NORD

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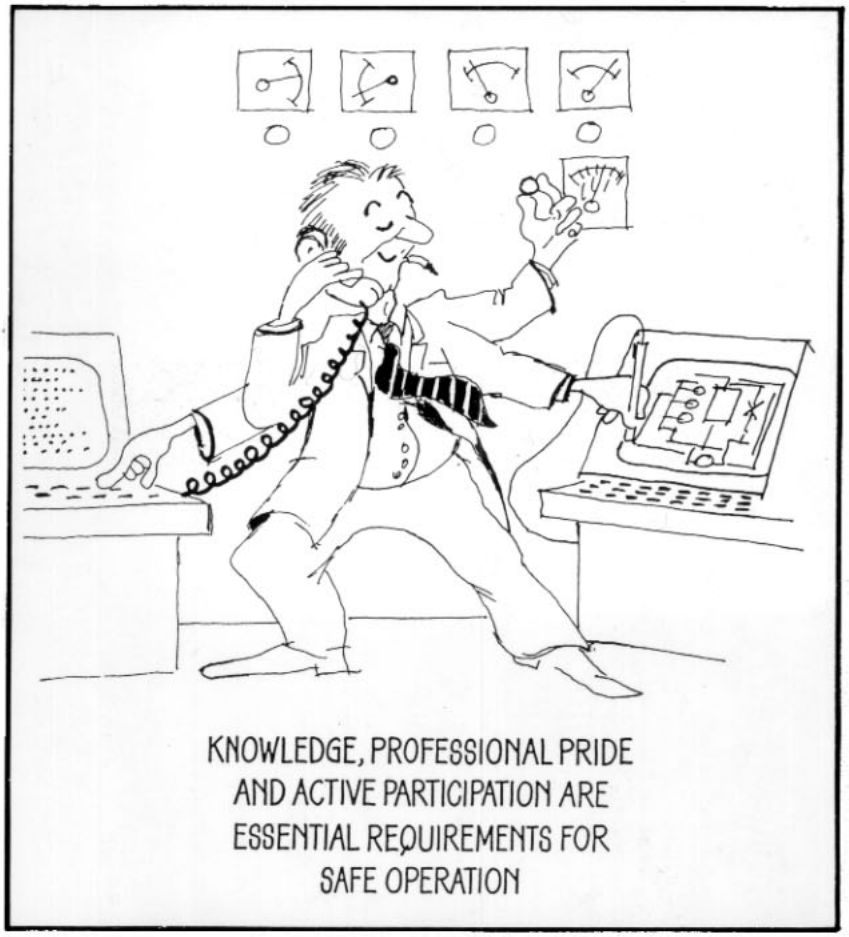
ORGANIZATION FOR SAFETY



KNOWLEDGE, PROFESSIONAL PRIDE
AND ACTIVE PARTICIPATION ARE
ESSENTIAL REQUIREMENTS FOR
SAFE OPERATION

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LIT(85)3

ORGANIZATION FOR SAFETY

FINAL REPORT OF THE NKA-PROJECT LIT-2

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ABSTRACT

Organizational questions are - in addition to equipment and personnel - of major importance when striving for a high safety level in industrial plants. A systematic procedure has been developed which enables organizations to make a check of their own safety oriented qualities. The report addresses professionals in charge of safety and personnel engaged in risk prone processes.

KEY WORDS

Behavior - Education - Ethical Aspects - Human Factors - Reliability - Industrial Plants - Information - Man-Machine Systems - Nuclear Power Plants - Organizational Models - Personnel - Planning - Power Generation - System Analysis

PREFACE.

The safety of nuclear power, as for other complicated industrial processes, depends on an accurate and timely execution of tasks during the operation. There is, however, always the possibility that human errors either directly or indirectly initiate an unwanted course of events.
The general aim is then to decrease the probability of human errors and to increase the probability of their detection. This is in principle made possible by a careful task design and by giving the human operator an appropriate training. This means in practice that one should consider the tools of the operator, the organization he is working in, and the training he is given. All these aspects have been addressed in the Nordic LIT - research programme over the period 1981 to 1985.

The Nordic LIT - research programme has concentrated on:

- human errors in test and maintenance (LIT - 1)
- safety oriented organizations and human reliability (LIT - 2)
- computer aided design of control rooms and plant automation (LIT - 3.1)
- computer aided operation and experimental validation (LIT - 3.2 and LIT - 3.3)
- planning and evaluation of operator training (LIT - 4)

These fields of research were selected from the experience of an earlier phase of the Nordic cooperation (cf. the reference Wahlström, Rasmussen, 1983)

The Nordic LIT - programme involved a total effort of about 40 personyears of qualified researchers in Denmark, Finland, Norway and Sweden. The resarch programme has been financed partly by project funds from the Nordic Council of Ministers and partly by funds from the different participating organizations. The LIT - research programme was initiated by the Nordic Liasion Committee for Atomic Energy (NKA) as a

part of the Nordic cooperation in the field of safety in the energy production field. The following organizations have been financing and have also been directly involved in the LIT - research programme:

Risø National Laboratory, Roskilde, Denmark
Technical Research Centre of Finland (VTT),
Espoo, Finland
Institute for Energy Technology (IFE),Halden,Norway
Swedish Nuclear Power Inspectorate (SKI),
Stockholm, Sweden
Swedish State Power Board, Vällingby,Swden

The LIT - programme is reported in the following final reports:

- The human component in the safety of complex systems; LIT programme summary report, NKA/LIT (85) 1

- Human errors in test and maintenance of nuclear power plants - Nordic Project work; LIT - 1 final report,NKA/LIT (85)2

- Organization for safety; LIT - 2 final report, NKA/LIT (85) 3

- The design process and the use of computerized tools in in control room design; LIT 3.1 final report, NKA/LIT (85) 4

- Computer aided operation of complex systems; LIT - 3.2 and 3.3. final report, NKA/LIT (85) 5.

- Training in diagnostic skills for nuclear power plants; LIT - 4 final report, NKA/LIT (85) 6.

Reference

Wahlström,B. and Rasmussen,J. (1983): Nordic cooperation in the field of human factors in nuclear power plants. Nuclear Power Experience, IAEA Vienna, 1983,IAEA-CN-42/247, PP 281 - 290.

SUMMARY

When assessing safety in a production system, attention is concentrated mainly on safety measures related to plant construction and on staff qualification requirements. Too often the **plant organization**, which plays an important role when safety is concerned, is ignored.

The extensively documented TMI plant incident in the USA in 1979, as well as other events, as for instance the Seveso chemical reactor plant disaster in Italy, 1976, and the accident at Union Carbide's pesticide plant in Bhopal, India in 1984, have clearly demonstrated that deficiencies of plant organization contribute significantly to the origin and aggravation of process failure.

The present project has concentrated on the way in which organizational factors can affect safety.

The tasks of an organization are numerous and varied. In addition to management of normal operation, it is necessary to continuously assess and improve its understanding of the prevailing external conditions for existance. Thus, the surrounding social and environmental setting changes with time. Also, different periods in the life of the organization pose different challenges, from planning and construction via operation to shutdown - or decommissioning and dismantling. Changing external demands will influence work conditions for the operators, which in turn will affect the plant organization

To meet these problems, sets of rules are laid down to regulate work and work conditions for the staff. It is well known, that parallel to establishment of such rules, or **formal** organization, an **informal** organization evolves, which may match the formal organization in a positive or negative manner.

In the project several external and internal factors are discussed, relevant to the operator's influence on safety. Important issues are staff recruitment and training, as well as motivation, loyalty and attitudes towards the organization's objectives and basic values.

Organizational aims have ethical as well as economical components, and the staff should be able to identify themselves with its aims and values. But, also the individuals in the organization must have an opportunity to influence these aims and values. This calls for active participation, for which a prerequisite is flexible management and an adequate information system.

In the project a method is presented that can help an organization to examine, on its own, those factors of relevance to safety that may influence the overall safety level of the organization. The method includes, firstly, a descriptive model, defining and explaining important notions and factors, and secondly, a check-list to be used when applying the model in practice. The procedure can be used when unplanned events have occurred, or during normal operation in order to monitor weak signals from the organization. In the descriptive model special emphasis has been put on identification and description of factors that are relevant for safety. The model was developed with large, risk prone process plants in mind, as for instance chemical industry, energy production plants, transport systems and the like, but in principle it can be used on any kind of organization.

Disturbances in this kind of plants may threaten the environment as well as the plant itself. It is then of the utmost importance that the operator's work conditions are designed in a way that enables him to understand the process. They should also provide him with adequate professional support and guidance in difficult situations. A proper balance between industrial democracy, as well as a logical and unambiguous structure of command and responsibility, is necessary to achieve satisfaction, motivation, and real participation.

One may conclude that in spite of the steady influx of computer based process control systems, the human operator will, not least for safety consideration, maintain his role as the ultimate defence against disturbances that may occur because of lack of foresightedness, or because of external events influencing operation or plant status.

The operator has to be trained and equipped for this role. The procedure developed through the present project can be used to investigate the operator's work conditions, and assess where and how improvements are called for.

When organizing for safety there is a considerable risk of thinking in "technical" models - that is, securing safety by providing alternative ways of operating, for example by building **redundancies** into the technical system. Although seeming quite logical from an engineer's point of view, it could be dangerous if the system then became too complicated to provide efficient support to the operator when handling crises. A considerable contribution to overall system safety is the operator's acceptance and understanding of logic behind lines of responsibility and command, and behind procedures for operation.

SAMMENDRAG.

Ved planlegging av sikkerheten for et produksjonssystem konsentreres gjerne oppmerksomheten om sikkerhetstiltak i selve anleggskonstruksjonen, samt fastsettelse av krav til personalets kvalifikasjoner. Ofte uteglemmes **driftsorganisasjonen,** som spiller en viktig rolle også i sammenheng med sikkerhet.

Reaktoruhellet i 1979 ved TMI-anlegget i USA, sammen med mange andre hendelser, som for eksempel ulykkene i de kjemiske fabrikkene i Seveso i Italia i 1976 og i Bhopal i India i 1984, har vist at organisatoriske svakheter bidrar avgjørende til start og utvikling av ulykker i prosessanlegg.

I det nordiske LIT-2 prosjektet har man konsentrert oppmerksomheten om de organisatoriske problemer og virkemidler som har betydning for sikkerheten.

En organisasjons oppgaver er mange og omfattende; ved siden av administrasjon og ledelse skal organisasjonen også stadig forbedre sin forståelse av **forutsetningene** for sitt virke. Denne, sist nevnte, oppgave er omfattende og komplisert, fordi organisasjonen opererer under stadig skiftende forhold i sitt miljø og i samfunnet. Dessuten gjennomlever organisasjonen perioder som stiller ulike krav, fra planlegging gjennom drift til nedleggelse. Endringer i forutsetningene vil også gi operatørene varierende arbeidsbetingelser, som påvirker og påvirkes av organisasjonens adferd.
For å løse disse oppgavene vil organisasjonen utvikle et regelverk, som fastlegger arbeidsvilkårene for individene i organisasjonen. Det er vel kjent at det parallelt med utvikling av slike regler, eller formell organisasjon, oppstår en **uformell organisasjon,** med uformelle kontakter, som både i positiv og negativ retning kan komplettere den formelle.

LIT-2-prosjektet diskuterer en rekke ytre og indre betingelser for operatørens innflytelse på sikkerheten. Rapporten omhandler, ved siden av spørsmål knyttet til rekruttering og opplæring av personale, også motivasjon, lojalitet og forholdet til organisasjonens mål og verdigrunnlag.

De mål organisasjonen setter for sin virksomhet, har både økonomiske og etiske komponenter. Organisasjonens medlemmer må kunne identifisere seg med disse målene.
Medarbeiderne har også krav på å få forholdene lagt til rette for aktiv medvirkning - dette gjelder også utforming av mål.
En slik gjensidig påvirkning forutsetter et smidig ledelses-apparat og et adekvat informasjonssystem.

Gjennom LIT-2-prosjektet er det utviklet et hjelpemiddel for organisasjonen slik at den på egen hånd kan gjennomgå og vurdere de faktorer som er av betydning for sikkerhetsnivået.
Hjelpemiddelet er en organisasjonsbeskrivelse, med definisjon og forklaring av viktige begrep og faktorer, samt en prosedyre for veiledning ved gjennomgåelse av egen organisasjon og situasjon. Prosedyren kan brukes etter en uønsket hendelse, samt til å oppfange svake signaler i normal drift.
Organisasjonsbeskrivelsen er utarbeidet med spesilt henblikk på å isolere og diskutere de faktorer og trekk som er relevante for sikkerheten. Den er hovedsaklig beregnet på større, faretilbydende anlegg, som for eksempel kjemisk industri, energiproduserende anlegg, transportsystemer o.l.
Der hvor ett av organisasjonens fremste mål er et høyt sikkerhets-nivå, vil dette danne rammer for operatørens arbeidssituasjon.
I prosessindustri av forannevnte typer vil uhell ikke bare ha økonomiske konsekvenser, men ofte også true det omgivende miljø.
Nettopp i slike anlegg er det av største betydning at drifts-personalets arbeidssituasjon tilrettelegges slik at det har de beste muligheter for å tilegne seg prosessforståelse, forståelse for sikkerhetskrav, samt faglig støtte og god ledelse fra organisasjonen i vanskelige og uventede situasjoner. En riktig balanse mellom industrielt demokrati og logisk og éntydig ansvars- og myndighetsstruktur er nødvendig for å oppnå tilfredshet, motivasjon og reell medvirkning.

Sammenfattende kan det sies at til tross for den stadig økende anvendelse av automatisk regulering av produksjonsprosesser, ikke minst for sikkerhetsformål, vil den menneskelige operatør alltid måtte være en garanti mot feil og uhell som kan oppstå på grunn av manglende forutseenhet hos konstruktøren, eller på grunn av ytre omstendigheter som måtte virke forstyrrende på driften eller anleggets status.

Driftspersonalet må forberedes og utstyres for denne viktige rollen.
I LIT-2-prosjektet har man utarbeidet en prosedyre som organisasjonen selv kan anvende for å understreke i hvilken grad de nødvendige forutsetninger er lagt til rette, og hvor det er nødvendig å gjennomføre forbedringstiltak.

Når man ønsker å organisere med henblikk på sikkerheten, er det en betydelig risiko for å tenke "teknisk" - det vil si at man sørger for sikkerheten gjennom å bygge inn flere alternative "veier" i styringssystemet, slik man gjør med rent tekniske systemer. Dette kan synes logisk, sett fra en ingeniørs synspunkt. Men det ligger også et element av fare i det å konstruere en organisasjon som er for komplisert til å være en effektiv støtte for operatøren når beslutninger må tas under en krise.

CONTENTS.

SAFETY ORIENTED ORGANIZATION AND HUMAN RELIABILITY.

1. INTRODUCTORY OBSERVATIONS.

1.1. BACKGROUND.

The Nordic Council of Ministers has, through its Liaison Committee on Atomic Energy, initiated and sponsored several projects concerned with human reliability. The report at hand describes some of the results of one of the subprojects, LIT - 2, concluded at the end of 1984.
The aim of the project was to contribute to a better understanding of organizational factors affecting safety of process plants and to present a qualitative method of observing and evaluating organizational performance.

For a long time both the plant itself (technology) and the operators (staff) have been constantly improved.
Because of lack of knowledge and scant tradition the same has not been the case when it comes to dealing with the operational organization.

The extensively documented TMI - 2 incident in the USA in 1979, as well as other events, as for instance the Seveso chemical reactor plant disaster in Italy, 1976, and the accident at Union Carbide's pesticide plant in Bhopal, India in 1984, have clearly demonstrated that deficiencies of plant organization contribute significantly to the origin and aggravation of process failure. Many reports evaluating system disturbances and crashes point out the human factor as crucial when it comes to system reliability. However, scrutinization of these reports, and close investigations of organizational performance, often reveal deficiencies in organizational resources and functions as the ultimate cause. For example, the operator does often not receive necessary support from the organization e.g. in terms of relevant information. Even worse, organizational dysfunctions can prevent him from using all his available capabilities.

An organizational deficiency or weakness is defined as a factor that in a negative manner influences the achievement of the intended safety standards. The actual process state and organizational environment determine whether the effect is grave or not. For a safety oriented organization it is of vital interest to establish in what ways and to what extent safety is affected by an organizational deficiency.

1.2. THE LIT PROJECT.

For more than a decade the Nordic countries have cooperated on various projects concerned with process plant performance and safety. Sweden and Finland have nuclear power plants, and all the countries have large and complicated oil and chemical process industries, and an extensive resarch activity has been undertaken concerning this particular problem area.
After completion of a four year inter-Nordic research programme 1977-80 on control room design, the NKA/KRU-programme, which mostly dealt with information devices and signal system design, a natural follow-up was a project dealing with staff quality and organization. Very soon it became clear that the control room organization could not be considered separately - it had to be studied in a framework of plant organization, with all its aspects. Thus, the LIT project was divided into smaller projects, some concerned with "hardware" safety measures and some with total system design, with the "LIT-2" project dealing with organization and human reliability aspects, referring to a total plant organization as the relevant problem area.

1.3 PURPOSE.

The report at hand does not pretend to be an ordinary, extensive project summary, complete with all the findings and conclusions. Rather, it intends to present to the already qualified reader an idea of framework, approach and some vital conclusions, the latter to vet the interest and curiosity and stimulate to further examinations of the LIT-2 project as well as other research. The LIT-2 project has, although chiefly being undertaken by people belonging to the nuclear power

production community, from the very start been addressing process plants in general, especially risk prone and danger offering processes. Thus, nuclear power plants have been regarded as having much in common with oil industry (refineries,oil drilling and oil production platforms), chemical process plants, pharmaceutical industry, etc.
Nuclear power production has, admittedly, some characteristics not usually attributed to "normal" industry. Thus, the public concern puts some heavy demands on the responsible operators of such utilities; up to now, much more stringent than what is required from e.g. chemical industry, although consequenses of failures in traditional industry often may exeed those at a nuclear power plant. However, recent events such as the disasters in Seveso (1976) and Bhopal (1984) have led to an increasing interest in process plant operations, in general.
One important objective of the Project Group's has been that the framework and outline of the description of an organization, its behaviour and resources, should make it possible for any organization's members to develop a model of their own organization autonomously, based on their own experience and needs and the contemporary situation.

The reader should bear in mind that any organization operating a process offering risks to public safety and health, is relevant to the LIT-2 project. Beyond doubt we will, in a comparatively short time, see an increasing public interest in these matters, also regarding "traditional" industry.

2. ORGANIZATION AND MAN.

2.1 MAN IN A COMPLEX ENVIRONMENT.

Instead of marking time chronologically by Great Wars and Warm Summers, there is now a tendency to distinguish between Before and After TMI! This incident put a scare into everyone concerned (and who is not?) about safety of highly complex and risk prone production systems throughout the world, regardless the type of plant or product.
Typically, oil retrieval and refinery plants, explosives production plants, transport systems etc. are now scrutinized like never before, using more or less sophisticated methods and tools for assessing safety, not to speak about the commotion within the nuclear power plant community, where the above-mentioned incident made a major setback or a major push forward, depending on the angle from where it is looked at. As it is agreed, the human factor is at the same time the most valuable and the most dangerous in the total control system. Thus, there is a heavy demand on the professionals to design a system which

- makes it possible for the human component to exploit all its talents and skilfulness in diagnosing and preventing anything nasty that may come up during plant operation in spite of the designers' almost devilish foresightedness

and

- makes it impossible for the human component, even if he is stressed, bewildered, misled and disinformed, to make any error when operating the plant under normal conditions and particularly during disturbances.

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* The much referred to "TMI-incident" occurred in a nuclear power plant on Three Mile Island (USA) in March 1979, feeding the anxiety between sceptics to the overall safety of nuclear power production. The nuclear power community world wide took this incident very seriously, and the interest in non-technical as well as the more traditional engineering aspects of safety got a tremendous boost.
Fortunately, the incident caused no danger to individuals, public health or environment, but it was a sharp reminder of possible consequences of operational failures.

Did anyone say that this task is difficult?
That is a clear understatement. The task is - impossible. What has to be made, is a compromise between ideals on both sides, and then to provide the poor operating crew with **automatics** which will put the plant into a safe state even if the crew is incapable of handling the situation. What is then left to the crew? The crew's task will be surveillance of the control system and within strict limits to operate the plant in an **economically** optimal way, provided that nothing serious occurs, creating a situation in which the **safety system overrides** the crew's decisions.

But - isn't this to repudiate the human component as the superior within the control system?
The answer is **NO**. There will always exist a possibility of the **unthinkable**, the **incredible**, the incident so unlikely that even the most paranoïd designer was not able to imagine it.
The operating crew is primarily there to take care of **that very** possibility, but there is no reason why it should not be spared the task of handling urgent dangers which can be taken care of by automatics. All efforts should therefore be spent on preparing the crew for the **unthinkable**, by designing the control system's man-process interface, work organization and work procedures in such a way that the crew is **supported** and not **hampered** in its primary task of saving the Day when everything seems to be countering the book.
What the crew needs in such a situation is competence, good and firm leadership and an organization which provides all the necessary information in a clear and unambiguous manner.

2.2 ORGANIZATION - A MEANS TO OVERCOME COMPLEXITY.

In general, one might state that "Human Error" should never be used as a means of explaining operational failures or disturbances. Human Errors, which have got the doubtful honour of serving as a label on man's shortcomings when operating close to technical equipment, certainly exist. However, errors are committed on all levels and at all stages of design, development and operation; thus also in organization.
We will not repeat all the various facettes of organization behaviour, but just emphasize the role of the organization as the body providing the human member with all its resources and the necessary support in any given situation.
Failing to recognize this responsibility, the organization as such is the one to blame in case of malfunction - and there are numerous examples of such failures - of the more spectacular are the now ill-famed TMI incident, and severe accidents claiming lives in the North Sea oil production.
(The most serious being the capsize of the platform "Alexander Kielland" in 1981, claiming 123 lives. Also loss of lives during diving operations and construction work on platforms on-shore have occured, due to a series of organizationa failures, like insufficient inspection routines, incomplete procedures and unsatisfactory training and supervising.)
The Seveso-accident (Italy 1976) where,although only a trifling amount of the deadly poisonous dioxin was released, the consequences were enormous, and the accident at Bhopal (India 1984) where thousands of lives were lost and hundreds of thousands seriously injured, can also be blamed on organizational shortcomings, in the sense that the responsibilities of an organization operating a plant embrace development of fool-proof procedures for all operational aspects, training and supervision of operation discipline.
Little interest has been paid up to date to the organizational embedding of the operator and his immediate surroundings. Typically, one of the conclusions from the Kemeny-report after the TMI incident was that the licensing authorities had concerned themselves almost entirely with the mere technical aspects of safety precautions (including of course software reliability connected with computer applications) while the more

psychological and sociological aspects within the plant organizations were treated rather leniently.
What do we imply by using words like "psychological" and "sociological"? Obviously, we do not intend to reduce the importance or the emphasis on the technical features.
What we are looking for is a reasonable socio-technical analysis of the staff's situation, concerning, amongst other questions,

- to what extent personality and old-fashioned "intelligence" should be taken into account when defining work tasks
- to what extent education and training have any impact on motivation, skill and safe performance
- to what extent wage and promotion policies contribute to the operator's motivation and liability to improve his qualifications
- to what extent value systems and cultural setting provide a basis for loyalty and professional pride.

The Gaussian distribution is applied for nearly any conceivable purpose: This curve has a maximum in a point representing the mean or "normal" value. When applied on human characteristics it is important to bear in mind that "normal" is a notion not existing. The control system designer has to know the operator's capabilities **and** limitations (that the operator is, so to speak, "a clever fool"), but all the time remember the huge variety of personality and competence characteristics represented within even the smallest crew.
The control crew is there to supervise the control system - **including** the emergency system. If **Murphy's Law** is valid for the plant itself, there is no reason to believe that even the emergency system, however intricate and multiplied, is beyond suspicion. Thus, the indeed unexpected event might concern also this system, which is a pivotal reason for the operator's presence.
A happy matching of man's inventiveness and adaptibility with the computer's swiftness, accuracy and vast information handling capacity, depends on a proper allocation of tasks between man and machine.

This means ensuring on the one hand that the operator's demands for meaningfulness of job contents and exploitation of his education, training and skills are met, and on the other hand that decisions and actions made by the operator are to a proper extent examined by the automatics, securing the quality of system performance.
It is, therefore, necessary to avoid a senseless focusing on "human factors engineering" and rather treat this obviously important topic as an **integrated part** of organization.

A clogged demineralizer line that caused a turbine to trip, a leaky pressurizer that disguised a loss - of - coolant accident, and a valve that stuck open - these were the equipment problems that triggered the incident at Three Mile Island.
Since that accident, however, study after study have observed that if the automatic safety systems had been untouched by human hands, these hardware failures **might** not have led to the calamity.
The real damage (at TMI) was caused by unprepared operators, confused by both inadequate training and poor diagnostic aids, who inadvertently, but systematically, checkmated every automatic safety system. The incident showed that ill-prepared operators could make things worse.
In addition, it revealed that lack of adequate organizational rules may well be the main contributor to disaster.
Also in more "traditional" industrial plants, and on oil production platforms, several examples of the latter factor have been observed.
In this respect, much can be learned from the elaborate and rigid procedures and training systems developed and used at German nuclear power plants. In these procedures both likely and unlikely incidents are thoroughly described, and rules for actions prescribed. Nevertheless, in spite of the procedural quidance, the training aims at providing the operators with knowledge and a self-assured attitude to system operation, alongside supervision and strict discipline.

The LIT-2 project has undertaken a number of studies ** concerning organizational contributions to operational mishaps.
Although these (mishaps) did not have spectacular consequences, the conclusion of the studies is that organization has to reach back to the very conception of the system to be built.
The abovementioned role of the organization as the support of man in his capacity as the real controller - also of safety - must be a built-in quality, and not be an accessory.

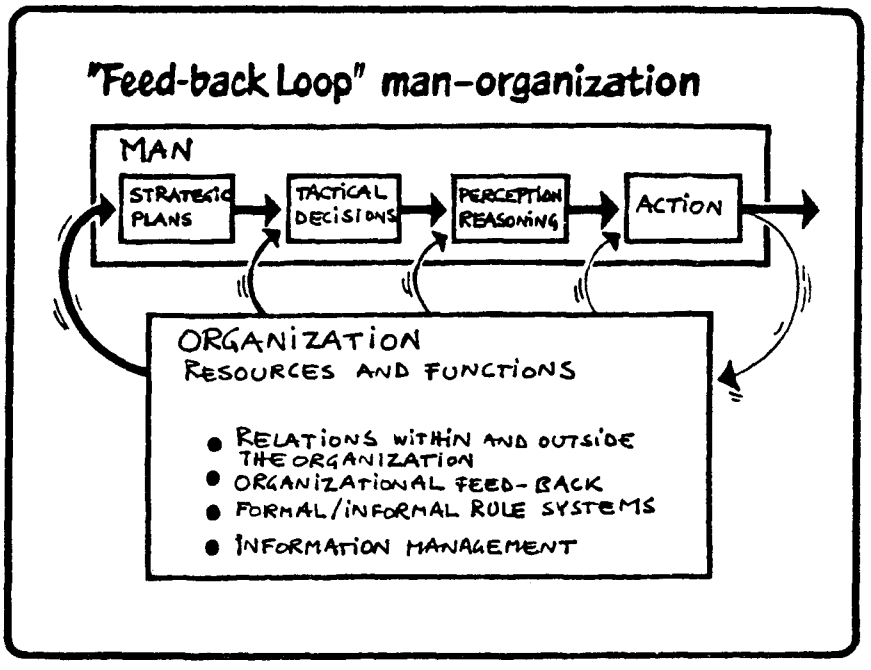


Fig.1. Man and organization.

** The conclusions of the studies are collected in ORGRIP - PROCEDUR. (see LIT - 2 REPORTS).

3. PROJECT GROUP CONCLUSIONS AND RECOMMENDATIONS.

3.1. OBJECTIVE(S).

The Project Group put up a formidable objective - to assess in what manner the non-hardware system components - that is, individuals and organization - influence the overall safety of a risk prone process.

An organization is to be considered as a set of rules, both formal and informal, with the purpose of harmonizing skills, efforts and interests in controlling an operation or a system. This definition does not consider system type or category - it covers non-technical and technical systems equally well. However, the purpose of this project has been to study a technical system, that is a risk offering, highly sophisticated plant manned by skilled and disciplined people- in casu a nuclear power production plant,an oil refinery or off-shore oil rig, a chemical plant or the like.
The idea is that "our" organization can be modelled in "technical-bureaucratical" terms.
Two objectives of the Project Group's were to provide
1) a comprehensible description of an organization's functions and their technical implications, by dividing the whole into three basic systems (see LIT - 2 report 1), and
2) a procedure by which an assessment of organizational performances could be established in relation to safety (LIT - 2 report 2.).
Using this framework, one would concentrate on the main part of organizational life, i.e. the production phase. Here one would look more closely at some of the most important phenomena occuring in day-to- day operation, that is: Disturbances, errors, "narrow-escapes", problems arising from bureaucracy, myth establishment, power structure and responsibility/authority relationships (or lack of same) etc.
The aim was to present the organization and its life in such a manner that the experienced reader (presumably) would recognize the patterns and be able to develop the picture for his own use and his own situation. In this case he should consult the checklist in LIT - 2 report 2.

Modern economy is based on numerous kinds of sophisticated man-machine systems. One project objective has been to identify and describe some of the crucial factors controlling the behaviour of organization and men; especially behaviour having impact on system safety.

3.2. ORGANIZATION - LIFE CYCLUS.

An organization (we are now speaking about organizations supposed to operate technical plants) has a life cyclus:

1. Design phase - the organization is built up from scratch, and its various parts are designated their responsibilities and communications. This is above all the phase in which the set of values is decided upon and "ideologies" are formed.

2. Start-up phase - the organization is manned with flesh and blood, which invariably leads to forming an "organization within the organization" - the informal one.

3. Operation phase - this phase is supposed to yield economic rewards, and is often considered being the actual life of the organization. The intelligent reader will know better. After a while, maintenance of plant and control systems is becoming increasingly important - and costly. Thus, the organization (especially the kind we are talking about in this context) must be able to handle the threat of deterioration of equipment - and also deterioration due to organizational fatigue (for example because of lack of follow-up on training and motivation).
   One should, also, consider that a continuous change in the environment - laws, rules, public demands and the like, imposes a steady flow of new work conditions on the organization.

4. A down-scaling phase - we are, again, talking about highly sophisticated technical systems, operating with the single purpose of producing or handling some sort of product or service of which there might be a passing demand, or maybe the process itself puts a limited life time on the plant.

This phase, in case our system belongs to such a category, must be planned already from the beginning - that is, in parallel to design, or phase 1.

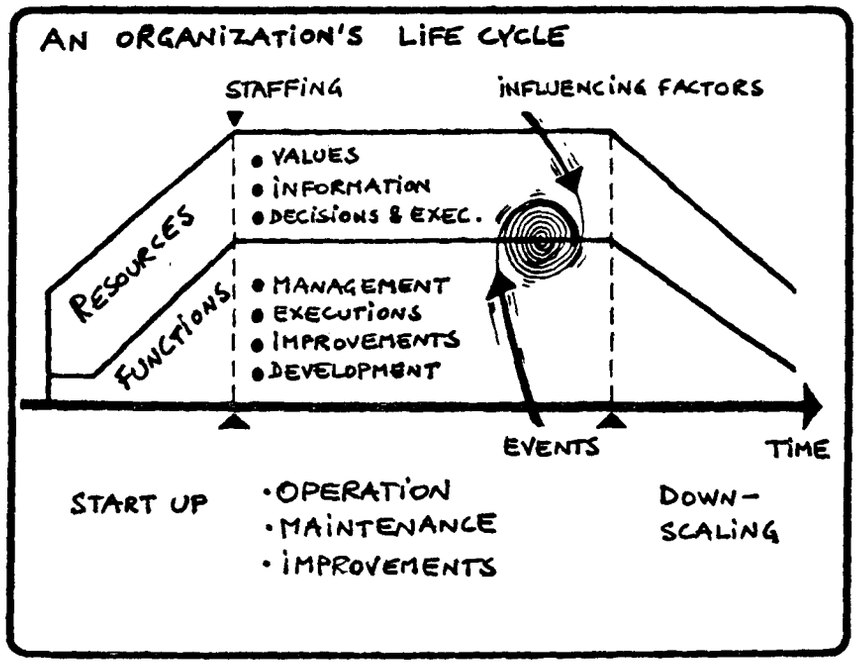


Fig.2. Life cycle of an organization.

Through all these phases, and most certainly during the last three mentioned, the organization must be able to cope with

- normal situations,such as stagnations and crises of different kinds. Under special circumstances, there may even arise a need of
- reconstruction or recovery, but this has not been thoroughly penetrated in the actual study, due to lack of relevant experience in the Nordic countries.

However, we do know that our immensely costly and complex production systems, especially within the field of energy production, have a definite life time. For example, the big platform constructions in the North Sea, put there at great efforts and costs, will have to be moved, even removed, probably in about 15 years' time.

Teams of experts are now engaged in planning this type of operation. Similarly, nuclear power production plants need to be decommissioned after a predescribed period of time (in Sweden perhaps even earlier).
These examples will emphasize the necessity of planning the complete cyclus for a production system, as mentioned above.
However, for production systems of the kind discussed here, there is a possibility of further complication, arising if and when the surrounding society raises additional safety demands - as, for example, created by environmental concern.
Such complications will, surely, implicate new and difficult safety problems, which will have to be solved by the organization while operating.
The incessant "change of the scene" in safety matters may cause despair - however, one should bear in mind that in such cases the surrounding society and the plant organization have mutual interests, and cooperation is called for, and will improve relations.
There is a certain limit to the capability of an organization concerning follow-up on new and stiffer demands. However, a responsible organization operating within a responsible society, will be able to cope with reality - even of the political kind.

3.3. ORGANIZATION - MEANT TO SUPPORT MAN WHEN MEETING EXPECTATIONS AND DEMANDS.

The organization must be able to cope with a number of system states from routine operation (including start-up and shut-down) through relatively "innocent" incidents to emergencies.
This means, as well, that the organization must provide efficient support to the individual when stressed, bewildered and exposed to unknown situations.
In the long run the organization is also expected to promote development of competence and motivation, including loyalty to the overall system purpose.

These expectations toward the organization may seem enormous, even unrealistic. However, our fairly developed industrial societies have time and again proved their abilities to rightly assess and exploit human capabilities, and it has been a paramount task for the project group to point out - not only the shortcomings of man - but rather emphasize his uniqueness and capabilities (when properly trained) in coping with complex technology and unprecedented situations. The organization, of which he is a member, is built to assist him when performing his work, which includes perception, cognition, decision and action, as well as communication, professional development, etc.

What about centralized versus de-centralized safety work?
Again, one should refer to the previous discussion of system life cycle viewed in connection with the value of participation and shared responsibility:
Development and enforcement of safety procedures and attitudes should be a major responsibility and task during the pre-operation phase.
Acceptance of - and familiarity with - rules and procedures are heavily depending on participation in development. However, it is not just everyone's right - not to speak about responsibility - to interprete or downgrade rules once introduced and made operative. Misgivings and discoveries of procedural inadequacies are to be reported through the line, to be taken into consideration by the proper organization components and authorities.

By assessing relevant factors influencing man's work situation, inside the system as well as the ones caused by its environment, it is possible to recognise important features of an organization capable of meeting the rather heavy demands mentioned earlier in this chapter.

3.4. INDIVIDUAL AND ORGANIZATION.

Studies of incidents, mishaps and accidents resulting in injuries, deaths or large-scale damages to equipment or environment are invariably closely examined to find the cause and - if possible - countermeasures for the future.
Very often the conclusion of such examinations is that the very cause of the calamity was a "human error". Human errors (HE) can be assigned to one or more individuals, or to parts of the organization. The need of a "scape-goat" to carry the blame for an unwanted outcome has, unfortunately, too often led to singling out first line operators as the responsible launching link in the chain of events. One should, however, be aware that the organizational infrastructure, which is designed by managers, and operation procedures, intended to be obeyed and on which the operators have had little or no influence, very likely have been of crucial importance at the start and development of a mishandled situation.
True, man is a failure-prone animal, and will, if pressed and badly prepared, very likely misinterprete and commit follies. However, knowing some important handicaps of the human being in a sophisticated technical environment, and his superior capacities compared with the equipment he is supposed to handle, it is possible to compensate his shortcomings and turn him into a safety asset.

When studying man in a technical environment, one must, however, also take into consideration his irrationalities in terms of social behaviour and communication, as well as his perception, judgement, norms and the like.
This rather complicated picture is the starting point of assessing the organization as an efficient support to the operator at work. Thus, the system and procedure designers are to be equalled with the first line operators when human errors are concerned. (The reader is referred to reports from the project LIT - 3.1).

When organizing for safety there is a considerable risk of thinking only in "technical" models - that is, securing safety by making alternative ways of operating, as we know it from constructing redundancies into the technical system.
Although seeming quite logical (from an engineer's point of view), there is also an element of danger in building an organization too complicated to be an efficient support to the operator(s) when handling crises.
A considerable contribution to overall system safety is the operator's acceptance and feeling of logic behind lines of responsibility and command and procedures for operation.

Thus, every member of the organization should feel responsibility and possibility of letting his voice be heard when measures of relevance to operation and safety are discussed and built into the organization and procedures.

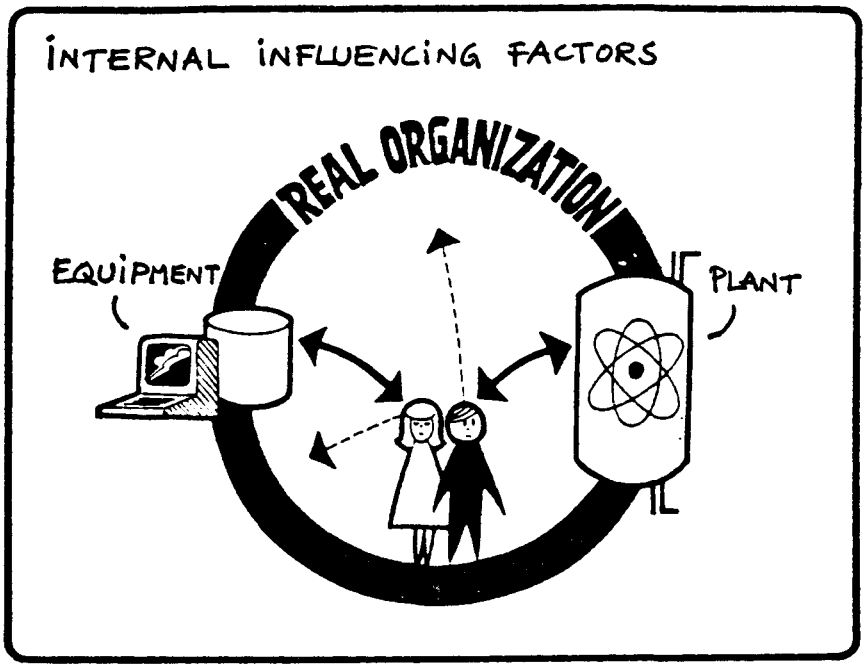
3.5. ORGANIZATIONAL INFRASTRUCTURE.

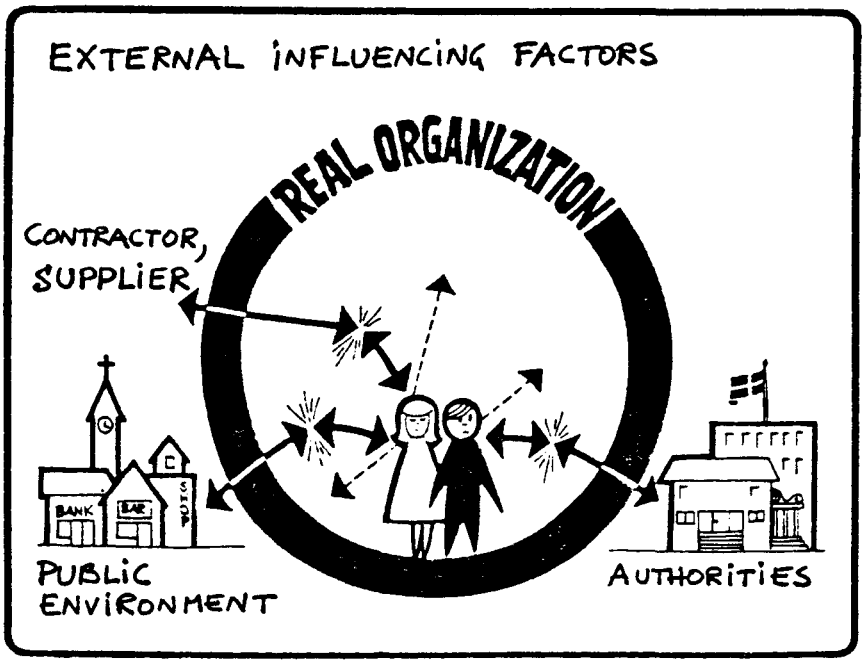
The system concerned in this context are invariably large organizations, with a heavy infrastructure (head offices, licensing organizations, deliverers of various system components etc.). The operating part of the organization, the plant, has to find its place and ways within this complicated framework.
Important issues as for example recruitment, education and training, wage policies etc. will usually be handled by the abovementioned organization components not being composed by first-line operators.
More often than not this will create tensions between "our" plant organization and the other part of the total system, supposed to be our source of support and advice.
Questions of competence will be frequent, and tend to erode what should be a harmonious cooperation to promote efficiency, safety and thriving. How to avoid this, very common, organizational "disease"?

Although being a well known phenomenon and an almost inevitable process in large organizations, there are examples of organizations which have avoided the problem. These organizations are, invariably, very "open", meaning that all members are encouraged to come forward with their misgivings and suggestions, feeling that they are taken seriously by their superiors.

Such a climate is of incalculable value when safety is concerned. Closely connected with a "free to speak up" organizational climate is also the willingness to report "near accidents". The feeling that such reporting does not hamper one's career, but rather improves it, has been recognised as a crucial factor in organization for safety.
Obviously, and undeniably, the responsibility of creating an "open" organizational climate lies primarily with the local plant - or operative - organization.
However, an open "island" in a sea of formalities and bureaucracy made up by the surrounding "mother organization" and supporting public agencies, is an impossibility.
Thus, development of a safety promoting, open organization must be initiated, fed and supported from the very top.

In the Nordic countries, relations to authorities are fairly open and unbureaucratic. This is, however, not to be regarded as a natural asset, but should be cultivated, nursed and watched, even be considered as a major tool in striving for safety.
Short and efficient communication lines, person-to-person contacts and a relationship void of prestige and power markings are basics to openness - and safety.





The organization and its influencing factors

3.6. COMMUNICATION - INFORMATION FEEDBACK

Time lags in communication are frequently causing unnecessary mishaps - we are now speaking of lack of efficiency in feedback to construction and delivery companies, not only suppliers of plant hardware, but also sub-contractors, suppliers of logistics etc. Development of an efficient system for information - not only to "those concerned" in the traditional meaning of the notion - but to all and everyone who might be of relevance to operational safety, is important.
Examples of failings in this rather obvious organizational duty are known, for example from construction of oil drilling platforms for North Sea operations.
Numerous problems and costs could have been avoided quite easily by informing designers of discoveries made under operation of their previous construction. (An example is the lack of follow - up on experiences from the large drilling platform DYVI ALPHA, causing the same failures to be made on later DYVI platforms, also with regard to safety relevant construction details).

3.7. ORGANIZATION VERSUS PUBLIC INTEREST.

Energy is a politically sensitive matter, causing wide dissents. So is also the case of energy production; particularly nuclear production of electric energy has been subject to public concern. Obviously, the morale of plant operators is influenced by their esteem among their fellow countrymen.
Supply of applicants for vacancies is one thing; when staff is recruited, further education is also depending on morale (professional pride) within the staff. Thus, one might conclude that one - not so remote - responsibility of the organization operating any politically sensitive production system is to participate in information about its activities and products toward the surrounding society.
Beyond doubt many would reject such an idea, but as safety ultimately depends on the quality of the men and women operating the plant, they should, in fact, regard public relations, especially information, as one of their essential duties.
Vulgarity in argumentation caused by ignorance is not only a Middle Age phenomenon; to ignore ignorance is a grave mistake in the Age of TV.
Actually, one should remember the sad fact that the burden of proof lies with the organization, not with the public (and evidently not with the journalists).

3.8. MANAGEMENT AND ADMINISTRATION.

Beyond doubt responsibility and line of command is important to safety. However, these very notions have got a foul taste to most people belonging to the Nordic industrial culture.

The project group emphasizes the necessity of assigning correct names also to sensitive matters, but also that acceptance of a power structure depends heavily on openness and thorough information.

One major responsibility of the management's is to evaluate the total competence within the system, in relation to
- Plant and equipment
- Personnel
- Organization
- Organizational relations (towards inner and outer environment)

Competence has, thus, in this context, a wide interpretation, comprizing professional knowledge as well as hardware reliability and organizational atmosphere.
By consciously designing a policy concerning competence, there is an inherent decision of accepting a certain incompetence (!). This is not a paradox, but rather a brutal fact.
No real organization can possibly possess all thinkable varieties and levels of competence. However, when deciding a profile of competence, and, thus, incompetence, this should be made known to relevant parties of interest.

Not to be elaborated in this context is the obvious managerial task of controlling the safety activities and their actual effectiveness in relation to what was once decided upon.
Important in this supervision is division, or categorization, of activities into personnel related and non-personnel related duties. Of relevance to the project group has, obviously, been the personnel related safety matters, as for instance recruitment, education and training, motivation etc.
Of particular interest is an issue normally not paid much attention, namely status -and power structure (between connaisseurs known as"territoriality" or revier claiming).
These phenomena, which are caused by people's ambitions, are illogical, and therefore uncompatible with safety.

3.9. MYTHS.

Does the headline look a wee bit strange in this context?
We have, previously, mentioned informal organization as an inevitable result of any effort of trying to make a number of individuals working together within a formalized structure.
An important contributor to such an organization is development and nursing of formal and informal myths.
A myth may be good for the organization and its objective, provided that it contributes to the motivation of individuals.
But, certainly, the opposite may also be the case.
What is, then, a myth?
It may be described as a symbol, suitable for an individual's identification with his organization and its purpose.
For example:
"For an X-company member nothing is impossible", or, an other well known one:
"For us in X there is nothing like impossible- it might, however, take a little longer".
Astonishing results have been reported by organizations having made conscious efforts toward planting and developing rather primitive and childish myths, in an effort to boost organization morale.

Cultivation of the organization's "myth flora" is, thus, an important managerial task, not to be overlooked in the striving for "seriousness". Nothing is a more serious matter than motivation and morale, when safety is concerned.

3.10. THE IMPACT OF SOCIAL CULTURE ON INDUSTRIAL SAFETY.

Culture is a notion usually connected with socioanthropology - that is, distant societies, races and environmental conditions are compared with one's own, in order to point out differences. In the Nordic countries, cultural aspects are frequently waived as being of no importance - the assumption being that the society is rather homogenous, although slight differences between individuals are recognised.
True, there is, to some extent, a certain homogenity in the Northern societies. However, the experienced reader will acknowledge that there exists a definite industrial cultural heterogenity, not only between nations, but also within one specific country. This means, for example, that what is possible, even obvious, in one part of the industrial scene is literally impossible, or undesirable, in an other.
(An example is the experience gained from building and staffing a huge paper mill in the middle of Norway; it turned out that the applicants, who were not experienced factory workers, but rather huntsmen, fishermen and farmers, expected much more freedom in their job situation than their fellows at a similar plant in the south of the country).

Important safety influencing factors as for example work discipline attitudes, general level of knowledge (we are now speaking of non-professional matters) and the like may vary considerably from one region to an other, and from one professional "class" to an other.
Thus, to ensure a safety concern throughout the organization, attention should be paid to cultural aspects.
An obvious example is transfer of knowledge and findings from research and development to practical use, in which cultural differences between science and work life surface (vocabulary, general language etc.). In this context cross-cultural mixture of individuals and professions is valuable.

The traditional suspicion (some would even use the word hostility) between representatives from engineering or technical sciences and those from behavioural sciences, has to be broken - behavioural science being a necessity in searching for a better understanding of human reactions in critical situations.
Cross-professional knowledge is still a scarcity, as the needs of such qualifications have not been regarded enough important by traditional industry.

In danger-offering systems, where people represent the ultimate safety barrière, the understanding of both technical matters, organization and human behaviour is a crucial factor.
A certain development can be traced in the industrial society in general, but as in many other sectors, the technically advanced organizations have to break barriers and solve the problems in their own ways.
A both positively and negatively influencing fact is that the development of operating organizations, expecially within energy production, has had to be done in parallel with development of their counterparts, namely licensing authorities. This process has indeed led to the invaluable advantage of a professionally close cooperation, but also to a certain competition concerning qualified people (as,for instance, during the nursery years of Norwegian oil field development).

3.11. STAFF QUALITY.

Not surprising, we must emphasize that the most important step in ensuring staff quality is recruiting.
Basic education and previous experience make (personality is not forgotten!) the material to be further developed by courses and other forms of training.

The organizations we are speaking of in this context, have in general the advantage - and the burden - of being in public view; that means, also, that they are more free to establish personnel policies than what is the case in "neighbouring" industrial organizations. Unions and other pressure groups which usually protest recruitment involving such sensitive issues as "personality tests" or the like (we are now speaking about the lower levels of operational staff) will understand that organizations of this particular kind will depend on staff members above a certain threshold concerning stability of mind, intelligence etc.

Thus,the opportunity is there,to be used consciously and delicately. Once recruited, the individual is assigned his duties and initial position. Individual development, as well as organization development, is from this stage depending on the organization's ability to build and execute a training programme. This programme will, necessarily, involve a heavy amount of professional matters, i.e. technical curricula.
But, a good measure of motivation and organization related issues should be found in courses and programmes at every level, throughout every one's career.

Large organizations of "our" kind are, unfortunately, exposed to a particular threat: They tend to establish bureaucracies and norms, which in turn lead to conformity. This is expecially dangerous to safety, as safety consciousness depends, basically, upon personal engagement and a "restlessness" in striving for higher quality in every respect.

Not to be forgotten, however, is the need of discipline. This, in many respects, sensitive matter is, paradoxically, also promoted by the positive "restlessness", due to identification with the overall objectives, purposes and strategies of the organization.

The development of data processing hardware and software has, paradoxically, to some extent disturbed the existing theories and models concerning education and training. From one point of view, the computer based systems have eased the problems in man-process interface considerably, making it now possible to concentrate on man-process communication on a "higher" level. But, on the other hand, the computer systems as such have got a spot-lighted position, and more and more attention is directed towards improving the computer - to - process communication, leaving the operator out of the deal.
The situation calls, once again, for "cross-cultural", at least cross-professional, interest.
Human behaviour, or, rather, expected human behaviour, in stress and under pressure, has proved to be the most important safety factor.
In order to analyse and improve the performance of human beings under such circumstances, it is useful to distinguish between three types; according to a theory developed by Risö National Laboratory in Denmark (Rasmussen 1979):

- Skill based behaviour (the operator is drilled to perform series of automatic moves, trigged by recognition of a store of known stimuli)

- Rule based behaviour (the operator is, again, drilled - but at this stage in using a set of rules, or procedures, covering a set of possibilities. This implies, thus, that the operator must be able to detect and recognise problems coming up, in order to engage his tool-case of rules).

- Knowledge based behaviour (this implies that the operator has a thorough understanding of the physics, chemistry and mechanics of the process he is supposed to control. He must be able to detect and recognise a problem,even if such a problem has never been seen or described,and to develop a strategy of problem solving,including development of necessary procedures).

The last stage, or level, of operator quality is, certainly, utopian, if taken most extremely. However, this level is also describing the operator's ideal situation from the point of view of work environment and work place design.
Now - how to ensure safety in case the operator is to be "turned loose" to operate in the way described above, and with the utmost sovereignty concerning definition of danger etc.?
In our, "Nordic" culture we put considerable, many would say ultimate, trust in knowledge as the key to production quantity and quality - and safety. We also believe that knowledge is a necessity in striving for thriving and work morale, which is, also, a keynote to safety.
If we believe that the human operator is the pivotal contributor to safety, and that his (or her) ingenuity and decisiveness will save the day when the very problem occur that not even the most inventive designer could have imagined, then we put the necessary interest and provide resources to giving every individual the opportunity and encouragement to obtain the knowledge demanded by expected job and task performance.

3.12 REWARDING OPENNESS.

In Maslow's "hierarchy of needs" the uppermost stage is "self realization". In short, any member of the organization - provided satisfaction of basic needs - has a right to be a really full member of the organization - right to vent his opinions, right to be taken seriously, right to develop professional skill and pride.

Thus, the organization should encourage its members to come forward with suggestions, and also encourage reporting of errors that might have - if bad luck - resulted in mishaps or disturbances.
"Non-punitive reporting"has, actually, been undertaken as a major issue in-for example-the U.S.Air Force, where pilots have got assurances that their careers will not suffer even if they report grave mistakes during flying missions.
Rumours among crews in plants belonging to "the energy production community" have revealed that such reporting is still regarded as doubtful or even bad for professional careers and promotion. The organization should, for the sake of safety, take considerable interest in developing an atmosphere encouraging free exhange of information, most important are bad experiences and "narrow escapes".

4. PREVIOUS WORK.

Scientific work on organization related to safety has a comparatively short history.
Essentially, one might say that the first significant work in this field of interest surfaced not more than 15 years ago. The interest has climbed steadily since, and there is, now, a considerable number of institutions and professionals working on issues related to the problem area. However, focusing on the very connection between organization and safety is rare; thus, the LIT-2 project and its ORGRIP reports - to some extent - provide a new angle of view. This is particulary because the work has been undertaken in close cooperation between researchers and professionals from the operating plants - mainly nuclear industry, but also oil industry and other industrial plants with stiff safety requirements.
Generally, previous work has been mainly concentrating on organizational tasks, like, for example, education, training and motivation. Very little attention has been paid toward information, responsibility and command structure, value systems etc.

4.1 REPORTS.

The project LIT-2 has resulted in a number of reports and papers, with the common denomination ORGRIP (Organizational Reliability Improvement Procedure)- a label to be used as identification on the various more specialized papers, as indicated separately on the cover of this report.

The ORGRIP reports are dedicated to fill the gap between - on the one hand - organizational purpose and the role of an organization in its cultural environment, and -on the other hand- its more clear-cut tasks and operations.

5. NOTIONS AND TERMS OF RELEVANCE TO ORGANIZATIONAL SAFETY ASPECTS.

5.1. INTRODUCTION.

Considerable effort has been addressed toward establishing a (comparatively!) firm vocabulary basis for the LIT-2 project work. True, there is a vast amount of publications dealing with organization and safety,but - alas - most of the material is produced by organization theoretics with more experience from the academic world than from technically complicated production.

However, it must be admitted that quite a few publications, especially from recent years, have proved satisfactory also from a practitioner's viewpoint. This is, perhaps, due to the fact that several newer reports, concerning spectacular incidents in the nuclear and oil industry fields, have been produced by people who actually have been "sitting in the jam" themselves, and thus have had both the relevant experience and the need of communicating this experiences to fellow sufferers.

The flora of terms and notions within the field of safety and accident prevention is vast, and there is definitely a need of establishing an operational vocabulary. The project group has not undertaken such a formidable task.
However, certain terms had to be defined, and others to be mentioned, in order to facilitate the mutual understanding of the reports forming a part of the ORGRIP parcel.

In the following some crucial notions and terms,proved necessary and adequate for the LIT-2 group, are outlined.
The order of appearance, as well as the relevant organizational level, is of little importance in this context.

INDUSTRIAL SAFETY:

Safety against danger and damages to resources, that is, plant staff equipment and internal and external environment.

INFORMATION:

Information is an abstract matter, operating within a framework of codes which carry meaningful messages provided consistency of codexes between source and addressee.
Interpretation of information, or a message, is, as the reader is well aware of, not only a question of using identical vocabularies, but also a matter of motivation and general level of knowledge, necessary to fill out vacancies in the information and completing the picture.

MAN-MACHINE SYSTEM:

An arrangement of components (men,hardware and software) in a defined order, with the purpose of functioning as a whole in performing specified tasks in a given environment.
Specific interest is connected with process control systems, that is, systems void of manual tasks, and characterized by surveillance, cognitive demands, decisions and a steady flow of information.
In such systems there are several interfaces demanding attention and thorough design:
- Man-process interface
- Man-man interface (internal organization)
- Man-environment interface and system - environment interface.

Each of these are characterized by rules, continuous changes and need of adjustment. The most spectacular, and from a technical point of view the most easy to define and handle, is the man-process interface. The others should, however, not be forgotten in the striving for a safe total system concept.

OBJECTIVE AND TASK:

An objective is a desired state with respect to space and time. Objectives, coupled with available means, are directed towards problem solving. Objectives, and means, are preferably quantified.
"The hierarchy of objectives and means" indicates that what is a purpose at one level in the organization, is a means, or a tool, for the next higher level to achieve its objective, and so on, Objectives may be "open" or not; official or un-official. Objectives have to exist between certain boundaries, and are often subject to change. The objectives (the ruling objectives referred to time and space) will define the corresponding tasks for organization fractions and individuals.

ORGANIZATION:

A structured pattern of relations and rules between people dedicated to a complex of tasks and consciously and systematically establishing - and working to satisfy - mutually agreed objectives

QUALITY:

Quality is defined as the value of a product or service, measured by a scale of values that may be different from one individual to an other, from one organization to an other. Values (or rather, value opinions) are also changing over time. Everyone knows the saying:"Taste is not to be discussed". However, in this context we are not dealing with taste,but with a complex of values partly ethical, partly technical. Of the latter are factors like availability, ergonomics, maintainability etc. Ethical values are, obviously, more difficult to name in few words, but in this context the recognition of man as a highly sophisticated creature, with promises but also with expectations towards his role and tasks is an example of an attitude, or value, of this kind.

RESPONSIBILITY:

Responsibility is - in this context - a liability to act in a prescribed manner under given circumstances, that is, a liability to meet defined expectations connected with one's role in the organization. Thus, responsibility is a controlling factor in the sense that a given responsibility is used as a managerial task allocation.
Responsibility is inevitably lashed to authority (there are different opinions on this matter in our democratic societies) and is beyond doubt a pivotal safety factor in organizations discussed in this context.

RISK:

The combined effect of possibility of damages caused by system operation, and the consequences of said damages.

RISK ANALYSIS:

A systematical method aiming at identifying, categorizing and quantifying potentialities of danger in a system.

SAFETY:

An activity is considered safe when its risks are within accepted boundaries.

SAFETY FUNCTION:

Expectations or tasks referring to certain organizational resources, defining same resource
connected with possible unwanted chains of events in the total production system. A safety function is to be interpreted as active, while a safety oriented function is "non-active" and has, rather, the character of planning and preparation.

SAFETY POLICY:

Goals, strategies and tactics aimed at achieving and preserving safety in the organization.

SYSTEM:

The term "system" is threadbare and abused, being used to describe all sorts of -more or less - organized collection of men, hardware and software. However, in this context we want to revive the meaning of the word, by dividing its contents into three different, and yet intertwined, factors,namely

Information system
Value system
and **Decision and executive system.**

INFORMATION SYSTEM:

Information is a flow of messages more or less meaningful and relevant for the matter at hand.
Information can be used as a means to achieve control, by clever administration of knowledge (or the opposite), or it can be available to all members of the organization, in order to strengthen general knowledge, cooperation and morale.
Obviously, information has several different meanings, from pure and simple technical information to information of a more subtle kind, like - for example - myths, which is mentioned separatly in this report.
In short, information is, if properly handled, the very glue, but also the lubricant, linking the organization's various parts and factions and easing their cooperation, both day by day and when planning future operations and dealing with the outside world.

VALUE SYSTEM:

Especially important for an organization of the kind discussed in this context, is the conscious establishment of ethical values. Awareness of resources and their value to the organization and its environment, safety consciousness and attentiveness toward quality are all examples of a value oriented system, which embraces a basic human orientation, or an acknowledgement of man's and society's needs, demands and rights. The value system will be reflected by the organization's behaviour. but should also be explicitly expressed in its goals, objectives and plans.

DECISION - AND EXECUTIVE SYSTEM:

Decisions and their executions are - to some extent - taken care of by formalized rules and lines in the organization. The organization will,thus, conserve a pattern of dealing with decisions, orders and reporting. However, if the organization is a stable system(in this context), there is at least one member of the organization whose task is to act as "non-conservative"; that is, the supreme leader. Yards of book-shelves are filled with publications about How To Be A Leader,etc. Few of them emphasize this person's responsibility of being restless, wary of stale routines, looking for new ways of executing routine matters, not to speak of looking for new ways of handling fresh problems.
The decision and executive system has the value system as a compass, and the information system as a resource when carrying out its task.

UNWANTED CONSEQUENCES:

Reduced or halted production, production disturbances (wastes,wreckages,dangerous situations etc.)

WORK ETHICS, PRODUCTION CULTURE:

Every society has got a culture, whether highly ethical or not is a question of taste and a more complicated cultural framework than can possibly be discussed here.
However, in our Nordic societies we claim (careful now!) to cultivate what might be called a "protestantic work morale" - which implies a dedication to one's task and responsibilities (see RESPONSIBILITY) and submission toward organizational demands as authority and the like.
Work ethics can be regarded as a framework of unwritten "codes" defining the expected attitudes and acts from an organization member when performing in his or her job. The "codes", or codex, is defined by the total society, and is, as everything else, submitted to changes over time.
Production culture is the part of the overall work ethics which can be related to the production, that is, a codex regulating one's behaviour and acts in connection with the organization's ultimate raison d'être.

6. POSTSCRIPT.

Having painted a rather discouraging picture of organizations handling danger-offering operations, the Project Group comforts the Reader:
There is, indeed, a path through the mine-field for the bewildered and anxious designer, organizer, leader and operative - the path being cobbled by professional competence, thoroughness, foresightedness (with just a little dash of paranoia) and above all, trust in human uniqueness when operating man-made systems.
Organization is built on functions, which in turn yield resources to man if he knows where, when and how to put them to his use.
An organization is but a man-made means to provide support when other man-made systems become too complicated to cope with - and as such it should be designed and maintained with care.

REFERENCES.

In the following a limited number of relevant and important publications is listed - the reader being asked not to regard it as complete:

Cohen,A: Factors in Successful Occupational Safety Programs, Journal of Safety Research, 1977,vol.9, No.4.

Firenze,R.J: The Process of Accident Control, Kendell - Hunt,Dubuque,Iowa,1978.

Hamilton, G: Risk Management. Nordiska Olycksfallsforskningsseminariet AO/KTH,Stockholm, 1981.

Hammer,W: Occupational Safety Management and Engineering, Prentice-Hall,Englewood Cliffs,1976.

Hellesøy,H: Arbeidsplass Statfjord(Work Place Statfjord) Universitetsforlaget,Oslo 1984.

Johnson,W.G: MORT Safety Assurance Systems, National Safety Council,U.S.A.,1980.

Kjellén,U: An evaluation of Safety information systems at six medium-sized and large firms, Journal of Occupational Accidents, 3:273.288,1982 a.

Kjellén,U: Analysis and development of corporate practices for accident control. Stockholm, KTH,TRITA-AVE-0001,1983.

Lindqvist, J: Principal functional and design interfaces between production system, human and organization. IVA's Beijersymposium,Human Reliability in Complex Technical Systems, IVA-Rapport 228,Stockholm,1983.

Rasmussen,J: On the Structure of Knowledge - a Morphology of Mental Models in a Man-Machine System Context. Førsøgsanlæget,Risø,Risø-M-2192, Roskilde 1979.

Robinson,G.H. Accidents and Sociotechnical Systems: Principles for Design,Accident Analysis & Prevention, 1982,vol.14,no.2.

Rydnert,B. Stene,B. LIT-2 Slutsatser från fallstudie 1: Stadsforsenstörningen. LIT-2 (83) 402,1983.

LIT-2 Organisationsuppbyggandet Forsmark 3, LIT-2(83) 406,1983.

Sammanfattning av LIT-2 arbetet kring Ringhals' organisation i samband med sprickbildning ("julstoppet" 1982). LIT-2 (84) 411, 1984.

SINTEF: Sikkerhetsanalyser av prosess og hjelpe-systemer ved prosjektering av prosess-anlegg til havs. (Safety analysis of process- and auxiliary systems for design of deep sea process plants). SINTEF,Trondheim 1983.

Smith,M.J. et.al.: Behavioural Modification Applied to Occupational Safety.
Journal of Safety Research,1978,vol.10 no.2.

Smith,M.J.et.al.: Characteristics of Successful Safety Programs.
Journal of Safety Research,1978, vol.10,no.1.

Swain,A.D: Design Techniques for Improving Human Performance in Production,
LUTAB,Stockholm, 1974.

Zohar,D: Promoting the use of Personal Protective Equipment by Behaviour Modification Techniques.
Journal of Safety Research, 1980.

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- One giving a set of generalized questions embracing a plant organization's various phenomena and behavioural patterns, and

- one providing an interpretation, based on the described organizational model and offering an explanation of the patterns observed.

3. ORGRIP - PROJECT SYNTHESIS.

This part describes the project idea and the project work, and embraces also a discussion of possible further development of the ORGRIP model.

4. ORGRIP - ORGANIZATION FOR SAFETY.

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