NASA-CR-193462

(NASA-CR-193462) PROCEEDINGS OF THE 1992 ANNUAL MEETING NASA OCCUPATIONAL HEALTH PROGRAM (BioTechnology) 312 p

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OCCUPATIONAL
HEALTH
PROGRAM

Proceedings of

1992 Annual Meeting NASA Occupational Health Program

November 30 - December 4, 1992
San Jose, California

HEALTH
WELL-BEING
PRODUCTIVITY

Occupational Health and Aerospace Medicine Division
National Aeronautics and Space Administration
Washington, D.C.

July 1993

- Conference Proceedings -

OCCUPATIONAL HEALTH MEETING

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

30 November - 04 December 1992

Prepared for:

NASA Occupational Health and Aerospace Medicine Division
Washington, D.C. 20546
under Contract NASW-4176

by:

BioTechnology, Inc.
405 N. Washington Street
Suite 203
Falls Church, Virginia 22046

The Aerospace Medical Association (AsMA) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to sponsor continuing medical education for physicians.

A total of 14.25 credit hours for AMA Category 1 CME's for participating physicians has been approved by the Aerospace Medical Association.

Program approved by the American Association of Occupational Health Nurses (AAOHN) Continuing Education and Approval Program for 25.8 contact hours. Approval Code 700-046-007.

The American Board of Industrial Hygiene (ABIH) will award 2.5 Certification Maintenance Credits for all attending Certified Industrial Hygienists.

FOREWORD

The learned jurist Oliver Wendell Holmes observed that the ultimate good is best reached "by free trade in ideas." In our world, the ultimate good is found in a NASA workforce that is healthy and productive. The free trade in ideas supporting our pursuit of this ultimate good occurs in large measure during our Annual Meeting. This meeting is an indispensable part of our Occupational Health Program.

In preparing for this year's Annual Meeting, care was taken to ensure that the invited speakers would address issues of real importance for our day-to-day occupational health programs. I feel we have succeeded. The speakers represent excellent practitioners in the occupational health field and the topics are most relevant to our needs.

New this year are the Workshops on "Occupational Epidemiology" and "Introduction to Biostatistics." These workshops are offered as a means of ensuring that Occupational Health Program employees have greater understanding of the issues in data management within occupational and environmental health programs.

The final day of the meeting, as always, is devoted entirely to presentations by Center personnel describing new programs developed and problems faced at their individual Centers. This exchange of information across NASA facilities is critical as we seek agency-wide improvement in our efforts to maintain and enhance employee health. I encourage each of you to begin very soon to reflect on topics appropriate for next year's meeting.

I extend my personal thanks to the invited speakers, to the NASA speakers, and to all attendees. The NASA Occupational Health Program draws heavily on your contributions and discussions. Many thanks.

Marshal S. Levine, M.D., MPH
Director, Occupational Health and
Aerospace Medicine Division
NASA Headquarters

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OPENING REMARKS

Marshal S. Levine, M.D., MPH
Director
Occupational Health and Aerospace Medicine Division
NASA Headquarters

We in the NASA Occupational Health Program are fully committed to the proposition that employee health is a *sine qua non* for a productive agency capable of achieving the expressed goals of the National Aeronautics and Space Administration. The information obtained and ideas exchanged during our Annual Meeting are essential as we strive each year to maintain and enhance the health of the NASA workforce.

I would like to welcome each of you today to participate in an exchange of ideas. To begin this exchange, we will have presentations by a number of individuals with outstanding credentials in occupational medicine and in environmental health. The selection of topics covers issues of importance both for Headquarters activities and for the operations of occupational health programs at the different Centers.

For those of you with special interests, we have scheduled breakout sessions on Occupational Medicine, Environmental Health, and Physical Fitness and Health Education for Wednesday afternoon. Next year, we plan to rotate the coverage of the breakout sessions somewhat to ensure that proper attention is given to each of the different disciplines included in our Occupational Health Program.

Our Thursday afternoon tour will take us through the facilities of the Ames Research Center. Ames conducts both laboratory and flight research in support of space missions and aeronautics programs. Their facilities are impressive. I certainly want to thank all of those at the Ames Research Center for their hospitality, and in particular Mr. Victor Peterson, Dr. Ralph Pelligra, and Mr. Steve Brisbin, the first two of whom will address us during the meeting.

Our meeting will begin today with a Welcome by Mr. Victor Peterson, Deputy Director of the NASA Ames Research Center and a long-time friend of our Occupational Health Program. For our Keynote Address, we are most fortunate in having a gentleman

we all know through his excellent reputation as a leader in the fields of environmental health and industrial safety: Dr. Paul Zeimer, Assistant Secretary, Environment, Safety and Health, U.S. Department of Energy. Now, let us begin what should be a challenging and productive meeting.

WELCOME

Victor L. Peterson
Deputy Director
NASA Ames Research Center

We at the Ames Research Center are very pleased that San Jose was selected as the site for this year's National Aeronautics and Space Administration Annual Meeting of the Occupational Health Program. I want to welcome all of you, and let you know that I am very happy that you will have the opportunity to spend an afternoon touring the Center later this week. While you will not be able to see the entire Center in one afternoon, hopefully we have outlined a tour that will be of particular interest to this group.

Ames is 53 years old now. Formed in 1939, it was the second of the original NACA (National Advisory Committee for Aeronautics) Centers. Ames became part of NASA when the Agency was created in 1958. I joined Ames when it was still a part of NACA, and have been fortunate to see the development of the NASA program through its entire history. In addition, I have served under all of the NASA Administrators and all of the Ames' Center Directors.

As you probably know, Ames Research Center is a two-site Center. We are responsible for the site at Moffett Field and also for the Dryden Flight Research Facility, which is located in Southern California on the corner of Edwards Air Force Base. We support the Space Shuttle landings at that facility, and all of our high performance flight research is done at Dryden.

Ames Research Center employs approximately 5,000 people; 4,000 are at the Moffett site and about 1,000 are at the Dryden facility. About half of these 5,000 people are civil servants and the other half are support service contractors, students, research fellows, and visiting professors. A contingent of about 150 Army Aviation Researchers are also located at Moffett. Our budget for fiscal year 1992 was $670 million, making us the 9th largest employer in the Santa Clara Valley with the largest R&D budget of any private or public organization in the Bay Area. We have a wide variety of programs in both aeronautics and space. About 60 percent of our effort is in aeronautics and the other 40 percent in the space program. We refer to Ames as a "technical Disneyland."

The aeronautics programs at Ames are centered around four major types of facilities:

Supercomputers: Ames has the most powerful complex of supercomputers in NASA and, in fact, in the entire aerospace community. We operate one of our two supercomputer facilities as a national facility with people using the system from locations all around the country. The 1,500 users include aircraft companies, universities involved in aeronautics programs, and other government laboratories.

Wind Tunnels: The second type of major facility we have for aeronautics is wind tunnels. The largest wind tunnel in the world is located at Ames, along with several other wind tunnels that are also considered national facilities. Every airplane, both military and civilian, that has been developed in this country since the early 1950's has gone through one of the wind tunnels at Ames in the course of its development. We are completing work now on the new transport for Boeing, the 777. We are currently rebuilding one of our wind tunnels, the 12-foot pressure wind tunnel. This rebuilding process involves a lot of welding, including the welding of steel plates that range up to more than 2 inches thick. The almost daily inspections of the welds involves the use of high energy field radiographic sources including 200 curie iridium sealed sources. Public safety is a major concern during the performance of the weld inspections. The world's largest wind tunnel is currently being repainted, and I believe this is the largest lead abatement program going on in the country now. This wind tunnel was built many years ago and painted with the old lead-based type paints. In the repainting process, all of the old lead-based paint must be stripped off and replaced with more modern types of coatings. Stripping the paint off of a facility of this size and keeping it contained poses an interesting problem. The wind frequently blows off the bay at Moffett, and during the stripping process the entire area that is being worked must be draped.

Flight Simulators: The third class of facilities at Ames is flight simulators, including one which is the largest moving base simulator in the country. This simulator actually has a travel of 60 feet in one direction and 40 feet in another direction, and then 3 degrees of freedom in the cab. It represents pretty well a full 6 degree of freedom motion. We use the simulators to study aerospace

human factors issues and aircraft and spacecraft control problems. We also use them to look for ways to improve air traffic control in the country. One of the simulators is used extensively for Space Shuttle pilot training during emergency situations. This is the highest fidelity simulation of landing the Orbiter while experiencing cross winds, tire blowouts, or turbulence at the last minute. Landings on either a concrete runway surface or a hard, sand-type surface can be simulated. Twice a year all of the Space Shuttle pilots come out for emergency landing training at that facility.

Research Aircraft: The fourth class of facilities we have on the aeronautical side involves research aircraft. Research aircraft are located both at Moffett and at Dryden. High performance flight research is done at Dryden, and the more contained, lower performance flight research is done at Moffett. We fly a lot of rotorcraft at Moffett. We are responsible for developing the tilt rotor which has graduated into being developed as the V-22 for the Marine Corps. We are currently looking at civil uses for the tilt rotor concept. Powered lift research is also done at Moffett, and we have a couple of Marine AV8-B airplanes that can take off vertically and fly supersonic. These are relatively conventional-looking airplanes, but they can take off and land vertically. Dryden inherited three SR-71 airplanes from the Air Force when they retired the fleet, and these are capable of speeds in excess of Mach 3. We are preparing now to use them for testing supersonic transport technology. Certain ideas can be tested on the airplane at Mach numbers up to 3. There is also a fleet of F-18's at Dryden, and we did the X-29 program in conjunction with DARPA and Grumman. The X-29 was a forward swept wing airplane. We are now conducting the X-31 program together with MBB from Germany and several organizations in this country.

On the space side, we have a wide variety of areas of work including Life Sciences, Earth and Atmospheric Sciences, and Space Sciences. Life Sciences is probably of most interest to you, and you will see some of the work that goes on in that area when you tour the Center. In Atmospheric Sciences we operate a fleet of what we call platform aircraft. They are deployed all over the world. We have a DC-8 and three ER-2 airplanes which are upgraded versions of the old spy plane called the U2. These allow us to fly experiments at quite high altitudes all around the world. Data for studying the ozone depletion over the Antarctic and Arctic were obtained using these airplanes. Principal investigators are from all over the world. Announcements of

opportunities are issued and investigators present proposals. These experiments, including some of our own, are then flown at various locations around the world to study the effects of mankind on the atmosphere and on the land masses and oceans. Moffett also has a C-141 airplane that has a 1-meter infrared telescope on it. This allows flight above most of the water vapor in the Earth's atmosphere and enables distant objects to be seen. This supplies information which helps studies of the origin of the universe. We also manage the program on the search for extraterrestrial intelligence, or SETI. On Thursday you will hear a talk on the SETI Program. The SETI program has captured the imaginations of everyone. Columbus Day this year was the celebration of the 500th anniversary of Columbus discovering America, and that day was also the official start of the SETI Program.

Ames is also responsible for managing the centrifuge program for the Space Station, a facility that will allow us to vary the gravity from roughly zero G up to 2 G's. It is not large enough for humans but will be used mainly for animal studies. It will allow us to do controlled variable-gravity type experiments for extended periods of time at gravities between 0 and 2 G. Another facility for supporting our human research is the 20 G human centrifuge. It is my understanding that this is the only man-rated centrifuge in NASA. We also have a human bed-rest facility in which subjects can be placed, slightly head down, for extended periods of time. When one is maintained in that position for extended periods of time, the cardiovascular deconditioning that occurs in long-term spaceflight can be simulated to some degree. After that position is maintained for an extended period of time, the subject can then be placed on the centrifuge in order to study the effects of recovering from simulated weightlessness.

Ames also has a neutral buoyancy test facility which is used in our space suit development work. Ames and Johnson Space Center are the two Centers currently working on space suit technology. Together we have developed a high-pressure hard suit for use in long-term space missions such as around a habitat on the moon or Mars. The idea of going to a pressure of 8 psi rather than a lower pressure of 4 or 5 psi is that the long pre-breathing exercises that have to occur when one uses a low pressure suit can be avoided. Later this week, Dr. Ralph Pelligra from Ames will tell you more about these human-oriented programs, and you will be able to see these facilities during your visit to our facility.

The people at Ames have a great deal of respect for the NASA Occupational Health Program. It is a strong and forward-looking program that is absolutely essential to protect the work force. Because of the type of work we do at the Center, which ranges from centrifuges to simulators to high-performance research aircraft, we must be very concerned with the every-day hazards posed by operating these types of facilities, and we appreciate the Health Maintenance Programs that are dedicated to assuring peak performance of our work force. Obviously we cannot get anything done without people, and if people are unable to perform up to their fullest potential, then our performance as a Center will suffer. We simply could not operate without a careful, strong and controlled program in the health maintenance and occupational safety and hazard areas. Thank you for helping us do our job through the health and maintenance of the life quality of our work force.

N94-10610

NEW HEALTH AND SAFETY INITIATIVES AT THE DEPARTMENT OF ENERGY (DOE)

Paul L. Ziemer, Ph.D.
Assistant Secretary for Environment, Safety and Health
U.S. Department of Energy

It is a pleasure to participate in NASA's annual Occupational Health Program meeting and to address such a distinguished group of medical and occupational safety and health professionals. I am pleased to have this opportunity to tell you about some of the lessons we have learned in the area of occupational safety and health and about a few of the new initiatives we have recently launched at the Department of Energy.

I think that our new programs will be of interest to you because NASA and the DOE have many features in common. For example, both organizations engage in advanced research and development activities, operate pioneering scientific laboratories, and own contractor-operated production and research facilities. Although the Department of Energy's complex is considerably larger than NASA's -- we have several hundred sites and nearly 170,000 contractor employees in the DOE complex -- many of our occupational safety and health problems are undoubtedly similar. To address these issues, we at DOE have developed new programs and redirected old ones in the areas of occupational medicine, industrial hygiene, epidemiology, and occupational safety. Early indications are that our new programs are achieving a considerable measure of success. For example, DOE-wide injury and illness rates are generally well below those for comparable private-sector operations. If that is the case, why are we taking time and resources to launch new occupational safety and health initiatives?

My answer is simple: If even one DOE worker gets sick or is injured because of conditions on the job, it is one too many. A few months ago, for example, a DOE maintenance worker at Hanford fell to his death through a hole in a rotted-out roof that he was surveying before starting to work on it. Even more recently, a supervisor, unaware of his facility's rule prohibiting persons from entering a crawl space under a building while the conveyor was operating, died when he fell onto the running belt. Many of you also know that DOE's workers have experienced an unacceptably high incidence of chronic beryllium disease as a result of their work at our facilities.

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I know that you as health and safety professionals share my belief that every one of these preventable illnesses and injuries is reason enough for us to pursue, and to pursue aggressively, a comprehensive Occupational Safety and Health Program at DOE and throughout the Federal Government. My talk today focuses on the fundamental redirection of DOE's Worker Safety and Health Program that has taken place over the past three years.

In 1989, Admiral Watkins, the then newly appointed Secretary of Energy, promised the President, the Congress, and the American people that he would establish "a new culture of accountability at the Department of Energy." One of the first things Admiral Watkins did was to invite the Department of Labor's Occupational Safety and Health Administration (OSHA) to join with DOE to conduct inspections of several DOE facilities to evaluate DOE's Occupational Safety and Health Programs for its contractors. As you may know, DOE has been exempt from OSHA oversight and has always been responsible for its own safety and health program. Consequently, this was the first time OSHA compliance inspectors had assessed our facilities.

The results of these early "Tiger Team" assessments, as we called them, were very enlightening because they pointed to several key safety and health issues, such as the need for greater management commitment and employee involvement in the Occupational Safety and Health Program. I believe that these same issues face every employer, whether in the private sector or in government. Let me review some of these issues.

Occupational Safety and Health Issues Facing DOE (Lessons Learned in Occupational Safety and Health)

1. Workplace Risk Levels

Prior to 1990, the injury and illness rates reported by DOE were unreliable because DOE was not applying Bureau of Labor statistics recording and reporting criteria, which meant that comparing DOE's rates with anyone else's was essentially meaningless. Back then, DOE touted statistics that were factors of 4 to 5 below industry averages as evidence that DOE had exemplary occupation safety and health programs. The conversion to Bureau of Labor statistics reporting practices in 1990, however, led

to an immediate factor of 2 increase in DOE's injury/illness rates. Furthermore, we find that the Department's statistics are trending upwards, at least in part because of more and better reporting. Thus, overall, any statistical gap between DOE's rates and those of the private sector has become considerably smaller.

The important thing to note here is the risk inherent in making injury and illness data a surrogate for occupational safety and health performance. As a relative measure of workplace trends, injury and illness data can help to target where problems are occurring and encourage systematic investigation into weaknesses in current occupational safety and health programs. As exclusive indicators, however, these same data can mask broad occupational safety and health program deficiencies.

Simply put, an inadequate program is ripe for a serious accident -- one for which no safety net will exist because good procedures, training, supervision, and hazard abatement have not happened. Skilled and experienced workers can work safely for an amazingly long time, until the lack of built-in safety and health procedures shows and someone makes a very human mistake. All of the accidental fatalities this past year in DOE -- seven deaths in three accidents -- have been the result of inadequate management oversight and program implementation.

2. Hazard Abatement

In its 1990 evaluation of DOE's facilities, OSHA observed that at some sites, hazards had been identified but had remained uncorrected for more than a year because area supervisors did not recognize those items as major priorities. We also learned during these early assessments that some facilities had conducted a baseline occupational safety and health compliance survey of their program that had identified numerous deficiencies but had not subsequently established an abatement process to correct these hazards.

The issue here has two aspects, but only one obvious solution. First, although hazard identification and prevention surveys are important, they are, at best, only half of the answer. For example, although DOE contractors have made noteworthy progress in "baselining" their facilities for occupational safety and health deficiencies, line management has struggled mightily with the other half of the equation; i.e., how to effectively manage the abatement process. Second, the significance of this issue from

the standpoint of risk to workers is not always appreciated. Too often, basic hardware fixes that would reduce or eliminate hazards are consigned to the multi-year Federal budget process, where they can languish for years, instead of being handled as a matter of routine maintenance.

There is also another dimension to abatement action. It relates to the significance attached to what would be classified in the private sector as "imminent danger" and "willful violations" under OSHA enforcement. Willful violations are defined as situations "where the evidence shows either an intentional violation of the (OSH) Act or plain indifference to its requirements." Simply stated, the employer in these cases was aware that a hazardous condition existed and that it violated occupational safety and health requirements and did not make a reasonable effort to eliminate the hazard. I might add that this is the provision under which the owner of a chicken processing firm in North Carolina was recently sentenced to 20 years in prison for negligence in a fatal fire last year.

The message here is not to put the abatement of hazards on your "ten-year" occupational safety and health corrective action plan. It is unconscionable to permit workers to be exposed to serious risks that can be avoided, abated, or compensated for by alternative measures.

3. Accountability for OSH Compliance

The concept of management accountability is the central focus of the DOE Directives, new orders and initiatives that have been taken over the past three years. Such accountability is the "right stuff" that has been incorporated into the nuclear safety program in this country and that has been popularized by the total quality management (TQM) movement. For occupational safety and health this concept means many things, but for DOE and its contractors, accountability can be reduced to a few telling indicators. One is the proactiveness of the Occupational Safety and Health Program. Another is the degree to which management is involved, provides resources, and conducts reality checks on program results.

A number of DOE contractors have established OSHA voluntary protection programs, risk-ranked abatement actions, and are performing aggressive baseline and

follow-up workplace surveys. These companies recognize that accident **prevention** is where the payoff is.

In my opinion, line management accountability is as basic as this: Enforce all worker safety and health requirements and conduct sufficient workplace inspections to give you the confidence that reality matches your expectations. If it takes the threat of regulatory enforcement action for managers to do the right thing, then such a threat will become a self-fulfilling prophecy. Oversight alone will never ensure safety. The essence of a model Occupational Safety and Health Program is for management and workers to work together to build excellence from within.

4. Workplace Surveillance

This is a precept that governed the nuclear navy under Admiral Rickover and has become one of the core values in DOE's operations over the past several years. It also happens to be one of the tenets of total quality management: The need for measuring the quality of delivered services or products. The old syndrome of the desk-bound manager or occupational safety and health professional is found far too often in governmental organizations. However, although policies and procedures are important, they cannot ensure worker safety and health on the factory floor. It is the proper implementation of these same policies and procedures that makes the difference. If managers do not leave their desks to "walk their spaces," they are flying blind. If you do not find your program's deficiencies, they will most assuredly find you. And often, unfortunately, the form this takes is a worker's life or health.

5. Employee Involvement

One of the legacies of DOE's isolation from the mainstream of occupational safety and health is a sometimes antiquated approach to employee involvement in Occupational Safety and Health Programs. A top-down, command-and-control philosophy is still employed at many plants. Worker safety and health policies are dictated by and continue to be considered the sole province of management.

Fortunately, this approach is increasingly recognized as a throwback to an era where safety and health was an adversarial issue, one that had to be negotiated over a bargaining table. Employees have intimate insight and knowledge of worksite conditions

and are most at risk of potential exposure to occupational hazards. Experience has demonstrated that workers are valuable problem-solvers and are more likely to support programs if they have had the opportunity to provide input to those programs. These "Lessons Learned," which are summarized in Exhibit 1, are currently being implemented at DOE's facilities. We are not satisfied that they have been fully and consistently implemented throughout the line, but we are confident that we have made a good beginning and are definitely making headway.

Exhibit 1. Lessons Learned in Occupational Safety and Health

- **Workplace Risk Levels** -- Injury and illness rates that are lower than those in private industry are not necessarily a badge of success.

- **Hazard Abatement** -- Without an effective system you expose your workers to unnecessary risk.

- **Accountability for OSH Compliance** -- If you must be compelled to comply, then you do not have the "right stuff."

- **Workplace Surveillance** -- If you do not regularly walk your spaces, you cannot measure the quality of your OSH program.

- **Employee Involvement** -- The worker is the ultimate stakeholder for safety.

Now I would like to tell you about some of the new programs and initiatives in occupational safety and health that we have put in place to address some of the issues raised by our lessons learned.

New Occupational Health Initiatives

1. Occupational Medicine

In the last year, the Office of Occupational Medicine at DOE has undergone a major transformation. A new Director, Dr. George Gebus, has been appointed, and the staff has increased to 10 full-time health care professionals, each with a different specialty. The office has adopted a Mission and Function Statement (Exhibit 2) that reflects its new role.

Exhibit 2. Mission and Function Statement
Office of Occupational Medicine

- Ensure that contractor employees are provided with high-quality occupational medicine services;
- Ensure that the health of employees and the public play a primary role in decisions made at DOE sites;
- Ensure that DOE contractor Occupational Medical Programs meet all applicable Federal, State, and local requirements;
- Develop policies, standards, and guidelines in the area of occupational medicine; and
- Perform oversight of DOE contractor Occupational Medicine Programs.

These responsibilities include a new and proactive oversight role in relation to contractor medical programs. For example, in the last year, Office of Occupational Medicine personnel have participated in eight Tiger Team assessments and have visited 30 contractor Occupational Medicine Programs to review their status. These assessment teams found several kinds of common contractor medical program deficiencies, some of which are shown in Exhibit 3.

Exhibit 3. Frequent Deficiencies in Contractor Occupational Medicine Programs

- Inadequate characterization of worker exposures to hazardous substances.
- Poor feedback between the industrial hygiene and medical staffs.
- Contractor medical staff are not spending enough time on site.
- Medical staffing levels at some facilities are below minimum levels.
- Senior medical personnel do not have access to top management.

The Office of Occupational Medicine is addressing many of these issues in the new DOE Directive (we refer to it as an Order) that will govern the conduct of occupational medicine programs at contractor facilities in the future. The new Contractor Occupational Medical Program Order provides minimum standards for such programs and addresses many different issues, including staffing, monitored care, and coordination among the Occupational Medicine, Industrial Hygiene, and Occupational Safety Programs at each site.

The Office of Occupational Medicine is also developing guidelines to assist contractors in developing employee assistance programs, stress test programs for employees with physically demanding jobs, and blood pressure screening programs. Other modules planned for future development include those for weight management, stress management, smoking cessation, mammography screening, and health risk appraisals for employees.

DOE is also supporting the national drive to obtain permission to use the drug Prussian Blue. Prussian Blue is used in Europe to treat workers who have been contaminated with internally deposited cesium, and DOE believes that it should be available here as well.

2. Epidemiology

Another area of health research that has undergone major change at DOE in the last few years is epidemiology. In 1989, Secretary Watkins chartered an independent, outside panel of public health experts to evaluate DOE's Epidemiology Program and to make recommendations for strengthening it. The panel, called the Secretarial Panel for the Evaluation of Epidemiologic Research Activities (SPEERA), developed and submitted its report to the Secretary in March 1990. The SPEERA Report recommended that DOE consolidate all of its descriptive epidemiologic activities in a single office. The Department has responded by establishing the Office of Epidemiology and Health Surveillance within the purview of the Assistant Secretary for Environment, Safety and Health. This office has since inaugurated many of the practices and programs recommended by the SPEERA panel, as shown in Exhibit 4.

Exhibit 4. SPEERA Panel Recommendations Adopted by DOE

- Allow for greater public participation in epidemiologic research at DOE.
- Share DOE information with workers and communities near DOE facilities.
- Establish a comprehensive health surveillance system to provide timely and usable information on the health impacts of DOE's activities.
- Find ways to translate the findings of epidemiologic research into operational policies and practices.
- Develop new epidemiologic methodologies to advance our knowledge of the health effects of DOE's activities.
- Promote research and training opportunities for young investigators.

We have also entered into a Memorandum of Understanding (MOU) with the Department of Health and Human Services that allows DOE to take advantage of that

Department's expertise and experience in the conduct of analytical epidemiologic studies. Under the terms of the MOU, the management functions for all DOE-supported analytical epidemiological research have been delegated to the Centers for Disease Control's National Institute for Occupational Safety and Health (NIOSH).

We are also working closely with NIOSH and others to control chronic beryllium disease. DOE and its predecessor agencies have been concerned about the development of beryllium disease in workers within the complex for close to 50 years, ever since the Atomic Energy Commission first established exposure limits for this indispensable metal. Despite beryllium exposure control strategies targeted at the current OSHA limit, a number of DOE workers have been diagnosed with chronic beryllium disease in recent years.

To respond to this problem, the Department has launched an aggressive, multi-faceted program aimed at understanding the natural history of the disease, developing non-invasive methods for detecting it at its earliest stages, including the detection of signs of a compromised immune system even before the employee experiences symptoms, and establishing industrial hygiene requirements that will protect workers from contracting the disease. The Department has initiated several beryllium-related activities, as can be seen in Exhibit 5.

Exhibit 5. DOE Initiatives Related to Beryllium Disease

- Fund research for streamlining and automating the lymphocyte transformation test (the non-invasive clinical screening test being developed to identify beryllium-sensitized workers).
- Make a major effort to identify workers within the complex who have been exposed to beryllium and who should be included in DOE's research studies.
- Provide special testing and medical surveillance to workers with known exposure to beryllium.
- Conduct dose reconstruction studies to estimate historical exposures of workers within the complex.

The goal of these efforts and of our beryllium-related work with NIOSH and other agencies and organizations is to control the conditions that cause beryllium disease and to identify current and previous workers who have contracted, or may contract, this disease so that they can obtain counselling and treatment.

New Occupational Safety Initiatives

Workers within the DOE complex are involved in operations that range from weapons production to underground construction, from laboratory research to hazardous waste cleanup. No other group of workers in the world -- with the possible exception of Department of Defense workers -- faces such a broad range of occupational safety and health hazards. Protecting our workers from these hazards has required us to develop a correspondingly broad Occupational Safety and Health Program and to identify ways of delivering this program where it is needed -- at the individual site level. We have done this by implementing the following kinds of programs.

1. Site Representative Program

To increase the flow of information from the field to Headquarters and to augment DOE's presence at contractor facilities, we have recently expanded and redirected the Site Representative Program. There are currently 11 site representatives in the program, and more are expected to be added in the near future. These representatives are responsible to my office for the timely and ongoing monitoring of Occupational Safety and Health Program activities in the field, and they report to me on a monthly basis. When the site representatives identify problems in Occupational Safety and Health Program implementation that deserve serious attention, they forward their reports to the senior DOE program official for follow-up and resolution. Examples of the Occupational Safety and Health Program areas routinely assessed by these professionals include those shown in Exhibit 6.

Exhibit 6. Occupational Safety and Health Topics Included in Site Representative Oversight Activities

- Hazard Identification, Analysis, Control, and Abatement
- Employee Concerns and Complaints
- Hazard Communication
- Facility Safety (Fire Safety, Walking/Working Surfaces, Means of Egress)
- Equipment Safety (Lockout/Tagout, Machine Guarding)

In the last 15 months, the site representatives have conducted a total of 51 assessments covering 11 occupational safety and health-related technical areas at 8 DOE facilities. The Site Representative Program has greatly enhanced DOE on-site presence at contractor facilities -- it gives us real-time, first-hand knowledge of the status of contractor Occupational Safety and Health Programs at these high-risk sites. This information, in turn, has allowed us to tailor training programs, assistance visits, and oversight activities to the areas where they are most needed and will make the most difference. The Site Representative Program is part of the way in which we are "walking our spaces," one of the lessons learned referred to earlier.

2. Construction Safety Program

Earlier evaluations of DOE's Occupational Safety and Health Program identified several areas in construction safety that needed strengthening. To respond to this need, DOE has launched several initiatives designed to provide the field with the knowledge, skills, and tools necessary to implement effective construction safety management programs. One of the most important of these is the drafting of a new DOE Order on construction safety that is comprehensive in scope and places particular emphasis on the self-assessment of construction safety programs and on-site surveillance at construction sites. The Order requires construction contractors to perform project hazard analyses to identify hazards at the earliest possible stage, and mandates coordination between construction contractors and the host contractor at the site. It also requires an aggressive program of worksite inspections, often on a daily basis.

3. Systems for Addressing Employee Concerns

Two years ago, when OSHA was invited by the Secretary to evaluate DOE's Occupational Safety and Health Program, OSHA concluded that DOE needed a better and more effective system for addressing safety and health complaints made by workers at our facilities. For example, OSHA found that, in some instances, complaints made to DOE personnel were simply turned over to the contractor involved for handling, an approach that sometimes left the safety issue unaddressed and made the employee vulnerable to criticism or reprisal. The Department has taken action to address this problem on two fronts. First, the Secretary established an Employee Concerns Committee, and this group has drafted an order specifying procedures for identifying, reporting, and resolving employee safety and health concerns. These procedures follow the system established and used successfully by OSHA for many years.

Second, DOE has developed and published in the *Federal Register* a final rule entitled "Criteria and Procedures for DOE Contractor Employee Protection Program." This regulation establishes an independent Office of Whistleblower Administration and Investigation that reports directly to the Secretary on these matters.

4. Memorandum of Understanding Between DOE and the Department of Labor (OSHA)

One of the major highlights of the last year was the recent signing of a Memorandum of Understanding (MOU) between DOE and the Department of Labor, whose Occupational Safety and Health Administration (OSHA) is recognized as the country's leading occupational safety and health agency. Under the terms of the MOU, DOE and OSHA have agreed to work together over the next few years to advance the cause of worker safety and health at DOE by strengthening several aspects of our Occupational Safety and Health Program. These include such activities as the exchange of technical information on safety and health; conferences, seminars, and workshops on emerging occupational safety and health topics such as ergonomics; and training in hazard identification and methods of control for DOE and contractor personnel. Professional staff from DOE and OSHA are already meeting to develop plans for an extensive series of joint DOE-OSHA activities that will capture and utilize OSHA's expertise to enhance DOE's Occupational Safety and Health Program.

5. Commitment of Resources to Occupational Safety and Health

We at the Department of Energy believe that one of the best ways to demonstrate our commitment to worker safety and health is to commit a larger share of our resources to this important undertaking. The most important resources behind any program are the men and women with the training and skills to implement that program -- in this case, specialists in occupational safety and health. In the last two years we have nearly tripled the number of occupational safety and health professionals at Headquarters, a major feat in this time of shrinking budgets and diminished resources. A large number of these professionals have come from OSHA itself, and thus bring to DOE years of training and expertise in the implementation of comprehensive worker safety and health programs. This "staffing up" reflects our belief that people, not paper, are what make things happen. The increase in occupational safety and health staff at Headquarters has also occurred on a more modest scale at the field offices and contractor facilities. The overall impact of this commitment throughout the line is that DOE now has in place the professional expertise to implement and invigorate its Occupational Safety and Health Program where it counts: At the many sites operated by our contractors and their employees across the country.

6. Voluntary Protection Program

In the early 1980's, OSHA developed a program called the Voluntary Protection Program, or "VPP," that was designed to encourage and recognize those companies in the private sector that had the best occupational safety and health programs. Under this program, OSHA recognizes excellence in occupational safety and health by awarding unique status to these companies in terms of public recognition and compliance incentives. DOE has launched an initiative to implement a similar program for DOE contractors. To date, DOE has become a charter member of the non-profit, voluntary Prevention Program Association and is developing guidelines for participation in the Department's VPP Program. Our goal is to have one or more facilities enrolled within the year. DOE's Voluntary Protection Program reflects our belief that public recognition and encouragement are one method of providing contractors with the incentive they need to provide their employees with Occupational Safety and Health Programs that go beyond compliance to achieve excellence.

7. Training in Occupational Safety

The fatalities I spoke about earlier also clearly testify to the need for better training of workers throughout the complex. Last January, in response to this need, we published a major DOE Guide entitled, "Occupational Safety and Health Training Requirements and Implementation Guide." The Guide contains a list of occupational safety and health training requirements for personnel at all levels, and is designed to help us develop courses and training materials tailored to the needs of our contractors. In the last two years we have developed a large number of new occupational safety and health training courses targeted to specific categories of personnel such as occupational safety and health managers, first-line supervisors, safety professionals, and industrial hygienists; or to specific occupational hazards such as machine guarding, construction safety problems, and trenching and excavation. To date, we have conducted 55 classes at 30 different locations within the complex, and we expect to enroll as many as 1,300 students in our Occupational Safety and Health Training Program in 1993.

We have also set up a joint program with the Occupational Safety and Health Administration's Training Institute in Des Plains, Illinois, and this arrangement has allowed us to make several of the Institute's basic occupational safety and health courses available to DOE and contractor personnel. A training resource has also been established at one of our national laboratories, Pacific Northwest Laboratories, and several courses have been developed by this occupational safety and health training group.

8. Technical Assistance, Hazard Communication, and Compliance Assistance

To meet the needs of DOE's field offices and contractors for technical assistance in occupational safety and health, we have established a multi-faceted Technical Information and Assistance Program to ensure that the appropriate "know-how" is available when needed. The program ranges from a quarterly newsletter called "Safety Connection" to a call-in service named the "INFOLINE," which provides safety and health professionals across the complex with instant access to the latest information on the toxicity and other characteristics of hazardous materials.

Another recent initiative that is showing great promise is our Technical Assistance Visit Program. This program resembles OSHA's Consultation Program in that it is a voluntary and non-penalty oriented program designed to help contractors achieve compliance. However, it goes beyond OSHA's Consultation Program in several important respects. First, it is a joint operation that involves personnel from my office, the line organization with responsibility for the site involved, and the contractor in planning and carrying out the visit. Second, each technical assistance visit is tailored specifically to the safety and health needs of the site. Third, each visit consists of an integrated learning experience that involves open-ended discussions, formalized instruction, and hands-on experience. To date we have conducted several multi-day assist visits to contractor facilities, and the initial response has been very favorable. We expect to be expanding this program considerably in the coming year.

Another technical information exchange initiative will provide DOE users with direct on-line access to OSHA's vast Computerized Information System (called "OCIS" for short). OCIS contains all of OSHA's Standards, interpretations of Standards, relevant court decisions, information on the toxicological and other properties of 1,500 widely used industrial chemicals, and operation-specific hazard and engineering control information. We believe that access to this national occupational safety and health resource will greatly enhance the quality of DOE's Occupational Safety and Health Program across the complex.

9. Worker Protection Pilot Program

The Occupational Safety and Health Worker Protection Pilot Program (OSHWPP) is an initiative designed to offer public recognition to contractors within the complex who have outstanding safety and health programs. Under this program, each line organization identifies candidate programs with the potential to serve as models for other contractor programs in the same technical area. For example, if one contractor in the complex has developed a model laser safety program, that program would be made available to other contractors after a careful review and pilot-test of the candidate program. The recognition received by the contractor who developed the model program would act as an incentive to encourage other contractors to develop similar programs. At present, several candidate programs have been identified and are being reviewed for conformance with DOE-developed WPP guidelines. We believe that the Worker Protection Pilot

Program offers a unique opportunity to expand DOE and contractor line program expertise and promote consistency and excellence in Occupational Safety and Health Programs across the complex.

10. Development of Occupational Safety and Health Standards, Directives, and Programs

The large number of on-site assessments DOE and others have conducted at our contractor facilities in recent years identified a number of safety and health areas within the complex needing additional attention. These include several areas where there are regulatory gaps; i.e., hazards that have not to date been addressed by OSHA regulations. Examples include non-ionizing radiation, biohazards, reproductive and developmental toxins, confined spaces, and ergonomic hazards. Wherever we have identified a need for worker protection, we are hard at work developing Standards, training courses, model programs, and other approaches to address the problem. Some of the Standards and programs we have initiated to date are shown in Exhibit 7.

Exhibit 7. New Initiatives in Occupational Safety and Health

Industrial Hygiene Standards for:

- Beryllium
- Non-Ionizing Radiation
- Hazard Communication
- Management of Asbestos Hazards
- Respiratory Protection
- Occupational Carcinogens
- Exposure Assessment
- Occupational Noise
- Hazardous Waste Operations and Emergency Response
- Reproductive/Developmental Hazards
- Biohazards
- Chemical Hazards in Laboratories

Standard for Hazardous Waste Operations Training at Nuclear Facilities (Section 3131 of DOD Authorization Act)

Programs in:

- Ergonomics
- Process Safety Management
- Confined Spaces
- Lock-out/Tag-out
- Trenching and Excavation
- Fall Protection
- Fire Protection
- Electrical Safety
- Firearms Safety
- Explosives Safety
- Pressure Vessel Safety

Conclusion

My talk has touched upon some of the more important lessons learned and the more noteworthy initiatives DOE has put into motion in the last three years to protect the health and safety of our contractor employees. What we have learned in the process should come as no surprise to those of you who have been working in this field:

- That management commitment to safety and health is critical to a successful program;
- That meaningful employee participation in all aspects of the program enhances its effectiveness at every level; and
- That the dedication and expertise of medical and occupational safety and health professionals are needed if the challenging problems presented by the complex and technologically advanced environment at DOE facilities are to be overcome.

I believe that we have made a good beginning in the long and arduous task of building an Occupational Safety and Health Program that will serve as a model for others, and I can assure you that we intend to continue our efforts to protect every worker within the complex from occupational injury and disease.

N94-16611

AMERICANS WITH DISABILITIES ACT CONSIDERATIONS FOR THE PRACTICE OF OCCUPATIONAL MEDICINE

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and
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The Americans with Disabilities Act (ADA), although developed in the context of civil rights legislation, is likely to have notable impact on the practice of occupational medicine. The ADA contains provisions limiting the use of preplacement examinations to determinations of the capability to perform the essential functions of the job and of direct threat to the health and safety of the job applicant or others. The Title I employment provisions of the ADA establish definitions and requirements similar to those found in section 504 of the Rehabilitation Act of 1973, as amended; leading cases that have been litigated under the Rehabilitation Act, as amended, are described. The limitations of available scientific and medical information related to determinations of job capability and direct threat and ramifications of the ADA on the practice of occupational medicine are discussed.

The Americans with Disabilities Act (ADA) was signed into law on July 26, 1990, with enforcement dates for employers with more than 25 employees of July 26, 1992 and for employers with more than 15 employees of July 26, 1994. The ADA is considered an extension of civil rights legislation: the Title I provisions of the ADA establish legal standards for a number of procedures that relate to the employment process. These standards "prohibit discrimination against qualified individuals with disabilities in all aspects of employment."[1] Persons are considered qualified by having, having had, or being regarded by an employer as having a medical impairment. Over 43 million persons in the United States with a wide variety of orthopedic, cardiovascular, pulmonary, and other medical conditions are estimated to be qualified under the ADA by these criteria.

St. Clair, S. & Shults, J. Americans with Disabilities Act. Considerations for the Practice of Occupational Medicine. Reprinted courtesy of the *Journal of Occupational Medicine*, 34(5), May 1992.

The ADA is intended as "enabling" legislation: the intent is to establish standards that encourage the employer to find ways to accommodate disabled workers rather than to find ways or reasons to prevent disabled persons from being employed. Employers are encouraged to define specific job positions in terms of essential job functions and to provide reasonable accommodation in those instances where it is medically determined that a person is incapable of performing the essential job functions or poses a health or safety risk to self or others in doing so.

The purposes for which medical examinations may be provided in relationship to employment are clearly defined under the ADA. Before employment, employers may not make medical inquiries (including questions related to history of Workers' Compensation injury) until a job offer has been made. The job offer may be made contingent on the results of a medical examination, but the employer's use of medical examinations and the information obtained from them is limited to considerations of job capability and "direct threat" ("significant risk of substantial harm to self or others") with respect to the performance of essential job functions.

With respect to other employment-related medical examinations, the ADA does not affect medical examinations required for compliance with government regulations (e.g., OSHA or DOT examinations) or voluntary medical examinations. The ADA also does not prohibit fitness-for-duty, medical surveillance, return-to-work, or disability examinations as long as these are job-related and consistent with business necessity. The information from all employment-related medical examinations, however, is required to be maintained and released according to specific confidentiality provisions. Drug testing is not considered a medical examination under the ADA, but information obtained from drug testing is subject to the confidentiality provisions of the ADA.

Direct Threat:
Precedents in the Rehabilitation Act of 1973, as Amended

Although the ADA contains new legal phraseology regarding certain employment standards, it is important to recognize that there are medicolegal precedents for the Title I provisions of the ADA. In particular, the Rehabilitation Act of 1973, as amended, and the case law of surrounding litigation, has provided a template for many of these. The language used in various portions of the ADA and in the associated documentation from

the Equal Employment Opportunity Commission (EEOC)[1] includes many specific phrases that appear in the case law evolving from the Rehabilitation Act of 1973, as amended.

This is most clearly evident with respect to direct threat issues. The ADA requires that medical decisions regarding the hiring of applicants or the placement of current employees be based solely on job capability and direct threat (significant risk of substantial harm) and that such determinations must be based on the worker's present ability to safely perform the essential functions of the job.

In describing precedents available from the Rehabilitation Act, as amended, however, it should be noted that the wording of the standard regarding direct threat in the Rehabilitation Act is different from that in the ADA. The standard for the cases considered under the Rehabilitation Act (and for many cases litigated under state discrimination statues as well) has been "a reasonable probability of substantial harm."[2] Although it is quite unlikely that in many cases the results under either standard would be the same, it remains to be seen as to whether court interpretations of "reasonable probability" differ in practice from "significant risk."

Most occupational physicians and other occupational health providers have had little or no experience in dealing with individual cases litigated under the Rehabilitation Act of 1973, as amended, or state discrimination statutes. To illustrate the ways in which issues related to direct threat may be considered, three leading cases regarded as seminal in the development of case law under the Rehabilitation Act of 1973, as amended, are described below.

Office of Federal Contract Compliance (OFCCP) v E.E. Black, Ltd.[3]

A worker who applied for a job with a construction firm as an apprentice carpenter had done similar work for 3 years. Two years before his application, he experienced low back pain in association with lifting at work and was treated for several months but was able to return to regular work. One year before his application he experienced similar pain during lifting at work but was evaluated and returned to work the same day. On his medical examination before employment, a routine roentgenogram of the spine revealed a partially sacralized vertebra. The applicant was denied

employment based on the examining physician's opinion that the applicant was a "poor risk for heavy labor." The applicant subsequently obtained an orthopedic consultation at his own expense; the consulting orthopedist noted the history of back injuries and found a spina bifida occulta and rotoscoliosis in addition to the sacralized vertebra but stated that none of these would prevent the applicant from performing the job of apprentice carpenter.

In finding for the applicant, the Court established that "whenever (an employer) applies physical or mental job qualification requirements in the selection of applicants or employees for employment or other change in employment status such as promotion, demotion or training, to the extent that qualification requirements tend to screen out qualified handicapped individuals, the requirements shall be related to the specific job or jobs for which the individual is being considered and shall be consistent with business necessity and the safe performance of the job. (The employer) shall have the burden to demonstrate that it has complied with the requirements of this paragraph."

In this case, the Court found that the employer's requirement for a healthy back "met the needed relation to the job and constituted a valid job performance requirement." However, the Court determined that the employer failed to establish that the applicant's medical condition was related to his current capacity to perform the job. Although the Court held that risk of future injury could be the basis for rejection of an otherwise qualified job applicant, the Court held that the employer in this case failed the burden-of-proof requirement to demonstrate reasonable probability of substantial harm.

In establishing this opinion, the Court appointed an independent medical expert, a qualified neurosurgeon, to review the facts of the case and also obtained and reviewed scientific and medical studies related to the patient's condition and roentgenogram findings. The Court found that this evidence was contradictory and inconsistent with respect to demonstrating significant risk of future injury.

Further, the Court "rejected Black's argument that hiring someone with a great risk of future back injury was justified by business necessity because of the very high potential workers' compensation costs....a policy of excluding potential employees to reduce an employer's costs shifts and financial burden to the rejected handicapped individual. This is contrary to the intent of protective statutes such as the Act."

The case discussion emphasized that the impaired worker must be examined with respect to the particular circumstances of job position; an impairment in abstract cannot be evaluated: "the Court believes that the real focus must be on the individual job seeker, and not solely on the impairment or the perceived impairment. This necessitates a case-by-case determination of whether the impairment or perceived impairment of a rejected, qualified job seeker, constitutes, for that individual a substantial handicap to employment."

OFCCP and James W. Thompson v
PPG Industries, Inc.[4]

A worker applied for a job as a production laborer. He had been previously diagnosed with epilepsy but had been seizure-free for 2 years; a few episodes of perceived auras without frank seizure activity involving no loss of consciousness had occurred during this time. The company physician and a consulting neurologist for the company determined that the applicant was at elevated risk for seizures and therefore should not be given the job. The applicant's personal physician, subsequently consulted, stated that in his opinion the applicant was well controlled on medications and no work restrictions were necessary.

In finding for the applicant, the Court opined that the employer has a duty to "gather all relevant information regarding (the applicant's) work history and medical history and independently assess the probability and severity of potential injury; such objective evaluations should be based on facts the employer knew or should have known at the time." The Court deemed that information from the personal physician was important in determining the medical condition of the individual relative to job capabilities or safety risks and that considerations of direct threat may be based on such information as an applicant's previous work history, activities outside of employment, or previous experience in similar jobs: "such a determination cannot be based merely on an employer's subjective evaluation or, except in cases of a more apparent nature, merely on medical reports. The question is whether, in light of the individual's work history and medical history, employment of that individual would pose a reasonable probability of substantial harm."

The Court further found that the restrictions placed by the company physician "often reflected stereotypical assumptions about epileptics, not an assessment of (the applicant's) individual condition in relation to the specific job duties and hazards" and that "(the employer) cannot shield itself from liability by the kind of wholesale, uncritical reliance on medical opinions it demonstrated in this case."

OFCCP v Texas Industries[5]

A woman who applied for a job driving a cement truck was denied employment after a preplacement medical examination revealed a partially sacralized vertebra on routine back roentgenograms as well as a history of partial laminectomy for removal of a herniated disc 9 years previously. An orthopedic surgeon consulted by the employer agreed with the opinion of the company physician that the applicant should be denied employment based on the increased risk of future injury to the person caused by the sacralized vertebra and history of laminectomy. Both physicians also raised concerns regarding public safety posed by the applicant driving a truck suggesting that the onset of back spasms and/or pain during driving activities might be likely to make it impossible for the applicant to control the truck.

The applicant obtained an opinion from the orthopedic surgeon who had performed the laminectomy that she was capable of performing the duties of the job applied for. Although this physician agreed that her risk of future injury was higher than average, he detected no physical limitations and did not believe restrictions were necessary or indicated. The woman subsequently worked for another trucking company for several years without incident, a job that included driving trucks as a contractor for the employer that had rejected her.

In ruling for the applicant, the Appeals Court judged that the likelihood (probability) and certainty (predictability) that an injury will occur is crucial to determinations regarding risk of injury. In particular, the certainty that an injury will occur to the particular person based on individual clinical factors and not simply based on assumptions of risk is important. Medical opinions, even from qualified physicians, may not meet this standard unless substantiated by statistical scientific evidence, historical case descriptions, or information from the patient's medical history. The Court judged that, in certain instances, historical data regarding a person's work history may be as or

more important than medical opinions when issues regarding the likelihood of substantial harm or injury are involved. Considerations of risk to the public might lower the threshold of risk or imminence applicable to an individual case, but such considerations remain even when public safety is concerned.

Job Capability and Direct Threat: Further Discussion

According to the ADA, judgments regarding direct threat must be based on *reasonable medical judgment* and on *current medical knowledge and/or the best objective evidence*[1]. No specific guidelines are provided regarding the degree of risk that is acceptable or unacceptable. However, criteria are outlined by which such risk will be judged. A high probability of substantial harm must be demonstrated, rather than mere demonstration of an elevated risk or of a remote or speculative risk.

The ADA explicitly describes four criteria to be used in determining whether significant risk of substantial harm exists: (1) *probability* -- the statistical likelihood of the harm occurring, (2) *severity* -- the nature and severity of the potential harm, (3) *imminence* -- the time frame in which the harm is likely to occur, and (4) *duration* -- how long the risk is likely to be present.[1]

The case law under the Rehabilitation Act demonstrates how some of these concepts have been interpreted. For example, in the *Texas Industries* case described above, the Court held the opinion that the mere presence of risk that is higher than average is not sufficient. In the *E.E. Black* case, the Court provided an example of imminence that would be sufficient to suggest direct threat, but unfortunately the example given was so extreme that the illustrative value is unclear: a person with a 90% probability of having a heart attack within one month would clearly have an imminent risk constituting direct threat.[3]

There are additional threads that run through the case law with respect to direct threat determinations, some explicitly referred to in the ADA and accompanying documentation. *Case-by-case analysis* is one such principle: impairment considered in the abstract, especially based on diagnostic descriptions alone, is likely to be insufficient for such determinations. It is necessary to consider all aspects of a person's clinical

presentation as well as nonmedical factors in relationship to the specific circumstances of the particular job. Stereotypical assumptions about certain conditions or work activities are unlikely to be upheld if challenged.

It also should be evident that *additional medical opinions* may be helpful in assessing whether direct threat exists, but they provide no guarantee that medical restrictions will be judged valid if challenged. The *medical opinion of the personal physician* is likely to be considered important and may be given more credibility than that of physicians acting as employer agents. To the extent that any and all medical opinions use or refer to *scientific data and statistics* they appear likely to be rendered more credible. However, individualized predictability (the extent to which opinions regarding direct threat can be applied to the particular individual in question) is critical, and may be based on occupational and nonoccupational history in addition to relevant medical factors.

Although it was not deemed relevant in that particular case, the *Texas Industries* case considered the issue as to whether a different standard of risk may be considered in those cases where risk to the public or other workers is present as opposed to those situations in which the risk appears to be limited to the worker. It appears that risk to the public may lower the threshold of risk required to constitute direct threat in individualized determinations. Although the effect is likely to be the same, consideration of such risk may alternatively be weighed as part of the determination regarding the "substantial" nature of the harm.

Currently, the ADA contains no specific mechanism for resolution of professional opinion. It is the responsibility of the employer to obtain valid medical opinions and to decide on an appropriate course of action when conflicting opinions are obtained. A determination that a direct threat to health or safety of the worker or others will not necessarily exclude the employee from a particular job. The employer (using all means available including medical opinions) must determine that reasonable accommodation would not reduce risk to acceptable levels.

Job Analysis, Medical Determinations of Job Capability and Direct Threat, the Medical Standards and Screening

Under the ADA, medical recommendations regarding both job capability and direct threat are required to be made on the basis of the worker's ability to perform the essential functions of the job with or without reasonable accommodation. However, there are no specific requirements regarding the methods to be used to determine essential job functions or the methods to be used to make medical determinations regarding capability or direct threat, although guidelines are provided regarding those factors that may be considered in determining whether a job function is essential.[1]

Methods for job analysis to be used in conjunction with medical examinations have been described.[6,7] These involve determinations of job demands in terms of a combination of ergonomic evaluation, evaluation of other physical and nonphysical job demands, and time allocation to various tasks. The job analysis information is made available to the examining physician, and direct familiarization by the examining physician with specific job demands is advocated.

Few attempts have been made to fully integrate job analysis with the establishment of medical standards. One comprehensive attempt, the San Bernardino study,[8] rates all job functions on scales related to physical capabilities and estimates the capabilities of individuals with particular medical conditions with respect to the scales used to rate job functions. It is unclear, however, whether the rationale and methods for establishing medical restrictions conform sufficiently to the standards required by the ADA with respect to probability, severity, imminence, and duration for such methods to be considered.

All these methods suffer from the need for relatively time-consuming job analysis and the lack of long-term validation studies for the standards described. One attempt at eliminating or reducing the need for physician knowledge of job functions is the "specific" method proposed by Hanman.[9] With this technique, a person is medically rated as to capability of performing specific activities or being able to tolerate specific environmental conditions. This method does not suggest the need for physician knowledge of job conditions, inasmuch as physician recommendations are made in the abstract and subsequently compared with separately assessed analysis of the activities and environmental conditions of the job. Although such a method offers simplicity and may

be useful for initial evaluations, it is unlikely that recommendations made in the abstract by physicians without specific knowledge of job duties will be able to accurately determine whether a worker can perform particular job functions.

Several descriptions of acceptable methodologies and rationale for provision of preplacement examinations exist that are not described in relationship to a specific method of job analysis. The ADA essentially provides legal authority to ethical and scientific guidelines recommended by many authorities for these types of examinations.[10-15] However, such consensus about process is unlikely to mitigate the controversy that can be anticipated because of differences of opinion regarding specific clinical determinations of risk.

For physicians providing preplacement or periodic medical examinations in the context of general prevention/health promotion programs, as suggested by Felton and others,[10,15,16] guidelines such as those recommended by the Preventive Medicine Task Force and other similar efforts provide an excellent basis for age-appropriate examinations.[17,18] Similarly, recommendations are available regarding process and content considerations with respect to preplacement and periodic medical monitoring examinations related to specific chemical and physical hazards, such as those currently regulated by Occupational Safety and Health Administration (OSHA) standards for which there has been National Institute for Occupational Safety and Health (NIOSH) evaluation.[10,12-14,19-21]

Such guidelines, however, seldom provide specific criteria regarding the need for restrictions or removal from exposure based on health or safety risk except related to very specific exposure or health effect indices. Although more general criteria have been established for very specific job functions in safety-sensitive positions (such as for airline pilots and commercial truck drivers), these generally provide little guidance to the clinician faced with making specific recommendations in other job circumstances.[22] The San Bernardino study[8] did attempt to provide a rationale as to employment considerations for a large number of medical conditions, but the medical standards are dependent on the specific job analysis methods described and were intended only as an initial attempt at the development of medical standards.

Ideally, considerations of job capabilities (and especially direct threat) should be based on epidemiologic and/or other scientific information that allows prediction of

capability or risk with respect to specific job tasks. Unfortunately, for the vast majority of job requirements and medical conditions, there is little or no sound scientific information on which a clinical judgment can be based, placing great responsibility on the individual clinician to attempt to make a valid clinical judgment in the absence of good predictive data. In the introduction to the most comprehensive review to date of issues related to medical evaluations for job capability and health risk, the editors note "clinicians must be aware of the considerable scientific uncertainty involved in these evaluations.[23]

A strong argument can be made that, given this uncertainty, there is little value to such medical determinations. Indeed, a number of authors have raised the question of the value of preplacement medical examinations and discussed the various considerations faced by employers and occupational physicians in determining whether such examinations are likely to be of benefit.[24-27] However, given the continued presence of workplace hazards as well as the emergency of new types of occupational disease, and the increasing costs associated with the treatment of occupational accidents and illnesses, it is likely that extensive use of both medical examinations and various screening modalities will continue.

Although the ADA does not permit the use of medical screening of workers for the purpose of reducing an employer's costs related to the treatment of future illness or injury (occupational or nonoccupational), it does not prohibit screening tests for job capability or direct threat. According to the ADA, such screening tests should offer valid predictive accuracy (particularly in relationship to sensitivity, specificity, and positive predictive value) and should not screen out impaired or handicapped persons, or other groups of workers (such as certain minorities or women), unless a clear business need is demonstrated.[1] Even demonstration of a clear business need may be insufficient if screening methodologies used selectively screen out specific groups.

A great deal of confusion has been generated by guidelines previously published by the EEOC (the Uniform Guidelines on Employee Selection Procedures) with respect to both the Rehabilitation Act of 1973, as amended, and the ADA.[28] These guidelines represent the most comprehensive effort to date by the EEOC to define valid screening principles in terms of statistical validity relative to concerns regarding discrimination, yet these guidelines are specifically noted by the EEOC *not* to apply to the Rehabilitation Act of 1973, as amended, or the ADA. It remains to be seen whether individual Courts will

consider these or similar standards relevant to determinations of direct threat in individual cases.

Some authors[29-31] have advocated the use of certain screening methodologies with respect to the performance of specific physical tasks, especially materials handling and movement. Screening methodologies based on ergonomic analysis of specific job tasks followed by simulation of those tasks in screening evaluations have been used to assess both capability and risk. Such methodologies, depending on the screening standards used, may be consistent with ADA requirements regarding direct threat determinations. Because these usually require extensive ergonomic analysis and specific validation before use, the utility of such methods may be limited, and when held to high scientific standards, most screening methodologies fail because of unacceptable standards of sensitivity and specificity.[32,33]

What constitutes acceptable sensitivity and specificity, however, is likely to vary depending on the perspective taken, e.g., employer or applicant for employment. Individual Courts also are likely to vary in the interpretation of such standards, so the success or failure of particular methods legally is difficult to predict. Employers and occupational physicians will need to carefully consider the value of such screening methods and carefully scrutinize such methods from the medical, legal, and ethical perspective to assess the likelihood that specific methods will be considered acceptable within the framework of the ADA.

Additional questions are raised with regard to such screening, particularly with respect to the distinction between medical and nonmedical screening modalities. Certain aspects of screening programs are clearly medical in nature, such as the determination of the presence of disqualifying medical conditions. Others are considered nonmedical, such as agility tests performed before placement in law-enforcement positions.[1] For many screening modalities, however, the distinction is likely to be less clear, such as various types of strength testing that may be performed to determine job capability or direct threat. The place of such examinations in the employment process, e.g., before or after a job offer, and whether a physician is required to participate in such determinations is likely to require specific assessment based on the characteristics of the screening modality used.

Confidentiality Issues and Drug Testing: Brief Notes

The confidentiality provisions of the ADA provide legal constraints regarding information release that are supportive of ethical guidelines currently in use.[1,34] It is unfortunate, however, that the law did not more clearly address the problem of access to medical records by nonmedical personnel and that ADA requirements are currently somewhat contradictory. Although information given by medical providers to supervisors and management personnel is limited to descriptions of necessary restrictions and accommodations, the Technical Assistance Manual[35] describes procedures for the handling of medical information and records that suggest that employer representatives involved in hiring, human resources, or personnel functions may not be considered "management" personnel for purposes of information dissemination. The Technical Assistance Manual describes keeping medical records separate from other personnel records, and recommends limiting access to such records. However, there are no specific provisions limiting such access to qualified medical personnel. We hope some additional provisions in the future may address this double standard.

Provisions related to substance abuse and drug testing should result in eligibility for employment for those persons who have received adequate treatment after substance abuse has been detected. It will be difficult for occupational physicians and other occupational health providers to make determinations regarding current versus past use and to determine when adequate rehabilitation has occurred. The need for recommendations regarding continued or follow-up treatment and/or drug testing is likely to become more frequent.

ADA Impact on the Practice of Occupational Medicine

The impact on the practice of occupational medicine that the ADA is likely to have is difficult to predict. The Rehabilitation Act of 1973 and many individual state statutes contain provisions similar to the provisions of the ADA, yet the widespread perception that these laws had failed to establish fair employment practices with respect to handicapped workers contributed to the enactment of the ADA. In contrast to these previous statutes, there now appears to be a high degree of awareness of the ADA on the part of employers, occupational physicians, other occupational health providers, and the

legal community. In addition, specific budget allocations to the EEOC for enforcement are substantial. Finally, because the ADA has the empowerment of federal mandates, the legislation supersedes local or state legislation of lesser impact and provides uniformity. For these reasons the ADA is likely to have substantial repercussions in terms of changes in employment practice, and case litigation.

It is also important to recognize that the specific impact of the ADA on case law, and the ways that such case law will subsequently affect the practice of occupational medicine, will depend to a great extent on the interpretation placed on certain key phrases in ADA. Indeterminate wording and the use of new phraseology that has yet to be interpreted in case law add to the difficulty in predicting the extent to which legal standards established under the ADA may call for changes in occupational medical practice. Jurisdictional differences are certain to further add to confusion and to make it likely that the true impact of the ADA will not be completely felt until enough cases have been taken to higher Court levels to establish some clear legal precedents.

Despite these caveats, the ADA is likely to positively impact occupational medicine practice. The confidentiality provisions of the ADA should provide some impetus to the use of practices previously justified on primarily ethical grounds. Provisions related to drug testing and substance abuse appropriately reflect substance abuse as a treatable medical illness, although new challenges will be present with respect to making determinations regarding current substance abuse and ascertaining when rehabilitation has occurred.

Further benefit should accrue from the impetus to the development of standardization in procedures and practices related to preplacement medical and screening evaluations and other employment-related medical examinations, although in many cases the law requires more specificity than medical science currently can provide. Such standards, however, reflect a policy of enablement of workers with disabilities at the cost of conservative hiring strategies. In response to this, medical resources may be refocused from global (and somewhat superficial) preemployment screening to more sophisticated analysis of qualification, accommodations, and modification of work.

Occupational physicians and other occupational health providers are more likely than before to be challenged in terms of providing recommendations consistent with current medical, scientific, and ethical information and guidelines. It is likely liability

issues for physicians under the ADA will reflect previous issues that have arisen in the context of employment-related examinations. These included breaches of confidentiality, improper authorization to perform duties that involve direct threat, negligent interference with a contractual relationship, and failure to communicate results of examinations to workers.[36,37]

The ADA, although establishing standards by which employment-related medical examinations and screening must be conducted, does not resolve more fundamental issues for employers and occupational physicians regarding the value of such examinations in a variety of situations. Complex issues related to employer benefit, worker benefit, and public benefit make generalizations impossible regarding decisions as to the frequency and content of such examinations and testing.[14,26,38] At the least, employers and occupational physicians should be less likely to consider use of screening modalities that fail to meet EEOC requirements regarding predictive validity.

The ADA may have the overall impact of forcing industry, especially small industry, to implement health and safety practices that emphasize prevention rather than screening. Many employers have mistakenly assumed that employment-related medical examinations could be used to screen out workers likely to have work-related injuries, despite the dubious scientific as well as legal basis for this practice. The ADA, by requiring that standards consistent with current medical knowledge be used, as well as by requiring reasonable accommodation, may effectively force industry to emphasize strategies including engineering controls, use of personal protective clothing and equipment, and education to improve workplace health and safety practices as the primary means of reducing workplace accidents and injuries. Employment-related medical examinations, valuable tools as part of an employer's overall health and safety program, may be used more in this context as a result of the ADA.

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N94-16612

ERGONOMICS IN THE OFFICE ENVIRONMENT

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Perhaps the four most popular "ergonomic" office culprits are: (l) the computer or visual display terminal (VDT), (2) the office chair, (3) the work station, and (4) other automated equipment such as the facsimile machine, photocopier, etc. Among the ergonomics issues in the office environment are visual fatigue, musculoskeletal disorders, psychosocial factors and problems, and radiation/electromagnetic (VLF, ELF) field exposure from VDT's. We will address each of these in turn and then review some regulatory considerations regarding such stressors in the office and general industrial environment.

Visual Fatigue and Related Issues

Visual fatigue typically may involve one or both of two different types of problems, ocularmotor fatigue and general fatigue. Accommodative or ocularmotor fatigue refers to the loss of accommodation, blurring, or shadow images which may be experienced when the muscles that allow one to accommodate or focus on the "near point" VDT screen or other reading task tire and involuntarily relax. One of the primary methods to avoid this effect is to allow the eye an opportunity to focus on more distant objects (e.g., a view out of a nearby window) which relieves the static contraction in muscles. The second type of fatigue is more holistic or general. In this case people may experience headaches and environmentally related problems such as eye soreness and dryness. One of the principal task factors with eye dryness is that the blink rate declines when one focuses attention on a visual task. That is, the eye is open for a longer period of time allowing a greater rate of evaporation. Also, with the use now of contact lenses as corrective lenses as opposed to glasses, the eye is more sensitive to drying or irritation.

The sources of these problems include CRT work station factors such as luminance of the screen, contrast characters, image size and density (how well resolved the image is), and glare. Glare is both a major work station factor and a major environmental factor. In the environmental area we have to deal with the level of humidity in the air, overhead illuminance problems in terms of glare, dust, environmental

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tobacco smoke, etc. Task or the software factors include many of the same things involved in musculoskeletal exposures such as required processing speed, total time on task, repetition, forced error rate, task complexity, and frequency of use. Perhaps the largest personal factor is lack of proper vision correction or developing eye disease.

There are many different sources of glare. In addition to external glare sources such as sunlight through a window, internal glare sources often exist above the work station in overhead fluorescent lights. Modifications can be made to lights and/or changes in work station positioning can be made to reduce glare. When work stations are placed up against a window, an individual can periodically change his/her depth of focus and relax the accommodative muscles. However, the direct glare in such a situation can be considerable. To modify the luminance level of light coming in through a window, translucent film can be placed on the surface of the window to reduce the overall luminance transmitted and still allow the person to look out and change accommodation. Desk lights can cause glare by reflecting onto the screen or off of the work surface. Whenever there is a high level of contrast or "luminance ratio" between the task and the surrounding work area, there will be problems with being able to properly adapt to what is appearing on the screen.

Musculoskeletal Issues

Musculoskeletal problems include upper extremity cumulative trauma disorders such as carpal tunnel syndrome, tendinitis, tenosynovitis, ganglion cyst, etc.; low back problems including low back pain, strain, and disc herniation; and other problems such as neck strains and leg discomfort. Most of these problems arise from work station problems such as poor positioning/layout resulting in awkward trunk and upper extremity postures, particularly deviation from the neutral; static loading of low back; and compression ischemia, particularly at the forearm, wrist, and thigh. It is typical to find a work station that is basically a table. That is, it is poorly rounded. People utilize the edge as a wrist support, placing point compression on the tendons just before they enter the carpal tunnel. While this may not precipitate carpal tunnel or tendinitis, it could conceivably aggravate the tendon and perhaps synovium producing typical symptoms of pain and numbness. Regarding low back disorders, a person who has been sitting at a desk all day and suddenly twists around to grab something can easily suffer back strain. Other factors include the amount of force used, which is typically more an issue in manufacturing environments than in office environments.

Nearly all office environments contain these musculoskeletal exposures. People try to economize on the amount of energy expended and, instead of physically moving themselves to an appropriate position, they tend to twist the body. While this is possibly more metabolically efficient, from an exposure standpoint it is potentially harmful, especially when repeated. Other factors involved are length of time on a task, repetition in terms of the keying rate and the total volume of keying done, the time constraints on the work being done, whether the task software itself is causing problems because of the number of keystrokes that must be performed to achieve the performance objective, and lack of recovery time. Hand posture complexity is also an issue. If one has to simultaneously hit the Control/Alt/F1/Shift/F6 keys at the same time (an exaggeration), groups of muscles within the hand, particularly the interossei, will be placed in conflict with each other. The muscle groups between the metacarpal bones are not adapted to multiple function or even dual function tasks. As an example, if one grasps a screwdriver and tries to thread or start a screw with the part of the same hand that is free, he/she will find that the hand goes into a fatigue state very rapidly. This is because two competitive performance objectives have been set up for those groups of muscles, and they are actually straining against each other to achieve both at the same time -- holding an object in the hand while trying to manipulate another object at the distal end of the phalanges. An example of static posture familiar to nearly everyone is tilting the neck to hold a telephone in place, in some cases combined with other upper extremity work. Static contraction creates an imbalance in the demand for and supply of blood and metabolites needed for cell respiration. In static exertions there is an isometric contraction; one is not moving, just maintaining a position, but the blood supply is reduced because of the tourniquet effect of the contraction. The arterioles and veins in that particular muscle tend to be shut down substantially because of the amount of force generated and maintained -- it is not dynamic and does not vary -- and a fatigue state is reached much more quickly.

Surprisingly, seated work can be more uncomfortable than standing work. Seated work increases spinal compression, may involve poorly supported manual lifting (seemingly innocuous weight), and can contribute to poor reaching practices or designs. In a study performed by the Georgia Tech Research Institute involving industrial operators who worked either seated or standing, we found that a seated task is not necessarily more comfortable, even though it requires a lower level energy expenditure. Our standing operator population reported less discomfort than our seated operator population. In fact, a greater percentage of seated operators experienced discomfort in

the neck, upper back, middle back, and low back. Except for the feet, the standing operators did not experience the number or types of problems experienced by the seated workers.

In the sitting position the spine actually rotates back and the body assumes a more c-shaped or kyphotic curvature. The pelvic girdle rotates up and back. This tends to take a load that was centered over the lumbar vertebrae and extends it out and away, creating an increased moment in the low back and increased intradiscal pressure. The disc in the lumbar area is actually wedge-shaped, not a uniform shape, and sitting places a greater amount of pressure on the anterior portion of the disc. This forces the gel-like material in the center of the disc back to the other end of the structure where the spinal cord is located. Long-term, repeated activity involving this asymmetric stress can produce degradation. This may contribute to irritation or bulging around the disc and, in some cases, problems with leakage of material through the external or annular disc wall. This is the postural consequence of sitting.

The typical office worker is seated erect initially because that is what all of the physical therapists and orthopedists recommend, and, in fact, this tends to keep the spine in a more lordotic configuration. However, it does not take very long until one slumps forward. The reason for this is the static contraction of the low back musculature. When seated erect, the back muscles are more active, even when compared to standing erect. So, there is a very high level of EMG activity in the trapezius and latissimus dorsi muscles and the left and right sacrospinalis (as illustrated from Lundervold's work summarized by Grandjean), and as soon as one slumps, that activity is dramatically reduced. In fact, the externally applied loads are not reduced, which means that the muscles are relaxing at the expense of something else. The something else's are the passive tissue systems such as the intervertebral discs and the many ligaments which hold the spine together and provide support in the absence of muscle activity. So, slumping occurs as a result of fatigue in the back muscles. One has a choice: to either slump and stress the passive tissue elements, or sit up straight and stress the active ones. The active ones tend to fatigue quickly and noticeably tend to get relief.

Ideally, the posture of the seated employee would be tilted back to support the majority of the load on a chair's back rest and to widen the trunk/thigh angle, actually returning the back to a more lordotic configuration. There are several ways of accomplishing the same thing, but two of the most typical are to put the backrest back,

or to tilt the seat pan forward while the backrest stays fairly vertical. The problems with the latter include increased compression on the feet, so people must become familiar with a different configuration of postural stresses and sensations. One worker here came up with a creative way to support the upper torso mass by using the knee as an alternate support point. This created some relief in the low back because the upper torso mass was no longer being supported at that point; however, his trade-off is compression at the knee.

Psychosocial Issues

The issue of psychosocial stress and its contribution to work-related disorders has not been exhaustively investigated. Of particular interest is an article that appeared in the *American Psychologist* in the mid 1980's concerning the Australian RSI (repetitive strain injury) epidemic. This article contends that the RSI epidemic in Australia was a result of "technoshock." The technology was introduced rather rapidly -- the transition from the typewriter to the personal computer was rapid and poorly supported. This created a heightened state of tension and evoked psychological factors related to physical disability in the work population, and a wave of RSI resulted. Certainly, introducing this office technology into the workplace can result in some angst or unhappiness among the work population, and not all of the responses will be positively adaptive. There is some research evidence that when a person working at his/her maximum output is asked to perform the job faster, they do not actually move faster but they begin to recruit other muscles not really required. This precipitates unnecessary strain on the muscle system and contributes to discomfort and fatigue. The research challenge, then, is to ascertain where the psychological aspects end and the physical aspects begin, because they are fairly well interlinked.

Software and hardware have a big role to play in terms of user friendliness. How easy is it to accidentally erase the work that you have spent many hours generating (which might send your blood pressure through the roof)? At Georgia Tech, we once used a VDT in our consultation program that had the Delete Page key right next to the Delete Line key, with no "Are you sure?" type of redundant protection on it. This used to send quite a few people through the roof. Of course that is a hardware example, but the same type of thing is possible in software. How easy is it to make an error? How fast is the program proceeding? Do you have a program that requires a lot of processing speed on a very slow machine so that you can get five, six, or seven keystrokes ahead

of yourself before the machine catches up and you see the consequences? These kinds of problems are common and can contribute to psychological stress.

Organizational factors also have to be considered, such as whether or not there is organizational electronic monitoring. If there is monitoring, it could be monitoring of output in terms of words per minute or monitoring of people's telephone conversations, etc. Another factor is support for the task. How well are individuals trained for the task or the technology being introduced? For example, a new machine is brought in and each worker is given a mouse. Do you simply give each employee a mouse and say "good luck," or do you actually provide them some education on how to install and use it properly? These issues are often neglected in the office environment because there is an assumption that "anyone can figure it out." Often there is a problem with actual technical support in that everyone does not have immediate access to a computer sophisticate who is available to assist in the event of a "crashed" disc or a "catastrophically" modified program.

Personal factors can also be in stress. Included are standard psychosocial factors such as basic mental health, marital status, age, and type of home environment. To a certain extent these factors can be reflected in the workplace in terms of labor/management relationships.

Electromagnetic Field Exposure Issues

Research evidence to date does not indicate that a substantial risk is presented either from extremely low frequency or very low frequency electromagnetic fields, voltage fields, or any other type of field emanating from the VDT. A recent study by NIOSH researchers (Schnorr, et al., 1991, *New England Journal of Medicine* 324:727-33) determined that there was no impact of the VDT in terms of field exposure on a very large population (4,246 women telephone operators and 882 pregnancies) in terms of spontaneous abortion outcomes. However, most of the traditional factors such as tobacco and alcohol use that one would anticipate to be important or influential were present. Another study (Walsh, et al., 1991, *American Industrial Hygiene Association Journal* 52[8]:324-331) looked at 54 work stations and 1,166 workers. The levels they monitored did not exceed levels from the overhead lighting, building wiring, or anything else in the exposure environment. In fact, most of the complaints and problems the employees presented with were related to ergonomic factors such as screen positioning,

work station design, etc. Dr. Edward Rinalducci presented at this conference in 1990. His paper appears in the 1990 *Proceedings,* and provides a very good overview of VDT-specific issues. It is intensive toward design and engineering aspects of the VDT work station and gives the reader a good review of radiation studies.

Regulations and Other Standards

Some U.S. VDT ergonomics design guidelines (not all-inclusive) are:

- o ANSI/HFS 100-1988 Human Factors Engineering of Visual Display Terminal Workstations.
- o MIL-STD-1472D or more current version.
- o OSHA 3092 (general, easy to apply principles).

The ANSI/HFS 100-1988 Human Factors Engineering of Visual Display Terminal Workstations tends to be very technical. Some of the military standards are easier to read. OSHA 3092 is very condensed and gives the reader a general work station outlay and a good sense of what a work station should look like.

With respect to mandatory standards, there have been a series of failed municipal efforts to regulate use of VDTs in the workplace. Some recent U.S. attempts at regulation include:

- o Suffolk County, N.Y., passed a VDT law in May, 1988 requiring:

  Adjustable furniture, VDT equipment, maximum time on task without break (3 hours), employers pay 80 percent of cost of eye exams, lenses, and frames, and training on potential health hazards.

  December 1989, N.Y. State Supreme Court struck down the law in civil suit filed by employers, finding that the county "lacked authority" to promulgate law.

- o A New York City VDT law passed by City Council but was vetoed by Mayor Ed Koch in December, 1989.

- o The City of San Francisco passed a VDT Ordinance in December in 1990 which was similar to the Suffolk County law. It required up to $250

expenditure per work station for corrective action. It applied to employees with greater than 4 hours per day on a VDT and set minimum work station standards, work/rest requirements (break after 2 hours), and training requirements.

Bay area employers filed a challenge to the law in September, 1991, in California Superior Court. On February 13, 1992, the Court overturned the ordinance eliminating the second major municipal VDT regulation effort. The Court cited "lack of jurisdiction."

- Draft Cal-OSHA (state) ergonomics standard was circulated during the summer of 1992. This standard includes a VDT Appendix and is still under review.

In most cases, these were attempts to require employers to survey the work force to find out what types of problems were there. They also included work limitations in terms of how long one could work before a break (some of the research evidence documents that long-term exposure can lead to greater symptom presentation than exposure on a short-term basis). They further required employers to provide employees with vision exams and corrective lenses if needed. The San Francisco law also called for the provision of a specific dollar figure for work station corrective action. Both of these attempts at regulation failed because in both cases the state courts responded to employer suits which challenged them. The typical finding was that the rulemaking was not under the scope of the municipalities authority (that it was a reserved State or Federal function). Partly in response, California now has a draft standard under review. This is a more generic ergonomics standard and is not specific to VDT's, although it does include a specific sub-part that deals with VDT's. This Draft Standard is "subject to a lengthy review."

Some of the driving forces behind the regulatory actions include:

- Disorders associated with repeated trauma are the leading occupational illnesses in the nation, representing more than half of all reported occupational illnesses.

- Pending class action, product liability suits against computer manufacturers including Apple, IBM, Northern Telecom, AT&T, NCR, Atex (Kodak), and Wang concerning keyboard design.

- The Americans with Disabilities Act (ADA) may threaten worker's compensation as the "exclusive remedy" for workplace injury. In a recent case against Boeing under an ADA-like Washington state statute, the company was ordered to pay an employee with work-related, chronic tendinitis $1.16 million in compensation and damages.

- The American National Standards Institute (ANSI) and the American Society for testing and Materials (ASTM) both have voluntary, consensus standards activities underway in ergonomics.

Ergonomics is becoming one of the leading occupational health and safety concerns in the nation because of the rate at which musculoskeletal disorder incidence has increased. When looking at this data, the tendency is to believe that about half of all of the occupational illnesses and injuries in the United States are cumulative trauma disorders. But, in fact, this BLS category actually includes other types of trauma issues such as occupational hearing loss, and most of the incidents that were reported in 1981, 1982, and 1983 probably represented occupational noise-induced hearing loss and other types of vibration or pressure problems. So, while the growth has been substantial, it is not all cumulative trauma disorders of the hand and wrist. In fact, in the period 1985 to 1987, OSHA undertook a major crusade to improve recordkeeping and reporting and increased the sensitivity of the system. This has certainly contributed to the growth in this category.

Litigation is currently underway against a number of VDT station manufacturers, including Kodak, IBM, Apple, and NCR. There does not appear to be a good defense for these keyboard manufacturers other than no one knew that VDT's would present such problems.

Another driving factor is the American Disabilities Act (ADA), which is probably more relevant to private than public employers. There is a growing perception that ADA is becoming a way around workers compensation as exclusive remedy. In other words, it is becoming the next remedy. We are seeing cases such as the one Boeing recently had settled against it where $1.16 million was awarded to a single employee who experienced a work-related, chronic tendinitis. This worker went through the medical management system, was arguably mismanaged in the medical management system, and the company failed to make reasonable accommodation. This was not an ADA case, per se, but the State of Washington has its own version of the same type of law, and the

finding was that, for failure to make reasonable accommodation to this work-related or work-aggravated or work-created tendinitis, the company owed this individual $1.16 million. This was not for a congenital birth defect, an accident, or anything that was pre-existing, but rather for these types of repetitive motion injuries becoming defined as disabilities and therefore potentially compensable under the reasonable accommodation provisions of that Act.

ASTM and ANSI both have voluntary, consensus standards activities underway in ergonomics. All of this is pushing the Occupational Safety and Health Administration's agenda to release their Advance Notice of Proposed Rulemaking (ANPR) for the Standard in August of 1992. The ANPR is a call for information from employers/labor on ergonomics effectiveness and feasibility. The model they propose using is the model used in the Meatpacking Standard of 1990. OSHA needs evidence of effectiveness and feasibility to convince the Office of Management and Budgets (OMB) and overcome employer resistance. Organized labor has applied substantial pressure on OSHA, including requesting, in the summer of 1991, an Emergency Temporary Standard (ETS). The Department of Labor (DOL) denied this request in the spring of 1992 because of lack of appropriate legal consideration; that is, it was not deemed an hazard of sufficient severity and immediacy to warrant foregoing the normal rulemaking process.

There are other pressures as well, including Pepperidge Farm's citations. When this review appeal concludes it will probably be one of the longest-running review cases in OSHA history. The Administrative Law Judge is, as of the present date, still pondering the results of a case in which arguments closed in March of 1991. If the citation is overturned, it would provide substantial incentive for the Agency because it could restrict their ability to use the general duty clause to regulate ergonomic hazards.

The Comprehensive OSHA Reform Act did not pass this year but may, in fact, pass with the new administration and new Congress. The original bill came with its own regulatory agenda attached. If this Act had passed in the format in which it was originally proposed, it would include, among other deadlines, a deadline for promulgation of an ergonomics standard. The proposed ANPR format is very similar to the meatpacking safety and health guidelines in that it might require surveillance, systematic hazard analysis, prevention and control measures whether engineering or administrative, health management, and training and education of employees and medical specialists. The ANPR is asking whether there should be qualifications for program

managers and analysts, because presently there are very loose definitions of what an ergonomist actually is, what type of person is needed to perform these types of analyses, and what the analyses might entail. They want incidence data and information on what the impact of ergonomics intervention has been for companies. They are beginning to emphasize the concept of a "systematic" approach to analysis. This is odd since we really do not have very good definitions of what the exposure/outcome relationships are, and the belief that there might be a way to systematize the analyses without that knowledge seems inappropriate.

Following is a series of generic recommendations and office task considerations:

1. Consider upper extremity repetition in software development (perhaps most important for CTD's).

   - "Enlarge" the task so that keyboard activity is distributed with other, non-repetitive tasks (reading, copying, faxing, etc.).

   - Use programmed rest breaks (short duration) to break up keyboard activity.

   - Include repetition and ease-of-use considerations into new software purchasing decisions.

   - Build macros (user programmable shortcuts). Simplify most frequently used operations. Macros can reduce repetition, the opportunity for error, and may also improve efficiency.

   - Minimize "unfriendly software." Forced errors increase repetition.

   - Seek out automation for repetitive tasks (e.g., large-volume stapling, collating, hole punching).

2. Visual distance, viewing angles, glare

   - Top of screen at 1" to 2" below seated eye height.

   - Watch for direct and reflected glare.

   - Recommended distance is 20" (50 cm, ANSI/HFS-100), although distances of 51 to 100 cm have been found to reduce visual fatigue.

   - Use document holders to reduce eye/neck activity.

- Frequent slumping toward or squinting at screen may indicate lack of proper correction or fatigue.
- Have employee vision evaluated.

3. Work surface height/Posture
   - Position hand work at elbow height whether seated or standing.
   - Avoid flexion/extension of wrist through proper keyboard height.
   - Adjustable designs will reduce musculoskeletal strain.
   - Headset telephones may help to minimize neck strain.
   - Look at height of community/support personnel equipment (e.g., facsimile, desktop copier, printer).

4. Static exertion
   - Provide chairs with armrests which a VDT operator has the option of using.
   - Provide support for arms on work surface.
   - Provide larger work areas around keyboard/mouse.
   - Design work to incorporate frequent changes in posture.
   - Provide adjustable workstation and chair components.

5. Minimize reach distance/Moments on spine
   - Limit frequent reaches to in front of the body and 18 inches from the shoulder.
   - Avoid extended reaches, reaches up above shoulder and eye height.
   - Tasks requiring frequent extended reaches should be standing tasks.
   - Avoid handling items or lifting at a distance from the body.
   - Design lifts so that object mass can be brought as close as possible to the center of the body.
   - Reduce forward bending of the torso (stooping) and avoid tilting of the head.
   - Obtain and use materials handling aids: hand trucks, carts, etc.
   - Design loads for lifting ease/minimize weight.
   - Use foot rails to relieve spine loading for standing workers.

6. Edge compression

- Watch for edges cutting into wrist, palm, arm, elbow, thigh.
- Pad edges of workstations, chair armrests.
- Use adjustable, upholstered work chairs.
- Use footrests where the feet are unsupported.
- Use antistress mats or pads to relieve compression on feet (standing at the copier, fax, etc.).

7. Ingress/egress

- Are awkward postures required to get in or out?
- Use swiveling chairs (lockable feature).
- Use wheeled chairs (watch friction issues, lockable castors).

8. Seated work/Chairs

- Adjust existing chair to popliteal height.
- Adjust/use backrest.

Objectives:

o Maintain more natural lordotic curvature (slight forward tilt, backrest).

o Support weight where possible to reduce muscle fatigue and spinal load (backrest angle, arm rests).

o Avoid compression of soft tissues (buttocks, thighs, calves, arms).

o Have seat adjusted to proper height for work (1 to 2 inches below popliteal crease).

Features to look for in new chairs:

- Adjustable height
- Adjustable backrest: height, angle, distance
- Adjustable pan tilt
- Adequate padding and a waterfall front edge to reduce compression
- 5 leg base
- Easy to adjust
- Texture of material; does is breathe, does it resist slippage?
- Swivel; improve egress and reach situations

- Wheels; improve egress and reach situations.

  (Caution: Wheels and swivels and other aspects are highly task-dependent as to their desirability.)

Problem-solving approaches:

o "Enlarge" task to incorporate frequent changes in posture or position.

o Increase frequency of rest breaks/microbreaks.

o For seated tasks, use adjustable seating to accommodate as much of the population as possible. Provide arm support where feasible to relieve low back compression. Look for characteristics noted previously.

9. Stress

- Provide appropriate training for users/operators. (Common error: four years using a spreadsheet program is often not sufficient background to use a slide or graphics program.)
- Provide adequate support for systems (e.g., the "computer guru").
- Practice proper O&M (copier/fax toner replenished, efficient repair/recovery systems).
- Minimize use of organizational monitoring.
- Minimize monotony by diversifying task activities, increasing control/responsibility.
- Poor environmental conditions may also contribute to psychological stress. Respond to environmental stressors including temperature, ventilation problems, noise.
- Practitioners: treat workers as customers; not as organisms under study.

10. Medical Management (based on OSHA 3123 and draft ANSI recommendations)

- Know your population (screening)
- Know your exposures (walkthroughs)
- Return specific restrictions
- Develop a structured treatment algorithm
- Identify modified or light-duty alternatives to minimize lost time
- Encourage reporting of discomfort; refer serious cases.

11. Other Considerations

- Watch employees carefully for problem indications: pain complaints, workstation modifications.
- Train employees: postures to avoid, CTD's, work practices, how to adjust devices.
- Have high-risk (incidence) tasks evaluated by ergonomics professional.
- Recruit employee feedback and monitor effects of any change you make.
- Last, but not least, watch out for the sometimes self-evident employee workstation modifications.

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N94-16613

EMERGENCY PREPAREDNESS AND PLANNING

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p. 8

It is a pleasure to be able to talk with you today, and it is hoped that some of the ideas presented here may be of interest in your emergency response programs.

I am with the Monsanto facility located 16 miles west of New Orleans. This is a large industrial complex that houses 660 regular employees and over 1,000 contractors. In addition to my work with Monsanto, I have worked with the Emergency Medical Service (EMS) on the streets of New Orleans and with the New Orleans Police and Health Departments for the past 18 years.

Among the most unique things about New Orleans are its history and heritage. The number of very old, authentic buildings still standing is amazing. The oldest apartment buildings in the United States are located in New Orleans. Emergency planning for this area is very important, in part because the Port of New Orleans is now the third largest port in the United States, exporting a lot of the products from Monsanto and the other major chemical companies in the United States. A large percentage of the goods produced in the United States are shipped through the Port of New Orleans for export all over the world.

When millions of people pack the streets, such as during Mardi Gras in New Orleans, having an emergency plan in place is especially critical. It must be an especially good plan, and the people who carry out this plan must be the best. If a chemical emergency should occur involving one of the hotels during Mardi Gras or if a chemical emergency involving the Port of New Orleans should occur, it could be a catastrophe.

Most of the people who visit the beautiful plantation homes in and around New Orleans are elderly; they are retired people on vacation. Buses containing 60 to 90 people each tour these plantation homes. These plantation homes all require emergency plans including provisions for evacuation.

Hazardous materials are everywhere. Most hazardous materials are transported by tank car. If you are familiar with the diamond system of the NFPA 704 that is used on placards and trucks, you would probably be surprised to learn that this hotel would be rated a "3" for health because of the amount of pool chlorine stored here. It would be rated a "4" for fire hazard because of the amount of Sterno[R] stored here for use in warmers, the amount of propane gas that is kept on hand for use at parties around the pool, and the amount of janitorial supply flammables stored in this hotel. In the reactivity state it would be rated a "3" because of the amount of pool chlorine reacting with water.

If NASA wanted to build a facility in your neighborhood, the neighbors would probably complain because of the danger of hazardous chemicals. If Monsanto wanted to build a facility in your neighborhood, the neighbors would be in an uproar -- they would be protesting. But if a large department store wanted to build a facility in your neighborhood, the neighbors would probably not object. However, most department stores house and store large quantities of hazardous materials. The general residents do not worry about the department stores located in their area because they do not believe they could possibly harm them. However, most large department stores offer for sale pesticides, herbicides, chemicals for use in swimming pools, and other hazardous materials. They all should have pre-emergency preparedness plans.

I would like first to tell you something about Monsanto's emergency response plan, and then offer some suggestions that might be of value in designing or modifying your facilities' plans. Large employers such as NASA, the Department of Energy, and Monsanto all have the same kinds of problems. Often the facilities are large, complex, and confusing. It is important to determine what level of medically-trained people are needed at a facility. Monsanto has people on duty around-the clock who are trained all the way up to the paramedic level and, in addition, occupational health nurses come in on a day basis. In the line of emergency response, the Monsanto facility located in New Orleans has 100 fire fighters, EMT's, and emergency responders. All are prepared for any emergency. Other Monsanto plants do not have facilities that are quite as large, and instead they depend on either small fire brigades or local fire departments. In addition to fire-fighting, emergency response includes such things as the testing of fire equipment and sprinkler systems. My responsibility is to make sure that Monsanto has a fire department with sufficient equipment and personnel, and a medical service. We have the best equipment money can buy. A lot of our budget money goes into training and

education. We are proud of the amount of money we spend on emergency response and the fact that, as a result, we never have emergencies.

One very good program that we have at Monsanto includes cardiac pulmonary resuscitation (CPR) certification for every employee in the plant. Even if this never has to be used at the plant, the benefits of knowing how to perform CPR in the employees' homes or anywhere else outside of the plant are significant. Right now, if an employee of Monsanto were to suffer a cardiac arrest with no pulse or respiration, within a very short time another employee would start CPR. A defibrillator would arrive within 5 minutes. These two facts would greatly increase a victim's chances of survival from a heart attack. If one were to have a heart attack on the job, the chances of survival are far greater than if that heart attack occurred at home.

The first emergency medical training (EMT) program Monsanto put in place cost $88,000. Twenty-five EMT's graduated from that class. As a result of the success of that program our Monsanto facility now has 53 EMT's; on every shift there are 5 or 6 EMT's, there are paramedics, and nurses. Every EMT or paramedic at the facility wears a fanny-pack containing medical supplies and a vest to identify the wearer and what role he/she plays in an emergency.

Having advanced life support monitors in our facilities has greatly benefitted us, especially in the event of a hazardous materials incident. When people are dealing with hazardous chemicals there is always the potential for exposure. When chemicals such as super-heated gases at fires occur, there is the potential for the respiratory airways to swell and the patient may require early intertracheal intubation. Because fire-fighting is a strenuous job, cardiac arrest can occur. The endotracheal paramedic kits contain cardiac drugs that can be utilized immediately. When exposed to chemicals, fluid can build up in the lungs and suction can be performed through the intubation tube to remove the fluid. The paramedics also carry atropine and various narcotics that are available for use when necessary.

At Monsanto, the smallest blister is considered a recordable injury. We encourage the reporting of even the smallest injury because, if a number of minor injuries occur, we can then trace the source of these injuries and attempt to remove the cause. We have a program called CARE (Correcting Actions and Reinforcing Excellence) that consists of cards placed throughout the facility and mail slots. Once a

week, each employee is encouraged to pick up a CARE card and observe employees working. When an unsafe action is observed, it is recorded on this card. There is a reward system involved in the CARE program. If an employee turns in a card once a week, at the end of the year he/she is eligible for a drawing in which a very nice prize is awarded. Nearly everyone participates in the CARE program.

In the area of contractor injuries, Monsanto now requires pre-registration for all contractors who come into our facilities. Certification is required in the form of a license to allow one to work in our facility. No sub-contractor is allowed to work in our facility unless they are pre-registered and have taken a four-hour training course. Very few people are allowed into the plant without this formal training. For example, the man who works on the fire trucks at Monsanto is a contractor. If the fire truck breaks down in the middle of the night, he is pre-approved to come in and repair it. If he had not been pre-approved, the fire truck would stay in need of repair until he was trained. We are very serious in our attempt to reduce contractor injuries.

Among the many specialized areas is the ability to rescue people from confined spaces or by aerial rescue, and a hazardous material response team to handle incidents that might occur both inside the facility and outside on the highways. Times have changed. Years ago we used pickup trucks in our hazmat (hazardous materials) efforts. We would load the materials necessary for the job onto the trucks and go out to wash off hazardous materials that had been spilled on the highways. The materials would be left on the side of the road, or covered with sand, or buried. Today, we are closer to having to dig up the entire highway and replace it. We were doing hazmat when hazmat wasn't cool. Hazmat is a very popular area these days. Although hazmat is prepared to cover incidents involving tank trucks and tank cars, 90 percent of the hazardous materials calls that come into Monsanto involve 55-gallon or smaller drums. Most problems will arise inside your facilities -- someone mishandling or misusing chemicals -- and this is what you are required to be prepared for.

When transporting hazardous materials by truck, it is necessary to perform an analysis of the transportation routes and the types of chemicals that will be shipped over these routes. As an example, Monsanto shipped chemicals in compressed gas cylinders, and found that in one particular area of highway these trucks would overturn frequently. Investigation revealed that these turnovers were due to bad humps on the Interstate coming off of some bridges. We posted large signs warning of the road condition ahead

and for vehicles carrying hazardous materials to reduce their speeds. Even though these signs had been posted, two trucks still turned over. We then went to the carriers and demanded that only drivers be used for this route who had traveled this route before and were familiar with it. Since then we have used only carriers with the best equipment and experienced drivers, drivers who have gone through training and drug screening, and we have not turned over a truck since 1985.

The United States has an emergency plan in the event of war. Within just a few days, the United States could be successful because of this plan. We also have a system in place in the event of nuclear emergencies. Strict guidelines and very technical and well-written emergency plans are in place at nuclear plants. There are also many excellent plans in place to deal with natural disasters such as earthquakes, floods, etc. When these kinds of emergencies occur in foreign countries where there are no emergency plans, there is no way to know where the proper equipment will come from, where food and water will come from, or how to shelter those who are homeless as a result of the emergency. When the earthquake occurred in Armenia in December of 1988 we had to take food with us from the United States. Recently in Miami we saw a very bad hurricane, and the same hurricane hit Louisiana. At my facility in New Orleans our fire department trucks went out 39 times in 16 hours during the hurricane. We encountered everything from roofs blowing off of buildings to windows broken, alarms sounding, chemicals that should be kept from becoming wet, etc. From this emergency the people of Louisiana learned that they must leave very quickly when a hurricane is forecast.

Miamisburg, Ohio; Livingston, Louisiana; and Kingman, Arizona, have all had hazardous materials emergencies. In the Ohio incident, a phosphorous train derailed and 33,000 people were evacuated. Monsanto handled this emergency because the product involved was Monsanto's. Monsanto does not drive the train, but if it goes off the track we get the bad publicity. In this case, a car was burning. The man who was responsible for driving the bulldozer to cover up the spill was not trained in hazardous materials, and the people who were trained in hazmat were not trained to drive a bulldozer. It turned out that it was easier to train the Monsanto hazmat people to drive the machine than to attempt to train the bulldozer driver in how to handle hazardous materials. This community did not have a good emergency plan and, in spite of the warnings, they let their people re-occupy their homes that night. The situation once again became an emergency in the middle of the night, and all of these people had to be evacuated for a

second time. During the Livingston, Louisiana, train derailment, 23 train cars were involved, and the emergency lasted for 17 days. The Louisiana State Police are in charge of all hazmat incidents in Louisiana, and Livingston had an emergency plan in place when this accident occurred. They closed the highway, set up a command post, and evacuated 17,000 people within a radius of five miles. In this accident, the liquid in some of the train cars was brought to a boil and expanded, resulting in explosions. But of the total of 23 cars, only two were totally lost. The residents could not be allowed back into the area to feed their livestock, and after three days the veterinarian asked if there was a plan to feed these animals. There was no plan in place for the feeding of the livestock, so the veterinarian taught our emergency people to feed them. The Kingman, Arizona, incident involved propane leaking from a tanker. There was no emergency plan available and, as a result, men were sent in to cool the tank down and blow out the relief valve. The relief valve was snuffed out and, as a result, the propane leaked out of the relief valve so fast that it froze up. When it froze up it had no vent, and the flames continued to heat the car, boiling the liquid on the inside. Subsequently the vapor built up and the car exploded, killing 13 firemen and injuring 92 bystanders.

There is a big difference between training and education. Fire academies, hazardous materials schools, and emergency planning schools teach that the weakest part of a tank car is the ends; it is designed that when the car over-pressurizes the ends will fail. This leads people to believe that the best approach to the burning tank car is from the sides. In fact, if the car explodes it can take out a radius of two miles.

Evacuation is an important contingency that should be included in every emergency plan. There are times when the best plan of action is to evacuate, secure the area, and let the fire take its course.

What are the risks and benefits of having an emergency plan versus not having such a program? Facilities without such a program are courting disaster. In an emergency situation there is no way one can perform and function as well without a plan. Without the proper training the first thing one might think of to do in an emergency situation is run.

In Bhopal, India, over 22,000 people died and more than 200,000 people were injured because of a chemical emergency in which there was no emergency plan. At Chernobyl, we will never know the entire story. A U.S. delegation of hazardous

materials experts recently toured the area, and they say that the only people at Chernobyl now are adult workers -- there are no children, no livestock, and no living plants. In the United States, the incident at Three-Mile Island was less severe, but was very close to the incidents in Bhopal and Chernobyl. However, we had an opportunity to learn from the incident at Three-Mile Island. Because of this incident there are now strict guidelines, and emergency planning for nuclear plants is very stringent.

All facilities, including manufacturing plants, assembly lines, laboratories, and control rooms must have an emergency plan that is best suited to their needs. The plan must cover the event of small spills as well as large spills, and small fires and large fires. Adequate medical assistance must be available. A risk assessment of each facility has to include all aspects of the facility; for fires, it must consider what the fire threat is, the kinds of fires that are possible, and how big the fire could be. For emergencies requiring medical intervention, the risk assessment must include the probability of injury from the smallest laceration to the most serious injury; burns, broken bones, and inhalation injuries.

A written emergency preparedness plan is necessary. If a written plan is not available an employer might have to rely on the fire department's plan which may not be designed for its specific needs. Three things are needed: (1) a risk analysis of your facility, (2) a vulnerability analysis concerning the possible outcome of potential emergencies, and (3) hazard identification advising the local agencies and ambulance services of your facility's dangers. To design a written plan, all aspects must be considered including minor and major spills, minor and major fires, minor and major medical problems, and minor and major hazmat. All of the potential problems involving your facility should be listed. Meet with your department heads, and meet with your local agencies; police, fire, EMS, hospitals, and your local government. A side benefit of having a good plan in place is the elimination of potential citations and fines.

There will soon be an official regulation released concerning confined space. Nation-wide, nearly 15 emergency responders are killed in events related to confined space. Most of these fatalities are fire fighters. Another problem involves falls. Workers can not only fall from heights, but can be injured as the result of objects falling on them. The proper equipment must be available to rescue and treat individuals involved in these types of incidents. High-angle rescue requires special equipment and expertise. Decontamination might include not only the removal of materials from

clothing, but also the removal of materials from people. Decontamination also requires special skills and training.

At Monsanto we do not see the Occupational Safety and Health Administration (OSHA) on a regular basis, but we do see them after a serious accident or incident has occurred. To be in compliance, the laws must be followed. In the case of hazmat, CFR 1910 120 must be complied with. In the case of a fire brigade, NFPA 600 must be complied with. There are different guidelines and laws to cover all of these, and it is up to the employer to comply with the law.

Accidents do happen in the chemical business. These accidents are in large part caused by human error, and we are continually working to reduce the number and severity of these accident and incidents. While the chemical industry often comes under scrutiny, without chemicals including herbicides and pesticides, life would be very different. Even the chemicals in our foods are there to protect us. Chemicals contribute to an improved standard of living for all of us.

N94-16614

LEAD POISONING: AN OVERVIEW

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A problem that should be of great concern to all of us is the lead poisoning of children. First, I would like to present a short overview concerning the reasons everyone should care about lead poisoning, then discuss the history of lead poisoning, what is happening today across the country, and the future.

Lead is a Serious, Nationwide Health Problem

Lead poisoning is the number one environmental poison of young children in the United States. It is estimated that three to four million children in this country have lead poisoning. By anyone's measure, this is of epidemic proportions. These children are suffering losses in health, they exhibit numerous behavioral problems affecting them and everyone around them, and many of these children are affected into their adulthood. Adults who suffered with lead poisoning when children demonstrate a tragic loss of productivity. NASA, who tries to hire the best and brightest, has fewer people from which to choose today because of lead poisoning. In addition, a tremendous number of lead poisoned children require remedial education, and this is a great drain on our educational systems.

Lead poisoning reduces the body's ability to metabolize vitamin D; it reduces the ability to form heme which is used to make hemoglobin in the blood; it decreases intelligence, school performance, and attention span; it increases irritability; it stunts growth; and it causes hearing loss. Lead does not discriminate, it circulates through the blood system to all tissues and bones in a child. It affects each child differently. Lead accumulates in bones and tissues, and each exposure adds to the problem. This is very bad for adults, but for children it can be devastating.

The most severe results of the ingestion of lead occur in children under the age of 6 for several reasons. First, these children are prone to put their hands in their mouths. The toys they play with are often dirty, and they put them in their mouths.

They play in the soil around their houses. They are most susceptible to lead poisoning because they live down at the level where leaded dust is found. At this age children are not fully developed, so their systems are sponge-like in seeking those things needed for development, such as calcium, iron, etc. Children up to the age of six years absorb up to five times as much lead as an adult. An adult absorbs up to 10 percent, but it does not stay in the bones and tissues of adults as long as in children. Children in this age range can absorb up to 50 percent, and it stays in the bones and tissues longer. Lead equivalent to a couple of grains of sugar over a fairly short period of time will poison a child.

Lead in pregnant women can pass to the fetus. Even if a woman is not exposed to lead during pregnancy, if she had been exposed to lead prior to the pregnancy, the pregnancy could cause the lead accumulated in the tissues and bones of the body to mobilize and enter the bloodstream.

The History -- Lead was a National Health Threat Long Ago

The history of lead goes all the way back to the Roman aqueducts. We have all heard various versions of why Rome fell. One of them is that Roman aqueducts were lined with lead. Since lead is a very pliable material and one of the first metals available to civilization, it was widely used. The Romans also used lead to make wine goblets and other drinking vessels. Today, some of you may be drinking from leaded glass and may be using leaded glass decanters. Back in the late 1790's Benjamin Franklin was very concerned that people collected drinking water off of roofs that had lead liners beneath the shingles; even then there was enough medical knowledge to know that lead was a problem.

By the 1920's there were many published reports in medical journals of childhood lead poisoning in this country. During the 1920's and 1930's many countries banned the use of paint in houses. Paint for use indoors was banned in Great Britain in 1926, in Spain in 1931, in Sweden in 1926, in Cuba in 1934, and in Poland in 1927. During that period, Australia, Belgium, Greece, and Yugoslavia also banned using paint inside houses. The United States did not ban the use of paint in houses, even though industry knew about the health hazards. The same is true with respect to the hazards of using lead in gasoline.

Up until the 1940's lead was the material of preference used by paint manufacturers. A quart of paint could contain up to 50 percent lead. This is 500,000 ppm, compared to the 100 ppm the Consumer Product Safety Commission (CPSC) is considering for the future. The Housing and Urban Development (HUD) regulations, which are the only nationwide established regulations and only used with respect to certain federally funded facilities for residences, considers 5,000 ppm in a sample the action level that should cause concern. It is estimated that 57 million houses in the United States contain some leaded paint, and that 20 million houses in the country are health hazards. It is also estimated that 3 to 4 million of these houses contain children under 6 years of age. Many of these residences have paint on the inside and outside walls that contains 300,000 and 400,000 ppm. The use of lead in paint decreased after the 1940's, but into the 1970's a substantial percentage of residences were still painted with lead-based paint containing high levels of lead -- levels still high enough to poison a child.

There are many stories of people who have traced the history of lead and its use by manufacturers and of medical consultants defending those uses because of lack of proof that it caused harm. Industries were quite successful in blocking attempts to pass legislation and regulations. It was only last April that California banned the use of lead in gasoline. Several years ago when lead was banned for use in newer automobiles, California had about a million older cars that could not run on unleaded gasoline.

Lead is very persistent. One of the big problems today is the amount of lead that is present in the soil near busy streets and freeways all over the country. We are especially familiar with this problem here in California because of the earthquake that resulted in the collapse of a 2-tier freeway in Oakland, California. The community did not want that freeway rebuilt because it cut the community in half. During testing done around the freeway they discovered so much lead present in people's yards and in school yards that the dirt was classified as hazardous waste. This meant that the soil would have to be taken to a class one hazardous disposal site.

Current Issues

Paint containing lead is a serious problem today. It is often thought that the problem arises because children eat paint chips, and this is true in a small number of

cases. But most cases of lead poisoning in children are caused by leaded dust from the paint inside and outside of houses. Children get this dust on their hands and then put their hands in their mouths.

Lead in house paint has not been banned. The lead content in paint was reduced substantially in 1978, but it can still contain 600 parts per million (ppm). More and more studies are being done on the toxicity of lead, especially for children, and the Consumer Product Safety Commission (CPSC) is considering lowering that level to an allowable 100 ppm.

There are many other sources of lead: water, ceramic tableware, tin cans, and work clothes. Recently the newspapers reported that various water districts were required by the EPA to go out and test people's tap water and report their findings to the EPA. This is not source water, just tap water. They reported that a lot of the water districts were over what the EPA considers the "bright line" for drinking water, which is 15 parts per billion (ppb). San Francisco's water district is over that bright line, and is about to take action based on the EPA requirements. EPA requires at the very least that the people in the community should know that tap water could contain lead. But when the EPA in Washington designed the guideline they neglected to consider that some people rent the dwellings in which they live. In San Francisco, 70 percent of the residents rent, and no notice of lead in the water is being sent to these renters, only to the rate payers who own the dwellings. We are now insisting that the San Francisco Water Department remedy this.

It was recently estimated that lead in drinking water may contribute 10 to 20 percent of the total lead exposure in children. The age of the house or apartment is important, and it is also important to be aware of the potential lead problem wherever one drinks. Water coolers can be a problem wherever you or your children go: schools, child care facilities, etc. Ceramic tableware, especially from Asia, Mexico, Central and South America, can also contain lead which leaches into food. The Chinatown area in San Francisco houses the largest population of Chinese-speaking people in North America. Testing was done in 1989 on ceramics sold in Chinatown, and up to 40 percent of the tableware that was inspected failed the test; that is, it leeched lead in unacceptable amounts. These ceramic products are supposed to be inspected before they are allowed to come into the United States. Lead is also found in tin cans coming from Mexico and Central and South America. Some products sold in the United States,

especially in areas with Latino populations, are in tin cans that are lead-soldered. Acidic food and juice causes lead to leach more rapidly, and cans containing fruit or fruit juices are especially dangerous.

A blood test is required to determine if a child has lead poisoning. In order to detect lead poisoning in a child by appearance, the lead poisoning would have to have progressed so far that the child would be in critical condition and be hospitalized. Symptoms of lead poisoning are similar to those of a cold or the flu; the child is irritable, complains of stomachache, and does not sleep well. Unfortunately, most doctors are not yet routinely testing children.

Lead poisoning cannot be cured and its effects are fairly permanent. The level of exposure, length of time of the exposure, and diet are all factors in the permanence of lead poisoning. The best treatments include lowering the level of lead in the blood. If a child is hospitalized for lead poisoning, the blood can be treated with a drug that attaches to the lead and is then excreted, lowering the lead level. The problem is that the body tends to "equalize" the distribution of lead, so the lead in the bones and tissues will then begin to re-enter the blood stream and the treatment may have to be repeated. Prevention and good diet are the recommended treatments for children with lower levels of lead in the blood. After treatment, these children should be carefully watched for behavioral problems related to lead poisoning.

The research that has been done over the last few years has greatly improved. It is now realized that very small amounts of lead in the system can cause lead poisoning. Right now the "bright line" that determines when a child has lead poisoning is 10 micrograms per deciliter, an amount so small it is almost off the meter. Even at levels lower than 10 mg/dl, children may be affected.

There is no inexpensive, non-invasive test for past exposures. The current blood lead level test reveals exposures within the previous 30 days. This will not tell you what lead content is in a child's bones or tissues. A child can very easily have suffered from past exposures, but the test results would not indicate this. One problem that is not yet being discussed is the impact of chronic low level exposures (below 10 micrograms per deciliter) over an extended period of time.

The results of a recent study in Australia also indicate that research is improving. This study involved children with levels of lead in the blood of 10 to 25 micrograms per deciliter. It took into account the IQ of the mothers, parenting styles, other illnesses in the family, birth order of the children, parents' smoking habits, and other possible impacts on children's health. The study concluded that twice as many of the children with lead poisoning at low levels needed remedial education as compared to children who were not poisoned.

The study that really sounded the alarm in the United States was done by Professor Needleman and published in 1979. In this study baby teeth were tested to determine blood lead levels. This is not a normal test that can be done simply or inexpensively. Dr. Needleman then traced the history of these children who, by this time, were young adults. He visited the schools they attended and interviewed the teachers in an attempt to determine the characteristics of the students, their behavior and scholastic achievements. He discovered that many of these young adults who had levels of lead in the blood above the "bright line" were abnormal in their behavior. His research indicated that these young adults were six times more likely than normal to have reading disabilities and behavioral problems, and were seven times more likely than normal to drop out of school as a result of these problems. In general, these people cannot cope well with the world and will not be as productive in adulthood. This is a tragic loss. Professor Needleman's research findings have since been confirmed many times.

Many states have been trying to deal with the problem of lead for as long as 30 years. But most people are still not aware of the severity of the problem. The answer to the problem of lead poisoning is prevention, which is difficult. Many places in the United States are literally painted with lead. There is lead solder in the pipes of newer homes; the soil near highways and busy streets still contain lead; lead is still present in some paints, ceramic tableware, tin cans, and work clothes. The federal government does not have standards or guidelines for reducing lead hazard exposures in private housing. While a few states do have guidelines, many others do not. California does not. Los Angeles contains over one million houses which have been painted with lead-based paint; in San Francisco it is estimated that 260,000 out of the total of 330,000 dwellings were painted with lead.

We have a great need for new and better tools in the construction and contracting industry for the removal of lead. Even people skilled in this work find that it is very expensive to do, and removing lead from all of the houses, buildings, schools, etc., is prohibitively expensive. The removal of lead from dwellings and buildings is very invasive and causes a great amount of displacement. We need to find less invasive ways to solve the lead problem. As an example, in San Francisco, one of the most dense cities in the country, there is a problem with relocating tenants. If it is mandated that landlords must remove the lead, many tenants will be out in the street; not only because people cannot live in the dwellings while this work is in progress, but also because the landlord will pass the costs on to the tenants.

I am happy to report that in the last days of President Bush's tenure he signed an amendment to the National Housing Bill. This amendment will provide new funding for Federal-assisted housing; that is, housing with Federal Housing Administration (FHA) and Federal National Mortgage Association (FNMA) mortgages, public housing, and even private housing the federal government helps to finance and subsidize for low and moderate income people. There will be more disclosures to buyers and lessees. This amendment also contains legislation for worker training. There is a mandate that the federal government assist in private housing with respect to lead hazard reduction regulations and with public education. There will also be new Federal Occupational Safety and Health (OSHA) requirements.

You will hear more from the EPA. There will be a lot of publicity across the country, and there will be a Hotline (1-800-LEAD-FYI). San Francisco was selected as one of the target cities for publicity because of the work by the Coalition to Prevent Lead Poisoning. But how can a call to a Hotline in Washington, D.C., help people living in San Francisco?

The people answering the Hotline in Washington, D.C., cannot be expected to know anything about the San Francisco water department. In addition, San Francisco is a European/American minority city where large numbers of different racial and ethnic people live. Many do not speak English. They may not be able to read very well even in their own languages, and they do not get their information through the same sources that you and I might. These people need to be reached perhaps more than anyone else, because in some of the places they live the children are at higher risk for lead poisoning. How is that Hotline going to help these parents? How many languages will that Hotline

be able to handle? Everything we at the Coalition to Prevent Lead Poisoning do, including our literature, is in up to six languages. We work with community groups throughout the city and discuss these problems with their leaders. We request that they tell the parents in their community about these problems. There are substantial numbers of people in this country who need this information, and the EPA Hotline will not help them.

Every state is mandated by the federal government to have a "Well Child" health care program. "Well Child" programs are partially funded by the federal government and provide free medical care. Complete physical checkups, including blood-lead level tests, hearing, vision, immunizations, etc., are free to children 6 years old or younger. The program in California covers the children of people whose incomes do not exceed 200 percent of the poverty level. In San Francisco, about 75 percent of the children are eligible to receive this care. Unfortunately, the program in California is terribly under-utilized, and only about 35 percent of all of the eligible children in San Francisco actually use it. Many parents who live in public housing projects are not aware of this program or do not have access to the care. It is a great tragedy that these eligible children do not have lead blood testing done.

Prior to 1991 there was no program at all in the City and County of San Francisco for anything having to do with lead. Only three children were reported to the local authorities as having blood lead poisoning in the three years prior to 1991. In 1991, a very good pediatrician who came to work for the Public Health Department was able to convince some medical facilities to begin testing for levels of lead in the blood. Out of the first 1,199 children tested, 8.3 percent, or 99 of the children were shown to have blood lead poisoning. This is a very high percentage of any target population, yet it is believed that if the children had been selected by going from door to door in high risk areas it would have been even higher. This 8.3 percent was only for current exposure and not for past exposures. A great number of the children who tested negative may already have had lead poisoning.

Seventy-five to eighty percent of the housing in San Francisco was built before 1950, and even the housing built after 1950 poses a potential problem. At any one time approximately 44,000 children in San Francisco (ages newborn through 5 years), whether they live in the upper-, middle-, or lower-class housing, are at risk.

The Public Health Department in San Francisco has a budget of over $2.5 billion, and is the size of many State Health Departments. San Francisco had no funding for the lead problem until 1992, and we had to fight to keep the funding for three people in the Public Health Department's budget.

The Coalition to Prevent Lead Poisoning in San Francisco started with the knowledge that a substantial number of people in the community were not aware of the lead problem, and that there will never be any political will to increase the budget in the Health Department and solve this serious problem unless the public knows about it. We have many community and social service groups in the city, and they had to be made aware of the problem. This is what we have been doing. We have also been providing them with the tools needed so they can go out into their communities to educate and encourage parents, in a number of different languages, to have their children tested through the "Well Child" program.

People also need to know how to reduce the hazards where they live. The Coalition to Prevent Lead Poisoning provides libraries and social service agencies with this information. The Coalition holds workshops for health care providers and gives them fact sheets and pamphlets to distribute to their patients. These fact sheets answer questions such as, "What is lead poisoning?", "How does my child get it?", "How can I recognize it?", and "What can I do?" The Department of Social Services mails this information to AFDC and food stamp recipients. We have also been working with the Water Departments to get this information out to residents. We are also working to get legislation passed that will help increase getting the information to landlords and tenants and purchasers of products in home improvement establishments. (This legislation was passed on December 23, 1992.)

It is also important to get information concerning lead poisoning to physicians. Some physicians still resist testing children, claiming that more research needs to be done. At least one large health maintenance organization (HMO) is resisting and does not want to include testing as part of regular examinations of children. We need to make industries, including insurance companies, aware of the problem. For example, insurance companies in Massachusetts will not insure anyone doing lead hazard reduction work unless he/she has gone through a State program which requires attending courses and being an apprentice for 15 lead-abatement jobs. This helps make sure that competent contractors are doing lead hazard reduction work correctly. It is doubtful that this will

occur in California or in many other states anytime soon. There is also a law in Massachusetts that physicians can have their licenses revoked if they fail to test children at 12, 24, 36, and 48 months of age. This is not the case anywhere else in the country.

In human terms, the cost for the failure to remove lead from our society will be incredible if we do not act now. In dollar terms, there is no question that dealing with this problem will be expensive, but every study done has shown that it will be much more expensive if we do not act to prevent future lead exposures. People in federal agencies who are trying to set federal policy claim we could save $2,000 for each child with lead poisoning if we act now, compared to what we lose in terms of medical costs, educational costs, the loss of productivity, and emotional losses if we fail to take action.

Conclusion

While this is not a story with a happy ending, more of us now know about childhood lead poisoning. The reality is that the story will not end for decades after enormous expense and significant damage to generations of people. There is a bitter lesson to be learned here. It happens time and time again that a few people in a few companies have made and continue to make decisions which have caused and will continue to cause this country great loss. These people make choices about products and allow the products to enter the environment without understanding their impact. They allow these products to be used even after they do understand their impact. Some of these decisions have cost us incredible amounts. Adding lead to paint was not necessary, it was simply determined that lead provided good qualities for paint. Adding lead to gasoline was not necessary. Yet this economic system has not found a way to consider the social, health and economic consequences of these choices.

I hope the information presented here will help you to protect your children. Please also do whatever you can in your community to help reduce lead hazards for children; they need all of the help they can get.

N94-16615

MEDICAL SURVEILLANCE AND BIOLOGICAL MONITORING OF LEAD EXPOSED EMPLOYEES

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Employee health protection is an employer responsibility. The multi-faceted aspects of employee protection from the potentially harmful effects of inorganic lead sometimes stress the relationships of several employer units. These include supervision and management, safety, operations and maintenance, engineering, environmental health, environmental management, and occupational medicine.

The administrative aspects of program development are going to be discussed. My presentation today is to emphasize the opportunity for cooperation by all of the employee health components in developing an optimum surveillance and protection program.

References to biological monitoring may be confusing. I would like to try to clarify some of the terminology.

Clinical Monitoring refers to the physical examination which includes the review of the history and the hands-on examination.

Medical Monitoring is sometimes called "health effects monitoring" and is the standardized assessment of measurable biological functions which is a part of most comprehensive physical examinations. This would include the standard blood chemistry monitoring for liver, metabolic, kidney, and musculoskeletal abnormalities, as well as such tests as the electrocardiogram and pulmonary function. These are compared to a population normal as well as to the individual's baseline values.

Biological Monitoring is sometimes called "biochemical effects monitoring" and is the evaluation of specific environmental exposures through measurements of the agent or its metabolites in biological samples. These results are compared to reference values known as biological exposure indices (BEI).

Environmental Monitoring is the evaluation of exposure by sampling of the workplace environment for known or suspected hazardous agents. These results are compared to the published threshold limit values (TLV or PEL).

Much of the concern in the workplace is related to increasing public awareness regarding lead as a public health hazard. There is a general recognition that as many as 4 million children in the United States are at increased risk of lead poisoning, and that children have a greater sensitivity to the harmful effects of lead than do adults. The incomplete development of the blood-brain barrier in the very young child increases the risk of lead entry into the developing nervous system until around 3 years of age. This can result in prolonged neuro-behavioral problems. Children absorb and retain more lead in proportion to their weight. Iron deficiency, a condition more likely to occur in young children, increases the absorption of lead from the gastrointestinal (G.I.) tract. Since lead freely crosses the placenta, the fetus is at greatest risk. In fact, it is uncertain just how low maternal blood lead should be to avoid any threat to the developing fetus. There is increasing evidence of some developmental effect on the nervous system in infancy or perhaps in utero of blood lead levels even below 15 microgram per deciliter (mcg/dl). Several studies of non-occupationally exposed adults have shown that blood lead levels of 20 Mg/dl is not unusual. The average blood lead level in the United States population is stated to be about 10 mcg/dl before the legislated removal of lead from gasoline which began in 1976. Even the 10 mcg/dl population average is about three times higher than the average level found in some remote populations, and may be as much as 30 times higher than the theoretical level calculated for pre-industrial humans.

Until recently, population screening was often done by testing for erythrocyte protoporphyrin, commonly assayed as zinc protoporphyrin (ZPP). Lead inhibits the ferrochelase enzyme, which results in iron being unable to be incorporated into the protoporphyrin ring. Zinc has a greater affinity for protoporphyrin than iron in the absence of ferrochelase and, hence, increased amounts of ZPP are formed. This ZPP reaches a steady state in the blood only after the entire population of circulating red blood cells has turned over. This takes about 120 days; hence, the ZPP level lags behind the blood lead level and is an indirect measure of long-term lead exposure. A disadvantage of ZPP screening is that it is not sufficiently sensitive at the lower levels of lead exposure. Data from the Second National Health and Nutritional Examination Survey indicated that 58 percent of 118 children with blood lead levels above 30 mcg/dl had ZPP levels within normal limits. While ZPP level is still useful, it is not considered

as good a screening test as the blood lead. The normal levels for ZPP are usually below 35 mcg/dl. There are diseases which may cause a falsely elevated level, so the results should be interpreted with clinical correlation and knowledge of the blood lead level.

Florida requires the reporting of children's blood lead levels of 15 mcg/dl or higher. In 1989, 28 states and the District of Columbia required reporting blood lead levels in children. Seventeen of these states required reporting blood lead levels of 25 mcg/dl or higher.

In 1991, the U.S. Department of Health and Human Services released a strategic plan for the elimination of childhood lead poisoning as a public health problem over a 20-year effort. During 1992, there was funding for an effort to build a national surveillance system for monitoring children's blood lead.

While we all recall the stories of the inter-city lead poisoning epidemic in toddlers when they teethed on the window facings of wood painted with lead paint, there was the notion that by restricting the lead content of paints, which occurred in 1977, the problem would be eliminated. There are, however, a number of other sources of lead exposure in children, not the least of which is lead that may be brought home on the garments and tools of parents from the workplace.

We also have a greater recognition of the potential for adverse reproductive effects in both males and females. These findings have influenced the development of lead standards with regard to surveillance recommendations.

There are more than one hundred different occupations in which workers may be exposed to lead. Some of these are shown in Exhibit 1. Not only may lead dust and lead oxide fumes be inhaled, but lead particulates may be ingested in food, beverage, and smoke. If a proper shower and clothing change is not provided, it is possible to bring lead home on the skin, shoes, and clothing, and inadvertently expose family members. When inorganic lead enters the body, it is not metabolized but is directly absorbed, distributed, and excreted. Inhaled lead is completely absorbed from the lower respiratory tract. Only about 10 or 15 percent of the lead ingested in the G.I. tract is absorbed, but this amount increases to as much as 50 percent in children and pregnant women and, if iron or calcium deficiency or fasting nutritional problems exist, then even greater quantities may be absorbed.

Exhibit 1. Some Sources of Lead Exposure

Auto Repairs
Battery Workers
Construction Workers
Gas Station Attendants
Glass Manufacturing
Lead Miners
Pipe Fitters
Plumbers
Policemen
Printers
Reconstruction Workers
Ship Builders
Smelters and Refiners

Once in the body, lead is distributed mainly in three compartments: the blood; soft tissues which include kidney, bone marrow, liver, and brain; and mineralizing tissues which are bones and teeth. About 95 percent of the total body burden of lead in adults is contained in the bones and teeth. About 99 percent of the lead in the blood is associated with the red blood cells (erythrocytes). The remaining 1 percent is in the plasma, where it is available for transport to other tissues. If the lead in the blood is not retained, it is excreted through the kidneys or through biliary clearance into the G.I. tract. The half-life of lead in blood is about 25 days, in soft tissues about 40 days, and in non-labile bone more than 25 years. After a single exposure, a person's blood level may begin to return to normal, but the total body burden will stay elevated. Since the body accumulates lead over a lifetime and releases it slowly, even small doses over time may cause harm. A major one-time exposure to lead is not necessary for serious lead poisoning.

We have been doing lead determinations at the Kennedy Space Center (KSC) for several years and, as shown in Exhibit 2, the numbers have significantly increased since 1986.

Exhibit 2. Number of Employees in Surveillance Program

Year	Number
1986	1
1987	4
1988	6
1989	6
1990	48
1991	60
1992	255 (to 11/10/92)

We looked at our 1992 data in mid-August and found that there had been 171 blood lead tests requested on workers. The average blood lead was less than 5 mcg/dl, with a range from 0 to 24 mcg/dl. With such a low average in a workforce presumed to have been tested because of some workplace exposure, we felt that we needed to more closely confirm that we were monitoring the right worker group. There has been in place for several years a close communication between the two divisions of our department. When a lead worker's physical examination was requested, the name of the worker, his employer, and the worksite information was sent to our Environmental Health Division for confirmation that:

1. This workplace had previously been identified as a possible lead exposure environment.

2. This worker had been identified as an employee in that environment and that environmental data had been obtained to confirm that there was a need to have this person entered into the Lead Surveillance Program.

Likewise, when requests were made to the Environmental Health Division for investigation or surveillance of a possible lead environment, that information was communicated to the Occupational Medicine Division along with a list of employees who were identified to be placed in the Lead Medical Surveillance Program. The concern intensified within EG&G because of the identification of new work in lead/paint removal and lead abatement projects.

The surveillance program at the Kennedy Space Center has shown several areas where lead exposure is above the permissible exposure level. These are sandblasting of leaded paint in semi-enclosed or enclosed areas, welding, and grinding of lead-painted surfaces in enclosed or semi-enclosed areas, cable splicing of lead sleeves inside manholes or under canvas enclosures, and target practice on partially enclosed outdoor ranges. Numerous other operations have identified lead in the environment, but at levels below the permissible exposure level.

The effort to get all possibly exposed workers into the surveillance program has brought the number to 255 workers through November 10, 1992. The results of the biomonitoring are shown in Exhibit 3.

Exhibit 3

1/1/92 to 11/11/92

255 Employees in Surveillance Program

Average Blood Lead	4.59 mcg/dl (0-24)
Average ZPP	20.38 mcg/dl (9-61)

In addition, 21 employees alleging possible exposure but who do not work in a lead environment have been evaluated. Those results are shown in Exhibit 4.

Exhibit 4. Testing of "Non-Lead" Workers

21 Employees

Average Blood Lead	3.43 mcg/dl (0-13)
Average ZPP	15.76 mcg/dl (10-52)

While we have no specific explanation for the fact that our worker blood lead levels are so low in our surveillance program, we generally attribute this to a combination of factors. The most important is probably that this particular area of Florida has very low natural exposure to environmental leads from drinking water, automobile emissions, etc.; that many of the buildings and rapid growth in the communities have occurred since the mid-1970's; and that our worker protection programs at the Space Center have been effective. We have looked closely at the laboratory where our blood lead and ZPP levels are determined. The same lab has been used for nine years. It has all of the appropriate certifications, and we are confident in the accuracy of the results.

Because of the low levels in our employees, we have suggested that in our Hazardous Paint Removal Program and Lead Medical Surveillance Program we use 25 mcgs/dl as the action level.

Our program has been written to indicate that employees will be notified of actual blood lead level if their blood lead exceeds 25 mcgs/dl, and the Environmental Health Division will be notified in order to evaluate the employees' work practices and other non-work sources of possible exposure. A medical examination and consultation will be performed on any employee found to have a blood lead exceeding this action level. It should be noted that the Occupational Safety and Health Administration (OSHA) Lead Standard recommends 40 mcgs/dl as the action level. We have also proposed that the medical removal level be established at 40 mcgs/dl (60 mcgs/dl in the OSHA Lead Standard), and that employees be considered for removal from exposure when their blood lead is above this level. Each case will be evaluated by the Medical Director or Deputy Medical Director to determine if the employee is at increased risk of material impairment to health from exposure to lead prior to a determination with regard to either removal or return to employment in a lead environment exceeding the action level.

We believe that this very conservative approach is justified by our knowledge of the low blood lead levels in our workforce, but an individual decision would be made on each employee with the recognition that our job not only is to protect the health of the employee, but also to assure that every employee can continue to work safely.

N94-16616

ONGOING RECOVERY BASIC INFORMATION TOOL (ORBIT)

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The Federal Drug Free Work Place Program (DFWP) has now matured to the point of being able to return employees to sensitive testing designated positions (TDP) after completion of treatment for their addiction. The known tendency of addicted individuals to suffer multiple relapses prior to their final recovery has resulted in several positive urine tests (relapses) occurring among those Federal employees who have already completed treatment and who have been returned to TDPs. The very real potential for further relapses occurring after additional employees return to TDPs will be a critical factor in the ultimate success of the DFWP and in the public's impression of the program's effectiveness.

In response to this concern, NASA has begun development of its Ongoing Recovery Basic Information Tool (ORBIT) instrument. The aim of the NASA ORBIT is to provide Employee Assistance Program (EAP) professionals with an advanced clinical tool which will be helpful in supporting recovery from substance abuse and which will allow more accurate determinations of when clients may be successfully returned to sensitive positions.

The NASA ORBIT is a comprehensive instrument which helps identify and quantify the client's progress in those areas which most relate to recovery and continued abstinence. The NASA ORBIT instrument elicits detailed information from the referral source about the employee's clinical course during treatment, involves the client in the management of his/her own recovery, and includes the EAP professional's ongoing clinical impression of the employee's developing strengths and remaining weaknesses. These factors are then weighted and combined by a computer program to develop a numerical "score" which indicates the relative degree of the client's progress and his/her potential for continued abstinence. The NASA ORBIT "score" will provide the EAP professional with a powerful new clinical tool to assist in determining the advisability of returning clients to sensitive positions. The NASA ORBIT will also provide documented evidence to support recommendations which must be made to management concerning the return of employees to TDPs.

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In addition, the range and thoroughness of the information elicited by the NASA ORBIT and the requirement to observe and record details of the client's clinical course will serve as a "prompt" for maintaining a high quality of care for these DFWP employees. Even without quantifications of the predictability of continued successful abstinence, we feel that the prompting function of the instrument alone will, in and of itself, greatly improve treatment standards and facilitate the recovery process.

The NASA ORBIT instrument consists of four major components. The first is completed by the treatment provider, and includes information about the client's medical history, past addiction history, and progress during treatment. The second component, completed by the EAP professional, consists of questionnaires relating to seven major areas identified as influencing recovery, including family environment, coping skills, vocational adjustment, personality factors, stress level, codependence, and leisure activities. The third component of the NASA ORBIT involves the client in helping to chart and monitor his/her own progress toward recovery. The fourth component is an individualized recovery and back-to-work plan in cooperation with the EAP professional, the employee, and the employee's supervisor.

The initial drafts of the NASA ORBIT instrument have been reviewed for content and clinical appropriateness by a panel of NASA EAP professionals. Interim revised drafts have again been reviewed and further revised. A selected group of EAP counselors has attended a three-day intensive training course in the use of the NASA ORBIT and are now field testing the instrument in their clinical practices.

We anticipate that twenty to thirty clients will have been assessed by the NASA ORBIT field test over the next six months. These clients will then continue to be followed for an additional year to determine successful abstinence. The information collected by the field test will be analyzed and compared to evaluate and improve the effectiveness of the items used for "scoring" the progress of clients and for predicting successful continued abstinence.

A case-control study will also be developed to identify and evaluate the determinants of successful abstinence among the population of Federal DFWP employees who have already completed treatment and who have been returned to TDP positions during the several years since the institution of the DFWP.

Data from the field trial and data from the case-control study will be analyzed to prepare the weighting scheme and to develop the final NASA ORBIT scoring formula. The revised instrument, the weighting scheme, and the scoring formula will then be Beta tested for reliability and predictability. Following successful Beta testing, the NASA ORBIT will be made available for use by all Federal agencies.

This instrument can also be tailored to include recover from alcohol addiction. A later effort will incorporate data from alcohol abusers in anticipation of the addition of alcohol testing to the DFWP. Also of interest is that we feel the core approach of the NASA ORBIT can be modified for use in the primary prevention of addictive behavior as well as during recovery.

PROGRAMS AND RESOURCES FOR CONTROL OF JOB STRESS IN THE FEDERAL WORKPLACE

N94-16617

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A couple of weeks ago, the American Psychological Association and the National Institute of Occupational Safety and Health held a conference in Washington, D.C. entitled "Stress in the 90's." At this conference the Office of Personnel Management (OPM) conducted a session on "Programs and Resources for the Control of Job Stress in the Federal Workplace." I am going to present an overview of that three-hour session and some related information from the conference. My discussion will cover:

- Stress Terminology and Models
- Selected Programs and Resources
- Evaluation Research
- Some Concerns About Our Progress
- Plans to Expand Our Efforts at OPM.

Stress Terminology and Models

At the conference and in my readings I noticed that there is still a lack of a clear and generally accepted definition of what we mean by stress. Not only does this cause methodological problems for our research efforts, but it also affects our ability to identify relevant issues and target populations. Our ability to design and integrate programs and resources is likewise hindered. As social scientists, however, we always seem to be struggling with definitions, concepts, constructs, and paradigms. Fortunately, I do not need to resolve this issue here, and I mention it only because I considered it when selecting programs and resources to include in this presentation.

I also noticed that there was an abundance of different models which served as a basis for the various theories and programs. Actually, I find these models helpful and have selected some more-or-less standard ones to reference my comments.

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Treatment Intervention: Primary, Secondary, Tertiary

A commonly used treatment intervention model presented at the conference included primary, secondary, and tertiary treatment interventions. The model was focused on workplace issues by defining primary intervention as addressing workplace demands; secondary intervention as addressing worker reaction, adjustment and accommodation to these demands; and tertiary intervention as addressing the worker in distress. Most Federal and non-Federal programs appear to be focused on secondary interventions. Looked at another way, most of our activity appears to focus on the individual worker; that is, on managing and reducing the symptoms of worker strain, both physiological and psychological.

Programs and Resources

Employee Assistance Programs (EAPs)

All Federal Agencies are required to have or provide access to Employee Assistance Programs (EAPs). Currently, approximately one-half of the EAP programs are in-house and the other half are run by contractors. Some Agencies pool their resources and utilize EAP cooperatives such as those established by the Cooperative Administrative Support Unit Program of the President's Council on Management Improvement. During Fiscal Year 1991, approximately 78,000 employees used Federal EAPs. Nearly all EAPs have some sort of stress management program and provide short-term treatment for stress-related problems. In a related initiative, since 1987 approximately 861,000 Federal supervisors and managers have been trained in assisting troubled employees and referring them to EAPs.

Worksite Health Promotion Programs

Worksite health promotion programs were initiated in the wellness movement of the 1980's to bring broader perspective to occupational health activities and to be more outreach and prevention-oriented. Regarding stress control, these programs operate in the realization of the beneficial connection between fitness, wellness, and stress.

NASA has one of the star health promotion programs in the Federal Government. Various other Federal agencies have less elaborate health promotion programs, some of which are reviewed in a 1991 Office of Personnel Management (OPM) publication entitled "Worksite Health Promotion." Another star program is the one at the Army Materiel Command in Virginia. Like NASA's program, the Army Materiel Command program uses comprehensive health risk appraisals, medical screening protocols, and fitness facilities. Medical data obtained on incoming participants is fed into an automated system which maintains an extensive research database and which provides same-day diagnostics including intervention needs. Many of the interventions are handled in once-a-week, 60-minute training sessions which range from four to eight weeks in duration. The Program Manager reports that more than 5,000 employees have participated in the Army Materiel Command Program.

Work and Family Movement

Many Federal Agencies are actively involved in the work and family movement. One of the goals of this movement is to reduce employee stress by helping them achieve a healthy balance between their work and family lives. The Office of Personnel Management has established a Federal Work and Family Program Center which provides policy guidance, training, and technical assistance to Federal Agencies. OPM has also established the Interagency Partnership on Work and Family. This partnership works to establish coordinated Federal efforts in this area. Many Agencies have established their own work and family centers to focus on their particular initiatives such as work and family counselors and support groups. The work and family counselors are separate from the EAP counselors and provide counseling, resource and referral services focusing on balancing work and family life.

Dependent Care Programs

Primary among existing work and family programs are the dependent care programs. The Federal Government currently has between 800 and 900 child care centers for its workers. Most of these are in the Department of Defense (DoD). The General Services Administration (GSA) has established an Office of Child Care and development programs to provide technical assistance. At least two Agencies, the Internal Revenue Service (IRS) and Environmental Protection Agency (EPA) are working on the establishment of adult day care centers.

Organizational Intervention Model: Control, Clarity, Conflict Management

An intervention model that applies to many of our recently developed organizational programs was discussed by Dr. James Quick at the "Stress in the 90's" conference mentioned earlier. This model focuses on organizational and work redesign interventions for reducing occupational stress. The three components are to:

1. Increase the amount of employee control over work and work environment. This has been a popular issue of late.

2. Increase the amount of clarity in the work environment, especially in terms of expectations, policies, communications, and consequences.

3. Improve the management of conflict so that individuals professionalize if not personalize their conflicts.

I think that the following programs fit this model.

Additional Programs

With supervisor approval, Federal employees may use a combination of annual leave, sick leave, and leave without pay for parental and family responsibilities. Currently, nineteen Federal Agencies have formal dependent care leave policies.

The employee option of flexible work schedules, Flexitime, is widely available in many Federal Agencies. We estimate that 54 percent of Federal employees with dependent care needs work under Flexitime schedules.

The Office of Personnel Management has designated an office to coordinate and encourage Agency use of job sharing and part-time employment programs.

My favorite program, however, is Flexiplace, which allows employees to work at home or at geographically convenient satellite offices. Federal Agencies have the authority to establish Flexiplace programs, and at least fourteen have done so. Participants in this program have specified stress reduction as one of its primary benefits.

Other benefits cited by the participants include reduced commuting time and more control over time and environment. Between 800 and 1,000 employees currently participate in Flexiplace. We have completed an evaluation of the pilot program and the results are very positive, especially job performance and employee morale.

All Federal employees have access to formal dispute resolution mechanisms such as filing grievances. Human resources professionals have realized that disputes handled in the traditional formal and legalistic fashion usually add more stress to an already stressful situation. This is because someone becomes a winner and someone becomes a loser. Various Agencies such as the General Accounting Office (GAO) have turned to mediation. A neutral person helps two or more individuals explore ways to resolve their differences and arrive at an agreement that does not focus on win/lose or right/wrong. Beyond that, however, employee relations counselors at the Los Alamos National Laboratory believe they have improved upon the mediation approach by using dual advocacy mediation. This type of mediation utilizes two counselors who meet separately with the conflicting parties. They prepare the parties for mediation, meet with each other to plan the mediation, participate in the mediation, and develop relapse prevention plans.

A few Agencies are working to reduce stressors associated with their physical work spaces. The EPA has a unit which focuses on indoor air quality and sponsors an International Research and Advocacy Society for reducing indoor air pollution. The IRS has a Research and Technical Advisory Unit which focuses on ergonomic factors and the establishment of a comfortable and injury-free work space.

Finally, when things get really rough, some Agencies have programs designed for crisis intervention, such as the Traumatic Incident Program at the IRS and a similar program at the Drug Enforcement Agency (DEA).

Evaluation Research

Shifting our focus to resources, I will mention a few research studies that you may find interesting.

- Last year, the National Center for Health Fitness published a comprehensive evaluation of the Army Materiel Command's Health Promotion Project. It

covers 2,700 participants and reports impact findings on health indicators, sick leave, productivity, and cost benefit.

- The Office of Personnel Management will soon publish its final report on the work-at-home component of the Flexiplace Project. The findings will include job performance, health impact, sick leave, operational costs, etc.

In addition, the Office of Personnel Management has recently published several other studies which bear on our topic. These include:

- S.O.F.E., a comprehensive survey of 32,000 Federal employees containing attitude, behavioral, and organizational information useful to considerations of employee stress.

- A study of the work and family needs of the Federal work force and a report on Federal EAPs.

- The General Accounting Office recently published "The Changing Workforce," which compares Federal and non-Federal work and family programs.

Concerns About Our Progress: Program Availability, Cost Benefit, Outcome/Efficacy, Symptoms and Individuals

As you may have noticed, many of the programs mentioned here are only available at some Agencies. Where programs are available, even Government-wide, they are often only available to a limited number of employees. We need to find and utilize ways to make these programs more broadly available, not just for the benefit of employees, but also for evaluation purposes. It really does not serve us well to talk about programs that are not sufficiently available to have the impact for which they were designed.

With this in mind, managers and health professionals alike would be more inclined to utilize programs if they had access to broadly accepted cost benefit

information as well as solid research findings supporting program effectiveness. Currently, such information is hard to find.

As I mentioned earlier, there have been some concerns about our tendency to focus on stress management and individual adjustment. Many social scientists believe that we should place more emphasis on primary interventions that involve preventive measures such as organizational, workplace, and job redesign. One school of thought holds that stress experts and educators may be doing more harm than good by teaching people to "manage stress." It points out that, despite the proliferation of such techniques, millions of Americans continue to die and American business continues to lose billions of dollars from stress-related illnesses. Indeed, the stress epidemic appears to be worsening rather than improving. This school of thought maintains that instead of encouraging people to manage stress we should encourage them and their employers to focus on and resolve the specific problems troubling them; that we should be ready to apply organizational, environmental, or other external remedies as well as traditional individual therapies.

OPM Plans: Ongoing Research, Organizational Diagnosis, System Integration, Consultation/Referral, Healthy Companies

Mindful of these concerns and of the growing magnitude of the workplace stress problem, the Office of Personnel Research and Development at OPM is planning to expand its efforts to assist Agencies to achieve and maintain health Federal workplaces. We have put together the following tentative plans and, additionally, are open to any Agency recommendations regarding our role in this effort.

To begin with, we would like to establish ongoing research using Government-wide perspective and taking collective advantage of existing databases. The research would focus on areas such as outcomes, cost benefit, individual and organizational performance, and program utilization. We would also like to develop an efficient and accurate approach to organizational diagnosis and follow-up which would include methods of projecting gains and losses associated with the level and quality of management response to indicated problems.

We have noticed a great deal of fragmentation in the Federal approach to the healthy workplace. This is true at both the Government-wide and Agency-wide levels. In some cases, we have numerous programs all working separately with little coordination of their activities. We would like to design and encourage the implementation of integrated programs that can benefit from a united effort. As we develop expertise, information, and Federal networks, we will provide consultation and referral services to organizations and Agencies.

We have already joined a public/private partnership called Healthy Companies, and we plan to assist them with a fairly ambitious research effort they are undertaking. This research focuses on qualitative assessments of policies, practices, cost benefits, and employee attitudes along fourteen identified dimensions of a health workplace.

Finally, in response to concerns expressed to us by EAP practitioners, we plan to work with our Federal Employee Health Care policy people to establish a closer working relationship between health care providers and our EAP practitioners. Along these same lines, we plan to see if there are ways we can improve the mental health benefits offered by our managed care providers.

N94-16618

EDUCATION & TRAINING OF PROFESSIONAL INDUSTRIAL HYGIENISTS FOR 2020

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57-80
p 22

Introduction

I greatly appreciate the honor of speaking to so distinguished an audience, members of which provide a unique leadership in techniques for creating safe and healthy working environments world-wide. The opinions I shall express here are based on experience in many projects and many countries and, hence, are of a generalized nature. They are not intended to be critical of practices in the United States which has led the world community for so long in the field of industrial hygiene. Nevertheless, I would advise that it is time to review today's organization of education as other countries are moving ahead in implementing professional education for those who will practice in 2020. In particular, I identify the urgent need for curriculum review and development to meet the changing demands on an industrial hygienist's basic knowledge and practical skills.

This presentation is based on a paper[1] presented at the 1991 AIH Conference, but I will start with four questions:

1. Are we giving sufficient attention to the professional education of industrial hygienists?

2. Are we achieving an adequate measure of control of hazards at the workplace?

3. What is our record of success in this field?

4. Do we have clear objectives, both as a profession and as individuals?

I will discuss some aspects of these but will not attempt to provide answers, hoping thereby to stimulate discussion and to conceal the fact that I do not know the answers myself. I will, however, follow this discussion with a review of the overall need for training in industrial hygiene, and will conclude with some comments about needed changes in the education of future professional industrial hygienists.

A dilemma we currently face is whether we are going to be specialists working on specific aspects of industrial hygiene or general practitioners in industrial hygiene. Is the day of the general practitioner over? I personally do not believe that we should follow the continuing trend towards even greater specialization among our cousins in the medical profession; rather, we should maintain and strengthen our general practitioner status. While there must obviously be specialists for specialist industries or processes, I am convinced that every working industrial hygienist should adopt some "hobby" interest to address and develop in depth while maintaining general practice over a wide range of our field.

To make an analogy, in vision there is a central focus where one sees an object in great detail. This represents the central object of our research interest -- the harder we look, the more we perceive. But all around this central area of developed attention there is a much larger area of peripheral vision where we do not see detail, but where we do detect movement to which we can then direct our attention and examine in detail. In the same way a practicing hygienist has to be aware of movements in the whole broad field of industrial hygiene while maintaining and developing his/her specialized knowledge in a relevant subject appropriate to that particular time and place.

One other matter we should consider before turning to the four questions is the difference between education and training. The former we consider to be academic and philosophical; a system often unresponsive to the immediate demands and which may indeed have a quite unique inertia (some 1,000 years elapsed after the Romans left Britain before Latin was dropped from the mainstream curriculum of British schools). Finally, outside of business schools, education is generally not a money spinner. Training, on the other hand, is generally considered to be vocational (hands-on). It is much more responsive to need and is often profitable -- particularly where mass production methods can be applied.

Development of training may follow the following pattern. First, a need arises and is recognized. If this is sufficiently serious, legislation may be enacted and sometimes a requirement for the licensing of practitioners is introduced. This clearly identifies a need for people with appropriate skills. The opportunity for a career as a licensed practitioner becomes recognized, and individuals see the advantage of investing resources (time and capital) in being trained. A short-term training program can then lead to almost immediate gain by working in the field defined by the legislation. A

prime example of this is seen in the licensing for asbestos removal and remediation which has led to the introduction of many training programs to meet the need for appropriately qualified persons. In the case of education, however, the student looks for benefits not next year, but in 10, 20, or even 30 years ahead. The education system is much slower in responding to changing demands of the marketplace, and to be successful must predict the qualifications needed for work many years ahead (if only to benefit from donations from prosperous alumni).

Education is essentially proactive; training is reactive. The following redefinition distinguishes the two methods of gaining knowledge and skill:

> *The principal objective of training is to meet the needs of the marketplace; that of education should be to shape the marketplace.*

Both education and training are, of course, required for the career development of the practicing industrial hygienist.

Q.1. Are we giving sufficient attention to the basic professional education of industrial hygienists?

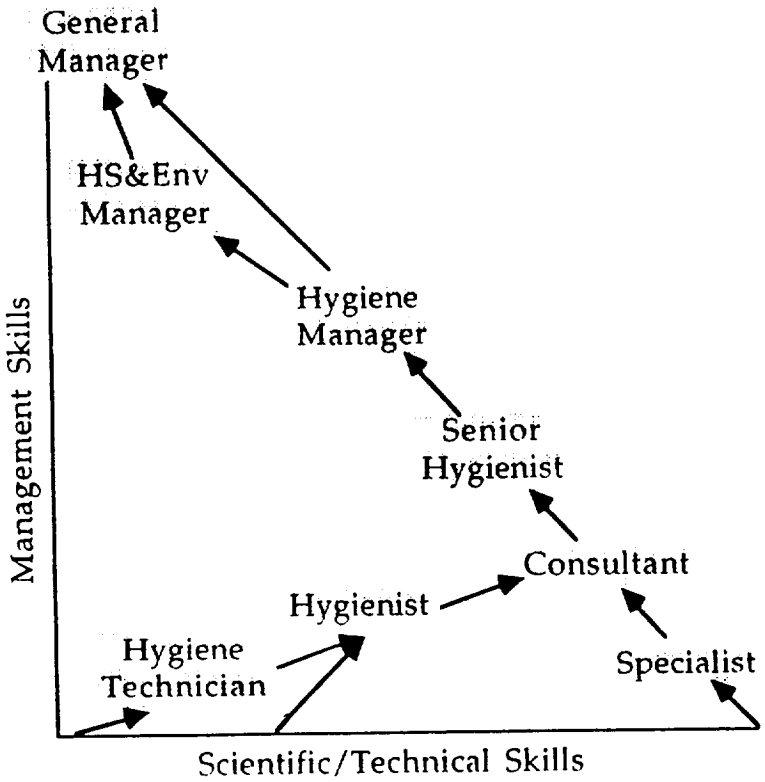
I have searched both the *AIHA Journal* and *Applied Environmental and Occupational Hygiene* and have found few papers on education in recent issues. There is an important paper by Terry Tredell[2] relating to education in the practice of industrial hygiene, but it largely concerns the role of mentors in the process. While many excellent professional development courses are presented at the Annual Conferences, papers on education itself appear to be restricted to the subject of AIDS and workers' training programs. It may be noted that my paper at the 1991 Conference was presented in the session entitled, "General Practice III - Regulatory Issues." Should education be regarded as a regulatory issue? I believe that regulation only becomes necessary where education has failed. Alternatively, how many papers on industrial hygiene needs have been published in education journals? I can claim just one.[3]

Outside of the United States the subject was reviewed in depth at an international meeting in Luxembourg in 1986 (published in 1988)[4] which was followed by a meeting in Geneva in 1989 with the title of "Approaches to Occupational Hygiene Training." An important follow-up meeting was again held in Geneva in 1991 with the title "The

Occupational Hygienist in Europe," but, in fact, it extended far beyond that region. At present in draft form, the report quotes eight functions from the previous meeting based on ILO Convention 161,[5] article 5, and lists four areas of required knowledge: supportive (background disciplines); related (toxicology, physiology, etc.); occupational hygiene (core subjects); specialization in depth (industrial ventilation, radiation protection, noise control, etc.). It is an important contribution to progress as it lists the necessary curriculum in considerable detail.

Another recent overseas article[6] that has some relevance to the U.S. scene was the report of the Joint Education and Training Committee of the British Occupational Hygiene Society and the British Institute of Occupational Hygienists. Exhibit 1 is taken from that paper:

Exhibit 1. A Model of the Occupational Hygiene Profession



At the top of the triangle is the General Manager who must have some knowledge of health, safety, and environmental matters to apply his management skills successfully. The Industrial Hygiene Manager and the Health, Safety, and Environment Manager must both have management skills, but are primarily the custodians of the scientific and technological knowledge on which the organization depends. The Senior Hygienist may

function with little management responsibility, but must have proactive skills in investigation and control of health hazards and carries some responsibility for decision making. That person may be responsible for directing the work of hygienists and hygiene technicians. The consultant brings specialist skills but generally has less responsibility for decisions and usually has none for implementation. The specialist is a person who has specific knowledge related to either processes or hazards, but who does not necessarily have the broad understanding needed for decisions of an executive nature.

This model provides a basis for identifying the education and training needs of both management and specialists in our field. In the past we have concentrated heavily on the scientific and technical role of the industrial hygienist, with inadequate consideration of the management skills also required in the senior positions.

Education needs can also be deduced from the recent publication, *Industrial Hygiene Work Force Characteristics: Employment, Education and Practice.*[7] Some of the key points of the 24-page report indicative of the present educational base of the profession are presented in Exhibit 2. The report itself should be consulted for full details, though some mysteries remain: How is training distinguished from education in #7? Perhaps training is what industrial hygienists give to others and education is what they receive themselves? If so, only 3.4 percent of their time is spent in education -- this represents only seven days per year. Is that enough? Those in general practice reported that 37 percent of their time was allotted to management issues, 30 percent to investigation, 10 percent to training, and 8 percent to laboratory/research activities.

Eighty-three percent were full-time, salaried workers, and 5 percent were full-time consultants. Sixty-three percent have doctoral or masters degrees. Fifty-one percent of certified industrial hygienists work in industry, 38 percent in consulting, and 29 percent in education. Educators appear to include the lowest proportion of CIH's. It is interesting to note that the average size of industrial hygiene staff is 10 in government service, 6 in consulting services, and 4 or less in employment classified as "elsewhere." Remarkably, 33 percent of industrial hygienists report that they work in organizations with less than 500 employees. Ten percent report to the Vice-President of the organization, and 18 percent to the Industrial Hygiene Supervisor.

Exhibit 2. Notes from *Industrial Hygiene Work Force Characteristics: Employment, Education and Practice* (Bureau of Health Professions, US DHHS July 1992)

This 24-page report contains a detailed analysis of responses to 28 questions and should be consulted for more complete details. The following notes identify points most indicative of the present educational base of the industrial hygiene profession.

1. 48% responded to the questionnaire which was sent to 7,000 members of AIHA in 1988.
2. 83% reported full-time salaried employment; 5% were full-time self-employed consultants.
3. 63% possessed masters or doctoral degrees.
4. 51% of those in industry were certified; 38% of those in consultancy; 29% of those in education.
5. Average salary of those qualified at B.S. level was $38K; at M.S. level $47K; at Ph.D. level $57K. (Note: Those with M.S. or Ph.D. in other disciplines averaged $5K more than above.)
6. 46% reported their work as general practice.
7. 37% of prime time was allocated to management; 30% to field investigation; 10% to training; 8% to laboratory/research activities; 3.4% to education.
8. 22% were employed in government agencies (average size of IH staff 10);
   17% were employed in consultancy services (average size of staff 6);
   7.1% were employed in education; 3.8% in laboratory/research; 38% in all identified industries, of which chemical and pharmaceutical led with 12% (average size staff of 4 or less).
9. 33% were in organizations employing <500 people; 69% in those employing <5,000; 96% in those employing <50,000.
10. 18% reported to industrial hygiene supervisor; 10% to vice president; <10% to other identified individuals.
11. 10% reported to personnel department; 9% to medical; 9% to environmental; 8% to safety; 8% to engineering/facility.

The financial incentive for education may be shown by average salaries of $38,000 for people with B.S. degrees, $47,000 for those with M.S. degrees, and $57,000 for those with doctorates, but this may be confounded by differing age distributions. Noteworthy is the fact that those who gained higher degrees in subjects other than

industrial hygiene earned $5,000 more than their peers. Does this suggest that we have some way to go to gain general recognition of industrial hygiene degrees?

At the 1992 Professional Conference, Constantin and Pennington[8] of DOE presented some first estimates of industrial hygiene education needs, and indicated that a more extensive study might be made in the future.

The conclusion must be that renewed effort is needed in the U.S. to identify present educational needs and to systematize systems for meeting future needs. Such a study as suggested by DOE would be of particularly great value to educators who should plan their programs some years in advance of their application.

Q.2. Are we achieving an adequate measure of control of hazards at the workplace?

A more specific question for the educator is, "Are we featuring control adequately in our curricula?" My experience of work in many countries, including the United States, indicates that we are not -- at least uniformly. There are certainly numerous large organizations in many countries with effective control programs, but many smaller operations fail. Even in the large units, quantitative evaluation may take an undue proportion of budget and control may be skimped. The present definition of an industrial hygienist reads:

> *An industrial hygienist is a person having a college or university degree or degrees, in engineering, chemistry, physics, medicine, or related physical and biological sciences who, by virtue of special studies and training, has acquired competence in industrial hygiene. Such special studies and training must have been sufficient in all of the above cognate sciences to provide the abilities:*
>
> *(1) to recognize adverse environmental factors and to understand their effect on people and their well-being*
>
> *(2) to evaluate, on the basis of experience and with the aid of quantitative measurement techniques, the magnitude of these stresses in terms of ability to impair people's health and well-being*
>
> *(3) to prescribe methods to eliminate, control, or reduce such stresses when necessary to alleviate their effects.*

Why does the industrial hygienist have responsibility only to "prescribe" methods to eliminate, control or reduce...? As a profession we are very active in recognition and evaluation, but often fall back on "more measurements are needed" when control is overdue. I would personally like to see a future definition of industrial hygiene read:

> *"The control of those factors in processes, environment, or work practices that may affect the health or well-being of people, or damage their environment."*

Reevaluation is required on the use and interpretation of animal experiments in occupational toxicology, and in the value of epidemiological studies of effects of exposure in small groups of workers. We can never determine the risks at the 10^{-6} level in processes where only 10 workers are employed; are we willing to accept that much higher risks will go undetected in small-scale operations? Perhaps a better economic and health return may be found in introducing control measures wherever reasonable doubt exists.

Q.3. What is our record of success in this field?

To set our record in context, I would refer you to the writing of E.S. Turner,[9] "The Road to Ruin. Shocking History of Social Reform," in which he shows clearly that some 100 years usually elapse between the first recognition of a problem and the time when society finally takes some action to control it. Even in that context, our performance cannot be considered outstanding, as illustrated below:

Lead

Year	
370 B.C.	Plumbism described by Hippocrates
50 A.D.	Pliny describes use of respirators for protection
1921 A.D.	ILO White Lead Convention (banned the use of white lead in paint)
1984 A.D.	OSHA Lead Standard (29 CFR 1910.1028)
1991 A.D.	$1 billion plan to reduce lead poisoning.

Neither Britain nor the United States ratified the ILO convention.[10] Today, the United States has the massive task of deleading its houses, while Britain faces a similar task to delead its drinking water system.

Asbestos

Year	
1900 A.D.	First asbestosis case was observed
1955 A.D.	First report of lung cancer risk
1986 A.D.	OSHA Asbestos Standard issued (29 CFR 1910.1101)
1991 A.D.	Asbestos trial in Baltimore set a precedent with 9,032 claims
1991 A.D.	Asbestos abatement in full swing.

The Hoover translation[11] of the work of Agricola (1556) suggests that lung cancer was recognized in asbestos mines as long ago as the 16th century -- though most miners did not live long enough to develop the disease.

Cotton

Year	
1854 A.D.	Novelist Elizabeth Gaskell describes death from byssinosis, and also exhaust ventilation for carding machines
1863 A.D.	First medical description of byssinosis
1930 A.D.	Incidence of byssinosis determined
1986 A.D.	OSHA Cotton Dust Standard (26 CFR 1910.1043).

Elizabeth Gaskell's novel[12] provides a vivid description of byssinosis symptoms and death. She also describes how employers would not install ventilation equipment because of cost, and that workers disliked it because it increased their appetites as they no longer chewed cotton dust. Appetites they could not afford.

Benzene

Year	
1897 A.D.	Santesson reports 4 fatal cases of aplastic anemia
1910 A.D.	Selling reports chronic occupational benzene cases in U.S.A. (leucopenia)
1913 A.D.	Koranyi's study stops treatment of leukemia with benzene
1931 A.D.	Alice Hamilton refers to lymphatic and myeloid leukemia
1938 A.D.	Renati & Vigliani report 10 cases of occupational leukemia
1946 to 1990 A.D.	TLV reduced progressively from 100 ppm to proposed 0.1 ppm (ACGIH)
1918 A.D.	Legge (UK) introduced xylene as safe replacement
1928 A.D.	U.S. substitutes toluene as solvent and rubber latex as cement.

Q.4. Do we have clear objectives, both as a profession and as individuals?

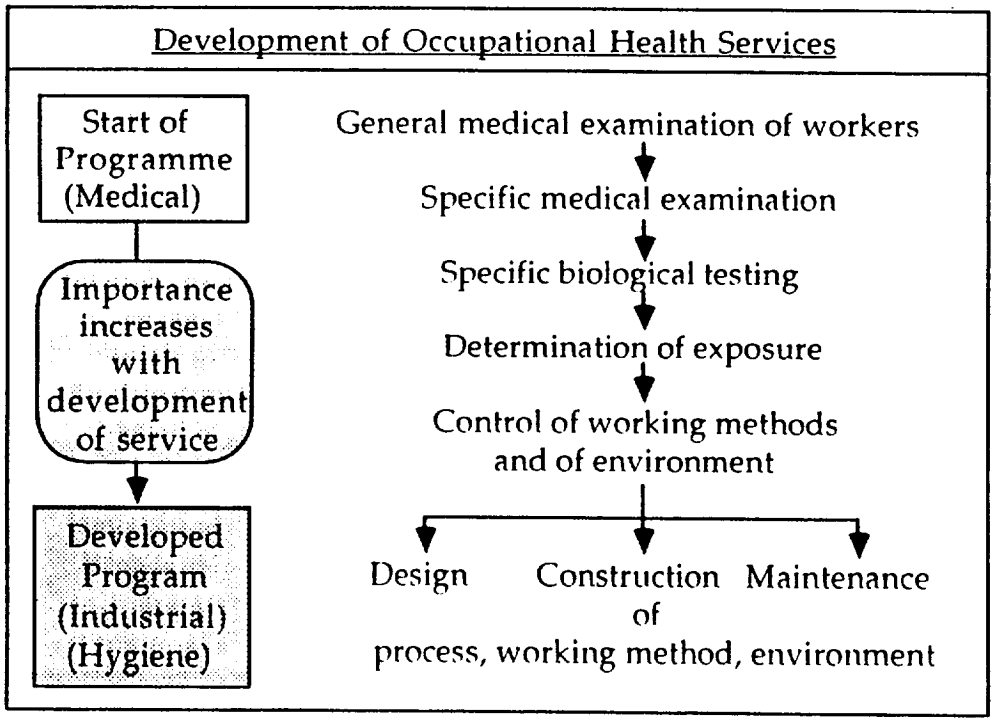
Mark Mikatavage[13] has proposed that the objectives should be to:

1. Reduce occupational skin disorders to 55/100,000 workers (that is, by 15%).
2. Reduce to 15% proportion of workers averaging > 85 dBA noise exposure.
3. Eliminate blood lead levels above 25 µg/dL.
4. Establish exposure standards in 50 states to prevent occupational lung diseases.
5. Reduce cumulative trauma disorder to < 60/100,000 (that is, by 40%).
6. Reduce hepatitis B infections to < 1250 (that is, by 500%).

Such objectives are beyond the reach of individual industrial hygienists and of the profession as a whole, although support should be given to those who have the power to introduce the system needed. (This is unlikely to be feasible outside a totalitarian country where the need is unlikely to be recognized.)

Industrial hygiene forms an integral part of occupational health, so it is appropriate to consider the normal pattern of development of the latter in any country. A generic structure is shown in Exhibit 3:

Exhibit 3



This could be a typical developmental process within a company or a country, and to provide the necessary skills a matching program to develop education and training is outlined in Exhibit 4:

Exhibit 4

Development of Program →			
Principal Activities			
Examination of workers	Examination of working methods and environment	Enactment and enforcement of legislation Social awareness	Design specification and standards setting
Principal Training Needs			
Occupational health physicians and nurses	Industrial hygienists and safety specialists Inspectors	Managers, workers and administrators Other health professionals	Design and service engineers

We then see a progress from (1) educating physicians and nurses needed at the primary stage of development, to (2) educating industrial hygienists, safety practitioners and inspectors needed to ensure better control of working practices and conditions, to (3) educating managers, workers, and administrators to meet their responsibilities and, finally, to (4) engineers required to design-out hazards, prepare specifications to ensure safe and healthy working methods and equipment, and to ensure that these conditions are maintained.

Overall, we need to look at the general training needs in health and safety with particular respect to industrial hygiene. An outline is presented as Exhibit 5.

Exhibit 5. Education and Training in Occupational Hygiene

Group - 1a Administrators with direct responsibility	
Introductory	2 week general course
Consolidation	1 year organization, technical, project
Continuing Education	seminars & short courses
Group - 1b Administrators without direct responsibility	
Introductory	2 week general course only
Group - 2a Employers' Associations - employers	
Weekend familiarizations	
Group - 2b Employers' Associations - specialists	
Introductory	2 week general course
Consolidation	1 year organization, technical, project
Continuing Education	seminars & short courses
Group - 3a Workers' Associations - specialists	
Introductory	2 week general course
Consolidation	centered on specific problems
Continuing Education	1-day course on specific topics
Group - 3b Workers' Associations - representatives	
1 week course + project	
Group - 4 Research & Trade Associations - specialists	
Introductory	2 week general course
Consolidation	supervised fieldwork
Continuing Education	as needed by developments
Group - 5 Line managers	
Introductory	2 day general course
Consolidation	1 week law & practice
Continuing Education	2/3 days every 3 years
Group - 6 Supervisors	
Introductory	2 day course
Consolidation	2 weeks practice & project
Continuing education	regular on-the-job briefing
Group - 7 Workers	
Introductory	during vocational training + job briefing
Consolidation	2 days job-related practice
Continuing education	whenever process or job changes
Group - 8 Professional occupational hygienists	
Introductory	6 month field familiarization
Consolidation	2 year MS (+ practice)
Continuing Education	revalidate every 5 years

Exhibit 5 (continued)

Group - 9 Occupational hygiene technicians	
Introductory	6 month field familiarization
Consolidation	3 months theory & practice
Continuing education	1 week development course every 2 years
Group - 10 Other health & safety professionals	
Introductory	2 week general course
Consolidation	to standards required by profession
Continuing Education	recent trends & at job change
Group - 11 Administrative & technical support staff	
Introductory	1 week general course
Consolidation	appropriate to needs
Continuing education	recent trends & at job change
Group - 12 Inspectoral	
Introductory	1 month legal & general
Consolidation	to professional standards or 1 year in first 5 years
Continuing Education	1 month every 3 years
Group - 13 Educational	
Introductory	2 week general course
Consolidation	training of trainers course after practical experience
Continuing education	2 weeks every 3 years or sabbatical in industry
Group - 14 Health & Safety related professional staff	
Introductory	in professional education
Consolidation	2 week general course + specialized courses
Continuing Education	recent trends
Group - 15 Political & media	
Introductory	national: 1 hour per year local: 1 hour twice per year
Consolidation	national occupational health and safety day or week
Continuing education	short courses/seminars/ briefings on current topics

Educational Needs of the Profession

Review of recent events in Britain and the European community highlights the essential need to gain public recognition of industrial hygiene as a professional field. In Britain, new legislation on the control of substances hazardous to health, rushed through to meet a deadline for a European Directive, provided an opportunity to introduce professional standards into legislation. We were not able to participate as there was no place for representation of a profession in the tripartite (government, employers, and unions) process of legislative drafting. However, although only a few in number, we gained some unofficial recognition, and now participate in discussions on how to introduce professional standards into compliance procedures.

A further opportunity to gain recognition was presented in the program for official recognition of core professions which may practice, without restriction, throughout the member states of the European community. In view of the very small numbers of professional industrial hygienists, this was not attempted. However, membership of one of the major professional institutions (medical, scientific, or engineering) offers this privilege.

On the drafting of relevant European Directives themselves, the profession has had little input. Texts were first prepared in offices of the Commission with little consultancy, and then reviewed by national delegations with little industrial hygiene representation. Discussion documents appeared with little time for comment and often provided outdated texts which were largely concerned with details of requirements rather than the principal structures themselves. (Some Directives were adopted even before the deadlines for submitting comments.)

Although this experience is not directly appropriate to the United States, similar key professional matters arise here. For example, will a CIH be permitted to practice industrial hygiene throughout the United States? If so, who else will? How do, or will, state licensing requirements (at present limited to asbestos and lead) impact the work of the professional?

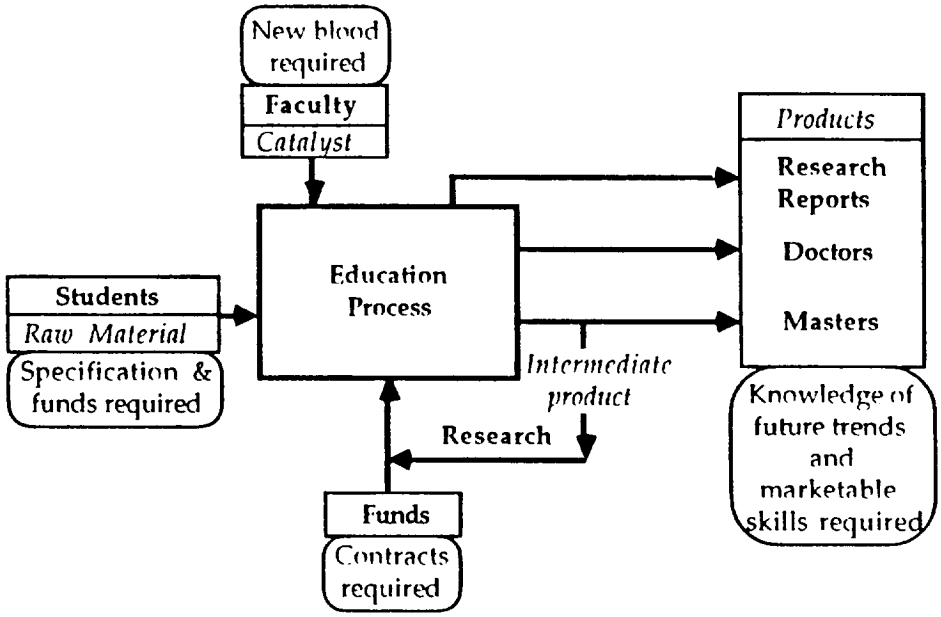
In the context of my subject, it is useful to consider professional education, per se, and I draw on the writing of Edgar Schein[14] who identifies three basic components of a professional education:

1. An underlying discipline or basic science component upon which the practice rests or from which it is developed.
2. An applied science or "engineering" component from which many of the day-to-day diagnostic procedures and problems-solutions are derived.
3. A skills and attitudinal component that concerns the actual performance of services to the client, using the underlying basic and applied knowledge.

The term "client" is here taken to include the employer where appropriate. It provides a reminder that the professional's first responsibility is to his/her profession -- even when he/she is the employee of some other person or organization. While Schein considers that these divisions constitute a hierarchy of application, justification, and status, they are also a useful tool to analyze essential components of education for the professional, and have been discussed elsewhere.[1]

Education is essentially a production process, and can be illustrated by analogy with a chemical engineering process (Exhibit 6).

Exhibit 6. Education Production Flow Chart

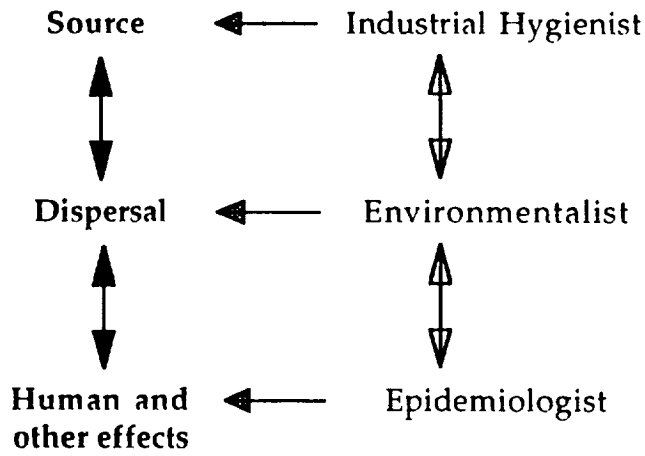


In recent years our profession has attracted students with principal interest in analysis, and the education they have received has enhanced their ability. In line with the flow chart shown in Exhibit 6 we should now be looking for students with a principal interest in synthesis to build on the profession's analytical knowledge. For this reason we should make careers in industrial hygiene attractive to those with engineering interests, and our courses should enable them to develop their abilities to synthesize systems of control. Although some now enter our profession with baccalaureates in industrial hygiene, I believe it preferable that the first degree should be in some traditional, rigorous subject -- preferably with technology/engineering as its core.

Our catalyst, the faculty, also needs consideration. Career attractiveness of teaching needs upgrading. Far too much time is spent by academics on writing research fund applications, and successful careers are too dependent on the weight of paper published. This does not make for committed responsibility to teaching or encourage good teaching practice. And why are only 19 percent of academic industrial hygienists certified professionals? These are rhetorical questions that need consideration and answers if our human products are to be of the quality required by the world marketplace.

I see the future position of the industrial hygienist with respect to fellow professionals as illustrated in Exhibit 7:

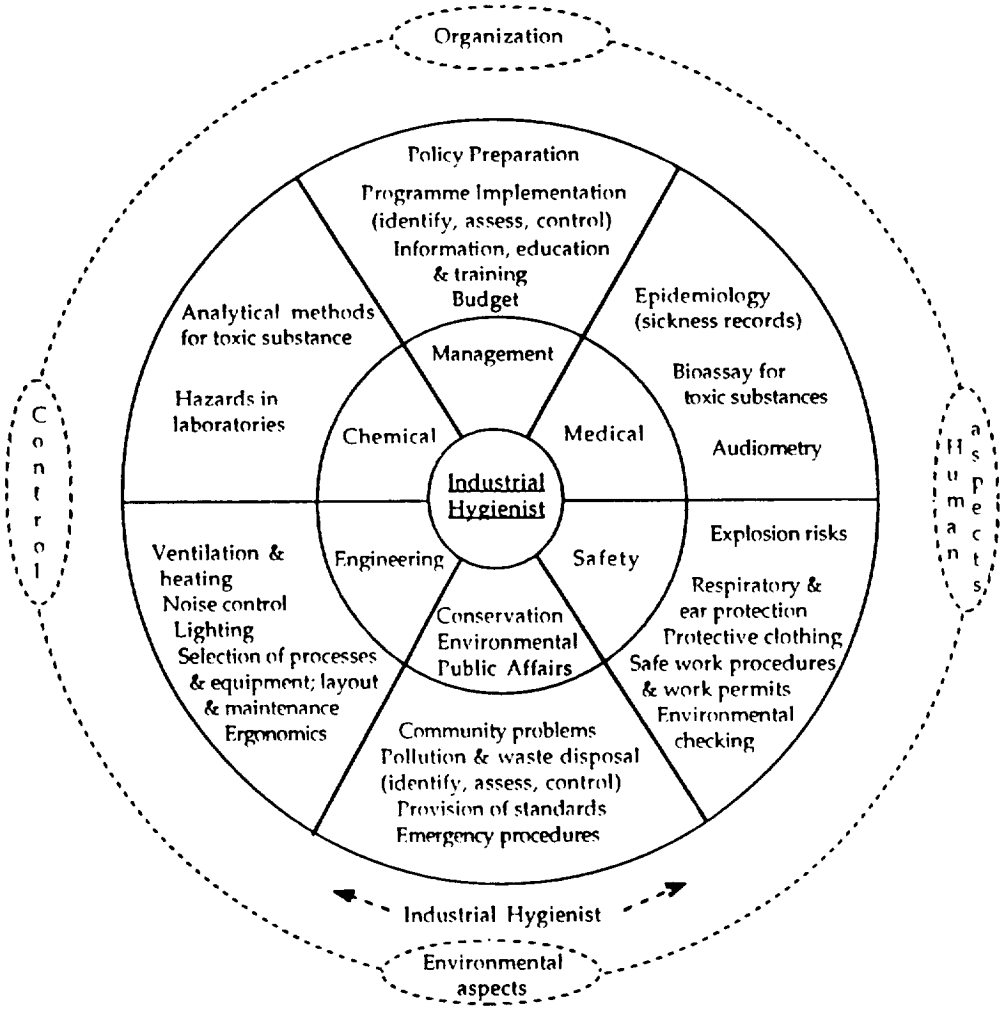
Exhibit 7. Future Relations With Fellow Professionals



This emphasizes the role of the industrial hygienist as the leader in course control rather than in "end-of-pipe" technology. He/she should be particularly skilled in such fields as toxic use reduction and specification of emission standards. This is already recognized in the field of noise where specification of noise levels for equipment purchase is routine, but needs urgently to be applied to permissible levels for release of air contaminants from equipment (e.g., grinders) or processes (e.g., welding). These would be comparable with specification of sound power level from mechanical equipment.

I believe the profession has been remiss in concentrating on the development of scientific skills at the cost of skills in human relations. Many students embark on their careers in industrial hygiene with no clear understanding of the organization of work or ability to communicate their knowledge to decision makers. The extent of the need to communicate is apparent from Exhibit 8, which puts the industrial hygienist at the center of the universe:

Exhibit 8. Industrial Hygienist's Contacts



The industrial hygienist must be able to communicate with, and persuade when necessary, all of these members of the organization in the languages of their own professions and specialties.

Curriculum

An outline of subject content needed for professional work is shown in Exhibit 9:

Exhibit 9

Academic Subjects
Applied physiology Epidemiology Occupational toxicology Statistical methods

Central to Occupational Hygiene		
	Hazardous Agents	
Identification information sources recognition practice Evaluation sampling & analysis biological indices Interpretation assessment hazard & risk Control process environment work practice	Chemical	Explosion Fire Toxicity Corrosivity Reactivity
	Physical	Noise & vibration Radiation - ionizing - non-ionizing EMF/ELF Thermal - stress - comfort Lighting
	Micro-biological	Bacteria Fungi Viruses Protozoa & their products
Field visits - field studies - laboratory studies Modelling - process/environmental/biological Information - data search, processing, recording, reporting		

Administrative Subjects
Communication Education & training Environmental issues Ergonomics & safety Legal aspects Management Practices Principles of public health Regulatory aspects

The extent of the education curriculum illustrated in Exhibit 9 indicates the problem of identifying the necessary depth of study in each facet, and matching this to the ability of the educational system to provide for this in two academic years at the masters level. It is evident that the profession should define the minimum knowledge required in essential core subjects and identify those facets that can be considered appropriate to specialized education and training. Acquisition of a masters degree in industrial hygiene cannot be considered the end of education. There should be a formal requirement for a period of apprenticeship or internship undertaken under the direct supervision of an academician.

At the Harvard School of Public Health, the new 20-credit intern course taken in the second year of the master's course is proving popular with students and judged beneficial by the faculty. For students, this should be only a start towards gaining competency in general practice, or experience needed to go forward to doctoral studies.

Continuing education is already recognized as a necessary requirement for sustaining professional qualification, and its increasing importance is indicated by the steady growth in number and quality of the professional development courses offered at annual conferences. Beyond the basic education required at the master's degree level for general practice of industrial hygiene, attention should be given to requirements for more advanced education to the doctoral level. To encourage discussion, some ideas on current research needs, which must form a platform for doctoral studies, are shown in Exhibit 10:

Exhibit 10. Immediate Research Needs on Hazardous Substances

Stage	Needed Research	To Study
Human	Pharmacokinetic modelling	Exposure to organ dose and BEI
Environment	Releases from sources	Release to exposure
Process	Toxics use reduction	Design to minimize presence of hazardous substances
Plant	Engineering design	Quantification of leakage Design to minimize release to environment

In the future, I believe the three development tracks summarized in Exhibit 11 will be recognized:

Exhibit 11. Three Development Tracks Beyond the Master's Degree

Development Track	Example of Further Training or Education
Management	MBA
Subject specialist	3 month to 1 year courses after Master's Degree
Research and advanced teaching	Doctoral studies

In conclusion, attention should be given to distinguishing between that fundamental knowledge which will be applied throughout a person's career and transient material representing "flavor of the month." Both are required; the first principally in education and the second principally in training. The dilemma facing the educator is to identify which apparent transient will become a permanent feature of professional activity in the medium and long term. A close watch must be kept on reviews of current practice and on predictions of future trends.[15,16] Development of techniques to maintain current awareness is an essential need for practitioners, and the current rapid development of information science is creating obsolescence in academic communities. The profession as a whole should be considering how it can best support educational organizations in teaching students cutting-edge information technology, even by such simple steps as putting journal contents on CD ROM and creating an electronic and updated version of the AIHA Guide to Technical Information Sources.[17] Today, what matters is not what you know nor who you know, but where you can find needed information quickly.

A final question that may help concentrate our thoughts on education for the future is, "How would Socrates have coped with multi-choice questions?" Or would he have been their author?

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PHYSICAL FITNESS AND THE *HEALTHY PEOPLE 2000* GOALS

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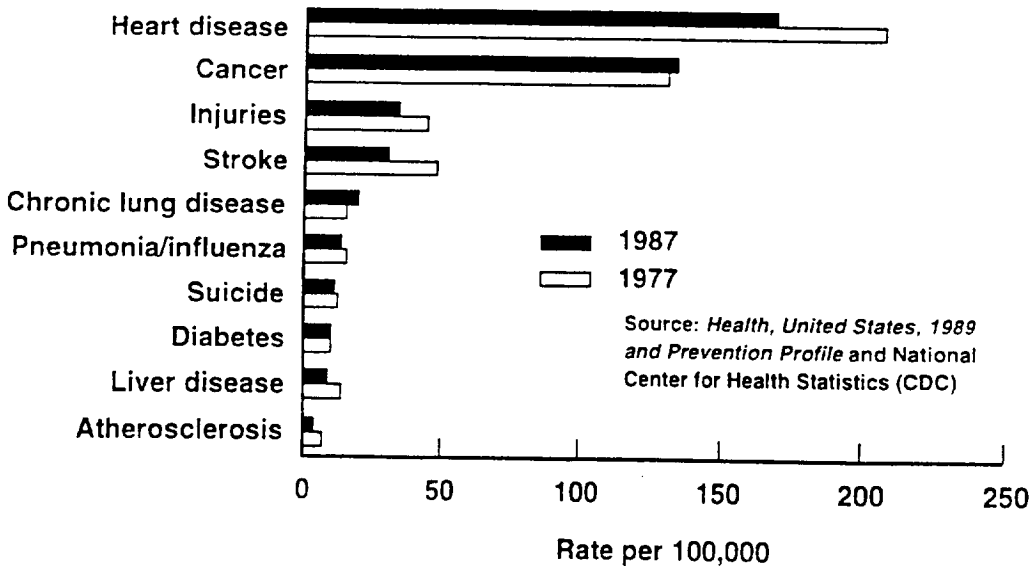
Healthy People 2000 is a statement of national objectives with the overall goal of improving American health.[1] It grew out of a 1979 report from the Surgeon General's Office which developed into a listing of objectives for the 1980's. In 1987, the U.S. Public Health Service of the Department of Human Services sponsored a national consortium with participation of all State Health Departments, the Institute of Medicine of the National Academy of Sciences, and the Secretary's Council on Health Promotion and Disease Prevention. Eight regional meetings heard testimony and studied documents from thousands of sources to determine how the nation's health was progressing and to develop tactics for improving health through the 1990's. They learned that over a 10-year period the nation's principal killers had become slightly less lethal (with the exception of cancer). Exhibit 1 shows the leading causes of death in the U.S. population.

Exhibit 1. Leading Causes of Death U.S. Population (Age Adjusted)



They also found that the cost of surviving a catastrophic health event had grown beyond the reach of all but the wealthy and near-wealthy (i.e., those with medical insurance and lots of extra savings). They learned that people of lower economic privilege either suffer and die early or the taxpayers pick up the medical bill.

Exhibit 2. Costs of Treatment for Selected Preventable Conditions

Condition	Overall Magnitude	Avoidable Intervention	Cost Per Patient
Heart Disease	7 Million With Coronary Artery Disease	Coronary Bypass Surgery	$30,000
	500,000 Deaths Per Year		
	284,000 Bypass Procedures Per Year		
Cancer	1 Million New Cases Per Year	Lung Cancer Treatment	$29,000
	510,000 Deaths Per Year	Cervical Cancer Treatment	$28,000
Stroke	600,000 Strokes Per Year	Hemiplegia Treatment and Rehabilitation	$22,000
	150,000 Deaths Per Year		

Recognizing that our deadliest and costliest diseases are preventable, *Healthy People 2000* released its goals and facilitating targets to promote healthy habits which help prevent disease and lower health care costs on a national level. The three broad

goals are to (1) increase the span of healthy life for Americans, (2) reduce health disparities among Americans, and (3) achieve access to preventive services for all Americans.

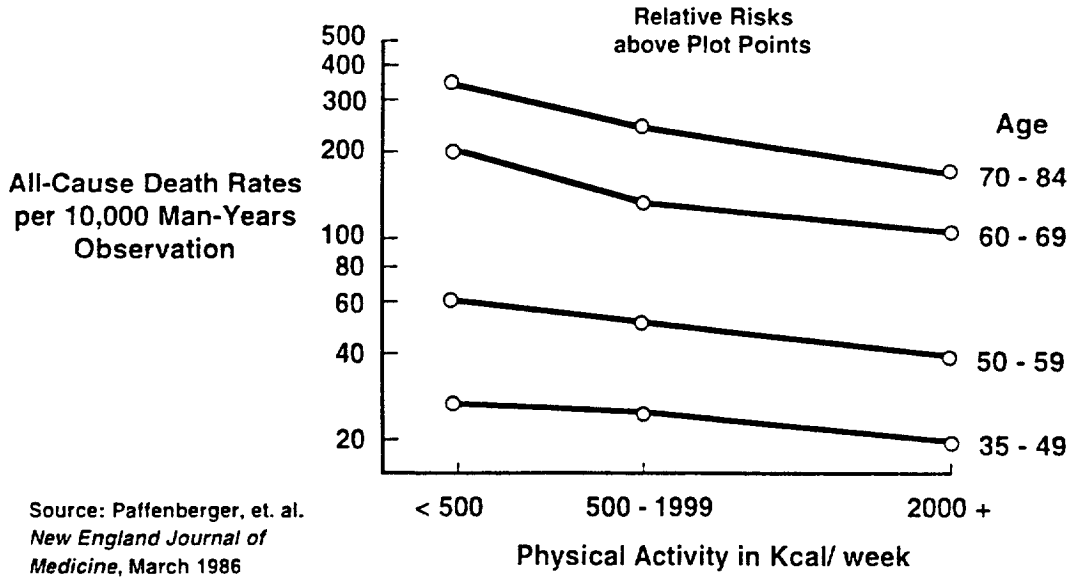
Plans for achieving the goals were defined by 22 priority areas with specific objectives to be accomplished by the turn of the century. These 22 priority areas are shown in Exhibit 3. It is highly informative that the first objective listed as top priority for health promotion is physical activity and fitness. The focus and purpose of this presentation is to explain the role of exercise and physical fitness in reaching the *Healthy People 2000* goals.

Exhibit 3. *Healthy People 2000* Priority Areas

- **Health Promotion**
  - Physical activity and fitness
  - Nutrition
  - Tobacco
  - Alcohol and other drugs
  - Family planning
  - Mental health and mental disorders
  - Violent and abusive behavior
- **Health Protection**
  - Educational and community-based programs
  - Unintentional injuries
  - Occupational safety and health
  - Environmental health
  - Food and drug safety
  - Oral health
- **Preventive Services**
  - Maternal and infant health
  - Heart disease and stroke
  - Cancer
  - Diabetes and chronic disabling conditions
  - HIV infection
  - Sexually transmitted diseases
  - Immunization and infectious disease
  - Clinical preventive services

Nutrition was the second listed priority. Without proper nutrition, health-related fitness is simply not achievable. A recent Gallop poll reported that physically active people have better nutritional habits than people who are sedentary. Non-use of tobacco is also the norm among the physically active. We published a study on exercise adherence in *Sports Medicine* in 1989[2] showing that smokers as a group rarely enroll in exercise programs, and the smoking habit was identified as the chief factor contributing to early drop-out. We also learned that, of the few smokers who continued exercising in the Johnson Space Center (JSC) Health-Related Fitness Program for a period of at least two years, 100 percent quit smoking. Other researchers report a lower incidence of alcohol abuse among physically active people. The physically active are also less afflicted by psychological stress. In fact, physical exercise at a moderate intensity is an effective therapy for lowering depression and anxiety. The point is that the influence exercise has on health is not entirely independent. It is also due to its interaction with other health habits: proper nutrition, abstention from tobacco, and moderate alcohol consumption. The long-term pattern of physical activity actually helps us live longer, as can be seen in Exhibit 4.[3]

Exhibit 4. Age-Specific Mortality (All Causes) Versus Physical Activity Levels



Source: Paffenberger, et. al. *New England Journal of Medicine*, March 1986

Dr. Paffenbarger of Stanford reported in a 1986 issue of the *New England Journal of Medicine*[3] that exercisers live longer than non-exercisers, and those who exercise a lot live longer than those who exercise a little. In other words, exercise reduces the mortality risk. The optimum effect is achieved from a weekly exercise regimen consuming 2,000 kilocalories or more, which is equivalent to jogging 15 to 20 miles or walking 20 to 30 miles per week. From this amount of exercise the projected life expectancy is increased by an average of two years. Two years may not seem like much unless compared with the projected increase in life expectancy with the eradication of cancer -- another two years.

Diseases and disorders related to physical activity include:

- Heart Disease
- Hypertension
- Diabetes
- Osteoporosis
- Cancer
- Stroke
- Chronic Backache
- Obesity

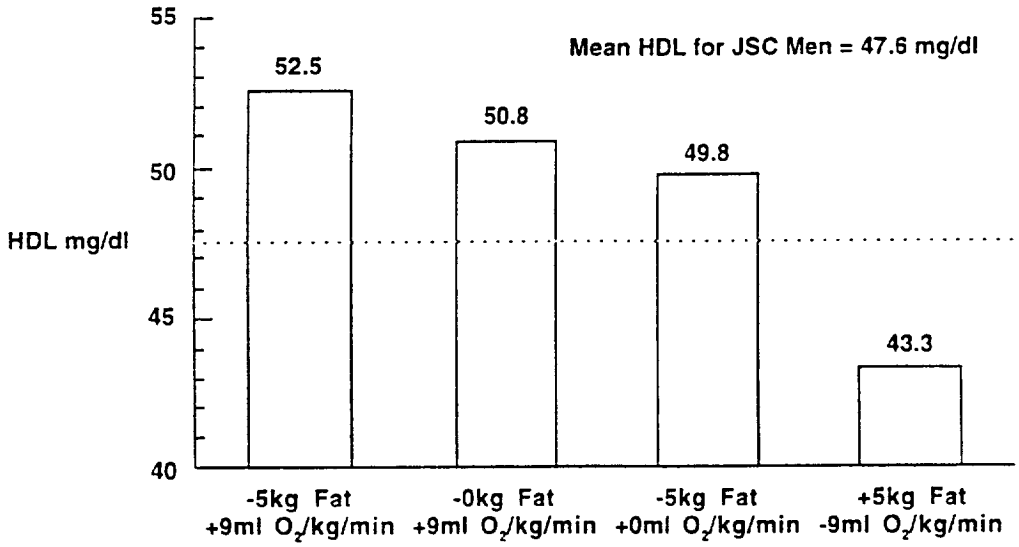
Exercise helps increase the life span by lowering the risk of fatal diseases. The first health status objective assigned by *Healthy People 2000* is the reduction of coronary heart disease by increasing physical activity. The value of exercise for preventing hypertension, stroke, diabetes, and osteoporosis and for rehabilitating the victims is also known. Recent research has also implicated physical activity in reducing the incidence of various forms of cancer. Workforce studies show that physical activity on the job reduces by half the incidence of colon cancer, and an impressive longitudinal study[4] on 5,300 women showed that a vigorous activity habit established early in life cut the risk of breast cancer by one-half and reproductive system cancer by two-thirds. The activity habit also lowers the risk of disability from chronic backache, which is the leading factor in industrial absenteeism. Also, exercise is the key to achieving and maintaining a healthy body weight.

The multifactorial nature of disease and the interrelationship of exercise with other factors makes it very difficult to explain the physiologic and biochemical mechanisms. Two exercise factors have been exposed in both cross-sectional and longitudinal research

as markers of health: aerobic capacity and body composition. Aerobic capacity is a person's maximal capacity for processing oxygen which is required for persistent work. Body composition is the division of body weight into fat and lean components and expressing them as a percentage (i.e., percent fat).

Several years ago we published a report[5] on the response of HDL-cholesterol to changes in aerobic capacity and fat weight (see Exhibit 5).

Exhibit 5. Increase Aerobic Capacity and Decrease Fat Weight to Optimally Increase HDL-Cholesterol

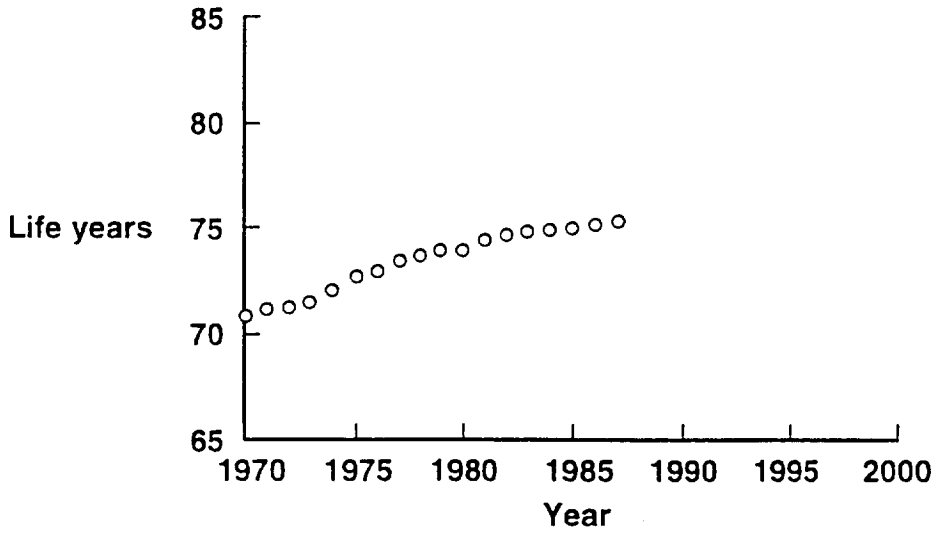


HDL-cholesterol is the cholesterol constituent with anti-atherogenic properties. The higher the HDL count in a sample of blood, the lower the risk for heart disease. Our study drew on data from men enrolled in the Health-Related Fitness Program at the JSC. On average, they were about 43 years old. Among other appraisals we measured their aerobic capacity, body composition, and blood lipids on two tests separated by about three years. The quantification of aerobic capacity is VO_2max, which expresses the volume of oxygen per unit of body weight that is consumed in the last minute of maximal effort test, normally performed on a treadmill. We learned that HDL-

cholesterol rises over time if (1) aerobic capacity goes up while fat weight remains constant, (2) fat weight goes down while aerobic capacity remains constant, or (3) fat weight goes down while aerobic capacity goes up -- this produces the greatest increase. It is important to recognize that a clinically significant change in HDL-cholesterol may require a dramatic fat loss and aerobic gain. Research shows that the beneficial change in HDL-cholesterol is delayed for about nine months and depends on exercise throughout that period equivalent to running 10 to 12 miles per week.

Life expectancy has gone up, due mostly to the eradication of lethal infectious diseases, reduction in the number of infant deaths and, more recently, the reduction in early heart attack deaths. Exhibit 6 shows life expectancy at birth of the U.S. population.

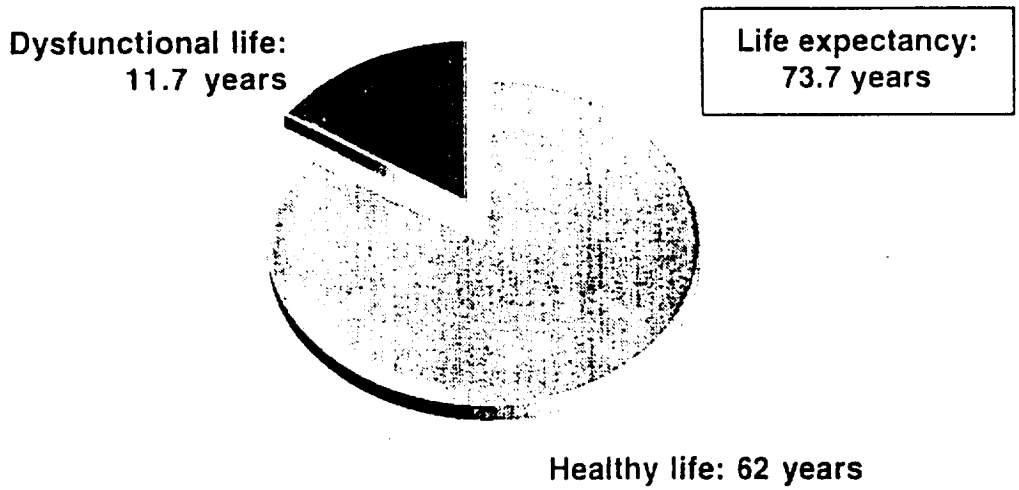
Exhibit 6. Life Expectancy at Birth, U.S. Population



Source: *Health, United States, 1989 and Prevention Profile*

Though medical science can claim a large share of the credit for keeping the average American alive longer, this does not mean that longer life is equated to longer health. People who reach age 65 can now expect to live into their eighties, but the last 12 years of remaining life are likely to be limited by sickness, weakness, and injury. Exhibit 7 shows years of healthy life as a proportion of life expectancy of the U.S. population.

Exhibit 7. Years of Healthy Life as a Proportion of Life Expectancy, U.S. Population (1980)



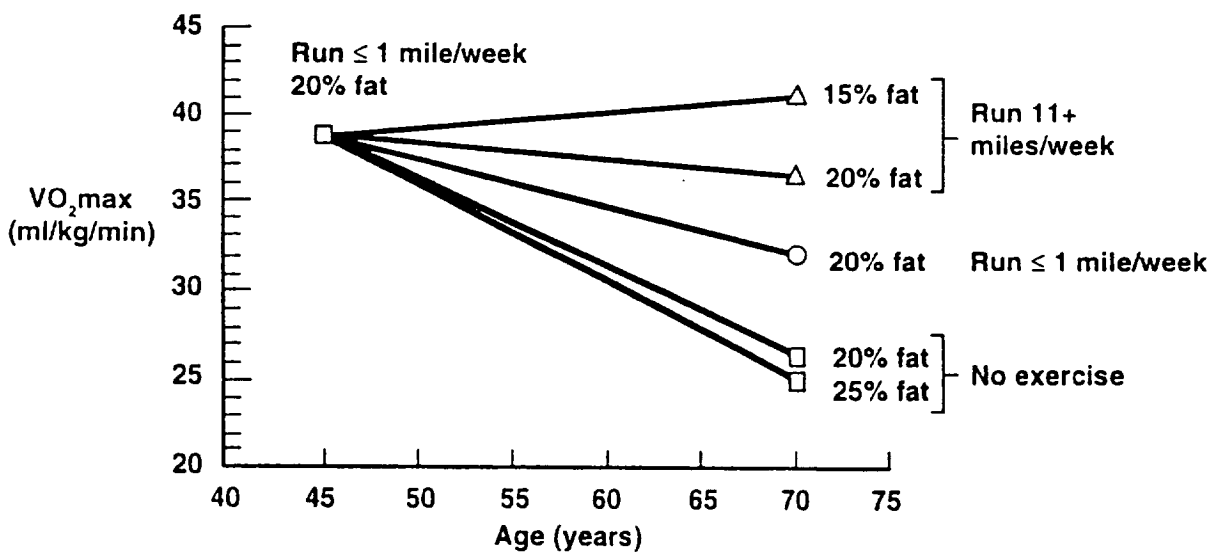
Source: National Vital Statistics System and National Health Interview Survey (CDC)

The elderly not only want a longer life, they also want to remain functionally independent. In other words, they want to retain the capacity to bathe and feed and care for themselves. To do this requires that they maintain their functional capacity. The most unarbitrary quantification of functional capacity is VO_2max. Agewise studies on VO_2max shows a yearly decline from about age 30. The average yearly decrease is

approximately 1/2 milliliter of oxygen per kilogram of body weight per year. Previous studies on aging and aerobic capacity failed to take other age-related changes into account. As a rule, people gain weight and become less active as they age. The decrease in aerobic capacity with aging may not be so much a function of the physiology of aging as the deterioration from reduced activity.

We recently completed an aging study on a large sample of men and women employed at the Johnson Space Center.[6,7] We developed a model for calculating the change in VO_2max with aging. Under the typical scenario of gradually reducing physical activity from age 45 to age 70, we found VO_2max falls at the rate reported in previous studies. However, if the activity level and body fat remain constant over 25 years, the VO_2max falls at only about half the rate (see Exhibit 8).

Exhibit 8. Change in VO_2max With Changes in Age, Percent Fat and Physical Activity



We also showed the potential for retaining or even increasing functional capacity over the years. The average weekly activity habit at age 45 for our employees was equivalent to exercising about 30 minutes or running about 1 mile. If that person increased the activity to an equivalence of running 11 or more miles per week, the functional capacity at age 70 would be about the same as it was 25 years previously. In fact, a higher functional capacity would actually be expected at age 70 if, in the process of increasing physical activity, the percent fat decreased.

The value of physical exercise is no secret. National polls show the American attitude toward exercise is quite favorable. Still, according to one poll, America's favorite activity is far from anything resembling physical activity. The national pastime is going out to eat, followed closely by watching television. The average American exercises very little if at all. Polls show that only about 22 percent of the adult population exercises at a moderate level -- equivalent to walking four or five times per week. No more than 10 percent of our adults exercise at an intensity, frequency, and duration appropriate for improving aerobic fitness. About 25 percent are completely sedentary.

The first priority of *Healthy People 2000* is to get the American population active. Exhibit 9 shows that our objective is to raise the level of moderate exercisers in the adult population from 22 percent to 30 percent by the turn of the century, double the proportion of vigorous exercisers from 10 percent to 20 percent, and drop the sedentary segment from 25 percent to 15 percent. To offset the potential for injury, at least 40 percent of the adult population should engage in strength and flexibility training.

Exhibit 9. Objectives for Physical Activity and Fitness

	Current	2000 Target
Moderate Activity (<60% VO_2max)	22%	30%
Vigorous Activity (>70% VO_2max)	10%	20%
No significant activity	25%	15%
Strength/Flexibility Training	No Data	40%

Under-exercise and over-nutrition share responsibility for the obesity epidemic in the United States. Some cross-population studies report that America is the fattest country in the world. By weight/height ratios, about 26 percent of adult Americans are overweight. By body composition standards, around 35 percent of the adult population is over-fat. Regardless of the standard used, the message is clear. The *Healthy People 2000* mission is to reduce overweight status to no more than 20 percent of the adult population (Exhibit 10). Additionally, by the year 2000 at least half of all overweight people should be on an exercise and diet program to attain healthy weight.

Exhibit 10. Objectives for Altering Overweight Status

	Current	2000 Target
Overweight Adults	26%	20%
Overweight People Combining Diet and Exercise to Attain a Healthy Weight	No Data	50%

What kind of exercise promotes fitness and health? The answer depends on an understanding of just what health-related fitness is. To the average person, physical fitness is a male professional athlete or a female New York model. Although these people may be healthy and fit, their principal activities -- sports and very low calorie diets -- do not promote fitness in a healthy sense. Perhaps the best way to explain health-related fitness is to define the operational components, each of which can be measured with objective tests and improved by specific activities. The components of health-related fitness are:

- Cardiorespiratory Endurance
- Body Composition
- Muscle Strength and Endurance
- Flexibility.

Cardiorespiratory endurance is the capacity of the heart, lungs, blood vessels, even the blood itself, to deliver oxygen to the muscles for relatively continuous work. It is quantified as VO_2max, and is positively related to the capacity for work and negatively related to risk for cardiovascular diseases.

Body composition is best described as the percentage of body weight which is fat weight. Over-fatness is a powerful and independent risk for a number of maladies such as cardiovascular diseases, cancers, diabetes, heat intolerance, and reduced physical performance.

Muscle strength is the capacity to exert force against resistance, and muscle endurance is the capacity to do so repeatedly. This component is more closely related to performance than to health. How strong one needs to be depends on what he/she does for a living and for fun. Lumberjacks and oil field workers must be strong or they will become injured on the job. Without adequate strength, weekend athletes will get hurt on the playing fields. For most Americans the ability to lift huge amounts of weight is not important for their jobs or for their sports. However, musculoskeletal injuries sideline more workers than any other single cause. Of major concern is the common backache which occurs most often because of weak and stiff muscles.

Put simply, flexibility is the capacity to bend, turn, twist, and stretch. This component is closely associated with muscle strength and endurance. Both components are highly related to physical activity and injury rate. Muscles that are not exercised shorten and stiffen. People who exercise the least suffer the more debilitating injuries, and they take longer to rehabilitate. A typical scenario work site involves a crew becoming progressively weaker over the years. Then the boss comes along and commands everyone to pitch in and clean up the storeroom for a short-notice inspection. The crew gets the job done, but a number of them cannot make it to work the next day due to the aches and strains that resulted from the weakness and stiffness that had progressed over time.

How can we become more fit and healthy without constantly being laid up by injury? For anyone who has not exercised for a long period of time, medical clearance should be obtained to ensure against latent disease or to adjust for anatomical or orthopedic anomalies. Screening by maximal treadmill test is recommended for people over age 40 or for those under 40 who have disease risk (abnormal resting ECG, smoking habit, obesity, high blood pressure, high serum cholesterol, diabetes mellitus, family history of heart disease).

A complete exercise program (Exhibit 11) describes a regimen for improving cardiorespiratory endurance, body composition, strength, and flexibility. The programs should overlap to reduce the injury risk.

Exhibit 11. The Exercise Program

- **Mode:** For each component, the plan takes into consideration the various modes of appropriate exercise.

- **Intensity:** Intensity describes the level of forcefulness needed to achieve a training effect while preventing over-stress.

- **Duration:** A description of how long each session lasts.

- **Frequency:** Frequency describes the number of sessions per week. If the exerciser hopes to improve without injury, the program must be regulated by gradual but steady progression.

Over the long term, the program should also allow for periods of rest.

Cardiorespiratory endurance activities must be the heart of the program because they offer the greatest contribution to health and longevity. Aerobic activities involve the large muscles of the body or they incorporate a number of large and smaller muscles working in synchrony. The activities should be done for lengthy periods at moderate to vigorous intensity. Controlling the intensity within the boundaries of safety and effectiveness is the most difficult task for the exerciser and the exercise director.

The American College of Sports Medicine (ACSM) recommends a training intensity between 60 percent and 90 percent of maximum heart rate,[8] or between 50 percent and 85 percent of VO_2max or heart rate maximum reserve (Exhibit 12). In June, 1992, we presented a paper at the Annual Meeting of the ACSM showing how difficult and potentially imprecise intensity regulation by VO_2 and heart rate methods really are in practice.[9]

Exhibit 12

ASCM Position Stand, Medicine and Science in Sports and Excercise (1990) Vol 22, p.265-274

The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults

AMERICAN COLLEGE of SPORTS MEDICINE
POSITION STAND

2. Intensity of Training: 60-90% of maximum heart rate (HRmax), or 50-85% of Maximum Oxygen uptake (VO_2max) or HRmax reserve.[1]

This Position Stand replaces th
Recommended Quantity and Qua
Maintaining Fitness in Healthy A

Increasing numbers of
volved in endurance trai ng and other forms of physical activity, and, th , the need for guidelines for exercise prescriptio is apparent. Based on the existing evidence conce ng exercise prescription for healthy adults and th need for guidelines, the American College of Sp s Medicine (ACSM) makes the following recomm dations for the quantity and quality of training f developing and maintaining cardiorespiratory fit ss, body composition, and muscular strength and durance in the healthy adult:

2. Intensity of training: 60–90% of maximum heart rate (HR_{max}), or 50–85% of maximum oxygen uptake ($\dot{V}O_{2max}$) or HR_{max} reserve.[1]

aerobic activity. Duration is dependent on the intensity of the activity; thus, lower intensity activity should be conducted over a longer period of time. Because of the

RATIONALE AND RESEARCH BACKGROUND

Introduction

The questions "How much exerci s enough," and "What type of exercise is bes for developing and maintaining fitness?" ar equently asked. It is recognized that the ter physical fitness" is composed of a variety of ch acteristics included in the broad categories of cardiovascular-respiratory fitness, body composition, muscular strength and endurance, and flexibility. In this context fitness is defined as the ability to perform moderate to vigorous levels of physical activity without undue fatigue and the capability of maintaining such ability throughout life (167). It is also recognized that the adaptive response to training is complex and includes peripheral, central, structural, and functional

A simpler means for controlling intensity is to use a scale of perceived exertion which was developed by Gunnar Borg[10] of Sweden (Exhibit 13). The scale ranges from zero to ten, and describes how a person feels when exercising aerobically. This subjective scale accounts not only for cardiorespiratory effort but also for muscle fatigue. The exerciser may use the scale to rate the overall feeling of exertion. The appropriate range is between the ratings of 4 (Somewhat Heavy) and 7 (Very Heavy), which is equivalent to 65-80 percent VO_2 max.

Exhibit 13. Rating of Perceived Exertion Scale (RPE)

0	Nothing at all
0.5	Extremely Light (just noticeable)
1	Very Light
2	Light (weak)
3	Moderate
4	Somewhat Heavy
5	Heavy (strong)
6	
7	Very Heavy
8	
9	
10	Extremely Heavy (almost max)
●	MAXIMAL

The RPE scale is used to relate how you feel when exercising aerobically. The shaded area represents the aerobic training window (i.e., between 65 and 80% of VO_2max). Scale was developed by and is the courtesy of Dr. G. Borg, Department of Psychology, University of Stockholm, Sweden.

Many activities are popular for improving aerobic capacity. For optimal benefits they should be done within the proper zone of intensity three to six times per week for durations ranging from 20 minutes to an hour. Running or jogging (at the rate of 12 minutes per mile or faster) is perhaps the most efficient for improving aerobic capacity and burning calories. During inclement weather the treadmill can be used for running or for another popular mode -- walking. Walking is particularly appropriate for people of low fitness. Because walking consumes about 25 percent fewer calories per mile than jogging, the duration of the workout has to be lengthened to get a similar benefit. For example, a person running at 10-minutes per mile will consume about 300 to 350 kilocalories in 30 minutes. To get an equal caloric effect, the walker, moving at 15-minutes per mile, will have to continue for a full hour.

The workload on a stationary bike can be adjusted to an appropriately vigorous intensity. Outdoor biking is a different story. Traffic conditions in the city make it very difficult to maintain an appropriate average intensity on a bicycle; therefore, the ride may have to last up to 90 minutes.

Swimming is another popular aerobic training mode with limitations similar to walking and biking. Research on swimming programs reveals a very poor fat-loss record. The problem may be a combination of the cooling properties of the water, less stressful horizontal position, and smaller muscles used as prime movers (i.e., the arms). For this reason, weight loss programs in the water may require at least 45 minutes per session.

The stair climber has become the most popular apparatus in the exercise club. The potential of this machine for aerobic training and weight control is seldom attained. Users tend to hold onto the rails, reducing much of the cardiovascular strain. Also, many users lean on the rails, extending their rumps, which alters the biomechanics of the activity so as to actually increase hip size by muscle hypertrophy -- the opposite goal for most exercisers.

Aerobic dancing is a very popular mode with great potential. However, research on weight loss by this means has given the activity very poor marks. The problem appears to be in the number of sessions per week and the duration of the aerobic activity phase. Most classes are scheduled to meet three days per week for an hour. After all of the stretching and strengthening activities, per class the aerobic training normally

averages no more than 20 minutes. The lesson for aerobic dancers is to select an instructor who will keep the class moving aerobically for at least 30 minutes and to attend the class three or four times each week.

The image of the ideal physique is thin, thin, thin. Fatness standards are too often influenced by Hollywood and Madison Avenue, which promotes a body image closer to emaciation than health. Guilt for overemphasizing leanness might be shared by the fitness industry. For example, a number of fitness textbooks and manuals encourage a body fat range for women between 15 percent and 26 percent. In view of the potential for error when measuring body fat (about 3.5 percent for the skin-fold method), a woman measured at 15 percent could be dangerously close to under-fatness, and there is no scientific or medical evidence of increased disease risk at 26 percent. As a general guide, the acceptable range of relative fat for men is between 10 percent and 22 percent; the range for women is between 18 percent and 32 percent. The standard for a man is about 15 percent and about 25 percent for a woman (see Exhibit 14). These are health standards. Athletes and movie stars may have leaner standards.

Exhibit 14. Relative Fatness

	Men	Women
Essential	3-5%	11-13%
Standard	15%	25%
Over-fat	20%	30%
Obese	25%	35%
Acceptable Range	10-22%	18-32%
Under-fat	3-7%	10-18%

People lose weight by expending excess calories in exercise, eating fewer calories than needed for current weight, or by a combination. Several years ago, a woman weighing 140 pounds with 35 percent fat came to the JSC Health-Related Fitness Office. Her goal was to lose 19 pounds. Her 20-year high school reunion was three months

away and she wanted to weigh the same as she had on the day of her graduation. She hoped to lose the weight by exercise alone -- with no dieting. She was capable of jogging 90 minutes per week (which is pretty good). We calculated that it would take 1.54 years for her to exercise away the 66,500 kilocalories contained in her excess 19 pounds (see Exhibit 15).

Exhibit 15. Weight Loss Through Exercise -- No Dieting

Scenario: 140 lb woman, 35% fat, needs to lose 19 lbs to reach her desired level of 25% fat	3500 Kcals/lb of fat x 19 lbs fat 66,500 Kcals must be expended in exercise
Jogging a 12-minute mile: burns 9.19 Kcals/minute	$\frac{63.64 \text{ kg} \times 8.66 \text{ METS}}{60 \text{ kg}} = 9.19$ Kcal/minute
burns 276 Kcals in 30 minutes	9.19 Kcal/min x 30 = 276 Kcals
burns 828 Kcals/week at 3x/week	276 Kcals x 3 = 828 Kcals
Weight loss = 19 lbs in 1.54 years	$\frac{66{,}500 \text{ Kcals}}{828 \text{ Kcal/week}} = 80.31$ weeks = 1.54 years

Since the reunion was only three months away, the exercise-only option was not acceptable. She decided to go on a crash diet. With 1,124 kilocalories per day, she lost the 19 pounds in three months. An assessment of her body composition revealed that she dropped from 35 percent fat to 27 percent fat, but the weight she lost was not all in the form of fat tissue. She lost 16 pounds of fat and 3 pounds of muscle (see Exhibit 16).

Exhibit 16. Weight Loss Through Dieting Only

1124 Kcal/day diet for 12 weeks to lose 19 lbs				
	Weight (lbs)	%Fat	Fat Weight (lbs)	Lean Weight (lbs)
Pre	140	35	49	91
Post	121	27	33	88
Change	-19	-8	-16	-3
Quits diet and 12 weeks later...				
	140	37	52	88
Change	+19	+10	+19	0

- Resulting Condition
  - muscle is lost in crash dieting
  - creeping obesity
  - reduction in strength

Metabolizing muscle tissue for energy is a common result of excessive caloric restriction. On the day of the reunion this woman began to put the weight back on, and 12 weeks later, 24 weeks after starting her diet, she returned to our program again weighing 140 pounds. But in terms of relative weight she was no longer the same person. She was like the man who at age 55 bragged of weighing the same as at age 20, but whose waist size had grown from 31 to 38 -- his chest fell. An assessment of body composition showed her relative fatness had risen to 37 percent (2 percent above the original). All of the weight gain had been in the form of fat. Because she had not exercised, she did not regain the lost muscle tissue. She failed to recognize that muscle weight cannot be gained by eating muscle; increasing muscle requires exercise. The overall result of her crash diet was that it made her fatter (37 percent versus 35 percent) and weaker (less muscle means less strength). Finally, she went on a combination program of exercise (jogging about 90 minutes per week) and dieting on a moderately restricted 1,500 kilocalories per day (note the previous diet had been 1,100 kilocalories per day). In 12 weeks she lost 19 pounds and dropped to 25 percent fat (see Exhibit 17). Interestingly, she lost 22 pounds of fat and regained the 3 pounds of muscle.

Exhibit 17. Weight Loss Through Exercise -- Plus Dieting

For 140 lb woman to lose 19 lbs in 12 weeks requires:
90 min/week jogging (12-minute mile)
1500 kcal/day diet

	Weight (lbs)	% Fat	Fat Weight (lbs)	Lean Weight (lbs)
Pre	140	37	52	88
Post	121	25	30	91
Change	-19	-12	22	+3

Muscle strength and muscle endurance are ordinarily more a concern for athletics than for health. Success in American sports is almost always related to the power and speed accrued from strength. However, the capacity to bench-press 300 pounds has no relation whatever to functional health. Nevertheless, many health conscious participants need some strength training, particularly for the upper body, because they commonly

become leg athletes. That is, they build up their legs by running or biking, but become derelict in the upper body from disuse. Weight-lifting is the most efficient means for improving strength. Many programs are effective. The workout plan should include a rest period of about a day following a vigorous bout. Maximal gains in strength have been reported on programs of three days per week, although similar though slightly lower gains were reported in twice-weekly programs. Abdominal muscles deserve special attention because weak abdominals increase the potential for back injuries. The bent-knee curl-up with the feet unsupported is the recommended calisthenic. Bending the knees removes the tendency to arch the back (a potential for injury), and keeping the feet unanchored places all the work responsibility on the abdominals. When the feet are anchored most of the effort is transferred from the abdominals to the thighs.

Exercise programs, especially those practiced to excess, bring some risk of musculoskeletal injury. One way to lower the probability of straining or tearing muscles and connective tissues is to retain their suppleness and pliability. This is done by stretching. Perhaps the easiest and most convenient technique is to gently stretch the muscle and hold the stretch statically at the point of tension for about 30 seconds.

For optimal improvements in cardiorespiratory endurance and body composition, aerobic exercises should be performed at about 70 percent of maximal capacity. The minimum frequency for aerobic conditioning is three days per week, but appreciable fat loss is not achieved unless the program is done at least four days per week. For increasing aerobic capacity the workouts should start at about 15 minutes to prevent injuries and progress to 45 or 60 minutes. The minimum duration for fat loss is 30 minutes and, depending on the intensity, the duration might even exceed an hour. It is important to appreciate that the often-quoted prescription of 20 minutes of aerobic exercise three days per week is the *minimum* for a beginner. Fitness will not progress unless the program progresses.

A well-rounded program also includes some weight training done two to three days per week for 30 to 45 minutes. A manageable program for the beginner involves jogging Monday, Wednesday, and Friday, and lifting weights Tuesday and Thursday. To maintain flexibility and reduce the chance of musculoskeletal injuries, a daily stretching routine should be followed. At a minimum the exercised muscles should be stretched for about 30 seconds following an aerobic workout. Exhibit 18 is a chart of recommended physical exercise.

Exhibit 18. Recommended Physical Exercise

Fitness Component	Exercise Type	Intensity	Frequency (times/wk)	Duration
Cardiorespiratory Endurance	Aerobic	50-85% VO_2max	3 - 5	15-60 Min.
Body Composition	Aerobic	50-85% VO_2max	4+	30-60 Min.
Muscular Strength	Weight-Lifting and Timed Calisthenics	60-80% 1RM	2 - 3	30-45 Min.
Flexibility	Static Stretching	Tension	Daily	30 Sec. Ea.

Exercise is really not complicated. The key is doing it. We published an evaluation of the Employee Wellness Program at JSC in *Aviation, Space and Environmental Medicine.*[11] The evaluation showed the program was indeed effective for improving fitness and health, but only for those who followed the program. The benefits of exercise come only to those who exercise.

Healthy People 2000 has given us the mission of getting more Americans to exercise at a level that is beneficial for health. In our efforts to persuade the sedentary population to take action we should not make the mistake of saying that exercise is easy. Sometimes exercise is downright hard. Developing the habit of exercising persistently over the weeks and months and years is certainly not easy. It is not easy for sedentary people to develop an exercise practice into a lifetime habit. Getting everyone to do it -- now that is hard.

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N94-16620

SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)

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511-55
P. 7

The scientific community now considers that life, including intelligent life, is widespread in the universe. The big question we face is: To what degree are we now capable of conducting searches for that extraterrestrial life, especially intelligent life?

I would like to start with a little background. We all see the world in different ways. From about the year 200 A.D. for some 1200 years we believed that the sun and stars revolved around the Earth and the Earth was the center of everything. Then along came Copernicus (1473-1543), Tycho Brahe (1546-1601), and Galileo (1564-1642), and the great Copernican Revolution of the 1500's and 1600's when it was proved that the sun, not the Earth, is the center, and the planets revolve around the sun. We are now looking at the Earth and its relationship to the universe in yet another new way.

Our galaxy is called the Milky Way. The diameter of the galaxy is 125,000 light-years from edge to edge. In other words, if one shines a light at one edge, it will take 125,000 years to cross. There are about 400 billion stars in our own galaxy alone and an estimated 100 billion galaxies. We all know that the sun is one of the stars in our galaxy and that our galaxy is only one of billions of galaxies. How much thought have you given to the fact that there may be millions and perhaps even billions of other intelligent beings and civilizations scattered throughout these galaxies? This is the theory today.

Life is very old and the story of evolution is well known. Fifteen billion years ago there was the so-called "Big-Bang." Then the galaxies, stars, and planets were formed. All of the planets of our solar system were born at roughly the same time as our sun, which is a star. Then the process of chemical evolution began; small molecules, the building blocks of life, condensed to form polymers which turned into proteins and sugars and fats and all the other substances, including DNA, which make up life -- with the origin of life occurring some four billion years ago here in this solar system on this planet called Earth. We, of course, are the descendants of this process which began so long ago. During the two and one-half billion years of unicellular life through the

Precambrian era, the evolution of incredibly complex biochemical mechanisms continued within cells. Finally multicellular life developed, and then more recently intelligence, the great break, which is cultural evolution superimposed on biological. With this came the rise of civilizations, the appearance of science and technology and, finally, our ability to make in our heads models of this entire process to study the whole question of life in the universe. This is one of the things that makes us human and which, as far as we know, dolphins, elephants, whales and chimpanzees do not have -- the ability of humans to study life in the universe or anything else with abstract models of the type which allow us to create hypotheses to test.

Given that there are 100 billion galaxies and each galaxy has possibly 1,000 billion stars, the question is whether the occurrences described above have happened elsewhere -- are there extrasolar planets? We haven't seen any directly, but the answer seems to be yes. Over the next few years there will be announcements of increasing evidence for the existence of extrasolar planets. The current hypothesis is that the natural consequence of the birth of a star is a retinue of planets. Has the process of chemical evolution and origin of life on some planets, all the way to intelligent civilizations, taken place anywhere else in the universe? The current hypothesis is that it has. We do not know how often, but this is a natural process and, where there is another sun and another Earth far out in the galaxy or in other galaxies, the exobiology community considers it likely that life will begin. The belief is that this process has taken place countless times, is taking place today, and will take place in the future. So we believe that the universe is teeming with life, including intelligent life.

If this is the case, is there any way we can detect the existence of extraterrestrial life, including intelligent life? In 1975 and 1976, Project Viking attempted to detect microbial life on the planet Mars. While this was not successful, we know that Mars had an atmosphere and water four billion years ago, so it is still possible that microbial life might have begun on Mars at the same time that life began on Earth. When we go back to Mars we will dig up soil and look for evidence of ancient life which became extinct.

Are there other ways of detecting life? An idea first proposed by Philip Morrison in 1959 and Frank Drake in 1960 was that, if one wants to talk to other civilizations across the great distances between the stars, one should listen for radio signals they might be transmitting. Based on that idea, a plan was put together within NASA about 25 years ago to search for extraterrestrial intelligence. This plan was called the Search for

Extraterrestrial Intelligence (SETI). The plan was to see if one could detect radio signals emanating from transmitters of other civilizations in the galaxy and even the universe. That plan developed and evolved over the last 25 years and is now in being. The NASA version of SETI is called the High Resolution Microwave Survey (HRMS).

Twenty years ago we had to determine whether listening for radio signals from other civilizations was the right approach. We looked at many other approaches, including the possibility of detecting particles or gravity waves or neutrinos or spacecraft. We also investigated the possibility of interstellar travel. However, the distances involved are immense. The star nearest to us is 4.3 light-years away, which means that light traveling at 186,000 miles per second takes 4.3 years to get to us from the nearest star. We determined that the closest stars in significant numbers are at least ten light-years away. We calculated that with our current technology and traveling at the speed of an Apollo-type spacecraft, it would take such a spacecraft 40,000 years to get to the nearest group of stars. In the future, if we were to consider space travel using matter and antimatter annihilation, the spacecraft would scorch the Earth with gamma rays during launch and would present other major engineering problems. But if we could consider using such a launch, the enormous propulsion system would be accelerating all the way, going up to 3/10th of the speed of light; the spacecraft would then turn around and decelerate to the target star system. If it is estimated to take 200-300 years to reach another civilization, the amount of energy required for one round trip is estimated to be equivalent to about five hundred thousand years of total Earth energy consumption. This was discouraging, so we turned to Morrison's suggestion and Drake's early searches and developed the NASA SETI plan. NASA has a mandate for the exploration of space and was ideally suited for this. NASA-Ames already had an Exobiology group with a nucleus of people studying extraterrestrial life.

Twenty-five years ago we first considered where we should look in the spectrum, because the frequencies of extraterrestrial radio signals are unknown. We determined the spectrum to look at was between one and ten gigahertz (GHz). In all of the noise, including synchrotron radiation from the galaxy, the remains of the Big Bang, quantum noise, interference from the Earth's atmosphere, there was a window and at the bottom of the window was a trough which was quiet. It makes sense that if one hopes to pick up a faint whisper from far away, one should listen in the quiet region of the spectrum. This region is called the microwave window. SETI listens on frequencies between 1 and

10 gigahertz for radio signals of extraterrestrial intelligent origin, and is doing so even as we speak.

The NASA version of SETI, called the High Resolution Microwave Survey (HRMS), is a joint program of two NASA Centers; NASA-Ames and the Jet Propulsion Laboratory (JPL), and has a dual-mode search strategy. In the Targeted Search mode, the beam of the telescope is pointed at suitable target stars. The beam is held on the target star and integrated. We look at nearby stars that are like our sun because we know there is life on a planet (Earth) that is going around the star called the sun. Perhaps there is life on planets going around other stars that are like our sun; the F, G, and K type stars. We look for signals between 1 and 3 gigahertz in the microwave window and with high resolution and sensitivity. The HRMS system is sensitive to a wide variety of steady pulsed signals. We assume that all signals are narrow-band, perhaps 1 Hz wide, and likely to be drifting in frequency. It is more efficient to look for lighthouse-type signals and drifting signals that are always on, which is called continuous wave, and drifting because of Doppler drift due to the rotation of the planet on which the transmitter sits.

The Sky Survey mode looks at the whole sky because if we spent ten years looking at single stars, most of the sky would not have been examined at all. Supposing that very far away there is a very powerful signal; with the Targeted Search we would have missed it. The Sky Survey search strategy is to take another group of radiotelescopes and move the beams of the telescopes very slowly across the sky, backwards and forwards. When it reaches the end of a traverse, the beam is moved 1/2 beam width and brought all the way back. In this way the entire sky is covered. This takes three years in the northern hemisphere and three years in the southern hemisphere. These are two major complementary searches. The Targeted Search is being done at Ames, and the Sky Survey is being carried out at JPL.

SETI uses big radiotelescopes located all over the world. These telescopes are used primarily for communicating with our spacecraft out in the solar system on interplanetary missions. They will also be used for SETI. The largest radiotelescope, employing a 305 meter dish, is at Arecibo in Puerto Rico (Exhibit 1). The large radiotelescope at Parkes in Australia is 70 meters in diameter. Goldstone in California's Mojave Desert is part of NASA's Deep Space Network, run by JPL, and uses a 34 meter antenna (Exhibit 2).

Exhibit 1. Aerial View of the World's Largest (305 M) Radio Telescope at Arecibo, Puerto Rico

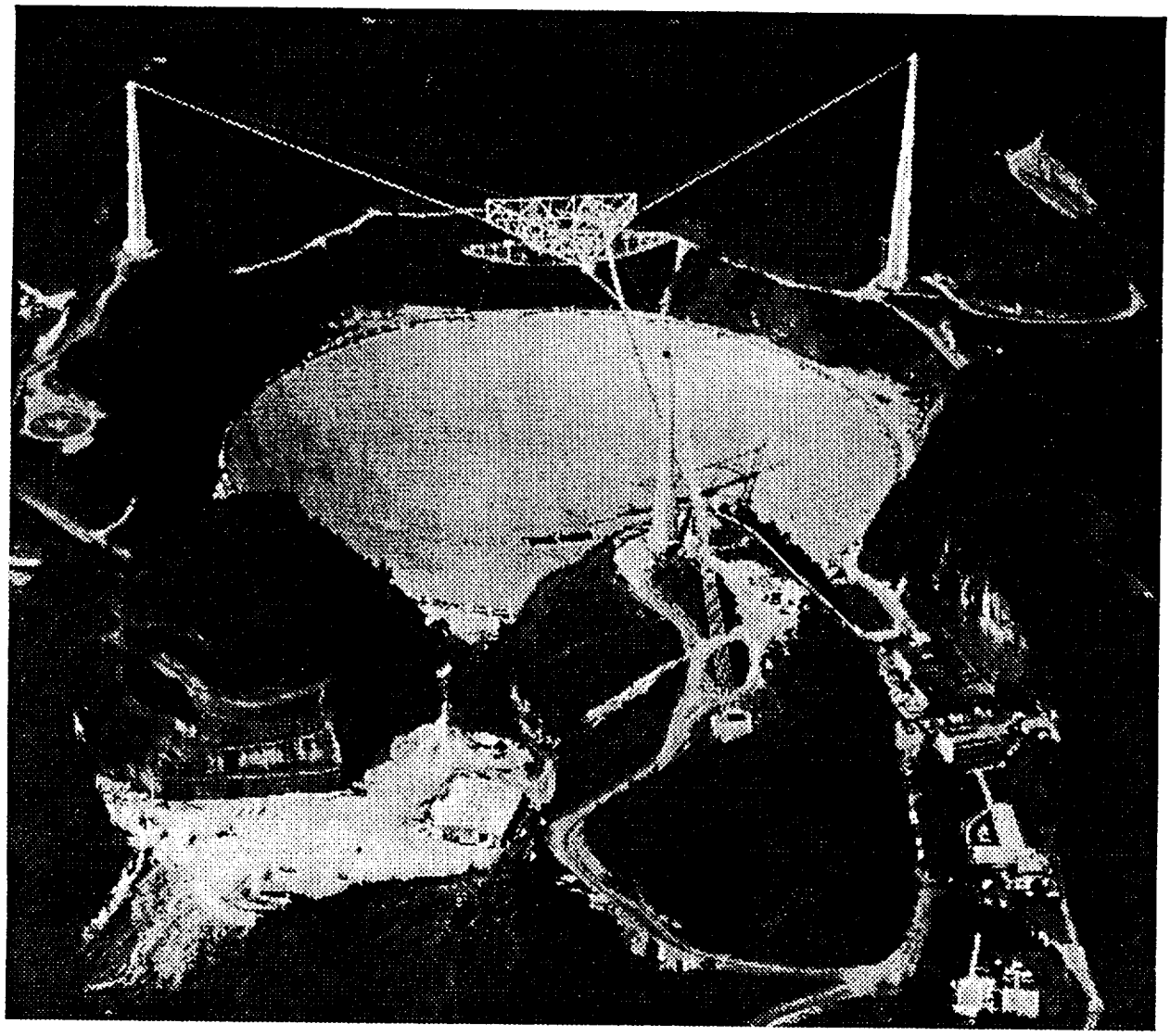
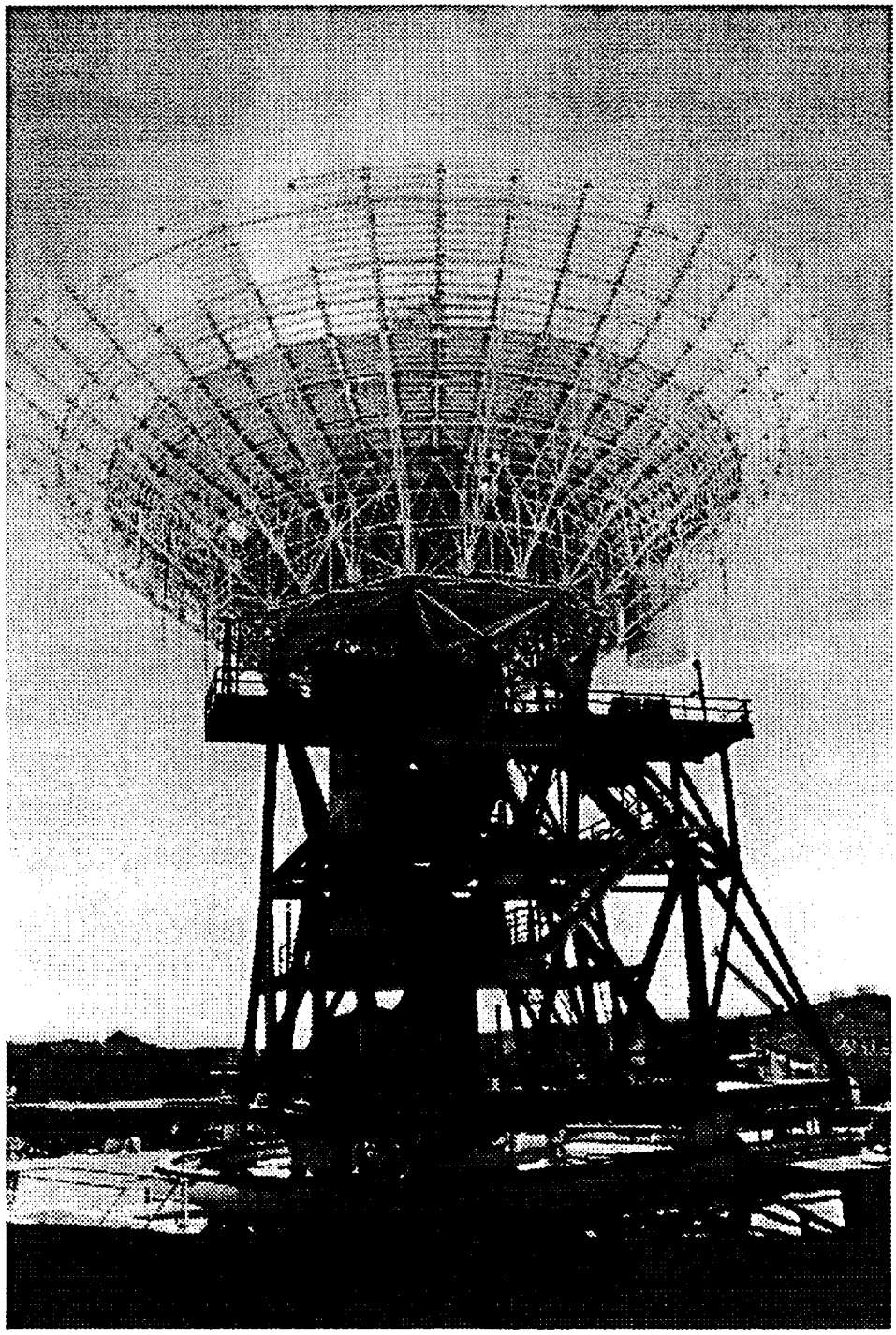
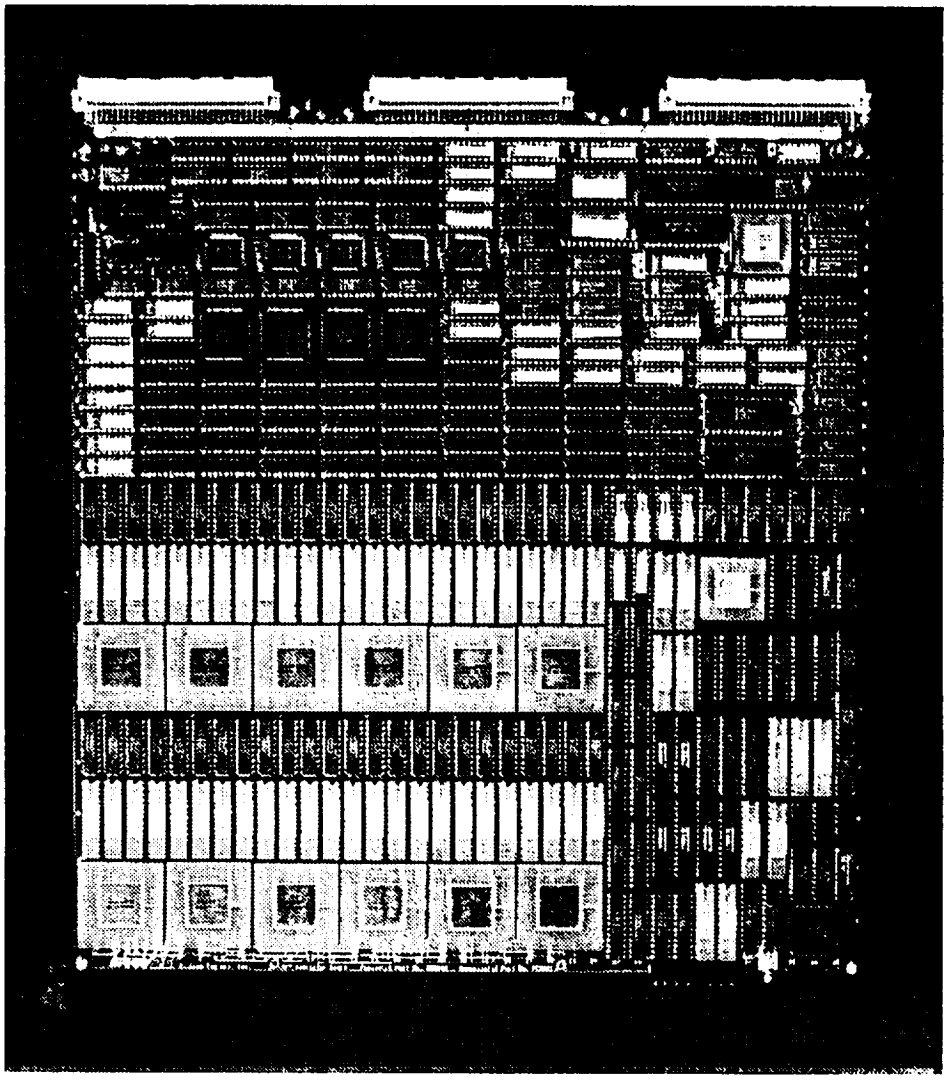


Exhibit 2. The High Efficiency Antenna at Goldstone, California, Operated for NASA by the Jet Propulsion Laboratory. The Antenna, 34 Meters in Diameter, Uses a Unique "Beam Waveguide" Design that Transfers and Focuses Radio Signals Into Ultra-Low-Noise Receivers.



The data stream is far too immense and difficult for humans to analyze, so we have an automated SETI system. This system includes the telescope where the signals are received and reflected back to a secondary focus, then into the telescope, and then into the SETI machine through the observatory computer. The radio frequency input goes to a receiver, is split into right circular polarization and left circular polarization, and then to two multichannel spectrum analyzers (Exhibit 3).

Exhibit 3. Discrete Fourier Transform PC Board Used in the Multi-Channel Spectrum Analyzer. This Board Contains 12 Custom VLSI Digital Signal Processing Chips for Computing Fast Fourier Transforms.



The multichannel spectrum analyzer splits the spectrum into 14 million individual channels which we listen to all at once because we do not know where the signal is in the microwave window. The signal then goes to a pattern detection machine which tries to determine if there is any significant artifact in the stream of analyzed data; in other words, a real extraterrestrial signal. This is all controlled by a computer; a control subsystem which links everything together and makes it work.

The analyzed signals go into the signal detection subsystem, which looks for patterns. The continuous wave stream goes through a data buffer and path sieve. Anything that survives the sieve is significantly different from the background noise and goes to the signal detection control subsystem as a candidate extraterrestrial intelligence signal.

If a signal looks promising, it goes through a yes/no logic tree to see how real it is. We are constantly bothered by interference because we on Earth generate a colossal number of signals. The problem is to separate all of our own signals from a real ETI signal. This is the purpose of the logic tree. If a signal passes all of the automatic tests, a scientist conducts more tests, the most important of which is to contact another observatory 3,000 miles away for verification. The scientist explains that we have a candidate ETI signal and gives the sky coordinates, sensitivity, polarization and drift. If the second observatory can verify, then the evidence is very good that this is a real signal.

We have made progress on SETI but much remains to be done. Significant advances have been made in our computerization. For example, in the early years we had large circuit boards, but we designed our own chip, the HRMS chip, which makes the system more portable. The HRMS system now can be built to fit in a trailer and taken anywhere.

So far, $50 million has been spent on the SETI system. The 10-year HRMS Project will probably cost another $130 million until completed at the beginning of the year 2003.

One of the most difficult things about this project is that so far we have not been able to verify any signals as extraterrestrial, and we do not know when we might have an authentic signal. It is possible that we may not detect a signal within the next ten

years. Perhaps our systems are not sensitive enough. But the next phase of SETI in the next century will have bigger and better machines. It would also be better if we could operate the system from space rather than Earth because the Earth is a source of heavy radio frequency interference. If we built a new telescope which would float free in space, the signals could be reflected to receivers on station-keeping spacecraft. The signals would go to the relay satellite and back to Earth for interpretation. The dish could be large and could be shielded from radio frequency interference from the Earth.

Another interesting possibility for the future is to utilize the far side of the moon. The far side of the moon is always quiet. The moon is locked in tidal rotation with the Earth, so it always faces away, and of course the bulk of the moon shields the far side from all radio frequency interference from Earth. Thus, it would be a very good place to place microwave or radio observatories.

As we continue the development of the SETI Program, both through the incorporation of more advanced technologies and possible use of more suitable receiving sites, our chances for success will improve. Whether we will identify signals from life elsewhere in the universe remains to be seen. However, we will have made a sincere and scientifically valid attempt to determine if such signals do in fact exist.

THE GODDARD SPACE FLIGHT CENTER ERGONOMICS PROGRAM

N94-16621

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p. 6

Introduction

The Environmental Health Unit, located on-site at the Goddard Space Flight Center (GSFC), is responsible for the implementation of the Center's Employee Environmental and Occupational Health Program. The Health Unit, Health Physics (HP), and Industrial Hygiene (IH) staffs collaborate to provide quality service to the employees at GSFC. The Health Unit staff identifies, evaluates, and ensures the control of occupational hazards on Center. In the past, components of the Industrial Hygiene Program have included the Industrial Hygiene Health Hazard Identification Program (IHHIP), the Hearing Conservation Program (HCP), the Hazard Communication Program, and the bi-annual fume hood survey. More recently, the Environmental Health Unit has expanded its services by adding the Ergonomics Program.

The Ergonomics Program was launched at GSFC in October, 1991, at the request of the Health Unit's Medical Director, John D. Foulke, M.D. Dr. Foulke felt that complaints of discomfort by video display terminal (VDT) users deserved special attention. In addition, he believed that the initiative would be helpful in identifying employees who could be at risk of developing carpal tunnel syndrome (CTS). Initially, the Industrial Hygiene staff evaluated the work stations of employees who had complained of discomfort. However, the staff also decided to launch a Center-wide survey to identify high risk VDT users and to correct work station deficiencies before they became problematic. This service has recently been extended to employees at the Wallops Flight Facility located at Wallops, Virginia.

As of October, 1992, there were 4,209 employees at GSFC; a combination of civil servants and contractors. The Ergonomic Program services are available to all employees on Center, but the majority of the evaluations have been performed at civil servants' work stations since contractors are required to have their own health and safety

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programs. Priority is usually given to individuals who claim that they have developed a cumulative trauma disorder (CTD), complain of pain or discomfort, and those who are referred by the staff of the Health Unit and the Health and Safety Branch. Following is a summary of the Ergonomics Program activities.

Program Activities

1. Work Station and Task Evaluations

In-depth analyses of work station design and employee tasks are performed. Approximately 100 evaluations have been conducted. These evaluations primarily include surveys of individual employee VDT work stations. Walk-through inspections are conducted in areas such as laboratories where the user population varies or where there are multiple work stations.

2. Illumination Surveys

Lighting system design and the orientation of luminaries and windows sometimes present unique and challenging problems, particularly in areas where there are multiple VDT work stations. Illumination surveys are, therefore, sometimes performed as part of the Ergonomics Program.

3. Employee Education

VDT operators are encouraged to assist in modifying their work stations. The Industrial Hygiene staff usually discusses work station deficiencies with the operators and demonstrates how corrections can be made.

4. Work Station Modification

Upon request, the Industrial Hygiene staff will provide assistance in modifying work stations. The use of resources available on Center is stressed. However, when this is not feasible or practical and it becomes necessary to purchase furniture or equipment, the Industrial Hygiene staff will assist in the selection of ergonomically sound items. This action usually requires collaboration with the VDT operators, their supervisors, and Logistics personnel.

5. **Written Survey Reports**

A report that details the findings of each survey and the recommendations made for correcting the deficiencies found is forwarded to the Head, Health and Safety Branch. Copies of the survey report are sent to the employee and supervisor. Additional copies are retained in a master file and in the employee's building file which is maintained in the Environmental Health Unit.

6. **Collaboration With Private Physicians**

Reports on the VDT work station evaluations performed are made available for review by private physicians who evaluate employees.

7. **Collaboration With Logistics Department**

The Logistics Department is responsible for purchasing VDT work station furniture on Center. The Industrial Hygiene staff has identified and discussed with the Logistics Department personnel the criteria that must be applied in selecting well-designed furniture. Specifically, the Industrial Hygiene staff has developed general guidelines for selecting ergonomically designed chairs. Findings of the VDT surveys conducted, numerous complaints about uncomfortable chairs, and problems encountered with their structural integrity prompted this action.

Identification of VDT Operators

There is no comprehensive listing of all of the VDT users on Center; consequently, their identification is not an easy task. In general, operators are identified through referrals made by the staff of the Health Unit, Health and Safety Branch employee complaints and requests, information gathered during building surveys and inspections, and input from the Industrial Hygiene Hazard Identification Program (IHHIP). As part of the IHHIP, employees are required to provide information on job tasks when they report for their baseline physical examination. This information is forwarded to the Environmental Health Unit and serves as a valuable tool in identifying newly hired employees who will be working with VDTs. This data is also used to

generate two lists of VDT users who are classified as programmers and video display terminal users. Since the programmers spend more than four hours per day working at their terminals, they are considered high risk operators.

Nature of the Complaints

Operator complaints appear to be consistent with current data. A review of the surveys completed to date indicates that the usual complaints by VDT users at GSFC are:

1. Persistent pain or soreness in the neck, shoulder, upper back, and lumbar area.

2. Pain in the wrist(s) which may travel up the arm, and decreasing inability to grasp and hold on to objects without experiencing pain.

3. Pain, numbness, and tingling in the fingers; cold fingers.

4. Pain or soreness in the elbow.

5. Problems (latency) in accommodating when shifting eyes from the screen to distant objects.

6. Headaches.

7. Cumulative trauma disorders such as carpal tunnel syndrome and tendinitis.

Survey Findings

Survey findings vary according to work station layout, task design, and individual differences. However, at GSFC some work station deficiencies appear to be more prevalent than others. A summary of these deficiencies follows.

Frequently Occurring Work Station Deficiencies

1. Abnormal postures due to inadequate work space and poor work station design.

2. Work station is poorly designed for tasks that require alternation of VDT work with other tasks.

3. Poor alignment of work station equipment.

4. Monitor too low.

5. Monitor too high.

6. Glare on screen.

7. Direct glare to operator's eyes.

8. Keyboard at improper height or angle.

9. Wrists unsupported or only partially supported.

10. Chair: Operator's back unsupported or inadequately supported.

11. Chair Seat: Improper height, incorrect size.

12. Chair armrests at improper height.

13. Poor screen character quality.

14. Employee works long hours at the VDT without taking a break.

Program Weaknesses

Time constraints preclude routine follow-up. Visits should be mandatory for employees who have been diagnosed as having a cumulative trauma disorder or who have complained of pain or discomfort. Routine follow-up visits should also be made to evaluate work stations that have been modified.

Standard items such as wrist-rests, anti-glare screens, and foot-rests needed for on-site work station modification are not available on Center.

Pre-screening to identify high risk employees should be performed. The National Institute of Occupational Safety and Health has determined that nearly all individuals who have been treated for carpal tunnel syndrome experience a reoccurrence of the disorder if they resume working at the same job or a similar one.

Emphasis should also be placed on evaluating tools, equipment, facility design, and jobs that involve the performance of tasks unrelated to the use of VDTs.

N94-16622

EFFICIENT MANAGEMENT OF CARDIOVASCULAR RISK SCREENING PROGRAMS

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Since the Kennedy Space Center (KSC) Cardiovascular Screening Program started in 1984, we have made many changes to accommodate the growing number of participants. As a result of these changes, screening of KSC employees has become more efficient and productive.

Overview

The Health Education Program at Kennedy Space Center is divided into twelve monthly programs:

1. Cardiovascular Screening
2. High Blood Pressure Screening
3. Colorectal Screening
4. Employee Assistance Program Month
5. Environmental Health Month

6-12. A variety of topics or timely subjects.

Employees are surveyed frequently to get their opinion of the program, what they like and dislike, possible improvements, and ideas for future programs. In the last survey, the topics of interest to most people were:

1. Exercise and Fitness
2. Diet and Weight Control
3. Stress
4. Nutrition
5. Back Care.

The Health Education Program

The Health Education Program has grown from 4,281 participants in 1984 to 16,528 in 1991. We have already passed that number in 1992. Exhibit 1 shows the growth of the entire program, by year, since 1984.

Exhibit 1. Summary of Health Education Program (Entire Program)

Year	Number of Participants
1984	4,281
1985	5,921
1986	5,209
1987	7,814
1988	8,517
1989	10,712
1990	12,618
1991	16,528

The Cardiovascular Screening Program

Participation in the Cardiovascular Screening Program has grown from 508 in 1984 to over 4,000 in 1992. Exhibit 2 summarizes this growth. As a result of the dramatic increase in the number of participants, we have had to streamline the program to make it as efficient as possible.

Exhibit 2. Summary of Cardiovascular Disease Screening Program

Year	Number of Participants
1984	508
1985	859
1986	1,260
1987	1,742
1988	2,302
1989	3,485
1990	3,402
1991	3,797
1992	4,056

Screening for cardiovacular disease is our most popular program. It is held each February in conjunction with National Heart Month at all three medical facilities; OHF, LAC, and CAC, every Monday through Friday from 0630 to 0900.

Participants in the program fill out a comprehensive questionnaire which includes:

1. Demographic Data
   a. Family Health History
   b. Current Health History
   c. Smoking and Exercise History

2. Blood Pressure Measurement

3. Blood Samples for analysis of cholesterol, triglycerides, HDL, and Glucose.

Participants are logged in when they arrive and are given a number. This number is put on the questionnaire, the laboratory slip, and the blood sample tube. All blood samples are checked to be sure that the name and number are correct on the tube before being sent out for analysis. If any lab value comes back extremely high or low, the participant is called and asked to repeat the test for verification. We have had cholesterols over 500, triglycerides over 3,000, and glucose over 600.

After all of the data are collected and entered into a computer, the risk factor is calculated by the computer using tables modified from the Framingham Study. Parameters used are age, sex, blood pressure, total cholesterol, and smoking habits. The cholesterol/HDL ratio is also calculated.

The Results Package

Each person who has taken part in the program is then sent a results package which includes:

1. Participant's lab values
2. Average population ranges for all values listed
3. An explanation of relative risk
4. Elevated risk factors the employee must modify to reduce risk

5. Risk factor values from previous years
6. A health information packet containing information on heart disease, exercise, diet, and smoking.

People with abnormally high test results are contacted personally by telephone or called in for a meeting for further clarification of the results and counseling. They are then referred to their personal physician for further evaluation.

Improvements in the Program

The Cardiovascular Screening Program at KSC has greatly improved since 1984. During the first few years:

1. It took 1/2 to 1 hour in the Medical Facility to complete the screening.

2. It took 3 to 4 weeks to get the results, because:
   - participants filled out the questionnaire at the Medical Facility on the day of the screening;
   - two registered nurses took blood pressures;
   - one laboratory technician drew blood;
   - after receiving the data from the lab, I calculated the risk factor from a table;
   - I filled out the results letter by hand; and
   - I addressed and stuffed the envelopes and mailed the results.

In 1992, we screened over 4,000 participants, and it took 5 to 15 minutes at the Medical Facility and 3 days to 1 week to get the results.

The screening of KSC employees takes a great deal of teamwork and cooperation by everyone in the Medical Department. Some days over 300 people go through the screening in 2-1/2 hours. We are pleased with the efficiency of the program, but most gratifying is that the KSC employees tell us how quick and easy the process is. A description of the changes made to achieve this improvement follows.

1. **The Questionnaire**

In 1984:

The questionnaire was filled out on the day of the screening, and took between 15 and 45 minutes to complete. This questionnaire completion process required the use of rooms with tables and chairs and someone had to be present to answer questions. This resulted in a lot of confusion and patient flow problems.

At Present:

We now have questionnaires available at all three Medical Facilities, starting the third week in January. These questionnaires can be picked up at any time, completed at the participant's leisure, and brought in on the day of the screening. This saves each participant at least 30 minutes in the Medical Facility. While we do have questionnaires available for anyone who has not filled one out ahead of time, 98 percent of the participants complete them before they arrive.

2. **The Schedule**

We have held the screening every Monday through Friday from 0700 to 0900 each February since 1984, but, as the number of participants grew, the lines became very long. Part of the solution was to add an extra 1/2 hour to the screening time. We now start at 0630. This has greatly improved the flow and shortened the lines. Each year we look at attendance data at each facility and add or subtract days as needed. We have also added extra days for our second shift from 1400 to 1600.

3. **Staffing**

In 1984:

We had two registered nurses taking blood pressures and one laboratory technician drawing blood.

At Present:

There are 5 or 6 registered nurses and EMT's taking blood pressures and 4 laboratory technicians drawing blood. We have a dedicated data input clerk for the screening and can get additional help if the workload increases. We utilize clerical staff to send out the results.

4. **Patient Flow**

Each year we re-evaluate patient flow in each facility to determine where it can be improved. Signs and arrows now direct participants to each station. We put the information on the blood sample tubes when the employee is logged in at the beginning of the screening. In the past, laboratory technicians did this before drawing blood, which created long lines at the laboratory station.

5. **Additional Laboratory Values**

In the first few years we had separate cardiovascular and diabetes screenings. We combined these two screenings in 1986, saving time, money, and an additional venipuncture for our employees. In 1989 we added HDL because of its importance in predicting heart disease. Our participation increased dramatically in that year.

6. **Automation**

Our greatest improvement has been in automation, which has greatly increased productivity.

- We now have a program to calculate the risk factor and cholesterol/HDL ratio.
- The computer now prints the results letters and the mailing labels.
- Our data input clerks put all of the demographic data into the computer or update the data that is already in the computer.

- Laboratory values received from the hospital laboratory are dumped into our database, saving time and assuring greater accuracy.

- All of the data from 1984 to 1992 is now in a computer program. This can be called up on my desk computer if an employee needs a printout for all of the previous years that he/she has participated in the screening.

- I receive a daily printout of all participants as well as a printout of the high risk results. I use this to call employees who need counseling and referral. This saves a lot of time. Formerly, I had to go through each printout and determine which participants were at high risk.

Plans for 1993

In 1993 we plan to add cholesterol/HDL ratio history along with risk factor history. This will enable an employee to measure his/her progress from year to year. We are also planning to calculate LDL and include this information in the results letter.

While employee screening is a tremendous undertaking for the Medical Department, it is a very important aspect of the employees' health and well being. We are always looking for areas of improvement.

INDUSTRIAL HYGIENE LABORATORY ACCREDITATION "THE JSC EXPERIENCE"

N94-16823

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Introduction

The American Industrial Hygiene Association (AIHA) is a society of professionals dedicated to the health and safety of workers and the community. With more than 10,000 members, the AIHA is the largest international association serving occupational and environmental health professionals practicing industrial hygiene in private industry, academia, government, labor, and independent organizations.

In 1973, AIHA developed a National Industrial Hygiene Laboratory Accreditation Program. The purposes of this program are shown in Exhibit 1.

Exhibit 1. Industrial Hygiene Laboratory Accreditation

Purposes for Accreditation

- Establish and maintain the highest possible standards for laboratories analyzing samples which evaluate workplace exposures.
- Encourage laboratories to employ well-qualified personnel, follow controlled procedures, and utilize properly maintained equipment.
- Proficiency Evaluations.

There are now 350 AIHA accredited commercial, industrial, academic and government laboratories in the United States, Canada, and overseas. More than 1,000 laboratories participate in AIHA's multi-element Proficiency Analytical Test (PAT) Program.

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The Environmental Health Laboratory at Johnson Space Center (JSC) achieved laboratory accreditation by the American Industrial Hygiene Association in 1986. The procedures to acquire and maintain accreditation are very detailed and require that specific criteria be satisfied. Industrial hygiene laboratories seeking accreditation must employ certain key personnel, have a comprehensive Quality Control (QC) Program that meets strict guidelines, have a safe and properly equipped facility, and maintain proper recordkeeping and methodologies. In addition, participation in the AIHA PAT program is a prerequisite to qualifying under the Laboratory Accreditation Program (LAP) (Exhibit 2).

Exhibit 2. Standards for Accreditation

AIHA Proficiency Analytical Testing (PAT) Program

- Required for All Categories of Contaminants Analyzed
- Initial Accreditation Requirement
- Requirements for Maintaining Accreditation
- Requirements for Reaccreditation

Laboratories in the LAP are required to analyze all categories of contaminants from which samples are accepted for analysis. This presentation outlines these requirements in detail and offers some insight into the steps necessary toward proficiency analytical testing, completion of the accreditation application, cost for the program, the site visit evaluation and, finally, what is required by the Laboratory Accreditation Committee (LAC) to maintain accreditation.

Industrial hygiene laboratories applying for initial accreditation must be enrolled in the AIHA PAT Program or some proficiency testing program accepted by the LAC and must complete two consecutive rounds of quarterly analyses with no more than 5 percent total outliers. Outliers are defined as any value exceeding a +2 or -2 standard deviation from the reference value for an analyte. Laboratories may opt to seek

accreditation based on analysis of all or part of the samples offered. PAT samples available for analysis are silica, asbestos, solvents, and metals. Four samples and a blank are submitted in each category. Our laboratory at JSC performs analysis of all components with the exception of silica.

Accreditation program dues are $500.00 a year. The annual sample kit fee is $1,248.00. To include silica would add $552.00 to the annual cost. When a site visit is conducted, you must pay all travel costs associated with the visit.

The next step to accreditation is the application process. For purposes of proper evaluation by the LAC, an organizational chart is required as well as a brief description of the laboratory operation. Personnel profiles for the Laboratory Director, Laboratory Supervisor, Quality Control Coordinator and Industrial Hygiene Analysts are to be submitted. These profiles outline the education and experience required for each position (Exhibit 3).

Exhibit 3. Standards for Accreditation

Personnel

- Laboratory Director (overall operation)
  - Bachelor's degree in a basic science
  - Either five years industrial hygiene experience beyond degree or full ABIH certification
- Laboratory Supervisor (day-to-day operation)
  - Bachelor's degree in a basic science
  - Minimum five years industrial hygiene experience beyond degree or full ABIH certification in chemical aspects
- Quality Control Coordinator (QCC)
  - Bachelor's degree in a basic science
  - Knowledge of statistics and QC procedures
- Industrial Hygiene Analyst
  - Qualified by education and/or experience

Quality Control

As can be seen in Exhibit 4, you must also submit a written quality control (QC) plan and the Table of Contents from the Laboratory Quality Assurance Manual. A description of intralaboratory quality control procedures for both precision and accuracy is also required. You must provide examples of current completed worksheets, control charts, and reports, and indicate procedures used for routine checking and calibration of equipment and instruments used for industrial hygiene analysis. A description of the process utilized in the adoption and revision of analytical procedures in the laboratory must be included. Further QC information required for the application includes a description of laboratory policy about participation in proficiency programs or comparative studies "round robin" QC exchange with other laboratories. Most of the time, laboratory QC sample exchanges are done with other AIHA accredited laboratories.

Exhibit 4. Standards for Accreditation

Quality Control Program

- Written Quality Control Plan
- Designated Quality Control Coordinator
- AIHA PAT Participation
- Records of Control Samples
- Records of Routine Calibrations of Instruments
- Adequate Retrieval of Quality Control Data
- Reagent Checks
- Cleanliness and Housekeeping (avoid contamination)
- Asbestos Analysis Must Comply with CFR 1910.1001 Appendix A

In the event an external laboratory is contacted for analysis of samples, a description of the laboratory selection process and control procedures must be provided.

Asbestos

Asbestos is regarded with particular interest. An entire section of the application is devoted to asbestos. Laboratories seeking fiber counting accreditation for asbestos fiber index must be prepared to document all formal or in-house training that each asbestos analyst has received. A summary of the course outline must be submitted, along with a listing of your equipment available for the analysis of asbestos using NIOSH Method 7400, a copy of the methods written by your laboratory (Standard Operating Procedures), and a written QC manual which addresses asbestos specifically. Asbestos QC requirements must comply with CFR 1910.1001 Appendix A. Examples of completed QC information such as QC tables and/or charts must be supplied as evidence of proper documentation.

AIHA also has a proficiency testing program for the analysis of asbestos in bulk materials. Samples are distributed through the Research Triangle Institute in Research Triangle Park on a quarterly basis. This program is similar to the National Voluntary Laboratory Accreditation Program (NVLAP), but no site visit is conducted. NVLAP is run by the National Institute for Standards and Technology. Proficiency testing along with quarterly round-robin sample exchanges with other laboratories accounts for a large percentage of the QC done in asbestos work.

Facilities

An industrial hygiene laboratory should have the physical facilities, ventilation, utilities, and safe procedures for chemical storage, usage, and disposal, and have safety equipment and sanitary conditions adequate for the services provided (Exhibit 5).

Exhibit 5. Standards for Accreditation

o Facilities	o Records	o Methods
- Safety Equipment	- Numbering System	- Accepted and Documented IH Methods
- Ventilation	- Calibration and Maintenance	- Approved Manual
- Space		

The LAC is very interested in these items; in fact, a large part of the actual site visit is an evaluation of the overall laboratory facility. In the application for accreditation, you

are required to submit a laboratory floor plan with approximate dimensions and labels for major analytical equipment.

You must provide an inventory of the laboratory safety equipment, describe the hazard communication program as it applies to your operation and, finally, you must outline the laboratory policy pertaining to housekeeping because improper housekeeping leads to cleanliness problems and contamination errors. Laboratory ventilation is of extreme importance, and the Accreditation Committee wants to ensure that laboratory fume hoods are functioning adequately and meet performance criteria. You must describe the frequency of air flow monitoring and calibration activities and provide current examples of monitoring records.

Other recordkeeping requirements mandate a unique numbering system for sample tracking; no log numbers are to be duplicated.

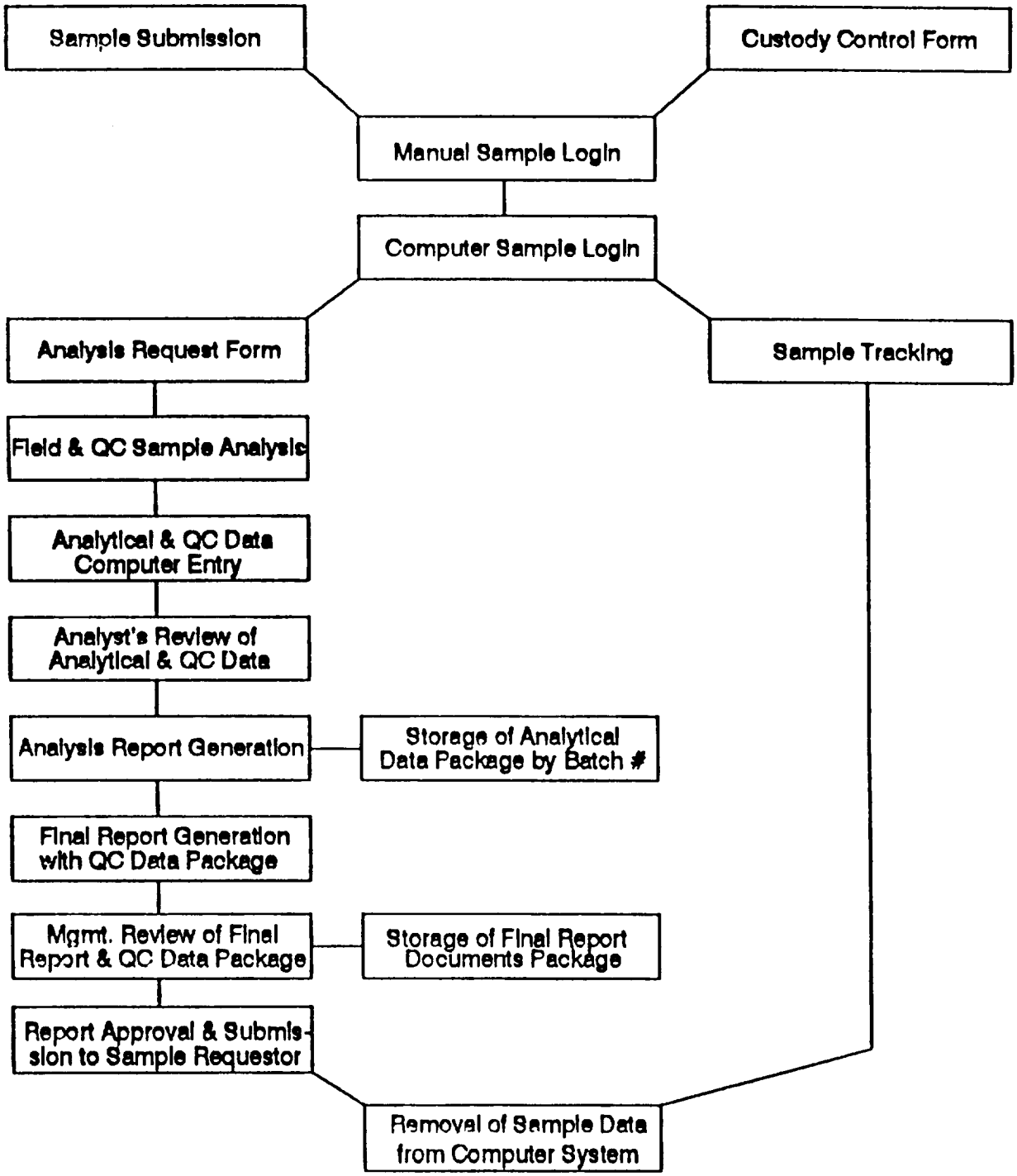
Information Storage and Retrieval System

A good analytical laboratory must exhibit the ability to track progress of samples from receipt and log-in through analysis -- from data review and approval to final reporting with ultimate archival or storage of raw and reduced data. This process is critical to a solid operation and to maintaining organization. Exhibit 6 is a flow diagram of sample tracking in the Environmental Health Laboratory at JSC.

To finalize this section of the application you must also submit examples of completed forms which illustrate this process in your laboratory as well as examples of external laboratory reports with QC reports attached.

The Accreditation Committee is interested in the type and number of analyses completed during a representative 12-month period. This provides you with an opportunity to document all work done in the laboratory and, more specifically, you are also requested to submit a breakdown that reflects actual industrial hygiene and analytical capability. You must list all elements or compounds analyzed for industrial hygiene purposes, the procedure or analytical method used, the instrumentation used, and provide necessary QA references. Analysis which are beyond the scope of your laboratory must also be accounted for, as well as any necessary QC documentation.

Exhibit 6. NASA/JSC Environmental Health Laboratory
Laboratory Information Management System



Lead Accreditation

To keep current with the growing concern over lead exposures, the AIHA has developed a National Accreditation Program for laboratories analyzing lead (Exhibit 7).

Exhibit 7. Environmental Lead Laboratory Accreditation Program (ELLAP)

- Enrollment began October 1, 1992
- Laboratories serving lead hazard assessment and abatements
- Paint chip, soil, and dust wipe samples for analysis of lead
- Application process and major requirements similar to AIHA LAP
- Interim accreditation available is already PAT proficient in metals

A committee meeting was held in March at PITTCON '92, where representatives from the Environmental Protection Agency (EPA) and National Institutes of Safety and Health (NIOSH) participated. The requirements are much like those for regular laboratory accreditation, and include site visits, etc. During the laboratory inspection, the site visitor submits a sample for analysis. After the initial inspection, site visits are performed every three years. This program accredits laboratories, not individuals or companies, and the data is handled by NIOSH. Currently, no methods for analysis have been specified or required, but you must prove accuracy and precision with the methods you are using in your laboratory.

On October 1, 1992, the AIHA began accepting applications for enrollment. This program is designed for laboratories analyzing paint chips, soil, or wipes of dust, and is to begin in November, 1992. A laboratory can participate in proficiency testing without seeking accreditation. You may submit an abbreviated application if your laboratory is already AIHA accredited and proficient in metals. The Environmental Health Laboratory at JSC plans to enroll in the lead program as soon as possible.

SPACE SHUTTLE SOLID ROCKET MOTOR EXPOSURE MONITORING

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N94-16624

ABSTRACT

During the processing of the Space Shuttle Solid Rocket Booster (SRB) segments at the Kennedy Space Center an odor was detected around the solid propellant. An Industrial Hygiene survey was conducted to determine the chemical identity of the SRB offgassing constituents. Air samples were collected inside a forward SRB segment and analyzed to determine chemical composition. Specific chemical analysis for suspected offgassing constituents of the propellant indicated ammonia to be present. A gas chromatograph mass spectroscopy (GC/MS) analysis of the air samples detected numerous high molecular weight hydrocarbons.

INTRODUCTION

Solid Rocket Boosters (SRB) are processed at the Kennedy Space Center (KSC) as part of the Space Transportation System. Each SRB is made up of four separate segments. The segments are shipped to the KSC by rail car and are received at the Rotation Processing Segment Facility. KSC personnel remove the segments from the shipping containers, remove shipping rings, perform solid propellant grain inspections and prepare the segments for storage in the nearby Surge Buildings. The segments remain in the Surge Buildings for extended periods of time where they are inspected on a weekly basis. After storage, the segments are brought out of the Surge Building and moved to the Vehicle Assembly Building where the segments are stacked and mated to the Space Shuttle Launch Vehicle.

Personnel performing certain SRB operations at KSC have detected odors when working around the solid propellant. Personnel have indicated that the odors are most prevalent when the segment shipping containers are initially removed and during grain inspections. The odors are reportedly stronger in the forward and aft segments where no cross ventilation is available. The chemical identity or source of these odors is unknown. In an effort to determine the identity of the offgassing constituents of the solid

propellant, air sampling was performed inside of a forward segment during storage. The air samples were analyzed for specific chemical compounds as well as being analyzed for the presence of unknowns.

The Material Safety Data Sheet lists the ingredients of the SRB propellant as ammonium perchlorate, aluminum powder, HB polymer, bisphenol A/epichlorohydrin, and iron oxide. The HB polymer contains a polymer identified as polybutadiene acrylic acid acrylonitrile polymer (PBAN) which may contain trace amounts of butadiene, acrylic acid, acrylonitrile, and hydroquinone.

METHODOLOGY

A MULTI-AIR WM 02-8914 multistation air flow vacuum sampling pump was utilized to pull air through the various sample collection devices. The sampling collection devices were connected to the sampling pump via Tygon tubing. The sampling media were selected based on the possible offgassing constituents of the SRB propellant. The appropriate National Institute for Occupational Safety and Health (NIOSH) sampling methods were utilized for the collection of samples. Table I lists the sampling and analytical methods utilized during the survey.

The sampling collection devices were placed inside the protective Herculite cover at the open end of the forward segment. Continuous sampling was performed beginning May 4, 1992 until May 8, 1992. The same sampling methods were repeated on May 11, 1992 until May 15, 1992. Continuous sampling was performed to obtain large sample volumes. Sampling volumes exceeded the NIOSH recommended sample volumes to insure a sufficient quantity of material for analysis.

Three separate sorbent sampling tubes (one charcoal tube and two Tenax tubes) were also used during the sampling period to test for the presence of unknowns. The sorbent sampling tubes were also connected to the multistage sample pump. An air flow rate through each tube was maintained at 0.4 liters per minute during the sampling period. The sample volume for these tubes ranged from 2521 liters to 2838 liters. Analysis of the sampling tubes was performed using gas chromatography, mass spectroscopy. The major peaks of the gas chromatogram were analyzed by the mass spectrometer to determine the chemical identity of the separated compounds. The GC/MS

analysis results were reported by listing the compounds with the best internal mass spectrometer library match.

A Gastec Passive Dosimeter Tube for ammonia, No. 3D, was also placed inside the Herculite cover and was used to indicate the presence of ammonia. The Passive Dosimeter Tube is cross-sensitive to amines and hydrazine but is not sensitive to aromatic amines. The dosimeter tube is designed to passively measure ambient levels of ammonia and give a visible indication by colorimetric change on the tube. The manufacturer's instructions recommend ten-hour sampling periods to detect a range of 2.5 parts per million (ppm) to 50 ppm. The dosimeter tubes were evaluated for colorimetric indication once each 24-hour period during the survey.

RESULTS

The sampling results for the compound specific analysis are listed in Table II. The GC/MS analysis of the samples for unknowns are listed in Table III.

CONCLUSIONS

A number of chemical compounds have been identified to be present in the SRB segment bore. These compounds included ammonia and the high molecular weight hydrocarbons identified by the Gas Chromatography/Mass Spectrophotometry analysis (see table II). Other chemical compounds suspected of being present, based on the chemical composition of the SRB propellant, were not detected or were found to be present at trace amounts. These included, acrylonitrile, bisphenol A, 1,3 butadiene, epichlorohydrin, and hydrogen chloride. The chemical composition of the odor associated with the SRB Propellant is believed to be a mixture of ammonia and the high molecular weight hydrocarbons identified in Table II. The concentration of ammonia detected ranged from 1.8 ppm to 8.2 ppm. The odor threshold of ammonia is listed as 5.2 ppm. It should be noted that odor associated with the SRB propellant does not smell like ammonia. The concentrations of the identified hydrocarbons were unable to be determined due to the analysis method utilized. It is recommended that personnel exposure monitoring be performed during ground processing operations to quantify employee exposure levels to the identified chemical compounds.

Table I. Sampling and Analytical Methodology

Chemical	NIOSH	Collection	Analysis
acrylonitrile	1604	Charcoal tube	GC/MS *
ammonia	P&CAM S347	H_2SO_4 treated Silica gel	NH3 specific electrode & Ion Chromatography
1,3 butadiene	1024	charcoal tube	GC/MS
bisphenol A	P&CAM 333	glass fiber filter	GC/MS
epichloro-hydrin	1010	charcoal tube	GC/MS
hydrogen chloride	P&CAM 310	silica gel	Ion Chromatography
inorganic acid	7903	silica gel	Ion Chromatography

* Gas Chromatography / Mass Spectroscopy

Table II. Compound Specific Analysis Results

Chemical	Sample Analysis	Analysis Method	Sample Results
acrylonitrile	963 liters	GC/MS *	None detected
acrylonitrile	989 liters	GC/MS	None detected
ammonia	859 liters	Ammonia specific electrode	1.78 parts per million (ppm)
ammonia	1373 liters	Ammonia specific electrode	8.24 ppm
ammonia	96 hours passive diffusion	Colorimetric Indicator	4.7 ppm
ammonia	105 hours passive diffusion	Colorimetric Indicator	4.8 ppm
bisphenol A	1307 liters	GC/MS	None detected
bisphenol A	1855 liters	GC/MS	None detected
1,3 butadiene	1698 liters	GC/MS	None detected
1,3 butadiene	2511 liters	GC/MS	None detected
epichlorohydrin	999 liters	GC/MS	None detected
epichlorohydrin	1392 liters	GC/MS	None detected
hydrochloric acid	1799 liters	IC **	0.002 ppm
hydrochloric acid	1210 liters	IC	0.003 ppm
sulfuric acid	3067 liters	IC	0.001 ppm
sulfuric acid	3169 liter	IC	0.001 ppm
nitric acid	3067 liters	IC	0.002 ppm
nitric acid	3169 liters	IC	0.001 ppm
hydrochloric acid	3067 liters	IC	0.002 ppm
hydrochloric acid	3169 liters	IC	0.001 ppm

* Gas Chromatography Mass Spectroscopy ** Ion Chromatography

Table III. Gas Chromatography/Mass Spectroscopy Analysis Results

Sample #	Sample Media	Desorption Agent
92-05-085	Charcoal tube	Carbon Disulfide
Retention Time	**MS Library Match**	
401 seconds	4-ethnyl cyclohexene	
653 seconds	2,6,7-trimethyl decane	
732 seconds	2,5,6-trimethyl decane	
Sample #	**Sample Media**	**Desorption Agent**
92-05-085-02	Tenax	methylene chloride
Retention Time	**MS Library Match**	
	No peaks detected	
Sample #	**Sample Media**	**Desorption Agent**
92-05-085-03	Tenax	methylene chloride
Retention Time	**MS Library Match**	
642 seconds	trans-4-chlorocyclohexanol	
Sample #	**Sample Media**	**Desorption Agent**
92-05-086-01	Charcoal	carbon disulfide
Retention Time	**MS Library Match**	
393 seconds	4-ethenyl-cyclohexene	
	(E,Z) 1,5-cyclooctadiene	
731 seconds	2,5,6-trimethyldecane	
Sample #	**Sample Media**	**Desorption Agent**
92-05-087-01	Charcoal	carbon disulfide
Retention Time	**MS Library Match**	
418 seconds	4-ethenyl-cyclohexene	

Sample #	Sample Media	Desorption Agent
92-05-090-01	Charcoal	carbon disulfide
Retention Time	MS Library Match	
398 seconds	4-ethenyl-cyclohexene	
651 seconds	2,6-dimethylnonane	
656 seconds	4-ethenyl-cyclohexene	
732 seconds	2,5,6-trimethyldecane	

Sample #	Sample Media	Desorption Agent
92-06-186-01	Charcoal	carbon disulfide
Retention Time	MS Library Match	
321 seconds	4-ethenyl-cyclohexene	
	1,5-cyclooctadiene	
581 seconds	decane	
	2,5,6-trimethyldecane	
611 seconds	4-methyldecane	
702 seconds	2,5,6-trimethyldecane	

Sample #	Sample Media	Desorption Agent
92-06-181-01	Charcoal	carbon disulfide
Retention Time	MS Library Match	
378 seconds	4-ethenyl-cyclohexene	
	1,5-cyclooctadiene	
603 seconds	decane	
	2,5,6-trimethyldecane	
629 seconds	4-methyldecane	
712 seconds	2,5,6-trimethyl decane	

Sample #	Sample Media	Desorption Agent
92-06-184-01	Charcoal	carbon disulfide
Retention Time	**MS Library Match**	
291 seconds	4-ethenyl-cyclohexene	
396 seconds	2,5,6-trimethyldecane	
564 seconds	decane	
	2,5,6-trimethyldecane	
596 seconds	2,3-dimethylnonane	
693 seconds	2,5,6-trimethyldecane	

Sample #	Sample Media	Desorption Agent
92-06-198-01	Charcoal	carbon disulfide
Retention Time	**MS Library Match**	
382 seconds	4-ethenyl-cyclohexene	
	1,5-cyclooctadiene	
606 seconds	decane	
	2,5,6-trimethyldecane	
633 seconds	2,6-dimethylnonane	
714 seconds	2,5,6-trimethyldecane	

Sample #	Sample Media	Desorption Agent
92-06-198-03	Tenax	methylene chloride
Retention Time	**MS Library Match**	
616 seconds	4-ethyl-pyridine	

Sample #	Sample Media	Desorption Agent
92-06-198-05	Tenax	methylene chloride
Retention Time	**MS Library Match**	
564 seconds	4-ethyl-pyridine	

N94-16625

ILLNESS/INJURY PATTERN COMPLEX 40 (TITAN)

Sharon Blasdell, R.N., COHN
EG&G Florida/KSC

On July 31, 1991, EG&G Medical began providing medical support at the Titan Area Clinic (TAC). The hours of operation are 0700-2300, Monday through Friday, with Emergency Medical Services (EMS) provided 24-hours a day, seven days a week. The TAC consists of a 10' x 10' section of a trailer that also houses Bechtel Safety. Supplies consisted of an examining table, an eye wash chair, first aid equipment, over-the counter medications, spine boards, a portable rescuscitator, etc.

All of the nurses are Advanced Cardiac Life Support (ACLS) certified. Although the Titan Area Clinic is strictly a first-aid station with no ACLS facilities on-site, it is staffed with an Occupational Health Nurse with ACLS certification. If ACLS or additional help is needed, the nurse activates EMS by dialing 911. The nurse responds to any medical problems or emergencies on the complex, but activates EMS prior to leaving the TAC. A Bechtel Safety Representative accompanies the nurse to the site and assists as needed.

During our walk-down visit prior to the beginning of coverage we were told by the on-site manager that there were approximately 950 employees at the work site, two work shifts of 11 hours each, and only about 150 of these employees worked during the second shift. The employees work long hours -- the shifts are 0630 to 1730 and 1730 to 0430, 5, 6 and sometimes 7 days a week.

The Site Manager stated that about 50 percent of the employees seen were for eye injuries, and about 20 percent of these were referred out to an ophthalmologist. We discovered that, in an area where sand blasting was being done, the people who worked at the higher levels had eye protection but the workers below working at low levels had no eye protection. Eye protection was immediately provided to everyone working in any area where sandblasting was taking place.

Exhibit 1 is a breakdown of the illnesses and injuries at the site, by month, from July 31, 1991 to June 26, 1992.

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Exhibit 1. Total TAC Injury and Illness 7/31/91 - 6/26/92

		July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total	%
A	FB Eye	1	23	24	37	33	35	60	46	30	11	11	2	313	22
B	Sprains/Strains	4	7	29	30	25	20	28	32	31	9	13	7	125	16
C	Lacerations		19	12	16	8	17	14	20	26	4	17	8	161	11
D	Recheck Wounds		9	7	5	8	18	27	27	31	4	28		164	11
E	Contusions		14	14	7	14	27	17	17	13	8	3	7	141	10
F	B/P Checks		21	14	7	6	4	10	26	19	10	16		133	9
G	Other		13	4	6	9	10	10	7	2	1		3	65	4
H	Burns	2	6	4	8	6	8	5	7	5	2	2	2	57	4
I	Recheck Eye		3	1	2	2	6	9	7	3	1	3		37	3
K	Non- Occupational		16	7	1	2	2		2	4	1			35	2
L	Allergic Reactions		4	4	1	2	1	6	6	3				27	2
M	FB Wounds		6	1	1	2	1	5	4	3	3			26	2
N	EMS Calls 911		1				1	1	3					6	1
O	Earache	1	1		6	1	2		2	3	1	1		17	1
	Totals:	8	151	125	130	123	157	192	207	173	55	94	29	1443	100

Exhibit 2 is a graph showing the percentage of each of the medical conditions that precipitated visits to the TAC in the period July 31, 1991 to June 26, 1992. This exhibit shows that treatment as a result of foreign bodies in the eye made up 22 percent of the total. Most of the strains and sprains involved the back. Eleven percent of the people were seen as a result of lacerations; 47 percent of these lacerations were lacerations of the fingers. The workers who used respirators had their blood pressures checked. The burns reported were mainly arc burns. During this entire period, there were only five cases in which the 911 system was used and the paramedics transported the patients to emergency rooms.

Exhibit 2. Total TAC Injury and Illness
7/31/91 to 6/26/92

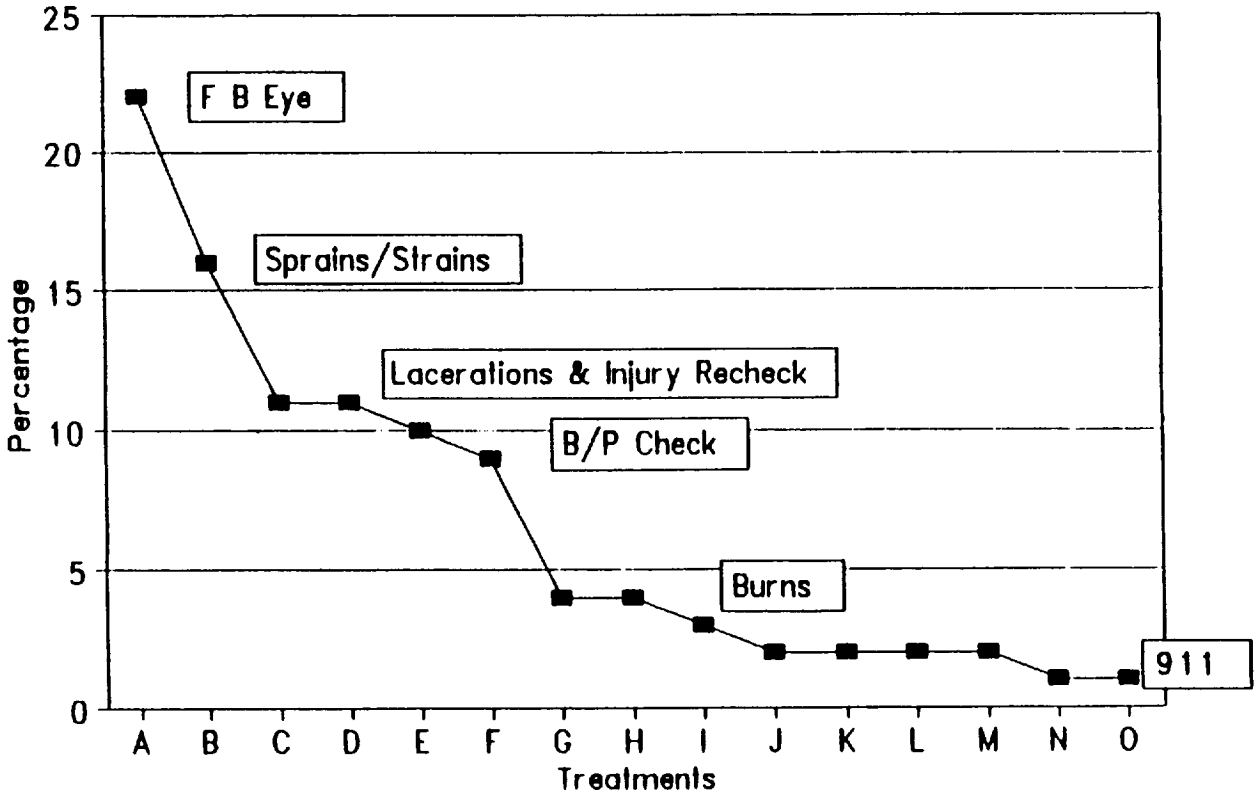


Exhibit 3 is a graph showing the number of visits to the Clinic by hours of operation, from 7 a.m to 11 p.m. during this same time period. Predominently the patients were seen on the first shift, when there were about 700 employees. During February we did have an 11 p.m. to 7 a.m. shift and, during that time, we only saw a total of 11 patients.

Exhibit 3. TAC Hours of Operation
7/31/91 to 6/26/92

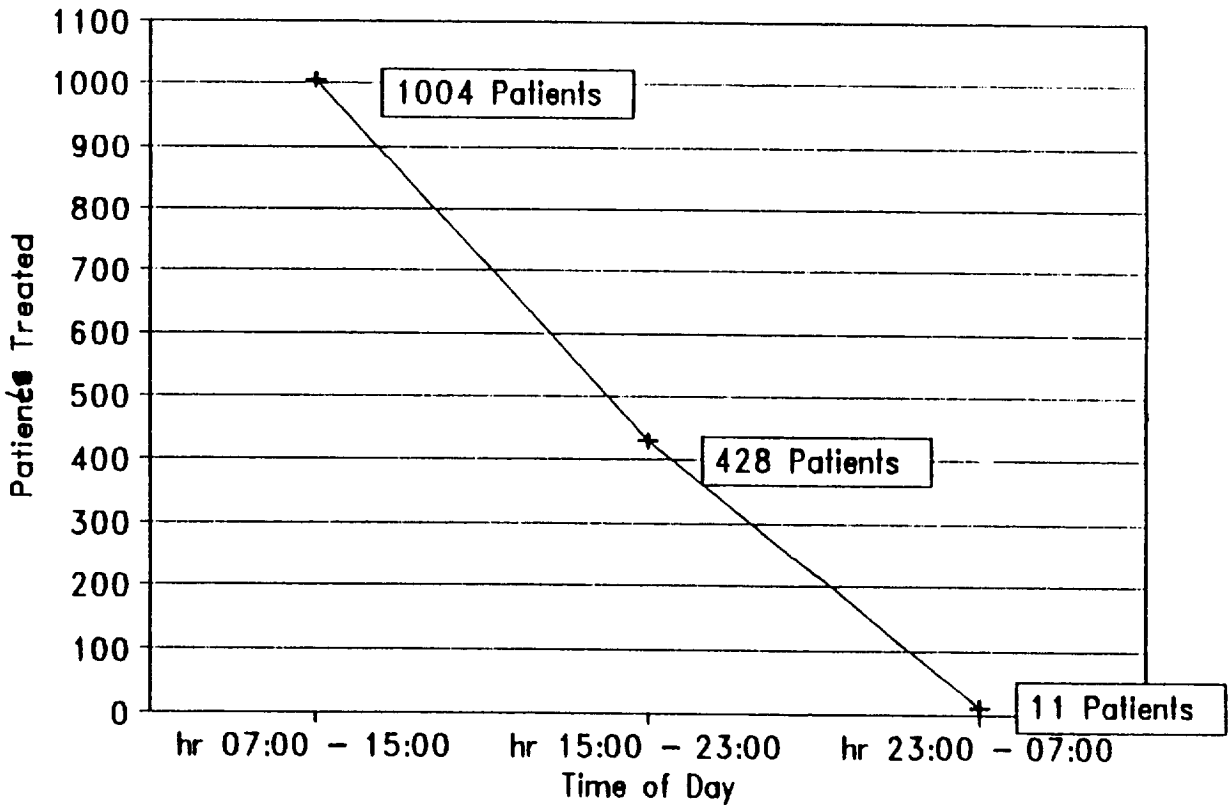
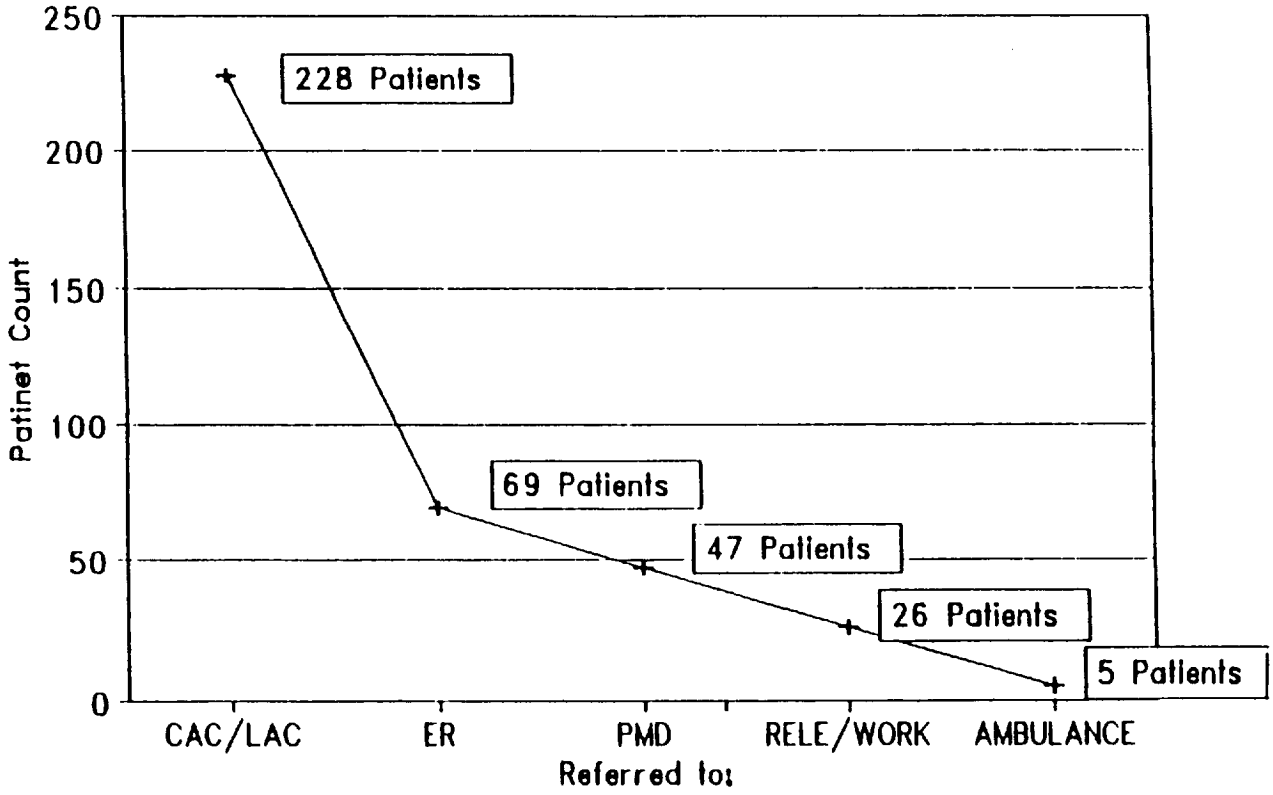


Exhibit 4 shows patient disposition. Of a total of 228 patients sent to the Cape Area Clinic or the Launch Area Clinic during this 11-month period, 26 actually had to be released from work. Releasing a patient from work is a problem because, if iron workers who came from Tampa, Alabama, Louisiana, etc., missed a day's work, they were sent back to their home base and the Union would then send out the next person in line for that position. Therefore, it is imperative that we keep these people at work whenever possible. Forty-seven patients were referred to their private physicians. These were non-occupational patients and included illnesses such as the common cold. We treated these as patients at the Clinic and then referred them to their own physicians. The on-site Safety Representative also had a contracting physician, and some people are referred to that physician.

Exhibit 4. TAC Patient Disposition
7/31/91 - 6/26/92



Overall, the services provided at this facility proved to be quite beneficial, not only for the contracting employer, but also for the employees who received on-site medical care. The quality of employee medical care had improved. A physician was readily available to treat various conditions including the removal of foreign bodies in the eye, lacerations requiring suturing, and to take X-rays to rule out fractures. Appropriate follow-up care was also provided on-site.

It was cost effective both from the direct care aspect and the benefits of not having to release employees for extended periods of time for evaluations at the local hospital emergency department or walk-in clinic. Employees lost very little time from work, and benefitted from the convenience of the service.

N94-16626

IDENTIFYING AND RESPONDING TO CUSTOMER NEEDS AT THE KENNEDY SPACE CENTER

E.B. Ferguson, M.D., M.P.H.
EG&G Florida/NASA Kennedy Space Center

All of us have become well educated in the tenets and essentials of total quality management. It is not my intention today to review those basics, but rather to present one of our approaches to identifying customer perceived needs and responding to them.

Our Patient Questionnaire Program at the Kennedy Space Center (KSC) has been in place for several years. It has helped to identify customer perceptions and needs. Shown in Exhibit 1 are the elements of information requested on the Patient Service Questionnaire.

Exhibit 1. Patient Questionnaire

1. Medical Facility (check one)
   _____Occupational Health Facility _____ CCAFS Clinic
   _____Launch Area Clinic
2. Date Visited _____
3. _____Physical Exam _____Treatment _____Other
4. Please rate the following areas. If excellent or poor rating is because of an employee's personal service or action, please identify that person by name if possible.

	Excellent	Satisfactory	Poor
o Courtesy	_____	_____	_____
o Quality of treatment/service	_____	_____	_____
o Timeliness	_____	_____	_____
o Attitude of Personnel	_____	_____	_____
o Info/Instructions provided	_____	_____	_____
o Overall	_____	_____	_____

5. We are constantly trying to improve patient care and solicit your comments/suggestions.

_____
_____
_____
_____

Please provide the following information if you desire a response to your comments.

Name _____ Organization _____
Mail Code _____

Exhibit 2 shows the results from 1,507 questionnaires received during the first eight months of 1990.

Exhibit 2. Results of Patient Questionnaire

Reporting Period: 01/01/90-08/31/90

	Excellent		Satisfactory		Poor	
Courtesy	1436	95%	71	05%	0	0%
Treatment Quality	1374	91%	133	09%	0	0%
Timeliness	1322	88%	178	12%	7	0%
Attitude	1427	95%	79	05%	1	0%
Information/Instruction	1342	89%	161	11%	4	0%
Overall	1349	92%	113	08%	0	0%

A total of 2,660 questionnaires were returned in 1990. The results indicated that 93 percent rated the medical services to be excellent overall, 96 percent rated medical services attitude to be excellent, and 96 percent indicated courtesy to be excellent. Remember that about 80 percent of our health services are for other contractor and government agencies and that an average of seven Medical Department employees have direct interaction with each of the patients during a visit.

It is interesting for benchmarking purposes to compare this with the results of a survey from a national publication, shown in Exhibit 3.

Exhibit 3. Percent Patient Satisfaction With Most Recent Doctor Visit

	Very Satisfied	Somewhat Satisfied	Not Very Satisfied	Not At All Satisfied
The way the doctor's staff treated you	71	23	4	2
The way the doctor explained things to you	66	23	6	4
The amount of time you had to wait before seeing a doctor	49	30	11	9
The fee the doctor charged	39	36	11	7
Overall, how satisfied were you?	60	32	5	3

Source: Office of Issue and Communications Research

I would like to focus now on the fact that 11 percent considered timeliness of service to be less than excellent, and 10 percent considered the amount of information received in relation to their health program to be less than excellent.

Timeliness is often subjective, so in response to this perceived concern, our patient data cards were changed based on a suggestion submitted by one of our clerical employees in order to more specifically identify time spent in various components of the visit. These changes are shown in Exhibit 4.

Exhibit 4. 1990 Patient Info Data Worksheet
(Please Print)

Arrival Time	First Name	Initial	Last Name
Social Security Number		Present Employer	
Job Phone	Supv. Name & Phone		
Sex / Race	Date of Birth	Date of Hire at KSC	
Bldg. No	Job Title	Mail Code	
Out To		Date	

KSC Form 28-211 (PA) (Rev. 1/88)

1991 Patient Info Data Worksheet
(Please Print)

Arrival Time	First Name	Initial	Last Name
Social Security Number		Present Employer	
Job Phone	Supv. Name & Phone		
Sex / Race	Date of Birth	Date of Hire at KSC	
Bldg. No.	Job Title	Mail Code	
ADDED: ROUTE TIME	TRIAGE TIME	DOCTOR'S TIME	

KSC Form 28-211 (PA) (Rev. 1/88)

This gave us the opportunity to dissect the specifics and work out any related problems. Our studies over a period of four months indicated that there was a 7-minute average wait before seeing a nurse, and a 16-minute average wait to see a physician. We shared this information with the members of our health care team and developed an approach to improving these services.

All agreed about the importance of perceptions. They recognized the need to tell the patient of any anticipated delay in service, and use communications to demonstrate responsiveness to the patient's needs.

The second area of concern, patient information, led us to develop what has sometimes been called "Discharge Summaries." We have labeled them "Health Tips." These take the 45 most frequently seen health problems and provide information on the condition, treatment, and self-care. A list of available topics is given in Exhibit 5.

Exhibit 5. Index of Topics in Kennedy Space Center's "Health Tips"

Abrasions
Abcesses
Allergies
Antibiotics
Anti-inflammatory Drugs (Non-Steroidal)
Back Pain
Blood Pressure Readings
Breast Lumps
Carpal Tunnel Syndrome
Cholesterol/Triglycerides (Elevated)
Contact Dermatitis
Contusions
Crutch
Dizziness and Vertigo
Ear Infections (Swimmer's Ear)
Eye (Inflammatory Problems)
Fainting
Flu
Gastritis and Peptic Ulcers
Head Injuries
Headaches
Hemorrhoids
Oral Herpes (Cold Sores)
Immunization
Inhalations of Toxic Agents
Insect Stings
Knee Injuries
Lacerations (Cuts)
Lung (Spot)
Muscle Spasms
Muscle Strains
Neck Pain
Non-Occupational Illness/Injury
Pap Smear
Prostate Cancer
Puncture Wounds
Sprains
Sunburn
Tachycardia and Palpitations
Throat and Tonsils (Infections)
Upper Respiratory Infections
Visual Acuity Problems
Vomiting and Diarrhea (Gastroenteritis)
Wound Infections

These are given out in all of our medical facilities by the nurse or the physician based on a condition which is discovered at the time of treatment or physical examination. We have found them to be very well received. The health tips can also be published in a variety of Center-wide publications and through our Health Education Program to provide public information on medical topics.

Our perception was that through a team approach we had effectively addressed these two areas of concern. Our re-survey in 1992, shown in Exhibit 6, was somewhat surprising. The results were almost identical to those a year earlier.

Exhibit 6. Results of Patient Questionnaire

Reporting Period: 01/01/90-08/31/90

	Excellent		Satisfactory		Poor	
Courtesy	2545	96%	115	04%	0	0%
Quality of Treatment/Service	2449	92%	211	08%	0	0%
Timeliness	2351	88%	293	11%	16	0%
Attitude of Personnel	2528	95%	131	05%	1	0%
Information/Instructions Provided	2390	90%	263	10%	7	0%
Overall	2479	93%	181	07%	0	0%

We do not accept the suggestion that these evaluations of our services are the best we can achieve. We believe that the lesson to be learned is that customer satisfaction takes continuous daily effort to sustain and improve. You cannot let down after initial successes. We are committed to an ongoing team effort to identify customer needs as well as perceptions and use the results in a continuous improvement process.

APPENDIX A

During this Annual Meeting of the NASA Occupational Health Program, on Wednesday afternoon, December 2, three separate "Breakout" sessions were held:

Occupational Health,
chaired by Stephen A. Weirich, M.D.

Industrial Hygiene,
chaired by Steven Brown, CIH

Physical Fitness and Health,
chaired by Jeffrey Moen.

These sessions provided an opportunity for the various NASA Centers to come together for an exchange of information and ideas, and to present the latest developments in their programs.

These sessions proved very successful. This Appendix presents some of the information presented, along with information on other methodologies and procedures now in use or planned for the future.

OCCUPATIONAL HEALTH

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S13-52

TUBERCULOSIS: A CASE FOR INCREASED SCREENING

Stephen A. Weirich, M.D.
NASA Lewis Research Center

N94-16627

Background

Tuberculosis (TB) has plagued people and animals since antiquity. In the early 20th century and before, this disease was epidemic, responsible for killing hundreds of thousands if not millions of people. In earlier days, tuberculosis had been called phthisis, galloping consumption, and white plague. But with the advent of modern medicine which brought antibiotics and infection control practices, and with improved sanitation techniques, nutrition, and hygiene practices, tuberculosis was quickly following the way of small pox in becoming extinct in developed countries like the United States -- that is, until the 1980's.

In 1953 (the first year of national reporting of diseases in the Unied States), there were 84,304 cases of reported TB in this country. Every year following, the number of cases fell about 5 percent annually, until 1984 when fewer than 22,000 new cases of TB were diagnosed. But in 1985 there was no further decline in the number of tuberculosis cases, and in 1986 there was even a 2.6 percent increase in TB cases. From 1985 to 1991 the number of TB cases jumped 16 percent nationally. In 1991 there were 26,283 new cases of TB reported to the Center for Disease Control (CDC) in Atlanta, and over 1,800 people died of tuberculosis. Not only has there been a significant rise in the number of TB cases over the past seven years, but there have been significant epidemiologic changes in the age, sex, ethnicity, and body site distribution of this disease.

Why the recent resurgence of this old foe in this country? Much of the cause has been blamed on the frightening spread of HIV infection and, while this is a major contributor, it is not the only reason. There have been increasing numbers of immigrants and refugees to the United States from TB-endemic countries in Asia, Africa, and the Pacific Islands. Homelessness, drug abuse, prison overcrowding, and cuts in health care funding have added to the problem. And most recently there has been the emergence of drug-resistance strains of tuberculosis which has caused significant concern. Today it is

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estimated that 7 percent of the U.S. population (or 15 million people) are infected with tuberculosis, with over 2 billion people infected worldwide.

Epidemiological Shifts

Tuberculosis is increasingly becoming a disease among minorities in this country. Between 1985 and 1990, the number of tuberculosis cases grew 55 percent among Hispanics, 27 percent among non-Hispanic blacks, and 19.6 percent among Asians and Pacific Islanders. At the same time, the incidence of TB has dropped 7 percent among non-Hispanic whites and Native Americans/Alaskans. Members of racial minority groups are now twice as likely to be infected with tuberculosis as are whites. In 1953, non-whites accounted for 24 percent of all TB cases, whereas in 1990, 70 percent of TB cases occurred in non-whites. Foreign-born persons now comprise 24 percent of TB cases, with 60 percent of these people having been in the United States less than five years. Eighty-six percent of childhood tuberculosis (age less than 15) occurs in minority children.

Urban areas have always had higher rates of tuberculosis, and this continues to hold true today -- 37.6 percent of TB occurs in large cities in this country, while only 18 percent of the U.S. population lives in cities. Between 1985 and 1990, Miami, San Francisco, Newark, Tampa, and New York City have consistently ranked among the 10 cities with populations greater than 250,000 with the highest TB rates. The astonishing corollary to this statistic is that TB is also on the rise in smaller cities and rural areas where, overall, most of the cases still occur.

While TB is still predominantly a concern of older age groups, the greatest increase in the numbers of TB cases since 1985 has occurred in the 25 to 44 year old age group. The national median age at diagnosis of tuberculosis dropped from 49 years old in 1985 to 47 years old by 1987. People over 65 years old represent approximately 30 percent of all cases, and since 1985 the incidence of TB has not increased in this age group.

In AIDS patients, 10 percent have concomitant tuberculosis, with TB increasingly heralding the diagnosis of AIDS in HIV-infected people. In one 1988 study from a New York City hospital, 55 percent of their TB patients were HIV-infected. As the incidence of HIV infection continues to shift from a predominantly homosexual, white, middle-class

population to a more impoverished, heterosexual, inner-city minority population with a higher prevalence of TB infection, the contribution of HIV-related TB mortality could be substantial in some areas. The degree to which the estimated 15 million people with latent TB infection in this country overlaps with the estimated 1.5 to 2 million HIV-infected persons is unknown, but will prove to be an increasingly important factor in the future rate of TB.

Recently there have been horrifying reports of the development of drug-resistant strains of TB, resistance to the usual antibiotics that have traditionally kept TB infection in check. In New York City, as many as 20 percent of the TB patients are infected with *Mycobacterium tuberculosis* that is resistant to both isoniazid and rifampin, and 33 percent of the cases were resistant to one of these antituberculous antibiotics. But this problem is not unique to New York City. Nationwide, during the first three months of 1992, 14.4 percent of all TB cases demonstrated resistance to at least one antituberculous drug, and 3.3 percent of cases were resistant to both isoniazid and rifampin. In contrast, between 1982 and 1986 only 0.5 percent of TB, nationwide, were resistant to both of these drugs.

Pathophysiology of Tuberculosis

The development of tuberculosis is a two-stage process. The first stage is the acquisition of the infection; the second stage is the development of disease after infection. The causative agent is the bacillus called *Mycobacterium tuberculosis* complex, which is comprised of three specific species: *M. tuberculosis, M. bovis,* and *M. africanum.* Infection occurs predominantly by the inhalation of respiratory droplets that are contaminated with *Mycobacterium tuberculosis* complex produced from people with active pulmonary tuberculosis who are coughing. Twenty-five percent of the people exposed to TB develop infection. The probability of acquiring infection is primarily dependent on the risk of exposure to air contaminants with the bacteria and the number of organisms inhaled (inoculum size). Six groups of people who are at higher risk of being infection with tuberculosis have been identified:

1. Persons infected with HIV or who are at high risk of HIV infection.
2. Close contacts of persons known to have or suspected of having infectious tuberculosis (including their health care providers).
3. Foreign-born persons from countries with a high TB prevalence.

4. Medically under-served, low-income populations.
5. Alcoholics and intravenous drug users.
6. Residents of long-term care facilities, correctional institutions, mental institutions, nursing homes, and other long-term residential facilities.

Once the bacteria is inhaled, it harbors in the lungs. The initial infection provokes an immune response mediated by T lymphocytes that activate macrophages. This same cell-mediated response is responsible for the reaction to a TB skin test. This immune response controls the infection by rendering the organism inactive and dormant. Furthermore, this response provides the host with good, although incomplete, protection against exogenous reinfection which is present for as long as the TB skin test is reactive.

Between 85 and 90 percent of those infected with tuberculosis will never develop the disease, and will, therefore, never be contagious. But approximately 10 percent of infected people will develop clinically apparent disease sometime during their lives. Overall, 3.3 percent of those infected will develop active disease within one year after infection. Twelve special clinical situations have been identified as rendering an individual at higher risk for the eventual development of disease if infection with tuberculosis has already occurred:

1. HIV infected.
2. Silicosis.
3. Abnormal chest X-ray showing fibrotic lesions that are likely to represent old, healed TB.
4. Gastrectomy.
5. Jejunoileal bypass.
6. Weight of 10 percent or more <u>below</u> ideal body weight.
7. Chronic malabsorption syndromes.
8. End-stage renal disease.
9. Diabetes mellitus.
10. Conditions requiring prolonged, high-dose corticosteroid therapy or other immunosuppressive therapy.
11. Hematologic disorders, especially leukemia and Hodgkin's disease.
12. Other malignancies, especially carcinomas of the oropharynx and upper GI tract.

Of people with active tuberculous disease, 90 percent have harbored the infection for greater than one year, indicating that the remaining 10 percent have a progression to disease within one year after initial infection.

Ninety percent of active tuberculous disease is pulmonary, with 10 percent of active TB involving extrapulmonary sites, especially the pleura, lymph nodes, bone, kidney, pericardium, meninges, peritoneum, or intestines. The incidence of extrapulmonary TB, which is more difficult to diagnose because of its insidious symptomatology, is increasing sharply among AIDS patients and intravenous drug users. For HIV-infected people there is a 100-fold greater risk of developing disease once infected with TB, with an average rate of 7 to 10 percent of patients infected with both HIV and tuberculosis going on to develop active tuberculous disease each year.

Screening for Tuberculosis

Prior to 1984, epidemiologists and infectious disease specialists expected tuberculosis in this country to be all but obliterated by 1990. Now with the resurgence of TB, public health officials hope to have TB controlled by the year 2010. To achieve this goal the population needs to be screened, especially people who are either in a high risk group for TB infection or those who are at high risk of developing the disease if infected. Those who are discovered to harbor latent tuberculosis infection need to be treated or at least monitored for the development of disease.

Mantoux Skin Test

The preferred screening test for tuberculosis infection is the Mantoux skin test. This test involves the *intradermal* injection of 5 tuberculin units (TU) of purified protein derivative (PPD), which is a filtrate of sterile, killed concentrates from cultures of *tubercle bacilli*. Reaction to the injected PPD is a cellular hypersensitivity reaction characterized by induration of the skin at the injection site (not just erythema) which occurs within 48 to 72 hours (when the test should be read) and is typically sustained for at least 5 days.

The sensitivity and specificity of the Mantoux skin test are both very high, rendering the test diagnostic for the presence of tuberculosis infection. The causes of both false positive and false negative results are outlined in Tables 1 and 2, respectively.

Table 1. Causes of False Positive Tuberculin Reactions

1. Previous vaccination with BCG.
2. Cross-reactivity to other non-tuberculous mycobacterial infections.

Table 2. Causes of False Negative Tuberculin Reactions

1. Active infections
   a. Viral (e.g., mumps, measles, chicken pox)
   b. Bacterial (e.g., typhus, overwhelming tuberculosis)
   c. Fungal.
2. Live virus vaccines (e.g., MMR, oral polio).
3. Metabolic/nutritional derangement (e.g., chronic renal failure, severe protein deficiency.
4. Lymph system diseases (e.g., Hodgkin's lymphoma, sarcoidosis).
5. Immunosuppression (e.g., corticosteroids, chemotherapy, HIV disease).
6. Age (newborn or the elderly).
7. Stress (e.g., burns, post-op, mental illness).
8. Mechanical (injection too deep, inexperienced reader).
9. Improper storage of PPD (exposure to light or heat).

Classically, a positive Mantoux skin test was interpreted as 10 mm or more of skin induration. This cutoff was determined on the basis of tests performed in over 275,000 naval recruits between 1958 and 1965. The larger the area of induration, the greater the likelihood that the reaction represents infection with tuberculosis. However, the epidemiology of tuberculosis has changed, and the CDC in 1990 issued new guidelines for the interpretation of the tuberculin reaction, outlined in Table 3.

Table 3. Cutoff Points for Significant PPD Test

1. Reaction > = 5 mm
   a. Persons with HIV infection.
   b. Household or close contact of a patient with infectious tuberculosis.
   c. Persons with chest X-rays consistent with old, healed tuberculosis.

2. Reaction > = 10 mm
   a. Foreign-born persons from countries with high tuberculosis prevalence.
   b. Medically under-served, low-income populations, including high-risk minorities.
   c. Intravenous drug users.
   d. Persons with other medical factors known to increase the risk of development of disease.
   e. Other populations that have been identified locally.

3. Reaction > = 15
   a. All other persons.

Because reaction to PPD requires intact cellular immunity, there is a high rate of anergy to PPD among HIV-infected people whose cellular immunity has been destroyed by the HIV virus. Also, in general, 10 percent of all people with tuberculosis infection (with or without HIV infection) are anergic. Therefore, for HIV-infected people or those who are suspected to be anergic, the CDC recommends the simultaneous intradermal injection of an anergy control panel comprised of *Candida*, mumps, tetanus toxoid and/or trichophyton -- ubiquitous substances which also require intact cellular immunity for a

positive reaction. If a patient develops induration at any of the anergy panel test sites, then he or she is not anergic and the reaction at the PPD site is accurate.

Repeated skin testing of individuals not previously infected with tuberculosis will not cause sensitization to tuberculin. However, delayed hypersensitivity to tuberculin may gradually wane over the years. The stimulus of an initial test may "boost" or increase the size of the reaction following a second test if it is given within one year after the first. This "booster phenomenon" is encountered most frequently in people over the age of 55 who were initially infected with tuberculosis many years earlier, and frequently leads to the inappropriate diagnosis of a new infection.

BCG (*bacille Calmette-Guerin*) Vaccination

The BCG vaccine is an attenuated substrain of *M. bovis* which has been widely used in many countries since 1929. The U.S. and the Netherlands are the only two countries that have never used the BCG vaccine on a national scale. In ten randomized, controlled trials performed since the 1930's, the protective effect against TB rendered by BCG vaccination has ranged from 0 to 80 percent in different populations. The interpretation of a PPD skin test following BCG vaccination is difficult since prior BCG vaccination is a common cause for false positive PPD skin test results. But the probability that a skin test reaction results from infection of tuberculosis increases:

1. When the size of the reaction increases with subsequent skin tests.
2. When the patient is a known contact of a person with tuberculosis.
3. When there is a family history of tuberculosis or when a patient's country of origin has a high tuberculosis prevalence.
4. As the length of time between vaccination and PPD skin testing increases.

Prophylaxis for People with Positive PPD Skin tests

After a patient is determined to be infected with tuberculosis by a true positive PPD skin test, the presence of active disease needs to be ruled out. If there is no evidence of active disease, then chemoprophylaxis with antituberculous medications may be indicated.

Typically, tuberculosis prophylaxis involves taking isoniazid (INH) daily at a dose of 300 mg a day in adults and 10-14 mg/kg (maximum dose of 300 mg) a day in children for 6 months to 1 year. INH prophylaxis is 93 to 98 percent effective in curing TB if a person is 100 percent compliant with his/her treatment. However, because compliance is rarely 100 percent, INH therapy is actually effective between 60 and 80 percent of the time.

The major side effect of INH is the development of drug-induced hepatitis, which is age-related, frequently self-limited, and can occur in up to 10 to 20 percent of people in varying degrees who take the medication. Despite the notoriety of INH-induced hepatitis, the percentage of people who develop it to the point of having to discontinue the drug is actually quite low, as outlined in Table 4.

Table 4. Risk of Isoniazid-Related Hepatitis

Age (years)	Percentage with Hepatitis
0-19	0
20-34	0.3
35-49	1.2
50-64	2.3

Other side effects of INH include drug interactions with phenytoin (Dilantin), where there is an increase in the serum phenytoin levels that can lead to phenytoin toxicity, and disulfiram (Antabuse), where behavioral changes can develop. Also, 1 percent of patients on INH develop a peripheral neuropathy due to pyridoxine (Vitamin B6) deficiency which can be prevented by the administration of pyridoxine at a dosage of 10 to 25 mg a day. Finally, INH can induce a Lupus erythematosus-like syndrome, skin rash, or drug fever.

In general, those who should receive INH prophylaxis among PPD reactors include:

1. Household and close contacts, regardless of age, of infectious TB cases.
2. Newly infected persons, regardless of age, because the risk of developing disease is greatest in the first two years after infection.
3. Persons, regardless of age, with past clinical TB who have not previously been treated with adequate chemotherapy.
4. Persons, regardless of age, with significant reactions to PPD and abnormal chest X-rays (even if asymptomatic).
5. Persons with significant reactions to PPD in the twelve special clinical situations outlined earlier.
6. PPD reactors under the age of 35 years.

Recommendations

Given the worrisome rise in tuberculous disease since 1985, health care providers need to participate in more widespread screening for tuberculosis infection and consider both pulmonary and extrapulmonary disease higher up in their differential diagnoses if it is appropriate given the specific clinical picture. Certainly, if a patient falls into one of the CDC's six high-risk groups for TB infection outlined earlier, then screening for TB is strongly recommended. Similarly, if a patient proves to harbor *M. tuberculosis* complex infection, it may be prudent to encourage that patient to undergo confidential, if not anonymous, HIV antibody testing, given the more fulminant and atypical course of tuberculous disease in HIV-infected individuals.

In an Occupational Health Clinic, certainly all of the health care providers should be screened annually for tuberculous infection, as should facility paramedics and fire fighters. A strong case can be made to include cafeteria workers and security guards in an annual screening program. I also recommend that the PPD status of all employees easily be ascertained by incorporating at least a baseline test, one time, in the employees' annual health physical. The PPD test should then be repeated when an employee reaches the age of 55 or soon thereafter. The cost of PPD (Aplisol) is about $29.25 per 5 cc vial which contains 50 tests, or 58.5 cents per test. The added costs of nursing/physician time and the supplies required to perform the test are truly negligible if the process is incorporated into an already scheduled physical exam. In addition, employees may have

better compliance returning to an office-based health clinic in two or three days to have their PPD test read than would be the case if they had to go to an off-site private physician's office or health center.

When treating sick employees with a nagging cough that has "just hung on," the health care provider needs to strongly consider, along with bronchitis, community-acquired pneumonia, post-viral cough, chronic sinusitis, and asthma, the possibility of whether this could be tuberculous disease, and think about recommending PPD skin testing.

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SUMMARY OF FOLLOW-UP RESULTS FROM POTENTIAL TUBERCULOSIS EXPOSURES

N94-16628

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There were two isolated episodes of Lewis Research Center (LeRC) workers who were diagnosed with pulmonary tuberculosis (TB) during the fall of 1990. The specifics surrounding each case were very different, and it is clear that the two episodes were completely unrelated. The fact that the final diagnoses of pulmonary tuberculosis came within three weeks of each other was purely coincidental.

While it became evident that neither worker diagnosed with tuberculosis contracted the infection while working at Lewis, there was some concern that co-workers, especially those who had close contact with either individual, may have been infected. This was especially a concern in the second incident, which involved an employee who worked in Building 49. This employee was symptomatic and had been coughing for almost six weeks before the final diagnosis of tuberculosis was made. The first case involved an employee who worked in the Engine Research Building (ERB) basement. This employee was neither symptomatic nor contagious, and the diagnosis of pulmonary tuberculosis was actually an incidental finding when a lung nodule, suspicious for cancer, was biopsied and subsequent cultures grew *Mycobacterium tuberculosis*, the organism responsible for TB.

The Occupational Medicine Service (OMS) conducted separate informational sessions and offered free PPD skin testing to all employees, both NASA and contractors, who felt that they were at risk of having been exposed to tuberculosis from either individual. Skin testing was conducted immediately to determine if the employee had previously been exposed to TB, and for all negative skin tests the PPD skin test was then repeated in three months to determine if that individual had indeed been infected with TB from one of the NASA employees.

Eleven (11) employees reported to OMS from the basement of ERB. Skin tests were done in September on these individuals, and 10 out of the 11 were negative. The eleventh individual had an equivocal result (borderline positive). This individual had no known exposure to TB in the past, and he was currently asymptomatic. After three

months the skin tests were repeated on all 11 of the individuals, including the individual with the equivocal results. All were negative on repeat except for the employee with the equivocal results. On repeat testing, his results were positive. A chest X-ray was negative, and the patient was referred to the Metro Health Center Tuberculosis Clinic where it was determined that he had experienced a booster phenomenon and his exposure to TB had most likely occurred as a child. His family was skin tested, with all having negative results. Currently, this employee is taking six months of INH (Isoniazid).

Thirty-nine (39) individuals reported to OMS for skin tests from the Building 49 incident, including seven (7) workers identified by the index case as having been in frequent contact with him. Thirty-seven had negative skin tests initially. One individual had a known prior history of a positive PPD skin test, so a chest X-ray was done that was negative. One individual tested positively to the PPD initially, and on further investigation it was discovered that she had received the BCG vaccination as a child in a developing country. She was given a chest X-ray, which was also negative. Repeat PPD skin tests were then performed on 36 individuals after three months, and all of the repeat tests were negative. The two individuals with known positive PPD reactions have been advised to receive annual chest X-rays. One individual has not returned for repeat testing because she is currently pregnant and would prefer not being retested until after the delivery of her child.

In summary, no NASA or contractor employee from either incident involving potential exposure to TB has been infected with the *Mycobacterium tuberculosis* bacteria as a result of exposure in the workplace. Stemming from these two incidents are three corollaries:

1. The Occupational Medicine Service is revising their annual health screening exams to at least offer PPD skin testing to employees as a baseline test.

2. The Director of Occupational Medicine Service and the Director of the Office of Health Services approached the Directors of the Cafeteria Exchange Workers and offered free PPD skin tests to all cafeteria workers. This service was implemented on a voluntary basis. To date, no one from the Cafeteria Exchange has requested skin testing.

3. All employees in the Office of Occupational Medicine Service are receiving annual PPD skin tests or chest X-rays if the employee has a known positive PPD reaction.

LEGIONELLA: AN OVERVIEW

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N94-16629

History

During the summer of 1976, at an American Legion Convention held at the Bellevue-Stratford Hotel in Philadelphia, 221 participants became mysteriously ill with a fulminant pneumonia. Thirty-four people died. Within six months, the Centers for Disease Control (CDC) had isolated the causative agent: a newly discovered bacteria which was aptly named *Legionella*, and the fulminant pneumonia it caused was called Legionnaires' Disease.

In retrospect, a similar episode had occurred at the same Philadelphia hotel in 1974 where 20 guests became ill with severe pneumonia but no one succumbed. Also in July 1968 at a Health Department building in Pontiac, Michigan, 144 employees and visitors developed a self-limited, flu-like illness which had been blamed on a cryptic "virus." Eight and a half years later, the CDC determined it was actually *Legionella* that had caused this minor epidemic in Pontiac, but the resultant disease was not as virulent as Legionnaires' Disease and was subsequently named Pontiac Fever.

Today, *Legionella* and the infections it can cause are notorious but probably under-diagnosed. Now more than 25 species of *Legionella* have been recognized, with 18 of them having been implicated in causing human disease. The bacteria responsible for the outbreak at the American Legion Convention has been identified as *Legionella pneumophila*, with 14 recognized serotypes. Serotype 1 was specifically responsible for the Legionnaires' Disease outbreak in 1976, and is believed to account for about 50 percent of human disease from *Legionella* species. "Legionellosis" is the term used to refer to the spectrum of disease caused by any species of *Legionella*.

Bacteriology, Ecology and Transmission

Legionella are gram-negative, aerobic bacilli which are ubiquitous in the natural environment, particularly found in mud, frozen streams, hot springs, and stagnant lakes

and ponds. They are small in size, measuring 0.3 to 0.9 microns by 2 to 5 microns. Human disease occurs when a sufficient environmental inoculum is aerosolized and inhaled by a human host. Because of the small size of the bacteria, if inhaled it can easily reach the terminal bronchioles and alveoli of the lung where infection can occur. The course of subsequent disease is determined by the virulence of the bacterium, the immune competence of the human host, and the inoculum size. Immunocompetent individuals develop Pontiac Fever, whereas people that are relatively immunocompromised may develop Legionnaires' Disease.

The growth of *Legionella* is amplified under certain conditions, many of which can be easily found in man-made water supplies -- specifically cooling towers, air conditioning systems, humidifiers, whirlpool baths, respiratory nebulizers, showers, vaporizers, and forced-air heating systems. The air conditioning system of the Bellevue-Stratford Hotel in Philadelphia was determined to have been contaminated with *L. pneumophila*.

Legionella can grow when the ambient water/air temperature is between 20°-70°C, but, in particular, the bacteria proliferate in a warm environment between 35°-43°C. Growth of *Legionella* is further promoted in the presence of low concentrations of iron, zinc, potassium (typical corrosion products in many plumbing systems), and low levels of other competing microorganisms.

If water from man-made water sources contaminated with *Legionella* is aerosolized, the bacteria are readily inhaled. In addition, dusts generated from construction and landscaping activities can aerosolize virulent *Legionella*. Aerosolized *L. pneumophila* can survive for more than two hours, and have been isolated more than one mile downwind of an infected cooling tower. Other routes of entry into human hosts include microaspiration and dermal exposure through wounds that are cleaned with *Legionella*-infected water causing wound infections. While *Legionella* has been isolated in potable drinking water, infection does <u>not</u> occur following ingestion of contaminated water. Furthermore, once infection has occurred, person-to-person transmission does not exist.

Epidemiology

Legionella is probably responsible for 1 to 3 percent of community-acquired pneumonias, and up to 25 percent of "atypical" community-acquired pneumonias. In absolute numbers, *Legionella* is believed to cause 50,000 to 60,000 cases of community-acquired pneumonia each year, and is responsible for an additional 200,000 cases of nosocomial (or hospital-acquired) pneumonia each year. At least 4 percent of the American population demonstrate serologic evidence of prior exposure to at least one *Legionella* species, indicating past infection. Despite these impressive numbers, as of November 2, 1992, only 1,094 cases of *Legionella* had been reported to the CDC so far this year even though Legionellosis is a reportable disease, indicating that this disease is either under-reported or under-diagnosed, or both.

Clinical Manifestations

Legionellosis describes a spectrum of disease, with the now-recognized Legionnaires' Disease (pneumonia) and Pontiac Fever at opposite ends of this spectrum.

Legionnaires' Disease (Legionella pneumonia) is characterized by an abrupt prodrome of malaise, headache, myalgia, and weakness. Within 24 hours the patient develops a fever (exceeding 40°C in half of the patients), rigors, nonproductive cough that can become eventually productive with some blood-tinged sputum, pleuritic chest pain, and dyspnea. Gastrointestinal complaints of diarrhea, nausea, vomiting, and abdominal pain are common, and frequently there is a change in mental status. Unusual clinical signs and laboratory hallmarks of Legionnaires' Disease besides a marked leukocytosis include a relative bradycardia given the patient's temperature elevation, elevated liver function tests (specifically alkaline phosphatase, and transaminase levels), hyponatremia, hypophosphatemia, and rapidly progressive asymmetrical pulmonary infiltrates on chest X-ray.

If an individual is exposed to *Legionella*, the risk of developing pneumonia is 1 to 7 percent. The incubation period is 2 to 12 days. The development of pneumonia is primarily dependent on the presence of specific risk factors, most of which render the host relatively immunocompromised. These risk factors include:

1. **Immunosuppression** (especially individuals with compromised cell-mediated immunity, as in renal transplant recipients).
2. **Concomitant Chronic Disease**, especially diabetes mellitus or COPD.
3. Age Greater than 50 Years Old.
4. Heavy alcohol use.
5. Cigarette smoking.
6. Male (men:women incidence is 3:1).

The overall fatality from *Legionella* pneumonia is 15 percent. In immunocompromised hosts, if untreated, the fatality rates have exceeded 80 percent. Even in immunocompetent hosts who are appropriately treated, the fatality rate is upwards of 7 percent. If the patient survives the infection, there has been no reported sequelae, and if the patient is immunocompetent, the infection renders them immune to reinfection from the same strain of *Legionella*.

Pontiac Fever, as previously mentioned, is an acute, self-limited, flu-like illness that develops within 24 to 48 hours after exposure to the *Legionella* bacterium. If an individual receives a sufficient inoculum of bacteria, the chances of contracting Pontiac Fever approach 95 to 100 percent, regardless of the person's immune status. Symptoms include malaise, myalgia, and headache initially, with the eventual development of fever, chills, cough, coryza, and sore throat. Diarrhea, nausea, dizziness, and mild photophobia may develop. Symptoms typically last 2 to 5 days and resolve with or without antibiotics, with no sequelae, and the condition is never fatal. Unlike the pneumonia, there are no recognized risk factors for the development of Pontiac Fever. Given the non-specificity of the disease's symptoms, frequently this condition is misdiagnosed as a "short-lived viral syndrome."

Diagnosis

There are no good, reliable, and rapid tests to confirm the presence of *Legionella* species, which certainly contributes to the under-reporting of Legionellosis. Proper diagnosis and expedient treatment is dependent on a high index of suspicion on the part of the health care provider.

Legionella can be cultured from induced sputum samples or transtracheal aspirates (because if the patient has a cough it is usually nonproductive). However, the bacteria require a special culture media for adequate in vitro growth, called buffered charcoal yeast extract agar with alpha-ketoglutarate, which must be specifically ordered by the clinician. Typically it takes 2 to 5 days to properly identify the organism.

There are several commercially available urine antigen tests that utilize an enzyme-linked immunosorbent assay, a radioimmune assay, or latex agglutination to detect the presence of antigen in the patient's urine. While these tests are relatively rapid and accurate, they are expensive. Their main disadvantage is that antigenuria may persist for months following an infection with *Legionella*, which can obscure the distinction between acute and past infection.

The most widely used diagnostic test is a serum antibody test. Commercially available tests identify antibodies against six serotypes of *L. pneumophila* and seven other *Legionella* species. Diagnosis of *Legionella* infection is confirmed if there is a four-fold rise in the antibody titer between the acute and convalescent sera, which are typically drawn three to four weeks apart. Convalescent titers must be positive to at least a 1:128 dilution. A single titer that is positive at 1:256 dilution, or greater, is considered diagnostic for *Legionella* infection. Besides the disadvantage of having to wait 3 to 4 weeks to confirm the diagnosis of Legionellosis, only 80 percent of patients will have seroconverted even 10 weeks after the acute infection.

Treatment

Legionella is an intracellular parasite. Only antibiotics that can penetrate cells are effective in treating Legionellosis. These drugs include erythromycin (and the newer macrolides: azithromycin and clarithromycin), rifampin, tetracyclines, and quinolones. Recommended dosages for the treatment of *Legionella* pneumonia are Erythromycin 1 gram IV Q6H, or Doxycycline 200 mg IV Q12H. Parenteral administration is preferred given the frequent gastrointestinal symptoms patients have with the pneumonia. Clinical response is frequently seen within 5 days, at which point the antibiotics can be given orally (Erythromycin 500 mg po Q6H, or Doxycycline 100 mg po Q12H). If there is no significant clinical response to the original parenteral administration of antibiotics, Rifampin 600 mg IV Q12H should be added to the regimen.

Prevention

Unlike other common microbial agents that cause pneumonia, *Legionella* has a source that is extrinsic to the host, and thus the disease can be prevented (at least in theory) by control measures directed at the environmental source. Control of *Legionella* growth can be accomplished by:

1. Preventing the accumulation of stagnant water in an indoor environment.

2. Preventing the dispersal of cooling tower effluent into the indoor environment.

3. Maintaining adequate temperature and/or chlorination of hot water systems, and even periodically elevating the water temperature above 60 to 70°C and flushing the system through distal sites (e.g., faucets, shower heads).

In the absence of diagnosed disease from *Legionella*, routine monitoring of water systems for the presence of the bacteria is not recommended. Given the ubiquity of this organism in the environment, it is frequently found in man-made water systems. The development of human disease is dependent not only on the presence of the bacteria, but the virulence of the particular strain of the bacteria and the bioavailability of the bacteria in a form that can be inhaled by the human host. Therefore, routine testing for *Legionella* should not replace sound engineering practices combined with a regular maintenance and cleaning program of indoor water systems.

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N94-16630

SCREENING FOR PROSTATE CANCER

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Despite recent advances in both the survival and cure rates for many forms of cancer, unfortunately the same has not been true for prostate cancer. In fact, the age-adjusted death rate from prostate cancer has not significantly improved since 1949, and prostate cancer remains the most common cancer in American men, causing the second highest cancer mortality rate.

Scientific studies have found no consistent correlation of prostate cancer with diet, venereal disease, sexual habits, smoking, or occupational exposure. However, there does seem to be correlation with higher serum testosterone levels. It also appears that there may be a familial tendency for the development of prostate cancer, although no chromosomal abnormalities have been discovered that can predict whether or not an individual will develop prostate cancer.

Approximately 100,000 cases of prostate cancer are diagnosed annually, and 28,000 men die each year from this disease. But the good news is that prostate cancer is a relatively slow growing tumor that also metastasizes (or spreads to other parts of the body) slowly. It is not uncommon for a man to be diagnosed with prostate cancer, live for many years, and die of something else completely unrelated to the prostate cancer.

The chance of a man developing clinically evident prostate cancer anytime during his lifetime is only 6 to 8 percent. Autopsies that were performed on men who died from causes other than prostate cancer have demonstrated that the chance of their being microscopic evidence of prostate cancer greatly increases as men get older. About 10 percent of all men in their 50's will have microscopic evidence of prostate cancer. By the time a man is in his 80's, the chances of his having microscopic evidence of prostate cancer jumps to 70 percent. But nine out of ten prostate cancers are never detected and are clinically unimportant because they either do not cause symptoms or do not spread fast enough.

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To date, there has not been a good screening test that detects the presence of prostate cancer in men who are without symptoms. In order for a screening test to be good it should be inexpensive, non-invasive, easy to do, and accurate.

The oldest and most widely used screening test has been the digital rectal examination. While this test is inexpensive, relatively non-invasive (although some may argue differently), and easy to do, it is not very accurate. Even given the best situations and longest fingers, a physician can only feel about 9 percent of the entire surface of the prostate gland.

In April 1991, the *New England Journal of Medicine* published an article that suggested using a blood test that measures the level of prostate-specific antigen (PSA) as a screening test for prostate cancer. PSA is a protein that is only made in certain prostate cells called epithelial cells. The level of this protein is elevated in between 25 and 92 percent of patients with prostate cancer, but it is also elevated in 30 to 50 percent of patients with an enlarged prostate gland (a condition called benign prostate hypertrophy which affects practically every man over the age of 30 to varying degrees), and in patients with an infection of the prostate gland.

The PSA test is not a new test, but has been available for several years. It has been an extremely useful test to help monitor the progression of prostate cancer in a patient who is known to have prostate cancer. But its usefulness as a screening test is debatable. Reviewing the four criteria of a good screening test, the PSA test is not particularly inexpensive. The average price of the PSA test is about $100.00 (prices may vary depending on which laboratory does the test). The test is fairly non-invasive (only requiring a needlestick to obtain the blood), and is easy to do, although you must send the blood to a specialized laboratory which may not always be accessible. However, the biggest controversy over the PSA test is with its accuracy.

Physicians and epidemiologists measure a test's accuracy by virtue of its "sensitivity" and "specificity." Simply defined, "sensitivity" is the measurement of the ability of a test to be positive when the disease is actually present, whereas "specificity" is a measurement of the ability of a test to be negative when the disease is not present. Because of the relatively high rate of both false positive and false negative tests, the PSA test is neither very sensitive or specific. The published sensitivity rates for the PSA test are around 80 percent, with specificity rates between 38 and 56 percent. In other words,

when an individual has prostate cancer the PSA will be positive only 80 percent of the time, thereby missing 20 percent of the cases of prostate cancer (a false negative test). Similarly, if an individual does not have prostate cancer, then the PSA will be negative only 38 to 56 percent of the time, thereby yielding a false positive test 44 to 62 percent of the time. Given the PSA test's high false positive and false negative rates, the accuracy of the test in diagnosing either the presence or absence of prostate cancer in asymptomatic men is greatly diminished.

Because of the PSA test's inaccuracy and relatively high cost, it does not fulfill the criteria of a good screening test. However, the PSA test can be very useful in many circumstances. If a prostate nodule is detected on rectal exam, the PSA test can help determine whether or not the nodule is malignant. As previously stated, the PSA test is excellent at following the course of a patient who is known to have prostate cancer. And the PSA test is excellent at diagnosing prostate cancer that has metastasized (or spread) beyond the prostate gland when the primary tumor is so small that it cannot be felt. I also recommend the PSA test for men with certain risk factors for prostate cancer, specifically if they are over the age of 50, have a strong family history of prostate cancer (especially if the family members with prostate cancer were diagnosed at a relatively young age), or if a patient has symptoms of urinary obstruction.

Currently, the Occupational Medicine Services (OMS) at Lewis encourages all male employees over the age of 40 to get at least an annual rectal exam, which is available to all government employees during their annual health screening physical offered through OMS. The American Cancer Society and the National Cancer Institute recommend the annual rectal exam for men over the age of 40, but the U.S. Preventive Services Task Force states there is insufficient evidence to recommend either for or against the annual rectal exam. Currently, none of these groups advocate the PSA test as a screening tool for prostate cancer in men without symptoms. However, if you feel that you should have a PSA test, please talk with your personal physician for further information.

INDUSTRIAL HYGIENE

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INDUSTRIAL HYGIENE BREAKOUT SESSION

During the Industrial Hygiene Breakout session, many topics were discussed and a sharing of information took place.

Equipment

Lead: Mike Cardinale, CIH, reported that Kennedy Space Center has purchased an infra-red spectrum analyzer. This analyzer has the capability to given an instantaneous read-out of lead exposure levels. The cost of the equipment was $50,000, and it is working well.

Hydrazine: New OSHA-approved dosimeters able to give measurement readings at the newly proposed TWA of 0.01 ppm.

Software

Many Centers reported excellent results and availability with the CC Info and the OSHA CD ROM systems.

Michael Blotzer, CIH, of Lewis Research Center, discussed the possibility of creating an Agency-wide computer bulletin board system specifically for occupational health issues.

Conferences

Lead Management Meeting: Gene Proctor discussed the possibility of initiating a NASA lead management meeting or training seminar sometime in the spring.

NOTE: This meeting will be held on June 14-16, 1993, in Pittsburgh, Pennsylvania.

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Lead: Information from the October 1993 Lead Tech Conference (Bethesda, Maryland, attended by Gene Proctor and Dianna Giammarco) will be distributed to Occupational Health personnel throughout the Agency.

Other Topics

Legionella: An announcement was made that Agency guidelines for the control of legionella bacteria would be completed and distributed soon. Center representative discussed alternative means of controlling the build-up of legionella bacteria such as ozone and ultraviolet light.

NOTE: This information was mailed in May 1993. For additional information, please contact Tonja Drake, BioTechnology, Inc., (703) 534-8200.

Ergonomics: Gene Proctor discussed the possibility of developing a training program to address the ergonomic needs Agency-wide.

All attendees of the Industrial Hygiene Breakout session recommended that these sessions be held during future Occupational Health Meetings.

PHYSICAL FITNESS AND HEALTH EDUCATION

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PHYSICAL FITNESS AND HEALTH EDUCATION

Jeffrey J. Moen
Program Manager, Physical Exercise Program
NASA Marshall Space Flight Center

On Wednesday, December 2, 1992, the afternoon session of the NASA Occupational Health Program Meeting was designated a "Breakout" session for those involved in the exercise programs at the NASA Centers. Chairman of this program was Jeff Moen, Program Manager of the Physical Exercise Program at the Marshall Space Flight Center. Those in attendance were:

Mary Beaton, Langley Research Center, Fitness Center Coordinator

Cathy Angotti, Program Coordinator for Fitness and Nutrition, NASA Headquarters

Randy Pratt, Program Director, Ames Research Center

Larry Weir, Physical Fitness Director, Johnson Space Center

Christy Hoffman, Physical Fitness Coordinator, Kennedy Space Center

Julie Gates, Dryden Flight Research Facility.

Each participant was asked to give a brief review of their health promotion and exercise programs. Some of the suggested areas to cover were:

Policy procedures to enter the programs
Eligibility
TDY eligibility
Health promotions offered
General facility management.

After each Center's representative reviewed their program, time was given for further discussion and to answer questions raised by the other Center representatives.

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The session produced a beneficial exchange of ideas and increased insight on the successes and obstacles unique to each Center. It is now apparent that each of the Centers is unique and governed under different policies. Through this exchange, various management techniques and styles, as well as philosophies concerning exercise and health promotion, were observed. Each of the Center's represented functions successfully given its own philosophies, regulations, and policies.

All of the time that was allotted during this half-day session was spent on Center presentations. Although all of the Centers were not represented at the meeting, those in attendance thoroughly covered and explained their Center's operational policies. The order of presentation was alphabetical, by Center.

The following pages are a brief review of some of the Center presentations.

N94-16631

PHYSICAL FITNESS AND HEALTH EDUCATION PROGRAM AT NASA HEADQUARTERS

Cathy Angotti, R.D., L.D.
Occupational Health Office
NASA Headquarters

Policy Procedures to Enter the NASA Headquarters Physical Fitness and Health Program

Eligibility for participation in the Physical Fitness Program at NASA Headquarters is dependent, first, on a chart review by a staff physician. If the person has not taken advantage of having a physical examination, a questionnaire is administered that provides known personal and family medical background. If the reviewing physician feels that a treadmill test is warranted, it may be given. If a more serious condition is found to exist, the employee will be required to obtain clearance for his/her PMD with concurrence from the NASA physician. All participants must be "cleared" before they can participate in the program and the facility.

After a person has been cleared to use the facility, the Fitness staff is notified. The Fitness staff then contacts the employee to schedule an appointment for fitness testing and a personal exercise program. At this initial appointment, proper equipment use and maintenance is explained.

Eligibility

Only civil servants are eligible to use the Fitness Facility. At one time, contractors were allowed to use the facility on a "space available" basis if they met the medical clearance requirements. While this is no longer the case, a few contractors do still use the facility, but when they leave the Agency, they will be replaced with NASA employees.

TDY Eligibility

A NASA employee from another Center who is cleared in his/her own facility or who has a medical record on file with that facility may be cleared to use the

Headquarters facility. It is necessary that these employees complete the appropriate form for use of the facility, inform their originating Center Medical Unit, and have that physician give verbal approval to the staff Headquarters physician.

Health Promotions Offered

The Fitness Facility has been positioned as an extension of overall health promotion and disease prevention efforts. There is a close working relationship between the Fitness Manager, the clinic staff, and the nutritionist.

Major effort is given to the Annual Agency Fitness Challenge. A walking club was established with a t-shirt incentive for participants who walked 1,000 minutes or more. The staff promotes Headquarters involvement in National Fitness Day. A weight loss competition, between organizational codes, was successfully planned and implemented. Consideration for a follow-up program or making this competition an annual event is being evaluated. Classes are offered periodically on back care, strength training, toning, the biofeedback role in stress management, etc. These sessions are then turned into "instant talks," with appropriate handout materials given out by the speaker (EAP, nutritionist, etc) and made available to anyone who requests them. Softball is a well supported intra-mural sport, and the annual NASA golf tournament is fun for the seasoned player as well as the "duffer."

Two aerobics classes are offered each day: step aerobics and the more traditional dance aerobics. This program is entirely self-supporting, with an average of 500 participant visits each month. A small monthly fee is charged for unlimited sessions to pay the cost of the outside instructors.

General Facility Management

The entire Headquarters operation was moved from several buildings into one new facility during 1992, and will be completed before the summer of 1993. To smooth out some of the "kinks" in the delivery of normal service that can happen in a move of this magnitude, Town Meetings were held which enabled the employees to interact with the staff as a group.

The program is run with two full-time slots that are staggered to cover the extended hours of the facility. The Fitness Manager has a Master's Degree in exercise physiology and an extensive background in cardiac rehabilitation. This background is an excellent complement to the ongoing Cardiovascular Risk Reduction Program that is run by the nutritionist.

The 4,500 square foot Physical Facility is located below the lobby on the concourse level, and includes locker rooms for men and women. A variety of equipment is available to meet the aerobic and strength conditioning needs of the population. An average of 140 people use the facility each day, and this is likely to increase as the move is finalized and all of the NASA Headquarters employees are located in the same building.

The 1,000 square foot Aerobic Facility, located directly across the hall, is separate from the main Fitness Facility. This facility's floor surfaces are appropriate for aerobic activities.

N94-16632

AMES FITNESS PROGRAM

Randy Pratt
Fitness Program Director
NASA Ames Research Center

The Ames Fitness Program services 5,000 civil servants and contractors working at Ames Research Center. A 3,000 square foot fitness center, equipped with cardiovascular machines, weight training machines, and free weight equipment is on site. Thirty exercise classes are held each week at the Center. A weight loss program is offered, including individual exercise prescriptions, fitness testing, and organized monthly runs. The Fitness Center is staffed by one full-time program coordinator and 15 hours per week of part-time help.

Membership is available to all employees at Ames at no charge, and there are no fees for participation in any of the program activities. Prior to using the Center, employees must obtain a physical examination and complete a membership package.

Funding for the Ames Fitness Program was in jeopardy in December, 1992; however, the employees circulated a petition in support of the program and collected more than 1,500 signatures in only three days. Funding has been approved through October 1993.

The Center relies heavily on user support in the form of donated services and funds (more than $60,000 in 1992). Exemplifying this support was the construction of a horizontal climbing wall (valued at $15,000) built and installed entirely with donated services and funds.

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N94-16633

JOHNSON SPACE CENTER
HEALTH RELATED FITNESS PROGRAM

Larry T. Wier, Ed.D.
NASA Johnson Space Center

- Emphasis on Health – not Athletics
- Program includes
  - medical clearance by exam and stress test (ACSM Guidelines)
  - prescribed exercise
  - education component
  - quarterly fitness appraisals
  - quarterly newsletter
  - nutrition intervention program

Education Component

- Courses
  - Initial HRFP I 12 weeks, 3 days/week
  - Refresher HRFPII 10 weeks, 4 days/week
  - Refresher HRFPIII 10 weeks, 5 days/week
- Lecture series on The Role of Exercise in Health; one hour per meeting
  - lecture: 15 - 20 minutes
  - prescribed exercise: 20 - 45 minutes
- Written cognitive final test
- Fitness appraisals at beginning, middle and end

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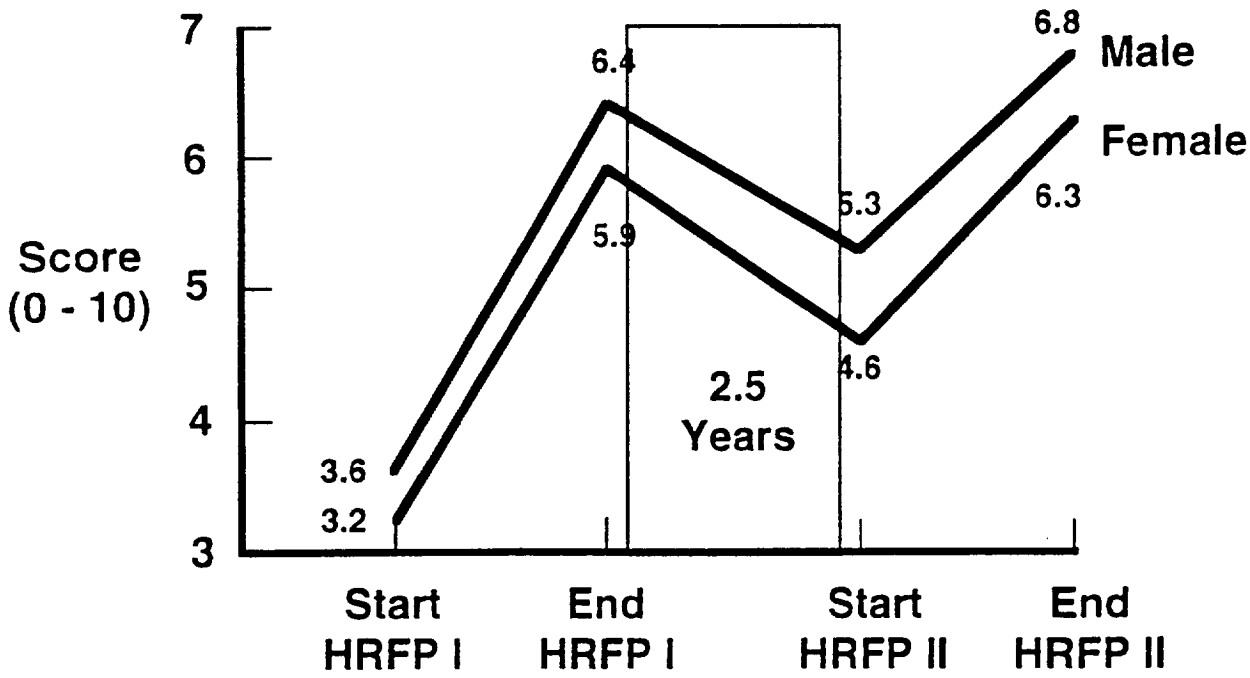
Activity Ratings



Lecture Topics for HRFP 1 (12 weeks)

The JSC Health Related Fitness Course
Components Fitness
Body Leanness
Exercise Prescription
Exercise in the South Texas Environment
Energy Expenditure II (Calories)
Basic Nutrition
Cardiovascular Disease Rick Factors
Hyperlipidemia
Psychological Stress and Depression
Gender and Physical Exercise
Strength Training
Musculoskeletal Function
Exercise Intensity
Principles of Training
Energy Expenditure 1 (VO_2 and Mets)
Physical Fitness Appraisals
Weight Management
Hypertension and Blood Pressure
Obesity
Age and Physical Exercise
Orienteering

Note: A lecture outline is provided at each class; a written exam is given at the end of the course.

Lecture Topics for HRFP II (10 weeks)

Introduction to HRFP II
Common Injuries
Reading the Labels
Dieting and Exercising on the Go
Blood Lipids
Exercise and Air Pollution
Exercise for Seniors
Motivation for Adherence to Exercise
Evaluating the NASA/JSC HRFP
Protecting the Back
Weight Watching Tips
Diet Analysis
Exercise and Cancer Risk
Exercise for Children
Psychological Benefits of Exercise

Note: A lecture outline is provided at each class; a written exam is given at the end of the course.

Lecture Topics for HRFP III (10 Weeks)

Energy Sources as Fuel
Anabolic-Androgenic Steroids
Special Consideration for Strength Training in Athletics
Designing Strength Training Programs
Protecting the Skin
Diabetes
Pulmonary Function and Respiratory Diseases
Pregnancy, Exercise and Fitness
Biomechanics of Fitness Exercise
Arthritis and Osteoporosis
Environmental Extremes: High Altitude and Underwater
Cold Stress
Supplements and Ergogenic Aids
Medications and Exercise
Exercise, Fitness and Self-Esteem

Note: A lecture outline is provided at each class; a written exam is given at the end of the course.

Program Evaluation

- Enrollment
  - October, 1983 : 72 Active Members
  - Fall, 1992 : 1419 Active Members
- 36% of the JSC civil servants and 401 contractors
- Drop-out Rate: 20% in the 12-week course
- Long-term adherence (90 minutes+/week for at least 2 years): 40%
- Membership reflects JSC population:
  - Avg age = 40 (JSC Avg age = 41)
  - Women = 33% (JSC female pop = 33%)
- Enrollees vs non-enrollees
  - at the start of program: medical statistics are the same
  - within 3 years: program compliers
    - increase aerobic capacity
    - decrease body fat and cholesterol
  - non-enrollees deteriorate as expected with aging
  - exercise level is the prevalent factor explaining difference in group changes

Nutrition Intervention Program

- Program includes
  - blood chemistry analysis at the beginning and after 12 weeks
  - series of lectures on diet and nutrition
  - private consultations with dietitian
  - yearly reviews
- Who is eligible
  - all JSC civil servants, contractors and spouses
  - family member who buys and prepares the food should attend
  - husband and wife teams are encouraged
- Lecture topics include
  - dietary guidelines set by the American Heart Association and National Cholesterol Education Program
  - label reading
  - dining out
  - meal planning and preparation

Research

Assessing Fitness

Accuracy of VO_2max Prediction Models to Measure Change, *Medicine and Science in Sports and Exercise*, April, 1990

Prediction of Functional Aerobic Capacity Without Exercise Testing, *Medi ine and Science in Sports and Exercise*, January, 1990

%VO_2max and %HRmax Reserve Are Not Equal Methods of Assessing Exercise Intensity, *Medicine and Science in Sports and Exercise*, April, 1992

Aging

Changes in Physical Fitness over Time: The Influence of Exercise, Body Composition, and Age, *JAMA*, (in press)

The Role of Body Composition and Physical Activity on the Age-Related Decline in VO_2max in Women (Ages 21-63), *Medicine and Science in Sports and Exercise*, pending.

Program evaluation

Evaluation fo the NASA/JSC Health Related Fitness Program, *Aviation, Space and Environmental Medicine*, May, 1989

Adherence

Risk Profiles for Estimating Exercise Behavior, *Medicine and Science in Sports and Exercise*, April, 1988

Factors Affecting Compliance in the NASA/Johnson Space Center Fitness Program, *Sports Medicine*, July, 1989

Blood lipids

Effects of Body Composition and VO_2max on HDL-C: Cross Sectional and Longitudinal Analyses, *Medicine and Science in Sports and Exercise*, April, 1991

N94-16634

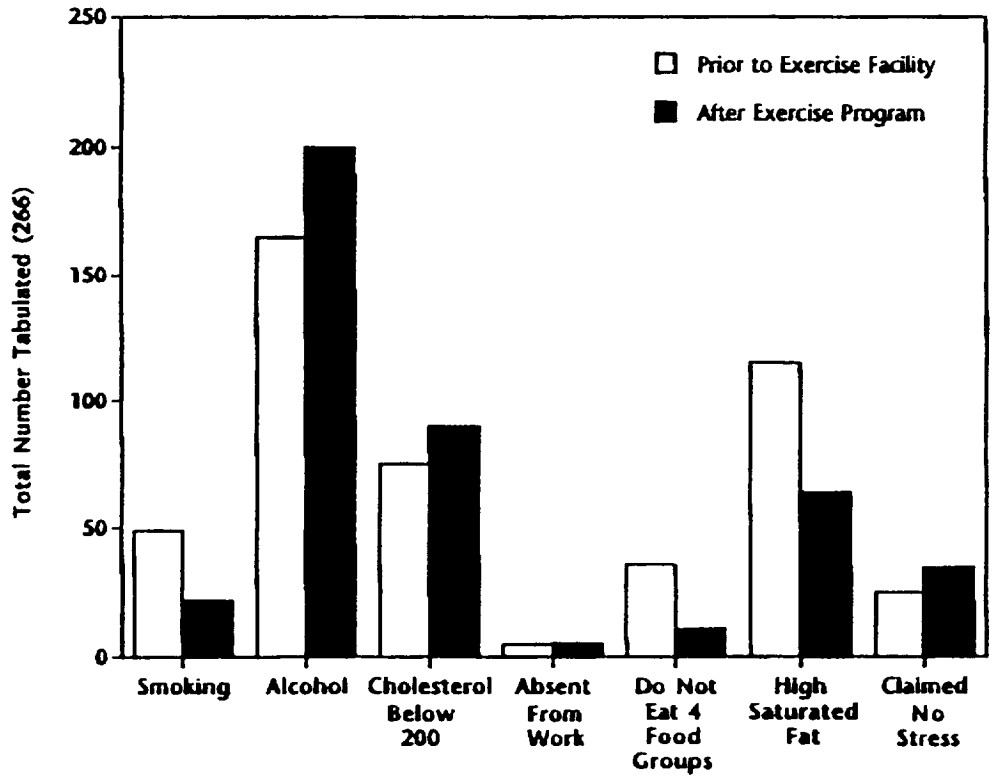
KENNEDY SPACE CENTER EXERCISE PROGRAM

Cristy Hoffman
Bionetics Corporation/NASA Kennedy Space Center

The Kennedy Space Center (KSC) Fitness Program began in February 1993. The program is managed by the Biomedical Operations and Research Office and operated by the Bionetics Corporation. The facilities and programs are offered to civil servants, all contractors, temporary duty assignment (TDY) participants, and retirees. All users must first have a medical clearance. A computer-generated check-in system is used to monitor participant usage.

The exercise facilities are well attended. Of a total population of approximately 20,000 employees, over 7,000 are registered in the exercise program. For fiscal year 1992 the monthly average attendance was 1,854 (Exhibit 1).

Exhibit 1. Exercise Facility Attendance November 1991 through October 1992



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There are a total of seven staff members. All have B.S. degrees or higher in a field related to exercise physiology, and all are certified in cardiopulmonary resuscitation, first aid, Certified Strength and Conditioning Specialist through the National Strength and Conditioning Association, and Health Fitness Instructor through the American College of Sports Medicine. Some staff members also have Certified Athletic Trainer, Aerobic and Fitness Association of America, and the National Dance Exercise Instructor Training Association certifications.

Keeping the equipment operational is a vital part of the success of the program. We have found that the best method to maintain our equipment is a formal program that includes tracking charts for daily, weekly, monthly, and quarterly maintenance tasks. This program, reported in quarterly and annual reports, was implemented in July 1991 and has resulted in a decrease in turn-around time, reduced outside labor costs, and reduced parts costs.

Also important in keeping the attendance high are the motivational programs developed and implemented by the staff. The following programs are available to help motivate and increase participant adherence:

1. An athletic trainer is available to maintain prescribed rehabilitation programs, provide injury prevention education, and act as liaison between local physicians and physical therapists.

2. Personal fitness training is a very important part of the program. Special exercise programs are designed on an individual or group basis for body building, sports specific training, general health and fitness, and recovery from minor injury.

3. Two exercise classes are offered: a strength/conditioning/flexibility class, and a low-impact aerobics class.

4. KSC offers many motivational programs throughout the year, such as Exercise Across America, Intercenter Run, President's Challenge, Rowing Regatta, etc. These programs encourage the participants to stay motivated by making exercise fun and challenging.

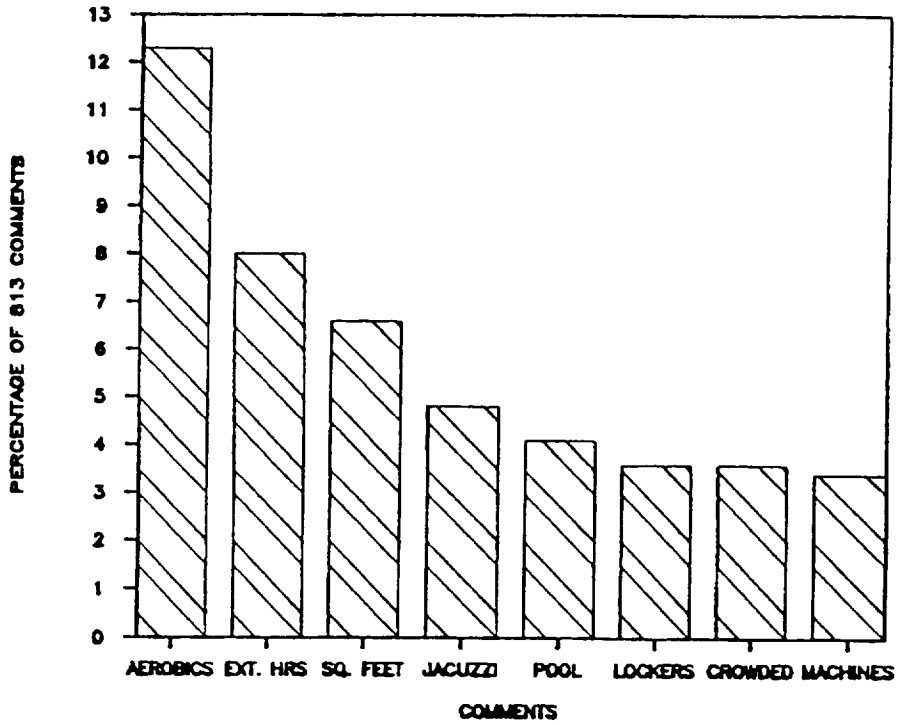
5. Educational information is written and provided by the staff in the form of flyers, brochures, and posters. Staff training is also offered. This training consists of a 6-week aerobics class training program and a manual for

weight training that details the different muscle groups and how each is exercised for maximum benefit.

6. The Wellness Network consists of individuals from different contractors who meet once a month to discuss wellness activities held within each company and activities for all of KSC. The activities to date have included health fairs, smoking cessation courses, food festivals, stress management, weight management, and Dance for Heart.

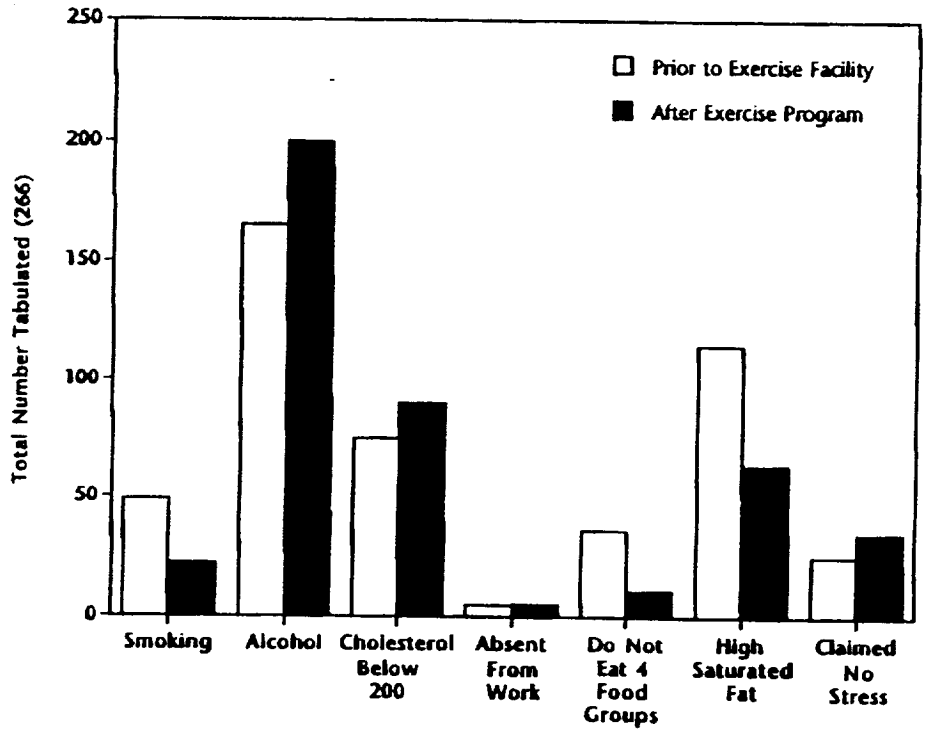
All of the above programs have been very successful and have resulted in an atmosphere conducive to promoting health. In order to demonstrate the success of the program and determine that the needs of the clientele are being met, different methods for analysis have been initiated in the past three years. A Center-wide survey analyzed the fitness needs of the KSC population and allowed the implementation of many different programs. Exercise classes and longer hours were the two requests most often made, and both have been implemented (Exhibit 2).

Exhibit 2. 1990 Exercise Facility Survey Results of Comments Section - O&C



More recently, a facility user Demographic Survey, similar to the ACSM's Health Risk Appraisal, was sent out to the participants. Some of the results from this survey are shown in Exhibit 3.

Exhibit 3. Facility User Demographic Survey



The last analysis was a review of the literature on the benefits of corporate wellness. This 42-page document was prepared after a review of over 60 articles on wellness programs. The study centers on the cost benefits associated with the implementation of a wellness program.

Plans to diversify include expanding the variety of exercise classes and the inclusion of a nutritional component. Other areas scheduled for improvement include increasing the methods of measurement to help trend our successes.

The KSC exercise program has improved over the past two years. Opportunities such as this Breakout Session are a perfect way to pool the resources of the NASA Centers and offer an opportunity to share the accomplishments that each has achieved and receive recognition for all of the hard work and perseverance.

N94-16635

THE LANGLEY FITNESS CENTER

NASA Langley Research Center

NASA Langley recognizes the importance of healthy employees by committing itself to offering a complete Fitness Program. The scope of the program focuses on promoting overall health and wellness in an effort to reduce the risks of illness and disease and to increase productivity. This is accomplished through a comprehensive Health and Fitness Program offered to all NASA employees.

The Langley Fitness Center is a 4,000-square foot facility that houses a full line of Cybex Eagle strength equipment, Hydrafitness training equipment, Stairmasters, Schwinn Airdynes, rowing machines, treadmills, and free weights. The facility is open from 6 a.m. to 7 p.m., Monday through Friday, and is staffed by an Exercise Physiologist, a full-time assistant, and a part-time assistant.

Entry into the program is required prior to participation in the facility. Each member must fill out an application and be medically cleared by our staff physician. Requirements include a physical examination within the past year and a treadmill test within the past three years. These are all conducted at the Clinic. A health and wellness assessment is then completed which evaluates the individual's body fat, strength and flexibility, blood lipid levels, aerobic fitness level, and nutritional status, if desired. A personalized exercise prescription is written for each employee incorporating their individual needs and goals.

Two equipment instructions are also completed as part of the introduction to the Center. This includes the proper use and form used on the apparatus and recommended stretching and abdominal exercises. The prescription is reviewed and the log-in computer is also explained. The Fitness Center utilizes a log-in/log-out computer software program which aids in the daily data collecting for management purposes. Each member must log in upon entering the facility. When an individual has completed his/her workout they must log out and input what activities they completed while in the facility. Monthly progress reports are printed for each member which provides them with feedback on their time spent exercising, the activities they performed, and the calories they expended. Various other management reports are also generated for facility usage and active/non-active members. Since the inception of the Langley Fitness Center,

an estimated 1,400 members have been processed with an average monthly active rate of 480 participants. This count represents only the number of members who entered the facility in a one-month period.

Follow-up evaluations are also conducted after six months and one year from entering the program to give the members feedback and encourage adherence. Other motivating tools are incorporated into the program to help make exercise more challenging and fun. These tools range from the simple logging sheets for both aerobic exercise and strength training to incentive games and wellness programs.

The promotional programs can be grouped into three areas: (1) incentive games for exercise adherence; (2) ongoing promotional programs for the overall health and fitness program; and (3) yearly sponsored programs for the Langley Fitness Center. The following list describes the main program:

Exercise Incentive Games

Superbowl FITball: This game is run every January to coincide with the Superbowl. Each participant must perform aerobic exercise for a specified amount of time to achieve a block on the football pool or grid. Due to its popularity, there is a five square limit per person. The two teams in the Superbowl are represented on the horizontal and vertical axis and the winners are determined by the actual score of the Superbowl. Winners for the first half, second half, and final game score receive a Superbowl team t-shirt.

Climb the Flights of Liberty: This game was held during the month of May for National Fitness Month. The flights of stairs in the Statue of Liberty represented different exercise tasks. Participants moved up the statue with individual flags. The goal was to reach the top and receive an award.

Trip to Key West: A travel game using a map from NASA Langley to Key West. Miles were converted to a logical and manageable goal. Participants had to climb, walk, run, or jog and row their way to Key West, depending on the terrain. Everyone who reached the Keys won, and a party was held at the end of the game to announce the three top winners.

LFC Olympics: The Langley Fitness Center had a mini-Olympics while the Summer Olympics were taking place. Participants could enter one or all ten categories. Five were strength-related and five were aerobic-related. Categories like the broad jump, pull-ups, and dips were the most fun for the participants to challenge each other. Prizes and ribbons were given to the first, second, and third place winners.

TRYathlon: For a six-week period, members were able to challenge themselves in a tryathlon equivalent to a half Ironman. The swimming section was represented by rowing, and the biking and running were conducted either inside or outside.

12 Days of Fitness: This holiday game is held in December for 12 days prior to Christmas. Participants must complete at least 10 days of the specified activities to receive a prize. The past year, prizes were five sets of movie passes.

Promotional Programs

Employee of the Month: New members are evaluated upon entering the program and then re-evaluated in six months and again in one year. Employees who have shown improvement are recognized along with the individual who shows the most improvement in various health and fitness parameters.

Cardiac Education: This is a promotional and educational class related to an existing cardiac rehab class which runs three times a week before work. The last Friday of each month there is a seminar on either a nutrition or exercise topic, and refreshments are served. Some of the previous topics have been Eating Out, the Effects of Exercise on the Heart, Medications and Your Body's Reactions, the 1990's Nutrition Quiz, Laughing Your Way to Health, and Emergency Precautions for Cardiac Care.

Brown Bag Seminars: These seminars are held once a month in the cafeteria and are open to all employees. The topics relate to all wellness issues such as Toxins of Summer; Safe and Sane Exercise; Sunburn, Tanning and the Elements; Aging Facts and Fancy; Preventing and Controlling Diabetes; Low Fat Diets for Painless Weight Loss; Hearing Impairment; etc.

Free-Weight Spotlights: These are 15- to 20-minute seminars that take place on the Fitness Center floor covering free weight exercises. Proper spotting, form, and new exercises are highlighted. These are run periodically throughout the year.

Health for Life: This is a 12-week intense weight loss program specifically designed for the obese individual. This program entails twice-a-week exercise classes and once-a-week seminars covering issues of nutrition, health, and exercise. The class strives for individualization, so the classes are limited to 20 people. Pre- and post-data are taken for analysis and measurement. The program incorporates its own incentive games and programs to keep the participants reaching for their goals.

Weight Loss: The weight loss program was designed for anyone wanting to lose weight. Emphasis is on a health lifestyle versus a diet which may or may not work. Seminars on nutrition and exercise are held once a week for 8 weeks, and the participants are encouraged to participate in our existing exercise programs. A limited amount of pre- and post-tests are taken in comparison to the Health for Life Program. The number of participants per class is limited only by the size of the meeting room (50).

Yearly LFC Programs

Cardiovascular Rehabilitation: This class is specialized for post-cardiac patients and high-risk patients who are referred to us by the Clinic physician. Special clearance must also be made by the patient's cardiologist as to specific medications and recommended exercise intensity. This class is held three days a week from 7:30 to 8:30 a.m.

Aerobics Classes: Aerobics classes are held free of charge to all employees at Langley. The classes are held at 6:15 to 7:15 a.m. and 11:00 to 11:45 a.m. on Mondays, Wednesdays, and Fridays. An "Absolutely ABS" class is held at 5:00 to 5:30 p.m. on Mondays, Wednesdays, and Fridays as well. This class highlights the midsection and stretching.

PSA: This is our Presidential Sports Award Program which is open to all employees and runs from March through August.

National Fitness Month: Every year the Fitness Center promotes health and fitness throughout the month of May. Special incentives and games are run within the Center and special events take place on Federal Fitness Day. Some of these include aerobics classes and a Center-wide fun run or walk.

Turkey Trot: This is a two-mile, predict your time, run, walk, or trot held a week before Thanksgiving. Winners receive ribbons or a t-shirt, and turkeys are raffled off after the race at a party held within the Fitness Center.

N94-16636

PHYSICAL EXERCISE PROGRAM

Marshall Space Flight Center

The Marshall Space Flight Center
Physical Education Program

The Physical Exercise Program at the Marshall Space Flight Center (MSFC) has been in existence since 1981. The Center is located in Building 4494, west end. The Center consists of approximately 5,000 square feet, and houses locker rooms for men and women, an exercise area, a class room, an office, and a therapy room. The facility is open Monday through Friday, except on government holidays, from 10:30 a.m. to 7:00 p.m. No one is allowed in the facility without the supervision of the Program Manager or the Assistant Program Coordinator. As would be expected, we have various pieces of aerobic and resistance machines for participant utilization. Aerobic dance classes are held four times each week, and there are plans to begin a step aerobics program.

Enrollment in the program is limited to NASA civil service employees, co-op students, summer faculty, and those who work for the National Research Association. Each person who signs a request for participation in the program must have a physical examination with a GXT that is offered by our NASA Medical Center or by their personal physician and approved by the Medical Director. Upon approval, the individual is then contacted by the Physical Exercise Program for a fitness evaluation. Employees of other Centers on TDY are eligible to use the MSFC under the following conditions:

1. If they are NASA civil service employees.
2. If they are approved for their home Center's exercise program.
3. Upon receipt of a letter or telephone call from the Fitness Director at their home Center.

The Marshall Space Flight Center also offers several health education courses which are taught through the Physical Exercise Program. The courses taught are:

1. The American Red Cross Back Injury Prevention.
2. The American Lung Association "In Control" Smoking Cessation.
3. Lifestyle for a Lifetime Weight Loss Program.

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These programs are open to all NASA civil service employees. The Back Injury Prevention course is open also to on-site contractors, and the Smoking Cessation class is open to spouses and retirees as well as the individuals mentioned above.

Our Smoking Cessation Program is held on a quarterly basis and is advertised through the NASA weekly Bulletin. The course lasts for twelve consecutive work days with a thirteenth review and commitment session held two weeks later. Each session is held for 30 minutes, and administrative leave is granted for class participation. The course instructors are staff members of the Physical Exercise Program. For NASA civil service there is no charge to take the course, but contractors, spouses, and retirees pay $17.00 to cover the cost of the workbook. The initial cost for the program was $45.00 for the videotape and workbooks. A one-year follow-up is sent to all who complete the course to evaluate its effectiveness.

The Back Injury Prevention course offered at MSFC is designed by the American Red Cross. The course is offered in one two- and a half-hour session. It is taught during work hours, and administrative leave is granted. The course is free to the participants. The Manager of the Exercise Program facilitates the class. The costs involved in this program are as follows: $50.00 to be certified by the American Red Cross, $5.00 for the workbook, $3.00 administrative fee per participant and the cost to build weighted lifting boxes.

The Lifestyle for a Lifetime Weight Loss Program was developed on-site. The program is offered in six weekly one-hour classes. The course is taught during the lunch hour, with administrative leave granted and lunch time to be used concurrently. The course is taught by the exercise staff, the Medical Center staff physician, and the NASA MSFC psychologist. The cost for the program involves the publishing of the manual and various handouts. The program includes a one-year follow-up survey evaluation.

Other functions offered by the Physical Exercise Program are a yearly Health Fair during the annual NASA picnic; the annual Employees Health and Fitness Week in conjunction with Employees' Health and Fitness Day; a biannual predicted time run; and other motivational-type challenges to encourage employees to exercise.

The Physical Fitness and Health Breakout Session

Each Center's presentation generated a great deal of interest among all of the Fitness Managers of the other Centers. Because of this, all of the time allotted for the Exercise Breakout Session was spent on Center presentations and did not allow time for other topics on the agenda. A recommendation was made to resume the Exercise Breakout Session the following morning before the general session began, and this was agreed to by all.

In the Thursday morning session, Cathy Angotti reported on the Intra-Agency Challenge. It was reported that the Agency did poorer than in the previous year with the total number of logs turned in. Discussion then concerned each individual Center's participation in the Intra-Agency Challenge, and the role of each Center in carrying out the challenge. Cathy reported that the main functions of the challenge are to:

1. Motivate each Center's participants to exercise by having specific goals to meet individually and as a team.

2. A means of tracking NASA as an Agency as it tries to reach the Healthy People 2000 goals.

3. Setting an example for other Agencies in using The President's Council on Physical Fitness and Sports NASA Agency-wide.

4. A means of justifying the importance of physical activity in the workplace through employee participation.

OTHER PROGRAMS

Following are nine examples of written medical monitoring programs that can be adapted to any occupational medical facility's purposes. Seven of these programs, covering Arsenic, Asbestos, Hearing Conservation, Lead, Mercury, Respiratory Protection, and General Medical Surveillance, were written by Stephen A. Weirich, M.D., Hummer Associates, Medical Director at the NASA Lewis Research Center, and these programs are currently being followed at Lewis.

Also included are two examples of written "Exposure Control Plans" now required by OSHA's Bloodborne Pathogen Standard to be implemented by any facility where there is a measurable risk of occupational exposure to blood or other potentially infectious materials. The first Exposure Control Plan was written by Sharon Blasdell, R.N., C.O.H.N., of EG&G Florida at the Kennedy Space Center. The second example was prepared by Caro Luhrs, M.D., and Rita Teitelbaum, R.N., of Hummer Associates at the Veterans Administration Headquarters in Washington, D.C.

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ARSENIC SURVEILLANCE PROGRAM

NASA Lewis Research Center
Occupational Medicine Service

N94-16637

Background

There are three basic forms of arsenic; salts, oxides, and arsine gas, all of which are toxic to humans. Chronic inhalation of inorganic arsenic compounds is the most common cause of industrial arsenic poisoning; however, arsenic also enters the body via ingestion and absorption through the skin. Trivalent arsenic (arsenite) is more toxic than pentavalent arsenic (arsenate) by several orders of magnitude, yet the arsenates are better absorbed and may be converted to arsenites once in the body.

Arsenicals are found in pesticides, herbicides, rat poisons, semiconductors, and wood preservatives, and are often by-products of some industrial metallurgical applications (e.g., copper smelting). Additionally, arsenic compounds have been found in seafood and as an ingredient in some homeopathic medications. Arsenic binds with the sulfhydryl groups of the body's proteins, interfering with the ability of various enzymes to catalyze crucial cell metabolism. Arsenic has also been shown to increase chromosomal breakage and therefore may be teratogenic, mutagenic, and carcinogenic.

Acute clinical symptoms from arsenic exposure can vary widely depending on the type and chemical state of the arsenic involved, age and physical condition of the subject, and the duration and dose of the exposure. Symptoms of acute poisoning may occur within minutes or be delayed for several hours. Initially, acute exposure to arsenic can be irritating to both the skin and mucous membranes of the respiratory system and gastrointestinal tract. When there is a primary inhalation of an arsenic-containing substance, much of the substance is actually ingested as accumulated inhaled material in the mucous secretions of the upper respiratory system are swallowed. Arsenicals can cause damage to capillary walls rendering them quite friable. Inhalation can lead to nosebleeds and perforation of the nasal sputum as well as causing small hemorrhages on the mucous membranes of the entire respiratory tree and gastrointestinal tract, and causing hemorrhages directly on exposed skin. Symptoms of nausea, vomiting (often hematemesis), colicky abdominal pain, diarrhea (often bloody), thirst, dizziness, muscle cramps, and burning of the mouth result from inflammation of the gastrointestinal tract

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mucosa. Similar damage can occur to the brain's capillaries if a large enough dose of arsenic is ingested or inhaled, resulting in peri-capillary edema, intraluminal clotting and, eventually, infarct. The heart can be affected acutely, as demonstrated by electrocardiogram changes which principally include tenting and elevation of the T-wave, and can progress with chronic exposure onto QT prolongation. Death is frequently rapid and occurs through disseminated central nervous system damage, marked weakness and muscle paralysis, liver and kidney damage, and vasomotor collapse.

Arsine gas, unlike arsenic, preferentially binds to hemoglobin causing massive hemolysis, hemoglobinuria, jaundice, and subsequent renal failure. Inhalation of very small quantities of arsine gas can be rapidly fatal. For example, inhaling 250 ppm (parts per million) of arsine gas is instantly fatal, while exposure to 25-50 ppm over 30 minutes is lethal.

About five weeks after an acute exposure to arsenic, the **Mees line**, a transverse white line in the nails, 1 to 2 mm in width, becomes visible above the cuticle. The lines advance at about 1 mm per week, allowing estimation of the time of acute exposure.

Chronic exposure to low levels of arsenic compounds may result in small, superficial ulcers in the gastrointestinal tract or affect other mucous membranes, causing keratoconjunctivitis, corneal necrosis, and rhinopharyngeal-tracheobronchitis. Hepatic enlargement, frequently with few liver function abnormalities, has been observed. Peripheral neuritis, in a "stocking glove" distribution, resulting in motor dysfunction and paresthesia can occur. Chronic skin changes are the best recognized result of long-term arsenic exposure, with facial edema, erythema, desquamation, and hyperpigmentation of resultant scars frequent signs. The hyperpigmentation frequently also occurs over the neck, armpits, and nipples. Hyperkeratosis of the palms and soles often are apparent, which can progress occasionally to skin cancers. Painful hot, swollen feet that make walking very difficult are readily diagnosable symptoms of chronic arsenic exposure. Various degrees of bone marrow suppression have been reported, leading to depletion of specific cell lines, or pancytopenia.

Quantitative 24-hour urine collections seem to be the most reliable laboratory measurement of arsenic poisoning. After a single dose of arsenic, most urinary excretion occurs over the first four days, with virtually negligible levels found after the sixth day. The upper limit of normal for a 24-hour urine arsenic is 100 μg (micrograms)/24 hours.

Blood arsenic levels (with normal less than 7 μg/100 ml) do not correlate well with chronic exposure, although they may help to confirm diagnosis after an acute exposure. Spot urine arsenic levels have been unreliable and may be falsely elevated after eating seafood, for example, or other arsenic-containing substances. Hair and nail analysis for arsenic is also inconsistent and unreliable.

Purpose

The purpose of the Arsenic Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who is exposed to arsenic above the action level, at the physician's discretion;

2. Educate that employee about the nature of arsenic, the proper use of respiratory protection and protective clothing, and appropriate sanitation practices to be used when handling arsenic-containing substances;

3. Monitor those employees by obtaining an extensive past medical and occupational exposure history, and then perform periodic physical exams with twenty-four (24) hour urine collections for arsenic concentrations to detect early signs and symptoms of arsenic poisoning. When arsenic exposure is anticipated, a baseline physical exam with a 24-hour urine collection for arsenic shall be obtained.

Medical Surveillance

The specifics of the Medical Surveillance Program for Arsenic Exposure at the NASA Lewis Research Center will fulfill the criteria required by OSHA and will incorporate recommendations from NIOSH.

The permissible exposure limit (PEL) for arsenic-containing compounds, as defined by OSHA, are:

Inorganic arsenic	0.010 mg/m^3 (10 μg/m^3)
Organic arsenic	0.5 mg/m^3 (500 μg/m^3)
Arsine gas	0.2 mg/m^3 (0.05 ppm)

All PELs are based on an 8-hour TWA. There are no specified STEL or Ceiling Limits for any arsenic-containing substance.

Of greatest clinical importance in an occupational setting are inorganic arsenic substances. The **Action Level (AL)** for inorganic arsenic compounds is defined as 0.005 mg/m^3 (or **5 μg/m^3**). Medical surveillance for arsenic exposure is required for employees exposed at or above the AL for 30 days or more per year.

NASA employees identified by the Office of Environmental Programs as having been exposed to the AL for arsenic will be entered into the medical surveillance program. As soon as possible, these employees will need:

1. **Medical and Work Histories**, with special attention to:
   - dietary habits
   - previous occupational exposures
   - smoking history
   - respiratory symptoms
   - muscle weakness, paresthesia, loss of sensation in extremities
   - skin pigmentations (erythema or hyperpigmentation)
   - skin changes, especially of the palms or soles.

2. **A Complete Physical Exam**, with special attention to:
   - Skin (color, hyperkeratosis, hyperpigmented lesions, fingernails)
   - Mucous membranes (nose, mouth, GI tract, respiratory system)
   - Abdominal exam (tenderness, hepatomegaly)
   - Neurologic exam (strength, sensation, DTRs).

3. **Laboratory Exam**, to include:
   - Chest X-ray
   - CBC with differential
   - Serum chemistries (BUN, Creatinine, LFTs, bilirubin)
   - Urinalysis with microscopy
   - EKG (T-wave abnormalities, QT prolongation)

- Sputum cytology (not recommended in employees under 45 years of age with fewer than 10 years of exposure under the AL)
- Stool guaiac, where acute exposure is suspected
- Abdominal X-rays (KUB), where ingestion is suspected
- 24-hour urine collection for arsenic (normal $< 100\ \mu g$).

The above evaluation will need to be repeated, at least within seven (7) days **if the 24-hour urine arsenic is greater than 100 μg**. The frequency at which this exam should be repeated is left to the discretion of the physician, and is based on clinical symptomatology, physical signs, and laboratory abnormalities.

In the event that the Office of Environmental Programs determines that an employee is at an increased risk of arsenic exposure at or above the AL because of the nature of the employee's job or the potential presence of arsenic-containing compounds in the work environment, then that employee shall receive the above evaluation as a baseline exam before potential exposure, followed by annual arsenic surveillance exams, until such time as the OEP determines that the employee is no longer at risk for arsenic exposure.

If there is a risk of any exposure to arsenic in an employee's work environment, regardless if this potential exposure is deemed to be above or below the AL for arsenic as determined by the OEP, then that employee will receive annual arsenic surveillance exams.

Upon retirement or termination of employment, an employee who has been involved in an ongoing arsenic medical surveillance program is entitled to a final arsenic surveillance exam with the appropriate laboratory studies. The Occupational Medicine Service will not continue surveillance of an individual once they have retired or are no longer employed by NASA. During the final examination, recommendations will be given to the individual for continued medical surveillance, if necessary, to be performed by the individual's private physician.

Summary Table for Frequency of Arsenic Surveillance Exams

Anticipated exposure to arsenic at or above the AL	Baseline arsenic surveillance exam before exposure
Acute exposure to arsenic at or above the PEL	Immediate exam, if possible, with appropriate follow-up as dictated by physical and laboratory findings
Work environment with chronic arsenic levels at or above the AL for 30 days or more per year:	
a. <45 years old with <10 years exposure	Annual Exam
b. >/=45 years old regardless of duration of exposure	Semi-annual exam (every 6 months)
c. >/=10 years exposure regardless of age	Semi-annual exam (every 6 months)
Any risk of arsenic exposure	Annual exam

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3. U.S. Department of Health and Human Services. Pocket Guide to Chemical Hazards, 1990: 42-43.

4. Medical Surveillance Procedures Manual and NOHIMS Medical Matrix (Edition 3), January 1989: 30-33.

5. Micromedix, Inc. "TOMES-Plus System," Toxicology, Occupational Medicine and Environmental Series, January 1991.

N94-16638

ASBESTOS SURVEILLANCE PROGRAM

NASA Lewis Research Center
Occupational Medicine Service

Background

Asbestos is a family of minerals which includes six chemically and physically distinct substances: chrysotile, crociodolite, amosite, anthophyllite, tremolite, and actinolite. These substances are all crystalline hydrated silicates with a fibrous geometry. However, they are divided into two subgroups based on their fiber morphology: the **serpentine group** which includes chrysotile with curly, often bundled fibrils; and the **amphibole group** which includes crociodolite, amosite, anthophyllite, tremolite, and actinolite with needle-like fibers. This distinction is important medically as increased pathogenicity is attributed to the amphiboles which can penetrate deeper into the lung and are seemingly less soluble. Fortunately, it is chrysotile, a member of the serpentine group, which accounts for 90 to 95 percent of the asbestos produced and used commercially in this country.

There are four diseases associated with asbestos exposure: mesothelioma, lung cancer (specifically bronchogenic carcinoma), asbestosis (asbestos-induced pulmonary fibrosis), and benign pleural disorders.

Mesothelioma is a malignant tumor arising in the pleura and peritoneum, of which 80 percent have occurred in individuals exposed to asbestos in the workplace or who have lived near asbestos mines. The average latency period between first exposure to asbestos and the clinical diagnosis of malignant mesothelioma is 35 to 40 years. Most deaths have occurred in individuals over age 60. There is no evidence that smoking enhances the prevalence of this malignancy.

Bronchogenic carcinoma has developed in asbestos workers an average of 20 to 30 years after first exposure to asbestos. There seems to be a dose-response relationship between asbestos concentrations to which an individual is exposed and the length of time of exposure in the development of lung cancer. However, lung tumors are exceedingly rare among asbestos workers who do not smoke.

Asbestosis is a progressively restrictive lung disease characterized on pulmonary function tests by diminutions of vital capacity, total lung capacity, residual lung volume, functional residual capacity and diffusing capacity. Frequently there is concomitant obstructive lung disease due to smoking which exacerbates symptoms and worsens prognosis.

There are **four benign pleural disorders** due to asbestos exposure which include:

1. Benign pleural effusions: Often a unilateral sterile exudate, frequently serosanguinous, usually occurring in workers less than 20 years after the initial exposure to high concentrations of asbestos. Only one-third of these patients are symptomatic, and the majority of effusions resolve spontaneously.

2. Pleural plaques: The most common manifestation of asbestos exposure, characterized as fibrohyaline nodular lesions which are usually located bilaterally and appear 10 to 20 years after initial exposure to asbestos. These plaques cause no decrements in lung function, and currently it is felt that these plaques are not hallmarks of more significant disease.

3. Pleural fibrosis: A diffuse thickening of the visceral pleura which may impair pulmonary function but does not lead to malignancies.

4. Rounded atelectasis.

Of the three potentially fatal asbestos-related disorders, the development of bronchogenic carcinoma and the worsening of asbestosis are closely related to smoking. Therefore, any employee who smokes and who is entered into an asbestos surveillance program should strongly be encouraged to enter a smoking cessation program.

Purpose

The purpose of an Asbestos Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who has been exposed to asbestos in the past, currently is exposed to asbestos, or who may be exposed to asbestos because of the nature of the employee's job.

2. Educate that employee about the nature of asbestos, proper use of respiratory protection, and the evils of smoking, especially in individuals exposed to asbestos.

3. Monitor those employees by obtaining an extensive past medical and occupational exposure history and then performing periodic physical exams, chest X-rays and pulmonary function tests to detect early signs of asbestos-induced disease.

Medical Surveillance

The specifics of the Medical Surveillance Program for Asbestos Monitoring at NASA Lewis Research Center will fulfill the criteria required by OSHA and will incorporate recommendations from NIOSH, NOHIMS, and NAVOSH.

Significant asbestos exposure requiring medical surveillance is defined as exposure to any environment with an asbestos concentration of 0.1 asbestos fibers per cubic centimeter of air (0.1 f/cc), calculated as an eight (8) hour time-weighted average (TWA). This is called the action level (AL), which is half the permissible exposure limit (PEL) to asbestos of 0.2 f/cc, the environmental standard allowed by OSHA.

NASA employees identified by the Office of Environmental Programs as having been exposed to the AL for asbestos will be categorized into one of two broad categories:

1. Employees currently exposed to asbestos, or

2. Employees not currently exposed to asbestos but who have been exposed in the past. The Office of Environmental Programs (OEP) will evaluate historical data in cases where past exposure is alleged and no air monitoring results are available.

Employees in category 1 who are currently exposed to asbestos at or above the AL shall receive an annual physical exam (including a detailed examination of the chest,

and pulmonary function tests [PFTs] specifically including FEV1 and FVC), and a chest X-ray according to the schedule in Table 1.

Employees in category 2 who are not currently exposed to asbestos will receive a physical exam (with PFTs) and chest X-ray according to the schedule in Table 1. All chest X-rays will be submitted for certified "B" readings.

Table 1

Years Since First Asbestos Exposure	Age of Employee 15 to 35	35 to 45	45+
0 to 10 Years	Every 5 Years	Every 5 Years	Every 5 Years
10+ Years	Every 5 Years	Every 2 Years	Every Year

All new employees who may be exposed to asbestos during the course of their employment at NASA will have a preplacement physical exam which will include a chest X-ray and PFTs. Employees who may be exposed to asbestos include:

- Electricians
- Mechanics
- Plumbers
- Carpenters
- Pipefitters
- Contracting Officer Technical Representatives (COTRs) for asbestos abatement projects or constructions jobs where asbestos is likely to be encountered
- Asbestos Center Inspectors
- Firemen.

Continued medical surveillance for asbestos-related disease will be necessary for these new employees only if there is evidence of exposure to asbestos above the AL or upon recommendation from the Office of Environmental Programs.

Any employee who was exposed to asbestos while employed at NASA Lewis Research Center will have a complete physical exam, with a chest X-ray and PFTs, upon completion or termination of their employment. The Occupational Medical Service (OMS) will not continue surveillance of an individual once they have either retired from NASA or are no longer employed by NASA, but during the final physical exam recommendations will be given to the individual for continued medical surveillance to be completed by the individual's private doctor.

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5. *Medical Surveillance Procedures Manual and NOHIMS Medical Matrix (Edition 3)*, January 1989: 34-42.

6. *Navy Occupational Safety and Health (NAVOSH) Program Manual*, August 1983: 17-45.

HEARING CONSERVATION MEDICAL PROGRAM

NASA Lewis Research Center
Occupational Medicine Service

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Background

Hearing impairment can occur in one or both ears, and can be the result of infections, obstructions, trauma, prolonged exposure to noise, toxic agents, advancing age, and many diseases. Hearing loss can be broadly categorized into two types of impairment: conductive or sensorineural.

Occupational hearing loss due to prolonged exposures to noise at the workplace is due to sensorineural damage, specifically to the inner and outer hair cells of the organ of Corti within the cochlea of the inner ear. The hearing loss may be temporary or may become permanent, depending on the extent of damage to the hair cells and the ability of those hair cells to rejuvenate after repeated exposure of an unprotected individual to hazardous levels of noise. Classically, an individual exposed to prolonged noise loses hearing in the higher frequencies and, as the exposure to noise continues, the hearing loss worsens in these higher frequencies and extends into the adjacent lower frequencies. Initial deterioration of hearing may not be apparent to the individual. Often by the time there is subjective awareness of any loss, the impairment is affecting the frequencies less than 3000 Hz to 4000 Hz (the upper ranges of common human speech), and the impairment may be substantial and irreversible. Once the exposure to noise ceases, further damage is arrested.

Noise is defined as a sound which is undesired by the recipient. However, sounds that can cause sensorineural hearing do not always have to be perceived as undesirable, especially when an individual is exposed to excessive noise in recreational situations (e.g., rock music). Therefore, qualifying a sound as being undesirable before it is classified as noise can be misleading because a sound may be considered by the individual as desirable and yet still able to inculcate damage.

The criteria for safe noise levels are not clear-cut, and the present recommendations have been based on studies involving exposures to continuous noise. It is unclear whether this data is applicable for intermittent exposures to both continuous

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and impulse noise. Individuals have different tolerance levels to noise before there is permanent damage, so the current limits to noise exposure are set with the intention of protecting 90 percent or more of an exposed population (90 percent sensitivity rate).

Ideally, hearing loss due to noise exposure should be entirely preventable, especially in an occupational setting where there is available hearing protection, education, supervision, and audiometric surveillance.

Purpose

The purpose of the medical aspects of the Hearing Conservation Program at the NASA Lewis Research Center is to:

1. Identify any Lewis employee who is currently exposed to excessive noise levels or who may be exposed to excessive noise levels because of the nature of the employee's job.

2. Educate that employee about the nature of noise exposure and the risk of incurring permanent hearing impairment if exposed for prolonged periods of time to excessive noise without proper hearing protection.

3. Protect any employee identified as either exposed to excessive noise or at risk of exposure with approved hearing protection.

4. Monitor those employees who either have been exposed to or who are at risk of exposure to excessive noise by obtaining an extensive past medical, recreational, and occupational history and then performing annual audiometric exams to detect any early signs of hearing impairment.

5. Report to the Industrial Hygiene Office the names and workplaces of any employees who demonstrate a reproducible age-adjusted audiometric threshold shift (when compared to the baseline audiometry), unless the employee was originally referred to OMS by Industrial Hygiene, so that appropriate noise monitoring can be carried out and any appropriate engineering or design modifications can be implemented.

Medical Surveillance

The complete Hearing Conservation Program includes:

1. Noise monitoring
2. Posting of noise hazard areas
3. Issue and use of approved hearing protection
4. Audiometric testing (annually)
5. Records keeping
6. Education of workers and supervisors.

Items 1 and 2 are the responsibility of the Industrial Hygiene Office; items 3, 4, and 5 are the responsibility of the Occupational Medical Service; and item 6 is a responsibility jointly shared between Industrial Hygiene and the Occupational Medical Service.

Measurement of potentially hazardous noise levels will be conducted by the Industrial Hygiene Office when any information, observation, or calculation shows that an employee may be exposed to a noise level **in excess of 80 dB TWA** (8-hour time-weighted average). This is defined as the action level (AL) for noise exposure. The permissible exposure limit (PEL) for noise is dependent on duration of exposure and is best summarized in Table 1.

Table 1. Permissible Exposure Limits (PEL) for Continuous Noise

Duration (hours)	dB
16	80
8	85
4	90
2	95
1	100
0.5	105
0.25	110
0.125	115

It is optimal to keep noise exposures at or below the action level whenever possible. Any area with noise levels that exceed the PEL of 85 dB TWA will be clearly marked as a "Noise Hazard Area." Employees who work in these areas will be entered into the Medical Hearing Conservation Program if they are exposed to continuous noise at or above the AL of 80 dB TWA for at least 30 days out of a year. Similarly, the PELs for repeated impact noise to which an employee may be exposed and which would require exposed employees to be entered into the Hearing Conservation Program are listed in Table 2.

Table 2. Permissible Exposure Limits for Impact or Impulsive Noise

Sound Level (dBP)*	Permitted Number of Impacts/Day
140	100
130	1,000
120	10,000

*Decibels peak sound pressure level

Other new employees who are placed in a work environment that is a documented noise hazard area will automatically be placed in the Hearing Conservation Program.

Medical monitoring for the Hearing Conservation Program will consist of two sections: the Preemployment/Baseline Exam and the Annual Follow-up Exam.

The Preemployment/Baseline Exam includes four components:

1. Baseline Audiogram. All audiograms must be done after the individual has not been exposed to any noise exceeding 80 dB for at least fourteen (14) hours prior to the audiogram. The baseline audiogram will be part of all preemployment physicals on all new employees regardless of potential exposure to noise during the course of their employment at NASA.

2. Physical Examination, with special attention to the head, ears, nose, and throat, looking for pathology that may interfere with audiologic performance.

3. Work History. A detailed former work history with particular attention paid to exposure to any loud noises, use of hearing protection, and any documented hearing impairment.

4. Recreational history, with special attention to potential exposure to loud noises (e.g., hunting, target shooting, use of chain saws, lawn mowers, vacuum cleaners, etc.) and personal use of hearing protection.

The Annual Follow-Up Exam includes four components:

1. Repeat audiogram, again requiring 14 hours of no exposure to noises louder than 80 dB prior to the administration of the audiogram.

2. Limited physical exam, with particular attention to the head, ears, nose, and throat.

3. Interval history, including noise exposure at work and outside of work and use of hearing protection.

4. Education, including review of the effects of noise on hearing; noise control principles; the purpose of hearing protection; the proper selection, fitting, placement and care of the hearing protection; indications for hearing protection; and an explanation of the audiogram and the necessity of the individual's continued participation in medical surveillance.

Specific guidelines for the audiometric test equipment shall meet the specification, maintenance, and use requirements of ANSI S3.6 and 29 CFR 1910.95, Appendix C for pulsed-tone, self-recording audiometers. All personnel administering audiograms will be certified by the Council for Accreditation in Occupational Hearing Conservation (CAOHC). Interpretation will be done by a licensed medical doctor who is well versed in the reading and interpretation of audiograms.

A standard threshold shift (STS) is defined as an average hearing threshold shift of at least 10 dB at 2000, 3000, and 4000 Hz in either ear. If this occurs when

compared to the baseline audiogram, then the audiogram will be repeated within 30 days after the individual has not been exposed to any noises louder than 80 dB for the 14 hours prior to the administration of the audiogram.

When a permanent threshold shift is detected, the follow-up review will include:

1. Hearing Protection. The employee will be provided (and fitted as necessary) with hearing protectors and trained in their use when hearing protectors are not currently being used. When hearing protectors are already in use, the employee will be refitted with hearing protectors offering greater sound attenuation.

2. Hazardous effects of noise will be reviewed and the need for adequate hearing protection emphasized.

3. Inspection of the employee work area will be done by the Office of Industrial Hygiene and/or Safety to determine if work practices or changes in the equipment or procedures have increased the noise hazard. Abatement actions will be instituted as necessary.

4. Employee reassignment to a work area in a low noise area will occur if necessary to prevent any further noise-induced hearing impairment.

Referral to an audiologist is indicated when there is:

1. Average hearing threshold level at 500, 1000, 2000, and 3000 Hz greater than 25 dB.

2. Single frequency loss greater than 55 dB at 3000 Hz or greater than 30 dB at 500, 1000, or 2000 Hz.

3. Difference in average hearing threshold level between the better and poorer ear of more than 15 dB at 500, 1000, and 2000 Hz, or of more than 30 dB at 3000, 4000, and 6000 Hz.

4. Reduction in hearing threshold level in either ear from baseline or previous monitoring audiogram of more than 15 dB at 500, 1000, or 2000 Hz, or of more than 30 dB at 3000, 4000, or 6000 Hz.

5. Any variable or inconsistent responses or unusual hearing loss curves.

Referral to an otolaryngologist or qualified physician is indicated when there is:

1. The presence and persistence of ear pain, drainage, dizziness, severe persistent tinnitus, sudden or fluctuating hearing impairment, rapidly progressing hearing loss, a feeling of fullness or discomfort in one or both ears, unusual or inconsistent audiometric findings or a history of these conditions within the past twelve (12) months.

2. Where an employee has received an otologic evaluation previously on the basis of failing any of the above criteria and ear pain, draining, dizziness, or severe persistent tinnitus develops; or if a significant change in hearing level is observed.

3. Where the OMS medical professional suspects that a medical pathology of the ear is present regardless of whether the pathology is presumed to be due to or independent of the use of hearing protection

If hearing protection is recommended, then the protectors must attenuate employee noise exposure to a noise level of 85 dB TWA or less. If an employee demonstrates a standard threshold shift (STS), then hearing protectors must attenuate noise levels to 80 dB TWA.

All records of the Hearing Conservation Program will be kept confidential and yet always be available to the patients if they so desire.

References

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LEAD SURVEILLANCE PROGRAM

NASA Lewis Research Center
Occupational Medicine Services

S37-62
N94-16640

Background

Lead, in both its organic and inorganic forms, can be toxic to humans. While toxicity from organic lead substances causes signs and symptoms virtually indistinguishable from those caused by inorganic lead, the entrance of the organic lead substances into the body and their rate of metabolism and excretion differ markedly from that of inorganic lead.

Lead is a ubiquitous substance found in low levels in food, water, and the ambient air; therefore, all humans have some lead in their bodies. In certain occupations (listed in Table 1), a worker can be exposed to much higher concentrations of inorganic lead primarily through the inhalation of lead fumes or lead-containing dust particles.

Table 1. Occupations at Risk for Lead Exposure

Plumbers, Pipefitters	Policemen
Lead Miners	Steel Welders or Cutters
Auto Repairers	Construction Workers
Glass Manufacturers	Rubber Products Manufacturers
Shipbuilders	Gas Station Attendants
Printers	Battery Manufacturers
Plastics Manufacturers	Bridge Reconstruction Workers
Lead Smelters and Refiners	

Inhaled lead deposited in the lower respiratory tract is completely absorbed. Inorganic lead can also enter the body through ingestion. The rate of absorption of ingested lead from the GI tract is dependent on the age and nutritional state of the individual. A fasting state and iron or calcium deficiency can increase the absorption rate of lead up to 50 percent of the amount ingested. But typically the amount of lead

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absorbed from the GI tract of adults is 10 to 15 percent of the ingested quantity. Ingestion of lead is a much less significant route of entry in an occupational setting, especially if workers do not smoke, drink, or eat in lead-contaminated work areas. Once in the body, inorganic lead does not undergo biologic transformation.

In contrast, organic lead, found primarily in leaded gasolines as tetraethyl lead, can enter the body through either inhalation or absorption through the skin. Once in the body, organic lead compounds are metabolized in the liver. In 1976 and 1984, federal regulation drastically reduced the amount of lead in gasoline and, today, organic lead in gasoline is not a great environmental concern in the United States. Therefore, the primary mode of lead toxicity in an occupational setting is through the inhalation of inorganic lead dusts and fumes.

Once in the body, lead is distributed among three compartments:

1. Blood. Ninety-nine percent is associated with erythrocytes; 1 percent is in the plasma where it is available to transport to other tissues.
2. Soft tissues; kidneys, bone marrow, liver, and brain.
3, Mineralizing tissues; bones and teeth.

The excretion of lead is extremely slow, with the two primary routes of excretion being renal and hepatic. Other possible but less significant routes for lead excretion include sweat, milk, hair, nails, desquamating epithelia, and teeth. In single exposure studies, the half-life of lead in the blood is approximately 25 days; in soft tissues approximately 40 days; and in the non-labile portion of bone can be greater than 25 years.

For lead poisoning to develop, major acute exposures to lead need not occur. The body accumulates this metal over a lifetime and releases it slowly, so that even small doses over time can cause lead poisoning. It is the total body burden of lead that is related to the risk of adverse effects.

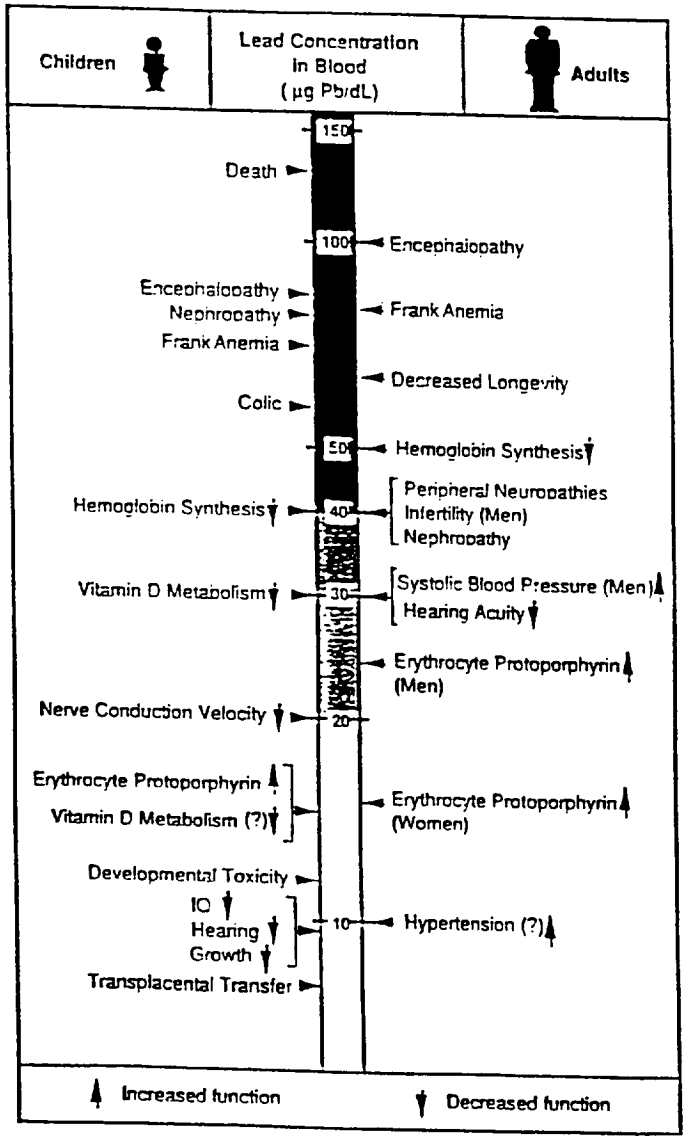
Lead toxicity in adults can cause:

1. Hematologic effects
2. Neurologic effects
3. Endocrine effects

4. Renal effects
5. Reproductive and developmental effects.

A summary of the physiologic toxic effects of lead in adults and children is summarized in Figure 1.

Figure 1. Effects of Inorganic Lead on Children and Adults -- Lowest Observable Adverse Effect Levels



Adapted from: ATSDR, Toxicology Profile for Lead (1989)
As displayed in the ATSDR's "Case Studies in Environmental Medicine: Lead Toxicity," June, 1990 (p.7)

Hematologic Effects: Anemia is a prominent finding in lead poisoning caused by the combined effect of (1) inhibition of hemoglobin synthesis, and (2) the shortened life span of circulating erythrocytes. Lead inhibits several enzymes that are critical to the synthesis of hemoglobin. One of the substrates of hemoglobin synthesis is erythrocyte protoporphyrin which, in its "free" state, actually exists as zinc protoporphyrin (ZPP) and builds up to measurable levels in chronic, relatively high levels of lead poisoning. Lead in high levels has been associated with hemolytic anemia, but in lower levels, lead seems to cause anemia by shortening the life span of circulating erythrocytes by making the cell walls of red cells more fragile. The anemia in adults is usually mild to moderate. Early in the course it is often microcytic and hypochromic, but with lead poisoning, the red cells are often normocytic and normochromic. Basophilic stippling of the red cells on a peripheral smear is often seen in chronic lead poisoning.

Neurologic Effects: The most sensitive target of lead poisoning is the nervous system. In adults, the neurologic effects include subtle behavioral changes, fatigue, and impaired concentration. Peripheral nervous system damage, primarily motor, often begins with aching and tenderness of joints and muscles (especially forearm extensor muscles), increased fatiguability of the muscles, and development of a fine tremor which can progress to painless paresis of one or more muscle groups (the classic "wrist drop" of lead palsy).

Endocrine Effects: Lead interferes with a hormonal form of Vitamin D, which can impair cell maturation and skeletal growth. Lead can impair thyroid function by preventing the uptake of iodine, and can have a direct effect to decrease the pituitary and adrenal gland functions.

Renal Effects: A direct effect on the kidney from long-term lead exposure is nephropathy, characterized by a progressive, irreversible impairment of renal function often accompanied by hypertension. The hypertension, if untreated, can then cause secondary cardiovascular effects including left ventricle hypertrophy, myocardial infarction, and cerebrovascular accidents. Lead also interferes with the normal excretion of uric acid which can cause hyperuricemia and gout. Lead has also been implicated as a potential human renal carcinogen, having caused kidney tumors in rats.

Reproductive and Developmental Effects: There has been a long history of spontaneous abortions and stillbirths among women working with lead as early as the turn of the century. Lead can readily cross the placenta, which not only affects the viability of the fetus, but its development as well. Reduced birth weights and premature births have been reported. Lead is a known animal teratogen, and is believed to be able to cause at least minor malformations in human fetuses. In men, data is also available which suggests that chronic exposure to lead can reduce sperm counts and motility.

Purpose

The purpose of the Lead Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who is exposed to lead above the action level or at the physician's discretion.

2. Educate that employee about the nature of lead, the proper use of respiratory protection and protective clothing, and appropriate sanitation practices to be used when exposed to lead-containing environments in the workplace.

3. Monitor those employees by obtaining an extensive past medical and occupational exposure history, and then performing period physical examinations with appropriate laboratory work to detect early signs and symptoms of lead poisoning. When lead exposure is anticipated, a baseline physical examination with the appropriate laboratory work shall be obtained.

Medical Surveillance

The specifics of the Medical Surveillance Program for Lead Exposure at the NASA Lewis Research Center will fulfill the criteria required by OSHA, as defined under 29 Code of Federal Regulations (CFR) 1910.1025, and will incorporate recommendations from NIOSH.

Since the primary occupational exposure to lead is through inhalation of inorganic lead fumes and dust particles, worker exposure limits are defined in terms of the concentration of lead in the ambient air and require air monitoring for measurement. The permissible exposure limit (PEL) for lead is 50 $\mu g/m^3$ as an 8-hour time-weighted average (TWA). The action level (AL) for lead is 30 $\mu g/m^3$ as an 8-hour TWA. Therefore, any worker who is exposed to the AL for lead for more than 30 days per year shall be included in the NASA Lewis Research Center Lead Medical Surveillance Program.

The maximum permissible limit for lead is calculated as:

Maximum Permissible Limit (in $\mu g/m^3$) = 400 hours worked in the day.

If an employee is exposed to the maximum permissible exposure limit for lead in any given work day, then he/she shall be entered in the Lead Medical Surveillance Program.

Requirements for specific types of respiratory protection, protective clothing, engineering control, safety controls, and hygiene facilities and practices will be determined and enforced by the Office of Industrial Hygiene and the Safety Office.

Current OSHA recommendations seek to limit a lead-exposed employee's blood lead level to less than 40 $\mu g/dl$ whole blood. However, as of the autumn of 1991, NIOSH now recommends limiting employee exposures to lead that result in blood lead levels less than 25 $\mu g/dl$ whole blood. Given that the toxicity of lead is dependent on the total body burden of lead and that in chronic low level exposures there can be significant toxicity to lead even with normal blood lead levels, the NASA Lewis Research Center Medical Surveillance Program for Lead will utilize the NIOSH recommendations of limiting employee blood levels to less than 25 $\mu g/dl$.

NASA employees identified by the Office of Industrial Hygiene as having either the potential to being exposed to lead at or above the AL or having been exposed at or above the AL to lead will be included in the Lead Medical Surveillance Program. Medical surveillance baseline examinations will include:

1. **Medical and work histories**, with special attention to:
   - Previous occupational or recreational exposure
   - Occupational and recreational history of all home occupants

- Family history, including use of unusual medications
- Use of imported or glazed ceramics
- Use of leaded crystal for storing drinking beverages (especially alcoholic)
- Drinking water source and type of pipe
- Nutritional status
- Proximity to industrial facilities and hazardous waste sites
- Smoking history
- Personal hygiene and other habits
- Past or current GI problems
- Past or current reproductive problems (including pregnancy status)
- Past or current cardiovascular problems (especially history of hypertension)
- Past or current neurologic problems
- Past or current hematological or renal problems
- Past or current history of gout.

2. **A complete physical examination**, with special attention to:
   - Vital signs, especially blood pressure
   - Teeth and gums (purplish line on gums called a "lead line")
   - Renal System
   - Neurologic system (behavioral changes, fatigue, tremors, peripheral motor neuropathy, seizures)
   - Cardiovascular system (hypertension, LVH, remote MI, neurologic deficits suggestive of CVA)
   - Hematologic system (pallor, signs of anemia including tachycardia, CHF, etc.)
   - Gastrointestinal system (abdominal pain, nausea)
   - Pulmonary system if respiratory clearance is needed.

3. **Laboratory examination**, to include:
   - Chest X-ray (as a baseline test if not already available)
   - Spirometry (if respiratory clearance is indicated)
   - CBC with differential (anemia, low red cell indices, basophilic stippling on peripheral smear)
   - Blood lead level (less than 25 μg/dl. If >/=60 μg/dl, the employee shall be removed from any occupational exposure)
   - ZPP (Zinc Protoporphyrin) level (less than 35 μg/dl)

- Serum chemistries (attention to BUN, creatinine, uric acid, T4, electrolytes, and serum calcium/phosphorus)
- Urinalysis with microscopy
- EKG if not done within past 12 months (attention to changes associated with chronic, uncontrolled hypertension).

The periodic requirements for lead medical examinations shall include:

1. **Follow-up blood lead and ZPP tests**:
   - **Semi-annual** (every 6 months) for workers exposed to greater than the AL but whose blood levels have been <25 μg/dl.
   - **Bimonthly** (every 2 months) for workers whose last blood level was >/= 25 μg/dl. Continue until two consecutive tests are <25 μg/dl.
   - **Monthly** for workers who have been removed from exposure to lead due to a blood level >/= 60 μg/dl. After the first excess, repeat the blood lead and ZPP within two weeks.
   - **Every two weeks** for workers exposed to the maximum permissible exposure limit, as defined in the "Background" section, regardless of the worker's past blood lead level.

2. **Complete lead examinations**:
   - **Annually** for workers exposed to the AL for lead (30 $\mu g/m^3$, 8-hour TWA for more than 30 days/year).
   - **As soon as possible after signs or symptoms of lead toxicity develop in anyone at any time.**
   - **Annually** for workers whose blood lead was >/= 25 μg/dl anytime during the previous 12 months.
   - **At the completion of any major lead abatement projects.**
   - **Upon retirement or termination of employment** of any worker who has been involved in an <u>ongoing</u> lead medical surveillance program.

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N94-16641

MERCURY SURVEILLANCE PROGRAM

NASA Lewis Research Center
Occupational Medicine Service

Background

Mercury, in both its organic and inorganic forms, can be toxic to humans. Both forms of mercury, the inorganic metal and the organic compounds, are quite volatile at room temperature. Therefore, human exposure to mercury is most common because of inhalation of its vapor. It is likely that mercury also can be absorbed through the skin, but this mode of entry has proven to be insignificant.

The permissible exposure limit (PEL) from the National Institute for Occupational Safety and Health (NIOSH) for exposure to mercury vapor is a concentration of 0.05 mg/m3 as an 8-hour time-weighted average. OSHA previously had used 0.1 mg/m3 as the PEL for mercury exposure. There have been no symptoms of mercury toxicity reported at exposure concentrations less than 0.01 mg/m3 and, thus, this level is considered a "safe" concentration level.

There is an affinity of mercury for sulfur and sulfhydryl groups, and it readily binds with proteins in the body. Mercury accumulates almost anywhere in the body; however, the organs with the longest retention times -- thus demonstrating the greatest effects from toxicity -- are the kidneys, brain, and testicles.

Acute poisoning by mercury vapor is dose-dependent and causes primarily pulmonary problems ranging from erosive bronchitis, bronchiolitis, interstitial pneumonitis, and progressing on to respiratory insufficiency. Also, exposed patients can acutely demonstrate tremor, excitability, memory loss, insomnia, GI disturbances, and renal damage (ranging from tubular dysfunction of varying severity to acute tubular necrosis).

Chronic exposure to mercury vapors at low doses can cause a syndrome called "micromercurialism," which includes symptoms of weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. Chronic exposure to higher concentrations of mercury can lead to inflammation of the gums; excessive salivation; fine trembling of

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muscles; coarse shaking of fingers, eyelids, and lips (characteristic of an intentional tremor because these movements often disappear during sleep); severe personality and behavioral changes; increased excitability; loss of memory; insomnia; and dermatitis (including a generalized rash, pruritus, erythema, and desquamation of especially the hands, feet, and nose). The acute and long-term effects of exposure to organic mercury compounds (mercuric salts, phenylmercury compounds, and alkoxyalkylmercury compounds) are more likely to be gastrointestinal disturbances and renal damage.

The average half-time of mercury in the body is approximately 60 to 70 days, although part of the mercury accumulated in the brain is slowly eliminated with a biological half-time that may exceed several years. The mercury concentration in the urine per gram of creatinine is the best index available for evaluating an exposure. Symptoms of mercurialism are more prevalent when urinary concentrations exceed 50 micrograms (μg) mercury per liter of urine. On a group basis, high levels of mercury in the urine may be associated with prolonged exposures to high concentrations of mercury vapor, and, thus, a greater likelihood of signs and symptoms of poisoning.

Purpose

The purpose of the Mercury Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who is exposed to mercury above the action level (AL) or at the physician's discretion.

2. Educate that employee about the nature of mercury, the proper use of respiratory protection and proper protective clothing when handling mercury, and appropriate sanitation practices when handling mercury.

3. Monitor those employees by obtaining an extensive past medical and occupational exposure history and then performing periodic physical examinations with twenty-four (24) hour urine collections for mercury concentrations to detect early signs and symptoms of mercurialism. When mercury exposure is anticipated, a baseline physical examination with a 24-hour urine collection for mercury shall be obtained.

Medical Surveillance

The specifics of the Medical Surveillance Program for Mercury Exposure at the NASA Lewis Research Center will fulfill the criteria required by OSHA, and will incorporate recommendations from NIOSH and the Department of Defense.

The PEL for mercury as defined by NIOSH is 0.05 mg mercury/m^3 as measured during an 8-hour time-weighted average (TWA). The action level for mercury constituting an occupational exposure as defined by OSHA is 40 percent of the PEL, or 0.02 mg mercury/m^3 TWA.

NASA employees identified by the Office of Environmental Programs as having been exposed to the AL for mercury will be entered into the Medical Surveillance Program. As soon as possible, these employees will need:

1. **Medical and work histories**, with special attention to:
   - Loss of weight
   - Sleeplessness
   - Tremors
   - Personality/behavioral changes
   - CNS involvement (such as changes in handwriting)

2. **A complete physical examination**, with special attention to:
   - Central nervous system
   - Peripheral nervous system (strength, sensation, DTRs)
   - Kidneys
   - Respiratory system
   - Skin (rashes, erosions, ulcers, pigment changes, eczema, etc.).

3. **Laboratory evaluation**, to include:
   - Complete blood count (CBC) with differential
   - Serum chemistries to include renal function tests (BUN, Creatinine), and electrolytes (Na+, K+, Cl-, CO2)
   - Urinalysis with microscopy
   - 24-hour urine collection for mercury.

The above evaluation will be repeated each month for at least two (2) months regardless of the findings of the initial evaluation. This evaluation will be repeated then every other

month for as long as the employee's work environment has a mercury concentration at or above the AL as determined by the OEP. If there is a one-time exposure to mercury at or above the AL, then the initial evaluation with the two monthly follow-up evaluations is all that is needed.

In the event that the OEP determines that an employee is at an increased risk of mercury exposure at or above the AL because of the nature of the employee's job or the potential presence of mercury in the work environment, then that employee shall receive the above evaluation as a baseline before potential exposure and then annually thereafter until such time that the OEP determines that the employee is no longer at risk for mercury exposure.

If there is risk of any exposure to mercury in an employee's work environment (regardless if this potential exposure is deemed to be above or below the AL for mercury as determined by OEP), then that employee will receive annual mercury surveillance examinations (physical examination and 24-hour urine collection).

Upon completion or termination of employment, an employee who has been involved in an ongoing Mercury Medical Surveillance Program is entitled to an ongoing mercury surveillance examination with the appropriate laboratory studies. The Occupational Medicine Service (OMS) will not continue surveillance of an individual once they have either retired from NASA or are no longer employed by NASA but, during the final physical examination, recommendations will be given to the individual for continued medical surveillance to be completed by the individual's private doctor.

Summary Table for Frequency of Mercury Surveillance Exams

Acute exposure to mercury at or above PEL	Exam q2 months, until mercury level below the PE
Work environment with chronic mercury levels at or above the AL	Exam q6 months, until mercury level below the AL
Any risk to mercury exposure	Exam q year (annually).

References

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N94-16842

RESPIRATORY PROTECTION PROGRAM
MEDICAL CLEARANCE FOR RESPIRATOR USE

NASA Lewis Research Center
Occupational Medicine Service

S3-52
176
P. 7

Background

Occupational exposures to various inhalants cause a large portion of occupational morbidity and mortality. The United States Department of Labor estimates that 65,000 U.S. workers annually develop respiratory disease because of work-related exposures, and 25,000 people die from these diseases every year. Many, if not all, of these cases are entirely preventable.

A complete Respiratory Protection Program, as defined by the Occupational Safety and Health Administration (OSHA) in the CFR 1910.134, includes provision for on-site hazard control measures incorporating occupational procedures; engineering controls; and the selection, fitting, use, and care of various kinds of personal respiratory protective gear. Additionally, health hazards in the workplace need to be identified and evaluated and permissible exposure limits then need to be ascertained. Methods of continued environmental monitoring to ensure that the state's permissible exposure limits (PEL) are not exceeded must be implemented. And always an ongoing priority is the education of the employee and employer about the toxicity of hazards and the safety measures designed to protect the worker from these hazards.

To cover all of the components of a Respiratory Protection Program is beyond the scope of this document and the jurisdiction of the Office of Occupational Medicine Services (OMS). Rather, this document will cover the rationale, procedures, and interpretation of results for the medical clearance of employee for use of personal respiratory protection devices.

The human cardiopulmonary system is a wonderfully complex and yet durable network directly involving not only the lungs, but the heart and blood vessels as well. At the most basic level, this system efficiently oxygenates the blood and removes the waste product, carbon dioxide (CO_2). There are many natural built-in defense

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mechanisms such as nose hairs and the cilia-lined mucous membranes of the respiratory tract that effectively filter larger dust particles from the inhaled air. However, in light of cardiopulmonary disease, damage to the respiratory tract from cigarette smoke and other irritants or a high concentration of air contaminants that overwhelm the natural defense mechanisms, dusts, gases, sprays, vapors, fumes, and even radiation can be inhaled directly into the lungs. With repeated exposures to these various toxic inhalants, significant lung damage with measurable clinical effects can be incurred. Often inhalants have an immediate toxic effect which can even prove fatal, but more frequently the physical damage becomes evident years after the initial exposure.

Minimizing the inhalation of harmful dusts, fumes, or vapors is the most effective method of preventing occupational lung diseases. Decreasing the inhalant concentration is accomplished through engineering control measures, with attention to appropriate ventilation and safe work practices. When needed, respiratory personal protective devices (respirators) are used to further minimize inhalant exposures.

There are several varieties of respirators, each with specific criteria for their use. However, all respirators impose added physiologic burdens on an individual. Not all people have the pulmonary and/or cardiovascular reserve available to accommodate this extra physiologic strain. Therefore, medical clearance should be required prior to the issuance of any respirator and periodically repeated if there is continued respirator use.

Among the physiologic loads imposed by respirators, there is an increase in "dead space," representing the volume of exhaled air that is rebreathed from the mask with each inspiration. Rebreathing this dead space air requires either an increased respiratory rate or an increase in the total volume of air breathed per breath in order to overcome the dead space effect. If an individual has significant respiratory disease, one or the other compensatory mechanisms to increase ventilation may not be achievable. Also, there is a resistance to airflow, especially when using a non-powered air-purifying respirator, that is called "flow resistive load." Increased pleural pressure must be generated to overcome the airflow resistance which causes an increase in respiratory work. If a respirator has significant expiratory impedance then, upon expiration, the intrathoracic pressure will need to be higher which will also increase the work of respiration. Increased respiratory work may produce dyspnea (shortness of breath). An

increase in inspiratory effort will lead to a concomitant decrease in expiratory time, which may also cause dyspnea.

The increased intrathoracic pressures required to overcome the airflow resistance will decrease filling of the heart with blood during diastole (relaxation). This may decrease the cardiac output if the individual does not have the cardiac reserve necessary to initiate a compensatory increase in heart rate, as described by the equation of cardiac physiology:

Cardiac output - Stroke volume X Heart rate

Also, myocardial ischemia can occur in individuals with significant coronary artery disease when the heart rate increases to maintain adequate cardiac output.

Other added stresses imposed by respirators are related to the physical characteristics of the device itself. The weight of a respirator (SCBA's can weigh up to 30 pounds) will increase energy demands just to carry it, and impose additional strain to the back and contribute to postural instability. Mobility can be limited by wearing a respirator. An individual's field of vision and clarity of vision is impeded. Speaking is difficult while wearing a respirator. Also, there may be a decreased ability to eliminate heat while wearing a respirator.

Certain pulmonary, cardiovascular, psychiatric, or other diseases may interfere with respirator use. Pulmonary diseases are generally classified as "restrictive" lung diseases (pulmonary fibrosis, silicosis, asbestosis, morbid obesity, severe kyphoscoliosis) and "obstructive" lung diseases (asthma, chronic bronchitis, emphysema, bronchiectasis). Restrictive lung diseases are characterized by a decrease in lung compliance, and it therefore may be difficult for these individuals to increase their tidal volume. Obstructive lung diseases are characterized by an increase in physiologic dead space and increased airway resistance. Wearing a respirator in either case would only exacerbate these already existing problems, and could lead to severe dyspnea or even to respiratory failure. Coronary artery disease and/or cardiac arrhythmias are aggravated in the presence of hypoxia (low oxygen) or hypercarbia (increased carbon dioxide). Psychiatric disorders such as certain phobias or personality traits may preclude respirator use or may make a worker unreliable in using respirators. Other medical conditions can interfere

with safe respirator use such as perforated tympanic membranes (eardrums), structural abnormalities of the face (including full beards), and musculoskeletal disorders that make it difficult to carry the heavier respirators.

Purpose

The purpose of a Respiratory Protection Program at the NASA Lewis Research Center shall be to:

1. Identify those employees who, because of physical disability and/or disease, should not wear respirators because the added physiological burden of the respirator would be detrimental to that worker's health or his/her ability to safely perform their job.

2. Educate employees about the necessity of respiratory protection in certain work environments and how respiratory protection can prevent future medical problems when used properly.

3. Monitor employees who require respiratory protection to ensure that after an employee has been medically cleared to use a respirator, physical conditions do not emerge or digress to the point where continued respirator use would be contraindicated.

Medical Surveillance

In compliance with OSHA policy, all employees who use respirators regularly or who may use respirators on a emergency basis will have an annual limited physical examination with spirometry testing. Supervisors of NASA employees who need medical clearance for respirator use will provide a list of these employees to the Office of Environmental Program who, in turn, will share this list with the Occupational Medicine Services Office. The limited medical exams can be incorporated with the annual health screening physicals that are available to all NASA employees.

A Respiratory History for Spirometry Questionnaire will be completed by the employee. Any employee who has had a respiratory infection within three weeks before

the spirometry testing will be rescheduled. Additional medical history will be obtained during the physical that will concentrate on pulmonary, cardiovascular, neuromuscular, or physical problems which can adversely affect safe respirator use.

The physical exam for respirator clearance will concentrate on obtaining the employee's vital signs (blood pressure, pulse, respiratory rate, and temperature) and close examination of the employee's head, eyes, ears, nose, throat, mouth, neck, heart, lungs, and chest wall.

Spirometry testing will be obtained to calculate the employee's forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and FEV1/FVC (or FEV1%). While several other calculated values are extrapolated from spirometry testing, these three values best reflect an individual's functional lung capacity. When these three values are abnormal, the other values may then be of more value in the interpretation of the spirometry results, and additional tests may be indicated (e.g., chest X-ray, arterial blood gas sampling, diffusion capacity calculation, etc.). The spirometer that is used, the calibration of this instrument, and the interpretation of the results will comply with the "Standards for Administration and Interpretation of Ventilatory Function Tests," developed by OSHA in consultation with NIOSH (*Federal Register, Rules and Regulations*, Vol. 45, No. 42, Appendix B, pp 13695-13696).

An employee's spirometric test results will be compared to a set of reference standards and also compared to that employee's previous studies, if available. If the spirometry results are abnormal, repeat spirometry testing will be scheduled. If there is a significant decrement in an employee's pulmonary function when compared to previous studies, even if the employee's results fall within "normal limits," a repeat spirometry test will be scheduled. No more than two spirometry tests will be scheduled in a given calendar year if solely for the purpose of respirator clearance. "Normal" spirometry results are outlined in Table 1. Contraindications for respirator use are outlined in Table 2.

Table 1. Normal Spirometry Results

FVC	>80% Age Predicted Value
FEV1	>80% Age Predicted Value
FEV1% (FEV1/FVC)	>70% (Actual Value)

Table 2. Contraindications for Respirator Usage

1. Spirometry results fall below those values documented in Table 2.
2. Uncontrolled cardiovascular disease (angina, valvular heart disease, known coronary artery disease, hypertension, or extracranial vascular disease).
3. Uncontrolled epilepsy.
4. Syncopal episodes.
5. Myasthenia gravis, or other fatiguing neuromuscular disorders.
6. Sleep apnea.
7. Facial deformity (including the presence of beards) that render respirator fitting difficult, and adequacy of the seal cannot be guaranteed.
8. Ill-fitting dentures.
9. Severe kyphoscoliosis.
10. Morbid obesity.
11. Psychiatric disorders where reliability of respirator usage cannot be guaranteed.
12. Perceived severe dyspnea (shortness of breath) when respirator is worn.

All employees who meet the medical criteria for respirator usage will have a certificate sent to their supervisor with a copy sent to the Office of Environmental Programs. Similarly, employees who do not meet the criteria for respirator usage will have a certificate sent to their supervisor and the Office of Environmental Programs.

References

1. *Harrison's Principles of Internal Medicine*, Ninth Edition, 1980: 1190-98.

2. Zenz, C. *Occupational Medicine: Principles and Practical Applications*, Second Edition, 1988: 250-253.

3. Altose, M.D. The Physiological Basis of Pulmonary Function Testing. CIBA *Clinical Symposia*, 1979.

4. Harber, P.H. Medical Evaluation for Respirator Use. *Journal of Occupational Medicine*, 1984; 26: 496-502.

5. 29 CFR, Section 1910.134.

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7. *Occupational Lung Diseases, An Introduction.* American Lung Association, 1983: 1-80.

N94-16643

GENERAL MEDICAL SURVEILLANCE PROGRAM

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NASA Lewis Research Center
Occupational Medicine Services

Background

The NASA Lewis Research Center (LeRC) is a laboratory where hazardous chemicals are frequently used. There exists a potential for employees to be exposed to these hazardous substances in performing their assigned work duties. With employee health and safety the primary objective, the handling of occupational exposures to hazardous substances at LeRC must meet the criteria as outlined in the CFR 1910.1450 (Occupational Exposure to Hazardous Chemicals in Laboratories), and NHS/IH-1845.5 (NASA Health Standard on Occupational Exposure to Hazardous Chemicals in Laboratories).

Communication and cooperation between the Occupational Medicine Services, the Industrial Hygiene Office, and the Safety Office is essential in order to ensure an organized approach in dealing with either a real or potential employee exposure to a hazardous substance which maximizes employee health and safety and appropriately utilizes state-of-the-art medical surveillance techniques. This document will provide suggested guidelines for this interdepartmental communication and cooperation.

In general, a hazardous chemical is any substance or material which is known or suspected to adversely affect a person's health. Most hazardous chemicals are so identified by the Occupational Health and Safety Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and by the American Conference of Governmental Industrial Hygienists (ACGIH). Specific threshold limit values (TLVs), as defined by the ACGIH, or permissible exposure limits (PELs), as defined by OSHA, have been identified for these hazardous chemicals. Medical surveillance is generally recommended if an individual is exposed to a hazardous chemical at or above the action level (AL) for that substance. The AL is generally defined as half of the PEL, although there are some exceptions to this rule.

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The route of exposure to a hazardous chemical is dependent on that substance's physical properties, but generally ranges from inhalation, ingestion, absorption through the integument, or absorption through mucous membranes.

Purpose

The purpose of the General Medical Surveillance Program at the NASA Lewis Research Center shall be to:

1. Identify any Lewis employee who is exposed to a hazardous chemical above the AL or at the physician's or industrial hygienist's discretion.

2. Educate that employee about the nature of the hazardous substance to which he/she has been exposed, the proper handling practices when working with that substance, proper ventilation procedures, respiratory protection and/or protective clothing to be worn when handling the substance, and about related personal health practices which may compound an adverse impact due to the hazardous chemical.

3. Monitor that employee for potential adverse effects from the exposure to a hazardous substance, utilizing appropriate medical surveillance procedures and protocols that have been determined for that particular hazardous substance.

Medical Surveillance

The specifics of a Medical Surveillance Program initiated because of an exposure to any hazardous chemical at the NASA Lewis Research Center will fulfill all criteria established for this hazardous substance by OSHA. If OSHA criteria have not been established for a particular substance, then other reputable sources, including NIOSH, ACGIH, and AIHA (American Industrial Hygienist Association) will be referenced.

There are three types of circumstances in which an employee may be included in a medical surveillance program because of an exposure to a hazardous chemical:

1. Emergency Situation: When an employee presents to Medical Services following an acute exposure to a hazardous substance (usually due to a spill), the appropriate emergency medical care will be rendered to stabilize the patient. The primary resources will be the TOMES-Plus Database which is accessible in Medical Services, and the Material Safety Data Sheet (MSDS) for the substance to which the patient was exposed. In some circumstances, the Poison Control Center for Cuyahoga County or local toxicology experts may be consulted. After the employee has been stabilized medically, the Office of Industrial Hygiene will be notified of the acute exposure and the results of their investigation and recommendations will determine if continued medical surveillance is indicated.

2. Chronic Exposure: If an employee presents to Occupational Medicine Services with the concern of having possibly been exposed to a hazardous substance and is currently without specific symptoms, the employee will be referred to the Office of Industrial Hygiene. If the Office of Industrial Hygiene concludes that the employee is at risk for having been exposed to a hazardous substance at or above the designated action level for that substance, then appropriate medical surveillance will be instituted.

3. Abnormal Physical Findings: If, during the course of a routine health screening physical examination, laboratory abnormalities, symptoms, or physical findings are discovered which are suggestive of an employee having possibly been exposed to a hazardous chemical, then the Office of Industrial Hygiene will be notified. Further medical surveillance exams will be offered if the Office of Industrial Hygiene determines that there exists a significant possibility that the employee was exposed to a hazardous chemical at or above the action level.

At NASA Lewis Research Center, the Safety Office investigates all work-related injuries and reported accidents. If, during the course of their investigation, the Safety Officer feels that an employee may have been exposed to a hazardous substance, then the Safety Office will consult the Office of Industrial Hygiene. Ultimately it is the Industrial Hygiene Office that determines if medical surveillance is appropriate following either a real or presumed exposure to a hazardous chemical.

Once an employee has entered a Medical Surveillance Program because of an exposure to hazardous chemicals at the work site, the laboratory results, abnormal physical findings, and subsequent determination for fitness-for-duty will be shared with the Office of Industrial Hygiene. Medical surveillance examinations, like office visits for work-related accidents or injuries, fall outside of the typical doctor-patient relationship and, therefore, are not privy to the usual laws that protect patient confidentiality. However, any confidential medical information which may be pertinent to the successful treatment of an employee undergoing regular medical surveillance and which is not directly job-related will be maintained in the strictest of confidence.

BLOODBORNE PATHOGENS PROGRAM

Sharon Blasdell, R.N., COHN
EG&G Florida/Kennedy Space Center

N94-16644

The final rule on the Occupational Exposure to Bloodborne Pathogens was published in the *Federal Register* on December 6, 1991. This Standard, 29 CFR Part 1910.130, is expected to prevent 8,900 hepatitis B infections and 200 deaths a year in health care workers in the United States. The Occupational Medicine and Environmental Health Services (OMEHS) at Kennedy Space Center (KSC) has been planning to implement this Standard for several years.

In 1987, the Morbidity and Mortality Report, published by the Centers for Disease Control (CDC), made recommendations for the prevention of HIV transmission in health care settings. As a result, most of the engineering and work practice controls, personal protective equipment, housekeeping functions, and hepatitis vaccination had been implemented at OMEHS clinics by December 1991. The program was expanded when the Standard was published in the *Federal Register* to include emergency first aid responders and janitors in addition to medical people in the clinics.

The Standard includes a training requirement. Since EG&G Florida comprises the greatest number of people involved at the Kennedy Space Center, its Exposure Control Plan includes provisions for a course which was titled, numbered, and available for all KSC and Cape Canaveral Air Force Station employees. Moreover, since the hepatitis vaccine was located in the EG&G medical facilities, any eligible employee from any company could receive the hepatitis vaccine from EG&G Medical.

The EG&G Exposure Control Plan for Occupational Exposure to Bloodborne Pathogens was published May 1, 1992. The training course was established and offered on a regular basis so that any new employee could be trained within the time required by the Standard. A roster of all who attend the training course is maintained. Utilizing our Health Information Management System (HIMS) of computerized medical records, EG&G Florida is able to code those who have received the hepatitis vaccine and those who have completed their bloodborne pathogen training. We are also able to identify those who decline the hepatitis vaccine.

A large number of people at the Kennedy Space Center and Cape Canaveral Air Force Station are in the program (see Exhibit 1). All of these people have had the one- and one-half hour training course. About one-fourth of the KSC Fire and Security personnel have declined the hepatitis vaccine. Johnson Controls Fire personnel have not elected to act as emergency first aid responders and, therefore, have not entered the program.

Exhibit 1. Hepatitis B Vaccine

AGENCY	BBP POPULATION	ACCEPTED	DECLINED
CIVIL SERVICE			
NASA MEDICAL	4	4	-0-
NAT. PARK SVC.	9	9	-0-
EG&G FLORIDA			
MEDICAL	58	57	1
FIRE	121	92	29
SECURITY	212	163	49
JANITORS	6	6	-0-
BIONETICS			
MEDICAL	45	44	1
JOHNSON CONTROLS	72	60	12
FIRE	-0-	-0-	-0-
SECURITY	9	8	1
JANITORS			
THIOKOL			
DIVERS	4	4	-0-
TWRS			
JANITORS	-0-	-0-	-0-
TOTALS	540	447	93

The medical records of any person exposed are kept strictly confidential and separate from an individual's medical records. All testing is coded so that only the physician will know the identify of any exposed person.

In the first nine months we have presented 60 classes and 90 hours of training to 540 personnel. We utilize our nursing educators in addition to the AMA video program to ensure that our training is specific to our settings.

The cost for this program as been over $50,000 for the vaccine. This does not include the costs for needles, syringes, the personnel costs including medical time, or employees' time absent from work to obtain the vaccine.

In conclusion, we feel that we have a very complete, comprehensive Bloodborne Pathogen Program at Kennedy Space Center.

OSHA BLOODBORNE PATHOGENS STANDARDS
EXPOSURE CONTROL PLAN

N94-16645

Prepared by: *Caro Elise Luhrs, M.D.*
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Hummer Associates
(April, 1992 - Revised June 1992)

The Hummer Associates Exposure Control Plan is designed to reduce significant occupational exposure to bloodborne pathogens and infectious materials for Hummer Associates health care personnel. Under universal precautions, **all patients and all body fluids are considered potentially infectious for bloodborne pathogens.** Medical personnel need not be at increased risk if universal precautions are correctly understood and followed. This program covers all employees who could reasonably anticipate contact with blood or other potentially infectious materials (OPIM*) during the performance of their job responsibilities. Although HIV and Hepatitis B (HBV) are mentioned most often, this program applies to all bloodborne diseases. The two main components needed to implement this program are universal precautions and engineering/work practice controls.

This program covers all employees who may have occupational exposure to blood or OPIM, including part-time, temporary, and per diem employees. It also covers any employee trained in first aid who is responsible for rendering medical assistance as part of his/her job duties; i.e., fitness personnel and secretaries who cover the Fitness Centers.

The OSHA Bloodborne Pathogen Standards seek to minimize the health risk from occupational exposure to blood and other potentially infectious materials utilizing a variety of steps which include:

- An exposure control plan.
- Engineering/work practice controls.
- Personal protective equipment (PPE).
- Housekeeping guidelines.
- Hepatitis B vaccination.
- Post-exposure evaluation and follow-up.
- Employee information and training.
- Comprehensive recordkeeping.

*Other Potentially Infectious Materials (OPIM): Human body fluids including semen; vaginal secretions; cerebrospinal, synovial, and pleural fluids; saliva; any body fluid that is visibly contaminated with blood.

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The Hummer Associates Exposure Control Plan incorporates all requirements of the OSHA Standards in a comprehensive package to be implemented in each of the Centers. The exposure control plan identifies tasks and procedures where occupational exposure to blood and OPIM may occur. The plan identifies the individuals who are at risk and need to be educated in other elements of the program. Exhibit 1 is a compliance calendar.

Exhibit 1. Compliance Calendar: The Following OSHA Standards Must be Implemented by the Noted Dates

Bloodborne Pathogens Standards	March 6, 1992
Exposure Control Plan	May 5, 1992
Employee Information Plan	June 4, 1992
Recordkeeping	June 4, 1992
Engineering/Work Practice Controls	July 6, 1992
Personal Protective Equipment	July 6, 1992
Housekeeping	July 6, 1992
Hepatitis B Vaccination	July 6, 1992
Post-Exposure Evaluation and Follow-Up	July 6, 1992
Labels and Signs	July 6, 1992

Job Classifications Covered Under Exposure Program

The following job classifications are those in which all employees will have contact with blood or OPIM:

- Physicians
- Nurses
- Nurse Practitioners
- Medical Technicians/Phlebotomists.

The following job classifications are those in which employees may on occasion have risk exposure:

- Fitness Center personnel
- Secretaries covering Fitness Centers
- Laundry personnel.

Engineering/Work Practice Controls

Handwashing Facilities

Hummer Associates shall see that all Centers have appropriate handwashing facilities. Proper handwashing technique shall be encouraged by the following:

- o Soap must be available with at least tepid running water.
- o If soap and water are not feasible, use antiseptic hand cleanser or towlette. Wash hands as soon as possible thereafter.
- o Handwashing facilities must be readily accessible to employees.
- o Hands and any other skin must be washed as soon as feasible following contact with blood or OPIM.
- o Hands must be washed immediately after removal of gloves or other personal protective equipment (PPE).

Sharps/Containers for Used Sharps

Handling of Used Sharps

Hummer Associates, through each agency, will provide the necessary supplies for safe handling of contaminated sharps. The employer shall see that all employees are trained in proper disposal of contaminated sharps:

- o Shearing or breaking of contaminated needles is prohibited.
- o Bending, recapping, or removing contaminated needles by hand is prohibited unless:
  - Recapping is properly performed by scoop method.
  - Needle removal is done by one-handed technique or mechanical device.
- o Disposable scissors, needles, syringes, razors, knife blades, tweezers, applicators, and used test tubes shall be considered sharps and disposed of accordingly.

Containers for Used Sharps

- o The containers for used sharps must be:
  - Puncture resistant.
  - Labeled or color coded in accordance with standards.
  - Leak proof on the sides and bottom

- Stored in a way that will not require employees to reach by hand into container where sharps are placed.
- Sealable.

o The sharps container must remain upright during use.

o Never overfill container.

o Duct tape may be used to secure container lid, but may not serve as lid.

o Self sheathing needle products must be disposed of in sharps container.

o Some sharps containers may contain residual liquid. If the container cannot be sealed to prevent leakage, it must be placed in a secondary container.

o Sharps containers must be located as close as possible to locations where sharps are used, and must be easily accessible.

Other Potentially Infectious Waste

Any disposable item contaminated with blood or OPIM must be considered as infectious. We have previously discussed the disposal procedure for sharps, or "hard materials." Soft infectious waste -- cotton balls, gauze, gloves, band-aids, hemoccult slides, and dextrostix also require special disposal procedures. They are as follows:

o Shall be placed in a red, plastic hazardous waste bag.

o When full (and it must not be overfilled), it is closed and secured with a twist tie, then placed in labeled hazardous waste container/box.

Containers for Laboratory Specimens

o Specimens of blood and OPIM must be placed in a container which prevents leakage during collection, handling, processing, storage, and transport.

o If contamination of outside or primary container occurs, or if specimen could puncture primary container, the primary container must be placed within a secondary container.

Second Containers

Second containers are required when outside contamination of first waste containers occurs. The second container must:

o Be closable.

o Adequately contain all contents, and prevent leakage during handling, storage, and transport.

Double bagging is only required when waste container is splashed with blood or OPIM, or is handled by an employee with contaminated gloves. Routine double bagging is not required.

Disposal of Hazardous Waste

Hummer Associates, through (each agency), has contracted with BFI Hazardous Waste Disposal Co., to remove infectious waste from the work site. BFI provides boxes and box liners for transport and disposal. Each Health Center must obtain the proper sharps containers and red hazardous waste bags. Each Center must arrange for proper labels and labeling of bags and containers. To prepare hazardous waste for transport and disposal:

- Properly close and seal sharps containers.
- Seal destruclip containers with duct tape.
- Secure red bags with "soft" waste.
- Place sealed sharps containers, sealed destruclip containers, and secured bags in appropriately labeled boxes which have been provided by BFI.
- This box will contain a red, thick plastic liner. The box will be sealed, as indicated on box.
- The labeled boxes will be removed for disposal by BFI.
- A designated employee will sign for the removal of box/boxes.
- At a later date, the Health Center will receive a copy of a form with the disposal location. This will be retained in the Health Center.

Hygiene, Food and Beverage

Special care must be taken around areas where food is stored, eaten, or prepared. Employees must always be aware that:

- Eating, drinking, smoking, applying makeup, and handling contact lenses are prohibited in work areas where there is a risk of occupational exposure.
- Food and drink must not be stored in places where infectious materials are located.
- Employees who are provided a designated lunch room or break area must wash up and change any contaminated clothing prior to entry.
- Mouth pipetting/suctioning of blood and other OPIM is prohibited.

Laundry

Handling of contaminated linens should be kept to a minimum. They should only be handled when bagging for removal and transport. Bagging should be red, so laundry is aware of biohazard. When handling linens, the employee must:

- o Consider all laundry as contaminated and use universal precautions -- wear gloves and any other necessary PPE when in contact with dirty linens.
- o If linens are soiled or wet and might leak, they must be placed in a red infectious waste leakproof bag.

Labeling/Sign Requirements

Signs, labels or appropriate colored bags must be used to identify hazardous or potentially hazardous materials. These must be universal and easily recognizable to persons who may not be familiar with universal precautions. The following are OSHA recommended guidelines:

- o Labels and signs must be used to identify items that can pose a hazard.
- o Labels must be affixed as close as feasible to the container with string, wire, or adhesive to prevent loss or removal.
- o Employees will be trained in basic label/sign requirements:
  - Labels/signs will be fluorescent orange or orange-red or predominately so, with letters or symbols in contrasting colors.
  - Red bags or red containers are permissible substitutes.

The following sources of hazardous waste must be labeled as noted:

- o Waste material container -- <u>biohazard label or red container</u>.
- o Contaminated sharps -- <u>Biohazard label or red container</u>.
- o Refrigerator/freezer holding blood or OPIM -- <u>biohazard label</u>.
- o Containers used for storage, transport, or shipping of blood or OPIM -- <u>biohazard label or red container</u>.
- o Individual specimens of blood or OPIM remaining in facility -- <u>no label if universal precautions in use</u>.
- o Individual containers of blood or OPIM placed in labeled container during storage, transport, shipment, or disposal -- <u>no additional label required</u>.
- o Contaminated equipment needing servicing or shipping -- <u>biohazard label placed on location of contamination</u>.

The following are exempted from labeling requirements:

- o Individual containers of blood placed in labeled containers during storage, transport, or shipping.
- o Hazardous waste which has been decontaminated.

Personal Protective Equipment (PPE)

Personal protective equipment (PPE) will be worn when engineering and work controls do not limit exposure to blood or OPIM. PPE includes, but is not limited to, gloves, gowns, lab coats, masks or eye protection. These items will be supplied free of charge by Hummer Associates. These items shall be:

- o Made of materials that do not permit blood or OPIM to pass through or reach employees' clothes, skin, eyes, mouth, or other mucous membranes.
- o In various sizes and at readily accessible locations.
- o Cleaned, laundered, disposed of and replaced by Hummer Associates.
- o Removed prior to leaving work area.
- o Used in accordance with the written policies of Hummer Associates.

Items of Personal Protective Equipment

Gloves

Gloves are not necessary for routine contact (blood pressures, counseling). They must be worn when it can be reasonably anticipated that the employee will have hand contact with blood, OPIM, or touching or handling contaminated items on surfaces. These gloves shall be:

- o Latex, disposable (NOT TO BE REUSED), changed between patients.
- o Replaced as soon as practical when contaminated.
- o Disposed of as infectious waste.

Hypoallergenic, powderless gloves or glove liners will be provided to employees who are allergic to normal gloves.

Eye Protection/Masks

These items shall be worn whenever splashes, spray, splatter, or droplets of blood or OPIM may be generated.

Scrubs/Gowns/Lab Coats

These items shall be worn when contamination of clothing may be anticipated.

CPR Shield

In the event that CPR must be given, a CPR shield shall be used when administering mouth-to-mouth resuscitation.

Personal protective equipment will be worn by all staff in direct contact with blood, body fluids, and OPIM, as listed in Exhibit 2:

Exhibit 2

Procedure	Gloves	Gown/Lab Coat	Mask/Goggles	None
Venipuncture	X			
Finger Sticks	X			
Oral Exams	X			
Vaginal/Rectal Exams	X			
Wound Care	X			
Handling Closed Specimens	X			
Vital Signs				X
EKG				X
CPR	X		*	
Sigmoidoscopy	X	X		
Cleaning of Contaminated Areas and Instruments	X**	X		
Cleaning of Blood/OPIM Spills	X**	X		
Cleaning of sigmoidoscope	X	X	X	

* Use CPR Shield ** Use heavy-duty latex-type utility gloves.

Procedures will be performed to minimize splashing, splattering, and generation of droplets.

Housekeeping

Decontamination of work surfaces and instruments is an ongoing process. Routine cleaning must be scheduled and procedures must be in place for accidental contamination.

Decontamination of Work/Exam Areas

Accidental Contamination

- Work surfaces, walls, table tops, floors, trash cans, and beds shall be cleaned as soon as possible after contamination.
- Surfaces shall be cleaned with a Chlorox solution of a dilution 1:10 (1 part Chlorox to 10 parts water).
- The solution need only stay in contact with the surface for a few seconds -- wipe on and wipe off.
- Broken glass should not be picked up by the hands or vacuum cleaner. Tools used to pick up glass must be decontaminated or disposed of properly. The glass must be disposed of in a sharps container.
- The employee shall wear gloves and gown when decontaminating the work areas.

Routine Cleaning of Work Areas

- Blood drawing areas and exam tables shall be disinfected on a daily basis.
- These areas shall be cleaned with a 1:10 dilution of Chlorox.
- The employee shall wear gloves and gown when disinfecting work areas.

Decontamination of Instruments

As previously mentioned, contaminated disposable instruments shall be disposed of in a sharps container. Reusable instruments shall be cleaned in the following manner:

- Employee cleaning the instruments shall wear gloves and gown.
- Any visible contaminants shall be rinsed off under tap water.
- Instruments shall be placed in a 1:10 dilution of Chlorox for 30 minutes, then rinsed with tap water.
- Those instruments that are to be sterilized shall be wrapped, dated, labeled accordingly, and sterilized.

Decontamination of Laboratory Equipment

When it is not feasible to decontaminate equipment prior to servicing or shipping, partial decontamination is required (e.g., flushing lines, wiping exterior). If equipment is heavily soiled, employee must prewash prior to servicing or shipping. Label must be affixed stating which portions of the equipment remain contaminated.

Hepatitis B Vaccination

Hummer Associates will provide appropriate HBV to all employees (including part-time and per diem) with occupational exposure to blood and OPIM. These vaccinations will be made available to new employees within 10 working days of their initial assignment, during work hours, and at the work site. These vaccinations will be free of charge to the employee. The injections will be administered in compliance with current CDC guidelines. Currently, no booster is recommended. There is exemption if:

- Employee has already received a complete vaccination series, with documentation.
- Employee has been shown to be immune to HBV, with documentation.
- Vaccine is contraindicated for medical reasons.

Exemption shall be noted in the employee's medical record. If an employee refuses to receive the HBV, the employee must sign a copy of OSHA's Hepatitis B Vaccination Declination. Exhibit 3 shows the wording of this Declination. This form may not be edited or altered in any way. If employee later decides to be vaccinated, employer will do so at no charge.

Exhibit 3. Hepatitis B Vaccine Declination

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring Hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with Hepatitis B vaccine, at no charge to myself. However, I decline Hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring Hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with Hepatitis B vaccine, I can receive the vaccination series at no charge to me.

_____

Employee Signature Date

Exposure Incident Evaluation and Follow-Up

Occupation exposure is exposure that occurs during the performance of an employee's job and places him/her at risk of developing HIV infection or Hepatitis B. Methods of exposure include:

- o Percutaneous inoculation or cut with a contaminated sharp object.
- o Contact of mucous membranes or non-intact skin (chapped, abraded, or inflamed) with blood and body fluids.

When such incident occurs, the Post Exposure Protocol must be initiated. The Post Exposure Protocol is as follows:

- o Thoroughly wash affected area at once.
- o Contact immediate supervisor who will then notify Medical Director.
- o Complete Employee Exposure Report (see Exhibit 4).
- o Obtain, with consent, blood samples from individual who was source of exposure incident.
- o If consent is not obtained, employer must document in writing that legally required consent cannot be obtained.
- o If documentation is infeasible (needle stick from unknown source), employer must state this in writing.
- o If source individual is known to be HIV and HBV positive, testing is not necessary.
  - Results of tests on source must be made available to employee, but disclosure to the employer is not required.
- o Medical Director and employee determine necessity for outside referral.
- o If Medical Director is not available within a reasonable amount of time, the Chief Nurse will determine the necessity for outside referral.
  - Outside referral is mandatory if:
    - Employee insists, for whatever reason.
    - There has been percutaneous or mucous membrane exposure to blood or any body fluid visually contaminated with blood.
  - Employer must provide the following information to outside physician:
    - Copy of Bloodborne Pathogen Standard.
    - Copy of Employee Exposure Report.
    - Job description of employee.
    - Source individual's HIV/HBV status, if known.
    - Employee's HBV vaccine status and other relevant information.
  - Outside physician medical evaluation will be sent to employer. This report must include:
    - Indication of vaccination and whether such vaccination was completed.

- Documentation that post-exposure evaluation was performed.
- Documentation that exposed employee was informed of results of evaluation and any medical condition resulting from exposure requiring further evaluation and treatment.

- Employer must provide employee with copy of this written report from outside specialist within 15 working days of receiving outside specialist evaluation.
- A release of information may be signed if the employee wishes the complete findings sent to the HCMD.

o Referral and treatment by outside physician will be at no cost to employee.

Exhibit 4. Employee Exposure Report

Employee's name_____ Position_____

Occurrence date_____ Reported date_____

Occurrence time_____ Reported time_____

Description of exposure_____

_____

_____

_____

Employee's HBV vaccination status (give dates)_____

_____

CONTACT SOURCE:

if known Name_____ Tele.#_____

Private MD_____ Tele.#_____

unknown _____

CONTACT SOURCE LAB RESULTS:

HBSAG _____

HIV _____

OTHER _____

Unable to obtain and reason_____

_____

RESOLUTION

Outside physician referral made_____

Physician's name_____ Date_____

No need for outside referral_____

_____ _____

Employee's Signature Attending RN / MD

Exhibit 5. OSHA Requirements for Outside Physician Medical Evaluation

The new OSHA Bloodborne Pathogen Standards require that the following elements must be covered in your medical evaluation:

- o Employee's name and physician.
- o Occurrence date and time.
- o Evaluate date.
- o Indication of vaccination and whether such vaccination was completed.
- o Documentation that post-exposure evaluation was performed.
- o Documentation that exposed employee was informed of results and any medical condition resulting from exposure requiring further evaluation and treatment.

PLEASE MAIL CONFIDENTIAL COPY TO REFERRING PHYSICIAN

Employee Information and Training

An important component of the Hummer Associates Exposure Control Plan is the education and training of the staff. The more educated the employee and the better understanding of the recommendations, the better the compliance.

- o Initial training must be accomplished within 90 days of Standard's effective date (June 4, 1992)
- o New employees (to include per diem and part-time) must be trained within 15 days of starting job and prior to being placed in positions where occupational exposure may occur.
- o Training will be annually thereafter, or at any time when there are modifications of new tasks or procedures.
- o Training will take place during work hours at the work location.

The Medical Director/Chief Nurse shall designate an Exposure Control Plan educator. The educator shall have an expertise in bloodborne pathogens and be knowledgeable in the Standards and how they relate to your particular workplace. The educator will conduct a training program that will include:

- o Copies of Bloodborne Standards for all staff.
- o General discussion of transmission and symptoms of bloodborne diseases, to include HIV, HBV, and others.

- Explanation of the Exposure Control Plan -- its use and purpose.
- Explanation of how to recognize activities that may involve exposure to blood or OPIM.
- Explanation of the use and limitations of appropriate engineering/work practice controls and personal protective equipment (PPE).
- Explanation of proper type, use, location, removal, handling, and disposal of PPE.
- Explanation of proper labeling/sign requirements for potential hazards.
- Discussion of all aspects of the Post Exposure Protocol.
- Discussion and explanation of Employee Exposure Report.

The educator will encourage an interactive question and answer period.

Recordkeeping: Medical Records and Training Records

Medical Records

Hummer Associates, at each Health Unit site, must initiate a Medical Record for any employee involved in an exposure incident. This record must include:

- Name and Social Security Number.
- Copy of Hepatitis B vaccination status (including dates of all vaccinations).
- Copy of Employee Exposure Report.
- Copy of results of medical testing, examinations, and follow-up.
- Employer's copy of outside physician's medical evaluation.
- Copy of information provided to outside physician for post-exposure evaluation.

Employer must ensure confidentiality of these records. Employee's express written consent is required for disclosure of medical records. Employer must maintain records at least for the duration of employment, plus 30 years.

Training Records

Hummer Associates is required to maintain accurate records of employee training (see Exhibit 6). These records shall include:

- Dates of the training sessions.
- Contents and summary of the training sessions.
- Names and qualifications of trainers.
- Names and titles of all attendees.

Training records must be retained for 3 years from the date of the training session. Records will be maintained on site. Medical/training records must be provided upon request for examination and copying to the subject employee and anyone with written consent of the employee or to OSHA. If the facility closes, Hummer Associates must inform the Director of NIOSH or designated representative at least 3 months before disposing of the medical/training records.

Exhibit 6. Training Record

FOR EACH TRAINING SESSION:

1. Date of training session _____

2. Content & summary of training session_____

_____

_____

_____

_____

_____

3. Name and qualifications of trainer_____

_____

4. Names and titles of attendees at session_____

_____

_____

_____

_____

_____

_____

Completed by _____Date_____

TRAINING RECORDS WILL BE RETAINED FOR 3 YEARS FROM DATE OF SESSION