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Aerospace Sessions

PRODUCT SAFETY IN AN R&D ENVIRONMENT

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You just can't escape the topic of product safety these days. Either Ralph Nader is telling a company what they are doing wrong, for free, or some court is telling them the same thing, but making them pay for it. In either case, the company would be much better off if they had a means of identifying safety problems and, hopefully, correcting them before outsiders get into the act.

I will discuss various alternative actions that a company could consider if they have as an objective improving their track record in the area of product safety, and then I will describe how we have approached the task in my company.

Faced with the requirement to upgrade the safety of its products, a company has a wide variety of possible actions. Some of them can easily be accomplished within an existing organizational structure—others may involve more drastic and costly management actions, such as changing or creating new responsibilities, perhaps accompanied by organizational changes. The appropriate type of action to be taken would vary substantially from company to company and would depend on many things such as the type of products being produced, the level of existing system safety activities, the requirements of the customer and/or the legal liability exposure, and so on.

Examples of management actions that could be taken without major impact on cost or without requiring changes in responsibilities are:

1. Conduct a motivational campaign for all employees, pointing out the importance of product safety consciousness at all levels.

2. Beef up the company training program in system safety engineering and other product safety related areas. Make key employees

aware of customer specifications and standards on product safety.

3. Establish additional design, development, and testing reviews.

4. Increase the depth of initial functional and structural analyses and conduct additional development and qualification testing.

This type of action is pretty obvious and the list can be expanded. However, there are also management actions of a more far reaching nature that also should be considered, such as:

1. Establishment of clearly identified product safety responsibilities within all levels of the organization.

2. Hire outside consultants to study current conditions and recommend design or management changes.

3. Create new organizational entities whose responsibilities are essentially those of check and balance in the product safety area. This would be similar to the check and balance function of product assurance as it relates to manufacturing.

4. The most comprehensive action would be combinations of the alternatives already discussed.

In the mid 1960's my company's management knew it had to make some changes in the area of product safety. Up until that time our two prime product lines were in the missile and space fields where man was not involved as crew or passenger. Traditional industrial safety practices were followed during the manufacturing process and it was only in development tests or during launch operations that the product itself was a hazard to man.

However, two things occurred that caused our management to examine possible changes in our operating mode. First, we be-

gan developing new products that did involve man as crew or passenger and which generally operated in hostile environments ranging from the ocean floor to deep space. Secondly, it became apparent that product safety was catching the attention of the entire nation, including our prime customer, the Defense Department. New specifications were being issued and legal actions were dramatically increasing in the liability area.

With these new products getting underway, and being well aware of the change in the national mood as regards safety, my management began examining what we should do. As you know, there is more than one way to skin a cat and you can get as many opinions and approaches on the subject as the number of cat skimmers you talk to. We were initially in this position but we finally narrowed the question down to two basic options:

1. Assigning full responsibility for product safety improvement to those who are responsible for product performance, cost and schedules (i.e., program managers).

2. Make organization and responsibility changes in order to create a check and balance situation by establishing new people or groups to advise and/or audit (in the area of product safety) the efforts of those responsible for performance, cost, and schedule.

In considering these alternatives it was tempting to select the first and merely demand from the existing managers and line organizations increased emphasis on product safety. However, after considering all of the pro's and con's, we elected to make the more drastic move. Our management decided that in an area as important as this, it would be prudent to accept the added organizational interface problems and perhaps additional cost in order to be sure that we would meet our objective of delivering safe products.

It was recognized that in the real world under the pressures of meeting schedules and holding down costs, in spite of best intentions, sometimes product safety might suffer in the day to day design and operating decision-making process. Accordingly, a check and balance policy was adopted.

Company Organization

The basic LMSC organization is as fol-

lows:

The Lockheed Missiles & Space Company has five service divisions and three product divisions. I am Director of the Operations Services Division. The three product divisions are like three separate companies, each possessing their own programs, engineering, manufacturing, testing, product assurance, etc., organizations, and headed by a vice president.

The Missile Systems Division is predominantly engaged in the submarine launched missile business—the Polaris and Poseidon missiles.

The Space Systems Division is predominantly engaged in the space vehicle, space satellite, and communications business for the Air Force and NASA.

Our Research and Development Division has four major product line organizations in addition to its many research organizations. Those four product organizations are: Ocean Systems, Airborne Systems, Ground Vehicle Systems, and Nuclear Systems.

Product Safety Functions

We have added to this organization functions relating strictly to product safety.

First, a Product Safety Board was established which reports directly to the company president and also on a dotted line basis to the corporate safety board.

Next, each of the vice presidents named a product safety representative who is responsible for product safety policy and coordination within the division. This is a full time job.

Each division has a Product Safety Committee or Board reporting to the vice president of the division. These committees are usually chaired by the product safety representative and act as an audit agency to review the quantity and quality of product safety effort within the division.

Finally, we have all of the existing system safety engineers and other personnel working in program offices and engineering who are doing the product safety task on a daily basis.

The LMSC Safety Board has dotted line cognizance over these functions.

Product Safety Board Membership and Activities

It was decided that a Board such as this should be composed of top level management and technical personnel from throughout the company. The President appointed me Chairman—first, because my line organizational position would allow me to be completely objective without any cost and schedule responsibilities getting in my way; second, because I had previous extensive technical and managerial experience within the product divisions.

Each major organizational element is represented. The product division vice presidents appoint a technical representative. These technical representatives also just happen to be their staff men. This provides a pyramid structure for better continuity of our overall LMSC product safety program with the LMSC Product Safety Board at the apex of the pyramid. The Board charter also designates specific specialists as members of the Board. Our Board has a full time secretary who is appointed by and works for me. Because of the complexities and diversity of Board activity, the secretary's responsibilities and capabilities may need to be much broader than the title implies. In our case, he is a safety specialist and is technically qualified to work with and understand the vast array of systems and technologies our Board encounters.

The basic functions and responsibilities assigned to our Board are:

1. To conduct a continuous review of product/system safety activities in each division.
2. To identify and select specific programs for detailed review and audit. Our minimum review requirements call for a review of the program safety plan, safety analyses, and test plans, procedures, and results. We report our evaluation of the program safety status to the LMSC president, division vice president and the program manager. If needed, the Board obtains experts in any field from within or outside the company to assist it in its reviews, etc.

3. To assure that thorough investigations and corrective actions are undertaken on product accidents, incidents, and significant events.

As chairman of the Board, I serve as the

LMSC interface with the corporation to report and receive product safety and mishap information.

Product Life Cycle Safety Review

While there may be minimum review requirements for our Board, it is a very rare occasion when that is all the Board does on a program review.

The life cycle of a product or system is the period between its birth, or concept, and its phase-out. I have broken the product life cycle down into its basic maturing periods or phases. However, the relative time spread for each phase is not truly represented and will vary considerably from program to program. The time overlap from one phase to the next is a naturally occurring characteristic of a dynamic program unless there are contractual or fiscal decision milestones which cause an abrupt transition between phases.

A Board such as ours may have little or no involvement during the conceptual phase except when a program asks for advice or it reviews the safety input to a contract proposal.

During the design, development and test phase, our Board reviews the program safety plan, design, and safety analyses. We review the test plans to determine whether the safety critical parameters will be tested. We inspect any mockup or prototype developed and review test results. Any accidents occurring during the test program are thoroughly investigated to determine whether hardware or procedural changes or additions are needed. During the production phase, the Board conducts a critical inspection of the first production article. We also review the formal operating and maintenance documents, since they are normally developed during this period.

After the product enters its operating and maintenance phase, the Board monitors its operational performance to identify problems or to assure that there are none. We review engineering and operational change proposals. Product mishaps are investigated to determine whether hardware or procedural changes are needed.

No activity for the Board during the phase-out period is indicated because the safety

considerations for this period, such as disposal of hazardous materials and components, should have been thoroughly considered and documented back in the first three phases of the product life cycle.

This is a highly condensed listing of Board activities occurring during a product's life cycle. You must remember that preceding and parallel to the Board's activities, there are several layers of program and division product safety activities going on during this period. In fact, the depth and detail of the Product Safety Board's activities will usually be, but not necessarily required to be, inversely proportional to that performed by those other organizations.

To keep track of the activities just described, we use a form for each program or division review. At the beginning of a review, we establish a schedule for certain basic review milestones to be compatible with the schedule of the program. As new and more specific review items evolve, they are added to our schedule.

Specific Program Review Activity

To try and cover all of the Product Safety Board's specific review activities on any one program would take too long, so I will discuss here how we tackled one functional system that is common to almost all of our manned products—the Respiratory Life Support System.

Here is a classic example where early decisions are essential and where compromise between many factors is inevitable. Some examples of fundamental design questions in this area that need to be resolved early are:

1. Is a simple open loop breathing system sufficient?
2. If a closed loop system is required, should it be a single or a two gas system?
3. Is an emergency system necessary? If so, what type?

4. What is the minimum duration of life support that should be provided by the primary Respiratory Life Support System? By the closed loop or emergency system?

Often these decisions can be quite difficult because you have to trade off factors of system complexity, fire and toxicity, cost, and experience of crew/passengers. For example,

the Apollo spacecraft used a 100 per cent oxygen system operating at about five psi. This system has the virtue of simplicity but has the disadvantage of higher fire hazard than a two gas system using nitrogen and oxygen.

Even complex systems can be made quite reliable by redundancy and multiple safeguards, but they may not be feasible because of cost, size, or weight. Crew and passenger experience and training may influence the choice of systems. A highly trained crew could safely operate a complicated system that would be dangerous for inexperienced passengers or crew.

Regardless of the type of system or where installed, there are certain basic requirements or considerations for a Respiratory Life Support System used by our Board. We concern ourselves with: the quality of air or gas supplied to the system; the quantity required for mission and reserve; distribution and circulation to avoid dead spots; discharge or absorption of contaminants generated by man and equipment; protection and comfort (from a human factors/safety standpoint) from temperature and humidity extremes; the need for, and design of, an emergency breathing system; that operating and maintenance personnel have adequate procedures and training; most important of all, that the system is thoroughly tested and the breathing atmosphere analyzed after everything is put together.

You might be interested in following the rationale used in selecting the life support systems for two of the products that our Board has reviewed. I will discuss the vehicle operating conditions and our thought process on selecting a suitable life support system.

Depth Submergency Rescue Submarine

The first is the deep submergency rescue vehicle we have built for the Navy. Its habitable capsule consists of three intersecting spheres, the forward one for the pilot and co-pilot and the aft two for one other crew member, plus space for 25 rescues from a downed submarine. A transfer bell is attached to the mid sphere to mate with the downed sub and provide a path for the escapees.

A closed loop system was an obvious choice but the designers and safety board had a difficult situation to face because we had no guarantee that the pressure inside the spheres would remain at one atmosphere after the hatch to the downed sub was opened. The Navy specified that due to flooding, the pressure in the downed vessel might be as high as five atmospheres. This hyperbaric condition required that when the DSRV was operating on the primary system, a method had to be devised to reduce the partial pressure of oxygen if the total pressure went up in the DSRV spheres.

It was finally decided that if air from the downed sub raised the total pressure, the crew and escapees in DSRV would merely breathe the oxygen down to the partial pressure of a standard atmosphere and then add oxygen as necessary to maintain that level. Therefore, it was only necessary to provide a one gas supply (oxygen) for the normal or cabin system, along with necessary sensors and controls.

The emergency breathing system was another matter. It had to supply a breathing gas at a total pressure slightly above the cabin pressure, whatever it might be. Also, the partial pressure of oxygen should remain at or around one standard atmosphere, or oxygen toxicity might result. This means that if the total pressure in the cabin is raised above atmospheric and if a closed loop emergency system is used, an inert gas such as nitrogen must be introduced to raise the total pressure in the emergency system above the cabin pressure while the partial pressure of oxygen remains constant.

Having a system which has two separate gas supplies, one of which will not support life, creates some knotty design, reliability, and procedures problems. As you can imagine, the DSRV respiratory life support system, particularly the emergency system and its operating and test procedures, have undergone extensive analysis and review by the Program, the LMSC Ocean System Safety Committee, and the LMSC Product Safety Board.

Offshore Petroleum System

Our offshore petroleum system illustrates

the necessity to sometimes use outside help in reviewing the safety aspects of a system. Our safety board has members experienced in the areas of ocean submersibles, land vehicles, aircraft, and space craft, but we knew very little about the hazards associated with working around a wellhead in a shirt sleeve environment on the bottom of the sea. Therefore, we undertook an extensive educational program to become familiar with petroleum industry operations and hazards. We obtained material and advice from many outside sources, including personnel who had been active in offshore drilling.

In the case of our offshore petroleum system, the type of life support system to be used was not an obvious choice. Here was a system that had to operate as much as 1,200 feet below the surface of the ocean. It consists of a wellhead cellar, which is not more than a room sitting on top of the well at the ocean floor, and a capsule which transports personnel and equipment from the ocean surface down to the cellar. It carries heavy machinery and requires large amounts of electrical power. The oil well may contribute toxic or explosive gases.

In considering the alternatives, the closed loop, self contained life support system appeared to have many advantages. It would eliminate the requirement to develop a complicated umbilical system to bring fresh air down and return it to the surface. It also would give more flexibility in maneuvering the capsule. On the other hand, with the contemplated protracted stay times on the bottom, the high flow rates considered necessary for safety, and the fact that in any event some sort of umbilical was required to provide the heavy electrical load, the decision was made to use an open loop system. However, it was clearly indicated that a back-up or emergency system was a must from a crew safety standpoint. It would be needed if any malfunction occurred in the umbilical system or if there was a fire or toxic fumes in the capsule which required the use of full face masks.

During an extensive testing program over a well in Louisiana, it was found that a flow of 30 standard cubic feet per minute of fresh air was more than sufficient to maintain the en-

closed environment well below the toxic limits of oil well and man made contaminants. The system was sized to deliver 47 cubic feet of air per minute. During operations, if the oil well outgasses, the exhaust system is connected to a hood or collecting enclosure around the source of outgassing to keep it confined and prevent it from entering the working atmosphere. The exhaust system also uses collectors throughout the capsule and cellar to provide the most efficient purging.

The emergency breathing system selected consists of full face masks and hoses connected to the umbilical air supply. In the event the umbilical supply is cut off, cross connections provide a means to use compressed air to provide adequate life support long enough to disengage the capsule from the wellhead cellar and rise to the surface. The use of compressed air instead of pure oxygen or a two gas system provides simplicity and reliability. As a result of our studies and review of the system, when the initial capsule was completed.

ed and under going tests in the Georgia Straits off British Columbia, I felt confident enough in the safety of the system to take a ride to a depth of 1000 feet. We mated with a simulated wellhead cellar, opened the capsule hatch, and actually climbed down into the cellar. I have to admit that my adrenalin was pumping a little until that hatch was closed and sealed.

Conclusion

In conclusion, I want to emphasize that there are no pat answers on product safety that fit all circumstances. In the case of our company, we took fairly extensive action simply because we felt that in the long run it was good business. To date it has had one easily recognizable result: a marked increase in awareness by all levels of the organization of the need for and the benefits of good product safety. The effectivity of this effort will be measured by the performance of our products.

THE SAFETY PROFESSIONAL'S PART IN DEVELOPING SAFE WORK PLACES

By GEORGE W. HARPER

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For the past two and a half years I have been a member and secretary of the Board of Certified Safety Professionals.

What is a profession? Webster's Unabridged Dictionary defines it as "that of which one professes knowledge; the occupation, if not purely commercial, mechanical, agricultural or the like, to which one devotes one's self; a calling in which one professes to have acquired some special knowledge used by way of instructing, guiding or advising others or of serving them in some art; calling; vocation; employment." Also, "the collective body of persons engaged in a calling."

A "professional" is one who engages in anything professionally; a professional work-

er, as opposed to amateur. Used as an adjective, the word professional means "of or pertaining to a profession, or calling; conforming to the rules or standards of a profession; following a profession, or some line of conduct as if it were a profession."

An editorial in the magazine *Sound and Vision* discussed the subject of "What is a 'Professional'?" I would like to share the three conclusions which were given in this editorial:

First of all, the professional offers a service, not a product. He doesn't sell anything, neither does he bargain, haggle, or bid competitively for work. He knows his worth and simply and directly states his fees. The client

information of; to make certain as a fact; to attest authoritatively; to verify. To testify to in writing; to make a declaration concerning, in writing, underhand; or hand and seal. To vouch or attest by a certificate."

This last step, "certification," is the action taken by the Board of Certified Safety Professionals based upon the testimony presented in writing by the applicant, and by those whom he has asked to write references. Before recapping the requirements for certification, I would like to quote the official definition of a "Certified Safety Professional" as set down by the Board: "Section 2. (a) Certified Safety Professional—An individual who utilizes the expertise derived from a knowledge of the various sciences and professional experience to create or develop procedures, processes, standards, specifications, and systems to achieve an optimal control or reduction of the hazards and exposures which are detrimental to people and or property by the utilization of analysis, synthesis, investigation, evaluation, research, planning, design, and consultation.

To fulfill completely all of the facts and details stated is a very large order. It calls for educated and dedicated individuals who will not be content with carrying on an injury reduction safety program, but who will attack the broader base of hazards control. A certified safety professional must enlarge his horizons and increase the depth of his activities. In every endeavor this means getting at the causes and making corrections.

To become a Certified Safety Professional an applicant must:

1. Submit an application on the proper form.
 2. Pay the required fees.
 3. Be of good character and reputation.
 4. Satisfy the educational requirements.
 5. Satisfy the experience requirements.
 6. Complete the examination requirements.
- The first two of these are easily accomplished and are fulfilled when you submit your application and send your check. The third of these is completed upon receipt of your recommendation letters.

The fourth, educational requirements, calls for a degree in science or engineering or other curriculum acceptable to the Board. In place

chooses or rejects, free from any duress, promotion, or advertising. The professional's record of accomplishment speaks for itself; his clients are witnesses to his abilities.

Second, the professional becomes involved—deeply and significantly—with his client, however minor or important the particular project may be. He offers his best efforts every time, not efforts scaled to the size, cost, or importance of the job.

Third, the professional accepts responsibility for what he does. In fact, for most professionals, the law clearly defines that responsibility and is adding to it daily. A professional's license to practice requires careful and conscientious efforts, and it unequivocally binds him to certain standards of practice.

Obviously, then, only a reasonably mature, educated, trained, experienced individual, dedicated to his field and committed to a life of service, can qualify as a professional.

The second definition needed is that for "safe" and "safety." You can see that I am working backward in the title "Certified Safety Professional." Turning again to the dictionary we find these two definitions: Safe: "Free from harm, injury, or risk; untouched or unthreatened by danger or injury; unharmed; unhurt; secure; sound; whole"; and Safety: "Condition or state of being safe; freedom from danger or hazard; exemption from hurt, injury, or loss."

There were many long and heated Board discussions with regard to where and how this concept should be applied. After hours of discussion it was agreed that the term safety, as defined, encompassed industrial safety (obviously), traffic, fleet construction, fire prevention, industrial hygiene, environmental health, radiological hazards.

A safety professional could be practicing in any of these areas, and if he met the requisites set forth by the Board he could be certified. Freedom from danger and exemption from hurt encompass one's entire life, and therefore those individuals who were practicing the techniques which prevented these adverse happenings were eligible for certification.

This brings us to the word "certify." This is defined in the dictionary as: "To give certain

of a degree, an applicant may substitute two years of sub-professional or professional safety experience.

The fifth, experience requirements, calls for five years of professional safety experience, two of which shall have been in "responsible charge." Advanced degrees and registration are accepted in place of some experience.

The sixth and last requirement is the passing of the examinations. However, until December 31, 1971, prior to exams, an additional five years of professional safety experience, all "responsible charge," may be substituted. After January 1, 1972, examinations are mandatory. With an acceptable degree it takes five years at the professional level plus passing the exams. Without a degree it takes 13 years experience plus passing the examinations.

The Board has received 2,800 applications, and at this point in time have certified 1,500 applicants. There have been a number of individuals who have not been certified under the waiver mainly because of lack of experience. In addition, there have been a very few who did not qualify at all.

Now to attack the other part of the title, "The Developing of Safe Work Places." There is no single simple solution to this. There are a great number of answers, with multiple solutions because of diverse problems. Obviously, we will still be attacking unsafe conditions, unsafe practices, and unsafe attitudes. We will still be confronted with both sub-standard environments and human errors.

Over the more than 30 years I have been in occupational safety I have sat in many a "gripe session" on the subject of "I wish my management would do something" on safety. When an individual is a professional and has the respect and status which goes with certification, he should have an easier job of convincing management and his superiors of the validity and import of his recommendations.

With the impact of OSHA and the hiring of qualified federal inspection officers, it is certain that the safety personnel representing management will have to be well versed in safety standards and procedures to converse on an equal footing with the inspection officers. A C.S.P. should be in a position to dis-

cuss the inspection report in a rational way, and to present his views and those of management, if there are differences of opinion.

Speaking of OSHA, I should like to express a deep concern about the hope of certain people that all that is needed to obtain safety is an inspection program. Certainly, inspection to discover sub-standard conditions is an asset, but it cannot be the only procedure in use.

One other aspect has been a problem, and I am sure you are aware of it. Many of the consensus standards contain a great number of safe practice rules. I know that there have been announcements that only the "shall" clauses (mandatory) will be enforced. Perhaps this information may be over looked by an overzealous inspector. I trust that in the long run we will see the development of standards which deal with the physical and environmental factor only. Safety rules and safe practices which govern behavior and job procedures are not standards and cannot be handled like them.

As the safety professional grows and develops, he will bring new methods and new techniques to bear on the problems of hazard control. In addition to standards, codes, technical manuals, and safety rules, he will introduce the use of flow charts, system analysis, critical path methods, and statistical analysis and inferences. He will use the national OSHA codes as a minimum and, where feasible, better these requirements.

In addition to bringing the plant environment in line with known and approved standards, the safety professional will initiate an attack on the problem of human failure with the use of a variety of techniques from the behavioral sciences. The new scientific approaches which have been developed, such as human factors, human engineering, biomechanical developments, and ergonomics, have a variety of techniques which can be used to improve the human aspects of the hazard control problems.

A few years ago an article in *Product Engineering* magazine made this statement: "Factory safety campaigns are worse than useless," says Dr. F. J. Gaudet, Director of the Laboratory of Psychological Studies at Stevens Institute. "We tend to use the same safety cure for

every one and every type of accident." Unfortunately there was considerable truth in the above statement. And what is more tragic, there is still a lot of truth in the statement today.

Safety, and I mean safety in its broadest connotation, has made considerable progress

during the past few years, but I feel that it has not kept pace with the needs of modern technology. We trust that the new safety professional will be able to bring new techniques and better methods and apply them effectively so the hazards which we have created may be controlled and we may have the security and contentment of a safer life.

HOW WALSH-HEALEY HAS PREPARED AEROSPACE INDUSTRIES FOR THE OCCUPATIONAL SAFETY AND HEALTH ACT

By GORDON W. ROSKO

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When it was suggested that the theme of this presentation might center around the Walsh-Healey Public Contracts Act and how it has helped aerospace industries, I responded by indicating the suggestions needed to see a psychiatrist. Who of us, having worked under the requirements of Walsh-Healey, has anything complimentary to say about the Act, much less commit those words to writing?

Returning to my desk bemused and muttering, "Walsh Healey, who was he anyway?" I busied myself with scattering newly arrived ANSI Standards about, looking for the safety engineers' security blanket—the coffee cup. Half a cup of coffee and twenty minutes into the new ANSI B11.71 Power Press Standard,

I suddenly realized, like all great inventors of the wheel, how wrong my initial response was as to how Walsh-Healey has benefited aerospace industries. Although too early to evaluate its historical impact on the safety movement, I have attempted to do so and convey to you some of the interesting highlights of thirty-four year old Walsh-Healey.

Safety. What does it mean to aerospace industries in 1971? What new responsibilities and challenges do we face? Is there anything we have learned in the past that might provide the curbstones for the road ahead?

Very definitely we face new challenges. However, the curbstones of guidance are in

place along the Aerospace Safety Highway. They were carefully laid in place in 1936 by Senator Walsh and Representative Healey who might well be considered the prime contractors for industry's present safety challenge—the Occupational Safety and Health Act Standards.

It is no longer a question of whether the Federal government should develop safety standards for all industries; the cry frequently heard today is, how can we comply with all those standards?

S-a-f-e-t-y. We know how to spell it, we know what it implies, but what does it mean today? Let's look at what the letters might stand for today.

S stands for "Safety Relief Device Standards-Cylinders for Compressed Gases S.1.1" a publication of the Compressed Gas Association, Inc.

A is for "Acetylene Tetrabromide," which has a threshold limit value of one part per million as adopted by the 33rd Annual Meeting of the American Conference of Governmental Industrial Hygienists in May 1971.

F means "Fixed Ladders, Safety Code For," American National Standards A14.3 published by the American Na-

tional Standards Institute.

E indicates compliance with the "Electrical Code (USAS C1-NFPA)," a United States of America Standard adopted by the National Fire Protection Association, an organization whose charter is to promote the science and improve the methods of fire protection.

T is "Transportation of Compressed Gases," a code of Federal Regulations, Title 14 Part 103—Hazardous Materials Regulation.

Y is a letter near the end of the alphabet, but in our case just the start of a continuing list of safety standards.

When we know what messages are contained in such manuals, standards, and specifications as AFM 127-100, 127-101, AMCR 385-224 USTM, Title 29 (CFR), NEPA VOL. 1-10, ASME, USAS-ANSI, DOD 4145.26M, AFSC-DH 1-6, MIL-S-38130A and on until we have gone through the word "safety" many more times, we then will have learned what meaning safe-e-y has today.

Voluntary safety standards have never been a luxury to aerospace or other industries which have entered into contracts with any agency of the United States. Federal contract clauses have required contractors to comply with mandatory safety standards since June 30, 1936. In 1935 assistants to the then Secretary of Labor drafted bills on approaches to establishing Federal wage and hour standards. One of these bills, S.3055, introduced by Senator Walsh, relied on the government's power to require its prime contractors and their subcontractors and suppliers to adopt minimum hour and wage and safety standards. Early in 1936, the United States Supreme Court in the Butler Case (United States v. Butler 297 U.S. 1) narrowed the scope of Federal authority to regulate labor conditions in industry through its contracting power, and Representative Healey's bill (HR 11554) was introduced on March 2, 1936 with that decision in mind. Both the

Walsh and Healey bills were sent to the House Judiciary Committee to be scrutinized for constitutionality. The Committee disregarded the broader Walsh bill and used the Healey bill as a basis for its own draft of the Walsh-Healey Act, which was signed into law on June 30, 1936. This act provided assurance to employees of a safe place to work, free from unsanitary or hazardous dangers.

A remaining point of historical interest before we move to a more current era emerges as a matter of record from Senate Committee hearings and House debates, which indicate very strongly that the Walsh-Healey Act was intended only for an interim period. This interim period lasted thirty-four years and still continues in effect today.

In its thirty-four year span many safety standards were promulgated and brought forth to become the basis of the Occupational Safety and Health Act. Without these standards for a base to build upon, the Occupational Safety and Health Act would not be the reality it is today. Many years were spent in the development process of these tried and proven standards.

During the development years of the Act, 1943 through 1952, approximately 7,500 investigations were conducted by the Wage and Hour Division of the Department of Labor. These investigations produced an average violation rate of 20 per cent. One out of every five plants visited were found in violation of the Safety and Health portion of the Walsh-Healey Public Contracts Act. Considering these plants had to comply with safety standards much more stringent than most neighboring plants operating under state or voluntary safety standards only, it's not a bad record.

During this same period, 23 states applied for qualification as agreement states; that is, to qualify states had to have safety laws comparable to or better than those regulations under the Act, to be granted privileges of self-inspection. Only six states earned the privilege of becoming agreement states.

With the development years passing, more safety regulations came forth under

the Act. A few of these were regulations governing flammable storage, mechanical ventilation, safe employee tool responsibility, machine guarding, materials handling requirements, and noise and radiation standards.

An example of Walsh-Healey guidance can be seen by looking at the December 28, 1960 publication of the *Federal Register*. The *Register* states that the welding and cutting of toxic materials such as cadmium and other metals of toxic significance must be provided with mechanical ventilation. It was not until six years later that the U.S. Department of Health, Education, and Welfare published an all industry's guideline, Bulletin No. 1518, "Working with Silver Solder," containing warnings to provide mechanical ventilation.

All has not been an understanding or easy road under Walsh-Healey. Its progress can be measured by giant steps forward and occasional stumbles. A stumble and cries of "flirting too hard" were heard when we read in the *Federal Register* on January 17, 1959 that noise was regulated at 85dbA. A sigh of relief, "That's better" came in May when we learned that it was changed to 90dbA. But the stage was set and the principal character actor's words are loud and clear: "Noise is unsafe."

I am sure there are many of you who worked in industry where plants operated under the voluntary safety standards principle, who instigated safety programs comparable to or better than those required by Walsh-Healey. However, the principles being developed during those years under Walsh-Healey were the same as those of the voluntary adoption followers, except that Walsh-Healey provided the initial spark instead of an industrial safety pacesetter.

Through the 1960's aerospace industries became adapted to meeting contractual requirements which spelled out that they develop and produce products, using as guidelines many varied sources of unrelated standards, unrelated in the sense that they covered many of the fields of science and humanities; related, however, in their message of safety.

Our preparation for tomorrow's safety

challenges was started in 1935 and its curb-stones, although somewhat chipped and worn as we look back, identify a clear road ahead.

Know, read, and learn how to use safety standards. They are tomorrow's tools today! The phrase "Tools of Tomorrow Today" connotes that the application of second or third generation standards to today's problems will enable you to maintain an adequate lead over tomorrow's regulatory standards.

What are second and third generation safety standards? A first generation standard would be a regulatory standard issued by the U.S. Department of Labor under various labor acts containing mandatory safety requirements. Also included as first generation safety standards are those state or contractual requirements which employers must abide by. Examples of first generation safety standards were published recently in the *Federal Register* under the authority granted by the Williams-Steiger Act to the Department of Labor.

The standards I have labeled as second generation standards, published by such agencies as ANSI, NFPA, and others are the basis for most of our regulatory standards in existence today. Many of these became regulatory first generation standards and were published by the Department of Labor in meeting their commitment to promulgate and publish workplace standards.

Does it not seem practical in today's busy work world that the first act which will arise from an organization contemplating new safety regulations is to look at what has already been written? What do we already know about the proposed subject? Who has written what and where can I get a copy? These are all questions which are asked when faced with updating or compiling a standard.

You say that's cheating—regulatory standard writers should be more original. How so? For one, our very basic tool, from our already overloaded safety tool box, is our unchallenged right to utilize any material formally published in the common interest of safety, providing that our motives are

the prevention of accidents, pain, or suffering. "A means is justified by its end."

Choosing any of the current OSHA standards, it is a simple task to trace their ancestry back several years to several non-regulatory standards or guidelines published 2, 5, or 10 years ago. Examining what takes place during the transitional phase for a non-regulatory to a regulatory standard, we find the following things have happened:

1. The standards necessity has been established because of an increase in accidents, or technological or manufacturing advancements or adjustments have taken place, broadening the use of a previous standard.
2. The standard must be altered generally to fit all industries under that classification.
3. The third and often not discussed subject is industry's willingness to adopt the standard. In looking at the development of a standard through several years, a

central theme arises. This theme emerges as we watch the content of a non-regulatory standard being delivered in phases to become regulatory. It's delivered in bite-size pieces. New Englanders have a saying which best describes the transitional phase: "You'll find that if cheese is eaten in small bite-size pieces it becomes more palatable and less binding."

The remaining point that must be made quite clear is in the form of questions, quite simple in meaning, but which we all must take more seriously: "Have you, Mr. Safety Professional, done your homework?" Do you know what standards exist? Which ones are being re-written? Do you really read the non-regulatory standards and guidelines? Do you attempt to phase them into your present safety programs today?

Don't wait until standards become regulatory—they are not bite-size any longer and you'll find them quite binding.

Air Transport Sessions

THE HEALTH OF GROUND EMPLOYEES IN RELATION TO NEW GENERATION AIRCRAFT

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The past sixty or so years have seen remarkable developments in aircraft design. In the years since the Second World War the pressurized cabin and the jet engine have had considerable impact on the design and development of civil air transport, enabling aircraft to fly higher and faster to the benefit of the travelling public. In their day, aircraft such as the Constellation and the Comet were worthy of the title "New Generation Aircraft." Currently, this title can be applied to aircraft in the jumbo jet category and to the supersonic transport.

Medical considerations with new generation aircraft are usually focused on aeromedical factors, although the SST has occasioned much, often ill-informed, comment in the public health field, particularly in respect to sonic boom and atmospheric pollution.

The relationship between new aircraft and the health of ground staff, however, excites little publicity outside airline medical departments, and it may be felt that medical problems do not exist in this context. While it is true that the medical, toxicological, and environmental problems which do arise are not as peculiar to the aircraft industry as the aeromedical factors associated with the design and operation of new aircraft, they are sufficiently interesting to warrant the attention of those practising in the field of health and safety in civil air transport.

Because BOAC have recently introduced the Boeing 747 into service and are currently considering SST operations with the aerospacial BAC Concorde, it is convenient to examine the health of ground staff in relation to new generation aircraft in the light of our experience with these two types. However, we provide a medical service to BEA as well

as BOAC and we are, of course, aware of similar medical considerations in BEA in respect to Airbus operations.

First Aid and Emergency Services

In the United Kingdom one of the primary functions of an airline medical department is to provide a first aid treatment and emergency service for those injured or taken ill at work. This is partly in response to United Kingdom legislation requiring the provision of first aid facilities, partly in response to occupational health philosophy in the U.K. and mainly due to our own firm belief that medical and surgical emergencies at work, together with the routine treatment of occupational conditions, is a service demanding the use of trained medical personnel. The term "medical personnel" includes qualified nursing staff, physiotherapists, radiographers, and so on. In BEA and BOAC, full 24 hour coverage is provided by registered nurses in areas of greatest staff concentrations, and at Heathrow Airport four Occupational Health Units are staffed on a 24 hour basis. Medical services are supplemented by trained first aiders where these are required to meet the provisions of U.K. legislation and where full professional cover cannot be justified in terms of the numbers of staff at risk.

Expansion of ground facilities and an increase in staff numbers often accompany the introduction of new aircraft and may create additional requirements for first aid and emergency coverage.

Several years ago there was considerable foresight in placing the main Occupational Health Unit serving BOAC in as central a location as possible in relation to actual and foreseeable building developments and staff

concentrations. Consequently, the main developments directly related to 747 operations have not required new medical accommodations, but two new Occupational Health Units, staffed by registered nurses, have been opened in building projects which have been expanded in response to 747 activities and which were remote from BOAC's headquarters and maintenance areas.

Shift Working. As yet there has been no necessity to change medical and nursing cover in response to altered shift work arrangements. Nevertheless, the operation of new aircraft may create an increased demand for shift working; for example, in response to the need for increased passenger handling requirements or high aircraft utilisation rates. The latter is a possible development as far as the SST is concerned and an airline medical department that provides adequate trained medical staff to meet first aid and emergency requirements may need to adapt to altered shift working arrangements.

The health of shift workers has attracted medical attention for many years. There is no evidence that conventional shift patterns have an adverse effect on health; indeed, sickness rates are often lower in shift workers than in those working normal daytime hours. However, certain medical conditions are not always compatible with shift working and staff suffering from stomach ulcers, diabetes mellitus, coronary artery disease, and certain other conditions may have to be restricted from shift duties. Assessment of fitness for shift working is a routine function of our medical department and is without problems.

If experience with the 747 and previous aircraft is typical of the pattern of airline development, foreseeable shift working requirements are not likely to create serious difficulties in respect of first aid and emergency cover or in health control.

Environmental Control. With the advent of an aircraft differing markedly from its predecessors in size, technology, or both, there will be developments within the airline to meet new operational requirements. These developments may give the medical department an opportunity to influence environmental factors related to the health, comfort, and work-

ing efficiency of ground personnel.

There were many opportunities to control the working environment when BOAC's 747 developments got under way. These will be illustrated by two specific examples from the various projects which encompassed, among other things, new hangarage, new workshops, extensions to the technical training center, and the provision of new ground support equipment.

O1 Hangar

Work on the first of the new hangars built to house the 747 commenced in April 1968, and the hangar was designated Hangar O1. Early in the design stage, an environmental committee was established and, in addition to Air Corporations Joint Medical Service representation, BOAC also had an environmental consultant serving on the committee. Excluding toxic and physical hazards, the environmental factors most closely related to health, comfort, and working efficiency are the thermal, acoustic, and visual environments. Under winter conditions, O1 Hangar is maintained at 68°F by means of underfloor and space heating. The latter is of an up-to-date design capable of meeting BOAC's specification that the hangar can be reheated to 60°F, depending on the ambient temperature, within 15 minutes of closing the hangar doors after these have been fully opened for the entry of an aircraft or some similar purpose.

The comfort conditions were defined as an air temperature of 68°F with air movement of 60 feet per minute at working level. Account was taken of the mean radiant temperature experienced by the occupants, especially from the floor, the surface temperature of which is not allowed to exceed 75°F.

No provision was made for summer cooling of the hangar. However, the building is insulated, and the glazing panels are of heat-reflecting glass. These provisions, combined with the air flow provided by the ventilating system and natural air flow through the building, are sufficient to maintain comfortable working conditions at the usual summer temperatures in the U.K. The general administration offices within the hangar, however, are fully air conditioned to maintain

70°F 12" and 50-55 per cent relative humidity.

Careful attention was paid to sound proofing to reduce noise from aircraft taking off and landing on the main runway, which is parallel to the front of the hangar and about 200 yards distant. With the doors closed the building structure provides about 30 dB of attenuation, successfully reducing the noise of aircraft operations and engine run-up tests on the adjacent apron.

All office accommodation within the hangar is double glazed to internal and external windows, and corridors are laid with foam-backed plastic sheet to muffle foot-falls. This high degree of acoustic attenuation in industrial accommodation overcomes communication difficulties which are so often a feature of offices in workshop areas. Apart from an improvement in the comfort of the occupants, there are clearly benefits in efficiency when conferences, telephone conversations, and the like are no longer interrupted by noises from the hangar, aprons, or runways.

While on the subject of noise, there is no evidence to show that noise is harmful, except to hearing, and complaints of fatigue, etc., are difficult to evaluate by objective scientific measurement of the usual physiological parameters. Even so, while noise may not shorten your life, it can certainly shorten your temper, as well as having other effects which are undesirable in terms of human comfort and efficiency.

A balanced lighting system of high pressure sodium and mercury fluorescent lamps provides general illumination of approximately 500-550 lux and, among other reasons, was chosen because it gives a psychologically satisfying effect of warm sunlight and good color rendering.

Glazed skylights and door panels were introduced into the design of the hangar to give a degree of contact with the external environment as well as to obtain the other benefits of natural daylight. The lighting is remarkably glare free, and vertical as well as horizontal surfaces are satisfactorily and evenly illuminated, a point of some importance for illumination of working surfaces as well as for visual comfort.

The hangar contains a mezzanine floor which is an important feature of the design

from the point of view of easy access to the aircraft and, together with suspended walkways, minimizes the use of portable access staging on the hangar floor.

The area beneath the mezzanine is shaded from the main hangar lighting and natural daylight from the roof. Care was taken to balance the supplementary lighting beneath the mezzanine with the general level of illumination in the rest of the hangar. Had this not been done, glare and contrast problems would have arisen. Good lighting is not simply a matter of visual comfort, as poor lighting can affect efficiency, engineering accuracy, safety, and so on.

Ground Support Equipment. The specifications for ground support equipment included ergonomic and other human factors engineering considerations, notably, ergonomic specifications for driving cabs.

Noise and Vibration Standards. Noise levels around the vehicles were limited so as not to exceed 85 dB(A at 15 feet from the perimeter of the vehicle. Additional specifications were that in the driver's cab, where there is a speech communication requirement, the speech interference level of noise shall not exceed 65 db, and in driver's cabs where there is no speech communication requirement the speech interference level shall not exceed 75 db.

In recent years increasing attention has been paid to the effect of vibration on body organs and systems. In motor vehicles the principal problem relates to vibration damage to the spinal column, and it was specified that "the driving position shall be so treated as to avoid body vibration and in particular shall completely exclude vibration below 12 Hertz."

Aircraft

Turning to the aircraft themselves, the most obvious feature of the 747 is its size. Servicing points are higher than on previous generation aircraft and can no longer be reached from ground level. Surprisingly, this is also the case with Concorde in which, because of the height of the undercarriage, servicing points, door sills, and the top of the fuselage are all at heights comparable with similar positions on the 747.

It was anticipated that staff with mobility limiting conditions, cardio-respiratory disorders, and the like, would experience difficulties in servicing and maintaining the 747. In practice, the problems are no greater than those experienced by engineering staff maintaining smaller aircraft where a high standard of fitness is already required to meet the physical demands of the work.

Engineering staff undergo a stringent pre-employment medical examination and procedures exist for suitable restriction of duties or transfer to other less physically demanding work areas for those employees who sustain some medical disability. As a result, the advent of the 747 has not revealed additional employees who find themselves unable to carry out routine maintenance procedures because of some medical problem.

The presence of the mezzanine floor in the 747 hangar has considerably improved the access situation for overhaul purposes, and has markedly reduced the amount of climbing normally undertaken by overhaul personnel. Fortunately, this will also apply to Concorde, which can be serviced in the same hangar and can utilise the same ground support equipment as the 747 in most instances.

Working at heights is always potentially hazardous. The risks are best avoided by suitably guarded and well designed stairways and access platforms, and these have been provided in O1 Hangar. Despite this, it was necessary for the medical department to consider whether the dimensions on the 747 increased the risks from falls in personnel liable to loss of consciousness or vertigo as a consequence of some medical condition. Design of the access staging and equipment for the 747 is such that the risks have diminished rather than increased, and there has been no reason to change existing medical standards designed to safeguard personnel from medical conditions rendering them liable to fall, despite the increased size of the aircraft.

One problem that was not foreseen is the increased physical effort involved in packing the escape chutes for the 747. The solution to the problem is simply to use more personnel in this packing task rather than set more stringent physical requirements for the employees.

Few esoteric problems in the field of physical or chemical hazards have revealed themselves in either the 747 or Concorde. In this respect, both aircraft are quite conventional in the range of equipment and material used. Nevertheless, there are a few changes from previous aircraft which require to be mentioned. Physical hazards in the medical sense encompass such matters as radiation, noise, etc., and radiation problems will be mentioned first.

Radiation. Radiographic inspection techniques, nuclear fall-out contamination of airframes and engines and certain equipment can expose staff to radiation risks. The problem of ionizing and electromagnetic radiation exposure have long been recognised and controlled. Until recently, the principal source of electromagnetic radiation in airline activities has been from search and control radar facilities, but microwave ovens have recently become an additional source of this type of radiation.

Radar. Search radar equipment on the 747 and Concorde is of a conventional type, and field strengths are below the limiting intensity of 10mw/cm². Existing precautions to limit its exposure will suffice.

Microwave Ovens. Microwave ovens are rapidly becoming an established feature of modern food technology, and the advantages they offer for extremely rapid heating of food make them desirable features in aircraft galleys. BOAC first used microwave ovens on aircraft in the Boeing 747, and they are likely to be a requirement for Concorde if the latter enters BOAC service.

The manufacturers have produced a very safe and sophisticated piece of equipment which meets safety standards laid down in the United States, and we are satisfied that the equipment is safe for use by cabin staff. Nevertheless, the medical department is in the process of introducing recommendations regarding the purchase, use, and maintenance of microwave ovens to ensure that even potential hazards are obviated and to build up factual experience on any problems that may arise.

Our main sources of reference are the "Safety Precautions Relating to Intense Radio Frequency Radiations," published by

Her Majesty's Stationery Office, London, and the "Intense Radio Frequency—Code of Practice," issued by the Chief Safety Officer, Ministry of Technology, 1968. These documents regard microwave radiation energy levels below 10mw/cm² as safe, although higher levels of exposure are permitted on a time weighted basis.

In normal use, an oven that is properly designed and maintained should not have a microwave radiation leakage in excess of 10mw/cm². It has been suggested that "normal" leakage should not exceed five mw/cm² and the 747 microwave ovens have, in fact, a leakage rate below one mw/cm².

The risks to maintenance workers arise from the possibility of damage leakage exceeding 10mw/cm² or intentional short circuiting of switches for test purposes during maintenance. To cover eventualities arising during use and maintenance, we have proposed that each oven on the 747 shall be monitored for door seal leakage and automatic interlock function at least once a week. Damaged ovens should be reported and returned for repair.

On maintenance or rectification, the ovens will be monitored before work is carried out and after work has been completed. If the reading prior to maintenance exceeds 10mw/cm² or some lower figure dictated by experience, then the current should be switched off and the fault rectified before further testing. This will ensure no hazard arising from the testing procedure. On completion of maintenance, the oven must have a further test to establish that it is within any limit set by the medical department prior to further use on the aircraft.

In addition to ensuring the safety of operators and maintenance personnel, the monitoring procedures will enable us to build up a body of information on levels of microwave radiation to be expected in use and maintenance and to deal with special problems should they arise.

For those unfamiliar with the effects of microwave radiation, the problem is that of thermal damage to tissues. As the microwave waves penetrate deeply with only minimal heating of the skin, deep seated body tissues can be burned without the prior warning of

skin burns occurring. The principal chronic effect is on the lens of the eye which, following long periods of exposure insufficient to cause effects on other organs, may develop cataracts. Providing exposure levels are below 10mw/cm², this will not occur. An American study of maintenance workers exposed over several years to levels of microwave radiation in the order of 20mw/cm², showed that they suffered no observable serious medical effects.

Even though short exposures to much higher doses do not appear harmful, we are confident that our own staff need not be exposed either acutely or chronically to doses above 10mw/cm². It must be stressed, therefore, that the risks are potential rather than actual and we believe that they can readily be controlled. To see the position in perspective it might be interesting for you to know that on a bright, sunny day we are exposed to microwave energy levels in the order of 100 mw/cm².

Turning to the matter of ionizing radiation, the first aspect to be dealt with is industrial radiography.

Industrial Radiography. Radiographic inspection techniques for non-destructive inspection of airframes, engines, and components continue to be increasingly used and are, in fact, being widely used on the 747 engine parts. Radioactive isotopes used as a radiographic source have increased in strength, and safety boundaries have been extending accordingly. Great care has to be taken to ensure that these boundaries do not encroach on areas occupied by other personnel and radiographic technicians are at greater risk if they fail to pay attention to correct working practices which, in the U.K., are prescribed by law. Over many years our film badge monitoring program has confirmed that the radiographic inspection procedures are safe and carefully adhered to, and film badge readings are repeatedly at negligible levels.

Depleted Uranium Balance Weights. A novel situation arises with the 747 which uses depleted uranium balance weights within the flying control surfaces on the tail. The distance of these weights from passengers and crew ensures that there is no radiation hazard. Similarly, ground personnel are not ex-

posed during routine servicing and maintenance procedures, and even those working on these control surfaces are not exposed to a significant radiation hazard as surface dose rates and exposure times are low.

An exemption has been obtained freeing BOAC from the appropriate statutory control requirements for sealed radiation sources recognising this situation as non-hazardous.

Radioactive Fall-Out Contamination of Airframes and Aero-Engines. Contamination of airframes and engines with nuclear fall-out material from atmospheric atomic explosions has been occurring for many years. A Ministry of Aviation Code of Practice on Radioactive Contamination of Aircraft (1966) deals with standards and precautions, and the recommendations of the Code of Practice have been followed in BEA and BOAC in appropriate situations. Both organizations were represented on the Radioactive Substances Advisory Committee Advisory Panel on the Radioactive Contamination of Aircraft responsible for drafting the code of practice.

Dealing with the subject briefly, contamination of the airframe is controlled by normal aircraft cleaning procedures, and engine contamination is removed during the stripping and cleaning procedures prior to engine overhaul.

For many years, levels of radioactive material on engines have been in Range 2 of the Code of Practice, that is between 10^4 to 10^5 microcuries/cm². At this level a controlled area need not be established but is recommended. The principal provisions of such a controlled area are:

1. That the work is segregated and the working area suitably indicated.
2. Unnecessary handling of contaminated surfaces must be avoided.
3. Personnel must wash their hands before eating, smoking, drinking, or applying cosmetics.
4. Protective clothing must be worn, and in Range 2 this simply means an overall.
5. Outdoor topcoats and jackets are left outside the controlled area and overalls stored and donned inside.
6. Dry dust raising operations should be avoided.

It must be emphasized that the aim is to

avoid ingestion or inhalation of radioactive material, and skin contamination per se is of no consequence at these levels of radioactivity. There is no risk whatsoever to passengers or crew from this type of radioactive fall-out contamination.

As far as Concorde is concerned contamination of the airframe and engines will be higher per mile flown because a greater proportion of the total flying hours will occur in the stratosphere, which is the area in which the fall-out contamination lingers. Nevertheless, it is not envisaged that additional control procedures will be required to protect maintenance personnel.

Kinetic Heating. Turning from radiation, another physical problem to be mentioned is that of kinetic heating of the Concorde airframe. At supersonic speeds, high airframe skin temperatures occur due to kinetic heating effects. At first it was thought that some parts of the aircraft structure might store heat sufficiently for them to remain hot after landing and thereby impede or hazard ground personnel. The cooling effect of descent through the cold layers of the atmosphere at subsonic speeds effectively dissipates the heat and no problems will arise.

Noise. Finally, in dealing with physical hazards, we turn to problems of noise. As far as ground personnel are concerned, noise exposures from take-off, landing, and ground running of either aircraft are not significantly different from jet engine, generation jets, and both the 747 and Concorde are better than some aircraft at present in operation.

While apron noise levels are frequently in excess of 90 dbA, the level at which a hearing loss risk starts to become significant, exposure of apron personnel to the noise is intermittent so that the accumulative exposure over an eight hour shift may be less than an equivalent continuous noise level of 85 dbA and, therefore, not cause noise induced hearing loss.

Ground power sources and ground support equipment are often the most significant noise sources in apron areas and, as stated previously, noise specifications were set for the 747 ground support equipment to deal with this problem at source. Nevertheless, in the present state of the art noise exposure on

the apron and in certain engineering areas demands the use of hearing protection, and this requirement is not significantly affected, either for better or worse, by 747 or possible Concorde operations.

For many years BEA and BOAC have operated a hearing conservation program under the direction of the medical department, and ear defenders currently used will provide adequate protection against the possibility of noise induced hearing loss arising from noise producing operational procedures associated with the 747 and Concorde.

Chemical Hazards

As far as toxicological hazards are concerned, only two have come to light which differ from those encountered in the routine maintenance requirements of present generation aircraft, and both these problems relate to Concorde.

Beryllium. The brake size on Concorde has been constrained by airframe design from growing proportionately as the aircraft weight has increased from a 112 ton design study to the 175 ton production airliner. Weight considerations have led to the use of beryllium metal sections as heat sinks backing the friction material.

The toxicology of beryllium and its compounds is complex, encompassing skin lesions and systemic effects on the lungs and other organs. These effects are the result of exposure to beryllium dust or to the dusts or solutions of beryllium compounds. There is little likelihood of such exposure occurring to airline employees from the use of solid blocks of beryllium metal as a static portion of the brake assembly. However, if there is any evidence of beryllium containing dusts being formed within the brake assembly or any requirement for the metal to be machined or processed by maintenance personnel, appropriate industrial hygiene precautions could be established. It should be pointed out that beryllium is widely handled in other industries without hazard to health providing appropriate precautions are taken.

Advanced carbon brakes are being developed and may replace the beryllium-containing brake assembly on production aircraft, so that even the very small potential

risks may never materialize.

Hydrazine. Hydrazine has been used as a rocket fuel in American and other space programs, as well as for military purposes as a missile propellant, and it is now making its appearance in the airline industry. Hydrazine fueled emergency power units have been installed on the prototype and pre-production Concorde and will probably be installed on production aircraft also. Concorde is not the only new aircraft to use this fuel for the emergency power unit and its use is likely to become more widespread in the airline industry.

Hydrazine has a potent effect on the skin, causing dermatitis or chemical burns. Chemical burns of the eyes can occur from splashes, and inhalation produces shortness of breath. Systemic effects on the internal organs and blood system have been noted in animals exposed to high concentrations.

The aim in aircraft maintenance and servicing procedures will be to avoid contact with hydrazine, thereby avoiding the necessity for protective clothing. In practice, avoiding contact appears to be relatively simple. The hydrazine reservoir is supplied sealed. Small leakages may occur while coupling the reservoir to the emergency power unit. Another possibility is that small quantities of hydrazine may be vented through a pressure release valve on the reservoir. In either case, the hydrazine will pass through vent ducts near the tail of the aircraft and the liquid contamination may either be visually detected or noticed by its characteristic smell. Fortunately, it can be detected by smell long before toxic concentrations develop in the atmosphere of the work place, and if there is doubt about the presence of vapor, simple air sampling procedures will detect it.

Equally fortunately, the liquid is slightly heavier than water, with which it is miscible, and it is not highly volatile. Contaminated aircraft parts will be flooded with water and the hydrazine washed away safely before maintenance procedures are undertaken.

Should the EPU be operated, contaminated aircraft parts will need to be washed down before servicing and maintenance activities can commence, and servicing the unit itself would require suitable precautions. At pres-

ent, it is envisaged that the EPU would not be re-used and special precautions, therefore, are unnecessary. If experience shows that there is a situation demanding the use of protective clothing, this will be provided, and there is no question that adequate protection can be afforded to airline personnel.

Although outside the medical field, it is worth noting that there is a fire hazard if hydrazine comes into contact with oxidising agents, and special provision will need to be made for storage, preferably with a water deluge system triggered by a hydrazine detector installed in the store.

Conclusion

New aircraft, by virtue of an increase in

size or new technical aspects, may introduce factors relevant to the health of airline ground personnel. Similarly, the impact of new generation aircraft on airline operations, and airline developments occurring coincidentally, may result in alterations to working practices or the working environment.

A few of the problems that arise have been exemplified in this presentation. Not only may the problems be overcome, but the changes brought about by the entry of new aircraft into airline service should be taken as opportunities to maintain and improve the high occupational health standards which generally prevail in the world's major airlines.

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