If not, they should be used promptly after release because of the danger of pinholing.

Glass jars with screw caps, cans with friction-top lids, and similar containers without hermetic seals, and hermetically sealed jars with anchor- or crown-type closures are difficult to salvage following contamination with polluted water or other filth. Pathogenic bacteria lodge under the caps or beneath rubber gaskets and may be introduced into the food when the container is opened. Foods in such containers should be sterilized before consumption.

Foods in cardboard cartons, paper wrappers, and similar containers may be contaminated with toxic bacteria or poisons through breaks in the packages. Water damage to this type of package calls for adequate sterilization of the contents before use if salvage is possible.

If transportation and manufacturing facilities are available, large stocks of some foods, sugar for example, may be salvaged by refining even though they are heavily contaminated.

The table gives a summary of some of the salvage methods suggested.

The most pressing problems which remain unsolved are: how to measure alpha contamination in the field with portable equipment; and how to cope effectively with sabotage of the food supply.

A Safe Water Supply In Civil Disaster

By **GORDON E. McCALLUM, B.S.**
WILLIAM E. HOLY, M.S.
HARVEY LUDWIG, M.S.

Water, although not a food, is essential to life and therefore a necessary component of man's diet. Furthermore, water is important in the preparation, processing, and distribution of many foods. Any comprehensive study of the food aspects of civil defense, therefore, should consider those changes in the quality and quantity of the public water supply which are likely to occur in a civil defense emergency. Civil defense officials will be particularly concerned inasmuch as they may be faced with the problem of providing an emergency supply of water in the event of failure or serious contamination of the public supply.

Contamination of Public Water Supply

While similar in many respects water differs from other utility services, such as gas and electricity, because of its vital public health significance. Possible contamination of the public water supply is one of the greatest hazards to the health of the community. Although it is well recognized that water readily transports organisms causing such diseases as typhoid, cholera, and dysentery, its safety is seldom questioned by the citizen of the modern community. This record of safety and achieved assurance did not just happen. It is the result of more than 100 years of effort, study, surveillance, and careful sanitary control. Continuous research has brought about marked improvements in water works equipment and materials as well as in their operation and use. Furthermore, these resources are now under the control of more competent personnel. However, these safeguards in the form of modern collection and treatment of sewage and purification and protection of public water supplies are man made. Consequently, they can be suddenly destroyed, particularly so by man himself.

Wartime attacks upon civilian populations would break down many of these safeguards and at the same time intensify public health hazards. In addition there would be new dangers arising from possible use of special weapons of war. Scientific research on biological, chemical, and radiological substances indicates that some of these agents could contaminate public water supplies. Such contamination might occur as a direct or incidental result of attack, or by sabotage.

Mr. McCallum is chief of health emergency planning of the Office of the Surgeon General, and Mr. Holy is water supply consultant of the Division of Sanitation, Public Health Service. Mr. Ludwig is sanitary engineer consultant of the Federal Civil Defense Administration.

Sewage

Sewage or organic contamination is most serious when it occurs within the water distribution system. Contamination in distribution systems may occur in normal times when pressures are reduced as a result of broken mains, heavy drafts for fire fighting, valve closures, and supply failures. Contamination may result from cross connections, backflow through faulty plumbing fixtures, and inadequate precautions taken during construction or repair operations. Incidences of such contamination will be greatly increased should the system be severely damaged.

Special Warfare Agents

Although the feasibility and effects of deliberate contamination of water is controversial, the vulnerability of the water works system to contamination by biological, chemical, and radiological warfare agents should be carefully studied. Water works structures which are most vital include unprotected transmission mains, water service lines connected to these mains, valve chambers, booster pumping stations, chlorination stations, and open reservoirs and other locations of water storage.

Precautions for the protection of these structures include automatic alarms at hidden work locations, backflow preventers, and automatic signal devices to give an appropriate alarm whenever an abnormal flow condition exists.

An automatic signal device to detect changes in chlorine residual might be useful in certain critical locations. Increased surveillance and intensified alertness are indicated.

Biological Warfare Agents

Biological warfare against human beings may be defined as the deliberate use of disease-producing organisms or their products to cause illness or death in a target population. BW agents may include bacteria, bacterial toxins, fungi, rickettsiae, viruses, and protozoa. It is generally conceded that the public water supply could be deliberately contaminated by certain of these agents.

It may be assumed that small quantities of BW agents may contaminate portions of a water supply system. Evidence that low doses of biological agents may be dangerous is suggested in the work of Kehr and Butterfield (*1*).

The agents of particular concern may be those not commonly found in water. As a result our normal public health safeguards might not be effective against them. We should not, however, rule out the possible use of common intestinal pathogens which by clever manipulations might be made to penetrate our water works defenses. The use of several agents simultaneously would complicate early attempts at detection and might make diagnosis of resulting diseases difficult.

Chemical Warfare Agents

The "war gases" may be defined as chemical agents used to create vapors, fogs, or aerosols that are poisonous by inhalation or, in the case of persistent agents, by contact and inhalation. Of the former, the mustard and nerve gases appear to be the most formidable.

Most effective poisons of the inhalation type are chemically unstable or otherwise not suitable for use as a water poison. However, some contamination of water might occur incidental to the tactical military use of these agents.

Pertinent details about chemical warfare agents, including procedures for their detection and control, are being assembled in a forthcoming Federal Civil Defense Administration manual on water utilities in disaster relief operations.

Radiological Warfare Agents

Deliberate attempts to contaminate water supplies with radiological agents are not considered likely at present. Other methods of contamination would appear more feasible. Contamination of reservoirs, however, and other open bodies of water might occur as an incidental result of an atomic bomb burst, particularly from surface or subsurface detonations.

Allowable concentrations of radiation in water for short periods during emergencies have been announced by, and are available from, the Federal Civil Defense Administration.

Detection of Contamination

Contamination in water supplies is routinely detected by the use of chemical, physical, and bacteriological examinations well known to water works and public health workers. The primary object has been the detection of contamination by sewage or human intestinal discharges. The standard bacteriological test for coliform organisms, which indicates intestinal contaminants, is an important procedure employed by health authorities to judge the sanitary quality of a water supply. One of the limitations of such tests is the time—24–48 hours—which elapses before the results are known and control measures instituted. In the past decade many water works in the United States have placed increased reliance on the chlorine residual determinations, which can be quickly accomplished, thus permitting prompt plant adjustments to insure the maintenance of desired residuals. Experience with any given water under normal conditions indicates the amount of chlorine needed.

The problem of detection in times of disaster may involve the determination of increase in sewage contamination, as well as possible biological, chemical, and radiological warfare agents. In the case of sewage contamination, the intensification of the control procedures already used is indicated. Continued study and adoption of new procedures as they are developed will be necessary to deal adequately with BW, CW, and RW agents.

Improved Bacteriological Techniques

The standard bacteriological examinations are, as previously noted, rather time consuming. Recognition of this shortcoming no doubt hastened further development of a promising device known as the "membrane filter" (*2*). This filter consists of a paperlike cellulose ester membrane containing a high concentration of uniformly spaced pores of relatively constant diameter. The pore diameter may be made sufficiently small to remove practically all of the bacteria in the water being filtered. An interesting feature of this filter is the high flow rate under relatively low hydraulic head, a property attributed to the fact that the pore is shaped like a funnel with the small opening at the inlet surface. No attempt is made to remove the bacteria captured by the filter, but, instead, they are cultured in place. This is done by placing the filter, after use, on an absorbent pad containing culture medium which, when wetted, will diffuse upward through the pores to form a satisfactory growth substrate for the organisms.

This technique makes possible a substantial reduction in the time, labor, and space required for conducting bacteriological examinations. Moreover, the results are precise and the method may be readily adapted to field use. These advantages indicate this device to be especially valuable for prompt detection of biological contamination.

Research work with the membrane filter is being continued, including studies to adapt it for rapidly detecting BW agents as well as coliform and other intestinal organisms. Its usefulness in recovering pathogenic bacteria and fungi may be increased by the development of more highly selective nutrient media. It is unlikely, however, that a single culture medium will be found to be sufficiently selective for all organisms.

Detecting Radioactivity

The levels of radioactivity previously mentioned may be measured with presently available portable monitoring instruments. Detailed data on this subject is available in a recent bulletin, "Use of Commercially Available Portable Survey Meters for Emergency Fission Product Monitoring of Water Supplies, August 3, 1951," published by the University of Rochester, New York, together with the United States Atomic Energy Commission.

Decontamination Measures

Many water works officials attempt to carry chlorine residuals throughout as much of the system as possible. Breakpoint chlorination, a process by which all organic matter is quickly oxidized by high chlorine concentration, has been increasingly used during the past 10 years. It represents a significant improvement in disinfection in that it provides a residual of free chlorine throughout the distribution system. As compared with the usual combined chlorine residual, free chlorine is an extremely effective disinfectant. For these reasons this type of disinfection should offer greater protection against biological agents than conventional or marginal chlorination which is frequently employed.

Inactivation of Biological Agents

Standard water purification procedures, including presedimentation, chemical coagulation and settling, adsorption on activated carbon, filtration and pH control, offer satisfactory protection against many bacteria and fungi. The unsatisfactory performance of these treatment methods in the removal of certain viruses has been suggested in recent work on infectious hepatitis and anterior poliomyelitis. Disinfection with chlorine in high concentration, however, does appear to be effective against these viruses.

It is hoped that additional safeguards to supplement chlorination may be found in studies of new water disinfectants.

Under emergency conditions routine treatment and disinfection may of course be supplemented by boiling.

The decontamination of a water supply system following a suspected or known BW attack will not differ materially from the procedure normally used for accidentally contaminated systems or those being placed in operation for the first time. This procedure should include a thorough flushing of all parts of the system, including household service connections, and disinfection with a strong chlorine solution.

Removal of Radioactive Materials

Removal of radioactive materials from water is involved and uncertain. Conventional treatment processes are not completely effective in removing all possible contaminants. The removal of any chemical substance, radioactive or not, is dependent upon its physical and chemical nature. A common radioactive characteristic does not imply a common removal tendency when subjected to the various treatment processes. If radioactive materials were to be deposited in a stream or watershed, several natural agencies would be effective in reducing the amount which might finally reach the treatment plant. Among these agencies, the most significant are:

1. Natural decay which is continuous, unaffected by the chemical or physical state of the isotope, and in most fission products quite rapid, decreasing with time.

2. Dilution of the radioactive materials with the water reducing the concentration significantly.

3. Adsorption of the radioactive substances on suspended turbidity particles or other matter with subsequent sedimentation, and adsorption on bottoms and banks of streams and reservoirs.

Research is under way to determine the efficiency of the several conventional water treatment processes in removing radioactive isotopes. The procedures that can be employed by a rapid sand filter plant to improve its efficiency for removing radioactive substances are:

1. Increased dosage of coagulant to produce most effective floc formation.

2. Maintenance of the pH of coagulation as high as possible (a pH of 10 or 11 being preferable) by the addition of excess lime or soda ash.

3. Addition of coagulant aids such as activated silica, bentonite or other clays, and activated carbon.

The general function of these steps is to improve coagulation and thus increase adsorption by agglomeration. Whether or not safe water is produced will depend upon initial concentration of contaminants in the water, their susceptibility to removal, and the efficiency of the treatment processes. In any event, the finished water should be assayed for radioactivity. If the amount exceeds accepted tolerance limits, it should of course not be used.

Emergency Water Supply

Provisions for emergency water rations should be made in the event the public supply is interrupted or so contaminated that it may not be safe. Instructions should be issued to home owners regarding the storage, home decontamination, and conservation of water.

Careful planning will be necessary to assure that an emergency water supply can be made available to institutions, refuge centers, hospitals, and first aid stations. Various emergency sources may be employed, for example, water contained in local covered storage reservoirs which may be used without special treatment, and nonpotable or contaminated supplies which are first made safe by filtration, disinfection, or both. Equipment needed will include mobile water treatment, filtration, chlorination and pumping units, hose lines, and tank trucks. Pre-disaster preparations should comprise an inventory of available trucks, including water sprinkling, milk, and petroleum products trucks, as well as plans for cleaning them.

Conclusion

In the event of enemy attack upon a community, its public water works system may be seriously damaged and the water supply subjected to gross contamination by sewage or special warfare agents. Also, in the immediate period following disaster, huge drafts may be placed upon the system to supply water for fire fighting. This, too, introduces additional hazards to the safety of the supply. Under these circumstances there may be a shortage of water over a considerable period, and water that is available may require special treatment. These effects can be minimized, however, by proper planning and preparation.

REFERENCES

(*1*) Kehr, R. W., and Butterfield, C. T.: Notes on relation between coliforms and enteric pathogens. Pub. Health Rep. 58: 589–607 (1943).

(*2*) Clark, Harold F., Geldreich, Edwin E., Jeter, Harold L., and Kabler, Paul W.: The membrane filter in sanitary bacteriology. Pub. Health Rep. 66: 951–977 (1951).

Milk Control Planning For Civil Disaster

By GORDON E. McCALLUM, C.E.,
JOHN D. FAULKNER, M.S.P.H.E.

In event of attack on major population centers, milk pasteurization plants and cold storage facilities, as well as transportation and utility services, are likely to be destroyed or their operations disrupted. Following such disaster, immediate measures must be taken to conserve and protect the target city's milk supply; to provide for its adequate processing for the health protection of consumers; and to insure milk distribution to those immediately requiring it.

Considerable attention has been paid in the United States in recent months to the development of plans by Federal (*1*, *2*), State, and municipal governments, and by industry (*3*) for dealing with milk supply problems likely to arise in event of large-scale civil disaster.

In the United States, the milk production and processing industries are decentralized over a vast geographic area, and all of our major cities have developed their own milksheds from which they obtain a large proportion of their fluid milk supply. Sanitary control of milk production and processing, as a preventive measure against transmission of milk-borne disease, is extensive. This control is exercised chiefly by State and local authorities, and not by the Federal Government. Practically all market milk sold in the United States is pasteurized, using a time-temperature combination of either 143° F. for 30 minutes or 161° F. for 15 seconds. Raw milk for pasteurization is usually transported from the dairy farm to country receiving stations, and thence to the pasteurization or processing plant, or to the plant direct, by automotive equipment. Although some milk for pasteurization is shipped to distant markets by rail, refrigerated or insulated automotive tank trucks are customarily used to haul raw milk great distances.

Diversion of Fluid Milk Supply

As most dairy farm producers of milk for pasteurization are not located in the immediate vicinity of our large urban centers, it is unlikely that many would be damaged or seriously affected by enemy air attack on a given target city. Conversely, many milk processing plants of an attacked city might be destroyed, seriously damaged, or otherwise made inoperative. Therefore, it is necessary to plan for emergency

Mr. McCallum is chief of health emergency planning of the Office of the Surgeon General, and Mr. Faulkner is chief of the milk and food branch of the Division of Sanitation, Public Health Service.