as this lack of understanding is there, I am afraid development is bound to be retarded.

We believe that even the worst employers leave us alone to do some work as long as we do not trespass very much on their grounds. We have ample opportunity to understand and appreciate the limitations set sometimes by finance, but most often by statutes and try to do what we can unless some of us have been exceptions because of some peculiar circumstances. I wish to take this platform to tell you we have no place in industry, if we do not work for you. And I can tell you this that employers do not want us only to ask them to get us an electrocardiagram costing Rs. 25 lakhs (for a small factory of 200 people). As you very correctly pointed out, it is the small things that really matter. As long as simple things are done regularly with conscious effort, with a human approach, I am sure that the Trade Unions will accept us.

Dr. Shanti Patel:

I was not trying to blame any Doctor. I actually referred to

the Lady Doctor who spoke here and said that 97 per cent of their workers are covered by family planning measures. I was paying a tribute. I also happen to be a Doctor of Medicine. So I do not think that the Doctors would hesitate to do whatever they can as far as health at the industrial level is concerned. My question was, are they able to do everything or get the necessary funds. Now, I will give you a simple example, the way in which ESI Scheme is being worked. Is it not a matter of shame for all of us Doctors? Let me for once accept all the allegations that are made against the worker, but is not the Doctor a party to whatever is being done—the medicines which are withheld whenever they are prescribed, the certificates which are given? Now this is something which we must try to improve and see that the man gets the medical aid that he requires. I will again illustrate: one of the Port Trusts have a very big hospital, well equipped. When we talk of staff being appointed, they are not prepared to pay the salary which should be paid to a full-time Doctor. I am saying this, except a few, the staff recruited there are not upto the standard. Merely because the employer is not willing to pay the price. Then there are other cases like where the Doctors would like to have a whole industrial health scheme. I am sure he would like a good diet to be given to start with. But then probably a Doctor will be told "this is none of your business". I have tried to do it and I have failed and that is why I am saying Doctors are kept out. But when I think of industrial health, the first thing that comes of my mind is to give the worker a proper diet at least at the factory level. And I would like to know from you as to how many of us have insisted on this and got it done. If we want to confine ourself to the activity that is prescribed under the law or what becomes an occupational disease, or where somebody is injured or somebody becomes ill, then it is a different matter. My concept of industrial health is entirely different.

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Summing Up

DR. J. B. SHRIVASTAVA

To my mind, occupational health has several facets, a facet of the employer, that of the employee and a facet which is of national importance, viz. the national productivity. Therefore, with regard to the health of the workers both in industry and agriculture, the Central and the State Governments have a responsibility to take note of occupational health hazards and consider occupational health can be further improved.

To me, and I am sure to my doctor colleagues as well, it is the preventive aspect which has much more importance than the curative aspect. When the patient starts coughing and shows the signs of fibrosis, the damage has already been done. It has already decreased his productivity—and changed his morbidity. To cure him is our responsibility because he has developed the disease in the course of industrial work. But it is due to the sheer neglect of the industry and the nation that he did develop the disease. What is the nation doing to save him from developing the disease?

In the preventive aspect it is not only the micro-atmosphere of the industry such as corrective measures taken so that asbestos fibres or silicon particles do not fly about or noise level is reduced which are important. In addition, there are a few problems at the macro-level such as nutrition, immunity, housing, and water supply which also should be tackled and considered at the same time. For instance, take the case of a heavily hook-worm infected industrial worker. His condition has nothing to do with the industry in which he is working. He got hook-worms from some where else. But for certain elements of his condition, the micro-environment of the industrial worker is also responsible. Better housing, better water supply, certain amount of nutritional inputs, education of children etc. are also sometimes necessary apart from right diagnosis and treatment.

What are the doctors doing in the whole gamut of occupational health? The same question does come again and again in similar conferences and seminars. One fact that I have repeatedly noticed, in medical profession in general, where the private practice element is not involved is that we are 'mercenaries'. I know my colleagues in the medical profession might frown on my statement. We do all that is expected of us weighing the service in terms of the money we are getting in return. Even where the remuneration is good, an attitude that the patient is an unmitigated nuisance, and the earlier we get rid of him the better it is, is taken. What is required is the spirit of devotion, involvement, and a feeling of responsibility that we are a part of the set-up that keeps the workers healthy and fit. One should also take some degree of pride in one's work, "I have diagnosed an early case of asbestosis and it has been confirmed and we are taking corrective action". What is disturbing to me is that the spirit of dedication and sense of involvement is lacking. There are some exceptions and they are doing very good work.

The field of occupational health, as I said, is very wide and along with its facets of prevention, cure or treatment, it has the more important aspect of promotion of health. Lack of health education among workers with regard to certain techniques and practices which is responsible, for instance, for the toxicity results that are occurring in the area of insecticides. Some of the insecticides with very low level to toxicity like Malathion once produced very highly toxic results in the State of Maharashtra, an incident which is unknown elsewhere. People were sleeping in the same clothings they were wearing while spraying the insecticides. They were smoking and drinking water without even washing. Elementary principles of prevention were not taken. The medical men might have done their duty in as much as they had supplied instruction pamphlets and explained them too. But our workers being what they are, we have to tell them repeatedly the do's and dont's and the risks involved. Such pains will be taken only by a person who is dedicated to his work. If you are not devoted to the worker and your attitude is to get him compensation if he dies, then, I believe, that the business of improving occupational health will have very limited impact.

Institute like Central Labour Institute are doing very good work. The National Institute of Occupational Health, Ahmedabad,

Institutes of Technology, Institute of Toxicology at Lucknow—all these are getting involved in occupational health, both in agriculture and industrial fields. But unless people at all levels have the urge to do something positive rather than treating it as a nuisance one has to put up with, I am afraid, any amount of research and exercise is not going to take us very far.

I hope, Seminars of this nature, at least will bring about an attitude in doctors and others who are involved in occupational health that the subject has got not only a curative aspect but also preventive and promotive aspects and that they have responsibilities in these areas.

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सत्यमेव जयते

training programmes

CENTRAL LABOUR INSTITUTE
BOMBAY

"The danger is that we may have to slacken our pace for lack of trained personnel. We have manpower enough and, sometimes, manpower can take the place even of capital. But without trained manpower we cannot go far. We have, therefore, in our planning to think ahead and train an adequate number of persons for all branches of national activity."

—JAWAHARLAL NEHRU

CONTENTS

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CENTRAL LABOUR INSTITUTE

The Central Labour Institute was established during the First Five Year Plan to function as a socio-economic laboratory dealing with the scientific study of different aspects of industrial development as related to the human factor. This national institute and its three extensions, the Regional Labour Institutes at Kanpur, Calcutta and Madras are intended to promote safety, health, improved working conditions and productivity in industry through various research, training and educational activities.

This booklet presents the training facilities provided by the Central Labour Institute.

The Institute has three wings, viz., Training, Research and Safety under which nine disciplines are grouped, apart from the Ergonomics Laboratory:

TRAINING WING

i. Staff Training
ii. Industrial Psychology
iii. Productivity

RESEARCH WING

iv. Industrial Hygiene
v. Industrial Medicine
vi. Industrial Physiology

SAFETY WING

vii. Industrial Safety, Health and Welfare
viii. Audio-visual and Training
ix. Laboratory-cum-Information.

ERGONOMICS LABORATORY

i. Industrial Ergonomics
ii. Environmental Engineering.

TRAINING PROGRAMMES OFFERED

One of the main activities of the Institute is to offer training programmes in various specialised areas for all levels. The faculty consists of highly qualified experts from different disciplines such as engineering, medicine, physiology and psychology. With the emphasis of the Institute on a multi-disciplinary approach in all its efforts, whether they be in research, training or education, the training programmes offered by the Institute provides the participants not only knowledge of the best available principles, methods and techniques that are suitable for solving the different problems faced by industry, but also insight into the advantage of and the method of approach in applying an integrated multi-disciplinary approach.

Besides inter-company programmes, the Institute also offers in-company programmes tailored to the specific needs and problems of individual organisations. Training programmes are arranged in English, Hindi or other languages.

The Institute has a mobile safety exhibition fully equipped to carry the message of safety to the door-steps of Industry.

TRAINING WING

The Training Wing of the Institute comprises of Staff Training Centre, Industrial Psychology Division and Productivity Centre. With the coordination of the three Centres, training assistance is provided to the organisations on the following lines:

1. Identifying the training requirements of the organisation and needs of a particular level in the organisation hierarchy.

2. Organising general or specific skill development in-company training programmes.

3. Establishing training cells and helping organisations to promote training activities and evaluating their effectiveness in terms of results.

The Wing also assists trade associations, professional bodies and local councils by organising inter-company courses on the following lines:

1. Developing a need and demand based course to meet the requirements of the industries in a particular region.

2. Conducting inter-company courses for specific levels such as Training Officers, Middle Management, Supervisors and Union Representatives.

3. Conducting specialised skill and concept development courses on disciplines of Industrial Engineering, Behavioural Sciences, Management Skills, etc.

Besides, multi-disciplinary research studies of national importance on 'Man-at-Work' and on specific request in-company research investigations on factors affecting human performance are undertaken.

STAFF TRAINING

The Staff Training Centre (formerly known as T.W.I. Centre) has specialised in Supervisory Training by conducting Supervisory Trainers' Training and Supervisory Development Programmes. To strengthen supervisory development efforts in the plants, the Centre has embarked on Management Trainers' Training and Management Skill Development Programmes. It also conducts in-company Supervisory and Management Development programmes based on study of organisation's training requirements.

OBJECTIVES

The objectives of the Centre are:

i. to create an awareness of the need for supervisory and management training.

ii. to render service and advice to business and industrial organisations to set up training departments for in-company training.

iii. to train and provide assistance to trainers to enable them to discharge their training responsibilities effectively.

The Centre organises training programmes for various levels from industrial, business and service organisations.

In-company programmes for Supervisory and Management Cadre are organised on the following lines—

helping organisations to analyse their own present and future training needs for various levels.

developing and conducting need based training programmes in consultation with company management.

MANAGERIAL EXCELLENCE

PROGRAMME PERSPECTIVE

Managerial Excellence is the key factor for organisation survival and growth. This demands Managers' awareness to the complexities of organisational system and dynamics of human behaviour. This, in turn, throws a challenge in developing competence in dealing with people and problem situations and manage

the organisational stress. This challenge of developing interpersonal competency has become a necessity in the context of planned change for organisational effectiveness and growth.

This programme, therefore, endeavours to develop managerial competency through experience based learning so as to enable the participants to reflect on their concepts, assumptions and approaches and reorganise them so as to function effectively in managing personnel system to achieve the desired organisational goals.

OBJECTIVE

developing insight into managerial role and expectations.

developing competence in interpersonal relations and problem solving.

increasing skills to cope up with organisational change and stress.

HIGHLIGHTS

Organisation Environment
Management Decisions
Inter-personal Relation
Executive Behaviour
Communication
Group Dynamics

TECHNIQUE

Experiential learning through Structured Exercises, Simulated Games and Diagnostic Clinics.

DURATION

Six days full-time.

HUMAN PROBLEMS AT WORK

PROGRAMME PERSPECTIVE

Human Relations are complicated by the conflicting attitudes. Attitudes are always loaded with feelings and the logic of feeling is different from logic of thinking. A basic requirement for human relations training, therefore, is an attitude change on the part of the persons.

Case studies based on sound filmstrips provide an excellent means for introducing and later discussing the subject of understanding human problems at work and dealing with people. The problem posed by the filmstrip is taken as a talking point which enables the participants to evolve sound principles of human relation and management.

OBJECTIVE

To acquaint the participants with vital area of Human Relations and its manifestations in work situation.

HIGHLIGHTS

The broad topics covered are:

Human resource in organisation
Inter-personal relations and teamwork
Organisational effectiveness and growth
Techniques of resolving conflicts
Decision and People

TECHNIQUE

A series of Flmstrip Case Studies are used in the programme.

DURATION

Three full days or six half days.

LEADERSHIP & HUMAN RELATIONS

PROGRAMME PERSPECTIVE

The Managerial effectiveness profoundly depends upon the style of his ability to create productive and successful group through good interpersonal relationships and effective communication. The manager's task as a leader in inducing changes in the behaviour patterns of his subordinates and the organisational environment necessitates evaluation of his own approach, leadership style and action.

OBJECTIVE

— to create awareness about one's own leadership style and qualities
— to orient attitude and approach for good interpersonal relations

— to develop analytical ability and critical thinking on human problems
— to increase the skill in communication for acceptable leadership and building team work.

HIGHLIGHTS

— Executive Leadership
— Group Influence
— Communication
— Transactional Analysis
— Human Relations
— Managerial Functions

TECHNIQUE

Learner oriented techniques based on experiential learning approach such as Filmstrips, Structured Exercises, Transactional Analysis, Simulated Games and Role Plays.

DURATION

Three days full time.

INTRA-ORGANISATION COMMUNICATION

PROGRAMME PERSPECTIVE

The ways and means of blending inter-personal communication with the organisational communication system affects the effectiveness of an organisation. This throws a great challenge to the executives in understanding the communication process and developing necessary skills. To this end in view, the executive should have insights into intricacies of the communication process and skills in directing, controlling and at the same time encouraging and supporting individual group initiative and creativity.

The programme endeavours to develop executive ability through experience based learning for:

developing insight into communication process

developing understanding of intra-organisation and interpersonal communication

increasing skills in improving and developing communication system

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HIGHLIGHTS

Concept and Process

Intra-personal

Inter-personal

Organisational

TECHNIQUES

Experiential learning through structured exercises, demonstration and role plays.

DURATION

Four days residential programme from 10.00 a.m. to 5.00 p.m. and 6.30 p.m. to 8.00 p.m.

CONFERENCE LEADING

PROGRAMME PERSPECTIVE

Conference has become an important means for consultative and participative approach in organisation problem solving and creativity. To achieve the purpose within the time, the conference leader has to be skilled in preparing for and leading meetings. Besides, the conference is useful as a training technique.

OBJECTIVE

To help executives to recognise the principles of effective conference leading.

To improve the skill needed for leading a meeting in which group participation is desired.

To develop desirable attitudes for listening and logical thinking.

HIGHLIGHTS

Types of Conference Meetings

Planned Conference

Aids and Techniques in conducting Conference

Controlling Discussions

TECHNIQUES

Lecture-cum-discussion method to impart principles of conference leading and followed by participants' practice in conducting discussion meetings followed by analysis and feed back for skill development.

DURATION

Six half days.

HUMAN RELATIONS & COMMUNICATION

PROGRAMME PERSPECTIVE

To integrate individual goals with the organisation objectives, an executive needs to study people and make planned efforts to understand intricacies of communication and relational problems. An executive has to constantly reflect and reorganise his concepts, assumptions and approaches so as to increase his ability to function effectively.

OBJECTIVE

To help develop understanding about communication and behaviour of people and acquire skill in improving inter-personal relations and communication system.

HIGHLIGHTS

To acquaint the participants with vital areas of communication and Human Relations and its manifestations in work situation through:

— Developing insight into the problems of inter-personal relations and communication

— Developing understanding of individual and group behaviour

— Increasing skill in building team effort and improving communication system

TECHNIQUE

Lectures on Socio-Managerial concepts and principles augmented by experiential learning through structured exercises and simulated games.

Case studies based on sound filmstrips are used for introducing and later discussing the subject of dealing with people.

DURATION

Three to four days full-time.

NOTE.—In company courses for functional executives.

SHOP FLOOR MANAGEMENT FOR RESULTS

PROGRAMME PERSPECTIVE

Effective Supervisory Leadership is the foundation on which the edifice of an organisation is built. The supervisor can

command leadership by working with and through people for achieving organisational goals. He, therefore, has to be a diagnostician and decision-maker on human and production problems for maximising performance and satisfaction.

OBJECTIVE

The course aims at systematic development of shop-floor supervisory leadership by developing analytical insight and approach in dealing with problem situations and building critical and creative attitudes for problem solving.

HIGHLIGHTS

Supervisory role in an organisation
Understanding and influencing behaviour of people
Maintaining harmonious group relationships
Improving group effort through planned communication
Creative approach in production problem solving
Preventive approach in tackling the problematic situations
Techniques in controlling and improving situations

TECHNIQUES

The course is conducted through lecture-cum-discussion method followed by discussions on case situations supplemented with films and filmstrips to demonstrate the application of principles.

DURATION

Twelve days full-time.

IN-COMPANY SUPERVISORY DEVELOPMENT

PROGRAMME PERSPECTIVE

The supervisor should have thorough knowledge of the company and possess ability to use productivity techniques for growth and social skills in getting loyalty and cooperation from people.

The programme comprises of company and technical information to be imparted by company officials and social skills such as Communication and Human Relations, Productivity and Control Techniques to be covered by the Centre.

OBJECTIVES

To impart information about the company, its procedures and supervisory role.

To develop ability to use productivity techniques with a view to make best use of the available resources.

To develop social skills so as to enable them to get the best out of people.

HIGHLIGHTS

The following topics would be broadly covered during the course:—

Knowledge of company organisation and his place in it.
Application of company objectives, policies and procedures.
Supervisor as a manager in his own sphere of work.
Elementary principles of Management and Organisation.
Planning and directing the work of his section.
Making the best use of the resources.
Leading men into a working team.
Effective communications.
Good housekeeping and safety of men and equipment.

TECHNIQUES

The programme is conducted by lecture-cum-discussion method followed by Case Study discussions and role playing situations. Films and filmstrips are used to ensure better understanding.

Project work in participant's organisation forms an integral part of training.

PARTICIPANTS

Assistant Departmental Heads, Foremen and Supervisors.

DURATION

The programme is conducted for two to three weeks full-time duration or four to six weeks part-time duration.

NOTES: 1. The programme may also be suitably adjusted in contents, methodology etc. studying the company's training requirements.
2. The course excluding company information can be conducted for a period of eight to ten days full time.

3. A course on basic principles of supervision covering communication skills such as Method Improvement, Communication and Human Relations is conducted for six days full time.

COMPREHENSIVE SUPERVISORY TRAINERS' DEVELOPMENT

PROGRAMME PERSPECTIVE

It is said that the success of a company depends upon the effectiveness of its supervision. Supervisors will be effective only if they are carefully selected and trained in skill development.

Analysis of supervisor's job has shown that a supervisor needs the following:—

1. Knowledge of work—knowledge of machines, materials, processes and operations.
2. Knowledge of responsibility—knowledge of rules, regulations, agreements, inter-departmental relationships, etc. and 'His Role' in Managerial functions.
3. Skill in improving methods—the ability to make the best possible use of men, machines and materials by avoiding accidents and consequent injury and damages.
4. Skill in instructing—the ability to give proper instructions or clear directions as and when necessary.
5. Skill in leading—the ability to lead and promote harmonious working relationship.

The first two requirements of the supervisors, viz., knowledge of work and knowledge of responsibilities vary widely and have to be learnt in the organisation. The knowledge and his role in managerial functions and other skills can be learnt through formal training.

OBJECTIVE

It aims at preparing Supervisory Trainers so that they, in turn, can help organise and conduct Supervisory Skill Development Programmes for the supervisory cadre in their organisation.

The objective of inplant supervisory programmes being to give awareness of need for development of skills and evolve through discussion basic principles and approaches in development of skills.

HIGHLIGHTS

This programme endeavours to develop understanding and skills of presentation of the following programmes to Supervisory personnel.

PHASE I

i. *Job Supervision :*

Basic functions of Management as applied to supervisory job.

ii. *Job Communication :*

Barriers in communication and way to develop Systematic on-the-job training and communications.

PHASE II

iii. *Advanced Job Method :*

Principles of improving Methods and Procedures of the jobs and the critical attitude for its diagnosis.

iv. *Job Safety :*

Making jobs safer by spotting the dangers in work area, work method and worker and taking corrective action.

PHASE III

v. *Job Relations :*

Building human relations through prevention and handling of human problems effectively.

vi. *Office Supervision :*

It incorporates Office Supervisor's Role, Staff Relations, Communication on-the-job and Work Simplification with cases on office situations.

EMPHASIS

These basic skill programmes for supervisors are presented by Training Officer from within the organisation through Group Discussion Method requiring supervisors to participate fully in the discussions, demonstrations and practice on their own job situations.

The programmes essentially help replace traditional habits and set attitudes through methodical and objective techniques. It helps broaden the mental outlook towards the job of supervision.

METHOD

During the institute (course for training of training officers) the contents of the programme in the form of discussion outline manuals are explained to the Training Officers. The necessary background information is supplied to widen the understanding of the principles and their relationship to the problems of supervision. They are given practice in presentation of these programmes to supervisors.

DURATION

Two weeks for each phase covering two institutes.

An interval of four to six weeks between two consecutive phases for conducting practice groups for supervisors from the organisation.

NOTE: A separate Institute of 2 weeks' duration each is also conducted for specific skill development such as:—

Advanced Job Methods for Industrial Engineers;
Job Supervision for Safety Officers;
Office Supervision for Organisation and Methods Officers.

TRAINING METHODS & TECHNIQUES

PROGRAMME PERSPECTIVE

Achieving results of training in the dynamic human network within the organisation throws a great challenge to the training officers. The complexities of the organisational frame-work and the constraints on it are increasing and it has become necessary that the training personnel develop their expertise and acquaint with the recent trends and techniques of training.

OBJECTIVE

To develop insight into trainers' role, methodology and application of training techniques and to help develop skills in designing and organising training.

HIGHLIGHTS

Trends and organisation of training
Identification and Evaluation
Principles of Teaching/Theory of learning
Traits of a good trainer
Motivation of participants

Lecture and Discussion Method
Intray Games and Structured Exercises
Case Method and Role Play
Instructing on the Job
Simulation Exercises
Developing of instructional materials
Evaluation of training programmes and trainees
Transactional Analysis
Interaction Laboratory
Audio-Visual Aids

TECHNIQUES

Lecture-cum-discussions followed by simulated games and skill sessions.

PARTICIPANTS

Training Officers/Managers & Personnel Officers.

DURATION

Six days full-time.

PERSONAL GROWTH & GROUP DYNAMICS

PROGRAMME PERSPECTIVE

There is a need for continuous improvement of organisational performance in a developing economy. Workers and trade unionists' commitment to organisational goals and their involvement in day-to-day activities is a critical requirement for better performance of the enterprise. The course will devote itself to the exploration of this new dimension of Union Leadership conducive for growth and welfare.

OBJECTIVE

To enlighten on integration of organisational requirements and individual needs effectively.

HIGHLIGHTS

Developing insight into the process of communication, human relation & group dynamics.
Developing insight for personal growth for bettering relations and team work.

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Developing diagnostic and conflict resolving skills.

Generating understanding of productivity techniques and techno-managerial innovations.

Enlightening on grievances arising out of the application of such techniques.

Analysing factors affecting workers safety, health and welfare.

Developing leadership skills for a meaningful use of participative & consultative forum.

TECHNIQUES

Lecture-cum-discussions followed by group discussions on case situations and experiential learning exercises and games.

DURATION

Five days full time.

INDUSTRIAL PSYCHOLOGY

The Centre aims at discovering the best possible human conditions in occupational work whether they relate to the best choice of vocation, the selection of the most suitable workers, or the best methods of work and training.

The main activities of the Centre are:—

i. to conduct practical research programmes in Industrial and Organisational Psychology

ii. to advise on the psychological adaptation of the job to the worker and of the worker to his Job

iii. to undertake investigations into a number of factors affecting health and efficiency of employees

iv. to undertake surveys/studies in areas of Personnel Managements and specific assignments on behaviour problems.

The Centre conducts Management Training Programmes in Behavioural Science Techniques and Human Resource Management.

HUMAN INTERACTION LABORATORY

PROGRAMME PERSPECTIVE

The Laboratory method of education creates work and learning environment involving others, where a process of self-discovery and growth can occur. It offers an opportunity for the

executive to increase insight into his own feelings and motivations, his reaction to others and theirs to him. He is also free to experiment with his behaviour. Hence a laboratory generally reveals new capability to work effectively with individuals and groups back in his own work setting.

OBJECTIVE

To increase man-management skills through experiential learning in human relations areas.

PROPOSED COVERAGE

1 — Understanding self and others

2 — Communication process and open collaborative feedback

3 — Emotional problems in groups and organisations

4 — Human needs and motivation

5 — Human conflicts and leadership dilemma.

TECHNIQUES

Laboratory methods, group training (T-Group), Sensitivity, structured exercises, games and sensory awareness.

PARTICIPANTS

Senior executives, covenated officers and departmental heads from any functional areas concerned with "people and decision making".

DURATION

6 days (Residential).

EMPLOYEE COUNSELLING

PROGRAMME PERSPECTIVE

Employee Counselling service is intended to assist an employee in making adjustment with his environment. Counselling is simply advising or evolving do's and don'ts. It is a process of "getting him wise" into his own motives, mirror his problems and conflicts so that he gets an insight into them and is able to generate self-directing motivational voltage.

OBJECTIVE

This course aims to develop insight into behaviour and skill in listening and reflecting and analytical outlook of those who are dealing with problem-afflicted employees.

HIGHLIGHTS

Theory and Principle of Counselling.
Approaches to Personality Diagnosis.
Psycho-diagnostic tests as an Aid to Counselling.
Workshop Interview Technique.
Workshop Listening Ability.
Understanding People.
Psycho-analytical mechanism in every-day life.

TECHNIQUES

Discussions based on life situations of human problems.

PARTICIPANTS

Personnel Officers, Safety Officers, Departmental Heads, Welfare Officers and Senior Supervisors.

DURATION

Three days full-time or six half days.

TRANSACTIONAL ANALYSIS WORKSHOP

PROGRAMME PERSPECTIVE

Transactional Analysis is an intelligent, rational approach to understanding the communications and human behaviour. The concepts of Transactional Analysis are widely used in Modern Management context to improve the quality of organisational behaviour and its effectiveness besides being useful for self exploration and personal growth.

OBJECTIVES

1. To stimulate an awareness of how personality affects communication and relationship patterns.
2. To stimulate an awareness of how the decisions a person makes about himself early in childhood relate to and influence his behaviour and attitudes as an adult—particularly as a manager.
3. To stimulate self direction and control and hence reduce blocks in organisation problem solving or decision making.

TECHNIQUES

The methods used are highly participative and include Concept Sessions, Group Exercises, Role Plays, etc.

PARTICIPANTS

The Workshop is designed for *YOU*, if you are in a managerial, technical, and administrative position from any functional areas of the organisation.

DURATION

Four Full days.

SELECTION & APPRAISAL TECHNIQUES

PROGRAMME PERSPECTIVE

With the rapid growth of industrialisation, there has been striking evidence of industries' current preoccupation with selection and appraisal problems. Companies which are trying to adopt new methods of selection are aware that use of psychological tests and systematic appraisal is an essential aid to develop man on the job.

OBJECTIVE

To train the concerned personnel in industry in introducing modern selection and appraisal techniques.

HIGHLIGHTS

Tests as an aid to selection
Introduction to test construction
Job Analysis
Validity and reliability of test
Analysis of test results
Employment interview
Employee evaluation
Dynamics of personality traits and their relation to job specification

PARTICIPANTS

Personnel Manager, Departmental Heads and other Senior Executives who are concerned with selection and appraisal.

DURATION

Ten working days.

PROJECT—ORIENTED TRAINING

The Industrial Psychology Division renders its services at the request of industries for achieving development by undertaking project studies on:

Management Styles
Identification of Training Needs
Attitude and Morale Surveys
Personnel Selection
Accidents and Absenteeism, etc.

Usually two or three officers are nominated from the industry to assist in the project work. Two or three days' course is organised and on-the-job training is imparted to them on methods and techniques employed in such projects and studies, such as:

Interview
Questionnaire Design
Statistical Analysis
Coding and Classification of Behavioural Data, etc.

Besides bringing out reports on such projects, the findings are fed back to Senior Executives by organising "feed back" sessions.

PRODUCTIVITY CENTRE

The Productivity Centre, the pioneer of productivity movement in India, provides Consultancy Service, conducts Training Programmes and carries out Research in Productivity Sciences at the request of the Industry, Business and Government.

OBJECTIVE:

The objectives of the Centre are:

i. to create an attitude receptive to the idea of productivity among the general public, employers and workers,
ii. to develop and promote productivity services in important areas and core sectors of economy,
iii. to further the application of Productivity Sciences for raising productivity of available resources, workers' earnings and to improve conditions of work,
iv. to promote labour-management cooperation and establish effective labour-management consultation system.

PROJECTS:

The Centre carries out project studies in management problems in administration, public utilities, hospitals, social institutions, manufacturing and agro-industries. To ensure effective implementation of the recommendations, the Centre insists on the participation of employees in those studies. The field of study and investigations cover Job Evaluation, Wage & Salary Administration, Production Norms, Man Power Planning, Office & Factory Layouts, Organisation & Methods etc.

The Centre conducts training programmes in techniques of Productivity Sciences for groups of organisations to suit the different levels of personnel.

MODERN AIDS TO MANAGEMENT

PROGRAMME PERSPECTIVE

Management in the final analysis is responsible for the effective utilisation of all resources for achieving success in terms of profit, growth and human satisfaction. Naturally, this requires an understanding of the techniques and aids in Management of Enterprise.

OBJECTIVES

The course will enable management executives to obtain:

i. an overview of an enterprise in operation
ii. the means of controlling performance and improving productivity
iii. skills of working with the people to become more effective in work and in relationship with others
iv. analytical thinking in decision making and appreciation for inter-functional relationship.

HIGHLIGHTS

Dimensions of Business Efficiency
Capital Project Evaluation
Materials Management, Value Analysis
Manpower Assessment
Man at Work
Communication in Industry

Accident Prevention and Protectivity
Work Design for job enrichment
Job Evaluation
Linking Wages with Productivity
Use of Computer in Industry
Project Management
Professionals and Trade Unions

TECHNIQUES

Lecture and group discussion on case studies, role-playing situations and management games, followed by syndicate discussions amongst the participants and senior management executives.

DURATION

Two weeks (full-time).

ADMINISTRATIVE MANAGEMENT

PROGRAMME PERSPECTIVE

The growing complexity of problems faced by organisations has led to voluminous growth of administrative work at all levels. Besides, the continuous rise in the cost of office accommodation, staff, furniture, stationery and equipment has made it essential to make efforts to achieve a higher level of efficiency in administration.

OBJECTIVE

To familiarise the participants with modern administrative management techniques to achieve higher level of efficiency.

HIGHLIGHTS

Systems approach to Administrative Management
Diagnosing uneconomical areas
Business communication
Office Systems and Mechanisation
Human Engineering in Office
Standard Procedure
Storage and Retrieval of Information
Management of change
Motivation and Job Design

PARTICIPANTS

The Course is intended for those who have to deal with administrative, personnel, sales, purchase, production and accounting aspects of business operations, Industrial Engineers, O & M Officers and Systems Engineers.

DURATION

Two weeks (full-time).

MATERIALS MANAGEMENT

PERSPECTIVE

In India about 90% of working capital is tied up in inventories and material cost constitutes about 60% of manufacturing cost. It is obvious that considerable scope exists for reducing manufacturing cost and releasing scarce capital for more profitable use. It is in this contaxt that materials management assumes great importance.

COURSE OUTLINE

Inventory models
Codification and standardisation
Value analysis
Purchasing system
Source development
Monitoring supplier performance
Quality control
Transportation
Warehouse
Use of computers in stock control
Inventory games
Inventory budget and review

PARTICIPANTS

Executives from purchase, stores, production planning, designs, inspection and industrial engineering departments.

DURATION

One week.

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MAINTENANCE MANAGEMENT

PROGRAMME PERSPECTIVE

One of the management responsibilities is to keep the production machinery, equipment and other facilities in efficient working condition to achieve their optimum utilization. Equipment failures and manufacturing shut downs are costly. In the present context of hard-to-get capital and foreign exchange, maintenance assumes still greater importance.

This course is designed to present the fundamentals for maintaining machinery and equipment, to emphasize the importance of preventive maintenance and to enable the participants to apply the techniques.

COURSE OUTLINE

— Methodology and Types of Maintenance
— Setting standards for Maintenance Work
— Application of PERT & Scheduling activities in Maintenance
— Control of Maintenance Stores & Spare Parts
— Preventive Maintenance Game
— Equipment Replacement Analysis
— Lubricants and Lubricating Systems
— How to practise Preventive Maintenance

PARTICIPANTS

Managers, Engineers and Maintenance Personnel from industrial establishments.

DURATION

One week.

WAGE AND SALARY ADMINISTRATION

PERSPECTIVE

Majority of industrial disputes relate to dissatisfaction over wages. Today, in most of the companies the problem is dealt through a process of bargaining and arbitration. Bargaining depends upon the relative power of the contestants. Arbitration rests on the wisdom and personal knowledge of the individual chosen to arbitrate. The programme helps initiate negotiation process on logic and approach.

OBJECTIVE

This course is designed to acquaint the participants with the techniques available to place the administration of wages on scientific basis rather than mere trial of strength.

COURSE OUTLINE

Evaluation of Wage Theories
Systems of Job Evaluation
Job Analysis
Evaluation of Technical and Administrative Jobs
Workload Surveys and Man-power Planning
Incentives
Executive Compensation
Merit Rating

PARTICIPANTS

Works Managers, Industrial Managers, Personnel Officers, Industrial Engineers and Trade Union Officials.

DURATION

One week.

JOB EVALUATION

PERSPECTIVE

This is designed to develop joint union-management teams in the theory and methodology of the various systems of Job Evaluation so that the committees can evaluate the jobs in their company.

COURSE OUTLINE

Wage theories
Job Evaluation objectives
Systems of Ranking, Classification, Point rating and Factor comparison
Selection and definition of factors and their degrees
Evaluation of Jobs
Common errors in rating
Checks for reliability and validity of evaluation
Wage survey and curves
Problems of implementation

PARTICIPANTS

Representatives of management and union who will form the Job Evaluation Committee.

DURATION

One week.

RESEARCH WING

The industrial worker is exposed to environmental factors such as intense noise, vibrations, extremes of temperature, ionising and non-ionising radiations, toxic and harmful chemicals and air-borne contaminants in addition to physical work load beyond his normal capacity. These in the absence of suitable control measures, impair the health of the industrial worker.

Industrial Hygiene, Industrial Medicine and Industrial Physiology Divisions of the Research Wing undertake research projects on the following lines:

1. Multi-disciplinary research projects to study the effects of environmental factors.

2. Investigations to study specific environmental hazards peculiar to industry and advise on suitable control measures.

The three disciplines offer training either in their specialised fields or integrated training for specific levels with the following emphasis:

1. Problem-oriented training to highlight hazards in typical industries and suggest control measures.

2. Project Oriented training in techniques of environmental hazard identification, evaluation, control and follow-up.

INDUSTRIAL HYGIENE

Numerous chemicals and other substances which are released into the working environment of factories are known to be toxic and affect the human organs. Apart from the health effects, there is also reduction in the work capacity of the exposed workers. These effects are dependent on the concentration of the particular substance in the working environment as well as the period the workers are exposed to such environments. Whereas it will be ideal to aim at complete elimination of these airborne substances, from economic and technical considerations, it is enough if the concentrations are reduced to the accepted safe levels.

The services offered to industry are:

1. Undertaking environmental surveys for studying and evaluating toxic chemical concentration and suggesting remedial measures.
2. Research into effects of various contaminants on the workers.
3. Conducting Training Courses on chemical hazards in different chemical industries.

The Laboratory is well-equipped with modern sampling equipments and manned by experts. A Respirator Testing Laboratory is offering testing services to manufacturers and users of such components.

HAZARDS IN CHEMICAL INDUSTRY

PROGRAMME PERSPECTIVE

Chemical industry is rapidly expanding in all parts of the country. New substances, hazards of which were not earlier realised, are manufactured and handled. The problem become more complex because some of the hazards are invisible and incomprehensible. If control and protection from these hazards is to be achieved, it is essential for all concerned to be fully aware of various aspects of the problem.

OBJECTIVE

To provide an insight into various problems of health and safety in the manufacture, handling and use of hazardous/toxic chemicals so as to evolve prevention and control measures.

HIGHLIGHTS

i. General Topics:

Toxicology, Air Monitoring,
Biochemical Studies.
Fires and Explosions.
Storage and Handling.
Air and Water Pollution.
Corrosion Problems.
Process Instrumentation.
Preventive and Control Measures.

ii. Specific Problems:

Chemical hazards with reference to particular groups of industries viz., pesticides, dyestuffs, heavy chemicals, fertilizers, paper, plastics, explosives, petrochemicals, viscose rayon, pharmaceuticals, paints and varnishes, etc.

TECHNIQUES

Lectures based on survey, research and field experience followed by discussions on case studies, and further augmented by problem oriented discussions, observation visits to industries, and training films.

DURATION

Two weeks full time.

CHEMICAL HAZARDS & CONTROL MEASURES IN TYPICAL INDUSTRIES

Industrial Hygiene Division organises specialised industry based courses on chemical hazards and their preventive and control measures.

These courses cover general topics such as:

Investigation techniques.
Environmental and biochemical appraisal.
Health and hygiene problems.
Hazards in storage and handling of chemicals.
Disposal of industrial effluents.
Preventive and control measures.
Provisions of concerned acts and rules.

The courses further lay emphasis on specialised aspects of each industry such as:

PETROCHEMICALS

Hazards from solvents, raw materials, intermediaries and end products.
Skin diseases.
Prevention of fires and explosions.
Maintenance problems.

PESTICIDES

Poisoning by organo phosphorous and chlorinated hydrocarbon compounds.

Hazards during spraying and application.

Medical aid and supervision.

DYESTUFFS

Hazards from Nitro and Amino Compounds, detection of exposure, monitoring of environment, control of carcinogenic chemicals.

TECHNIQUES

Lecture-cum-discussions followed by observation visits to laboratories and industrial plants.

DURATION

One week full time.

INDUSTRIAL HYGIENE PRINCIPLES

PROGRAMME PERSPECTIVE

Periodical industrial hygiene surveys help in maintaining the working environment safe for the workers. This in turn requires appropriate air sampling equipments and personnel trained in Industrial Hygiene Techniques.

OBJECTIVE

To impart training in Industrial Hygiene Survey and analytical techniques to representatives deputed by industry and state factory inspectorates, who can be engaged in environmental evaluations and biochemical appraisal of employee exposure.

HIGHLIGHTS

Techniques of air sampling and estimation of industrial pollutants.

Analysis of blood and urine samples of exposed workers.

Handling of instruments.

Project work by Participants.

TECHNIQUES

Theoretical instructions followed by discussions and Laboratory/field exercises.

DURATION

Four weeks full time.

INDUSTRIAL HYGIENE WORKSHOP

In many of the industrial plants, in order to control the level of pollutants in the working environments within safe limits, it is advisable to have some sort of inbuilt industrial hygiene monitoring facilities. This can be achieved if suitable personnel from the industries are made familiar with the various sampling and analytical techniques essential for industrial hygiene studies in their respective plants. The Workshop on Industrial Hygiene Techniques has been designed to meet this requirement. It consists of a course of lectures supplemented by detailed laboratory exercises under simulated conditions and a project work in the respective plants of the participants.

OBJECTIVE

To enable selected representatives from industries to achieve proficiency to carry out industrial hygiene studies relevant to their respective plants.

HIGHLIGHTS

Techniques of air sampling and estimation of air contaminants with a problem solving attitude.

Laboratory exercises.

Information on control techniques.

Project work in participant's own plant.

TECHNIQUES

Theoretical instructions and discussions.

Laboratory exercises.

Project Planning and Execution.

DURATION

One week full-time.

INDUSTRIAL MEDICINE

Numerous occupations involve exposure to adverse physical, chemical and biologic agents and there is an enormous growth in the number of environmental factors causing health hazards.

The portal of entry of the toxic substances into the body may be through inhalation, ingestion and skin absorption.

Most of the toxic agents have local effect on the skin or the mucous membrane of the eyes, nose and mouth.

The inhaled or ingested materials produce general effects like acute or chronic poisoning depending on the quantity of these toxic agents entering in body, and the length of exposure.

The toxic agents are metals and their compounds ; chemicals, both inorganic and organic ; noxious gases, harmful dusts of vegetable or inorganic origin and solvents.

The physical agents causing adverse effects are temperature—heat and cold, light, noise and vibration, electricity, radioactive substances and x-rays. Infections, trauma, skin lesions and eye injuries are some of the other health effects resulting from the various occupations of man.

The Division, therefore, carries out occupational health surveys and applied research in different types of industries to assess the extent of incidence of such occupational diseases and other symptoms.

The functions of the Division are:

1. To advise the Management regarding:
   (a) the hygiene of the workplace.
   (b) the general health of workers.
   (c) the occurrence and risk of health hazards.
2. (a) to undertake research for assessing the occupational health status of the workers ;
   (b) to impart training in occupational health for the benefit of Medical Officers.

REFRESHER COURSE ON OCCUPATIONAL HEALTH

OBJECTIVE

To educate on the different facets of occupational health problems arising out of exposure of the workers to industrial hazards and help in identifying the occupational diseases and taking preventive measures.

HIGHLIGHTS

Etiology of different occupational diseases.
Impact of the physical environmental factors.
Modern concepts in clinical biochemistry.
Industrial toxicology and epidemiology.
Bio-statistics to plan the investigations.
Special topics on air and water pollution problems.

TECHNIQUES

Lectures by specialists augmented by laboratory demonstrations and visits to industrial plants for on-the-spot discussions on special problems. Case studies and film shows are used to highlight the principles.

PARTICIPANTS

Medical Officers drawn from industry, and those attached to various governmental and private organisations and from Medical Colleges with interest in occupational health problems.

DURATION

Full-time course for 17 working days.
Appreciation course for 6 working days.

INDUSTRIAL PHYSIOLOGY

In Indian conditions the factors contributing to fatigue are work load during shift and stresses due to the thermal environment and unsuited machinery design for Indian workers.

The Division undertakes studies to evaluate the potential work capacity of industrial workers, the energy requirements of different operations in typical industries, the pattern of onset of fatigue in these workers and the physiological responses of the

workers under the combined stresses due to work and thermal conditions. It then advises on the steps to be taken to minimise such stresses.

The Division also undertakes lung function studies on workers exposed to occupational hazard. It also carries out anthropometric studies of representative samples of the population for working out norms for the industry as a whole.

Its services to the industry are:

1. Investigations on optimal rest pauses during shift for minimising fatigue.
2. Physiological evaluation of severity of different jobs.
3. Lung function tests of exposed workers.
4. Training Courses on 'Industrial Fatigue and Rest Allowances'.

COURSE ON OCCUPATIONAL PHYSIOLOGY

PROGRAMME PERSPECTIVE

In spite of rapid mechanisation and automation, the human power in our country is still considered to be a major source of energy in many occupational tasks. Stress due to physical work accompanied by environmental stresses, viz. heat, noise, vibration, inadequate lighting and toxic substances, prevalent in the working environments often puts undue strain affecting the health, comfort and efficiency of the workers. Apart from these, sub-optimal design of layout and improper matching of the man-machine system also add to the stresses. To ensure acceptable adjustment between man and work, it is, therefore, essential to know the normal physiological reactions of the workers and the extent of deviations in these physiological functions, resulting from these various stresses.

This course has been designed to provide essential information on these aspects with the ultimate aim of laying down recruitment standards for labour, tolerance limits of physiological workload, rate of work, optimal conditions of work and work environments.

OBJECTIVE

To provide an insight into the various aspects of physiology of man at work with special reference to occupational stresses and the possible remedial measures for proper utilization of human resources.

HIGHLIGHTS

- *Work Physiology :*
  Physiological responses to physical work—static & dynamic ; evaluation of occupational workload ; fatigue ; physical fitness ; organisation of heavy work ; concept of 'average' and 'standard' worker.
- *Biomechanics :*
  Muscle economy ; posture ; load lifting and carrying.
- *Environmental Physiology :*
  Mechanism of thermoregulation; physiologic responses to heat; environmental heat limits for day-to-day work; effects of noise, vibration and illumination.
- *Respiratory Physiology :*
  Lung functions—normal values effects of environmental contaminants like dust, fumes and gases.
- *Nutrition and Work Performance :*
  Energy expenditure in physical activities; balanced diet.
- *Selection, Training & Rehabilitation :*
  Physical fitness tests; physical training.

TECHNIQUES

Lectures based on research experience with the aid of slides and films; practical exercises in the laboratory as well as in some typical work situations.

PARTICIPANTS

Plant Physicians, Industrial Hygienists, Industrial Engineers and Industrial Consultants.

DURATION

6 days (full-time).

INDUSTRIAL FATIGUE & REST ALLOWANCES

PROGRAMME PERSPECTIVE

Fatigue accruing in industrial work situations can be physical as well as mental. Physical work of varying intensities combined with stresses due to various environmental factors, viz., heat, noise, improper illumination, etc. contribute to the onset of such fatigue. Under fatigued condition there is a gradual decrease

in the capacity for work as well as in the agility and alertness of individuals thereby leading to accident potentialities and lowered productivity. However, the impact of such fatigue can be minimised by introducing rationalised rest pauses based on physiological and psychological reactions of individuals to all these stresses.

OBJECTIVE

To familiarise with the pattern of physiological and psychological reactions of standard workers under different fatigue causing situations and to evolve the criteria on which rest allowance can be worked out.

HIGHLIGHTS

Causes and symptoms of fatigue

Assessment of physical and mental fatigue

Rest pause and its importance

Principle of fixing rest allowances

Prevention of mental and physical fatigue

TECHNIQUES

Lectures based on research experience with the aid of slides and films followed by practical demonstrations in the laboratory as well as in some typical industries.

DURATION

Six days full time.

SAFETY WING

The Safety Wing has the main objective of promoting safe and efficient working conditions in industry through research, training and educational activities. It aims to achieve this by:

i. creating an awareness and arousing consciousness for Safety ;

ii. carrying out training programmes, seminars and conferences on various aspects of industrial safety for different levels of management, trade unions and workers ;

iii. educating managements, employees and trade unions in the application of the principles of industrial safety ;

iv. carrying out research in relation to prevention of accidents in industrial operations and improvement of working conditions ;

v. promoting improvements in plant, equipment, appliances, methods, and arrangements for prevention of accidents and ill health and also for securing good working conditions ;

vi. providing assistance to industry in finding solutions to their problems in the above areas through training and consultancy service ; and

vii. providing authentic and up-to-date information on various aspects related to industrial safety.

INDUSTRIAL SAFETY

The rate of industrial accidents in our country is high. This calls for immediate action on the part of all concerned, particularly managements, trade unions, employees, safety officers, etc. For drawing attention to this urgent problem and organising efforts to control accidents in industry, safety education and training are vital.

The management personnel have to recognise the importance of safety as an integral part of production both for achieving optimum productivity and for protecting the most precious of the 5 Ms in industry—The Man. They have also to be equipped with the modern techniques and methods of accident prevention.

Employees do not always appreciate the need for safety in the various jobs and they tend to consider that such measures interfere with their work. No progress can be made without their active participation. The trade unions have also an effective role to play in influencing the safety behaviour of employees. Thus, it is important that employees and trade unions are convinced of the need for safety and educated on the common hazards and the control measures.

It will be appreciated that specialised training is required in the case of safety specialists like Safety Officers from industries and Factory Inspectors who have to provide guidance on the various aspects of accident prevention.

APPRECIATION PROGRAMME ON SAFETY FOR TOP MANAGEMENT

OBJECTIVE

The success in accident prevention largely depends on the support and leadership provided by the senior management. The programme is intended to provide to the top management an appreciation of industrial safety. It highlights the role the top management has to play in accident prevention.

HIGHLIGHTS

Concepts in Accident Prevention
Discovering and Controlling Hazards
Organising and Motivating for Safety

TECHNIQUES

Discussions and Case Studies

PARTICIPANTS

Top Management Personnel

DURATION

Four hours.

BASIC SAFETY COURSE FOR MANAGEMENT

OBJECTIVE

The course is designed to provide basic knowledge on the principles, techniques and methods of accident prevention. Emphasis is laid on development of correct attitude towards safety as this determines the style of supervision.

HIGHLIGHTS

Principles of Accident Prevention
Plant Safety Inspection
Job Safety Analysis
Accident Investigation, Reporting and Analysis
Maintaining Safe working Conditions and Practices
Health Hazards
Role of Middle Management
Securing Interest of Employees

TECHNIQUES

Lectures, discussions, case studies, role playing, film shows and demonstration.

PARTICIPANTS

Middle Management Personnel

DURATION

Four days full time or six days.

ADVANCED COURSE FOR MIDDLE MANAGEMENT

OBJECTIVE

Rapid technological changes in industry with consequent introduction of complex processes, plant and equipment have brought in hazards of various types. A deeper knowledge of modern techniques and methods of accident prevention is necessary for effective control of such hazards. The course is intended to equip the participants with the necessary knowledge for finding solutions to the safety problems faced by them in their plants.

HIGHLIGHTS

Principles of Accident Prevention
Techniques of Discovering Hazards
Collation and use of Accident Data
Legislations Relating to Safety
Plant Layout and Buildings
Effects and Control of Environmental Factors

Hazards and Control of Air-borne Contaminants
Making Plant and Equipment Safe
Safe Practices and Procedures
Safety Equipment
Ergonomic Approach to Safety
Organising and Motivating for Safety

TECHNIQUES

Lectures, discussions, case studies, film shows and demonstrations.

DURATION

Two weeks full time.

IN-PLANT PROGRAMMES

OBJECTIVE

Projects are undertaken in individual plants to provide guidance for improving safety performance after studying selected accident, organisational set up, procedures, physical conditions, work procedures and methods. As part of the project, in-plant courses are conducted for the senior management personnel.

These courses are designed to suit the specific needs of the establishments concerned, and are intended to generate management interest and support for a well organised safety programme based on methods and techniques of accident prevention.

HIGHLIGHTS

Concepts in Accident Prevention
Discovering and Controlling Hazards
Making Plant and Equipment Safe
Safe Work Practices
Specific Hazards and Control Measures
Organising for Safety
Motivating for Safety

TECHNIQUES

Lectures, discussions, case studies and film shows.

PARTICIPANTS

Senior Management Personnel

DURATION

Four days full time or six half days.

SAFETY IN MATERIALS HANDLING

OBJECTIVE

Roughly 25 percent of industrial accidents are attributable to materials handling. This highlights the need for greater attention to methods, equipment and appliances used and the safety measures to be adopted.

The course is intended to provide the technical know-how necessary to achieve the above objective.

HIGHLIGHTS

Plant Process Layout
Manual Handling
Stacking of Materials
Lifting Machinery and Tackles
Slinging Practices
Industrial Trucks
Conveyors
Handling and Storage of Dangerous Substances

TECHNIQUES

Lectures, discussions, case studies, film shows and demonstrations.

PARTICIPANTS

Management Personnel

DURATION

One week full time.

FIRE PREVENTION & PROTECTION

OBJECTIVE

Adequate measures for fire prevention and protection can prevent vast damages caused to plant, equipment and materials by fires. This course is designed to provide knowledge on the hazards of fire in different industries and practical measures for prevention and control of such hazards for ensuring safety of personnel and property.

GHLIGHTS

Need for protection
Statutory Requirements
Investigations and Reporting of Fires
Fixed Fire Fighting Installations
Design of Buildings and Plant Layout
Detection and Alarm Systems
Fire Protection Equipment
Fire Precautions in Specific Industries and Processes
Organising Fire Fighting Services
Rescue and First Aid

TECHNIQUES

Lectures, discussions, case studies, film shows and demonstrations of fire prevention and protection arrangements.

PARTICIPANTS

Fire Officers, Safety Officers and Management Personnel responsible for Fire Prevention and Protection.

DURATION

One week full time

COURSE FOR STAFF FROM INSTITUTES FOR TECHNICAL EDUCATION

OBJECTIVE

The students of the Institutes for Technical Education are the potential craftsmen and engineers of the future. To inculcate safety attitudes and habits in them it is essential to impart

safety education as an integral part of the curriculum at the impressionable age.

The course is designed to equip the teaching staff from these Institutes with sufficient knowledge to enable them to impart the necessary safety education to the students.

HIGHLIGHTS

Principles of Accident Prevention
Techniques of Discovering Hazards
Legislation relating to safety
Making Plant and Equipment Safe
Safe Practices and Procedures
Personal Protective Equipment
Organising and Motivating for Safety

TECHNIQUES

Lectures, discussions, case studies, film shows and demonstrations.

PARTICIPANTS

Teaching Staff from Engineering Colleges, Industrial Training Institutes, and other Technical Institutions.

DURATION

One week full time.

TRAINING COURSE FOR INSPECTORS OF FACTORIES

OBJECTIVE

The Factories Act is an important instrument in furthering the objective of promoting safety, health and welfare of workers in industry. Any legislation would become meaningful only when it is administered by a body of competent and specially qualified personnel. It is increasingly being appreciated that the role of the Inspector of Factories should not be limited to mere policy of compliance with the legal provisions, but that he should also provide expert guidance to managements and employees on the various aspects of providing safe, healthy and good conditions of work. To enable the Factory Inspectors to attain the required competence and to bring about uniformity in approach to the various technical and legal provisions of the Factories Act, it is necessary that specialised training is provided to them.

HIGHLIGHTS

Role of Factory Inspector
Concepts in Accident Prevention
Techniques for Discovering Hazard
Technical, Legal and Administrative Aspects of the Factories Act.
Complimentary Legislation bearing on Safety and Social Security.
Effects and Control of Environmental Factors
Occupational Diseases
Making Plant & Equipment Safe
Safe Practices and Procedures
Safety Equipment, Appliances and Devices
Ergonomic Approach to Safety
Special Safety & Health Requirements in respect of certain dangerous industries and processes.
Organising and Motivating for Safety.

TECHNIQUES

Lectures, discussions, case studies, film shows, seminars, laboratory and classroom exercises, demonstrations, and project assignments.

PARTICIPANTS

Inspectors of Factories.

DURATION

4 to 6 weeks full time.

DIPLOMA COURSE ON INDUSTRIAL SAFETY

OBJECTIVE

With complexities of processes, plant and equipment in modern industries, it is not possible to organise and sustain an effective accident prevention programme without the assistance and guidance from full-time safety specialist. Recognising this, the National Commission on Labour has recommended that safety engineers should be appointed in all factories employing 1,000 or more workers. There is thus a need to develope a cadre of qualified safety engineers.

This diploma course is intended to provide comprehensive education on industrial Safety with emphasis on the practical aspects of accident prevention to personnel sponsored by industry.

HIGHLIGHTS

Safety Philosophy and Awareness
Safe Working Conditions and their Development
Appraisal, Analysis, Inspection and Control Procedures
Occupational Hygiene and Health
Safety Organisation, Mobilisation and Safety Laws
Safety in Engineering Industry
Safety in Textile and Chemical Industry
Skills in Communication
Office Organisation and Methods
Maintenance, Design and Control of Plant & Equipment

TECHNIQUES

Lectures, discussions, case studies, film shows, seminars, role plays, laboratory and class room exercises, demonstrations and project assignments.

PARTICIPANTS

Persons with :

Diploma in any branch of technology with two years' work experience in industry (maintenance and/or manufacturing)

or

B. Sc. with 2 years' work experience in industry (maintenance and or manufacturing)

DURATION

One year

COURSE FOR WORKERS

OBJECTIVE

To bring safety to the shop floor level, it is essential that workers who have to carry out various jobs according to the safe procedures laid down, should be educated on safety. Formal courses are good means of safety education particularly in

bringing about change in attitudes. The course is designed essentially for creating proper attitude towards safety and providing basic knowledge on the safety measures to be adopted in many common industrial operations.

HIGHLIGHTS

Need for Safety
Workers' Role
Safety Requirements under the Factories Act & Rules
Safety Measures in common Industrial Operations
Health Hazards
Personal Protective Equipment

TECHNIQUES

Lectures, discussions, case studies, film shows and demonstrations.

PARTICIPANTS

Workers from industry

DURATION

Four days full time

MEDIA

Marathi, Hindi, Gujarati

PROGRAMME FOR TRADE UNION OFFICIALS

OBJECTIVE

Trade unions with the inherent advantage of position and influence, can contribute much towards education of the workers on safety. They, the guardians of the workers' right to be protected from occupational accidents and ill health, should have an appreciations of the principles, methods, and techniques in accident prevention to enable them both to contribute towards safety education and also to appreciate the different problems concerning the safty of their members and take them up with the managements for finding solutions.

This programme is aimed at providing an appreciation of the principles, methods and techniques in accident prevention to the trade union officials.

HIGHLIGHTS

Principles of Accident Prevention
Discovering and Controlling Hazards
Safety Organisation.
Creating and Maintaining Employees' Interest in Safety

TECHNIQUES

Lectures, discussions and case studies

PARTICIPANTS

Trade union officials

DURATION

One day full time—6 hours.

ONE DAY AND HALF DAY PROGRAMMES

OBJECTIVE

These programmes are designed for providing a brief appreciation of accident in industry.

HIGHLIGHTS

Accident Prevention
Safety Subject of Interest to the Group (for full day programmes)
Demonstration of Safety Equipment, Appliances, Methods and Arrangements at the Safety Exhibition of the Institute.
Visits to the Industrial Hygiene or other Laboratories according to the interest of the Group.

TECHNIQUES

Lectures, discussions, film shows and demonstrations.

PARTICIPANTS

Group of personnel including workers from industry, students from institutes for technical education and others.

DURATION

6 hours for one day programmes,
and
3 hours for half day programmes.

ERGONOMICS LABORATORY

Industrialisation today is characterised by technological innovation with consequent introduction of complex processes plant and equipment, high speeds of operation and often an unfavourable working environment. This has created stresses and strains on the man at work with adverse effects such as loss of efficiency, accidents and impaired health. In the interest of industrial efficiency, and also to safeguard the safety, Health and well-being of the persons employed, attention should be paid to the marrying of man and his work environment. This objective could be best achieved by studying the man machine systems in industry and making suitable adjustments through the Human Factors Engineering (Ergonomics) approach.

The Ergonomics Laboratory of the Institute has the following function :

(1) Carrying out research related to making the best adjustment between 'man and machine'.

(2) Educating industry on the advantages of and on the application of the principles of human factors engineering.

(3) Providing assistance to industry in finding solutions to their problems in the above area through training and consultancy service.

Training Progammes offered are on :

1. Industrial Ergonomics, and
2. Environmental Engineering subjects.

INDUSTRIAL ERGONOMICS

PROGRAMME PERSPECTIVE

Design and operation of plant and equipment without regard to the physical, physiological and psychological characteristics and limitations of man results in maladjustments in man-machine systems. These in turn lead to loss of efficiency and also cause strain, impaired health and accidents to employees. Such maladjustments could be effectively removed through the Human Factors Engineering (Ergonomics) approach.

OBJECTIVE

The course is aimed at providing the participants with the essential knowledge on the principles and practices of ergonomics in industry.

HIGHLIGHTS

Human Factors in Systems

Planning of Ergonomic Investigations

Muscular Work

Heavy Work and Organisation of Heavy Work

Motor Abilities of Man

Effects of Environmental Factors like Heat, Noise, Illumination, Chemical Contaminants, etc. on Man and his Work performance.

Principles of Control of the Environment

Human Characteristics in Sensing, Perceiving. Mediating and Making Judgements

Acquisition of Skills

Selection and Training

Performance Factors such as Motivation, Stress, Fatigue and Alertness

Design of Work and Workspace Arrangements

TECHNIQUES

Lectures, discussions, case studies, film shows, and demonstrations and exercises at the Institute Laboratories and factories.

PARTICIPANTS

Management personnel such as Design Engineers, Industrial Engineers, Plant Engineers, Production Personnel, Saftey Officers and Personnel Managers.

DURATION

Two weeks full time.

ENVIRONMENTAL ENGINEERING

The importance of providing as comfortable a physical work environment as possible free from harmful concentrations of air contaminants and stresses of heat, noise etc, is increasingly being recognised by industry. The toxic effects of different chemicals and the ill effects to health, of "physical agents" like heat, noise and vibration have been well established. With the latter, the detrimental effects on efficiency and productivity become a serious problem even before the effects on the health become pronounced.

The increasing awarness on the part of industrial mananagements of the need for providing better environmental conditions at the place of work, is reflected in the increase in recent years in the number of requests received by the Institute seeking advice on problems related to improving the invironment.

The Environmental Engineering Section which has recently been set up is equipped to provide to industry the following services.

i. conducting environmental studies to assess the levels of air contaminants, heat stress, noise, etc. and providing guidence on the control measures to be adopted to effect improvements to the environment.

ii. providing training to managers, designers, plant engineers, etc. to educate them on the ill effects of these environmental factors and on the methods and techniques of improving the environment.

INDUSTRIAL VENTILATION

PROGRAMME PERSPECTIVE

Modern industry characterised by its complex operations and processes, employs an increasingly large number of chemical substances and compounds. In the course of manipulation, handling and processing of these chemicals and other harmful substances, dusts, fumes, gases and mists are given off in the work environment. It is recognised that such contaminants in the environment, not only impair the health of the workmen employed therein but when flamable can also cause fires and explosions that result in damage to plant and equipment. Some of the processes add heat and humidity to the ambient air, causing thermal stress and discomfort. Industrial Ventilation is an effective means of controlling the heat stress and contamination in work environment in Industry.

OBJECTIVE

To provide the participants with the essential knowledge on the principles and practices involved in the design of effective ventilation systems in industry to provide a safe healthy and comfortable working environment.

HIGHLIGHTS

Engineering Control of In-Plant Environment

Industrial Heat Stress, its evaluation and Control

Principles of Ventilation

Mechanical Ventilation

Design of Local Exhaust systems

Air Flow Measurement and Interpretation

Plant Dust Collection Systems

Cost Analysis of ventilation Systems

TECHNIQUES

Lectures, discussions, case studies, film shows and laboratory and class room exercises.

PARTICIPANTS

Design and Plant Engineers, Safety Officers, Industrial Engineers and Managers in charge of production.

DURATION

10 days full time.

NOISE

PROGRAMME PERSPECTIVE

Noise is a potent hazard that impairs the health, efficiency and well being of persons in industries. Workers, managements and public authorities are becoming increasingly conscious of the need to control noise in industry.

OBJECTIVE

To educate the participants on the basic principles and techniques in recognition, evaluation and control of noise in work situation.

HIGHLIGHTS

Effects of Noise on Health and Performance
Physiology of Hearing
Physics of Noise
Instrumentation for Noise Measurement
Industrial Noise Survey
Criteria and Standards for Noise Levels
Engineering Control of Noise
Hearing Conservation Programme
Personal Protective Equipment

TECHNIQUE

Lectures, discussions, case studies and laboratory and class room exercises.

PARTICIPANTS

Design and Plant Engineers, Safety Officers, Industrial Engineers and Managers in charge of production.

DURATION

Five half days.

ENVIRONMENTAL CONTROL TECHNIQUES

PROGRAMME PERSPECTIVE

Workers in industry are exposed to numerous environmental hards arising from chemical contaminants and "physical agents". To maintain efficiency and protect the health of workers, the hazard potential must be correctly evaluated and appropriate control measures adopted, using proper techniques.

OBJECTIVES

To impart knowledge to the participants on the hazards and other deleterious effects of chemical contaminants and common physical agents as also on the different techniques to be adopted for controlling these hazards.

HIGHLIGHTS

Physical Agents and their Effects
Noise-Heat and Thermal Stress
Non-ionising Radiations-Cold and
Low Temperature Work-Illumination

Chemical Contaminants and their Effects
Techniques of Evaluation of Environment
Techniques of Control of Environment
Limitations of Control Techniques
Other Methods for Health Protection in Industry

TECHNIQUES

Lectures, case studies, laboratory exercises and demonstrations.

DURATION

Two weeks full-time.

GIPN—S4—3 CAF/Bom/75—10-11-75—1,500.

"I heartily endorse the proposition that any plan which exploits the raw materials of a country and neglects the potentially more powerful man-power is lop-sided and can never tend to establish human equality."

—Mahatma Gandhi

"Learning without thought is labour lost ; thought without learning is perilous".

—Confucious

Org. mond. Santé Sér. Rapp. techn., 1969, N° 412

ORGANISATION MONDIALE DE LA SANTÉ
SÉRIE DE RAPPORTS TECHNIQUES N° 412

Problèmes de santé associés au travail dans des conditions de contrainte thermique

Rapport d'un groupe scientifique de l'OMS

Ce rapport exprime les vues collectives d'un groupe international d'experts et ne représente pas nécessairement les décisions ou la politique officiellement adoptées par l'Organisation mondiale de la Santé.

GENÈVE
1969

L'Organisation mondiale de la Santé (OMS), créée en 1948, est une institution spécialisée, reliée à l'Organisation des Nations Unies. Au sein de l'OMS, plus de 120 pays échangent leurs connaissances, mettent en commun leur expérience et unissent leurs efforts pour élever le plus possible le niveau de santé des populations. Laissant aux pays le soin de résoudre les questions de santé publique qui sont exclusivement de leur ressort, l'OMS s'attaque aux grands problèmes dont la solution exige la collaboration de tous les pays, ou de plusieurs pays. Elle cherche par exemple à éliminer ou à combattre le paludisme, la schistosomiase, la variole et d'autres maladies transmissibles, ainsi que certaines affections cardio-vasculaires et le cancer. Il est d'autres activités encore où la collaboration internationale s'impose : établir des étalons internationaux pour les substances biologiques ainsi que des normes pour les pesticides et les appareils de pulvérisation, préparer une pharmacopée internationale, élaborer le Règlement sanitaire international et veiller à son application, reviser la liste internationale des maladies et causes de décès, rassembler et diffuser des renseignements épidémiologiques, recommander des dénominations communes pour les préparations pharmaceutiques, enfin favoriser l'échange d'informations scientifiques. En de nombreuses régions, des progrès doivent encore être accomplis dans certains domaines : protection de la maternité et de l'enfance, nutrition, soins infirmiers, santé mentale, hygiène dentaire, médecine sociale et médecine du travail, hygiène du milieu, administration de la santé publique, enseignement et formation professionnelle, éducation sanitaire de la population. C'est pourquoi l'Organisation réserve une part de ses ressources pour fournir aide et conseils et pour diffuser, par l'intermédiaire de ses publications, les dernières informations sur ces questions. Depuis 1958, une somme de connaissances a pu être acquise en diverses branches de la médecine et de la santé publique, grâce à un vaste programme international de recherches et une coordination des investigations. Ce programme, dont les divers aspects se reflètent dans les publications de l'OMS, prend toujours plus d'ampleur.

* * *

Pour obtenir des avis autorisés sur des sujets techniques et scientifiques, l'OMS réunit des comités ou autres groupes internationaux d'experts. Leurs membres ne reçoivent aucune rémunération et apportent leurs services à titre personnel et non en qualité de représentants de gouvernements ou d'autres organismes. Ils sont avant tout choisis en fonction du domaine de leur compétence et de leur expérience technique, mais aussi de la nécessité d'une répartition géographique adéquate.

Les rapports collectifs de ces comités et groupes internationaux sont publiés dans la *Série de Rapports techniques*. Bien qu'ils n'expriment pas nécessairement le point de vue de l'Organisation, celle-ci les prend en considération pour l'établissement de ses programmes.

Prix de l'abonnement annuel : Fr. s. 50,—, £ 5, ou $ 16,00.

On pourra se tenir au courant des nouveaux rapports publiés dans la *Série de Rapports techniques* en se référant à la *Chronique OMS*, qui en donne des résumés. Celle-ci paraît chaque mois en anglais, en chinois, en espagnol, en français et en russe.

Prix de l'abonnement annuel : Fr. s. 12,—, £ 1 4s. ou $ 4,—.

Ce rapport exprime les vues collectives d'un groupe international d'experts et ne représente pas nécessairement les décisions ou la politique officiellement adoptées par l'Organisation mondiale de la Santé.

ORGANISATION MONDIALE DE LA SANTÉ
SÉRIE DE RAPPORTS TECHNIQUES
Nº 412

PROBLÈMES DE SANTÉ ASSOCIÉS AU TRAVAIL DANS DES CONDITIONS DE CONTRAINTE THERMIQUE

Rapport d'un groupe scientifique de l'OMS

ORGANISATION MONDIALE DE LA SANTÉ
GENÈVE
1969

IMPRIMÉ EN SUISSE

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SUR LES PROBLÈMES DE SANTÉ ASSOCIÉS AU TRAVAIL
DANS DES CONDITIONS DE CONTRAINTE THERMIQUE

Genève, 29 août - 4 septembre 1967

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PROBLÈMES DE SANTÉ ASSOCIÉS AU TRAVAIL DANS DES CONDITIONS DE CONTRAINTE THERMIQUE

Rapport d'un groupe scientifique de l'OMS

Un groupe scientifique de l'OMS s'est réuni à Genève du 29 août au 4 septembre 1967 pour examiner les problèmes de santé associés au travail dans des conditions de contrainte thermique. Le Dr J. Karefa-Smart, Sous-Directeur général a ouvert la réunion au nom du Directeur général. Il a souligné que les niveaux de vie et de santé de la collectivité sont liés à la productivité industrielle et que celle-ci, à son tour, dépend du rendement et du confort des travailleurs. La médecine du travail revêt donc une importance spéciale dans les pays en voie de développement où la main-d'œuvre qualifiée est rare et où son remplacement pose souvent un problème difficile. Le Dr Karefa-Smart a mis en relief la nécessité de protéger les travailleurs contre des conditions physiques susceptibles de nuire à leur état de santé et a souligné que la chaleur représente à cet égard l'un des risques les plus courants. Le problème de la contrainte thermique est, de toute évidence, particulièrement grave dans les pays en voie de développement, dont la plupart sont situés en zone tropicale ou subtropicale.

Le Dr H. S. Belding a été élu Président, le Dr F. Lavenne Vice-Président et le Dr A. R. Lind Rapporteur.

1. INTRODUCTION

Dans l'industrie, par exemple dans les mines, les aciéries et les verreries, au cours des travaux agricoles et lors de la construction des routes, les ouvriers sont souvent exposés à des contraintes thermiques ambiantes considérables qui vont parfois jusqu'à menacer leur existence. Il est juste de considérer que le danger provient surtout d'un travail physique ou de mouvements pénibles exécutés dans un milieu chaud, car la charge thermique totale de l'organisme est en fait la somme de deux apports : celui du milieu ambiant et celui des combustions métaboliques. Physiologistes, ingénieurs et médecins se sont de plus en plus préoccupés de ce problème et ont fait considérablement avancer nos connaissances concernant la mesure et l'estimation des éléments qui interviennent à cet égard dans trois importants secteurs : *a*) les composantes de la contrainte thermique —

en particulier la chaleur d'origine métabolique, la température de l'air, l'humidité, les déplacements de l'air et la température de rayonnement ; *b*) les réactions de l'homme lorsqu'il travaille à la chaleur : variation de la température corporelle, de la fréquence cardiaque et de l'excrétion sudorale ; *c*) les conditions de chaleur que l'homme tolère bien, supporte médiocrement ou auxquelles il ne résiste que pendant des périodes strictement limitées.

Dans l'étude de ces facteurs on emploie des termes particuliers : *contrainte thermique*, *astreinte thermique*,[1] *limites de tolérance* et *conditions optimales*, par exemple. Les recherches sur les divers problèmes industriels de chaleur ne fournissent souvent que des renseignements d'intérêt local. D'autre part, la nécessité pour le chercheur de maintenir entre des limites strictement déterminées les facteurs humains et de milieu qui interviennent dans la contrainte thermique est reconnue depuis longtemps, et il y a des années que des recherches sont effectuées dans des salles chaudes en laboratoire. Malheureusement, rares sont les textes qui visent à fournir aux gouvernements, aux organes directeurs de l'industrie, aux ingénieurs, aux médecins et aux hygiénistes toutes les informations possibles, sous une forme suffisamment explicite.

En outre, les renseignements disponibles portent presque exclusivement sur l'industrie dans les pays développés et ne peuvent être appliqués sans réserves aux conditions générales dans les pays tropicaux où l'on attend de l'ouvrier qu'il supporte les effets combinés de la chaleur climatique et industrielle — la probabilité étant, en fait, qu'il ait à exécuter un travail pénible dans une ambiance chaude pendant huit heures consécutives et qu'il lui faille vivre, soumis pendant de longs mois sans relâche, de jour et de nuit, à une contrainte thermique. La situation est encore compliquée par le fait que sa ration alimentaire n'est pas toujours adaptée aux conditions qui lui sont imposées. Le présent rapport souligne la nécessité, rendue particulièrement urgente par le développement industriel actuel des pays dans les régions tropicales, d'un complément d'informations à cet égard. C'est aux gouvernements, aux directeurs d'usine et parfois aux syndicats qu'il incombe de stimuler les recherches sur les conditions ambiantes de

[1] Les termes « contrainte » et « astreinte » sont pris ici dans le sens qu'ont les mots anglais « stress » et « strain » dans le vocabulaire classique de l'ingénieur. Les stricts équivalents français des deux mots anglais seraient, en langage d'ingénieur, « tension » et « contrainte » respectivement. Toutefois, le mot « tension » a déjà plusieurs autres sens en physiologie et en médecine. Il a donc paru préférable d'employer ici « contrainte » et « astreinte », qui ont, en outre, l'avantage de conserver l'analogie de consonance des mots anglais. La *contrainte thermique* désigne la quantité de chaleur à éliminer pour que le corps reste en équilibre thermique ; elle correspond à la somme de la chaleur métabolique (diminuée de la dépense énergétique extérieure et du gain ou des pertes par convection et rayonnement). Quant à l'*astreinte thermique*, c'est un changement physiologique ou pathologique qui résulte de la contrainte thermique : augmentation de la fréquence cardiaque ou de la température corporelle, sudation, syncope due à la chaleur ou déséquilibre hydrominéral, par exemple.

travail qui affectent directement la santé, le rendement et le confort des travailleurs. Une aide financière devrait être assurée pour ces études lorsqu'il y a lieu. Il est indispensable d'accorder suffisamment d'attention aux considérations touchant les conditions de travail telles que celles qui concernent la construction des usines, la climatisation, la commande des sources thermiques localisées, l'aménagement de salles de repos fraîches, l'adoption de méthodes et d'horaires de travail convenables, l'approvisionnement suffisant en eau potable, les examens médicaux et la fourniture de certains vêtements protecteurs individuels. Il s'impose enfin de reconnaître combien certaines questions comme celles du logement et du régime alimentaire méritent de retenir l'attention.

2. RÉACTIONS PHYSIOLOGIQUES DE L'HOMME À LA CHALEUR

2.1 Généralités

Le système thermorégulateur de l'homme est complexe ; son rôle est de maintenir l'équilibre thermique des tissus internes dans un intervalle de température relativement étroit. Pour que cet équilibre de la température centrale soit assuré, il faut que la quantité de chaleur gagnée par l'organisme soit égale à celle qu'il perd. Comme la marge de variation des quantités en jeu est considérable, étant subordonnée à la dépense énergétique et aux conditions ambiantes, les mécanismes qui régissent la déperdition thermique doivent nécessairement être à la fois souples et efficaces. Enfin la quantité de chaleur échangée entre l'organisme et le milieu ambiant dépend des différences de température et de tension de vapeur entre la peau et l'environnement. Trois mécanismes interviennent : 1) selon que la température de l'air est inférieure ou supérieure à celle de la peau, l'organisme perd ou gagne de la chaleur par convection, et l'augmentation de la vitesse de l'air accroît l'intensité de ces échanges ; 2) selon que la température des surfaces environnantes est supérieure ou inférieure à la température cutanée, l'organisme gagne ou perd de la chaleur par rayonnement ; 3) l'évaporation de la sueur provoque une déperdition de chaleur corporelle ; la quantité de sueur qui peut être évaporée et, par conséquent, l'efficacité de la sudation comme moyen de se refraîchir dépendent de la différence entre la tension de vapeur dans le milieu ambiant et celle à la surface de la peau ; elle augmente avec les déplacements de l'air. Les coefficients d'échange thermique par ces trois voies ont été déterminés expérimentalement chez l'homme et permettent de calculer le gain ou la déperdition de chaleur connaissant la température de l'air, son humidité, la température moyenne de rayonnement et la vitesse de l'air. Si l'on est en outre renseigné sur la

production métabolique de chaleur, l'équilibre thermique se traduit par une formule simple : [1]

$$M \pm C \pm R - E = \pm S$$

où M représente la chaleur d'origine métabolique,

C, R et E, les échanges thermiques effectués, respectivement, par convection, rayonnement et évaporation, et

S la quantité de chaleur accumulée dans les tissus ou perdue par eux, la température corporelle ayant augmenté ou diminué en conséquence. (Lorsque l'organisme est en équilibre thermique, S est nul.)

Ces relations purement physiques sont elles-mêmes sous l'influence dynamique de deux mécanismes physiologiques, l'un assurant la régulation de la fonction cardio-vasculaire, l'autre celle de la transpiration. Outre qu'ils modifient la vitesse du transfert thermique des tissus internes vers la périphérie, ces deux mécanismes peuvent influencer la température cutanée et la tension de vapeur à la surface de la peau, agissant ainsi sur la vitesse du transfert de chaleur entre l'organisme et le milieu ambiant. La mise en œuvre de ces échanges physiologiques dynamiques demande un effort à l'ensemble de l'organisme, elle s'accompagne aussi de nombreuses réactions physiologiques, par exemple celles qui concernent l'équilibre hydrominéral et les fonctions humorales, auxquelles doit faire face le système thermorégulateur dans un climat chaud.

Il est donc à présumer que l'astreinte physiologique à laquelle est soumis un homme assis ou actif dans un milieu chaud, dépend de la contrainte thermique totale à laquelle il est exposé. Cette supposition logique a fait l'objet de nombreuses recherches qui, souvent, visaient en outre à établir un abaque des contraintes thermiques permettant d'évaluer les conditions génératrices d'une astreinte physiologique équivalente ; certains de ces abaques sont décrits ci-après. Lorsqu'on essaie de définir les conditions métaboliques et ambiantes qui peuvent provoquer la même astreinte physiologique, il est nécessaire de mesurer le niveau d'activité ou les variations de plusieurs fonctions organiques ; il convient alors de faire porter les mesures sur les conséquences de la thermorégulation ou sur les phénomènes qui lui sont étroitement liés. La température des tissus organiques profonds ou de la peau doit évidemment fournir certains renseignements quant au degré d'astreinte auquel est soumis le système thermorégulateur. De même, la fréquence cardiaque peut être considérée comme un indice simple et facilement observable de la charge imposée à la circulation par le travail

[1] Dans cette formule primitivement établie par Winslow, Herrington & Gagge en 1936 (*Amer. J. Physiol.*, **116**, 641) et qui depuis lors a été utilisée par de nombreux auteurs, la lettre S est parfois remplacée, maintenant, par la lettre Q ou par la lettre B.

et la charge thermique ; il est raisonnable d'admettre que le débit sudoral reflète l'astreinte thermique, puisque c'est dans l'évaporation de la sueur que réside la principale défense de l'organisme contre une élévation excessive de la température. En fait, il est dorénavant possible, dans l'ensemble, d'analyser les facteurs qui font varier ces paramètres en réponse à divers niveaux de contrainte d'origine métabolique ou ambiante et de déterminer quelles sont les mesures les plus indiquées selon les buts visés. Les différentes manières de procéder sont décrites dans la section traitant des indices de contrainte ou d'astreinte thermique. La plupart des chercheurs essaient de mesurer deux fonctions physiologiques ou davantage et de les rassembler en un seul indice d'astreinte thermique valable pour un ensemble donné de conditions. C'est un procédé judicieux puisque la thermorégulation, si simple en tant que notion, est un mécanisme extrêmement complexe et que les fonctions qui la composent paraissent pouvoir être affectées différemment selon les conditions de contrainte thermique climatique et d'activité métabolique. Néanmoins, il n'est pas toujours possible sur le lieu de travail de faire simultanément des mesures fiables de tous les facteurs en jeu. Il y a avantage à examiner tour à tour chacune de ces déterminations et à décider si, en pratique, elles indiquent de manière fiable si l'individu est soumis à une astreinte excessive pendant une exposition déterminée à la chaleur.

Naturellement, la plupart des données disponibles sont issues de recherches expérimentales faites en laboratoire. Les informations concernant la situation dans l'industrie sont insuffisantes. Il est extrêmement souhaitable de modifier cet état de choses, notamment parce que bien des caractéristiques pratiques des conditions industrielles peuvent affecter les réponses thermorégulatrices observées au cours des études expérimentales. On manque par exemple d'informations concernant les dépenses énergétiques chez les ouvriers de nombreux pays tropicaux où le poids corporel est nettement moindre qu'en Europe ou aux Etats-Unis ; on est aussi mal renseigné sur la mesure dans laquelle l'état de nutrition ou de santé et les variations des conditions économiques, techniques ou de logement peuvent agir sur les réponses physiologiques à une exposition thermique dans l'industrie. De plus interviennent divers facteurs individuels dont certains influent notoirement sur la thermorégulation. Il est donc nécessaire d'étudier ici quelques-uns d'entre eux avant d'examiner séparément les différentes mesures physiologiques.

2.2 Facteurs individuels

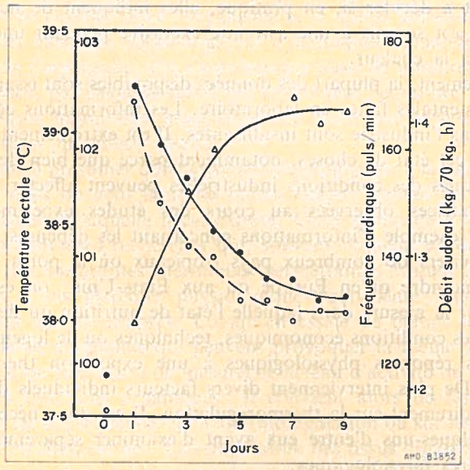
Plusieurs facteurs compliquent l'évaluation des effets de l'exposition à la chaleur. Certains d'entre eux sont certes faciles à identifier et à mesurer, mais d'autres ne le sont pas, et si l'on est très bien renseigné quant aux uns, on l'est très mal quant aux autres. En effectuant des recherches sur

des groupes de personnes exposées à la chaleur, on observe fréquemment que les réactions d'une ou plusieurs d'entre elles diffèrent totalement de celles des autres. Il se pourrait que ces différences reflètent simplement des différences d'état physiologique dues à l'acclimatement, à l'âge ou à la condition physique ou qu'elles résultent de différences liées au sexe, à la constitution physique ou à l'origine ethnique. De plus, le vêtement joue un rôle important car, en raison de son étroite association avec la peau, il modifie par là même le rapport entre celle-ci et le milieu ambiant. Les divers facteurs affectant les réactions à l'exposition thermique sont discutés ci-dessous.

Acclimatement

L'acclimatement thermique consiste en l'ensemble des ajustements physiologiques survenant chez les personnes qui, habituées à vivre dans un

FIG. 1. VARIATIONS DE LA TEMPÉRATURE RECTALE, DE LA FRÉQUENCE CARDIAQUE ET DU DÉBIT SUDORAL PENDANT L'ACCLIMATEMENT



- • température rectale
- ○ fréquence cardiaque
- △ débit sudoral

Le jour 0, les sujets ont travaillé pendant 100 min dans une ambiance fraîche, leur dépense énergétique étant de 300 kcal/h. Du jour 1 au jour 9, ils ont travaillé de la même façon, mais dans une ambiance à 48,9°C de température sèche et 26,7°C de température humide.

D'après Lind, A. R. & Bass, D. E. (1963) *Fed. Proc.*, **22**, 704.

climat frais, sont soudainement transplantées dans un climat chaud. Une adaptation analogue s'observe chez les habitants de pays chauds sous l'influence de l'élévation saisonnière de la température, en particulier si celle-ci est brutale, ou lors de la transition d'une occupation sédentaire à un métier comportant une activité physique. Les changements de milieu imposent une astreinte physiologique que diminue l'acclimatement. Celui-ci est, en fait, l'un des exemples les plus spectaculaires d'adaptation physiologique à une modification de l'ambiance. L'objet n'est pas ici de décrire en détail ce processus qui l'a été dans d'autres publications. Chez l'homme non acclimaté, la première exposition à la chaleur provoque, essentiellement, une élévation de la température rectale et du pouls, ainsi qu'une sudation faible (fig. 1) ; on observe une gêne et même une angoisse qui peuvent être suffisamment graves pour qu'il faille éviter une nouvelle exposition. L'acclimatement réduit l'impression de gêne et d'angoisse, diminue la température rectale et la fréquence cardiaque, augmente la sudation. Il y a de bonnes raisons de penser que cette influence favorable est due à une intensification de la sudation et à un abaissement de la température cutanée. Le processus d'acclimatement se développe surtout pendant les 4 à 6 premiers jours de l'exposition quotidienne répétée ou continue et il est achevé, ou presque, au bout de 2 semaines. Il est relatif, c'est-à-dire que l'homme entièrement adapté à des conditions de travail données ne l'est pas à des conditions de charge thermique supérieure. Puisque la contrainte thermique totale comporte une composante d'origine métabolique, il s'ensuit, par exemple, que le travailleur sédentaire d'un climat chaud n'est pas adapté au travail physique dans ce climat et que celui-ci provoque chez lui de la gêne ou de l'angoisse. L'influence favorable de l'acclimatement semble diminuer rapidement au début, bien qu'elle subsiste en partie pendant 3 ou 4 semaines. De toute évidence, une astreinte thermique excessive risque de se produire plus fréquemment chez les hommes qui ne sont pas entièrement acclimatés au travail à la chaleur et l'apparition de troubles analogues est à prévoir chez les nouveaux venus dans un pays chaud pendant la semaine de leur arrivée, ainsi que chez les ouvriers qui reprennent leur occupation après une absence d'au moins deux jours.

Age

Les informations dont on dispose quant aux effets du vieillissement sur les réponses physiologiques à la chaleur sont peu abondantes. Les observations faites donnent à penser que les adultes s'acclimatent bien mais, en général, l'astreinte physiologique due à des contraintes thermiques moyennes ou fortes augmente avec l'âge, principalement sans doute en raison d'une diminution de la capacité cardio-vasculaire. Il a été clairement démontré que les niveaux maximaux de fréquence cardiaque et de capacité de travail diminuent progressivement avec l'âge. D'autre part, on n'observe

guère de changement sinon aucun, en fonction de l'âge, dans la production de chaleur métabolique pour un travail mécanique donné. Rien n'indique que la température rectale maximale tolérée diminue avec l'âge. La réponse des glandes sudoripares aux changements de température se ralentit quand l'âge augmente, de telle sorte que la sudation perd de son efficacité en tant que mécanisme thermorégulateur de l'organisme. Compte tenu de l'ampleur de l'intervalle des âges dans la main-d'œuvre industrielle, il est urgent de recueillir de nombreux renseignements complémentaires qui permettent de préciser l'augmentation de l'astreinte thermique en fonction de l'âge.

Il ne faut pas oublier que, dans certaines industries, des adolescents sont parfois appelés à travailler dans une ambiance chaude ; les administrateurs et les médecins du travail peuvent avoir à leur accorder une attention médicale et des ménagements spéciaux.

Sexe

La proportion élevée de femmes dans certaines industries exige une meilleure compréhension des différences de thermorégulation entre les deux sexes. Les données disponibles permettent de penser qu'il y a peu de différence de pouvoir de sudation entre l'homme et la femme convenablement acclimatés, mais l'observation montre que la femme ne s'adapte pas aussi bien que l'homme, peut-être parce que sa capacité cardio-vasculaire est plus faible. La grossesse s'accompagne de grands changements dans de nombreux systèmes physiologiques, notamment le système cardio-vasculaire ; il est donc à présumer qu'elle augmente l'astreinte physiologique par exposition à la chaleur.

De nombreux pays ont adopté des règlements nationaux limitant l'emploi des femmes, enceintes ou non. Il existe également à cet effet des recommandations internationales (voir l'annexe).

Différences ethniques

Les réactions de plusieurs groupes ethniques à l'exposition thermique ont fait l'object d'études expérimentales comparées. Peut-être est-il surprenant de constater qu'après avoir tenu compte de la constitution physique, les différences globales entre groupes étaient faibles. Il s'impose de recueillir, tant en laboratoire que sur le terrain, de nombreux renseignements complémentaires à ce sujet.

Constitution physique

De simples considérations théoriques autorisent à penser que les caractères physiques ont un effet marqué sur la capacité thermorégulatrice.

Indubitablement, il a été amplement montré que le coup de chaleur frappe plus facilement un obèse qu'une personne relativement maigre. Cela s'explique peut-être par deux faits : chez le sujet maigre le rapport de la surface cutanée (déperdition de chaleur) au poids corporel (production de calories) est plus grand et la fonction circulatoire est moins intense. Les hommes de constitution physique légère peuvent être soumis à une contrainte thermique relativement plus forte lorsqu'ils accomplissent une série donnée de travaux, puisque leur capacité de travail maximale est plutôt moindre, et par conséquent être portés à en utiliser une proportion plus élevée pour exécuter la série de travaux considérée. Abstraction faite de ces considérations, il n'y a guère de raison de croire que la constitution physique influe sur les réponses physiologiques à la chaleur.

Aptitude physique

La notion d'aptitude physique est certes difficile à définir, mais elle n'en est pas moins un fait bien reconnu. Il ne fait pas de doute que les hommes s'adaptent d'autant mieux à la chaleur et au travail dans une ambiance chaude qu'ils sont en meilleure condition physique. Cette plus grande faculté d'adaptation est certainement imputable à une augmentation de la capacité cardio-vasculaire mais il se pourrait que d'autres facteurs interviennent également.

Habillement

Dans certaines occupations industrielles, il n'est pas rare que les ouvriers doivent porter un surplus de vêtements afin de se protéger contre les coupures, les écorchures ou l'effet de substances toxiques. Le contact étroit entre le vêtement et la peau peut modifier considérablement les échanges thermiques et, par conséquent, la contrainte thermique, quelles que soient les circonstances. L'influence des vêtements est difficile à apprécier, car ceux-ci réduisent la déperdition de chaleur par évaporation, ainsi que les échanges thermiques par rayonnement et convection ; cette réduction peut varier selon l'épaisseur du tissu, sa couleur et l'ampleur du vêtement.

Le port de vêtements par les ouvriers exposés sous abri aux rayonnements infrarouges ou travaillant au grand air sous le soleil peut diminuer de façon appréciable la charge de chaleur de rayonnement, mais il réduit en même temps la capacité de refroidissement par évaporation. Pour apprécier les effets des vêtements, il faut donc analyser séparément ces facteurs. En général, dans les climats chauds où l'intensité du rayonnement est faible, il convient de porter aussi peu de vêtements que le permettent les circonstances, mais dans les pays où cette intensité est forte, le vêtement complet est préférable pour diminuer les gains thermiques dus au rayon-

nement.[1] Dans les deux cas, les vêtements seront amples et faits de tissus légers.

Il y a lieu de souligner que les vêtements protecteurs spéciaux prévus pour certains travaux peuvent contribuer à la contrainte thermique totale, surtout s'ils sont étanches à la vapeur d'eau, restreignant ainsi considérablement, sinon complètement, la déperdition de chaleur par évaporation. Mais on peut recourir à des vêtements spéciaux ventilés par de l'air frais d'origine externe pour protéger les travailleurs à l'œuvre dans des espaces confinés où la contrainte thermique est élevée.

2.3 Fréquence cardiaque

Dans la pratique, la fréquence cardiaque se mesure le plus souvent en prenant simplement le pouls au poignet, mais des techniques plus élaborées sont faciles à mettre en œuvre. Elle reflète rapidement et fidèlement la dépense énergétique. On a démontré en outre que, dans des conditions stables de travail et de chaleur, les variations de la fréquence cardiaque concordent bien avec celles de la température rectale. Ces caractéristiques la rendent particulièrement utile comme indice d'astreinte physiologique chez les ouvriers exposés à la chaleur ; les avantages de cette méthode surpassent certainement ses inconvénients. Les principaux de ceux-ci sont l'emploi d'un seul critère, alors que plusieurs mécanismes homéostatiques interviennent simultanément, et le fait que la fréquence cardiaque répond à de nombreux stimuli, en particulier au stress psychique.

Trois déterminations de la fréquence cardiaque sont utilisables comme indices d'astreinte thermorégulatrice : le pouls, pendant ou aussitôt après le travail, l'augmentation du pouls après une période pouvant aller jusqu'à toute une journée de travail, et le temps de retour du pouls à sa fréquence de repos après le travail. Ces trois mesures seront examinées, selon qu'il y a lieu, ci-dessous. Il faut cependant noter que si une attention particulière a été accordée aux effets du travail dans une ambiance chaude, les réponses du pouls à cette ambiance chez le sujet assis doivent également être étudiées.

Lors d'un travail quotidien représentant une exposition prolongée à la chaleur, la fréquence cardiaque mesurée à la fin de la journée est parfois moins significative que les pics intermittents au cours du travail ou que l'augmentation de la fréquence dans la journée. Les pics de fréquence cardiaque correspondent à des périodes de pointe du travail et/ou de chaleur

[1] Voir Hertig B. A. & Belding, H. S. (1963) *Evaluation and control of heat hazards*. In : Hardy, J. D. ed., *Temperature : its measurement and control in science and industry*, vol. 3, part 3, New York, Rheinhold, pp. 347-355 ; Givoni, B. & Berner, E. (1967) *Effect of solar radiation on physiological heat strain in relation to work and clothing*, Haïfa, Technion (Rapport de recherche N° BSS-OH-IST-2 pour le Service de Santé publique des E.-U. A.).

et peuvent être examinés séparément en tant qu'expositions intenses ou de durée limitée. Les augmentations de la fréquence peuvent être étudiées en rapport avec toute la période de travail ou pour des séances alternées de travail et de repos. Brouha a admis, par exemple, que si la fréquence cardiaque, mesurée pendant les 30 premières secondes qui suivent la première séance de travail, n'excède pas 110 puls/min et que si elle diminue d'au moins 10 puls/min au cours des trois premières minutes de repos, l'astreinte cardiaque n'augmente pas si le même travail est recommencé au cours de la journée dans les mêmes conditions d'exposition à la chaleur. Cette supposition est facile à vérifier et si elle se révèle valable peut servir à concevoir les précautions de sécurité nécessaires dans toutes les circonstances industrielles où se posent des problèmes évidents de travail à la chaleur. A l'heure actuelle, on manque de données convenables pour être en mesure de recommander l'application de cette méthode aux conditions de travail à la chaleur en usine ou à l'air libre dans toutes les parties du monde.

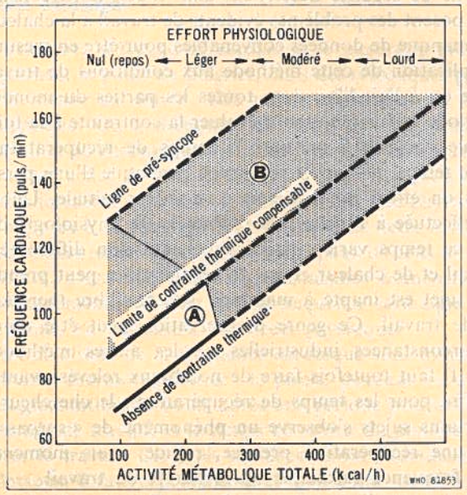
Une méthode intéressante pour évaluer la contrainte à la fois thermique et énergétique consiste à mesurer le temps de récupération cardiaque, c'est-à-dire le temps mis par la fréquence cardiaque d'une personne qui se repose après un effort pour revenir à sa valeur initiale. Une expérience, récemment effectuée à l'Institut Max-Planck de physiologie du travail, a montré que ce temps varie considérablement selon différentes combinaisons de travail et de chaleur et que la récupération peut prendre plusieurs heures si le sujet est inapte à maintenir son équilibre thermique pendant la période de travail. Ce genre d'observation peut être renouvelé dans toutes les circonstances industrielles où les autres méthodes semblent inadéquates. Il faut toutefois faire de nombreux relevés avant de pouvoir fixer un chiffre pour les temps de récupération ; le chercheur doit savoir que chez certains sujets s'observe un phénomène de « surpassement » qui consiste en une récupération précoce, rapide, mais momentanée seulement, de la fréquence cardiaque après l'arrêt du travail.

Si la fréquence cardiaque pendant le travail est appelée à servir d'indice de l'astreinte physiologique, il faut disposer de matériel convenable pour l'enregistrer sans contrarier le programme de travail. Dans des études en laboratoire, des jeunes gens en bonne condition physique ont supporté 160 puls/min pendant de courtes périodes sans dommage apparent. Pour l'instant, l'application des résultats de ces études dans l'industrie se heurte à des difficultés considérables. Tout d'abord, il ne faut pas oublier que les sujets examinés en laboratoire sous l'œil attentif d'observateurs qualifiés courent beaucoup moins de risques que des ouvriers qui, par ailleurs, seraient placés dans des conditions semblables. Ensuite, même si l'on était en mesure de répondre à la question fondamentale qui se pose de savoir quelle est l'importance de la fréquence cardiaque du point de vue de la sécurité et, par suite, de définir le chiffre optimal pendant le travail, il faudrait encore tenir compte des différences d'état de santé entre les

travailleurs des diverses parties du monde. De toute évidence des informations supplémentaires sont nécessaires.

On peut obtenir des indications sur la signification des fréquences cardiaques observées au cours du travail industriel en les comparant aux valeurs types enregistrées au cours d'études en laboratoire chez des hommes jeunes en bonne condition physique. La figure 2 représente les réponses caractéristiques parmi ce choix de sujets.[1]

FIG. 2. EFFET DE LA CONTRAINTE THERMIQUE SUR LA FRÉQUENCE CARDIAQUE POUR DIFFÉRENTS NIVEAUX DE DÉPENSE ÉNERGÉTIQUE



Fréquence cardiaque observée chez des hommes jeunes en bonne condition physique pour différents niveaux de dépense énergétique, avec et sans contrainte thermique. Voir dans le texte l'explication des diagonales et des zones mouchetées.

La diagonale inférieure indique le rapport entre la fréquence cardiaque et le niveau de dépense énergétique lorsque la contrainte thermique d'ambiance n'intervient pas. Cette fréquence cardiaque « spécifique du travail » augmente presque linéairement en fonction de la dépense énergétique. Au-dessus de 250 kcal/h, la diagonale est tracée en trait discontinu, ce qui correspond à l'observation, faite à l'Institut Max-Planck de physiologie du

[1] Les fréquences cardiaques et la classification des degrés d'effort physiologique indiquées en haut de cette figure sont données d'après Christensen, E. H. (1964) *L'homme au travail : étude succinte de physiologie appliquée aux conditions de travail dans un pays subtropical*, Genève, OIT (Série *Sécurité, hygiène et médecine du travail*, N° 4).

travail, que la capacité de dépense énergétique pendant une période de travail de 8 heures n'excède généralement pas 2000 kcal.

La diagonale centrale indique les limites approximatives de la fréquence cardiaque observée sur des hommes jeunes en bonne condition physique qui réussissent à compenser des conditions d'ambiance thermique élevée. Le critère d'une bonne compensation est l'aptitude à maintenir la température centrale constante par rapport au niveau général dans un environnement thermiquement neutre. Lind a suggéré que les conditions d'exposition professionnelle quotidienne prolongée devraient être comprises dans cette zone de « contrainte thermique compensable ». La limite supérieure de cette contrainte est représentée en trait discontinu au-dessus de 110 puls/min, car il est encore très douteux que la fréquence cardiaque moyenne pendant une période de travail puisse excéder cette valeur sans susciter l'apparition d'une fatigue cumulative. La ligne de présyncope indique un fait fréquemment observé, à savoir que la fréquence cardiaque peut s'élever pendant de courtes périodes, mais qu'un état permanent acceptable est irréalisable.

Deux exemples suffiront à montrer comment la figure 2 se prête à l'interprétation de la fréquence cardiaque observée chez un travailleur :

a) Le point A représente une fréquence cardiaque de 100 puls/min chez un ouvrier occupé à un travail « léger », continu. Interprétation : cette association de travail et de chaleur impose à l'ouvrier des conditions qui vraisemblablement ne seront pas excessives et n'auront pas d'effet cumulatif s'il est en bonne santé.

b) Le point B représente une fréquence cardiaque de 142 puls/min chez un homme occupé à un travail « modéré » dans une ambiance chaude. Interprétation : cette association de travail et de chaleur serait supportée pendant au moins quelques minutes par un homme jeune en bonne condition physique, mais toute exposition durable lui imposerait une charge excessive tant en raison d'une augmentation de la température centrale que de l'excès d'effort physiologique. Les périodes de récupération (pauses) sont une nécessité physiologique pour éviter les effets cumulatifs et la fatigue.

La figure 2 permet donc de trouver la signification des fréquences cardiaques observées. Mais l'usager du diagramme doit être averti que les positions exactes des lignes sont variables même chez des hommes jeunes en bonne condition physique. De plus, les fréquences cardiaques observées peuvent dépendre de divers facteurs tels que l'âge, le sexe et l'état général de santé.

Pour les sujets assis, ou au repos dans toute autre position, et exposés à la chaleur, la fréquence cardiaque n'est pas le meilleur indice d'astreinte physiologique. Des recherches en laboratoire donnent à penser que 110 puls/min représentent un maximum admissible, mais ce chiffre n'est lui aussi applicable à l'industrie que sous toutes les réserves précitées.

Compte tenu de l'ensemble des considérations précédemment exposées, il est recommandé d'accorder la priorité aux recherches sur la fréquence cardiaque pendant le travail et la période de récupération.

2.4 Température centrale

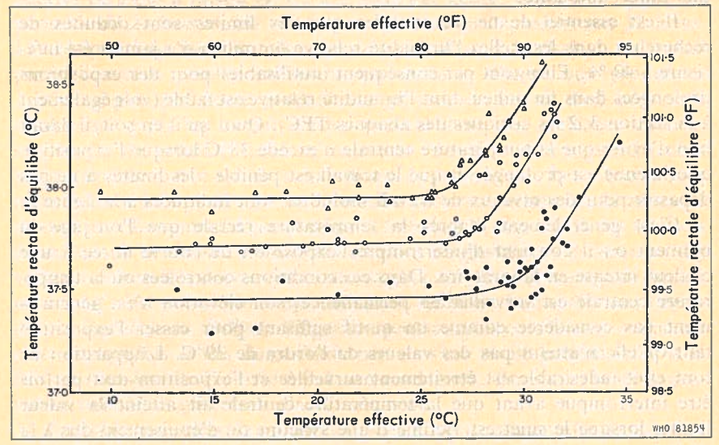
Le système thermorégulateur règle la température de tous les tissus corporels. Il est clair cependant que si l'on peut admettre de larges variations de la température des membres et des tissus périphériques du reste de l'organisme, la température des tissus profonds de la tête, du cou et du tronc doit rester dans des limites très étroites pour éviter l'incapacité professionnelle, la maladie ou l'invalidité, sinon même la mort. Il est difficile de savoir si la température rectale ou toute autre température des tissus profonds peut constituer à elle seule une mesure précise de l'astreinte thermique car elle est affectée par l'exercice musculaire, l'ingestion d'aliments, les variations au cours de la journée et la maladie. La température centrale peut néanmoins être prise comme indice de contrainte thermique si les conditions sont minutieusement définies.

Théoriquement, des limites de température centrale acceptables pour une exposition quotidienne prolongée dans l'industrie ne devraient être suggérées qu'à partir d'informations adéquates sur les effets de l'exposition quotidienne à la chaleur pendant de nombreuses années. Malheureusement, on ne dispose pas de ce genre d'informations et le seul fait certain est que toute augmentation de la température centrale due à une contrainte thermique ambiante est indésirable du point de vue de la santé en général. Nielsen [1] a montré que, dans une large gamme d'ambiances froides, fraîches et confortables, la température centrale augmente pendant le travail jusqu'à un niveau qui est déterminé par le niveau d'activité musculaire mais ne dépend pas de l'environnement. Cependant, il est notoire que dans les climats chauds le travail élève davantage la température centrale. Plusieurs études ont été entreprises, visant à augmenter la contrainte thermique ambiante à un point tel que la température centrale ne puisse plus dépendre uniquement de l'activité musculaire mais doive atteindre un niveau d'équilibre supérieur à celui qui correspond à une ambiance fraîche et agréable. En fait, on a observé que, même dans les climats tempérés, la température centrale n'est jamais complètement indépendante de la température ambiante, mais augmente en même temps qu'elle. Cet effet était particulièrement net chez les sujets assis et s'atténuait lorsque le rythme de travail augmentait. Pour une grande variété d'ambiances, fraîches et confortables, la température centrale était presque indépendante de la température extérieure mais, au-delà d'un certain seuil, de petites augmentations de cette dernière provoquaient une élévation nette du niveau d'équilibre de la température

[1] Nielsen, M. (1938) *Skand. Arch. Physiol.*, **79**, 193.

centrale. La fréquence cardiaque se comportait essentiellement de la même façon ; en fait certains auteurs ont prétendu que les variations de la température centrale résultent de changements de la fonction cardio-vasculaire mais que la température centrale, étant plus stable, reflète plus nettement l'effet des variations de la température extérieure. Pour une exposition quotidienne prolongée à la chaleur, on peut choisir une valeur limite définissant l'état du milieu au-dessous duquel la température centrale est principalement fonction de la vitesse des transformations métaboliques, et

FIG. 3. TEMPÉRATURE RECTALE D'ÉQUILIBRE À DIFFÉRENTS RÉGIMES DE TRAVAIL DANS DIVERSES CONDITIONS CLIMATIQUES



● dépense énergétique = 2,6 kcal·kg⁻¹·h⁻¹
○ dépense énergétique = 4,3 kcal·kg⁻¹·h⁻¹
△ dépense énergétique = 6,6 kcal·kg⁻¹·h⁻¹

Toutes les mesures sont rapportées au même sujet.

D'après Lind, A. R. (1963) *J. appl. Physiol.*, **18**, 51.

non de la contrainte thermique climatique. Cette valeur peut être établie pour différents taux de travail à l'aide des abaques de température effective corrigée (TEC), décrits à la section 3.2, qui permettent d'exprimer par un seul nombre les divers facteurs climatiques du milieu. La figure 3, où les résultats relevés sur de nombreux sujets sont représentés comme caractéristiques d'un seul, illustre la méthode. Selon celle-ci, les limites de la TEC dans le milieu ambiant semblent être de 30°C pour un travail sédentaire

et léger (2,6 kcal · kg^{-1} · h^{-1}), de 28°C pour un travail modéré (4,3 kcal · kg^{-1} · h^{-1}) et de 26,5°C pour un travail pénible (6,6 kcal · kg^{-1} · h^{-1}).

On a montré également que divers facteurs couramment rencontrés dans l'industrie, qui semblaient devoir affecter les limites ambiantes critiques — variation individuelle, âge des hommes exposés, horaire de travail quotidien, fréquence des maladies dues à la chaleur, etc. — n'avaient en réalité aucune influence. Les limites indiquées ci-dessus s'appliquent à des hommes non acclimatés ou qui ne le sont que peu. On sait que l'acclimatement est l'un des facteurs qui modifient ces limites et il serait réaliste de prévoir une augmentation de 2°C de la TEC pour les sujets adaptés. Il est recommandé d'appliquer dans l'industrie ces limites critiques de la contrainte thermique ambiante.

Il est essentiel de ne pas oublier que ces limites sont déduites de recherches dans lesquelles l'humidité relative du milieu n'a jamais été inférieure à 40 %. Elles sont par conséquent inutilisables pour des expositions prolongées dans un milieu dont l'humidité relative est faible (voir également à la section 3.2 les critiques des abaques TEC). Quoi qu'il en soit, il paraît bon d'éviter que la température centrale n'excède 38°C lorsque l'exposition quotidienne est prolongée et que le travail est pénible : les limites à ne pas dépasser pour des niveaux de travail moindres sont indiquées à la figure 3.

C'est généralement d'après la température rectale que l'on juge du moment où il convient d'interrompre l'exposition de courte durée à une chaleur intense en laboratoire. Dans ces conditions contrôlées où la température centrale est surveillée en permanence, son élévation n'est généralement pas considérée comme un motif suffisant pour cesser l'exposition tant qu'elle n'atteint pas des valeurs de l'ordre de 39°C. L'apparition de tout effet indésirable est étroitement surveillée et l'exposition doit parfois être interrompue avant que la température centrale ait atteint la valeur limite, lorsque le sujet est victime d'une syncope ou d'épuisement dus à la chaleur ou que l'on constate un risque imminent de syncope ou d'épuisement. La proportion d'individus réagissant ainsi varie avec l'état d'acclimatement et, peut-être aussi, avec l'âge, la forme physique, etc. Il n'est pas facile de fixer une limite de température rectale spécifiquement applicable aux hommes exposés brièvement à une contrainte thermique importante, par exemple au cours de travaux de sauvetage dans les mines, car les malaises aigus dus à la chaleur, en particulier la syncope d'origine thermique, peuvent se produire alors que la température rectale est vraiment basse. Lorsqu'il est indispensable de limiter le temps d'exposition et qu'il est prévu que la température centrale atteindra 38°C, il convient de consulter un spécialiste.

2.5 Déperdition thermique par sudation

L'aptitude de l'homme à exécuter un travail dans un milieu dont la température approche ou dépasse sa température corporelle peut être attribuée à la capacité fonctionnelle de son mécanisme de sudation. L'homme peut produire 1 litre de sueur par heure et, dans des circonstances favorisant l'évaporation, pourrait théoriquement éliminer 600 kcal/h. Mais en pratique, l'évaporation atteint rarement ce niveau.

La sudation doit être envisagée de deux points de vue : *a*) le maintien de l'équilibre hydrominéral, compte tenu de la capacité fonctionnelle des glandes sudoripares ; *b*) la valeur de la sudation comme critère de la charge thermique totale imposée au système thermorégulateur.

En ce qui concerne le premier de ces aspects, la littérature signale qu'un sujet exposé à la chaleur en laboratoire a produit 2 litres de sueur en 30 minutes et qu'il est courant que des hommes transpirent pendant de courtes périodes à raison de 1,5 à 2 litres par heure. Cependant, pour des périodes de 24 heures, les valeurs enregistrées ne dépassent pas 12 litres. Les observations faites sur des ouvriers exécutant à la chaleur un travail particulièrement pénible indiquent que certains d'entre eux produisent 1 litre ou plus par heure pendant une période de travail de 8 heures. Il semble que pour un travail normal exécuté dans une ambiance chaude, ce pouvoir de sudation suffise à maintenir l'équilibre thermique. La véritable astreinte porte sur le métabolisme hydrominéral. Les observations recueillies en laboratoire et sur le terrain prouvent nettement la nécessité de mettre suffisamment d'eau potable et fraîche à la disposition des ouvriers travaillant à la chaleur ; c'est aux services de gestion qu'il incombe d'y veiller. Les hommes doivent être encouragés à absorber davantage de liquide car la soif n'est pas toujours une incitation suffisante à remédier aux déperditions liquidiennes. Différer l'ingestion pendant plusieurs heures — comme c'est quelquefois le cas dans l'industrie — s'est révélé préjudiciable à la fois au bien-être de l'individu et à son rendement. En outre, la déshydratation retarde le processus d'acclimatement.

Il semble que, dans de nombreux pays, l'apport alimentaire de chlorure de sodium permette la production d'au moins 5 litres de sueur par période de travail de 8 heures chez les hommes acclimatés, sans rupture de l'équilibre minéral. Lorsque les occupations exigent un débit sudoral élevé, un complément de sel est recommandé.

Pour ce qui est de sa valeur comme critère de la charge thermique, il semble que la sudation, dans des conditions où elle peut assurer le maintien de l'équilibre thermique, soit ajustée par l'organisme au niveau strictement nécessaire pour maintenir cet équilibre. Il y a évidemment des circonstances dans lesquelles se trouve dépassé le pouvoir sudoral maximal, ou la capacité d'évaporation du milieu à évaporer la sueur produite. Si la réaction sudorale est insuffisante, par exemple éventuellement chez les sujets non acclimatés, la température corporelle augmente et les effets de cette élévation peuvent représenter un réel danger pour la santé. Si l'humidité élevée du milieu limite l'évaporation de la sueur, il peut en résulter une rétroaction positive. La température de la peau augmente, ce qui force la température

centrale à s'élever et ces deux phénomènes suscitent la production d'une plus grande quantité de sueur profuse ; celle-ci est sans valeur pour la thermorégulation car, au lieu de s'évaporer, elle coule simplement sur la peau et imprègne les vêtements.

Lorsque la tension de vapeur du milieu ambiant est élevée, un autre mécanisme entre en jeu qui semble destiné à conserver l'eau et qui conduit à une diminution de la sudation. Ce phénomène, quelquefois appelé hidroméiose, présente des caractéristiques particulières — la production de la sueur est réduite après 1 ou 2 heures d'exposition à un milieu humide, mais cette réduction n'est jamais assez grave pour diminuer considérablement le refroidissement effectif par évaporation dans le milieu considéré.

Il importe de noter que ce mécanisme permet la production de grandes quantités de sueur, souvent sans signes d'astreinte physiologique intense à condition que la tension de vapeur ambiante soit faible ; si elle est élevée, l'astreinte physiologique peut être excessive.

Il est clair que le débit sudoral fournit une bonne indication de la charge thermique et, lorsque la tension de vapeur est élevée, de l'évaporation lente de la sueur. Elle peut ou non indiquer l'astreinte physiologique chez un sujet donné, dans des circonstances déterminées. Par exemple, l'élimination d'un litre par heure dans un milieu désertique peut rétablir l'équilibre menacé par une charge thermique totale — métabolique et ambiante — de 600 kcal/h (rendement 100 %), avec une astreinte cardio-vasculaire faible et sans élévation de la température corporelle. Cependant, la même intensité de sudation chez un sujet habillé, placé dans une ambiance humide, pourrait s'accompagner d'une astreinte intense si l'évaporation n'était que de 0,5 litre et si une partie de la sueur restait imprégnée dans les vêtements ou coulait simplement sur la peau.

L'excrétion sudorale quadrihoraire prédictible (P4SR) est un indice de contrainte thermique largement utilisé ; d'après McArdle lorsque cet indice dépasse 4,5, le nombre d'hommes qui, bien qu'acclimatés trouvent insupportables les conditions ambiantes, augmente. Une description de l'abaque P4SR et de ses limites d'utilisation est donnée dans la section 3.3.

3. INDICES DE CONTRAINTE THERMIQUE

3.1 Introduction

On a souvent tenté de rassembler en un seul indice les effets de deux ou plusieurs des divers facteurs qui influent sur les échanges thermiques entre l'homme et le milieu ambiant. Il s'agissait soit *a*) de concevoir des instruments destinés à jouer le rôle de modèles du corps humain, soit *b*) d'établir des formules ou des nomogrammes, sur des bases théoriques

ou empiriques, afin d'estimer la contrainte imposée par une large gamme de conditions de travail et de climat, ou d'estimer les astreintes physiologiques résultant de cette contrainte.

Quatre déterminations au moins sont nécessaires pour caractériser une ambiance chaude : la température de l'air (t_a), la température lue au thermomètre mouillé, dite température humide (t_h), la température lue au thermomètre sous globe noir (t_g), ou toute autre mesure du rayonnement thermique, et la vitesse de l'air (V_a). La tension de la vapeur d'eau dans l'air (humidité) peut se déduire de t_a et t_h sur un diagramme psychrométrique. La température de rayonnement moyenne de l'environnement se déduit de t_a, t_g et V_a. Ces mesures et les données de base sur la constitution physique, les vêtements, l'activité métabolique et le profil énergétique, permettent de déterminer la charge et les échanges thermiques de l'organisme. Toutes ces données représentent le minimum acceptable pour évaluer la contrainte thermique professionnelle. Il est indispensable qu'elles soient consignées pour que les conditions des différentes enquêtes soient comparables entre elles.

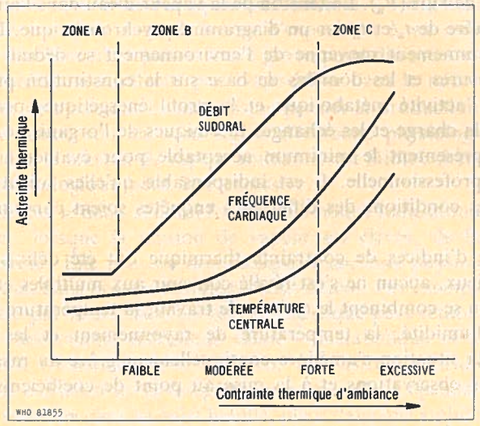
Nombre d'indices de contrainte thermique ont été définis. Après un examen sérieux, aucun ne s'est révélé convenir aux multiples et complexes situations où se combinent le rythme de travail, la température et la vitesse de l'air, l'humidité, la température de rayonnement et les vêtements. Toutefois, la situation s'améliore continuellement grâce au rassemblement de nouvelles observations et à la mise au point de coefficients d'échange thermique.

Pour les raisons indiquées ci-après, l'emploi dans l'industrie des quatre indices suivants est recommandé : la *température effective corrigée* (TEC), l'*excrétion sudorale quadrihoraire prédictible* (P4SR), l'*indice de contrainte thermique* de Belding & Hatch (HSI) et un *indice de contrainte thermique* (ITS) récemment décrit par Givoni.

Ces indices sont de différents types. Tous essayent de présenter un abaque sur lequel un nombre donné peut correspondre à diverses combinaisons des variables climatiques, des vêtements et, dans la plupart des cas, du travail. Les abaques TEC et P4SR revêtent la forme de nomogrammes, construits empiriquement d'après des observations expérimentales, abstraction faite de la façon dont ils ont été obtenus. Il est donc impossible de les remanier en fonction des observations les plus récentes, de manière à en élargir l'emploi ou à en améliorer la précision. L'inconvénient est grave lorsque ces abaques doivent être utilisés dans des conditions qui exigent une extrapolation par rapport aux données initiales. Les abaques HSI et ITS sont tous deux dressés d'après des coefficients d'échange thermique déterminés au préalable ; leur portée et leur précision dépendent donc des limites de ces coefficients. Ils offrent ainsi l'avantage de possibilités d'amélioration quant à l'intervalle d'application et à la précision, grâce à la prise en compte des données les plus récentes.

Il est intéressant d'envisager certaines des conséquences des réponses physiologiques à une contrainte thermique croissante, du point de vue de la ou des mesures physiologiques qu'il convient de choisir pour établir les indices de cette contrainte. A cet égard, la figure 4, qui représente

FIG. 4. VARIATIONS DU DÉBIT SUDORAL, DE LA FRÉQUENCE CARDIAQUE ET DE LA TEMPÉRATURE CENTRALE EN FONCTION DE LA CONTRAINTE THERMIQUE AMBIANTE



ZONE A : Absence de contrainte thermique.

ZONE B : Contrainte thermique croissante, débit sudoral en augmentation rapide presque linéaire, mais température centrale à peine altérée dans la majeure partie de la zone. L'astreinte est une fonction exponentielle de la fréquence cardiaque. Le débit sudoral est un bon indice de l'astreinte thermique.

ZONE C : Contrainte thermique croissante, débit sudoral presque maximal ou maximal inutilisable comme indice de la contrainte ou de l'astreinte. Fréquence cardiaque et température centrale augmentent rapidement, ce sont les meilleurs indices physiologiques de l'astreinte.

schématiquement les variations du débit sudoral, de la fréquence cardiaque et de la température centrale en fonction de la contrainte thermique ambiante, est révélatrice.

La contrainte thermique est portée en abscisses et l'astreinte thermique en ordonnées. Lorsque la contrainte thermique ambiante est faible (première partie de la zone B) pour un niveau de travail donné, la sudation augmente en même temps que la contrainte, alors que la fréquence cardiaque et la température centrale restent sensiblement constantes. Dans ces conditions, l'élévation rapide de la sudation constitue évidemment un meilleur indice de contrainte thermique que la fréquence cardiaque et la température centrale, considérées seules ou en association. Dans tous les cas, il a été démontré que, pour une contrainte thermique de cet ordre,

des quantités équivalentes de chaleur métabolique ou ambiante affectent différemment la fréquence cardiaque et la température centrale. Ainsi, la réponse de la fréquence cardiaque à une augmentation de 100 kcal de la chaleur métabolique est le double de la réaction à une même augmentation de la chaleur ambiante, alors que la température centrale varie à peu près également dans les deux cas. La contrainte thermique dans la zone B de la figure 4 peut être considérée comme faible au début de la sudation et forte lorsque les pertes sudorales approchent de leur valeur maximale. La zone C apparaît donc comme une zone de contrainte thermique excessive et l'excrétion sudorale, puisqu'elle varie peu lorsque la contrainte thermique augmente, ne semble pas raisonnablement fournir une mesure satisfaisante de celle-ci. C'est dans cette zone que se produisent les variations les plus importantes de la fréquence cardiaque et de la température centrale pour une exposition d'une durée déterminée ; par conséquent, si l'indice de contrainte doit être basé sur des réponses physiologiques, il serait logique d'utiliser pour les contraintes extrêmes l'un ou l'autre de ces paramètres ou les deux. Sinon l'indice devrait refléter une association des facteurs de milieu.

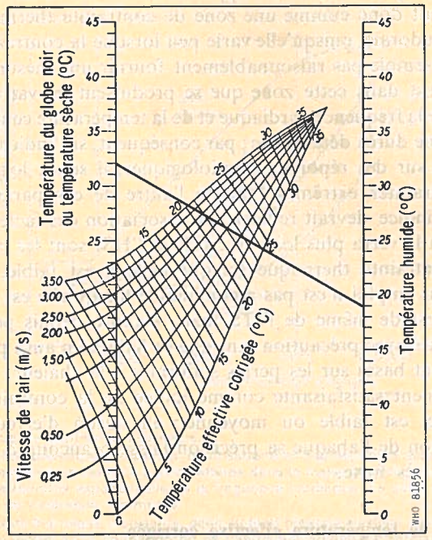
Comme on le verra plus loin, le P4SR et l'HSI sont les indices les plus sûrs de la contrainte thermique lorsque celle-ci est faible, moyenne ou forte, mais leur emploi n'est pas recommandé lorsqu'elle est excessivement élevée ; il en est de même de l'ITS mais, élaboré depuis peu, ce dernier devra être utilisé avec précaution tant que sa fiabilité n'aura pas été établie. Ces indices sont basés sur les pertes sudorales à la chaleur. La TEC n'est que moyennement satisfaisante comme indice de la contrainte thermique lorsque celle-ci est faible ou moyenne ; en raison d'erreurs inhérentes à la construction de l'abaque sa précision laisse beaucoup à désirer en cas de contrainte très forte.

3.2 Abaques de température effective corrigée

Les abaques de température effective (TE) et de température effective corrigée (TEC) existent respectivement depuis 40 et 20 ans. Ils ont été largement utilisés et présentent l'avantage d'être bien connus et d'un emploi facile. A l'origine les abaques de TE ont été conçus pour apprécier le confort d'hommes assis ou affectés à un travail léger, mais par la suite est apparue la possibilité de s'en servir plus généralement pour obtenir un indice de contrainte thermique dans l'industrie. Il existe deux abaques, l'un se rapportant à des hommes travaillant nus jusqu'à la ceinture, l'autre à des hommes complètement habillés pour le travail sous abri. Ils avaient été primitivement conçus pour évaluer l'impression subjective de confort donnée par une association de la température sèche, de la température humide et de la vitesse de l'air, en utilisant comme référence un air calme, saturé d'humidité donnant la même impression immédiate de chaleur que le milieu étudié. Plus tard, la température de l'air ayant été remplacée par la

température du globe noir pour tenir compte de la chaleur de rayonnement, les abaques ont été dits « de température effective corrigée ». La valeur du procédé employé pour tenir compte de la chaleur de rayonnement due au milieu ambiant a été prouvée par des expériences faites avec des charges thermiques rayonnantes déterminant des températures de rayon-

FIG. 5. ABAQUE DE BASE DE LA TEMPÉRATURE EFFECTIVE CORRIGÉE (TEC) POUR DES HOMMES NUS JUSQU'À LA CEINTURE



D'après Lavenne, F. (1965) *Rev. Inst. Hyg. Mines*, 20, N° 1, p. 3.

nement moyennes supérieures de 18°C aux températures de l'air. Rien n'est prévu dans le système des températures effectives pour tenir compte des différents taux de dépense énergétique. L'abaque « de base » de la TEC pour des hommes travaillant nus jusqu'à la ceinture est représenté à la figure 5. L'abaque « normal » de la TEC pour des hommes en tenue complète de travail sous abri est donnée ailleurs.[1]

Pour déterminer la TEC d'un milieu, il suffit de joindre en ligne droite le point qui représente la température de l'air (ou la température du globe noir) et celui qui représente la température humide, puis de noter l'inter-

[1] Voir, par exemple, Smith, F. E. (1955) Indices of heat stress, *Memor. med. Res. Coun.* (*Lond.*), N° 29, London, H. M. Stationery Office ; et Leithead, C. S. & Lind, A. R. (1964) *Heat stress and heat disorders*, London, Cassell, p. 276.

section de la droite avec la courbe diagonale allant de gauche à droite et correspondant à la vitesse de l'air. Il importe de ne pas oublier l'imprécision inhérente aux abaques s'ils sont utilisés dans des circonstances autres que celles initialement prévues. Il est notoire qu'ils exagèrent les effets des températures sèches élevées lorsque la vitesse de l'air est comprise entre 0,0 et 3,5 m/s et qu'ils sous-estiment les effets nocifs des ambiances chaudes et humides lorsque la vitesse de l'air est faible. Il est maintenant admis que des climats très différents de même TEC n'imposent pas la même astreinte physiologique à en juger par le temps de tolérance, la température rectale et la fréquence cardiaque. Une mise en garde s'impose contre l'utilisation des abaques TE et TEC comme base de règlements applicables à la pratique industrielle, à moins que ne soit prévue une marge d'erreur suffisante. En outre, les valeurs des indices TE et TEC perdent pratiquement toute signification dès lors qu'elles ignorent le niveau de travail des hommes exposés.

Ces abaques sont satisfaisants pour les cas de contrainte thermique légère, à condition que l'humidité relative ne sorte pas de certaines limites. Il est suggéré d'en éviter l'utilisation lorsqu'il s'agit de comparer entre eux des climats si l'humidité relative de l'un d'eux est inférieure à 40 %.

3.3 Excrétion sudorale quadrihoraire prédictible (P4SR)

L'abaque P4SR a été établi empiriquement [1] à partir des résultats d'une abondante série d'observations des pertes sudorales chez des hommes, vêtus d'un simple short ou d'une combinaison de travail, exposés en laboratoire à diverses ambiances et auxquels étaient imposées différentes dépenses énergétiques. Dans des limites assez larges, la contrainte thermique correspondant à un ensemble de conditions : température sèche, température humide, température du globe noir, déplacement de l'air, vêtements et niveau de travail, peut être évalué d'après un nomogramme. Elle est exprimée par l'excrétion sudorale prédictible, à l'erreur d'échantillonnage près, chez un groupe d'hommes jeunes, en bonne condition physique, acclimatés à la chaleur et exposés pendant 4 heures aux conditions indiquées. L'expression anglaise « sweat rate » est trompeuse puisque la valeur considérée n'est pas celle d'un débit sudoral (c'est-à-dire d'un volume de sueur excrété par unité de temps) mais d'une perte totale de liquide par sudation (c'est-à-dire de la somme des débits horaires successifs au cours d'une période de 4 heures). Il importe également de ne pas oublier que cette quantité est un indice de la contrainte et non de l'astreinte thermique, et que les sujets observés étaient de jeunes Européens, en bonne condition physique et acclimatés à la chaleur.

[1] McArdle, B. et al. (1947) The prediction of the physiological effects of warm and hot environments, *Royal Naval Personnel Research Committee*, *med. Res. Coun.* (*Lond.*), Report No. 47/391, London, H. M. Stationery Office.

L'emploi du nomogramme de l'indice P4SR pour trouver la valeur correspondant à une contrainte thermique donnée est convenablement exposé ailleurs,[1] il est donc inutile de le décrire ici. Principalement destiné à l'évaluation de la contrainte thermique, le nomogramme permet secondairement de prévoir l'ordre de grandeur des pertes sudorales et, par conséquent, les besoins en eau d'un groupe d'hommes exposés aux conditions étudiées.

Particulièrement précieux lorsqu'il est appliqué à des conditions qui ne sortent pas des limites des observations originales, l'abaque P4SR offre néanmoins des possibilités d'emploi considérables, mais il ne se prête à aucune modification, à aucun perfectionnement, ce qui restreint évidemment son intérêt pour les utilisateurs. Il présente aussi des inconvénients plus graves. Son application aux ambiances à degré d'humidité faible est imprécise ; elle n'est donc pas recommandée lorsque celui-ci descend à moins de 40 %. Le défaut inhérent au choix de la perte de liquide par sudation comme unité de référence tient à un fait abondamment reconnu : la production sudorale augmente avec l'acclimatement. Dans les climats chauds et secs cette augmentation est de l'ordre de 10 à 15 % ; dans les climats chauds et humides, elle peut aller jusqu'à 60 %. En outre, le travail dans une ambiance très chaude et très humide conduit rapidement à la diminution de la sudation d'origine thermique dont il a été question plus haut.

Naturellement nombre de ces critiques peuvent être également formulées à l'encontre d'autres indices de tension thermique, et la difficulté d'emploi de l'abaque P4SR dans l'industrie pour des hommes ne travaillant dans un milieu chaud que par intermittence au cours d'une journée de travail de 8 heures est regrettable. L'emploi de l'abaque P4SR est acceptable pour les contraintes thermiques modérées à fortes, surtout si les conditions restent suffisamment stables pendant une période d'environ 4 heures.

3.4 Indices d'équilibre thermique

La notion de calorimétrie fractionnelle, c'est-à-dire la détermination séparée, selon des principes physiques, des quantités de chaleur échangées par les diverses voies, est due à Winslow et al. (1936). Les coefficients originaux ont été améliorés une dizaine d'années plus tard. En 1955 Belding & Hatch [2] les ont utilisés dans la définition d'un nouvel indice de contrainte thermique (HSI). Celui-ci est déduit des flux de chaleur échangés avec l'ambiance par rayonnement et par convection ($R + C$) et de la production de chaleur métabolique (M) dont la somme représente la charge thermique totale à dissiper par évaporation (E_{req}) pour maintenir l'équilibre thermique. La possibilité que cet équilibre soit atteint dépend du rapport de E_{req} au pouvoir d'évaporation maximal calculé (E_{max}), en supposant toute la peau mouillée de sueur.

[1] Voir par exemple les références données dans la note de la page 27.

[2] Belding, H. S. & Hatch, T. F. (1955) *Heat. Pip. Air Condit.*, **27**, 129.

L'indice HSI ne permettait toutefois pas de prévoir convenablement le point critique où le rapport E_{req}/E_{max} est égal à 1,0 et au-delà duquel l'équilibre thermique est inaccessible, en partie à cause de l'imprécision des coefficients adoptés pour C et E_{max} (qui avaient été calculés pour des hommes travaillant nus jusqu'à la ceinture) et en partie parce qu'il n'était pas tenu compte du fait que le port de vêtements, même légers, réduit les échanges de chaleur par rayonnement, convection et évaporation (R, C et E). Les auteurs ont alors introduit des modifications visant à remédier à ces deux inconvénients. Les coefficients actuellement utilisés pour calculer les valeurs correspondant à l'homme standard, de 70 kg, travaillant nu jusqu'à la ceinture, sont :

$$R = 11\,(t_w - 35)\ \text{kcal/h}$$

La température moyenne de rayonnement t_w peut être déterminée à partir de la température du globe noir t_g (°C), de la vitesse de l'air V (en m/s) et de la température de l'air, t_a, par la formule :

$$t_w = t_g + 14{,}4\,V^{0,5}\,(t_g - t_a)$$

Dans les mêmes conditions d'exposition :

$$C = 6\,V^{0,6}\,(t_a - 35)\ \text{kcal/h}$$

Dans les deux cas, 35°C est la température approximative de la peau, applicable au niveau critique pour lequel $E_{req} = E_{max}$.

E_{max} est une fonction de la différence entre la tension de vapeur d'eau de la peau complètement mouillée à 35°C, soit 42 mm Hg, et la pression de la vapeur d'eau dans l'air ambiant, P_a :

$$E_{max} = 12\,V^{0,6}\,(42 - P_a)\ \text{kcal/h}$$

Afin d'introduire une correction approximative pour tenir compte du port de vêtements légers, il a été provisoirement recommandé que chacun de ces coefficients soit réduit d'un tiers. Il s'agit d'un ajustement empirique basé sur un petit nombre d'observations et il a été établi que, théoriquement, les corrections de ces coefficients doivent dépendre de certaines caractéristiques des conditions ambiantes, par exemple de la couleur des vêtements portés au soleil et de la vitesse du vent.

Indice de contrainte thermique

L'indice de contrainte thermique de Givoni (ITS) est tiré d'un groupe d'équations qui forment un modèle mathématique décrivant les mécanismes

biophysiques qu'implique le maintien de l'équilibre thermique entre le corps et le milieu ambiant, compte tenu des variations du pouvoir thermolytique de la sudation.[1] Comme l'HSI, l'ITS repose sur la quantité de sueur nécessaire pour assurer un refroidissement par évaporation qui maintienne l'équilibre thermique ; on peut apporter une correction qui tienne compte de l'influence des divers types de vêtements et de rayonnement solaire, mais l'étude de cet indice pour une ambiance à chaleur de rayonnement de grande longueur d'onde n'a pas encore été faite. L'ITS fournit une estimation linéaire continue de la contrainte thermique ; il est utilisable pour évaluer l'astreinte physiologique lorsque la sudation reflète la charge thermique. Au-delà de cette limite, il permet d'estimer la contrainte mais non l'astreinte physiologique. Comme le P4SR et l'HST, l'ITS peut servir à déterminer les besoins d'eau. Sa valeur de prédiction pour une large gamme d'ambiances est analogue à celle du P4SR dans les conditions où celui-ci est applicable. Il présente l'inconvénient d'être fondé uniquement sur la sudation et par conséquent d'être inutilisable lorsque les facteurs limitatifs sont la fréquence cardiaque et la température rectale.

La formule de base de l'ITS est la suivante :

$$S = (M \pm C \pm R) \times \frac{1}{f} = E\left(\frac{1}{f}\right)$$

où S représente le débit sudoral requis, M la production de chaleur métabolique, C et R les échanges caloriques par convection et par rayonnement (en kcal/h), f le rendement thermolytique de la sudation et E l'évaporation nécessaire à la dissipation de la charge thermique totale.

C, R et f dépendent des facteurs d'ambiance et des vêtements et se calculent par les formules générales suivantes :

$$C = \alpha V^{0,3}\,(t_a - 35)$$

$$R = k_{cl}\,(k_e \cdot k_p)\,I_N\,[1 - a\,(V^{0,2} - 0{,}88)]$$

$$\frac{1}{f} = e^{0,6}\left(\frac{E}{E_{max}} - 0{,}12\right)$$

$$E_{max} = \beta\, V^{0,3}\,(42 - P_a)$$

où α, k_{cl}, a et β dépendent des vêtements portés, k_e dépend du pouvoir réfléchissant de l'environnement, k_p de la posture de l'ouvrier, t_a est la température de l'air (°C), I_n l'intensité du rayonnement mesuré normalement aux rayons solaires (kcal/h), V la vitesse de l'air (m/s), e la base des logarithmes népériens, E_{max} le pouvoir d'évaporation de l'air (kcal/h), et P_a la pression de vapeur d'eau dans l'air (mm Hg).

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[1] Givoni, B. (1962) *The influence of work and environmental conditions on the physiological responses and thermal equilibrium of man.* In : *Proceedings of a UNESCO Symposium on Arid Zone Physiology and Psychology, Lucknow, Inde.*

Les valeurs du produit $k_e k_p$ pour différents milieux et différentes postures sont indiquées dans le tableau suivant :

Milieu	*Coefficient de rayonnement*	
	Position assise, dos au soleil	*Position debout, dos au soleil*
très réfléchissant (désert)	0,396	0,324
peu réfléchissant (forêt) .	0,377	0,266

Le tableau suivant indique les valeurs de α, β, k_{cl} et a pour divers vêtements :

Coefficient d'habillement	*Short (torse nu)*	*Vêtement d'été léger*	*Tenue (militaire) de treillis*
α	15,8	13,0	11,6
β	31,6	20,5	13,0
k_{cl}	1,0	0,5	0,4
a	0,35	0,52	0,52

Conclusions

Tous les indices de contrainte thermique décrits ci-dessus, ainsi que d'autres non examinés ici, sont considérés comme ayant rendu des services entre des limites déterminées. A long terme, la méthode de l'équilibre thermique semble devoir se prêter aux applications les plus larges car elle vise à mettre au point un indice rationnel basé sur les principes physiques des échanges de chaleur. Mais l'important problème que pose le rapport entre les astreintes physiologiques réelles telles que l'élévation de la fréquence cardiaque et la température centrale n'est encore que très incomplètement résolu.

4. RECHERCHES RECOMMANDÉES

Des discussions du Groupe il ressort nettement qu'à de nombreux égards nos connaissances sur les expositions professionnelles à la chaleur

sont insuffisantes. Voici, énumérés par ordre de priorité décroissante, les problèmes qui appellent de nouvelles recherches :

1. Les mécanismes physiologiques suscitant les modifications de la fréquence cardiaque pendant et après l'exposition professionnelle à une contrainte thermique ne sont pas parfaitement élucidés. De nouvelles études sont donc nécessaires pour mieux interpréter la fréquence cardiaque. Il faudrait aussi mettre au point une méthode type applicable à la collecte des données sur les taux de récupération, notamment en ce qui concerne la durée des observations et la posture du sujet.

2. Les indices d'équilibre thermique actuellement utilisés ne permettent pas de déterminer spécifiquement l'astreinte physiologique qui résulte d'une exposition à la chaleur ; il y a lieu de penser que leur interprétation dépend partiellement de la production de chaleur métabolique. Des recherches s'imposent pour déterminer la corrélation entre, d'une part, ces indices et, d'autre part, la fréquence cardiaque et la température centrale.

3. Les effets d'expositions prolongées à la chaleur (qu'elles soient professionnelles ou climatiques) sur le bien-être et le rendement au travail sont mal connus. On a admis que, tant qu'elle ne perturbe pas la température centrale, l'exposition professionnelle à la chaleur ne nuit pas à la santé ; c'est une hypothèse que des recherches épidémiologiques faites au moyen de données recueillies dans l'industrie concernant la santé et le rendement des ouvriers devraient aider à contrôler.

4. On est assez mal renseigné sur la contrainte et l'astreinte dues au travail à la chaleur par intermittence, ainsi que sur les possibilités d'application des indices de contrainte thermique dans ce cas. Il faudrait recueillir des données sur les points suivants : influence de la capacité thermique du vêtement sur le gain et la déperdition de chaleur ; influence du choc thermique, dû au froid dans la salle de récupération, sur les maladies respiratoires infectieuses ; espacement optimal des périodes de travail et intervalles de récupération (pauses) ; effets généraux des expositions professionnelles à la chaleur lorsque les travailleurs vivent dans une ambiance très froide (à taux d'humidité faible) ; enfin, méthodes d'évaluation de l'astreinte résultant d'une exposition intermittente.

5. Certaines études indiquent que la contrainte thermique influe sur la concentration, l'apprentissage, la vigilance, les performances psychomotrices, etc., et qu'elle n'est pas étrangère à certains accidents, mais on manque à ce sujet de renseignements quantitatifs.

6. Les associations de facteurs modifiant la charge thermique forment une gamme si vaste que dans aucune recherche elles n'ont toutes été prises en considération. Il est donc urgent de consacrer des études intensives aux effets de diverses associations contrôlées de travail et de chaleur ambiante. Elles devraient porter sur une grande variété de sujets présentant

des caractéristiques physiques différentes ; âge, sexe, constitution physique, etc. L'échange d'informations et le contrôle des conditions expérimentales entre laboratoires, d'une part, et laboratoires et industrie, d'autre part, sont indispensables. Des méthodes modernes de traitement par ordinateur, devraient permettre la rationalisation de ces données complexes.

7. Les valeurs numériques concernant la dépense énergétique et les échanges thermiques sont généralement rapportées à l'homme standard. Pour certains travaux, ces chiffres peuvent être adaptés à d'autres tailles et constitutions physiques par simple correction en proportion du poids corporel, mais dans le cas des professions qui exigent une dépense énergétique extérieure, par exemple soulever et porter des objets, cette simple correction n'est pas nécessairement suffisante. Pour tenir compte des différences de force musculaire et d'autres caractéristiques physiques, les rapports doivent être établis empiriquement.

8. De nouvelles études s'imposent pour préciser les effets des vêtements sur les échanges thermiques par diverses voies.

9. Une étude serait aussi nécessaire afin d'évaluer quantitativement l'importance de la température cutanée en association avec d'autres facteurs, pour essayer d'élucider et de déterminer les rapports entre la contrainte et l'astreinte.

10. Il faudrait mettre au point de nouvelles méthodes pour faciliter l'étude du rapport chaleur/travail chez des ouvriers exécutant diverses tâches. Peut-être pourrait-on concevoir un intégrateur de contrainte thermique que porterait l'ouvrier.

11. Il conviendrait de recueillir des renseignements concernant les problèmes spéciaux d'échange thermique et de lésion des tissus par la chaleur lorsque l'organisme est en contact direct avec des solides ou des liquides de conductivité élevée.

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Annexe

CONVENTIONS ET RECOMMANDATIONS DE L'ORGANISATION INTERNATIONALE DU TRAVAIL DONT CERTAINES SECTIONS TRAITENT DU TRAVAIL À LA CHALEUR

Convention N° 89 : *Travail de nuit des femmes occupées dans l'industrie* (Révisée en 1948), Article 7

Convention N° 90 : *Travail de nuit des enfants dans l'industrie* (Révisée en 1948), Article 4

Convention N° 120 : *Hygiène dans le commerce et les bureaux* (1964), Article 10

Convention N° 127 : *Poids maximum des charges pouvant être transportées par un seul travailleur* (1967)

Recommandation N° 97 : *Protection de la santé des travailleurs sur les lieux de travail* (1953), Article 2

Recommandation N° 120 : *Hygiène dans le commerce et les bureaux* (1964)
Partie IV. Aérage et ventilation
Partie VI. Température
Partie VIII. Eau potable

Recommandation N° 128 : *Poids maximum des charges pouvant être transportées par un seul travailleur* (1967), Article 13

N°		Prix Fr. s.	s.d.	$
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