

REFERENCES

1. American Public Health Association. *Design, Equipment and Operation of Swimming Pools and Other Public Bathing Places*. 1949. New York, N. Y.
2. American Public Health Association. *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes*. Eleventh Edition. 1960. New York, N. Y.
3. Fair, G. M. and Geyer, J. C. *Water Supply and Waste Water Disposal*. John Wiley and Sons, Inc. 1956. New York, N. Y.
4. Griffin, A. E. and Landshof, H. "How Chlorination Improves Swimming Pool Operation." *Public Works Magazine*, 83:1952. 58-61, 91.
5. Phelps, E. B. *Stream Sanitation*. John Wiley and Sons, Inc. New York, N. Y. 1944.
6. U. S. Department of Health, Education and Welfare. Public Health Service. *Swimming Pools—Disease Control Through Proper Design and Operation*. 1959. Washington, D. C.

SANITATION IN THE SPACE AGE¹

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The classic concepts of environmental sanitation have become an integral part of our way of life in this age. The advent of the space age requires an expansion of these concepts. We are faced today with phenomenal advances in transportation and communication. Are our sanitary surveillance techniques and regulations, basically geared for parochial communities, adequate to maintain the public health in a world served by supersonic carriers? Is our knowledge and training sufficient to meet the demands for ultraclean environments imposed by advances in medicine and industrial technology? We must be ready to consider such new problems as cleaning and disinfecting the hardware and materials being developed for space travel and exploration. We must gain a perspective of the environmental health problems of people confined in sealed capsules for long time periods. We must start thinking about the control of exotic and as yet undiscovered disease agents from other planets, the control of microbial dissemination from our world to others, the logistics of interplanetary quarantine. In addition to all of this, we must continue to provide the inhabitants of this world with a safe, clean and healthy environment.

SANITATION AS A WAY OF LIFE

Mankind's progress from the level of barbaric brute to the state of ethical civilization has been slow and arduous. One of the hallmarks in this evolution has been his increased awareness of and dependence on the benefits of a sanitary environment. It might easily be said, though not as easily documented, that the sanitary level of the environment can serve as a yardstick of the level of a civilization. In our mind we constantly associate the sight of "filth" with the description "backward", the image of "privy" with the adjective "primitive". Indeed, interspersed gen-

erously among the moral and spiritual laws of the Bible, are found principles and directives about environmental sanitation, which, if followed, would improve the level of public health in many lands even today. Thus regulations about food sanitation were intimately associated with rules about moral conduct even in antiquity. Laws about waste disposal and personal hygiene were closely allied with laws about social justice and humanitarianism.

In our land, and in this age, the concepts of environmental sanitation have become deeply woven into the fabric of our way of life. Americans expect and demand pure food, clean and safe milk and sanitary waste disposal. It has become part of our heritage, and it is no longer revolutionary to presume that every American family is entitled to live in decent housing, to eat in a restaurant without danger of food poisoning, to drink unpolluted water and to breathe clean air. We expect management to provide a safe and healthy factory environment, government to provide safe and healthy schools, entrepreneurs to provide safe and healthy recreational facilities. The American taxpayer considers it his just due to live in communities free from smog, mosquitoes and unpleasant odors. He expects his government to defend him from radiologic hazards, his hospitals to defend him from germs, his landlord to defend him from rodents. The up-to-date housewife today must become an expert in sanitary housekeeping. The quantity and variety of soap, cleaners, detergents, germicides, bleaches, water conditioners, laundromats, dishwashers, rug shampoos, and mouthwashes offered for sale is overwhelming. The fraction of our budget, and the amount of space in the supermarket devoted to environmental sanitation increases yearly. In brief, the various facets of environmental health

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are today considered the universal property of free man, and rightfully so. Professional workers in public health and professional sanitarians have been indoctrinating us with these ideas for many years. It is fundamental but true to consider sanitation as an integral aspect of our way of life.

THE DANGER OF COMPLACENCY

Under the circumstances described above, it is tempting for those engaged in professional sanitation work to relax and contemplate a job well done. We can take at least some of the credit for advancing civilization to this level. Ours is a noble and gratifying occupation which, if not exceptionally well rewarded financially, at least is recompensed by an atmosphere of public service and a feeling of historical significance. We feel that the maintenance of the status-quo, or even the gradual pushing forward of the classic concepts of environmental sanitation will justify our jobs, satisfy our collective conscience and consolidate our professional image. Granted that some among us, in editorials and speeches and private conversation, display an uneasy awareness that the world is rushing headlong past us. Granted that the occasional radical in our midst preaches the need for re-appraisal of our traditional mission. Most of us continue to do our daily jobs with tools and concepts that have been hallowed by tradition. For most of us, the future is next weekend and the distant future next summer's vacation. We have carved out a neat little niche in the public health structure and guard our bailiwick with valor. No outsider can do our job, and in return, we will not venture out of our little universe. And all too often we follow the paths of least resistance.

Just as a stream which meanders in its bed diverts its flow around the rocks and erodes through the softer clays instead, so have we been guilty of a meandering and uneven application of the limited knowledge and power in our grasp. The Dairy Industry has acceded to our regulations. Therefore, we regulate them into absurdity. Other industries show a little resistance. Therefore, we turn our heads and pretend that they aren't there. Our sanitary codes are a jigsaw of inconsistencies, in which the standards for milk products are spelled out to the last microbe per milliliter, while the hamburger stand next door is subject to a cursory examination, and the hospital kitchen is completely out of bounds.

But these arguments are not new, and certainly not a challenge of the space age. They are merely introduced as a preamble to the topic at hand, in order to permit us to retain our perspectives during a discussion of rockets and Martian microbes. It is essential that we remember the job left to do here

on earth, in our own little communities and in our own cities before we take off into the blue and beyond the blue.

THE CHALLENGE OF A RAPIDLY CHANGING TECHNOLOGY

In many respects, the challenge of the space age is something that should have been considered yesterday instead of today. In our rapidly changing world, in the age of technological advance, the person or profession which seeks solutions after the problem arises is already hopelessly behind. It is admittedly difficult to anticipate problems of the future and devise answers for questions not yet asked, but this is the paradox of our age. The primary single qualification for a space age sanitarian is imagination. Our lack of this commodity has already engendered some serious problems with which we are living today.

We are faced at this very moment with the sanitation problems resulting from the phenomenal advances in transportation and communication of the past decade. In some respects, these problems are precursors to those that will confront us during the advent of space travel, and we should examine them with deliberation. We all know how the world has shrunk. We are all aware that a man can board a jet in Karachi or Lhasa or Manila or Melbourne this morning and can attend our convention tomorrow morning. Yet this seemingly simple statement of a seemingly commonplace event is fraught with public health implication. No longer can we conveniently point to certain remote areas of our planet and say with assurance that the plague is endemic there, that cholera is ravaging there, that smallpox is breaking out there, and that we have nothing to worry about in Philadelphia because our sanitation laws are adequate to protect us.

Supersonic carriers and communication satellites have truly made our planet one community. The typhoid carrier in a Tokyo restaurant exerts as close an influence on the health of a San Francisco resident today, as did his grandfather in Oakland across the bay 50 years ago. The yellow fever harboring mosquito which bites an American sailor in Panama City today, is as close to Minneapolis as the International Airport where the sailor's jet plane lands. The staphylococcus toxin being elaborated on a cream puff in Vienna is less than 10 hours away from New York.

Yet our surveillance schedules and our regulatory laws and agencies are still geared to an age when horses pulled the wagons and county and state lines were significant boundaries. The first challenge of the space age, therefore, is the realization that our world is a tiny one. That continents are closer

today than countries were yesterday. That public health is not parochial and local, but world-wide. That the sanitarian must expand his dimensions and comprehend the big picture.

A second challenge of our technological age is posed by the imperative demand for ultraclean environments in medicine and industry. Every sanitarian thinks he knows what clean is. Consider then this situation. A surgeon wants to transplant a kidney from one patient to another. In order to ensure the success of this graft, he must neutralize in the recipient those antibody-producing mechanisms which would reject the "foreign protein". He accomplishes this by massive radiation treatment. Unfortunately, these antibody-producing mechanisms which are destroyed are the major defense mechanisms of the host against bacterial infections. Since the host now has absolutely no built-in defense, even one microorganism is a potential killer. The doctor then asks for something simple: "Provide this patient with an environment that is completely sterile for the length of time necessary for the graft to take." Can we grasp the significance of this demand? A sterile environment? No bacteria in the air to be breathed? No bacteria in the food? The water? The milk? No bacteria on the linens and utensils? Is it possible? This is a question that sanitary scientists must be equipped to answer. Is our knowledge and training sufficient to provide such an environment? Do we know enough about environmental sanitation to tell the engineers what to do?

One could elaborate at length about the environmental sanitation problems that challenge us in an era of rapid technological advance. One could discuss the problems of housing inspection in a country which is growing ever more urban. One could discuss the problems of insect and rodent control in cities that are built almost overnight. One could discuss the water and sewage problems of suburbia. One could discuss the influence of nuclear experiments in the Arctic on the iodine 131 level of Wisconsin milk.

And from these discussions would arise one overwhelming query. What are we, as sanitarians, as the profession charged with maintenance of environmental sanitation doing to improve our knowledge and our background and our abilities and our concepts to resolve these challenges?

And all of this, even before we enter the space age itself?

THE NEW DIMENSIONS OF SANITATION IN THE SPACE AGE

Once we enter the space age, we must be able to meet all of the aforementioned challenges, and

then to expand our parameters once more. The dimensions of the new age, of the next ten and twenty years are inspiring indeed. The only limits to the problems that will be posed to environmental sanitation specialists are limits imposed by our imagination. Time will not permit more than a brief cataloging of some of these problems. And lest it be thought that these topics are "Buck Rogers" pipe-dreams, one can be assured that the subjects of this discussion are presently being investigated in many sober and conservative laboratories in this country, and that the pressure for data is often overwhelming.

One of the new dimensions of sanitation is introduced by the phenomenal development in recent years of new metals and materials and fuels.

Most of us know how to pasteurize a tank of milk or sterilize a can of corn. Most can disinfect a glass pipeline or stainless steel vat. Most can outline a fair set of rules to keep spoilage bacteria out of cottage cheese. Now let us use this knowledge to sterilize a five-story Titan rocket, and keep it sterile while it passes through the atmosphere into space. Let us use this knowledge to sterilize a vacuum tube, an electronic computer, a transistor. Can we apply our cottage cheese background to keep spoilage organisms out of jet fuel tanks? The first cousins of the bacteria and fungi which form slime on cheese grow in kerosene fuels and form slimes in fuel tanks. The first cousins of the bacteria which cause ropy milk grow in wing tanks of supersonic aircraft and form sludges which foul carburetors. If we can solve the problem of rusty milk cans, can we control corrosion of fuel lines in rockets? How does one disinfect germanium, a laser, a hundred different plastics, a piece of hardware containing 535 different electronic components?

Another new dimension of sanitation is introduced by new concepts of the human environment. Imagine, if you will, sealing a group of people into a rather confined chamber and isolating them from our world for several weeks. Think of the water and food supply problems in a capsule which has to find space and weight for every gram. Solve the problem of waste disposal in this isolated environment. Imagine the odor problem when the entire ventilation system is self-contained. What happens to perspiration and urine and the stools? What if one of them is incubating the flu virus when placed in the capsule? What about personal hygiene in a sealed capsule without a shower? Environmental sanitation certainly must consider these problems within its scope.

A third dimension of space age sanitation deals with the hypothetical but practical consideration of exotic and as yet undiscovered microbial parasites from other worlds. This concept might sound far-

fetched, but can be ignored only with a certain statistical amount of risk. We should admit at the outset that we do not know if life exists on other planets in our solar system, or in other systems in our galaxy, or indeed elsewhere in the universe. That is, we have no *proof* for or against. Nevertheless, a certain amount of responsible theoretical research, based on what is astronomically deducible about atmospheric, geologic and climatologic conditions on Mars and to a lesser extent Venus, has led many astrobiologists to concede that life forms on these planets are entirely feasible. Some very good laboratory research under simulated Martian environments has shown that terrestrial microorganisms can survive and even multiply under those severe conditions.

The astrobiological world is still debating the merits of reported discoveries of microbial entities in carbon containing meteorite fragments. Our own group at General Mills is conducting balloon-borne explorations of the stratosphere to determine the possible presence of microorganisms in this strange environment.

We live in exciting times, during which tomorrow shows that yesterday's dreams are realities. A comprehensive consideration of space age sanitation must certainly not exclude the possibility of extraterrestrial microbes.

Along similar lines, a fourth dimension of space age sanitation is introduced: The philosophy and techniques associated with controlling the dissemination of microbial contaminants between the planets during our first fumbling probes and later explorations. Most of us are aware of the epidemiological consequences resulting from the introduction of a new etiologic agent into a previously unexposed population. The bubonic plague in Europe, measles in Polynesia, the Dutch Elm disease in America — are all tragic historical examples. We must anticipate similar phenomena on a cosmic scale if life forms are actually present on other planets. Appeals have been made by astrobiologists to sterilize our space probes to avoid contaminating the moon. Serious attempts certainly will be made in the future to eliminate or minimize the possibility of transporting terrestrial microbes to other planets. Similarly, thought must be given to the problem of returning extraterrestrial organisms to our own earth. We submit that aspects of these problems are not dissimilar to the enforcement of quarantine regula-

tions today. The logistics of interplanetary quarantine, however, are infinitely more complex. We do not now if organisms exist on Mars; how then do we know what the incubation period, or symptoms, or communicability is of a Martian disease? How can environmental sanitation contribute to a solution of these riddles?

We are privileged to live in a strange and exciting and wonderful era, with new and constant challenges ever before us. The experience and training of the professional sanitarian will be needed in this age, as they were in the past, to protect the public health on this earth, and to meet the challenges of the new dimensions revealed during man's quest beyond this earth.

POST-SCRIPT—THE FOREST AND THE TREES

Just as a review of the accomplishments of environmental sanitation encourages one to relax and contemplate a job well done, so does a glimpse into the future stimulate one to drop everything and plunge into the heady ferment of space-age sanitation. It might, therefore, be necessary at this time to return to earth and regain some perspective. While we must keep our eyes on the forest in the distance, it is still necessary to recognize the trees and the pitfalls of the woods in which we are now.

The challenge of the new era is real and significant. But just as real is the challenge of environmental sanitation today. We must be sure, during our attempts to provide astronauts with clean food and water, that the problem of foodborne intoxications and infections in restaurants and institutions is solved. Together with our efforts to provide a suitable and healthy environment in a space capsule, we must redouble our efforts to eliminate those nosocomial infections that are aggravated by unsanitary environments in our hospitals. We must spend some of the time necessary to solve waste disposal problems in a planetary rocket, on solving the problem of the suburbanite who drinks diluted sewage. We must plan for the future while improving our plan for today. This is a big order to fill. It will require a renewed dedication. It will require expanded training, imaginative programming, a more sophisticated education. It will require people who are dissatisfied with the status quo, and who cherish challenging the unknown. It is worth the effort.