SOUTHERN BAPTIST CONVENTION

DISASTER RELIEF

KENTUCKY

Bringing Help, Hope, and Healing

Water Purification Training Manual

KYBAPTIST.ORG/DR

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KBC KENTUCKY BAPTIST CONVENTION

CP COOPERATIVE PROGRAM

MISSION KY Eliza Broadus Offering

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ACKNOWLEDGEMENTS

The Southern Baptist Convention water purification program has been blessed with many godly visionaries. What started as the passion of a few has grown to a large group of volunteers from many state disaster relief ministries.

More and more water needs are being identified in third world countries. Most recently, Iraq, Iran, and Southeast Asia have benefited greatly from the Southern Baptist humanitarian response. Bam, Iran had critical needs after a large earthquake destroyed the city in 2004. Southeast Asia (Indonesia and Sri Lanka) suffered major devastation from a tsunami in 2004. The destruction from the war in Iraq has generated an enormous amount of water pollution/contaminates.

In particular, Larry Elliot had a burning vision, passion, and sense of urgency to provide clean, safe drinking water for the people in Iraq. Without concern for his own safety, he reached beyond U.S. military protection to serve those in need.

Larry is now with the Lord, looking down on us and urging those who hear God's call to continue the work that was begun. Larry, we thank you for your passion and vision and the Godly example you provided to us.

INTRODUCTION

Safe drinking water, clean air, and nutritious food are critical issues throughout the world. These are the basic elements we need for survival. As we drink, breathe, and eat, we are using the natural elements God placed on this earth to sustain life. However, through our ignorance and materialism, we are contaminating these "pure" creations of God and jeopardizing the lives of innocent humans who unknowingly ingest harmful and even fatal "man-made" industrial and human contaminants.

The U.S. probably has the most informed knowledge of contaminations in drinking water. Although we in the U.S. have knowingly contaminated territorial water, we have researched, diagnosed, and tested purification processes to restore the U.S. water delivery system locally. However, during times of disaster, the source of purified water is often inadvertently compromised with contaminants. Third world countries, who struggle in daily life with contaminated water, face an even worse situation during a disaster.

The Southern Baptist Convention desires to supplement the spiritual "living water" provided by missionaries with "livable" drinking water. This handbook provides information on systems developed within the convention that will, in fact, purify waters that have been contaminated.

The basic process of all the purification units uses the same system/techniques. The differences in the various units will be in flow through/volume, physical size, and transportability.

Improvements in the system are ongoing. In particular, Texas Baptist Men have simplified the system by replacing the electronics with mechanical/analog meters and equipment. In addition, the process sequence of the latest units has been changed to minimize particles and contaminants on the UV quartz sleeve.

Please keep in mind that this manual is a "living document." It is revised on a yearly basis as new technology becomes available. Also, criteria for water purification varies from country to country.

UNIT 1: METHODS OF PROCESSING WATER

Water that is unsuitable for drinking or of questionable purity can be processed in a variety of ways to make it potable (suitable for drinking).

DISINFECTION

Adding a poison to the water to kill bacteria results in disinfection. Care must be taken to prevent overdose, which can harm humans and animals. Chlorine is the most common type of disinfectant used in water.

Chlorine, a greenish yellow chemical, element Cl, atomic #17, atomic weight 35.5, is found in nature combined with other elements. It was employed as a war gas during World War I. Only 40 to 60 parts per million (ppm) of chlorine in air inhaled for 30 minutes or more can cause serious injury. Chlorine should be respected, but not feared, if handled in the right way. Chlorine has been universally accepted as an excellent disinfectant by public utility authorities. Chlorine kills rather than removes bacteria. The chlorine burns the bacteria and requires a contact time to accomplish this process. Recommended chlorine injection into drinking water will range between 4 and 8 ppm, (U.S. public utility water usually has 1 to 2 ppm). Water that has been chlorinated should be allowed to sit for at least 30 minutes before being used for drinking.

DISTILLATION

Distillation is accomplished by boiling the water until it becomes steam, then condensing the steam back to water. This process leaves a deposit of the harmful particles and minerals in the vessel used to boil the water. The vessel must be cleaned regularly to remove the deposit. The cost of heating the water is prohibitive. The most common use of this method is on ships that use engine heat to boil the water and remove the salt.

STERILIZATION

Ultraviolet (UV) light can provide a high level of sterilization in water. Sunlight is a natural source of ultraviolet light and provides "sterilization" as water flows down rivers, over waterfalls, through rapids, etc. When bacteria, viruses, and other microorganisms are exposed to the germicidal UV light at a particular wavelength (253.7 nanometers), their reproductive capabilities are destroyed, and they no longer pose a threat to human life. However, UV light does not provide a residual disinfectant in water, which can then be re-contaminated.

MICRO FILTRATION

Micro filtration can purify water by using filters that are not larger than 0.2 microns. This is extremely small and usually requires high pressure. Some viruses may be able to pass through these filters.

REVERSE OSMOSIS (RO)

Reverse osmosis (primarily for industrial use) removes salt, other minerals, bacteria, and other harmful organisms from water. However, certain bacteria and viruses may slip through the membrane. Most places that use reverse osmosis to purify water follow up with an ultraviolet treatment and/or chlorination. One third of the water in the RO process is used to back flush the system and is therefore wasted and must be discharged. RO requires energy that is not usually available.

UNIT 2: SOUTHERN BAPTIST DISASTER RELIEF WATER PURIFICATION UNITS: BACKGROUND AND GENERAL INFORMATION

For many years, Southern Baptist Disaster Relief (SBDR) has responded to natural and man-made crises throughout the United States and abroad. The response effort may include chainsaw removal of downed trees, mud-out of flooded homes, hot meals three times per day for thousands of people, childcare, initial medical assessment (sorting the more serious injuries from the minor ones prior to EMT/medical personnel arrival), and water purification to provide pure drinking water. In most natural disasters—floods, tornadoes, hurricanes, fires, etc.—there is an urgent need for "potable" or safe drinking water.

Contaminated water can severely exacerbate a disaster situation. Prior to restoration of drinkable public water, an interim water source or resource is needed. Southern Baptist Disaster Relief has been building transportable water purification units for a number of years. These units provide pure drinking water from a rate of 120 gallons per hour up to a maximum of 1,200 gallons per hour, depending on the water unit used.

There are numerous models for water purification used by SBDR. The intent of this handbook is to provide an understanding of the "process" and stages of purification used. Once this is understood, particular attention can be directed to specific models. The main differences that will be found within the various models will be the output capacity, i.e., gallons per minute or gallons per hour. Also, of course, there will be significant differences in the shape and packaging of the different units. However, once you understand the process and the function of each component, you will be able to recognize them as they are used in all units provided by SBDR. Some older units may have manual chlorinators as compared to the automatic chlorinators in the newer and updated models.

By fully understanding the general processing stages, you will be able to set up and operate more than one specific model or type of system. Each of the different types of water purifying units used by SBDR is described in this handbook.

Texas Baptist Men has designed a much simpler (less electronic hardware and displays) system, the 830 model. A number of these systems have been installed in Iraq and Iran recently. This simple standardized system allows for better logistics support, is adaptable for easy "carry on" to aircraft and is easily packaged for entry into foreign countries. The 830 has an improved process sequence which will be discussed later in this handbook.

At the 2005 Disaster Relief Roundtable, the national water purification subcommittee and other state disaster relief representatives made the decision to "standardize" water units to the "830" configuration, include this system in all domestic feeding units and transportable kitchens, as well as all stand-alone water purification systems for overseas disaster needs.

UNIT 3: COMPONENTS AND PROCESS FLOW FOR WATER PURIFICATION UNITS

FILTRATION
Micro filtration (blocking) and media filtration (contact) are both used in the water purification processes described in this manual.

BLOCKING - The two stages of micron filtration (5 and then 1 or 0.5 micron) essentially "block" insolubles that are greater in size than the filter rating. These "insolubles" can be a combination of harmful and harmless elements. The filtration "blocking" of harmful elements provides more purity to the water output of the micron filters. And the filtration "blocking" of the harmless insolubles eliminates the possibility of "shading" the subsequent filtration of ultraviolet light on any remaining harmful bacteria or viruses.

CONTACT - The media filtration (KDF/GAC) removes the contaminants by contact. Water with contaminants that pass through the media is exposed to a reaction by that media that renders contaminants harmless by a cladding and oxidation process. The media, depending on the volume/quantity, requires specific contact time with the water to allow the cladding/oxidation process to occur. Therefore, control of water flow rate through the media is essential to assure adequate contact reaction time. KDF/GAC media cartridges have specific maximum flow through rates which should be adhered to.

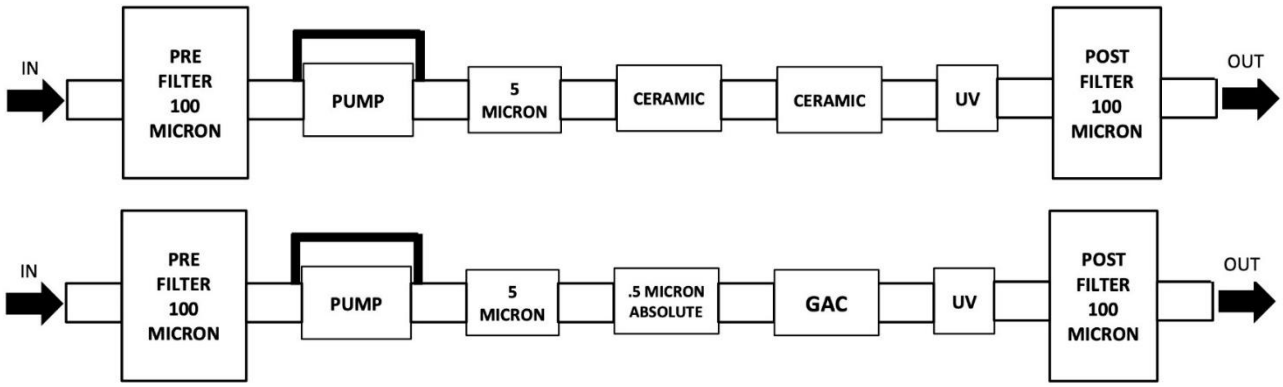
The Ultraviolet (UV) light filtration is another type of "contact" filtration. The filtration occurs by a specific frequency of UV light shining on a contaminant for a specific time. Again, the flow rate through the UV unit is essential. All UV lights have a specified maximum flow rate and should be adhered to.

SOURCE
Water is drawn by a self-priming pump or if pressurized, bypasses the pump and flows on to begin the purification/filtration process. This input source of water, if coming from other than a local pressurized water system, will be subject to foreign

matter that can block/clog the water pump impellor or the micron filters. Most systems have an input spin filter (80 mesh screen) that is removable for cleaning. Also, additional pre-filters should be used to remove debris if clogging is observed (Note: When water is to be drawn from a pond, lake, or stream, the hose input point should be placed 12-18 inches below the water surface.). The water flow rate will vary with each unit depending on the pump capacity, the pressure of the local water system, if used as a source, or the distance the pump must "lift" the water from the other static sources.

The 12-volt DC source is provided by either a battery or rectified 115 volts AC/240 volts AC power (these AC to DC rectifiers is designed into the water units). In foreign countries the power source voltages and frequencies are different. The voltage may vary from 220 to 240 volts AC, but the frequency is 50 cycles. Sometimes the pumps will overheat because of the power difference caused by the lower frequency and voltage. If this overheating problem exists, it may be necessary to purchase a 50-cycle water pump locally.

CURRENT SBC SYSTEM (830)



MICRON FILTERS

The next stage of water purification process is a series or sequence of two-micron filters. First, the term "micron" will be discussed to provide an understanding of the level of "filtration." Micron is, of course, a metric term. The U.S. has not adjusted well to the notion of the metric system. Here is a simple explanation: A micron is 10 to the minus 6 meters. What does this mean? 10 to the minus 6 meters means 0.000000 meters. Continuing on, one micron is 0.000001 meters. Convert metric (meters) to the more familiar Imperial/American Standard (inches). One meter is equal to 39.37 inches. Substitute the 1 meter for 39.37 inches, resulting in a value of one micron= 0.00003937 inches. Now you can better understand the fineness of filtration of a 5 micron and 1 micron filter. Metric to American Standard conversion tables is provided in Appendix C-1.

The two-micron filters, i.e., 5 micron and 1 micron, are staged to sequentially block small, microscopic, insoluble particles, some of which are protozoa and bacteria. The larger filter (5 micron) is first and blocks the larger particles, and then the second filter (1 micron) filters some of the remaining particles, protozoa, and bacteria. This micron filtration has two main purposes:

1. Filter out protozoa and some of the bacteria.
2. Filter out most of the particles in the water.

The latter filtration of particles is a very important pre-process prior to UV purifying. Particles in the water can block the ultraviolet rays from some of the bacteria.

Micro filtration blocks particles larger than the filter size, i.e., 5 microns and 1 micron. All protozoa and most bacteria are larger than 1 micron and will therefore be blocked. However, filtration will not block bacteria smaller than 1 micron and virus or E coli . Some of the contaminants the micron filters will block are:

Giardia—a protozoa often found in surface waters which have been contaminated by human sewage or by wildlife.

Cryptosporidium—contains reproductive body (spore) that is capable of developing asexually into an independent organism and propagates by spores as algae and fungi.

Bacterium (except E Coli)—any of numerous widely distributed unicellular microorganisms ranging from the harmless and beneficial to the intensely virulent and lethal.

ULTRAVIOLET (UV) LIGHT

Sunlight has natural UV rays. UV from the sun is used in aeration ponds by cities to help purify their water. The optimum frequency of UV light that will kill bacteria, viruses, and other microorganisms is a wavelength of 253.7 nanometers (10 to the minus nine power or 0.0000002537meters). These microorganisms must be exposed for a certain length of time in order to inactivate them and destroy their reproductive capabilities**.** The strength of dosage is a product of the UV light intensity and exposure time. This UV disinfection system channels water past submerged lamps that emit lethal doses of UV energy, destroying bacteria and viruses.

The UV lamp is housed in a quartz sleeve that is waterproof sealed and allows the water to pass around the UV bulb while exposing UV energy through that water. Any particles that may still be in the water would allow some bacteria or virus to be "shaded" from the UV light. Therefore, it is important to have the micron filtration prior to UV exposure.

UV dosage depends not only on the wattage or power of the UV bulb but also depends on the exposure time, i.e., flow rate of water through the unit. The UV intensity is fixed (except for slow degradation of intensity over the life of the bulb), but the water flow rate is variable. Therefore, it is important that the specified "flow rate" of water through the system is not exceeded. Water purification units will have flow rates of two gallons, four gallons, six gallons, and higher rates per minute. For product output measurement for dispensing of water needs, it may be more appropriate to use "gallons per hour," i.e., two gallons per minute would equate to 120 gallons per hour, etc. Allow the UV lamp to warm up for about five minutes before dispensing water.

MEDIA POD FILTRATION

The media pod is a combination of two media materials that will remove organic, inorganic, and metallic contaminates, including the 17 materials on the current U.S. Environmental Protection Agency Hazardous Materials List. Note: In most of the older water purification units, the media pod combines both media material. In the newer or later units, the two media have been separated.

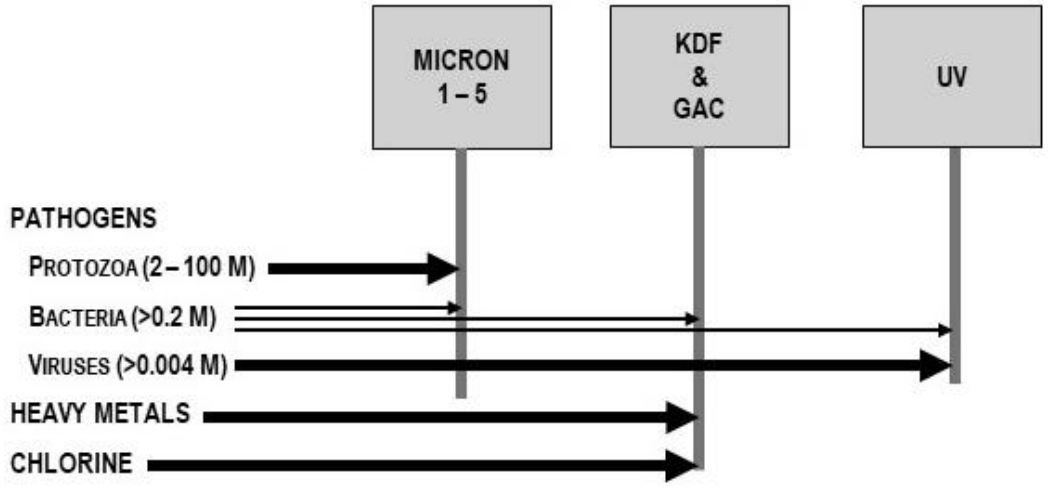
GRANULAR ACTIVATED CHARCOAL

One of these media is GAC or Granular Activated Carbon. Activated carbon has a positive charge and absorbs or traps volatile chemical and organic compounds. Carbon also removes taste, odor, color, and chlorine. The longer water is in contact with this filter medium, the more time the carbon has to react in removing the impurities. Therefore, the effectiveness of the filter is a function of the amount or volume of carbon and the flow rate of the water through the cartridge.

KDF (KINETIC DEGRADATION FLUXION) 55

The other media is KDF 55 Process Media. This media is a special high-purity alloy blend of zinc and copper pellets that works on the electro-chemical and spontaneous oxidation reduction (redox) principles. Water soluble cations (positively charged ions) of lead, barium, arsenic, cadmium, chromium, selenium, mercury, copper, nickel, iron as well as chlorine, heavy chloroforms, and other dissolved metals are oxidized into insoluble matter and attach to the media (chlorine is instantaneously oxidized).

FILTRATION / DISINFECTION



PROTOZOA: Cryptosporidium Parvum
Giardia

BACTERIA: Escherichia Coli (Enterotoxigenic)
Leptospira
Salmonella
Shigella
Vibrio Cholerae

VIRUSES: Enteroviruses
Hepatitis A Virus

HEAVY METALS: Iron and Zinc
Hydrogen Sulfide
Soluble Lead
Mercury and other toxic chemicals
Dissolved metals

Fig. D-3

CHLORINATION

Chlorination is the last stage of the water purification process. Chlorine has been universally accepted as an excellent disinfectant by public utility authorities. Chlorine kills rather than removes bacteria. The chlorine burns the bacteria and requires a contact time to accomplish this process. The remaining chlorine after "burning" bacteria is called "free chlorine." When testing the output of the water purification unit, the free chlorine and total chlorine should be the same, indicating no bacteria in the water. Commercially available water quality test strips (litmus strips) are provided with the water purification units. Follow the instructions on the bottle of test strips. Test strips should be kept in their original container, which should be kept closed before and after use. Be aware that chlorine has a shelf life (indicated on the container).

Note the following precautionary statements for chlorine: **CLOROX INFORMATION LINE**: 1-800-292-2200.

DANGER: CORROSIVE. May cause severe irritation or damage to eyes and skin. Harmful if swallowed. Protect eyes when handling. For prolonged use, wear gloves. Wash after contact with product. Avoid breathing vapors and use only in a well-ventilated area.

FIRST AID: IF IN EYES: hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first five minutes, then continue rinsing eye.

IF SWALLOWED: call a poison control center or doctor immediately. Have person sip a glassful of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person. Call a poison control center or doctor for further treatment advice. Have the product container or label with you when calling a poison control center or doctor or going for treatment.

NOTE TO PHYSICIAN: probable mucosal damage may contraindicate the use of gastric lavage.

PHYSICAL OR CHEMICAL HAZARDS: product contains a strong oxidizer. Always flush drains before and after use.

DO NOT USE OR MIX WITH OTHER HOUSEHOLD CHEMICALS such as toilet bowl cleaners, rust removers, acids, or products containing ammonia. This will release hazardous, irritating gases**.** Prolonged contact with metal may cause pitting or discoloration.

STORAGE AND DISPOSAL: STORE AWAY FROM CHILDREN. Reclose cap tightly after each use. Store this product upright in a cool, dry area away from direct sunlight and heat to avoid deterioration. Offer empty container for recycling. If recycling is not available, discard the container in trash. Not harmful to septic and wastewater treatment systems.

Although the processed water has now passed through micron filtering, UV sterilization, and the two forms of media purification and is assumed to be "drinkable" and contaminant free, chlorination is still required. Most United States public utilities require between 1 to 2 parts per million (ppm) chlorine in the water dispensed to the public. In disaster situations, SBDR will use a higher standard of 4 to 8 ppm in order to ensure integrity of purified water. Also, once the water is purified and contained in a holding tank, the chlorine will help to keep it pure. When water is dispensed into disaster victims' containers, there may be some contaminant in the container that will be "burned" by the residual chlorine. If chlorine is not injected at the water purifier output, before putting water into questionable containers, rinse each container with a mixture of 2 tablespoons chlorine (5.6% concentrate) per 1 gallon of water, or 1 capful of chlorine per 1 gallon of water. Chlorine normally used is liquid chlorine bleach such as Clorox. Also, chlorine pellets that are either commercial (very strong) or the type used in swimming pools may be used. One of the commercial pellets will chlorinate over 5,000 gallons of water. The chlorine mixture should be pre-mixed to provide a 2.25% mixture within the chlorinator injection unit. As an example, Clorox which is 5.25% would need only a mixture of half water, half Clorox.

Normal household bleach found in most stores is now 6% chlorine. This percentage figure represents parts per hundred. This is a bleach solution at 6 parts per hundred chlorine. If one ounce of bleach is added to 100 ounces of unchlorinated water, the chlorine is diluted by a ratio of 100:1, resulting in a solution with 6 parts per ten thousand.

UNIT 4: OPERATION OF THE WATER PURIFICATION SYSTEM DURING A DISASTER

Disasters occur randomly, generally without warning, and result in a rapid response need. The more trained and efficient SBDR can be through training during the "lulls" of disaster, the better SBDR will be able to respond to the needs. Disaster needs within the continental U.S. are more readily and easily accommodated because of our familiarity with "our" customs, language, infrastructure, and resources. However, disasters in foreign countries can and usually do create additional problems that SBDR needs to work out on a case-by-case basis. The following is a general procedure or the highlights of considerations for operating a water purification unit. In no way is this a rigid, "must follow" outline.

SITE LOCATION

This is a very important decision that can sometimes create unnecessary confusion and stress. People in a disaster situation need stability. A daily routine is very important. Once water is provided at a specific area or location and at a specific time, it is important to schedule this to continue regularly at the same place and time. Therefore, make every effort to select a site that will have an abundant water source, if possible, and at a convenient location, if possible. Interruption of schedule and location of water dispensing should be minimized.

SAFETY

Safety of all personnel is a top priority. If the site selected for water purification is in a shelter or refugee camp, interruption of water supply could cause unsettling or anger by the general population. It is recommended that water be purified at the source and then dispensed to the public at a site where needed.

Safety from animals, snakes, etc., is also important.

Operating electrical equipment in a wet area or during rain can be hazardous.

Safety of water unit operations personnel is critical. Before removal or contact with any of the filters, be sure to put on protective prophylactic disposable gloves. Remove all the old micron filter cartridges and place them in double plastic bags for later disposal and burial. Place a reminder note on the water unit that micron filter cartridges are out and new filter cartridges must be put in before starting the unit.

SECURITY

The security of equipment is very important. The water processing could be terminated because of lack of equipment/parts/supplies. In some countries miscommunication or misunderstanding could lead to missing tools, parts, or equipment. It is recommended that the area of work be "roped off" and entry restricted in that area. Portable generators that provide the necessary operating power could be a high value target almost anywhere during or after a disaster.

WATER SOURCE

The water source with the best probability of purifying should be selected. If negotiation with other agencies is required, the importance of this factor should be communicated. The quality of the water source determines the amount of water that can be purified and how much obstruction or restriction occurs from clogged filters. The water purification units can purify water in almost any condition, but each condition affects the amount of good water that is produced and its impact on the equipment.

SILT

Silt in the water source will cause the micron filters to clog quickly, requiring frequent replacement, which in turn requires a large supply of spare filters. Using water from a swiftly moving stream usually means that there is a lot of silt, i.e., the silt is more readily transported by the swift water flow. However, this silt concentration can be greatly reduced by digging or constructing a small pond or tank of water off to the side of the main water source. This will allow water to seep or will slow the flow, which will allow the silt to naturally "drop" to the bottom.

The pond area does not need to be large, possibly 10 feet in diameter and as deep as practical. Next, provide a channel from the main, fast flowing stream, and fill the channel with large rocks and some sand. Allow this pool to fill and settle and then place the "suction" line or pipe as near to the surface as possible. If possible, selecting a stream with cattails or reeds will provide a cleaner water source as this vegetation acts as a natural filter (Note: This does not apply to ponds with algae on the surface.).

PONDS

Many ponds have algae growth. This will clog the filters. If this is the only available water source, the algae most likely will be near the surface. You should place the suction line or pipe 12 to 18 inches below the algae but not on the bottom.

WELLS

The main problem with using an existing well is that the water level may be too low. Most of the water purifying units have a 12-foot suction hose. The reason for the 12-foot length is that the pump will not pull water any higher than 12 feet. This lift problem may also be a problem at a stream or pond.

LOCATION

The working location of the water purifier needs to be where it will not get muddy. There will be water on the ground because of spillage, etc. If a paved surface is not possible, a sandy soil would be the next level down. Lastly, if there is no alternative but in a muddy place, put the water purification unit on a wooden pallet or some large boards to keep it out of the mud. There are holes in the bottom of the water purification units to allow water to drain out. Mud can "back up" into the unit and prevent the unit from draining. This, in turn, could cause the electrical parts to get wet and short out, causing damage and safety of life issues. The site where the purified water is dispensed to the public should be away from the

working (purifying) location. This will avoid crowding and disruption of the purifying process.

PRODUCTION OF WATER
The best way to operate the water purifying units is to set up a "make tank" to store the purified water. The water units should be operated continuously, providing continuous water into the "make tank," which also will allow the chlorine mix to stabilize. This water should eventually be placed into a tank or tanks that will allow local people to draw water from a faucet and fill their containers. The "public" available tank or tanks should be some distance from the actual water purification operation so as to prevent any interference with the water purification process operation.

UNIT 5: POWER SOURCES

The water purification units developed by Southern Baptist Disaster Relief are designed to be adaptable to most power situations. The internal working voltages for most of the systems operate on 12 volts DC. These units generally allow full operation from an internal 12-volt DC battery, 12 volts DC from a jumped car electrical system, 115 volts AC., or 220/240 volts AC power source. Some systems need 115 volts AC or 220/240 volts AC for system operation. Within the continental U.S., when AC voltage is available, it is generally reliable in frequency (60 hertz) and amplitude (115/220/240 volts). However, in foreign countries it is recommended that local water pumps (designed for 50 hertz) be used.

Internal battery operation of the water purification unit can be sustained for a brief period of time before becoming discharged beyond the point of useful service. All efforts should be made to find a reliable power source such as a portable AC voltage generator to accommodate the water purification unit. If the water need is in the continental U.S., there will usually be a "feeding unit" accompanying the disaster need. Generally, portable generators are available with these units. In the third world country situation, there may be no alternative but to use local power. Be sure to have the voltage measured prior to power hook-up to the water processing unit!

DIESEL GENERATORS
Check the oil level each time the unit is refueled and use clean, fresh fuel.

GASOLINE GENERATORS
Check the oil level each time the unit is refueled. Do not refuel the generator when it is hot.

PRE-START CHECK
Never assume there is adequate oil...always check the oil level first. Fill the fuel tank and be sure to wipe any spillage. Make sure all power is turned off before starting (this removes the "starting" load from the generator). After the generator engine is running, turn on the electric power switch. Observe that the engine does not "bog down" with the load on. If it does, the load demand is too large...sequentially remove some of the other non-critical loads to allow normal running of the generator engine.

SHUT DOWN CHECK
Turn off the electrical power switch and allow the generator engine to idle down and run to cool the generator with no load. After shutdown, change the oil before storing the unit. Clean the unit.

UNIT 6: TESTING

Testing the water available at a disaster site is essential. For disasters within the USA, usually the municipal water system is the source of water that has been compromised in some way. In Third World countries, the water system is not usually a utility distribution system but individual sources at wells, streams or ponds. These sources may have always been contaminated to a certain extent and with the advent of a local disaster are compromised even more.

When there are water needs as a result of a disaster within the USA, the following testing procedure is used by the Tennessee Southern Baptist Disaster Relief team. Pressure at the tap from a water system at the disaster location (25 psi or more) indicates the system has integrity and the water plant is pumping or that standpipes (water tower or reservoir on a hill) still have usable water. If the plant is pumping, a measurement of Turbidity (see instruments noted below) will indicate if the municipal water plant is filtering (a low Turbidity reading indicates filtration is occurring). And finally, a measure of residual chlorine (see instruments noted below) in the water of 0.50ppm or more indicates the water is o.k. to use as is. Also, an additional test of the pH of the water will indicate if any contaminants are present. (A reading of 6 to 8 is in the neutral range, less than that would be acidity and greater represents the alkalinity.) It is important that you contact the local municipal water plant to confirm your test results. As an example, if your test results reveal low chlorine levels, generally it is o.k. to add chlorine to the water and go ahead and use it. Also, if the pH test is not in the normal range, the local water utility should be able to identify the problem. The water should be checked on a regular basis for the first few days (2 or more) to ensure that the system is stable.

As a last resort, if water is not available from the municipal system or has lost integrity, there is a high turbidity in the water, low or no pressure, no chlorine, then the complete SBC water purification system should be used until municipal water becomes available (this may mean pumping from a river, lake or pond temporarily).

In third world countries, it is likely there will be high turbidity levels in the water and probably no chlorine. Also, there may be high levels of bacteria and possibly heavy metals, and other contaminants. A method of field testing for all of these contaminants has not been developed within the SBC disaster relief organization. The design of the 830-water purification system has essentially a redundant purification process design, not unlike NASA's space systems. By redundancy, or "overkill" the stages of purification are providing a type of "fail-safe." Between micro filtration, media absorption and ionization, UV sterilization and finally chlorination, most contaminants are removed.

Measurement instruments used:
Hach Portable Turbid meter #46500.00, readout is in direct Nut's (nephelometric turbidity units),
Hach Pocket Colorimeter for Free and Total Chlorine, range 0.02 to 2.00 and 0.1 to 8.0,
Hach pH measurement strips

NOTE: **Turbidity** measures the scattering of light through water caused by materials in suspension or solution.
Nephelometric is the measurement of quantity or size of particles in suspension, by means of light transmitted or reflected from such particles.

"BOIL WATER" means the municipal system is up and running but chlorine has not passed throughout the distribution system and bacteria testing has not been completed. Even with a chlorine reading at a water tap that indicates the municipal system is working, the "boil water" condition will remain on until the municipal water company completes bacteria testing on the complete system. The ability to test the tap water and then verify it with the municipal water company will allow a 24–36-hour advantage on using the system.

UNIT 7: CLEANING AND STORAGE OR CONTINUED USE

The water unit will be used in two different disaster response situations: within the continental U.S. and in third world countries.

The first situation is in response to disasters within the continental U.S. These disasters sometimes include the need for water purification but usually last only two to three weeks maximum before the municipal water system is restored to normal operation. The water units are then removed, cleaned, packed and placed in storage until the next disaster need. In the cleaning, packing and storage, care must be taken to purge the system of all water to preclude bacteria/fungus/mold build

up in the system. Drain all water from the hoses, canisters, filters, UV unit and chlorinators. Any GAC filters should be removed and dried out.

The newer 830 water units should be completely disconnected and dried out, including the interconnecting hoses at the input/suction, stage to stage coupling, and output hose. Canisters should be removed and purged of water.

The second situation of water unit use is in response to a third world disaster. In this situation, the water units that are dispatched to the disaster area usually remain there permanently for continued use in purifying the drinking water. In this situation, it is very important that knowledge of life expectancy of the filters and media are known and accounted for. The micron filters and media have an expected lifetime. Usually the media (KDF and GAC) is much longer than the micron filters. However, accountability is necessary to ensure that the water unit will continue to provide disinfected drinking water. This means that volume output, i.e., gpm/gph must be monitored and recorded to know when filters must be replaced. Sometimes, the micron filters may continuously be clogged/blocked, requiring cleaning before their useful lifetime is reached.

UNIT 8: RECORD KEEPING

NAMB's (North American Mission Board) Incident Command Center requires daily information during national disaster relief responses. The daily reports provide data that support the needs of the Red Cross, FEMA (Federal Emergency Management Agency), Salvation Army, National Guard, and Southern Baptist Disaster Relief logistics needs. The 830 version of water purification units SBDR is now building includes a water meter that provides numerical readout of the total gallons of water processed. Therefore, the daily reporting is quite simple. This information should be provided to the site "white/blue hat" on a daily basis. Record keeping on the status of water purification units (i.e., repairs, components used, cleaning, lab tests, etc.) provides valuable information to the owners of the units as far as stocking spares and replacement parts and keeping up with the status of the unit. Repeated breakdowns or parts replacements are useful indicators of the possible need for a design change or the use of a more reliable component. Samples of the unit daily report, generator maintenance log, and filtration daily log are found in Appendices A-1 through A-3.

UNIT DAILY REPORT

The unit daily report records the number of volunteers onsite and total gallons of water purified that day, among other data.

FILTRATION DAILY LOG

The daily log should report the starting total gallons, final total gallons, record of chlorine checks, and any other items of note.

CLEANING RECORD

Each time the unit is used, it should be cleaned and noted on a record. This provides assurance that the unit has been prepared and is ready for future use with clean filters and spare parts replacements.

STORAGE CHECKLIST

A storage checklist will assure that the unit has all needed spares, components, and items available for the next disaster response.

OTHER AGENCY LAB TESTS

If a local agency has a lab test performed on the water purification unit where water is being dispensed, obtain a copy of the results and add this to the daily report and provide a copy to the site lead (white hat).

Kentucky Baptist Convention
Disaster Relief Ministry
13420 Eastpoint Centre Drive
Louisville, KY 40223
dr@kybaptist.org

WATER FILTRATION UNIT DAILY REPORT

Date:	***Time:***	***Disaster:***
Name of Unit:	***Unit #:***	
Location:	***Unit Blue Hat:***	

Initial Meter Reading:	***Date:***	***Time:***
Final Meter Reading:	***Date:***	***Time:***

Total Gallons Filtered:	***Water Source:***
Source Container:	
Verification of Source Container Condition:	
Disbursement of Water (locations):	

VOLUNTEER COUNT:	
	Number of team members at start of day
	Number of new team member arrivals today
	Total number of team members onsite today
	Number of local community volunteers working today
	Total volunteers working today (add lines C and D)
	Number of team members who departed today
	Number of team members at end of day
	Number of team members departing tomorrow

STAFF MEETINGS AND DEBRIEFINGS: (CHECK IF YES)			
	Morning meeting and devotional		Evening meeting and devotional

GENERATOR MAINTENANCE LOG

Date	Start Time	Stop Time	Oil Check	Oil Change	Fuel Check	Fuel Fill	Air Filter	Operator

DESCRIPTION OF THE MODEL 830 WATER PURIFIER

This purifier is designed to be a low-cost, batch-operated system capable of producing 400-600 gallons of safe drinking water per hour during emergencies and until the normal water supply has been restored. It is not designed to provide a long-term solution to a water problem. However, with proper care this unit should be able to produce safe water for at least a couple of years without significant cost. See photo at the end of this section to view the Model 830.

INPUT TANK

The input tank provides the raw water source for the purification. Each different situation will determine what action must be taken with this water. In some cases, this water may come from some questionable ground water source (pool, lake, shallow well, etc.) and may require pre-treatment with chlorine, while in other cases the water may contain some free chlorine and not require any pre-treatment. If the water is being pumped into the tank from a source where some trash may be in the water, that water should be filtered through the 100-micron filter sock. In the case where the water source is from a municipal water supply that might have become polluted, the sock may not be necessary.

PUMP

Unfiltered water is drawn by a 1HP jet pump capable of delivering 15 GPM head pressure at 50 pounds of pressure. In installations where the input tank cannot be placed level with or above the pump, care must be given to the choice of input hose.

FILTER ASSEMBLY

This assembly contains both 5-micron and 1-micron washable polyester filters, as well as 3 pressure gauges that are used for monitoring system performance. The gauges aid in determining when and which filter is becoming blocked and needs replacement.

KDF/GAC

These two components are discussed as a unit because they work together even though their functions are somewhat different. The term "KDF" refers to a polyester tank and the material it contains known as Kinetic Degradation Fluxion (KDF) 55 Process Medium.

KDF helps in the reduction of free chlorine as well as removing some heavy metals and aiding in reducing some microorganisms.

GAC is an acronym for granular activated carbon. Activated carbon is used to reduce chlorine, organics, color, tannin, and objectionable tastes and odors from water.

UV LIGHT ASSEMBLY

Ultraviolet (UV) light was added to the design to take care of any viruses or organisms that make it past the micron filters, KDF and GAC.

FLOW TOTALIZER

The flow totalizer is mounted on the UV light assembly board and is included to aid in determining the performance of the unit as well as providing a guide as to when some maintenance actions are necessary.

OUTPUT TANK

The output is considered the last part of the purifier even though it may in fact be part of an existing system. In one application, the output tank may be a holding tank where people may bring their vessels to be filled with safe drinking water, while in some other application this tank may be a holding tank from which water is distributed throughout a hospital.

CONVERSION TABLES

METRIC LENGTH AND AMERICAN STANDARD

		1 meter	=	39.37 inches
		0.1 meter	=	3.937 inches
		0.01 meter	=	0.3937 inches
		0.001 meter	=	0.03937 inches
		0.0001 meter	=	0.003937 inches
		0.00001 meter	=	0.0003937 inches
1 micron	**=**	**0.000001 meter**	**=**	**0.00003937 inches**
5 microns	**=**	**0.000005 meter**	**=**	**0.0001985 inches**

METRIC SYSTEM (VOLUME)

1 liter = 1.05 quarts = 33.6 ounces
0.1 liter = 3.36 ounces
0.01 liter = 0.336 ounces

MESH-MICRON EQUIVALENCY

80 mesh = 200 Microns
120 mesh = 130 Microns
140 mesh = 115 Microns
200 mesh = 75 Microns

TABLE FOR STOCK CHLORINE SOLUTION

1 quart = 32 ounces (oz)
1 gallon = 128 ounces
5 gallons = 640 ounces

STOCK CHLORINE SOLUTION FOR 1:100 RATIO

Mix five gallons of water with:

1.0 ounce of 6% chlorine	to get	0.9 ppm in final output
2.25 ounce of 6% chlorine	to get	2.0 ppm in final output
4.5 ounce of 6% chlorine	to get	4.1 ppm in final output
9.0 ounce of 6% chlorine	to get	8.3 ppm in final output

STOCK CHLORINE SOLUTION FOR ONE OUNCE TO ONE GALLON (128 OUNCES) = 1:128 RATIO

Mix 5 gallons of water with:

1.0 ounce of 6% chlorine	to get	0.7 ppm in final output
1.5 ounce of 6% chlorine	to get	1.0 ppm in final output
3.0 ounce of 6% chlorine	to get	2.1 ppm in final output
7.0 ounce of 6% chlorine	to get	5.1 ppm in final output
13 ounces of 6% chlorine	to get	9.5 ppm in final output

SIMPLIFIED METHOD for PURIFY DRINKING WATER

BOILING METHOD

Boiling is the preferred way to purify water. Bring water to a rolling boil for 3-5 minutes, keeping in mind that some water will evaporate. Let the water cool before drinking.

Boiled water will taste better if you put oxygen back into it by pouring the water back and forth between two clean containers. This will also improve the taste of stored water.

BLEACH METHOD

When boiling water is not possible, filter water, letting particles settle out. Pour off clean water. Add regular household liquid bleach (5.25 to 6% sodium hypochlorite, such as *Clorox* bleach not scented or color-safe) as follows:

- 4 drops regular liquid bleach per quart of water
- 16 drops regular liquid bleach per gallon of water
- 1 teaspoon regular liquid bleach per 5 gallons of water
- Mix well. Wait 30 minutes. Water should have a slight bleach odor. If not, repeat and wait 15 more minutes.