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Process Operation Manual

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Pangnirtung Wastewater Treatment Facility Upgrade

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1 General Information

1.1 Introduction

The Pangnirtung Wastewater Treatment Facility (WWTF) is a secondary mechanical treatment plant based on the activated sludge process. Specifically, the plant is a membrane bioreactor (MBR) system utilizing submerged hollow fiber style membranes to provide a high quality effluent. The system is designed to treat residential sewage and wastewater from a local fish processing facility for the Hamlet of Pangnirtung. Wastewater is trucked to the WWTP where contaminants including Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and ammonia-nitrogen (NH_3-N) are reduced to below the National Performance Standards (NPS) prior to discharge to a marine environment (Pangnirtung Fiord).

1.2 Objective

The purpose of this manual is to provide an organized collection of reference material for operations staff. The objectives of this manual are to provide the following:

1. Information on the treatment process to provide operators with an understanding of how the system is designed to operate.
2. General information and procedures to allow the operators to operate and monitor the treatment process.
3. An organized collection of specific equipment operation and maintenance manuals from the various equipment manufacturers and suppliers.

1.3 Manual Organization

This manual has been developed to provide a logical description of the treatment process and various procedures required to operate the facility. General health and safety considerations are located in Chapter 2, near the front of the manual to emphasize the importance of safe work practices. Chapter 3 provides an overview of the treatment system and descriptions of each main process. Chapters 4 and 5 provide more detailed information on the operation and monitoring of the facility including laboratory testing. The membrane process for this plant has been provided by GE Water and they have provided a detailed Operation and Maintenance Manual. Their manual covers many of the unit processes in further detail and has been as a separate standalone document. The final chapter of this manual provides some general information on common wastewater calculations that the operators should be familiar with.

1.4 Operator Responsibilities

The operators are responsible for the day-to-day operation, maintenance, and monitoring of the wastewater treatment facility. The system has been designed to meet specific effluent discharge requirements and it is the operators' responsibility to ensure the plant continues to operate as intended and meets these limits. This manual and its Appendices will cover the details of plant operation and monitoring in conjunction with the individual equipment operation and maintenance manuals. The operators are expected to be familiar with these manuals and the specific work procedures. Additional general responsibilities of the operators are as follows:

- Maintain the plant in a clean and tidy manner. This includes immediate clean-up of spills, trash, and debris.
- Follow all preventative maintenance recommendations as indicated in the various equipment manuals. The operators should keep a record of maintenance for each piece of equipment.
- The operators are expected to follow all safe work procedures. It is the responsibility of the operator to ensure that any visitors to the facility are aware of and follow all safe work procedures and have the proper personal protective equipment before entering the plant.
- The operators are responsible for inventory maintenance for supplies, chemicals, and spare parts. The operators should be aware of the shipping challenges to Pangnirtung and allow for this when ordering supplies. In some cases, it may be advisable to order a full year of supplies at once for the facility provided there are no expiry restrictions on the supplies.
- The operators will be required to have specific training and expertise. It is the responsibility of the operators to maintain any training required and to identify additional training needed for specific tasks.
- The Pangnirtung WWTF has been designed with the capability to remotely alert the operators of any emergency situations. The operators are responsible to respond to these alarms. If an operator must be away or is otherwise unable to respond, then an alternate person must be identified to respond in their absence.
- The operators are responsible for ensuring all external laboratory testing for regulatory purposes is completed in accordance with the requirements of the operating permit.
- The Pangnirtung WWTF is a complex treatment process that requires careful monitoring. The operators are expected to follow the recommended internal laboratory testing schedule and record all data in electronic spreadsheets.

2 Health and Safety Considerations

2.1 General

Health and safety is of critical importance for operation of the treatment plant both for the safety of the operator(s) and the public. The handling of human waste along with the operation of numerous mechanical and electrical equipment items present a number of potential risks if proper procedures and protocols are not followed. Adherence to health and safety codes, proper protective equipment, and proper procedures are the primary means of reducing and controlling the potential risks.

2.2 Manual Limitations and Other Resources

This section of the manual will provide some general health and safety considerations and practices that should be followed by all staff and visitors to the plant at all times. The manual, however, is not an exhaustive list of all potential health and safety issues nor is it the definitive guide for all safety related procedures. It is solely the responsibility of the operators to ensure that they are informed of all potential health and safety issues and are properly equipped to complete all work tasks as part of plant operation in a safe manner. This manual should only be considered as a supplement to other pertinent health and safety resources. At a minimum, the operators are expected to be aware of the following Health and Safety regulations and ensure that all work practices follow in accordance with these regulations and/or guidelines:

1. Canada Labour Code, Part II, Canada Occupational Health and Safety Regulations.
2. Northwest Territories and Nunavut Safety Act
3. Health Canada Workplace Hazardous Materials Information System (WHMIS) and Material Safety Data Sheets (MSDS)
4. Applicable codes of practice available from the Canadian Center for Occupational Health and Safety: http://www.ccohs.ca/legislation/nunavut.html

2.3 Operator Responsibilities

The plant operators are the first line of defense against potential health and safety issues. All operators are expected to follow safe work practices and adhere to all safety codes at all times. The operators are also responsible to ensure that any visitors to the facility are made of aware of and follow the appropriate safety procedures and protocols.

The operators are expected to be familiar with the contents of this manual as well as all applicable codes, regulations, and standards whether explicitly stated in this manual or not.

The operators should, in general, always consider health and safety risks prior to and during the completion of any work at the treatment plant. The primary goal of the operators should be zero health and safety incidents at this facility.

2.4 Public Health and Safety

Public health and safety is always an important consideration when dealing with wastewater handling and treatment. A major concern is contact with raw sewage that can lead to the spread of infectious diseases. The wastewater treatment system is designed to produce a high quality effluent suitable for discharge to the ocean outfall. Public health and safety concerns arise when there are bypasses of raw sewage or when there is poor treatment performance. The operators are responsible to the public to ensure that the system is maintained and operated as designed to provide the highest level of treatment possible. In the event of equipment failure or other unforeseen issues that may warrant the need for a temporary bypass, the operators are responsible to maintain continued public health and safety during the bypass event. This would include ensuring members of the public do not inadvertently come into contact with any untreated sewage.

2.5 Mechanical and Electrical Equipment Safety

The Pangnirtung WWTP includes numerous mechanical and electrical equipment systems. The operators are expected to be familiar with safe operating procedures for all equipment (generally found in the applicable manufacturer's operating and maintenance manuals). Following proper procedures for operation and maintenance is the best way to create a safe work environment. While each equipment item may have its own safe operating procedures that the operators should follow, this section will provide some general safety practices that should be used whenever work is being done on or near any mechanical or electrical equipment.

Improper operation of mechanical equipment exposes the risk of serious injury or trauma. Potential injuries may result certain equipment rotating at high speed, heavy objects, and the potential for crushing or pinching. Operation and maintenance of mechanical and electrical equipment presents the risk of injury due to electrical shock. Many of the equipment items installed at the plant require high voltage and amperage and if proper safety procedures are not followed, there is the risk of serious injury or death. The operators should always consult the manufacturer's documentation and manuals before completing any work on such equipment.

The operators must also know their own limitations with respect to working on this type of equipment. Any work that is outside of normal preventative maintenance, as recommended by the manufacturer, should be completed by a licensed technician and/or electrician who are specifically qualified for that particular piece of equipment. The operators should never attempt any repairs for which they are not specifically qualified and trained.

In addition to the manufacturer's guidelines and applicable health and safety regulations, if work must be done by the operators on or around any mechanical or electrical equipment, the following general safety measures should be observed at all times:

5. Always assume the electrical lines are energized unless they have been positively proven to be de-energized and properly grounded. If there is any uncertainty as to the state of a specific electrical line or piece of equipment, the operators should consult a licensed electrician before proceeding.
6. Use of metal ladders or other tools (i.e., hand tools, flashlights, etc.) around electrical equipment should be avoided if possible. Tools should be grounded or double insulated.
7. If work must be done by the operators on electrical equipment, a minimum of two people should be available to complete the work.
8. There will be a significant amount of both electrical equipment and water present at all times in the treatment plant. The operators should clean up any small liquid spills and avoid any standing water on the floor. Care should be taken when working on or near any electrical equipment to ensure that no water is in the area. There is potential for the operators to inadvertently ground themselves in water which could result in shock.
9. The operators should avoid grounding themselves to pipes or other metal objects when working on or near electrical equipment.
10. All electrical safety devices should be maintained and operable at all times. At no time should any electrical safety device be bypassed or removed.
11. All electrical equipment including motors, switches, and control boxes should be kept clean at all times.

2.6 Safety Equipment

Appropriate safety equipment and Personal Protective Equipment (PPE) shall be used and/or worn by the operators and all visitors at the treatment facility. The exact type and nature of the safety equipment and PPE will be dependent upon the specific type of work being carried out. This section will identify some common equipment that maybe required. The operators are expected to be aware that some specific tasks may require additional safety equipment that is not listed here.

The following is a list of common safety equipment and PPE that may be required on a regular basis:

- First aid kit(s)
- Safety boots, CSA approved, steel toe or equivalent
- Safety glasses/goggles and/or face shield
- Gloves (various types including rubber, latex/nitrile, and general purpose)
- Lab coats/aprons
- Respirator
- Personal gas detectors
- Non-metal flashlight
- Eyewash bottle/station
- Fire extinguishers
- Fall arrest harness and lanyard

2.7 Specific Safety Hazards

2.7.1 Disclaimer

A list of common safety hazards is provided in the following sections. The operators should be aware of the potential for any safety hazards whether specifically listed here or not. The operators should assess each scenario before completing any work to determine the potential hazards and the appropriate safe-work procedures, safety equipment, and PPE required.

2.7.2 Risk of Infection

Domestic wastewater, also referred to as raw sewage, contains bacterial organisms and, in some cases, viruses from human waste. As such, these organisms have the potential to be infectious and disease-causing. The operators should take care to protect themselves from the potential spread of infectious diseases. In general, avoiding direct contact and/or ingestion of this material is the best method of protection. Some general procedures for wastewater handling are as follows:

- Always wear rubber or latex/nitrile gloves when collecting samples and performing laboratory testing.

- Always wash hands immediately after handling wastewater.
- Do not touch around the face when handling wastewater.
- Do not eat, drink, or smoke during wastewater handling, sampling, or while performing laboratory testing. Any food storage should be kept separate from the wastewater process and laboratory areas.

In addition to the above safety procedures, it is also recommended for the operators to have specific vaccinations against common diseases. The operators should consult the local public health authority for additional recommendations and procedures for vaccines. Operators should maintain a personal record of vaccinations and booster schedules to ensure they remain protected. Some common vaccinations for wastewater operators are listed below:

- Tetanus
- Hepatitis A and B

2.7.3 Air Quality and Breathing

The Pangnirtung WWTF has been designed to include proper ventilation and air handling to promote good air quality throughout the common space within the building. The plant also includes permanent gas monitors that will provide an alarm if unsafe levels of specific gasses are present. In particular for a wastewater treatment facility, there is potential for accumulation of hydrogen sulfide (H_2S) to unsafe levels. Unsafe levels of this gas can lead to serious injury and death with very short exposure times. Areas in the plant where H_2S would be most likely to occur are in the headworks room in the presence of raw sewage or in the waste sludge dewatering room. Operators should always carry personal gas monitors at all times when entering these rooms regardless of the duration of time being spent in that room.

The operators should also be aware of confined spaces as addressed in the following section. Any confined space presents potential threats to air quality that can lead to injury or death.

2.7.4 Confined Spaces

Confined spaces are defined as fully or partially enclosed spaces that are not designed for continuous human occupancy and in which hazardous atmospheric conditions may be present due to the construction, location, contents, or work that is being performed in the space. Confined spaces can be optimal areas for accumulation of dangerous gasses or low oxygen levels. A wastewater treatment

facility presents numerous locations that can be potentially classified as confined spaces.

No person shall be allowed to enter a confined space unless that person has specific training in confined space entry and follows all safety procedures. Even with the appropriate training and safety procedures, it is recommended to avoid confined space entry if at all possible. Often there are other methods of work that can be used that do not require entry into the space. In many cases it is easier and safer to remove equipment from the space using hoists or cranes if work must be done.

A wastewater treatment plant has the potential to contain multiple confined spaces, some of which may be difficult to identify to an untrained operator. It is recommended that all operators complete confined space training course(s) in accordance with the local jurisdiction.

2.7.5 Fall Arrest

The Pangnirtung WWTF includes multiple zones and structures where there is potential for serious injury due to falling. In many cases the design of the plant includes safety cages, guardrails, or limited access to reduce the risk of falling. However, due to the height of the various tanks and zones in the facility, there is still the potential for danger. It is recommended that all operators undergo specific fall arrest training and be provided with the appropriate safety equipment if work must be performed at any height.

2.7.6 Hazardous Chemicals

Work within a wastewater treatment facility commonly requires the use of potentially hazardous chemicals. These chemicals may be required for process performance, cleaning, and/or laboratory testing. Operators are required to be familiar with proper handling, storage, and disposal techniques for all chemicals stored and used within the treatment facility. It is recommended that the operator undergo specific training on the Workplace Hazardous Materials Information System (WHMIS) and Material Safety Data Sheets (MSDS). These information systems will provide the full details on proper handling of hazardous chemicals. Copies of all relevant WHMIS signage and documentation shall be maintained at the treatment facility. Updated copies of MSDS for each chemical used/stored at the facility shall be maintained in an identified area. Operators are expected to follow all instructions contained within the MSDS. Copies of MSDS for process-related chemicals can be found in Appendix B of this manual and in the GE Operation and Maintenance Manual.

2.7.7 Laboratory Hazards

Many of the hazards that are present in the WWTF are also present in the laboratory. There is potential for hazardous chemicals, air quality issues, and risk of infection among other hazards. The operators will be required to sample and perform testing on raw wastewater and mixed liquor as part of the testing and this carries the potential for exposure to infectious bacteria and viruses. The lab testing is generally performed with specific test kits which have carefully laid-out procedures and safety considerations. Some of these test kits involve the use of chemical reagents which can be acidic, toxic, or otherwise hazardous. The operators are expected to follow all procedures and ensure that all safety measures are in place throughout the duration of the test.

The laboratory has been supplied with some specific safety equipment that should be used whenever required for specific testing. The following sections will address some general lab safety guidelines but the operator should always refer to manufacturer-supplied instructions and safety information to ensure the equipment is operated in a safe manner.

Some general safety considerations in the laboratory are as follows:

- The operators should make it a habit to wear latex or nitrile gloves at all times in the laboratory to reduce exposure to raw wastewater and hazardous chemicals.
- Appropriate eye protection shall be worn at all times in the laboratory which may include safety glasses/goggles or full face shield. In some cases, larger containers of stock chemical may need to be transferred or decanted into smaller containers. Depending on the nature of such chemicals, additional protective equipment including a lab apron and/or respirator may be required.
- The operators should be aware that some of the test procedures will require heating the samples in lab-scale ovens or furnaces. These devices have the potential to heat samples to over 550°C and could result in serious injury if proper procedures are not followed. Other lab equipment could present additional safety considerations that the operators should be aware of. The operators are expected to review and be familiar with the operating manuals for all lab equipment.
- The laboratory at the Pangnirtung WWTF has been equipped with a bench top fume hood system to help maintain air quality. Some lab testing will explicitly state that certain steps or procedures should be carried out within the containment area of the fume hood. If the operators are concerned about any potential chemical reactions, it would be recommended to perform such duties inside the fume hood. When using the fume hood, the protective glass pane should be lowered to the fullest extent possible. If the pane must be raised to allow access for a test procedure, it should be raised the minimum amount necessary to allow the operator to perform the specific task. The

ventilation fan should be left on during all procedures utilizing the fume hood. It is also recommended to leave the fume hood ventilation fan on for several minutes after the procedure is complete to promote complete evacuation of the hazardous substance.

- All chemicals should be clearly labeled in accordance with WHMIS procedures.
- Any chipped or broken glassware should not be used. Broken glassware should be immediately cleaned up and disposed of in a separate container specially marked for broken glass. Do not dispose of broken glass with other trash. All broken glass should be handled with tongs or swept up. Do not handle broken glass with bare hands.
- If acids must be handled, special care should be taken as these chemicals can be highly corrosive to human skin. If dilution is required, it should be done by slowly adding the acid to water. Never add water to concentrated acid.
- Suction bulbs or pipets should always be used when transferring liquids. Liquids should never be sucked into a pipet by mouth.
- Chemical such as oils, greases, mercury, strong acids or bases, and volatile solvents should not be disposed of down the sink. The MSDS for each chemical should be consulted for proper disposal techniques. For small quantities, it is recommended to store the waste chemicals in suitable containers until such time as the chemical can be disposed of properly. Each chemical should have its own separate storage container and should be clearly labeled.
- All chemical storage containers should be confirmed to be of suitable material for the chemical being stored. For example metal containers cannot be used for acids due to the corrosive nature of these chemicals.
- The laboratory should be equipped with at least one fire extinguisher of the “A,B,C” type.
- The laboratory should be equipped with at least one first aid kit that is readily accessible.

2.7.8 Explosive or Flammable Materials

Normal operation and maintenance of the treatment facility may require the handling and storage of potentially flammable or explosive materials. Materials such as fuels, oils, greases, and compressed gasses can be flammable, explosive, or both depending on the conditions and potential ignition sources. Updated MSDS shall be available for all such materials stored or used at the facility. The MSDS will provide critical information including conditions that could lead to an explosion or fire. Some general safety recommendations for these materials are as follows:

- Explosive or flammable materials should always be stored in approved containers. The operator should regularly inspect containers for damage or leaks and immediately replace the container. In some cases (example: propane tanks), the containers are marked with an expiration date. Any container that is beyond its expiration date shall be immediately discontinued from use regardless of the apparent condition of the container.
- Care should be taken to avoid storing these materials near potential ignition sources. Ignition sources can include heat and potential sources of sparks such as tools, workbench areas, and powered equipment. Smoking is another common ignition source and is prohibited at all times at the treatment facility.
- Greasy or oily rags should never be placed in a pile or bundle. The rags can produce excessive heat as they dry which can lead to a fire. Oily rags should be left open to dry and subsequently disposed of in accordance with the MSDS.
- Any tanks containing compressed gas must be stored in such a manner that prevents them from being inadvertently knocked over or punctured. A puncture in a compressed gas container can cause rapid pressure release which can turn the container into a dangerous projectile. Tanks can be punctured if they are knocked over or struck with another piece of equipment or machinery such as a forklift. Chains and/or safety cages may be required to ensure safe storage of these materials.

2.8 Emergency Contacts

The following list contains emergency contacts for various potential emergencies. It is recommended that this list be posted in the plant laboratory and office in a visible location for quick reference.

Organization	Contact Person	Contact Information
Fire Department		Phone: 473-4422
Health Center		Phone: 473-8977
Police (RCMP)		Phone: 473-1111

3 Wastewater Treatment System

3.1 System Overview

The upgraded Pangnirtung WWTF is a mechanical biological, suspended growth treatment system based on membrane bioreactor (MBR) technology. The plant is capable of a high level of treatment with biological nutrient removal (BNR) capability for nitrogen and a tertiary level of solids removal provided by the membranes. The system treats domestic sewage and some food processing waste (local fish processing plant) from the Hamlet which is delivered to the plant via a trucked system. This collection method results in a relatively low volume of wastewater but a relatively high contaminant concentration on a per capita basis. The system is designed to accept wastewater on a 7-day per week delivery schedule. Treated effluent is discharged to the Pangnirtung Fiord.

The following sections will provide some description of the main unit processes within the system. Further details can be found on the accompanying Process Flow Diagram and P&ID Drawings included in Appendix A. Some of the major unit processes have been provided by GE Water as part of the membrane technology package and these sections should be read in conjunction with the GE Operation and Maintenance Manual.

3.2 Design Criteria and Effluent Discharge Limits

The upgraded Pangnirtung WWTF has been designed to meet a specific set of design criteria. It is critical for the operator(s) to understand the operating conditions that the plant was designed for as well as the effluent discharge limits the system is designed to meet.

A summary of key operating conditions for the overall system are as follows. Additional operating conditions specific to the membrane system can be found in the GE Operation and Maintenance Manual.

Parameter	Unit	Design Value
Average Daily Flow	m^3/d	290
Peak Daily Flow	m^3/d	360
Peak Hourly Flow	L/s	7.8
Influent BOD_5	mg/L	1000
Influent TSS	mg/L	1070
Influent TKN	mg/L	250
Influent Total Phosphorous	mg/L	40

As with any wastewater treatment system, the Pangnirtung WWTF has been designed to meet effluent discharge limits for specific parameters. The operators are also expected to be familiar with the operating permit for the treatment facility as issued by the Nunavut Water Board (NWB). The permit will clearly identify all requirements that the system must meet including the effluent discharge regulations. The permit may also contain information related to bypass events, reporting, and record keeping.

The effluent limits that the plant is required to meet are as follows:

Parameter	Unit	Design Value
Influent BOD_5	mg/L	80
Influent TSS	mg/L	70

3.3 Equipment ID and Tagging System

The treatment system has been designed with an equipment identification and tagging system for all process equipment, valves, and instrumentation. The identification system uses the following format:

XX-YY-ZZ

Where:
XX = Process area identifier (2 digit number)
YY = Equipment type identifier (1-3 character code)
ZZ = Unique equipment number (2 digit number)

An example of this tagging system is 20-V-01, which is valve #1 in process area 20. A complete list of process area codes and equipment identifiers can be found on design Drawing P401-1 in Appendix A.

3.4 Influent System

All wastewater received at the facility for treatment arrives via the Hamlet's trucked collection system. An external connection is provided for truck discharge to the raw sewage sump. Prior to entering the sump, the wastewater passes through a manually-cleaned bar screen for removal of large debris. Dual submersible pumps (tags 10-RSP-01 & 10-RSP-02) operate in an alternating duty/standby arrangement to deliver raw wastewater to the system headworks.

3.5 System Headworks

The system headworks includes a fine drum screen (tag 10-FDS-01) for further removal of suspended solids material. The drum screen removes solids greater than 2 mm in size which have the potential to damage the downstream membranes. The drum screen (existing prior to the upgrade) has been retrofit with a new drum to provide the level of screening required. An existing screen backwash system is used to clean the screen to prevent excessive buildup of solids and blinding of the screen openings. Screened effluent passes through the screen openings and drains by gravity to the screened sewage sump. Dual submersible pumps (tags 10-SSP-01 & 10-SSP-02) operate in an alternating duty/standby arrangement to deliver screened wastewater to the equalization tank.

3.6 Preliminary Treatment (Equalization)

Preliminary treatment consists of equalization to attenuate flows and provide a consistent hydraulic and organic load to the biological treatment system. Wastewater is generally trucked to facility over a relatively short window (i.e., less than 8 hours) and the equalization tank (tag 20-TK-01) provides storage to allow this volume to be fed to the biological system more evenly over a full 24-hour period. Dual centrifugal anoxic tank feed pumps (tags 20-AFP-01 & 20-AFP-02) convey screened and equalized wastewater to the biological treatment system.

3.7 Secondary (Biological) Treatment

The secondary treatment system is where the majority of the biological treatment occurs along with suspended solids separation. Biological treatment at this facility includes nitrification and denitrification for removal of organic nitrogen and biological oxidation of organic material (i.e., BOD removal). The majority of the process design and control for this portion of the plant has been provided by GE Water as part of the membrane bioreactor process. The following sections will give a brief overview of the system but most of the details for this system have been provided as part of the GE Operation and Maintenance Manual.

3.7.1 Pre-Anoxic and Aeration Tanks

Wastewater from the equalization tank first enters the biological system via the pre-anoxic tank (tag 50-TK-01). Flow then passes into the aeration tank (tag 50-TK-02) through an opening in a common tank wall. The two tanks have been designed as concentric circular tanks with bolted steel construction. The inner zone is the pre-anoxic tank and the outer zone is the aeration tank. Within these two zones virtually 100% of the biological nitrogen and BOD removal occurs. The pre-anoxic tank is aerated for mixing the tank contents but the dissolved oxygen concentration is lowered to allow denitrification to proceed. The aeration tank is

aerated at a higher rate to provide both mixing and sufficient dissolved oxygen (typically ≥ 2.0 mg/L) for BOD oxidation and nitrification.

Further details on the operation of these processes can be found in the GE Operation and Maintenance Manual.

3.8 Membrane Bioreactor (MBR)

The MBR is based on a GE Water submerged membrane system. With the bulk of the biological treatment already completed in the pre-anoxic and aeration tanks, the MBR is used primarily as a solids separation process. The membranes are submerged in specially designed membrane tanks (tags 55-TK-01 & 55-TK-02). Mixed liquor flows by gravity from the aeration tank to the membrane tanks. Each membrane tank has a dedicated permeate pump (tags 55-PP-01 & 55-PP-02) that pull treated effluent (permeate) through the membranes. The mixed liquor is recycled back to the pre-anoxic tank using dedicated return activated sludge (RAS) pumps (tags 65-RP-01 & 65-RP-02) for each membrane tank.

Additional information on the operation and control of the MBR system can be found in the GE Operation and Maintenance Manual.

3.9 Disinfection and Final Effluent Discharge

Effluent from the permeate pumps is passed through an ultraviolet (UV) disinfection system prior to final discharge. The UV system deactivates any pathogens that may be present in the effluent. Final effluent is discharged to the environment by a gravity outfall pipe to a rock lined discharge swale leading to the Pangnirtung Fiord.

3.10 Sludge Handling and Disposal

Through the normal course of operation, the bacterial population within the biological treatment system will continue to grow as more wastewater is treated. In order to maintain a population within the recommended range, occasional wasting of excess sludge must be done. For this process, the RAS pumps for each membrane tank are capable of performing double duty. When sludge is required to be wasted, the RAS pumps can be controlled through valve actuation to direct this material to the waste sludge storage tank (tag 70-TK-01). From the storage tank, the waste sludge pump (tag 70-WSP-01) conveys this material to the sludge dewatering system.

The Pangnirtung WWTF has been upgraded with a passive sludge dewatering system known as a Geotube™. The Geotube™ is essentially a large filter bag that retains the waste solids and allows water to pass through. A polymer injection

system is used to add polymer to the waste sludge before it enters the Geotube™ and promote better solids separation. Waste sludge is pumped into the Geotube™ unit and the filtrate water is allowed to passively leach out of the bag into the filtrate collection sump. Water collected in the filtrate sump is returned to the pre-anoxic tank inlet using a submersible filtrate pump (tag 70-FRP-01).

3.11 Chemical Addition Systems

Various chemicals are required for normal operation of the system. Chemical dosing systems have been included in the design to meter these chemicals into the process at the proper injection point. Brief descriptions of these chemical systems are provided in the following sections.

3.11.1 Alkalinity Chemical Dosing (Soda Ash)

In any biological treatment system, a certain alkalinity level must be maintained in the mixed liquor to promote proper biological activity. Essentially alkalinity is a measure of the buffering capacity of the system to resist changes in pH due to the addition of acids in the wastewater. Sufficient alkalinity is required to maintain a neutral pH in the system. In many cases, sufficient alkalinity is provided by the wastewater and no supplemental chemical is required for this purpose. However, for the Pangnirtung WWTF, alkalinity will be consumed naturally through the nitrification process and additional chemical is required.

Supplemental alkalinity chemical will be added to the mixed liquor via the RAS return line. Dry sodium carbonate (commonly referred to as “soda ash”) is injected into the RAS line and the dosage is adjusted as required to maintain a neutral pH in the biological system. A dry chemical feeder system will deliver metered chemical into the system. The chemical addition system includes an educator feed system complete with an educator feed pump (tag 90-EFP-01). This pump pulls a sidestream flow from the main RAS line and delivers it to the chemical feed educator (90-ED-01). Dry chemical is injected into this sidestream which is subsequently re-introduced into the main RAS line prior to entering the pre-anoxic tank.

3.11.2 Membrane Cleaning Chemical

Over a period of normal operation of the MBR, it is possible for the surface of the membranes to become plugged or fouled with solid material. Periodically, as required, specific cleaning chemicals will be back-fed into the membranes to reverse this membrane fouling and restore permeability. Further details on the membrane cleaning chemical system operation and chemical preparation can be found in the GE Operation and Maintenance Manual.

3.11.3 Defoamer Addition

As with any aerated biological treatment system, there is potential for foaming to occur. Under normal operation of the plant, foaming would typically be minimal and it is anticipated that defoamer addition would not normally be required. However, during start-up or periods with abnormal operating conditions, foaming can be an issue. A defoamer chemical addition system has been included as part of the treatment process which will give the operator the capability to add defoamer on an as-needed basis. When needed, defoamer can be injected into the RAS line prior to entering the pre-anoxic tank.

4 Treatment System Operation and Control

4.1 Operation Overview

The Pangnirtung WWTF includes numerous mechanical and electrical equipment items, processes, and instruments. A robust control system complete with HMI, SCADA system, and remote alarm has been included to assist the operators with the normal operation of the facility. The treatment plant consists of a number of unit processes that need to function and communicate with each other in order for the entire system to function properly. The following section will present the general operating guidelines for each unit process in the system. For more details on the specific operation and maintenance of each process and piece of equipment, the operators should consult the manufacturers' specific operation and maintenance manuals.

4.2 Plant Hydraulics and Emergency Overflows

Flow through the plant is generated by mechanical energy (i.e., pumping) and by gravity where possible.

Emergency overflows for tanks have been included in the design and the operators should make themselves familiar with their locations. Under normal operation, there should be no overflows as this represents untreated, raw wastewater being discharged to the environment. Overflows should only be used in emergency situations where there is no alternative. The operators should attempt to minimize the duration of the overflow period by taking corrective action and making any repairs as quickly as possible.

The treatment plant is equipped with five (5) emergency overflow/bypass lines as follows:

1. Screen and screened wastewater sump bypass
2. Equalization tank bypass
3. Equalization tank emergency overflow
4. Membrane tanks emergency overflow
5. Sludge storage tank emergency overflow

All five of these overflow/bypass lines ultimately connect to the final effluent outfall pipe. If any of these overflows are used, the result is untreated or partially treated sewage being discharged to the environment. The operators should make every effort to avoid discharging untreated sewage. In the event of equipment failure, it may be necessary to overflow or bypass wastewater but the operators are expected to take steps to minimize these events. Adhering to recommended scheduled preventative maintenance practices will prolong equipment life and

reduce premature failures. Maintaining a sufficient inventory of spare parts and equipment will help to reduce equipment down-time in the event of failure.

Further details on the overflow/bypass of the plant can be found on the Process Flow Diagram and Process and Instrumentation Diagrams included in Appendix A.

4.3 Influent Systems, Headworks, and Equalization

Raw wastewater is trucked to the plant and is delivered to the raw wastewater sump.

4.3.1 Raw Wastewater Coarse Bar Screen

Wastewater flows by gravity through a manually cleaned coarse bar screen as it passes from the truck to the raw wastewater sump. The bars generally collect larger debris such as rags that can clog or damage the submersible sewage pumps. The operators are required to monitor the coarse screen and maintain the openings free of debris using the manual rake. It is recommended to check the bar screen on regular basis (i.e., at least daily) to ensure the screen does not become clogged.

4.3.2 Raw Sewage Pumping System

Wastewater from the coarse screen passes into the Raw Sewage Sump. The sump is equipped with two submersible pumps (tags 10-RSP-01 & 10-RSP-02) that can operate in an alternating duty cycle or with both pumps operating in parallel depending on the liquid level in the sump. The pump operation is controlled by four float-style level switches (tags 10-LS-01, 10-LS-02, 10-LS-03, & 10-LS-04).

A typical cycle of events during a truck fill operation would be as follows:

1. Sump is empty, all four floats hanging freely and no pumps are running.
2. Sump water level rises to activate the lowest float switch (tag 10-LS-04), no pumps are running.
3. Sump level rises to activate the second lowest float switch (tag 10-LS-03) which activates the first pump. Either of the two submersible pumps may start in accordance with the alternating duty arrangement.
4. Sump level rises to activate the second highest float switch (tag 10-LS-02) which activates the second pump. Both pumps are now in operation.
5. If the sump level rises to the point where the highest float switch is activated, a high level alarm is generated by the control system. Both pumps continue to operate and an alarm light is illuminated on the exterior of the building.

6. The truck filling operation ends and the sump level begins to decrease. Both pumps continue to operate until the level once again reaches the lowest float (tag 10-LS-04).
7. All float switches are hanging freely and both pumps are off.

The controls system (further details in Section 4.10) will automatically turn on the pumps and will provide a visual feedback to the HMI that the pumps have been called into operation. However, there is no feedback to ensure that the pumps have actually started or are operating properly. Potential issues, such as an electrical problem, pump malfunction or failure, or a pump becoming clogged, will not be readily apparent from the HMI. The operators are required to observe the operation of the pumps on a regular basis to ensure there are no issues.

4.3.3 Fine Screen

The rotary drum screen (tag 10-FDS-01) has been retrofit with a new drum to provide fine screening of all particles greater than 2 mm in size. The main purpose of the screen is to protect the downstream membranes from potential damage from larger particles. **The fine screen must be in operation at all times if wastewater is being pumped from the raw wastewater sump.** If the fine screen is not operational, then wastewater must be bypassed and cannot be fed to the treatment system.

Under normal operation, the fine screen starts automatically when either of the raw wastewater pumps has started. The screen continues to run until the end of a short time delay after the raw wastewater pumps have shut off.

The fine screen is equipped with a backwash water system that helps to clean the screen and prevent blinding of the pores. The backwash water is fed from the non-potable water system. Under normal operation, the backwash system operates automatically while the screen is running. The operator should regularly check on the operation of the non-potable water system to ensure that it is able to provide the required backwash flow to maintain the fine screen during operation. Additional details on the non-potable water system are provided in Section 4.9.

4.3.4 Screened Sewage Pumping System

Fine screened wastewater from the drum screen passes into the Screened Sewage Sump. Operation of the screened sewage sump proceeds in an identical fashion to the Raw Sewage Sump. There are two submersible pumps (tags 10-SSP-01 & 10-SSP-02) that operate in an alternating duty arrangement. Pump operation is automatically controlled based on sump level which is indicated by four (4) float-style level switches (tags 10-LS-05, 10-LS-06, 10-LS-07, & 10-LS-08). The sequence of operation of the pumps and level switches would be identical to the Raw Sewage Sump as described in Section 4.3.2.

4.3.5 Equalization Tank

Wastewater from the Screened Sewage Sump is pumped into the Equalization (EQ) Tank (Tag 20-TK-01). The main purpose of the EQ tank is to attenuate wastewater flow to provide a more consistent hydraulic and organic loading to the downstream biological treatment process. The EQ tank is aerated and mixed using a diffused air system and two aeration blowers (tags 25-AB-01 & 25-AB-02).

The most important operational consideration for the operators is managing the tank level. The automatic control system will do most of the work in terms of managing this tank but the operators need to fully understand the operation in order to make any adjustments to the setpoints. In general, the goal is to have the tank level as low as possible at the beginning of each day. This will provide the maximum volume of available storage for the incoming wastewater. The volume of water in the tank at any given time is a product of the influent flow from the screened sewage sump and the tank outflow generated by the anoxic tank feed pumps (tags 20-AFP-01 & 20-AFP-02). The operator has little control over the influent flow as the screened sewage pumps need to operate whenever a truck delivers a batch of wastewater to the plant. The main control is the speed of the anoxic tank feed pumps which are equipped with variable frequency drives. Further description on the operation of these pumps is provided in Section 4.3.6.

The EQ tank is mixed and aerated using diffused aeration through a diffuser grid installed on the tank floor. Air flow is provided by two aeration blowers (tags 25-AB-01 & 25-AB-02) which are physically located in the mechanical room. The primary purpose of the aeration system is to keep the tank contents mixed and to provide some aeration to prevent septic conditions. The treatment plant upgrade has included the addition of variable frequency drives for these pre-existing blowers. Tank level is monitored by a level transmitter (tag 20-LE/LT-01) which provides feedback to the PLC. The addition of speed control to the aeration blowers now allows the PLC to automatically adjust the blower speed depending on tank level. This allows for sufficient aeration to be provided at all tank levels without wasting energy by over-aerating at lower levels.

4.3.6 Anoxic Tank Feed Pumps

Wastewater from the EQ tank is fed to the biological treatment system by two anoxic-tank feed pumps (tags 20-AFP-01 & 20-AFP-02). The pumps operate in an alternating duty/standby arrangement to deliver wastewater to the pre-anoxic tank. The PLC automatically adjusts the speed of the pumps to provide a steady flow to the biological treatment system while also allowing the tank to be drained to the low operating level by 8 am the following day. The PLC continuously monitors both the level in the equalization tank (level transmitter tag 20-LE/LT-01) and the anoxic feed pump discharge flow rate (flowmeter tag 20-FE/FIT-01) to perform this operation.

4.4 Biological Treatment Control and Monitoring

The majority of the biological treatment is accomplished in the Pre-Anoxic Tank (tag 50-TK-01) and the Aeration Tank (tag 50-TK-02). These systems include two (2) aeration blowers (tags 60-AB-01 and 60-AB-02) and various online instruments for monitoring and control. Details on the operation, maintenance, and control of these systems can be found in the GE Operation and Maintenance Manual.

4.5 Membrane System Process

The membrane system provides the final solids-liquid separation prior to effluent discharge. The membrane system includes two aeration blowers (tags 60-AB-03 & 60-AB-04), various pumping systems, and multiple online instruments for control. Details on the operation, maintenance, and control of these systems can be found in the GE Operation and Maintenance Manual.

4.6 Sludge Handling

Sludge handling at the Pangnirtung WWTF generally refers to three (3) main processes. Return Activated Sludge (RAS) is a continuous recycle that returns mixed liquor from the membrane tanks to the pre-anoxic tank. Waste activated sludge is removed from the biological treatment process using a branch off the RAS line. This material is directed to the sludge storage tank prior to the third and final process which is sludge dewatering and disposal.

4.6.1 Return Activated Sludge (RAS) Control

Return activated sludge (RAS) pumps (tags 55-RP-01 & 55-RP-02) provide the recycle of mixed liquor from the membrane tanks to the pre-anoxic tank. The operators need to control the RAS flow to promote even mixed liquor distribution throughout the entire biological process. The RAS flow is also controlled to provide the correct mass flow of nitrate to the pre-anoxic tank. Further details on the RAS system are provided in the GE Operation and Maintenance Manual.

4.6.2 Waste Sludge Storage Tank

Periodically, a portion of the activated sludge in the biological treatment system must be wasted to maintain an appropriate MLSS concentration. Under normal operation, as described in Section 4.6.1, the mixed liquor is returned to the pre-anoxic tank using the RAS pumps. When wasting is required, the RAS stream can be instead diverted to the sludge storage tank (tag 70-TK-01). An automatic valve (tag 65-V-15) can be closed while another automatic valve (tag 70-V-01) can be opened to redirect sludge flow to the sludge storage tank. This operation is controlled by the GE PLC and further details on the operation can be found in the GE Operation and Maintenance Manual.

The sludge storage tank is aerated for mixing and to avoid septic conditions using a diffused aeration grid and aeration blowers. The aeration blowers (tags 75-AB-01 & 75-AB-02) are physically located in the mechanical room.

The level in the sludge storage tank is continuously monitored by a level transmitter (tag 70-LE/LT-01) with communication to the PLC.

4.6.3 Waste Activated Sludge (WAS) Control

Excess sludge that is directed to the sludge storage tank must be dewatered and removed from the system. The Pangnirtung WWTF has been equipped with waste sludge conditioning and dewatering system based on the use of Geotube™ dewatering bags. The bags allow for sludge to be pumped into the bag and excess water (i.e. filtrate) to freely drain out. The filtrate is collected and returned to the treatment process while the dewatered sludge material remains in the Geotube™ bag.

A peristaltic waste sludge pump (tag 70-WSP-01) is used to deliver waste sludge from the sludge storage tank to the Geotube™ bag. Conditioning of the waste sludge consists of polymer addition to help promote better separation of the water from the solid material. The system has been installed with a complete polymer dosing system including the polymer feed pump (tag 70-PFP-01) and water supply from the non-potable water system. The packaged system dilutes neat polymer to a recommended mixture and injects it into the waste sludge stream as it is discharged from the waste sludge pump. Further details on proper polymer mixing and operation of the polymer injection system can be found in the specific Operation and Maintenance manual from Bishop Water.

Due to the pulsing nature of the peristaltic-style of pump, both suction and discharge pulsation dampeners have been installed. These dampeners will help to smooth out the discharge flow and make it easier to adjust polymer dosage. A flowmeter (tag 70-FE/FIT-02) installed in the waste sludge discharge line is used to track the flow and total volume of waste sludge sent to the dewatering system.

The waste sludge pump (tag 70-WSP-01) is a peristaltic-style pump commonly referred to as a hose pump. A continuous piece of flexible tubing connects the pump suction to the pump discharge inside the body of the pump. When the pump is operating, a set of shoes press against the tubing causing it to be completely flattened underneath the shoe. This action completely seals off the tubing in two locations and traps a volume of liquid within the tubing. As the shoes rotate, this volume of liquid is pushed from the suction side of the pump to the discharge side. A general schematic of the pump operation has been provided in Figure 4-1 (for further details, consult the manufacturer's operation and maintenance manual). The action of compressing the tubing will eventually wear it out which can result in a crack in the tubing wall and a leak into the pump body. It is recommended to follow the manufacturer's guidelines for scheduled tubing replacement to avoid failure. In the event of a tubing failure, the pump has been equipped with a leak detector that will sense the presence of liquid within the pump body.

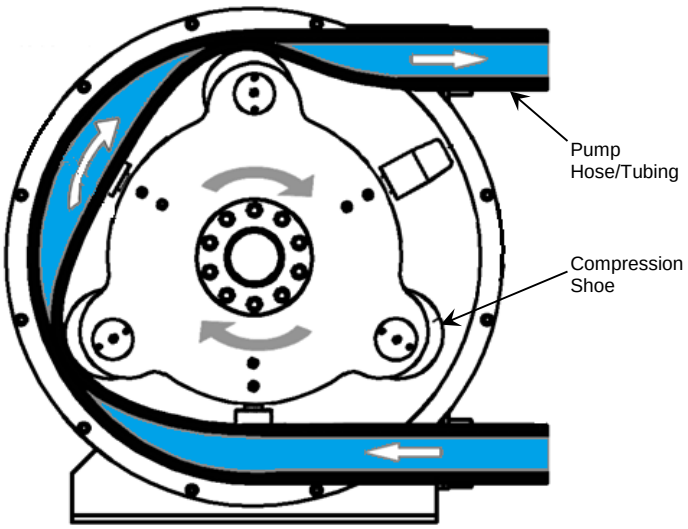


Figure 4-1: Peristaltic pump general operation schematic (actual pump may not be exactly as shown).

The Geotube™ dewatering bags for the Pangnirtung WWTF have been selected to fit into the bed of a dump trailer which is normally housed in the dewatering room. A capacitive sensor (tag 70-LS-04) suspended over the dewatering trailer will detect when the Geotube™ bag is full. When the very first Geotube™ bag is being filled, some calibration of the height of the sensor will be required. The operator will have to carefully observe the filling of the first bag and when it is full, the sensor should be adjusted to the proper height. The sensor must be adjusted so that it is in contact with the center of the Geotube™ bag when the bag is full.

Filtrate from the Geotube™ bag drains from the trailer to a nearby in-ground trench and sump (the trailer tailgate has to be propped open to allow the filtrate to drain). A submersible filtrate pump (tag 70-FRP-01) is used to pump filtrate from the sump back into the treatment process via the anoxic tank feed piping. Float-style level switches (tags 70-LS-01, 70-LS-02, and 70-LS-03) are used to automatically control the operation of the filtrate pump.

The sludge feed system is designed to require a manual start from the operator. The PLC and HMI will monitor the level in the sludge storage tank which will indicate to the operator that dewatering should proceed. The control system will not automatically initiate the dewatering operation. Once initiated by an operator, the waste sludge pump will feed sludge to the Geotube™ bag until one of the following conditions is met:

- The Geotube™ full bag sensor (tag 70-LS-04) is activated (indicating a full bag condition).
- The low level is reached in the sludge storage tank as measured by the tank level transmitter (70-LE/LT-01).
- The high-level float switch (tag 70-LS-03) is activated in the filtrate sump.
- The waste sludge pump leak detector is activated indicating the pump tubing is damaged and needs to be replaced.

If any of the four events listed above occur, the PLC will automatically stop the dewatering operation and an alarm will be sent out. The operator will have to address the cause of the alarm before the dewatering operation can be resumed. The PLC is programmed to require a manual input from the operator to resume dewatering after one of these four conditions has occurred.

The nature of the Geotube™ operation is that the bag will be filled and then allowed to drain. For this reason, it may be possible to add more sludge after a full bag condition has first been detected by 70-LS-04. After some time the bag will drain and free up some additional volume for further dewatering. When the bag is close to full it may require several manual restarts of the dewatering system due to full bag detection events.

4.6.4 Handling and Disposal of Dewatered Sludge

Once a Geotube™ bag has been completely filled and allowed to drain thoroughly, it must be removed from the treatment facility. The system has been designed so that the bags are filled in the bed of a hydraulic-actuated dump trailer which is normally parked in the dewatering room. When a bag is ready to be removed, the trailer can be hauled to an approved disposal site where the bag can be dumped. The trailer is then returned to the treatment facility and a new bag is placed.

Prior to removing the trailer and full Geotube™ bag from the dewatering room, the following steps must be taken:

1. Visually inspect the trailer and bag to ensure that all excess filtrate has drained from the bag and trailer.
2. Disconnect the feed hose on the top of the Geotube™ bag. Cap the bag fitting with the PVC cap provided with each bag. Further details can be found in the manufacturer's operation and maintenance manual.
3. Raise the full bag detection sensor out of the way to avoid obstruction with the trailer as it is removed from the dewatering room.
4. Follow any additional recommendations from the manufacturer for disposal of full Geotube™ bag.

After a full bag has been disposed, the trailer is to be returned to the dewatering room. The following steps must be taken prior to resuming dewatering operations after disposal of a full bag:

1. Place liner material and new Geotube™ in the dewatering trailer. Consult the manufacturer's operation and maintenance manual for additional details.
2. Reconnect waste sludge feed hose to Geotube™ bag. Consult the manufacturer's operation and maintenance manual for additional details.
3. Return full bag sensor to calibrated position.
4. Follow any additional recommendations from the manufacturer for placement of a new Geotube™ bag and resuming dewatering operations.

4.7 Alkalinity (Soda Ash) Chemical Addition

Under normal operation, chemical addition will be required for the biological system to supplement alkalinity. This will be accomplished by feeding dry sodium carbonate (commonly referred to as “soda ash”) into the RAS prior to entering the anoxic tank. Soda ash will be fed into the system using a bulk bag feeder and chemical educator system.

A sidestream flow of RAS will be drawn from the main line and pumped to the chemical eductor using a lobe-style educator feed pump (tag 90-EFP-01). Soda ash will be fed using the bulk bag feeder (tag 90-BBF-01). From the feeder, soda ash will be metered into a chemical hopper. The feeder is equipped with a variable frequency drive to allow for precise control of the amount of chemical being added to the process. The speed of the feeder and rate of chemical addition is controlled by the PLC and is based on the pH. An online pH sensor (tag 50-AE/AIT-02) monitors the system pH on the outlet of the aeration tank and feeds this information back to the PLC. The PLC can then make incremental changes to the chemical feed rate to maintain a specific pH setpoint. Generally, it is recommended to maintain a neutral pH (approximately 7.0) in the system at all times.

From the discharge of the educator feed pump, the RAS sidestream is pumped to a chemical educator (tag 90-ED-01) which draws chemical into the RAS flow. The flow of the liquid RAS through the throat of the educator creates suction on the injector port that pulls the chemical into the line. To aid with injection, a portion of the RAS flow from the educator feed pump can be directed to a small washdown hopper (tag 90-HOP-01). Dry chemical from the feeder is directed into the hopper to be mixed with the RAS before it is pulled into the educator unit positioned below the hopper. The flow of RAS to the hopper for mixing can be controlled by actuating a manual valve (tag 90-V-02) on the inlet line to the hopper. After the dry chemical is mixed in the hopper and pulled into the educator, the mixture passes through a static mixer (tag 90-MIX-01) installed in the educator discharge piping. The mixture of RAS and chemical is then injected back into the main RAS line before entering the anoxic tank.

The operator should consult the manufacturer’s operation and maintenance manual for additional details on the operation of all components of the alkalinity chemical system.

The bulk bag system will provide several days of chemical feed at design flow rate. The operator will be required to periodically change out the bulk bag to replenish the supply of dry chemical product. Bulk bags can be loaded into the feeder using the walk-behind electric fork lift unit. The operator should be completely familiar with the operation and control of the fork lift unit prior to attempting to load a bag into the feeder. The operator should consult the manufacturer’s operation and maintenance manual for further details on loading a bag in the feeder unit.

4.8 Effluent Systems

After passing through the biological treatment process, the permeate pumps (tags 55-PP-01 and 55-PP-2) draw treated permeate (effluent) from the membrane tanks. This treated effluent is directed to the ultraviolet (UV) disinfection system (tag 80-UV-01). Under normal operation the UV system operates passively. Treated effluent flows by gravity through the open channel and the submerged UV lights perform the disinfection. An outlet weir included with the UV system maintains a constant liquid level in the channel. The UV lights should remain submerged at all times when in operation and the outlet weir maintains a liquid level to meet this requirement.

The UV system includes a sensor to detect the intensity of the light output from the UV bulbs. On occasion, if the UV intensity declines, the bulbs may need to be replaced. For further details on the UV system, including instructions on maintenance and bulb replacement, the operators should consult the manufacturer's operation and maintenance manual.

If the UV system is to be down for short durations (i.e. 2 hours or less for maintenance), it is recommended to stop the flow of wastewater through the system. This can be accomplished by stopping the anoxic tank feed pumps and the permeate pumps. This will prevent the discharge of effluent from the system that has not been disinfected. If the UV system has to be shut down for a longer period of time, it can be bypassed by manually opening the UV bypass valve (tag 80-V-03) and manually closing the UV inlet valve (tag 80-V-01). The operators should make every effort to keep the UV system in operation whenever possible and minimize the down-time during maintenance or repair activities.

4.9 Non-Potable Water System

Due to the high quality of effluent produced by the membrane treatment system, it is suitable for use in the plant as a non-potable water source. A non-potable water system has been installed to store and pressurize this water for use in the plant. After the treated effluent discharges from the UV disinfection system, a portion of the flow can be directed to the non-potable water holding tank (tag 81-TK-01). A manual valve at the inlet to the holding tank (tag 81-V-01) can be opened to allow the tank to fill. The effluent discharge piping from the UV has been installed at an elevation that will not allow the non-potable water tank to overfill.

A pump and pressure tank provide the required pressure for the non-potable water to be used at various locations in the facility.

The non-potable water system has been plumbed to the following locations:

- Hose reels located in the new building expansion and the dewatering room.
- Make-up water for the polymer dosing system.

- Backwash water for the raw wastewater fine drum screen.
- Water supply to the citric acid tank (tag 91-TK-01) for chemical make-up

Because the system depends on treated effluent for the source water, the operators should be aware that if the treatment system is being bypassed, there is no source of non-potable water. If the system is bypassed then there may not be sufficient supply of non-potable water for the following operations:

- Membrane chemical cleaning.
- Sludge dewatering.
- Screen backwash.

For temporary purposes, the operators can transfer potable water to the non-potable water holding tank using a hose. Care must be taken to ensure the potable water source does not become contaminated during this operation.

4.10 Online Controls and Monitoring System

4.10.1 Overview

The treatment plant is monitored and controlled by programmable logic controller (PLC) systems. The operators should be aware that the GE membrane system and the sludge dewatering and polymer dosing skids are controlled by their own PLC and HMI systems which are separate from the general plant PLC. The sludge dewatering/polymer dosing PLC and HMI is discussed in the operation and maintenance manual from Bishop Water and the GE system is discussed further in the GE Operation and Maintenance Manual.

The following systems are controlled/monitored by the plant PLC and HMI:

- Raw sewage submersible pumps and level switches
- Automatic fine drum screen and backwash
- Screened sewage submersible pumps and level switches
- Anoxic tank feed pumps and flowmeter
- EQ tank instrumentation and aeration blowers
- UV disinfection system
- Alkalinity bulk bag feeder and educator feed pump
- Sludge storage tank instrumentation and aeration blowers

- Waste sludge pump and polymer dosing skid (monitoring only – control by Bishop Water PLC and HMI)
- Filtrate submersible pump and level switches

4.10.2 Operator Interface and HMI

The operators have access to the process PLC through the HMI (VT SCADA software) which is installed on a personal computer in the office/laboratory. The HMI displays various screens to the operator which provide critical information on the system operation and allows for some control inputs for various processes and equipment items (control of GE-supplied equipment must be handled through the GE control system and HMI).

The HMI screens for the process have been developed similar to a process flow diagram showing how the various unit processes are connected. Numerous instruments display instantaneous readings for flow, level, pH, etc. The screens also have visual indicators to show if certain equipment items have been called into operation. The HMI gives a good overview to the operator of what is happening in the system at any time. **The operators should make regular visual inspections of the equipment in operation. The operators should never rely solely on the computer to verify that the system is operating correctly.**

4.10.3 Control of GE-Supplied Membrane Equipment

All of the equipment supplied as part of the GE membrane process is controlled by the GE control system. Further details on this system can be found in the GE Operation and Maintenance Manual.

The following main equipment items are controlled/monitored by the GE control system.

- Anoxic tank instrumentation and aeration blowers
- Aeration tank instrumentation and aeration blowers
- Membrane tanks and scour blowers
- Permeate pumps and instrumentation
- RAS pumps
- WAS control valve
- Backpulse tank
- Membrane chemical cleaning systems

4.10.4 Control of Bishop Water Sludge Dewatering Equipment

A separate PLC and HMI system provides control of the sludge dewatering system. The general plant PLC is able to monitor this system but does not provide any control of the equipment. The HMI for the dewatering equipment is physically located on the polymer dosing skid near the sludge storage tank. This PLC will control the following equipment:

- Polymer dosing pump (Tag 70-PFP-01) and instrumentation
- Polymer make-up water inlet solenoid valve (Tag 70-V-17)
- Waste sludge pump (Tag 70-WSP-01) and instrumentation

4.10.5 Data Logging and Trending

The computer has the capability to log data and display historical trends through special screens in the VT SCADA HMI. Data that are logged from various instruments such as tank level, flow rate, etc., can be viewed with customizable displays and data ranges.

4.10.6 Plant Alarms and Dial-Out System

There are three (3) separate control systems that will monitor and control the treatment facility: the plant PLC, the GE PLC, and the building management system. All three of these control systems will monitor specific parameters and will generate alarms when a parameter falls outside of the acceptable range. An example would be if a tank level reaches the high level set-point, an alarm would be generated.

There are two levels of alarms identified as critical alarms and general alarms. **Critical alarms require the immediate attention of an operator to correct a problem. These alarms indicate that there is a problem with the process or the facility that could have serious consequences if action is not taken.** General alarms still require the attention of an operator but are not as urgent as critical alarms. General alarm conditions can elevate to critical alarm status if they are not eventually dealt with and corrected but the operator will have more time to deal with a general alarm before any serious problems arise.

All critical alarms will be communicated to the operator(s) through a dial-out system. This will allow an operator to be remotely alerted that there is a critical alarm condition at the plant and immediate attention is required. It is recommended that the operators work on a rotating schedule that will always have one person on-call at all times to be the first responder to critical alarms during

normal non-working hours. The auto-dialer will not identify the exact details of the alarm but will simply indicate that a critical alarm has been triggered. For any critical alarm that is generated, the on-call operator is expected to go to the treatment plant immediately to respond to the alarm. Further details on the exact cause of the alarm will be available from the plant computer. General alarms will not be sent out remotely through the dial-out system but will be indicated on the computer.

The following is a list of critical alarms that could be generated and require the operator's immediate attention:

- Low building temperature
- Hazardous gas accumulation
- High level in EQ Tank
- High level in Screened Sewage Sump
- VFD fault on bulk bag feeder
- Sludge Pump leak detector tripped
- GE Callout Alarm (see GE O&M Manual for more details)

4.11 Preventive Maintenance

Preventive maintenance of equipment at the Pangnirtung WWTF is important to allow equipment to operate properly over its expected life cycle. Preventive maintenance also enables equipment to operate as close as possible to best efficiency points to optimize energy consumption. A number of tasks are included in the regular preventive maintenance and the specific requirements will vary for each piece of equipment. The operators should consult the Operation and Maintenance Manuals provided for each piece of equipment for recommended preventive maintenance tasks and frequencies. The membrane system also has specific preventive maintenance requirements which are provided in the GE Operation and Maintenance Manual.

The operators are expected to be familiar with the maintenance requirements for each piece of equipment. It would be recommended for plant management to develop a preventive maintenance schedule for the equipment based on the information provided in the manufacturer-supplied manuals. It would also be recommended for the operators to maintain a maintenance log for each piece of equipment. This log should include as a minimum, the equipment name, equipment tag, date and time of completed maintenance or repairs, details on parts or materials required for the maintenance task, and the operator/technician who completed the service.

Some common tasks required for preventive maintenance are as follows (consult manufacturer manuals for complete details):

- Checking equipment alignment.
- Regular replenishment or replacement of all lubricants including oils and greases. In some cases this may require flushing of the old lubrication material.
- Replacement of specific wear parts.
- Checking belt tightness.

Although not specifically listed in many preventive maintenance programs, keeping equipment clean and free of debris will help avoid potential operating issues. Many mechanical/electrical equipment items rely on free air movement around the unit for cooling and debris or dirt build-up can lead to overheating and premature failure.

Some additional good practices for equipment preventive maintenance are as follows:

- The operators should be in the habit of making at least one walk-through of the facility on a daily basis. Visual inspection of the equipment in operation is

the best way to detect potential issues. Anytime an operator is in the facility, he or she should be on the lookout for potential issues. It is possible that issues may be detected by seeing, hearing, or even smelling something that is not normal.

- The facility should have a sufficiently stocked and well organized supply of spare parts and consumable products required for maintenance and repairs. The equipment manuals provided by the manufacturers should help identify common spare parts and consumables. Given the remote location of this facility, it is even more critical than most facilities to have these items on hand at all times. If the operators are unsure of quantities to have on hand, it is recommended to contact the manufacturer for assistance. It would be good practice at this facility to have a minimum supply to last one full year of operation.

5 Testing and Monitoring

5.1 Introduction

The Pangnirtung WWTF is a complex treatment process that is capable of generating a high quality of effluent if properly operated and maintained. A critical part of operating the treatment process is careful monitoring of the system. It is important to remember that the heart of the treatment system is a biological treatment process utilizing living organisms to degrade the wastewater contaminants. These living organisms require specific operating conditions to allow them to thrive and provide a consistent level of treatment. Careful monitoring, sampling, and testing will provide the operator with the information to assess the system performance and overall health of the biological process.

5.2 Sampling

As part of the plant operation, a number of laboratory test procedures will be performed on a regular basis. This testing will be done on samples collected at various points throughout the system. Correct sampling procedures are critical for laboratory testing. Proper techniques will help to ensure that the collected samples accurately reflect the actual process conditions within the system.

At the Pangnirtung WWTF, all samples will be grab samples collected by the operator (i.e., there are no automatic composite samplers installed). The following techniques should be used whenever grab samples are collected:

- If the sample is being collected from a tank or sump, the sample should be collected from a location where there is good mixing and the sample will be representative. The sample should not be skimmed from the surface, taken very close to the bottom, or near any sidewalls. The sample should be taken from a middle zone if possible where there is good mixing and the geometry of the tank/sump and any equipment within will not affect the quality of the sample.
- If the sample is taken from a sample tap from a tank or pipe, care should be taken to flush the sample line. The operator should open the sample valve to flush the contents of the sample line into a container. This material should be disposed of or returned to the process if possible. Immediately after flushing the line, the operator should collect the appropriate volume of sample in a separate container. The volume to be flushed prior to sampling will depend on the size of the line and distance between the sample valve and the main line/tank. Ideally, the entire volume of this sample line should be flushed to ensure the collected sample is fresh and representative.
- As much as possible, samples collected for testing should be tested immediately or as soon as practical after collecting the sample. If unforeseen circumstances require the operator's attention elsewhere and the sample sits for more than 15 minutes, a fresh sample should be taken.

- Samples should always be collected in clean, dry containers. Containers should be cleaned after each use.

5.3 Laboratory Testing

Laboratory testing for the Pangnirtung WWTF will consist of both in-house testing completed by the operator and external testing for regulatory purposes. The following sections provide some general guidelines for testing and analysis.

5.3.1 In-House Testing for Process Monitoring

In-house laboratory testing will be conducted strictly for monitoring the process performance. Any testing required for regulatory purposes is described under the section 5.3.2 – External Testing for Regulatory Purposes.

In order to effectively monitor the treatment performance, samples should be taken at several key points in the system. Depending on the location of the sample, specific analytical tests are recommended. A general overview of the lab testing is provided in the following sections. More detailed procedures can be found the appropriate Appendices.

5.3.1.1 Suspended Solids

The suspended solids test is a key measurement within a wastewater treatment facility. If this parameter is analyzed for both influent and effluent, it is possible to determine treatment performance based on percentage removal of suspended solids. If this test is performed on the mixed liquor in the biological zones it is possible to estimate the amount of biomass that is in the system. This is a critical parameter for controlling SRT and maintaining stable operation of the system.

The recommended method for this testing results in both a Total Suspended Solids (TSS) measurement as well as a Volatile Suspended Solids (VSS) measurement. When performed on the mixed liquor these results are commonly referred to as Mixed Liquor Suspended Solids (MLSS) and Mixed Liquor Volatile Suspended Solids (MLVSS). Essentially this test is completed by filtering the sample through a specific filter paper. The material that is trapped on the filter paper is then heated to a temperature of 103°C to ensure all moisture is removed from the material. The weight of the material remaining on the filter paper after this process, divided by the original filtered volume, gives the TSS concentration in mg/L. If this sample is further heated to 550°C, all of the volatile material will be removed from the sample. By comparing the measured mass before and after, it is possible to determine the mass of volatile material that has been removed by this procedure. Dividing this mass differential by the original filtered volume results in determining

the VSS concentration of the sample. The VSS concentration is commonly used to approximate the concentration of the organic material in the sample.

Additional information on solids in wastewater including the specific procedure for TSS and VSS testing has been included in Appendix C (excerpt from *Standard Methods for the Examination of Water & Wastewater, 21st Edition, 2005*).

5.3.1.2 HACH Test Kits and Spectrophotometer

A number of the analytical tests that will be addressed in the following sections are based on the use of HACH brand test kits which are analyzed on a DR3900 spectrophotometer. The methods are simplified versions of Standard Methods and the kits provide all of the reagents required to perform the analysis. The methods follow clearly defined procedures and are based on colorimetric methods. The degree of color change represents the concentration for a particular parameter. The degree of color change is then measured using the spectrophotometer. A copy of the user manual for the DR3900 unit has been included in Appendix D of this manual. The specific test procedures for the various parameters have been provided in Appendix E. The following sections provide some general information about the various parameters that will be tested using these methods.

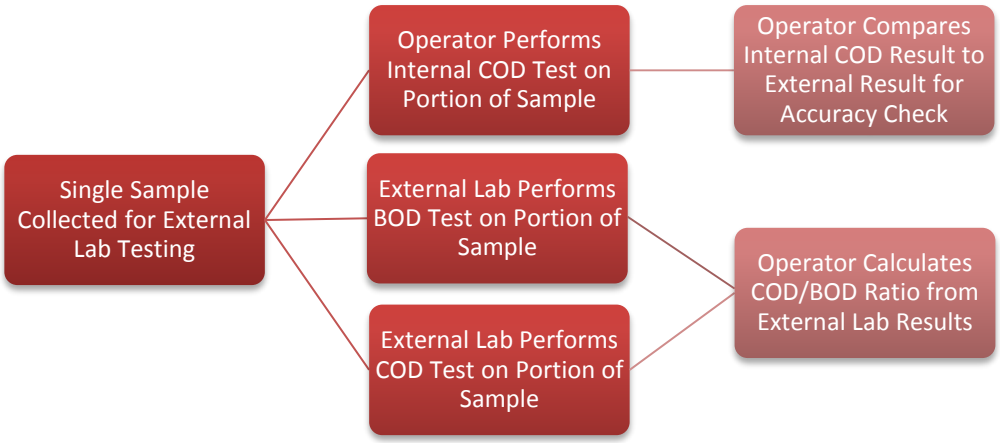
5.3.1.3 Chemical Oxygen Demand

Many plant operators are familiar with Biochemical Oxygen Demand (BOD) and most plants are required to monitor this for regulatory purposes (see section 5.3.2). However, the major downfall of the BOD test is that it requires 5 days of incubation before test results are known. This length of time is not acceptable from a process monitoring perspective or if system troubleshooting is required. An alternate method is to test for Chemical Oxygen Demand (COD) for internal testing and monitoring. This test requires samples to be added to pre-filled chemical vials followed by a heated reaction period. Typically, COD test results are known within 2-3 hours of taking the sample.

BOD and COD are both measurements of the oxygen demanding contaminants in the wastewater. BOD specifically is a measure of the amount of material in the wastewater that can be oxidized biologically. Commonly this is thought to be an approximation of the amount of “food” in the wastewater that can be taken up by the bacteria in the system. COD is a measure of all of the material that can be oxidized by chemical means. It should be noted that COD includes all of the oxygen demanding material measured by the BOD test. COD test results should always be higher than BOD for the same sample.

For the Pangnirtung WWTF, it is recommended that COD be tested in-house due to the performance-monitoring advantages afforded by the much shorter test duration. However, regular samples will be required to be sent away for external BOD testing for regulatory purposes. It is recommended that when a sample is

collected for external testing, the operator request both BOD and COD be performed by the external laboratory. The operator should also keep some of this same sample for internal COD testing. This method will allow for development of a COD:BOD ratio to be developed over time from the external lab test results. It will also allow an operator to compare his/her COD test results with the external lab's COD results for accuracy checks. The following diagram illustrates the strategy for COD testing when external samples are collected.



In-house COD testing will be performed using HACH colorimetric method 8000 and analyzed with the DR3900 unit. The specific test procedure has been included in Appendix E of this manual.

5.3.1.4 Nitrogen

In order to meet the national performance standards, the Pangnirtung WWTF is required to nitrify for removal of ammonia. The plant has been specifically designed to promote the growth of nitrifying bacteria which reduce ammonia by conversion to nitrate in the presence of sufficient dissolved oxygen. The laboratory at the treatment facility is equipped to measure both Total Kjeldahl Nitrogen (TKN) and ammonia-nitrogen (NH_3-N). In-house testing procedures for these parameters are based on HACH colorimetric method 10242 for TKN and 10205 for ammonia-nitrogen. The specific test procedures have been included in Appendix E of this manual.

5.3.1.5 Phosphorous

Phosphorous is not a parameter that the plant currently has to treat for from an effluent discharge perspective. However, phosphorous is a parameter of interest for process performance and monitoring as it is a key nutrient required by the bacteria for biological treatment. Given the atypical nature of the wastewater being treated at this facility, it is recommended to implement regular phosphorous testing

for the screened wastewater and the final effluent. By comparing the differential in these measurements, it is possible to estimate the amount of phosphorous being taken up by the bacteria for cell growth and development. In-house testing for total phosphorous (TP) is based on HACH colorimetric method 10242. The specific test procedures have been included in Appendix E of this manual.

5.3.1.6 Test Ranges and Sample Dilution

All of the tests performed with the use of the HACH test kits will have an acceptable range. During the final test analysis, the DR3900 will indicate if the tested sample is out of range. The operator should be familiar with the operating manual for the DR3900 unit and be able to recognize a test that is out of range. If the actual measured concentration is lower than this range then the test cannot be performed with that particular test kit. Often a low range version of the test kit can be purchased if this situation should present itself. If the actual measured result is higher than the range, a new test should be performed with a diluted sample.

After a period of time, the operator will gain a level of experience that should allow them to have a reasonable expectation of the test result. During initial operation, it may take multiple trials before a result is found to be in-range.

Dilution of a sample involves adding water to the original sample to reduce the concentration. **Only distilled or de-ionized water should be added for dilution and tap water should never be used.** The particular test is then carried out on the diluted sample to get a reading from the DR3900. This measurement must then be multiplied by the dilution factor to determine the actual measurement for the original, undiluted sample. An example of a test and setup for the dilution is as follows:

<u>Dilution Example:</u>

Assume a sample of raw wastewater is being tested for TKN concentration. The lab is equipped with a TKN test kit with a range of 0-16 mg/L. Suppose the operator thinks the actual TKN of the sample will be closer to 30 mg/L, which is outside of the range. The sample must be diluted in order to get a measurement.

<u>Recommended Approach:</u>

1. If the sample above is diluted to a third of its original concentration, it would likely fall within the range for the test (30 mg/L ÷ 3 = 10 mg/L estimated). This would be commonly referred to as a 2-to-1 dilution as it requires 2 parts of de-ionized water to be added to 1 part of original sample. The operator should be aware of how much sample is required for the test vial. It is recommended to prepare more than the required amount. Assume that the TKN test requires 1.3 mL of diluted sample for the test vial. For this example, 30 mL of diluted sample will be prepared.

2. The diluted sample should always be prepared in a separate container or beaker and should never be done in the actual test vial. Diluted sample can be transferred from the beaker to the test vial after the dilution has been completed.
3. To prepare 30 mL of diluted sample, the operator will require 1 part sample out of a total of 3 parts. In this case, the operator would add 10 mL of sample to a clean beaker (30 mL ÷ 3 parts). The operator would then add 20 mL of de-ionized water to give a total of 30 mL of diluted sample. Dilution volumes do not need to be exact so long as the volume of sample added and the total volume (sample plus water) are recorded.
4. The operator would then transfer the 1.3 mL of diluted sample required from the beaker to the test vial. The remainder of the test can be carried out in accordance with the specific procedure for TKN.
5. At the end of the test, the diluted sample is analyzed for TKN concentration using the DR3900 unit.
6. Assume for this example, that the DR3900 returns a result of 9.6 mg/L of TKN for the diluted sample. The operator must calculate the concentration of the original sample from the DR3900 reading and the recorded dilution ratio from step 3 as follows:

   DR3900 Reading for Diluted Sample = 9.6 mg/L

   Dilution Ratio from Step 3 = 30 mL (total volume) ÷ 10 mL (sample volume)

   = 3

   Calculated TKN of Original Sample = 9.6 mg/L x 3 = <u>28.8 mg/L</u>

   A value of 28.8 mg/L should be recorded as the final measured TKN concentration for this sample.

5.3.1.7 pH and Dissolved Oxygen

The Pangnirtung WWTF laboratory has been equipped with a HACH model HQ40d portable meter capable of measuring both the pH and dissolved oxygen (DO) of a sample. Both of these parameters are critical for stable operation of the treatment plant. Both are also measured continuously with online instrumentation at various points in the system which are connected to the plant PLC and displayed on the HMI. The main purpose of field testing for these parameters is to verify the accuracy of the online instrumentation at critical points in the system. Also, during troubleshooting, this meter will be able to provide additional readings at other points that do not have online instrumentation. The operating manual for the HQ40d has been included in Appendix F along with specific test procedures.

5.3.1.8 UV Transmittance

UV disinfection works by passing ultraviolet light through a liquid to deactivate pathogens. It is possible, however, for contaminants in the water to block the passage of UV light. UV transmittance is a measurement of the percentage of the light that passes through the sample. A higher percentage means more light passes through the sample which is better from a performance perspective. The UV disinfection system at the Pangnirtung WWTF has been designed to disinfect water with a UVT greater than 65%. The operator should perform regular UVT testing on the effluent to verify that the UVT is not less than this minimum requirement. Under normal operation, the membranes will produce a very high quality of effluent and UVT values should be much higher than this minimum threshold. If UVT values drop and begin to approach the minimum threshold, this is likely a sign that something is wrong with the treatment system and further investigation should be done to find the source of the problem. Excess suspended solids in the effluent can commonly be the cause of low UVT. With the membrane system this would only be possible if the membranes become damaged or if there is a bypass that is allowing solids to escape in the effluent.

A Realtech brand portable UV Transmittance (UVT) photometer has been included in the laboratory equipment for the Pangnirtung WWTF. The meter contains all required materials needed to perform the UVT test. A single result is given as the percent UVT. The operating instructions for this device are printed on the inside of the case.

5.3.1.9 Recommended Testing Schedule

It is recommended to follow a regular weekly schedule for internal laboratory testing as much as possible. During initial start-up and commissioning, or during periods of reduced treatment performance, it may be necessary to test at an increased frequency or sample from additional locations for troubleshooting purposes. In addition to laboratory testing, a number of parameters from various instruments should be recorded on a regular basis. A weekly testing and monitoring log has been prepared to assist the operators with completing this work. The log sheet lays out the schedule for all parameters as to when they should be tested and/or recorded. Days in the log where a parameter is not required to be tested and/or recorded have been crossed out. The operators should strive to complete the log sheet as much as possible each day. A copy of the log sheet has been included in Appendix H.

5.3.1.10 Additional Membrane Specific Testing

Additional testing and monitoring will be required that is specific to the MBR process and the performance of the membranes. Further details have been provided in the GE Operation and Maintenance Manual included.

5.3.1.11 Additional Laboratory Considerations

In addition to the specific laboratory procedures referenced above and in the Appendices, the following general guidelines are recommended:

- Some of the testing procedures will require weighing samples on electronic balances. These balances should be maintained clean at all times to provide the most accurate measurement. It may take several seconds for a reading to stabilize after a sample is placed on the balance. The operator should also ensure the balance is zeroed before taking any measurements.
- Several of the procedures will require transferring precise quantities of liquid from one container to another (e.g. transferring sample to a test vial for analysis). This is generally accomplished with a pipet that is capable of transferring exact quantities of liquid. The pipet should be operated in such a manner that sample is slowly drawn into the tip. If this is done too quickly, liquid can be drawn into the body of the pipet (potentially causing damage) and it can also affect the accuracy of the transfer volume.
- The operator should be aware that the specific test procedures may include some sample preparation. For some tests, this preparation may include mixing/blending of the sample to produce a homogeneous mixture.

5.3.2 External Testing for Regulatory Purposes

External testing will be required to satisfy the conditions of the operating permit as issued by the Nunavut Water Board. The specific conditions, with respect to measured parameters and frequency of sampling and testing, will all be identified in the permit. An external accredited laboratory approved by the Nunavut Water Board must be engaged to do the testing. It is the responsibility of the operator to ensure that sampling and delivery is done in accordance with the permit and the requirements of the external laboratory. The operator should consult the external laboratory to determine if any special provisions must be made for proper sample preparation and storage during transportation.

5.3.3 Laboratory Data Error Checking

The operators are encouraged to pay close attention to external lab test results and check data for potential errors. It is not uncommon to find errors in lab data. As indicated in the sections above, there may be some instances where the operator and the external lab have performed the same test on the same sample. If there are discrepancies in the two results, the operators should not necessarily conclude that they are the ones who have made the error. If the operators are unsure, or if there are potential errors in the external lab data, it is recommended to contact the lab and discuss the results. The operators should ask the lab about their specific procedures and try to determine what may have caused the error.

The operators are also encouraged to think about results of in-house lab testing to verify that the results make sense. The following is a list of potential results that should signal to the operator that something is wrong:

1. A VSS measurement should always be less than the TSS measurement for the same sample. Often mistakes are made during the calculation step for these results rather than the analysis procedure.
2. The measured ammonia-nitrogen (NH_3-N) concentration should always be less than the measured TKN concentration for the same sample.
3. The measured BOD should always be less than the measured COD for the same sample.
4. In general, the operators should expect to see fairly consistent lab results from day-to-day for most samples. The operators should be skeptical of data that shows a drastic change from one test to the next. While this is possible in some cases due to changing conditions, it should at least prompt them to have a closer look at the results and try to determine if errors were made.

5.4 Record Keeping

5.4.1 General

Any data that is generated as a result of the testing and monitoring of the facility should be recorded and maintained in a database. This includes hard copies of data and worksheets as well as electronic spreadsheets with key operational data. This data will provide valuable information to the operators and any other person who is reviewing or troubleshooting the plant in the future.

5.4.2 Testing Data Collection and Management

Recording of all external laboratory testing for regulatory purposes will be in accordance with the operating permit for the facility as issued by the Nunavut Water Board. The operators will be responsible for maintaining a record of all external lab testing in accordance with the permit.

In addition to the requirements set forth in the permit, it is recommended to maintain an organized log of testing results performed internally by the operators. Performing the testing will require recording sample volumes, masses, dilutions, instrument readings, and some intermediate calculations. A sample worksheet has been included in Appendix G of this manual. The operators are encouraged to make copies as needed of this sheet to use for recording lab test data and notes. Data sheets should be maintained in chronological order by date in a binder.

5.4.3 Use of Electronic Spreadsheets

Final results from all lab testing, both internal and external, should be recorded electronically in a spreadsheet. An electronic spreadsheet created in Microsoft Excel format has been provided by **exp** which allows for input of key data. Electronic data is critical for plant monitoring and troubleshooting as it allows for quick review of large quantities of data as well as the easy generation of trend charts.

All test data generated should be recorded as an entry in the electronic data in the spreadsheet.

5.5 Quality Assurance/Quality Control Plan

A copy of the Quality Assurance (QA)/Quality Control (QC) Plan for the Pangnirtung Wastewater Treatment Facility has been included in Appendix I. The document contains important details on the requirements for sampling, testing, and reporting for compliance purposes. The document also contains a copy of the water license for the Hamlet.

6 Common Wastewater Calculations

6.1 Units and Conversions

In general, all calculations and reported data should be done using the International System of Units (also known as SI units and commonly referred to as the metric system). All of the plant instrumentation and data logging, laboratory analysis equipment, and laboratory test procedures are based on the SI system of units. If any measurements are made in non-SI units, these units should be converted to SI prior to completing any calculations and for reporting purposes. Further information on the SI system of units including common conversion factors has been included in Appendix J.

6.2 General Calculations for System Monitoring

As part of the normal plant operation, monitoring, and laboratory testing, a number of calculations will need to be performed. The following sections provide some information on common calculations that will be required. Additional information on calculations can be found in Section 13 of the GE Operation and Maintenance Manual.

6.2.1 General Mass Loading Rate

In wastewater treatment systems, it is very common to see data reported as flow rates and parameter concentrations. For example, it would be common to see the daily flow reported in units of m^3/d and the influent COD concentration reported in units of mg/L. However, it may also be useful to determine the total mass of COD in the influent for that day in units of kg/d. An example calculation is shown as follows:

Measured Data:

- Daily influent flow rate = 1000 m^3/d
- Measured influent COD concentration = 250 mg/L

Calculation Steps:

1. Units of mg/L are equivalent to g/m^3. Therefore 250 mg/L = 250 g/m^3
2. Multiply the flow rate by the concentration:

   1000 m^3/d x 250 g/m^3 = 250,000 g/d
3. Convert to units of kg/d:

   250,000 g/d ÷ 1000 g/kg = <u>250 kg/d</u>

6.2.2 Organic Loading Rate (OLR)

The organic loading rate is a measure of the mass of organic material being applied to a particular process on unit-volume basis. The final result of this calculation will be in units of kg/m³·d. The measurement can be based on BOD or COD mass loading. In this case, COD loading is used in the following example calculation:

Measured/Known Data:

- Daily influent flow rate = 1000 m³/d
- Measured influent COD concentration = 250 mg/L
- Volume of Aeration Tank = 200 m³/d

Calculation Steps:

1. Calculate COD loading rate as shown in section 6.2.1 above:

   Calculated COD Loading Rate = 250 kg/d

2. Divide the loading rate by the known aeration tank volume:

   250 kg/d ÷ 200 m³/d = 1.25 kg/m³·d

   Note this can also be reported as 1.25 kg COD/m³·d

The calculation steps shown above are identical for a BOD-based OLR calculation. The only difference is that the calculation would substitute a measured BOD concentration in place of the measured COD value used here.

6.2.3 Hydraulic Retention Time (HRT)

Hydraulic retention time is a measure of the average time it takes for water to flow through a tank or vessel. In order to perform this calculation, measured flow rates must be known along with the volume of the tank. The result of the calculation is a time value typically reported in units of hours. An example calculation is shown below:

Measured/Known Data:

- Aeration Tank Volume = 200 m³
- Daily Influent Flow Rate = 1000 m³/d
- RAS Flow to Aeration Tank = 1200 m³/d

Calculation Steps:

1. Calculate total flow into tank from all sources (in this case the total flow is the sum of the influent and RAS flow rates):

   Total Flow = 1000 m^3/d + 1200 m^3/d = 2200 m^3/d

2. Divide the known tank volume by the total flow rate:

   200 m^3 ÷ 2200 m^3/d = 0.091 days

3. Convert the result from days to hours:

   0.091 days x 24 hours/day = 2.2 hours

Note that in the above calculation the measured tank effluent flow rate may also be known. If an effluent flow meter was installed on the tank effluent pipe, it would have recorded a daily flow equal to 2200 m^3/d. This value could have been used directly in step 2 of the calculation. The main point is to ensure that the calculation is based on the total flow rate passing through the tank which may be measured by different means depending on the specific tank.

6.2.4 Solids Retention Time (SRT)

Solids retention time (SRT) is not determined by the operator from a calculation but it is included in this section for reference. SRT is essentially the average time it takes a solid particle to pass through a specific process. It is common to have a plant operate at a target SRT set by the process designer. SRT is a parameter measured in units of time (typically as days or hours). SRT is a critical parameter and, as shown in the following section, it helps determine the required volume of sludge that should be wasted from the system.

6.2.5 Required WAS Volume

Most operators are keenly aware of the need to waste biological sludge from the treatment system. This material, referred to as waste activated sludge (WAS) is a key parameter that the operators must have control of. As biological treatment takes place, the bacteria produce new cells which adds to the suspended solids concentration in the reactors. It is commonly known that wasting sludge must be done to maintain the MLSS concentration in the target range. However, it is also important to ensure the plant is operating close to the target SRT. This calculation brings additional factors into focus including the total mass of bacteria (commonly referred to as biomass) within the system. MLSS, biomass, and daily sludge wasting are all related by the SRT parameter. Operating at the target SRT and MLSS helps to maintain sufficient biomass in the system for stable biological treatment. Typically, both the target MLSS concentration and SRT are set by the process designer. This information coupled with measured MLSS data for the

waste sludge material allows the operators to calculate both the mass and volume of waste sludge on a daily basis.

Measured/Known Data:

- Target SRT = 5 days
- Target MLSS in Biological Process = 8000 mg/L
- Aeration Tank Volume = 200 m³
- Pre-Anoxic Tank Volume = 100 m³
- Measured MLSS of WAS = 12,000 mg/L

Calculation Steps:

1. The daily mass of waste sludge (WAS) and total MLSS mass are related by the SRT based on the following formula:

   $$SRT\ (days) = \frac{Total\ Mass\ of\ MLSS\ in\ Biological\ System}{Total\ Daily\ Mass\ of\ WAS}$$

2. Calculate the total volume of the biological system:

   Total Volume = 200 m³ + 100 m³ = 300 m³

3. Calculate the target mass of MLSS in the system using the total volume and the target MLSS concentration:

   8000 mg/L = 8000 g/m³

   8000 g/m³ x 300 m³ = 2,400,000 g of MLSS in the system

   2,400,000 g = 2400 kg MLSS

4. Calculate the mass of WAS to be removed from the system by rearranging the general SRT formula shown above. Divide the total mass of MLSS in the system by the target SRT:

   Total mass of MLSS in system = 2400 kg

   2400 kg ÷ 5 days = 480 kg/d to be removed as WAS

5. Calculate the daily volume of WAS to be removed based on the measured WAS concentration:

   Measured WAS concentration = 12,000 mg/L = 12,000 g/m³

   480 kg/d x 1000 g/kg = 480,000 g/d

   480,000 g/d ÷ 12,000 g/m³ = <u>40 m³/d</u>

The above calculation can be used to provide the operators with an estimate of the target WAS volume that must be removed from the system to maintain both the

target MLSS and SRT for the process. The calculation steps assume the system is already operating close to the target MLSS value. If the actual measured MLSS is higher than the target, then the wasting volume will have to be set somewhat higher than the calculated WAS volume. If the actual measured MLSS is lower than the target, then the wasting volume will have to somewhat lower than the calculated volume. This calculation should be used to give the operators an initial estimate as to the amount of sludge to waste. Adjustments will need to be made based on the operators' experience with the system and actual MLSS conditions. The better this relationship can be controlled, the more stable the process will be in operation.

6.3 Calculations for Membrane System

The membrane system may require the operators to perform specific calculations as part of the regular checks and monitoring of the system. Details on these calculations have been provided in Section 13 of the GE Operation and Maintenance Manual.

6.4 Calculations for Laboratory Testing Analysis

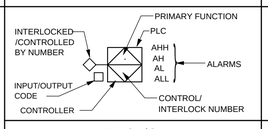
Some calculations may be required as part of the laboratory analysis. Generally these are intermediate calculations that are required to arrive at the final result. Additional details on these calculations can be found in the specific laboratory test procedures in the Appendices of this manual.

Appendix A – Process Flow Diagram and P&ID Drawings

ABBREVIATIONS

AA -	ANALYSIS ALARM
AAE -	AUTOMATIC AIR ELIMINATOR
AAIR -	ANALYSIS ALARM INDICATING RECORDER
AAV -	AUTOMATIC AIR VENT
AB -	AERATION BLOWER
AC -	ANALYSIS CONTROL OR AIR COMPRESSION
ACS -	AUTOMATIC COARSE SCREEN
AD -	AIR DRYER
ADE -	ANAEROBIC DIGESTER EFFLUENT
ADG -	ANAEROBIC DIGESTER GAS
ADR -	ANAEROBIC DIGESTER RECYCLE
ADRP -	ANAEROBIC DIGESTER RECYCLE PUMP
AE -	ANALYSIS ELEMENT
AF -	AIR FILTER
AFP -	ALUM FEED PUMP
AHLR -	ALARM HIGH/LOW RECORDING
AH -	ALARM HIGH
AHH -	ALARM HIGH/HIGH
AI -	ANALYSIS INDICATOR
AIR -	AIR
AIT -	ANALYSIS INDICATING TRANSMITTER
AL -	ALARM LOW
ALL -	ALARM LOW/LOW
AM -	AUGER MOTOR
AMS -	ALKALINITY METERING SYSTEM
AnMBR -	ANAEROBIC MEMBRANE BIOREACTOR
AOV -	AIR OPERATED VALVE
AR -	ANALYSIS RECORDER
ARI -	ANALYSIS RECORDER/INDICATOR OR ANAEROBIC REACTOR INFLUENT
ART -	AIR RECEIVER TANK
ARVB -	AIR RELIEF AND VACUUM BREAKER
AS -	AUTOMATIC SAMPLER
BB -	BIOGAS BLOWER
BC -	BELT CONVEYOR
BF -	BACK FLUSH
BFP -	BIOLOGICAL FEED PUMP
BG -	BIOGAS
BP -	BYPASS
BPV -	BACK PRESSURE VALVE
BS -	BAR SCREEN OR BASKET STRAINER
BSP -	BUILDING SUMP PUMP
BSV -	BLOCKING SAFETY VALVE
BVF -	BULK VOLUME FERMENTER
BWP -	BOOSTER WATER PUMP
CA -	COMPRESSED AIR
CAD -	COMPRESSED AIR DRYER
CBP -	CHEMICAL CLEANING WATER BOOSTER PUMP
CC -	CALIBRATION COLUMN
CD -	CONDENSATE DRAIN
CF -	COOLING FAN OR CHEMICAL FEED
CFP -	CHEMICAL FEED PUMP
CPF -	CHEMICAL POT FEEDER
CS -	CONTROL STATION
CV -	CONTROL VALVE
DBC -	DISTRIBUTION BELT CONVEYOR
DCS -	DISTRIBUTED CONTROL SYSTEM
DFB -	DUAL FUEL BOILER
DFO -	DROP FEED OILER
DFP -	DEFOAMER METERING PUMP
DO -	DISSOLVED OXYGEN
DP -	DEWATERING PRESS OR DILUTE POLYMER
DPG -	DIFFERENTIAL PRESSURE GAUGE OR DIGITAL PRESSURE GAUGE
DR -	DRAIN
DS -	DRAIN SUMP
DSP -	DRAIN SUMP PUMP
DT -	DRIP TRAP
ED -	EDUCTOR
EFF -	EFFLUENT
EFP -	EDUCTOR FEED PUMP
EJ -	EXPANSION JOINT
EOF -	EMERGENCY OVERFLOW
EP -	EFFLUENT PUMP
ETK -	EXPANSION TANK
FA -	FLOW ALARM
FAL -	FLOW ALARM LOW
FC -	FLOW CONTROLLER OR FLAME CHECK OR FLUSH CONNECTION
FCP -	FLARE CONTROL PANEL OR FERRIC CHLORIDE PUMP
FCV -	FLOW CONTROL VALVE
FD -	FLOOR DRAIN
FDS -	FINE DRUM SCREEN
FE -	FLOW ELEMENT
FI -	FLOW INDICATOR
FIT -	FLOW INDICATING TRANSMITTER
FL -	FLARE
FLV -	FLOAT VALVE
FM -	FLOWMETER
FQI -	FLOW QUANTITY INDICATOR
FQR -	FLOW QUANTITY RECORDER
FQRI -	FLOW QUANTITY RECORDER/INDICATOR
FS -	FERMENTER SLUDGE OR FINE SCREEN
FTA -	FLAME TRAP ASSEMBLY
FV -	FILL VALVE OR FOOT VALVE
FW -	FLUSH WATER
GEC -	GAS ELIMINATION CHAMBER
GG -	GAUGE GUARD
GR -	GRINDER
GV&B -	GATE VALVE & BOX
H -	HORN
HB -	HOSE BIBB
HOP -	HOPPER
HP -	HEATING PUMP
HS -	HAND SWITCH
HSFA -	HIGH SPEED FLOATING AERATOR
HX -	HEAT EXCHANGER
IC -	CURRENT CONTROLLER
INF -	INFLUENT
INJ -	VENTURI INJECTOR
IP -	INFLUENT PUMP
IT -	CURRENT TRANSMITTER
IV -	INJECTION VALVE
JRC -	JET RECIRCULATION
JRP -	JET RECIRCULATION PUMP
KC -	TIMER CONTROLLER
LA -	LEVEL ALARM
LAH -	LEVEL ALARM HIGH
LAL -	LEVEL ALARM LOW
LAHL -	LEVEL ALARM HIGH/LOW
LARI -	LEVEL ALARM RECORDER INDICATOR
LC -	LEVEL CONTROLLER
LCP -	LOCAL CONTROL PANEL
LE -	LEVEL ELEMENT
LI -	LEVEL INDICATOR
LIT -	LEVEL INDICATING TRANSMITTER
LR -	LEVEL RECORDER
LPS -	LADDER PIPE SUPPORT
LRI -	LEVEL RECORDER/INDICATOR
LS -	LEVEL SWITCH
LSC -	LEVEL SWITCH CLOSED
LSH -	LEVEL SWITCH HIGH
LSL -	LEVEL SWITCH LOW
MBR -	MEMBRANE BIOREACTOR
MCV -	MODULATING CONTROL VALVE
MFP -	MEMBRANE BIOREACTOR FEED PUMP
MPV -	MULTI-PUNCTURE VALVE
MH -	MAGNESIUM HYDROXIDE
MHP -	MAGNESIUM HYDROXIDE PUMP
MIX -	MIXER
MP -	MAGNESIUM HYDROXIDE PUMP
MPP -	MEMBRANE BIOREACTOR PERMEATE PUMP
MRP -	MEMBRANE BIOREACTOR RECYCLE PUMP
MV -	MOTORIZED VALVE
MWP -	MONITORING WELL PUMP
NC -	NORMALLY CLOSED
NMP -	NITROGEN METERING PUMP
NO -	NORMALLY OPEN
NOx -	NITROGEN
NP -	NUTRIENT PUMP OR NEAT POLYMER
NPW -	NON-POTABLE WATER
NWL -	NORMAL WATER LEVEL
NWP -	NON-POTABLE WATER PUMP
O2 -	OXYGEN
OCV -	OPEN/CLOSE VALVE
PAH -	PRESSURE ALARM HIGH
PAC -	POLY ALUMINUM CHLORIDE
PAL -	PRESSURE ALARM LOW
PAP -	PHOSPHORIC ACID PUMP
PAM -	POLYMER SYSTEM
PB -	PLOW BLENDER
PC -	PRESSURE CONTROLLER OR PRIMING CONNECTION
PCRI -	PRESSURE CONTROLLER RECORDER INDICATOR
PE -	PRESSURE ELEMENT
PFP -	POLYMER FEED PUMP
PG -	PRESSURE GAUGE OR PROPANE GAS
PH/T -	PH AND TEMPERATURE
PI -	PROCESS AND INSTRUMENTATION DIAGRAM
P&ID -	PRESSURE INDICATOR/MANOMETER
PIR -	POLYMER INJECTION RING
PIT -	PRESSURE INDICATING TRANSMITTER
PLC -	PROGRAMMABLE LOGIC CONTROLLER
PM -	PADDLE MOTOR
PMP -	PHOSPHORUS METERING PUMP
PP -	PURGE POINT OR POLYMER PUMP
PR -	PRESSURE RECORDER/INDICATOR
PRV -	PRESSURE RELIEF, REGULATING OR REDUCING VALVE
PS -	PRESSURE SWITCH
PSH -	PRESSURE SWITCH HIGH
PT -	PRESSURE TRANSMITTER
PV -	PINCH VALVE
QC -	QUICK CONNECT
RADS -	RECYCLE ANAEROBIC DIGESTER SLUDGE
RANS -	RETURN ANAEROBIC SLUDGE
RAS -	RECYCLE ACTIVATED SLUDGE
RAW -	RAW WASTEWATER
REC -	RECYCLE
REP -	REACTOR FEED PUMP
RP -	RETURN ACTIVATED SLUDGE PUMP
RSP -	RAW SEWAGE PUMP
RTP -	RAW WASTEWATER TRANSFER PUMP
S -	SOLENOID
SA -	SAMPLE
SARV -	SEWAGE AIR RELIEF VALVE
SBR -	SEQUENCING BATCH REACTOR
SC -	SPEED CONTROLLER/VFD OR SCREEN
SDB -	SLUDGE DUMPING BIN
SFB -	SINGLE FUEL BOILER
SFP -	SLUDGE FEED PUMP
SG -	SUCTION GUIDE OR SIGHT GLASS
SM -	STATIC MIXER
SMP -	SAMPLER PUMP
SMT -	SEDIMENT MOISTURE TRAP
SMU -	SUBMERGED MEMBRANE UNIT
SN -	SPARE NIPPLE
SO -	SULFIDE OXIDATION
SP -	SAMPLE POINT OR SOLUTION PUMP
SSP -	SCREENED SEWAGE PUMP
ST -	SAMPLE TAP
STR -	STRAINER
SV -	SOLENOID VALVE
SW -	SLUDGE WASTE
TA -	TEMPERATURE ALARM
TAH -	TEMPERATURE ALARM HIGH
TC -	TEMPERATURE CONTROLLER
TE -	TEMPERATURE ELEMENT
TG -	TEMPERATURE GAUGE
TI -	TEMPERATURE INDICATOR
TIT -	TEMPERATURE INDICATING TRANSMITTER
TIS -	TEMPERATURE INDICATING SWITCH
TK -	TANK
TR -	TRAILER
TRI -	TEMPERATURE RECORDER/INDICATOR
TS -	TEMPERATURE SWITCH OR TUBE SETTLER
TT -	TEMPERATURE TRANSMITTER
UAP -	UREA ADDITION PUMP
UV -	ULTRAVIOLET DISINFECTION
V -	VALVE
VAFM -	VARIABLE AREA FLOW METER
VFD -	VARIABLE FREQUENCY DRIVE
VE -	VACUUM EJECTOR
VT -	VENT
W -	WATER
WADS -	WASTE ANAEROBIC DIGESTER SLUDGE
WANS -	WASTE ANAEROBIC SLUDGE
WAS -	WASTE ACTIVATED SLUDGE
WC -	WASHER/CONTACTOR
WCP -	WATER CIRCULATING PUMP
WP -	WASTE ANAEROBIC SLUDGE PUMP
WPS -	WALL PIPE SUPPORT
WSP -	WASTE SLUDGE PUMP
WW -	WASTEWATER
WWP -	WASH WATER PUMP
YA -	EVENT ALARM
YC -	EVENT/STATUS CONTROLLER
YS -	EVENT SWITCH
ZS -	LIMIT SWITCH
ZSL -	LIMIT SWITCH LOW
ZSC -	LIMIT SWITCH CLOSED
ZSO -	LIMIT SWITCH OPEN
ZSOC -	LIMIT SWITCH OPEN/CLOSED

PLC AND DEVICE LEGEND



PLC I/O

A	1 DISCRETE OUTPUT	I	1 ANALOG OUTPUT
B	1 DISCRETE OUTPUT 2 DISCRETE INPUTS	J	2 DISCRETE OUTPUT
C	1 DISCRETE INPUT	K	4 DISCRETE INPUTS 2 ANALOG INPUTS
D	1 ANALOG INPUT	L	DEVICENET
E		XX	INTERLOCKS USED: 1-
F	1 DISCRETE OUTPUT 2 DISCRETE INPUTS 1 ANALOG OUTPUT		
G			
H	1 ANALOG OUTPUT 1 DISCRETE INPUT		

CONTROLLER / CONTROL PANELS

1 MBR
2 DEWATERING
3 DELTA V
4 AERATION

FIELD MOUNTED

PRIMARY REMOTE LOCATION

PLC SYMBOLS

FIELD MOUNTED

PRIMARY REMOTE LOCATION

INSTRUMENT SYMBOLS

SINGLE DEVICE FIELD MOUNTED

MULTIPLE DEVICES INTEGRALLY CONNECTED

MULTIPLE DEVICES REMOTELY CONNECTED

EQUIPMENT IDENTIFICATION PROCEDURE

NN DDD #

NN: TWO DIGIT PROCESS AREA NUMBER. THIS IS USED TO IDENTIFY THE AREA OF THE PROCESS IN WHICH THE EQUIPMENT IS USED RATHER THAN THE AREA IN WHICH IT IS LOCATED.

DDDD: DEVICE DESCRIPTION FROM LEGEND IN AREA NN. EG., THE FIRST PI IN THE HEADWORK SYSTEM IS 10-PI-01; ETC.

#: DEVICE/EQUIPMENT NUMBER

INFORMATION BLOCKS

FLOWSTREAM CONTINUATION TO/FROM OTHER DRAWINGS OR TO/FROM PROCESS BY OTHERS.

A — FLOWSTREAM CONTINUATION ON SAME DRAWING.

END DELIVERY (BATTERY LIMITS)

PIPING ACCESSORIES

AIR FILTER	CLEANOUT
PIPE CAP OR PLUG	PURGE POINT
COUPLING	DECANTER
BLIND FLANGE (IN-LINE)	BASKET STRAINER
BLIND FLANGE	LIQUID SEAL
COMPENSATOR	HEAT EXCHANGER
DRAIN	GUAGE GUARD
SPRAY NOZZLE	SEDIMENT MOISTURE TRAP
VENT	AIR RELIEF VALVE AND BREAKER
PULSE ABSORBER	HOSE CONNECTION
VENTURI INJECTOR	
UNION	
SIPHON	
SIGHT-GLASS WITH FLOW READING	
SIGHT-GLASS	
FLEXIBLE CONNECTOR	
FLEXIBLE CONNECTING REDUCER	
CONCENTRIC REDUCER	
ECCENTRIC REDUCER	
TRUCK CONNECTION	
GRAVITY FLOW	
JET MIX / JET AERATION	
SILENCER	
SPRAY NOZZLE	
HEADER	
FLAME ARRESTOR	
CONDENSATE OR DRIP TRAP	
STRAINER	
STATIC MIXER	
BRAIDED HOSE	

VALVES

	VALVE (BASIC SYMBOL)
	BALL VALVE
	PLUG VALVE
	THREE WAY PLUG VALVE
	DIAPHRAGM VALVE
	NEEDLE VALVE
	KNIFE GATE VALVE
	BUTTERFLY VALVE
	CHECK VALVE
	FOOT VALVE
	THREE WAY COCK
	PRESSURE REDUCING VALVE
	PRESSURE RELIEF VALVE
	OVER PRESSURE RELIEF VALVE
	UNDER PRESSURE RELIEF VALVE
	ADJUSTABLE OVER PRESSURE RELIEF VALVE
	BACK PRESSURE VALVE
	PINCH VALVE
	LUBRICATED PLUG VALVE
	MOTOR ACTUATED
	DIAPHRAGM ACTUATED
	FLOAT CONTROLLED
	SPRING ACTUATED
	WEIGHT CONTROLLED
S	SOLENOID VALVE
	PNEUMATIC CONTROL VALVE
	LOCKABLE ACTUATOR ON VALVE
	VENT VALVE
	PRESSURE REGULATOR
	MOTORIZIED SAFETY SHUT-OFF VALVE
	SHUT-OFF COCK
	TWIN FLAPPER CHECK VALVE
	MULTI-FUNCTION VALVE
GV&B	GATE VALVE AND BOX
BV&B	BUTTERFLY VALVE AND BOX

DRIVER TYPE

M ELECTRIC

H HYDRAULIC

P PNEUMATIC

PUMPS/ROTARY EQUIPMENT

	PUMP
	POSITIVE DISPLACEMENT PUMP
	FAN/ CENTRIFUGAL PUMP
	PD BLOWER
M	SUBMERSIBLE MIXER
M	IMPELLER TYPE MIXER
	COMPRESSOR
	MIXER
	CENTRIFUGAL BLOWER
	GRINDER

FINE SCREEN AND COMPACTOR

PROCESS AREA IDENTIFIERS

IDENTIFIER	DESCRIPTION
00-09	UNCLASSIFIED. USE THIS FOR ANY EQUIPMENT WHICH CANNOT BE PLACED INTO ANY OTHER AREA.
10-19	INFLUENT SYSTEM / HEADWORKS
20-29	PRIMARY CLARIFICATION/EQUALIZATION
30-39	ANAEROBIC SYSTEM
40-49	BIOGAS HANDLING/UTILIZATION SYSTEM
50-54	ANOXIC/PRE-AERATION SYSTEM
55-59	MBR SYSTEM
60-64	AERATION SYSTEM
65-69	RAS SYSTEM
70-79	SLUDGE MANAGEMENT SYSTEM
80-89	EFFLUENT TREATMENT AND PUMPING SYSTEMS
90-99	CHEMICAL METERING SYSTEMS

No.	Issue	Date
1	60% REVIEW SUBMISSION	2013-MAR-08
2	ISSUED FOR TENDER	2013-APR-10
3	RELEASED FOR CONSTRUCTION	2013-JUN-27

No.	Revision	Ckd. By	Date

NOTE: NOT ALL ABBREVIATIONS, LEGEND, SYMBOLS, VALVE TYPE, PROCESS AREA IDENTIFIERS, ETC. APPLY

PIPING IDENTIFICATION PROCEDURE

XX - XXX / XXX - XX / XX

- PIPE RATING FOLLOWED BY JOINT TYPE (WHEN REQUIRED FOR CLARIFICATION)
- PIPE MATERIAL ABBREVIATION
- FLOW STREAM ABBREVIATION
- FLOW STREAM SOURCE ABBREVIATION (WHEN REQUIRED FOR CLARIFICATION)
- NOMINAL DIAMETER IN mm

FLOWSTREAM SOURCE ABBREVIATION

MT	MEMBRANE TANK

PIPE MATERIAL ABBREVIATION

CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CARBON STEEL
CU	COPPER
PE/T	POLYETHYLENE TUBING
PVC	POLYVINYL CHLORIDE
PVC/BT	PVC BRAIDED TUBING
SS	STAINLESS STEEL

PIPE RATING

DR	DIMENSION RATIO
DWV	DRAIN, WASTE & VENT
GR	GRAVITY
T	TUBING
SCH	SCHEDULE

JOINT TYPE

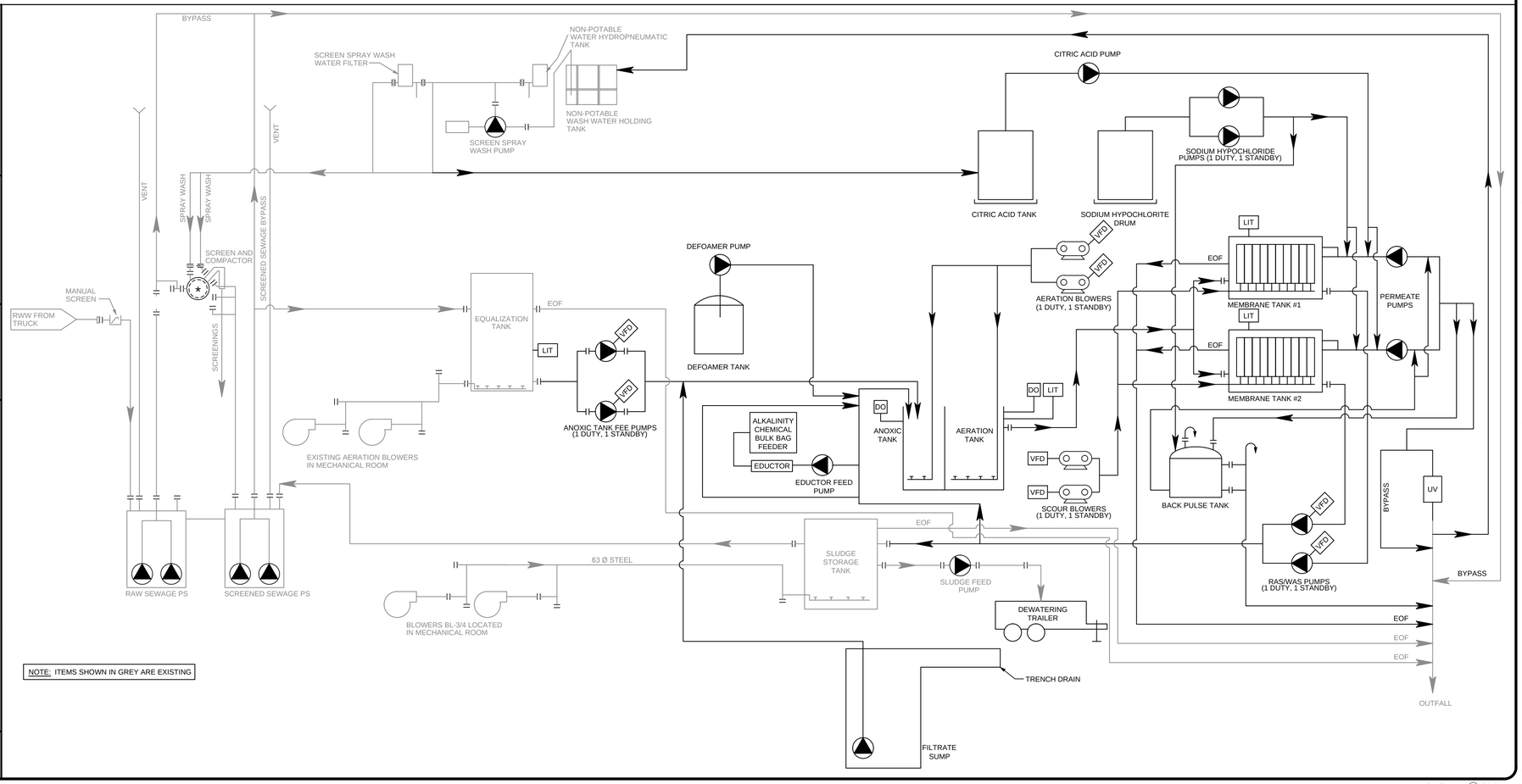
FL	FLANGED
G	GASKETED
NPT	THREADED
SW	SOLVENT WELDED
W	WELDED
SC	THREADED

FLOWSTREAM ABBREVIATION

AA	AERATION AIR
AD	ANAEROBIC DIGESTER
ATF	ANOXIC TANK FILL
ATT	ATTEMPERATION TANK
BF	BACKFLUSH
BG	BIOGAS
BPS	BYPASS
CA	COMPRESSED AIR
CAF	CITRIC ACID FEED
CC	CLEANING CHEMICAL
CCS	CLEANING CHEMICAL SOLUTION
CCW	CLEANING CHEMICAL WASTE
CEN	CENTRATE
CF	CHEMICAL FEED
CW	COLD WATER
DF	DEFOAMER
DR	DRAIN
EFF	EFFLUENT
EOF	EMERGENCY OVERFLOW
EQ IN	EQUALIZATION TANK INFLUENT
EQ VT	EQUALIZATION TANK VENT
FE	FERRIC/FERROUS
FILL	FILL
FL	FLAME LINE
FM	FORCE MAIN
GLR	GLYCOL RETURN
GLS	GLYCOL SUPPLY
GRIT	GRIT
HP	HYDROGEN PEROXIDE
HPW	HIGH PRESSURE WATER
HW	HOT WATER
INF	INFLUENT
MBP	MEMBRANE BACKPULSE
MF	MEMBRANE FEED
NG	NATURAL GAS
NP	NEAT POLYMER
NPW	NONPOTABLE WATER
OVF	OVERFLOW
PAC	POLY-ALUMINUM CHLORIDE
PER	PERMEATE
PG	PROPANE GAS
PF	POLYMER FEED
PW	POTABLE WATER
PX	PEROXIDE
R	RETURN
RANS	RETURN ANAEROBIC SLUDGE
RAS	RETURN ACTIVATED SLUDGE
RWW	RAW WASTEWATER
RWW FT	RAW WASTEWATER FROM TRUCK
REC	RECYCLE
S	SAMPLE OR SUPPLY
SA	SANITARY
SCOUR	SCOUR
SCUM	FLOATING SCUM
SF	SOLUTION FEED
SHF	SODIUM HYPOCHLORITE FEED
SR	SOLUTION RECYCLE
SREC	SUPERNATANT RECYCLE
SW	SERVICE WATER
SWW	SCREENED WASTEWATER
VT	VENT
W	WATER
WANS	WASTE ANAEROBIC SLUDGE
WAS	WASTE ACTIVATED SLUDGE
WCC	WASTE CLEANING CHEMICAL

SUPPLEMENT

PIPE SIZES ON SOME PIPING SYSTEMS, (NPW), MAY BE INDICATED USING THE NPS STANDARD BASED ON INCHES.



NOTE: ITEMS SHOWN IN GREY ARE EXISTING

FOR INFORMATION ONLY

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Dwg. Standards Ckd. By: PD

Designed By: DFB

Date Printed

Dwg. Design Ckd. By: SAO

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Project Title

WASTE WATER TREATMENT PLANT UPGRADE PANGNIRTUNG, NU

Dwg. Title

FLOW DIAGRAM, SYMBOLS, LEGEND & ABBREVIATIONS

Project No. OTT-00204430-A0

Dwg. No. **P401-1**

Rev. No. 0

Scale: NOT TO SCALE
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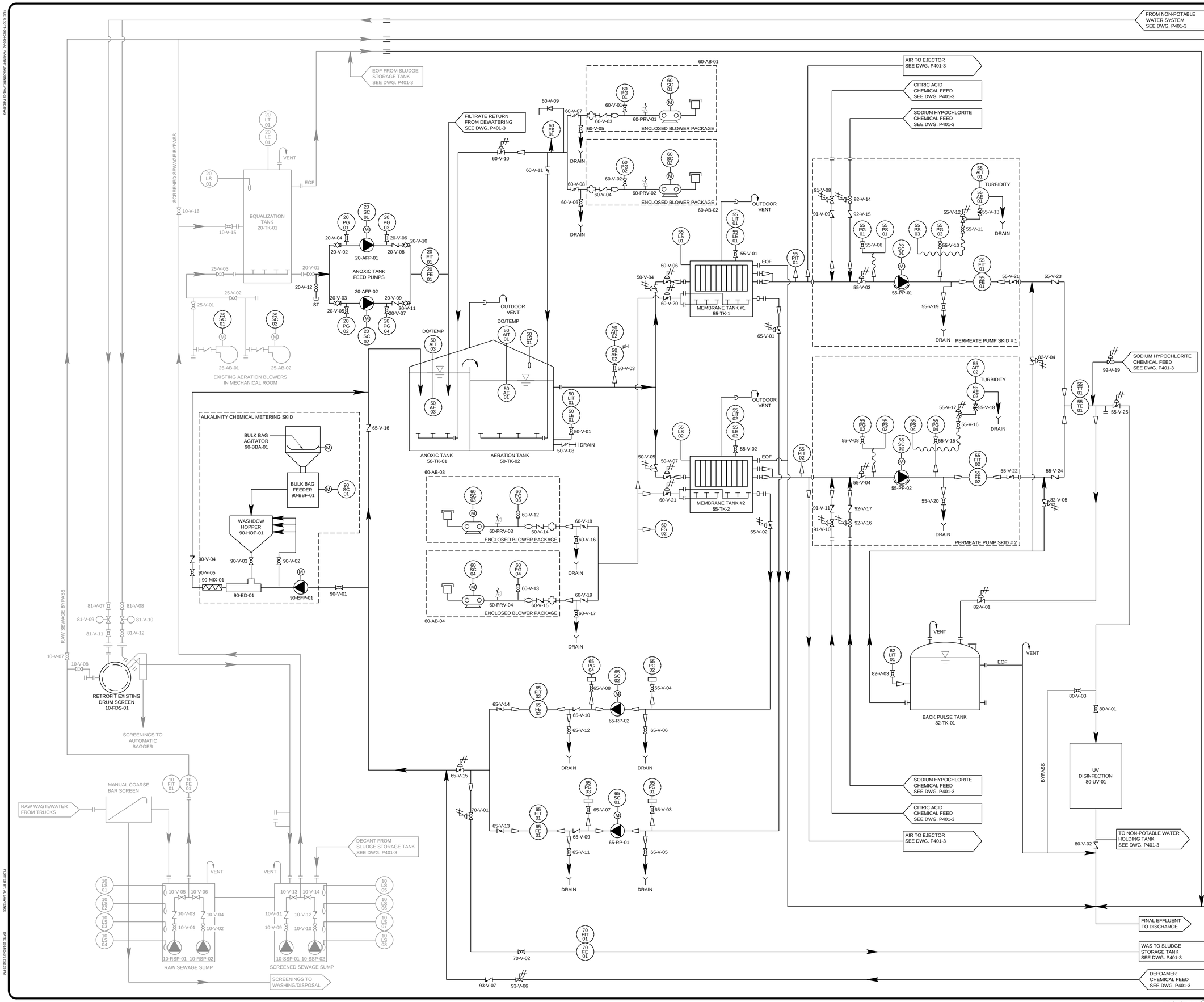

No.	Issue	Date
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3	RELEASED FOR CONSTRUCTION	2013-JUN-27
4	TAG NUMBER CORRECTIONS	2014-NOV-27

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Project Title

WASTE WATER TREATMENT PLANT UPGRADE PANGNIRTUNG, NU

Dwg. Title

PROCESS AND INSTRUMENTATION DIAGRAM (P&ID)

Project No. OTT-00204430-A0

Dwg. No. **P401-2**

Rev. No. 1

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WASTE SLUDGE FROM RECYCLE PUMPS SEE DWG. P401-2

OUTDOOR VENT

70 LT 01

70 LE 01

OVERFLOW TO FINAL EFFLUENT SEE DWG. P401-2

EOF

SLUDGE STORAGE TANK 70-TK-01 (REPURPOSED EXISTING SLUDGE DIGESTER)

70 LS 05

DECANT TO SCREENED SEWAGE SUMP SEE DWG. P401-2

70-V-03

75 PG 01

75-V-05

75-V-06

70-V-06

75-V-04

75-V-02

75-V-01

75-V-03

75-AB-01

75-AB-02

EXISTING AERATION BLOWERS IN MECHANICAL ROOM

WASTE SLUDGE PUMP AND POLYMER DOSING SKID

NEAT POLYMER TOTE

70-V-16

POLYMER FEED PUMP 70-PFP-01

70 PT 01

70 PE 01

70 PG 03

NEAT POLMER ACTIVATION DEVICE

S

70-V-19

MIXER 70-MIX-01

70-V-18

70-V-17

PULSATION DAMPER 70-PD-01

70-V-15

70 SC 01

70 PG 01

70 PG 02

70 PIT 02

70 FE 02

70-V-08

70-V-09

70-V-07

70-V-10

70-V-11

ST

70-WSP-01 SLUDGE PUMP

MIXER 70-MIX-02

70-V-12

70-V-13

ST

70-V-14

70 LS 04

DEWATERING 70-TR-01

DEWATERED SLUDGE TO DISPOSAL

TRENCH DRAIN

FILTRATE RETURN TO SCREENED SEWAGE SUMP SEE DWG. P401-2

70 PG 04

70-V-20

70 LS 03

70 LS 02

70 LS 01

70-V-22

70-V-21

70-FRP-01

FILTRATE SUMP

DEFOAMER CHEMICAL FEED SEE DWG. P401-2

93-V-05

93-BPV-01

93-V-04

93-V-03

92 SC 01

93-CFP-01

93-PRV-01

93 LS 01

93-V-01

DEFOAMER DRUM 93-TK-01

TO PROCESS PIPING

TO DEWATERING SCREEN SPRAY WASH SEE DWG. P401-2

80 PS 01

81-V-06

81-V-05

81-V-04

VENT

81-V-03

81-V-02

81-NWP-01

81-V-01

NON-POTABLE WATER HOLDING TANK (81-TK-01)

FROM UV DISINFECTION SEE DWG. P401-2

CITRIC ACID TO MEMBRANE TANK # 1 PERMEATE PIPING SEE DWG. P401-2

CITRIC ACID PANEL

91 PG 01

91-BPV-01

91-V-09

CITRIC ACID TO MEMBRANE TANK # 2 PERMEATE PIPING SEE DWG. P401-2

91-V-07

91-PRV-02

91-PRV-01

91-CC-01

91-V-05

91-CFP-01

91-V-06

91-V-04

91-V-07

91 LS 01

91-MIX-01

91-V-03

91-V-02

CITRIC ACID TANK 91-TK-01

91-V-01

SODIUM HYPOCHLORITE TO BACK PULSE TANK SEE DWG. P401-2

SODIUM HYPOCHLORITE TO MEMBRANE TANK #1 PERMEATE PIPING SEE DWG. P401-2

SODIUM HYPOCHLORITE TO MEMBRANE TANK #2 PERMEATE PIPING SEE DWG. P401-2

COMPRESSED AIR

92-PRV-03

SODIUM HYPOCHLORITE PANEL

92-V-11

S

92-V-16

92-V-18

92-BPV-01

92 PG 01

92-V-09

92-PRV-02

92-V-10

92-V-08

92-PRV-01

92-V-15

92-V-17

P

92-CFP-02

92-V-06

92-CC-01

92-V-03

92-CFP-01

92-V-07

92-V-04

92-V-05

92-V-08

92-V-02

92 LS 01

92-V-01

SODIUM HYPOCHLORITE DRUM 92-TK-01

61-V-11

MAINTENANCE SHOP

61 PS 01

61-V-02

19 Ø

61-V-08

61-PRV-01

TO MBR SYSTEM

61-V-12

DRAIN

61-V-09

61-AC-01

61-AC-02

61 PG 01

61-TK-03

19 Ø

AIR COMPRESSOR

TO DRAIN

61-V-01

61-V-03

61-AF-01

FILTER

61-V-04

61-V-06

61-AD-01 DRYER

61-V-07

TO DRAIN

61-AF-02

FILTER

61-V-05

AIR SUPPLY ASSEMPLY # 1

56-V-01

56-F-01

56-V-03

EJECTOR ASSEMBLY #1

56-V-07

56-V-05

56-VE-01

DRAIN

AIR VACUUM FROM PERMEATE HEADER TRAIN 1. SEE DWG P401-2

AIR SUPPLY ASSEMPLY # 2

56-V-02

56-F-02

56-V-04

EJECTOR ASSEMBLY #2

56-V-08

56-V-06

56-VE-02

DRAIN

AIR VACUUM FROM PERMEATE HEADER TRAIN 2. SEE DWG P401-2

61-V-10

No.	Issue	Date
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No.	Revision	Ckd. By	Date

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Project Title

WASTE WATER TREATMENT PLANT UPGRADE PANGNIRTUNG, NU

Dwg. Title

PROCESS AND INSTRUMENTATION DIAGRAM (P&ID)

Project No.		
OTT-00204430-A0		
Dwg. No.	**P401-3**	Rev. No. 1

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Appendix B – Material Safety Data Sheets (MSDS) for Selected Process and Laboratory Chemicals

Organic Cationic Emulsion
Solve 137

Material Safety Data Sheet

Date Issued: 04/05/2012
Date Revised: 04/05/2012

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **SOLVE 137**
CHEMICAL TYPE: Liquid Cationic Polyacrylamide
COMPANY: WaterSolve, LLC, 5031 68th St. S.E. Caledonia, MI 49316, USA
For Product information call 616-575-8693.
For Chemical Emergency Spill, Leak, Fire, Exposure, or Accident
Call CHEMTREC Day or Night
Within USA and Canada: 1-800-424-9300
Outside USA and Canada: +1 703-527-3887 (collect calls accepted)

2. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA Regulated Components

Component	CAS NO.	%	OSHA (pel)	AGGIH (TLV)
Petroleum distillate Hydrotreated light	064742-47-8	20-25	500 ppm 1200mg/m3 165ppm (Supplier)	(hud)

No permissible exposure limits (PEL/TLV) have been established by OSHA or ACGIH.

3. HAZARDS IDENTIFICATION

Emergency Overview
Appearance and odor: Off white, viscous liquid, slight hydrocarbon odor
Statement of Hazard: WARNING! CAUSES EYE AND SKIN IRRITATION

Potential Health effects
Effects of exposure:
The estimated acute oral (rat) LD50, acute dermal (rabbit) LD50 and 4-hour inhalation (rat) LC50 values for this material are >5000mg/kg , >2000 mg/kg and >20 mg/L respectively. Direct contact with this material may cause moderate skin and eye irritation. Refer to Section 11 for toxicology information on the regulated components of this product.

4. FIRST AID MEASURES

Ingestion: If swallowed, call a physician immediately. Only induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.
Skin contact: Remove contaminated clothing and shoes without delay. Wash immediately with plenty of water. Do not reuse contaminated clothing without laundering. Get medical attention if pain or irritation persists after washing or if signs and symptoms of overexposure appear.
Eye contact: Rinse immediately with plenty of water for at least 15 minutes. Obtain medical advice if there are persistent symptoms.
Inhalation: Material is not expected to be harmful if inhaled. Remove to fresh air.

5. FIRE FIGHTING MEASURES

Suitable Extinguishing Media:
Use water spray, carbon dioxide or dry chemical.

Protective Equipment:
Firefighters, and others exposed, wear self-contained breathing apparatus. Wear full firefighting protective clothing. See MSDS Section 8 (exposure Controls/Personal Protection)

Special Hazards:
Keep containers cool by spraying with water if exposed to fire.

Mechanical/Static Sensitivity Statements:
None

6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Personal precautions:
Refer to Section 8 (Exposure Controls/Personal Protection) for appropriate personal protective equipment.

Methods for Cleaning Up:
Products may cause a slip hazard. Spilled material should be absorbed onto an inert material and scooped up. Prevent liquid entering sewers. Flush spill area with water and scrub to remove residue. If slipperiness remains apply more dry-sweeping compound.

HANDLING AND STORAGE

Handling
Precautionary Measures: Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Special Handling Statements: None

STORAGE
To avoid product degradation and equipment corrosion, do not use iron, copper or aluminum containers or equipment. Flashpoint determinations on materials of this type are required by certain regulations and scientific standards to be performed using a Pensky-Martens type close cup test method. This method indicates a flash point greater than 93.3°C (200°F). Although there was no flashpoint detected below 93.3°C (200°F) by the Pensky-Martens Closed Tester method, some flammable vapors were evolved during the test as evidenced by the enlargement of the test flame: therefore, caution should be exercised during storage and handling.

Storage Temperature: Room temperature
Reason : Integrity

7. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering measures:
Where this material is not used in a closed system, good enclosure and local exhaust ventilation should be provided to control exposure.

Respiratory protection:
Where exposures are below the established exposure limit, no respiratory protection is required. Where exposures exceed the established exposure limit, use respiratory protection recommended for the material and level of exposure.

Eye protection:
Wear eye/face protection such as chemical splash proof goggles or face shield. Eyewash equipment and safety shower should be provided in areas of potential exposure.

Skin protection:
Avoid skin contact. Wear impermeable gloves and suitable protective clothing.

Additional Advice:
Food, beverages, and tobacco products should not be carried, stored, or consumed where this material is in use. Before eating, drinking, or smoking, wash face and hands thoroughly with soap and water.

8. PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor:	Off white liquid; slight hydrocarbon odor
Boiling Point:	Aqueous phase 100 ^{o}C; Oil phase ~175 ^{o}C
Melting Point:	Not available
Vapor Pressure:	Similar to water
Specific Gravity:	~1.0
Vapor Density:	similar to water
% Volatile (By Wt):	~50
pH:	3-4 in water
Saturation in Air (% by Vol):	Not available
Evaporation Rate:	Not available
Solubility in Water:	Limited by viscosity
Volatile Organic Content:	Not available
Flash point:	>100°C 212°F closed cup
Flammable Limits (% by vol):	Not available
Autoignition temp:	Not available
Decomposition temp:	Not available
Odor Threshold	Not available
Partition coefficient (n-octanol/water)	Not available

9. STABILITY AND REACTIVITY

Stability:	Stable
Conditions to avoid:	Avoid contact with strong oxidizing agents.
Polymerization:	Will not occur
Conditions to Avoid:	None known
Materials to avoid:	Strong oxidizing agents
Hazardous decomposition Products:	carbon monoxide Carbon dioxide Ammonia Oxides of nitrogen Hydrochloric acid

10. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3.
Toxicological information on the OSHA regulated components of this product is as follows:

Petroleum distillates, hydrotreated light (CAS#64742-47-8) has acute oral (rat) and dermal (rabbit) LD50 values of >5 g/kg and >3.16 g/kg, respectively. Prolonged or repeated skin contact tends to remove skin oils, possibly leading to irritation and dermatitis. Direct contact may cause eye irritation. Overexposure to high vapor concentrations, >~700PPM, are irritating to the eyes and respiratory tract and may cause headaches, dizziness, drowsiness, and other central nervous system effects, including death. Aspiration of minute amounts during ingestion or vomiting may cause mild to severe pulmonary injury and possible death. In a 90-day oral gavage (rats) study at 100, 500 and 1000 mg/kg, no treatment related mortalities were observed. There were no significant changes in body weights or food consumption in any dose groups. Increased liver weights were observed in male and female rats a 500 and 1000 mg/kg. Increased kidney weights were observed only in male rats at 500 and 1000mg/kg. Testes weights were significantly elevated in male rats at 1000 mg/kg. Kidney effects indicative of light hydrocarbon nephropathy, occurred in male rat kidneys at all dose levels. Histological findings of hepatocellular hypertrophy were seen in the livers of male rats at 1000mg/kg and in female rats at 500 and 1000 mg/kg. All treatment-related effects were reversible within the 4- week recovery period. Observed kidney effects (including light hydrocarbon nephropathy and increased kidney weight) are a unique response by male rats to chronic hydrocarbon exposure, which the U.S . EPA has declared no relevant to humans. High-dose liver effects (including hepatocellular, or enlarged liver cells) are a direct consequence of the sustained high-fat hydrocarbon diet. The No observed Adverse Effect Level (NOAEL) for this study was 1000mg/kg.

Alcohols (c10-16), ethoxylated toxicological properties have not been fully investigated. Based on similar materials, the acute oral (rat) LD50 is estimated to range from 1600-2500 mg/kg and the acute dermal (rabbit) LD50 value is estimated to be >2000mg/kg. Similar materials produced severe eye irritation and moderate skin irritation in studies with rabbits.

Alcohols C12-14 alcohol ethoxylated toxicological properties have not been fully investigated. The oral LD50 (rat) of this mixture is excepted to be consistent with the chemical family of ethoxylated alcohol surfactants and range from 1.6 to 2.5 g/kg. The acute dermal (rabbit) LD50 value is estimated to be >2.0 g/kg. One excepted component of this mixture was severely irritating to rabbits eyes (undiluted, Draize score=60). This mixture is expected to be moderately irritating to skin, based on data reported for C9-C11 6EO: (primary irritation index) Pll=5.3/8.

California Proposition 65 Warning (applicable in California only) - This product contains (a) chemical(s) known to the State of California to cause cancer and birth defects or other reproductive harm.

11. ECOLOGICAL INFORMATION LC 50

ALGAE TEST RESULTS
Test: Growth Inhibition (OECD 201) Due to the cationicity of the polymer, an algae growth inhibition test is not appropriate.

FISH TEST RESULTS
Test: EPA 821-R-02-012Method 2021.0
Duration: 48 hr
Species: Fathead Minnow *Pimephales promelas* LC50 = 7.6 mg/L

INVERTEBRATE TEST RESULTS
Test: EPA 821-R-02-012Method 2021.0
Duration: 48hr
Species: Water Flea *Daphnia magna* LC50 = 4.2 mg/L

DEGRADATION
Test: CO2 Evolution: Modified Sturm (OECD 301B)
The polymeric ingredient is not readily biodegradable, but degradable by hydrolysis. The large polymer size is incompatible with transport across biological membranes and diffusion; the bioconcentration factor is therefore considered to be zero.

12. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the product, as applied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA "listed hazardous waste" or has any of the four RCRA "hazardous waste characteristics." Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA "listed hazardous waste"; information contained in Section 15 of this MSDS is not intended to indicated if the product is a "listed hazardous waste." RCRA Hazardous Waste Characteristic. There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, See Section 5 of this MSDS (flash point). For Corrosivity, see sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations, may also apply to the classification of the material to be disposed. The company encourages the recycle, recovery and reuse of materials classified as RCRA hazardous wastes to be disposed of by thermal treatment or incineration at EPA approved facilities. The company has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

13. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

USDOT Proper Shipping Name: Not applicable/Not regulated
Transport Label Required: None
Hazardous Substances: Not applicable

TRANSPORT CANADA Proper Shipping Name: Not applicable/Not regulated

ICAO/IATA Proper Shipping name: Not applicable/Not regulated
Packing instructions/maximum net quantity per package:
Passenger Aircraft:
Cargo Aircraft:

IMO Proper shipping name: Not applicable/Not regulated

14. REGULATORY INFORMATION

USA: All components of this product are included on the TSCA Chemical Inventory or are not required to be listed on the TSCA Chemical I inventory.

Canada: All components of this product are included on the Domestic Substances List (DSL) or are not required to be listed on the DSL

.

European Union (EU): All components of this product are included on the European Inventory of Existing Chemical Substances (EINECS) or are not required to be listed on EINECS.

Australia: All components of this product are included in the Australian Inventory of Chemical Substances(AICA) or are not required to be listed on AICS.

China: All components of this product are included on the Chinese inventory or are not required to be listed on the Chinese Inventory.

Japan: All components of this product are included on the Japanese (ENCS) inventory or are not required to be listed ion the Japanese Inventory.

Korea: All components of this product are included on the Korean (ECL) inventory or are not required to be listed on the Korean inventory

Philippines: All components of this product are included on the Philippine (PICCS) inventory or are not required to be listed on the Philippine inventory.

OTHER ENVIRONMENTAL INFORMATION

The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

This product does not contain any components regulated under sections of the EPA.

Product Classification under section 311 of SARA
Acute (Y)

15. OTHER INFORMATION

NFPA HAZARD RATING (National Fire Protection Association)

Health 2- Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.

Fire 1 – Materials that must be preheated before ignition can occur.

Reactivity 0 –Materials that in themselves are normally stable, even under fire exposure conditions.

Reasonable care has been taken in the preparation of this information, but the manufacturer makes no warranty of merchantability or any other warranty, expressed or implied, with respect to this information. The manufacturer makes no representations and assumes no liability for any direct, incidental or consequential damages resulting from its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This information is for the specific material described only and may not be valid if the material is used in combination with any other materials or in any process. The user is responsible to determine the completeness of the information and suitability for the user's own particular use. The knowledge and belief of the company, the information is accurate and reliable as of the date indicated but the company makes no express or implied warranty of merchantability for the material or the information. The company makes no express or implied warranty of fitness for a purpose for the material or for the information. Users of any chemical should educate themselves on all aspects of its use by independent investigation of current scientific and medical knowledge that the material can be used safely.

National Chemicals Incorporated
PO Box 32 ◥ 105 Liberty Street ◥ Winona, MN 55987 ◥ Phone: 800-533-0027 or 507-454-5640 ◥ Fax: 507-454-5641

FOR CHEMICAL EMERGENCY
Involving Shipping and Handling Spills, Leak, Fire, Exposure or Accident
Call CHEMTREC 1–800–424–9300

Complies with OSHA's Hazard Communication Standard 29 CFR 1910.1200

Section 1 - Product Identification

Product Name: Sodium Carbonate/Soda Ash, all sizes Product ID: 0202X

Section 2 - Composition/Information on Ingredients

CHEMICAL NAME	CAS REG. #
Sodium Carbonate Anhydrous	497-19-8

Section 3 - Hazards Identification

EMERGENCY OVERVIEW: Product is non-combustible. Reacts with acid to release carbon dioxide gas and heat. Irritating to the eyes and continuous contact may irritate the skin. Not expected to be toxic to the environment, nor to aquatic organisms.

POTENTIAL HEALTH EFFECTS: Direct contact with the product causes irritation of the eyes and continuous contact may cause skin irritation (red, dry, cracked skin). Excessive levels of airborne dust may irritate the mucous membranes and upper respiratory tract.

Section 4 - First Aid Measures

EYES: Immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes, then continue flushing eyes for at least 15 minutes lifting the upper and lower eyelids intermittently. Washing eyes within several seconds is essential to achieve maximum effectiveness. See a medical doctor or ophthalmologist as necessary.

SKIN: Immediately flush contaminated areas with water. Remove contaminated clothing, jewelry, and shoes immediately. Wash contaminated areas with soap and water. Thoroughly clean and dry contaminated clothing and shoes before reuse. Get medical attention if irritation occurs and persists.

INHALATION: Remove to fresh air. Give artificial respiration if not breathing. If breathing is difficult, give oxygen.

INGESTION: Never give anything by mouth to an unconscious or convulsive person. If swallowed, do not induce vomiting. Give large amounts of water. If vomiting occurs spontaneously, keep airway clear. Give more water when vomiting stops. See a medical doctor immediately.

NOTE TO PHYSICIAN: While internal toxicity is low, irritant effects of high concentrations may produce corneal opacities and vesicular skin reactions in humans with abraded skin only. Treatment is symptomatic and supportive.

Section 5 - Fire Fighting Measures

FLAMMABLE LIMITS: not applicable

FIRE AND EXPLOSION HAZARDS: not applicable

EXTINGUISHING MEDIA: Water, water fog, carbon dioxide (CO_2), dry chemical

HAZARDOUS COMBUSTION PRODUCTS: Fumes of sodium oxide.

Section 9 - Accidental Release Measures

Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Residue may be flushed to sewer with plenty of water.

Section 7 - Handling and Storage

HANDLING: Avoid contact with eyes. Wash thoroughly after handling.

STORAGE: Keep container tightly closed and properly labeled. Store in cool, dry area, away from acids.

Section 8 - Exposure Controls / Personal Protection

EYE/FACE PROTECTION: Safety glasses with side shields are recommended.

SKIN PROTECTION: Dry product is generally non-irritating to intact skin but can be irritating where skin has been damaged and can create skin irritation after long exposures when moisture is present. Under such conditions, gloves are recommended.

RESPIRATORY PROTECTION: Avoid breathing dust.

HYGIENIC PRACTICES: Wash hands with soap and water after handling product.

Section 9 - Physical and Chemical Properties

APPEARANCE:	white, granular solid	ODOR:	odorless
BOILING POINT:	decomposes	WATER SOLUBILITY:	33.2% maximum
FREEZING POINT:	851° C (1564° F)	OXIDIZING PROPERTIES:	no data available
FLASH POINT:	non-combustible	PERCENT VOLATILE:	no data available
EVAPORATION RATE:	no data available	pH:	11.4 (1% solution)
DENSITY/WEIGHT PER VOLUME:	(g/mL) Dense Grades = 0.86 - 1.12; Light Grades = 0.70 - 0.90		

Section 10 - Stability and Reactivity

STABILITY: Stable

CONDITIONS TO AVOID: Contact with acids except under controlled conditions.

INCOMPATIBLE MATERIALS: Aluminum powder, acids, fluorine, molten lithium. Reacts with acids with release of large volumes of carbon dioxide gas and heat.

HAZARDOUS DECOMPOSITION: Heated to decomposition, it emits fumes of sodium oxide.

POLYMERIZATION: Will not occur

Section 11 - Toxicological Information

EYE EFFECTS: Severe irritant (rabbit) (Toxicology 23:281 (1982)).

SKIN EFFECTS: Non-irritating to intact skin. Minor irritation may occur on abraded skin. (Toxicol. Appl. Pharmacol. 31:481 (1975))

DERMAL LD50: No data available for the product.

ORAL LD50: Harmful if swallowed.

INHALATION LC50: 2.3mg/1 (2h) (rat) (Environ, Res. 31:138 (1983)).

SENSITIZATION: 0.25% sodium carbonate: Non-sensitizing (human) (Toxicol. Appl. Pharmacol. 31:481 (1975)).

ACUTE EFFECTS FROM OVEREXPOSURE: May cause severe irritation of the eyes, including corneal opacities. Dusts and mists may be irritating to the skin, mucous membranes and upper respiratory tract. No significant acute toxicological effects expected.

- EYES: Immediately flush with cool, running water for at least 15 minutes.
- SKIN: Immediately wash skin and clothing with soap and water.
- INHALATION: Remove to fresh air. If breathing is difficult, get medical attention.
- INGESTION: Rinse mouth at once; give vinegar or juice of lemon, orange or grapefruit. Do not induce vomiting.

CARCINOGENICITY: NTP: not listed IARC: not listed OSHA: not listed other: (ACGIH) not listed

Section 12 - Ecological Information

ECOTOXICOLOGICAL: 96-hour LC50 = 265-565 mg/L (daphnia magnia) (low toxicity) 96-hour LC50 = 300-320 mg/L (bluegill sunfish) (low toxicity)

CHEMICAL FATE: Biodegradability does not apply to inorganic substances. No significant toxicity to aquatic organisms is expected.

Section 13 - Disposal Method

Reuse or reprocess if possible. Flush spill with plenty of water before disposal. Dispose in accordance with all applicable regulations.

Section 14 - Transportation Information

Not classified as hazardous according to Department of Transportation.

Section 15 - Regulatory Information

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355, APPENDIX A): not listed

SECTION 311 HAZARD CATEGORIES (40 CFR 370): Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370): The Threshold Planning Quantity (TPQ) for this product, if treated as a mixture, is 10,000 lb; however, this product contains the following ingredients with a TPQ of less than 10,000 lb: None

SECTION 313 HAZARD REPORTABLE INGREDIENTS (40 CFR 370): not listed

CERCLA DESIGNATION AND REPORTABLE QUANTITIES (RQ) (40 CFR 302.4): not listed

TSCA INVENTORY STATUS (40 CFR 710): listed

RCRA IDENTIFICATION OF HAZARDOUS WASTE (40 CFR 261): Waste Number: Refer to Section 13 Disposal Methods for RCRA status.

CANADA WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM)

PRODUCT IDENTIFICATION NUMBER:	not applicable	HAZARD CLASSIFICATION / DIVISION:	D.2.B, E
INGREDIENT DISCLOSURE LIST:	listed	DOMESTIC SUBSTANCE LIST:	listed

Section 16 - Other Information

SUPERSEDES DATE: June 30, 2009

The information and recommendations in this Material Safety Data Sheet are based upon data believed to be correct and does not relate to its use in combination with any other material or process. Since use conditions vary, we assume no liability for failure to follow product use direction and safety precautions. As data, standards and regulations change; NO WARRANTY, EXPRESS OR IMPLIED, IS MADE AS TO THE COMPLETENESS OR CONTINUING ACCURACY OF THIS INFORMATION.

The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
tnt822	N/A	Hach Company	WHMIS	English	1
2283449	N/A	Hach Company	WHMIS	English	1
2283549	N/A	Hach Company	WHMIS	English	1
2283649	N/A	Hach Company	WHMIS	English	1
2756549	N/A	Hach Company	WHMIS	English	1
TNT845	TNT845A	Hach Company	WHMIS	English	1
TNT845	TNT845B	Hach Company	WHMIS	English	1
TNT845	TNT845C	Hach Company	WHMIS	English	1
TNT845	TNT845R	Hach Company	WHMIS	English	1
10649	N/A	Hach Company	WHMIS	English	1

Total Enclosures: 10

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00485

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: COD TNTPlus™, HR (20-1500 MG/L)
Catalog Number: TNT822

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00485
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
UN Number/PIN: 1830
Intended Use: Laboratory Use Determination of Chemical Oxygen Demand
Date of MSDS Preparation:
Day: 25
Month: November
Year: 2014
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, light orange liquid
Physical State: Liquid
Odor: Not determined
MAY BE FATAL IF SWALLOWED CAUSES SEVERE BURNS HARMFUL IF INHALED OR ABSORBED THROUGH SKIN
CANCER HAZARD CONTAINS MATERIAL WHICH CAN CAUSE CANCER CAN CAUSE KIDNEY AND CENTRAL NERVOUS SYSTEM EFFECTS
HMIS:
Health: 3*
Flammability: 0
Reactivity: 2
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: Causes severe burns
Skin Contact: Causes severe burns
Skin Absorption: Toxic. Will be absorbed through the skin. Effects similar to those of ingestion
Target Organs: Central nervous system Kidneys
Ingestion: Harmful Causes: severe burns May cause: abdominal pain circulatory disturbances diarrhea loosening of the teeth nausea vomiting rapid pulse and respirations toxic nephritis (inflammation of the kidneys) shock collapse kidney damage death
Target Organs: Central nervous system Kidneys
Inhalation: Causes: severe burns May cause: difficult breathing mouth soreness teeth erosion Effects similar to those of ingestion. Inhalation of mists / sprays: Causes asthma Causes damage to the nasal epithelia Causes lung cancer
Target Organs: Central nervous system Kidneys Lungs Teeth Nasal cavity
Medical Conditions Aggravated: Pre-existing: Respiratory conditions Eye conditions Skin conditions Allergies or sensitivity to chromates or chromic acid. Allergies or sensitivity to mercury.

Chronic Effects: Chronic overexposure may cause destruction of any tissue contacted difficult breathing mouth soreness erosion of the teeth accumulation of silver in body tissues which causes a slate-gray to bluish discoloration. cancer Chromate and dichromate salts may cause ulceration and perforation of the nasal septum, severe liver damage, central nervous system effects, and lung cancer. Mercury is a general protoplasmic poison; it circulates in the blood and is stored in the liver, kidneys, spleen and bones. Main symptoms are sore mouth, tremors and psychic disturbances.

Cancer / Reproductive Toxicity Information:

An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen

Hexavalent Chromium Compounds Sulfuric Acid - The IARC evaluation was based on exposure to the mist or vapor of concentrated sulfuric acid generated during chemical processes.

An ingredient of this mixture is: NTP Listed Group 1: Recognized Carcinogen

Hexavalent Chromium Compounds Sulfuric Acid Mist or Vapor

Additional Cancer / Reproductive Toxicity Information: Contains: a recognized teratogen.

Toxicologically Synergistic Products: None reported

WHMIS Hazard Classification: Class D, Division 1, Subdivision A - Very toxic materials (immediate effects) Class D, Division 2, Subdivision A - Very toxic materials (other toxic effects) Class E - Corrosive material

WHMIS Symbols: Acute Poison Corrosive

3. COMPOSITION / INFORMATION ON INGREDIENTS

Mercuric Sulfate

Percent Range: 0.5 - 2
Percent Range Units: weight / weight
CAS No.: 7783-35-9 Contains Mercury. Dispose Per Local, State or Federal Laws.
LD50: Oral rat LD_{50} = 57 mg/kg; Oral mouse LD_{50} = 25 mg/kg.
LC50: None reported
TLV: Skin: 0.025 mg Hg/m^3
PEL: 2 mg Hg/m^3
Ingredient WHMIS Symbol: Acute Poison

Demineralized Water

Percent Range: 1.0 - 10.0
Percent Range Units: weight / weight
CAS No.: 7732-18-5
LD50: LD50 oral rat = >89,800 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Chromic Acid

Percent Range: 0.1 - 1.0
Percent Range Units: weight / weight
CAS No.: 13530-68-2
LD50: Oral rat LD50 = 80 mg/kg
LC50: Inhalation human TCLo = 110 µg/m³
TLV: 0.05 mg/m^3 (0.0235 ppm as Cr^{+6})
PEL: 5 µg/m³ (0.00235 ppm Cr^{+6}), 8 Hr TWA; Action Level is 2.5 $\mu g/m^3$ (0.00117 ppm), 8 Hr TWA
Ingredient WHMIS Symbol: Not applicable

Silver Sulfate

Percent Range: 0.5 - 2
Percent Range Units: weight / weight
CAS No.: 10294-26-5
LD50: Oral Rat LD50 > 5000 mg/kg
LC50: None reported
TLV: 0.01 mg/m³ (Ag)
PEL: 0.01 mg/m³ (Ag)
Ingredient WHMIS Symbol: Not applicable

Sulfuric Acid

Percent Range: 85.0 - 95.0
Percent Range Units: weight / weight
CAS No.: 7664-93-9
LD50: Oral Rat LD50 = 2140 mg/kg
LC50: Inhalation Rat LC50 = 100 mg/L/4 hr
TLV: 1 mg/m^3
PEL: 1 mg/m^3
Ingredient WHMIS Symbol: Acute Poison Corrosive

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Do not induce vomiting. Give large quantities of water. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Not Flammable, but reacts with most metals to form flammable hydrogen gas. During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: Contact with metals gives off hydrogen gas which is flammable May react violently with: strong bases water
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance. Water runoff can cause environmental damage. Dike and collect water used to fight fire.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Releases of this material may contaminate the environment. Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment. Dike the spill to contain material for later disposal.
Clean-up Technique: Mercury and its compounds are extremely toxic! Be extremely careful not to contact the spill or breathe any vapors. If permitted by regulation, Absorb spilled liquid with non-reactive sorbent material. Dispose of all mercury contaminated material at a government approved hazardous waste facility. Dispose of material in government approved hazardous waste facility. Decontaminate area with commercially available mercury absorbing compounds. Otherwise, Pick up spill for disposal and place in a closed container Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. Deny access to unnecessary and unprotected personnel. Remain up-wind from spilled material. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: 137

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe mist or vapors. Use with adequate ventilation. Maintain general industrial hygiene practices when using this product.
Storage: Protect from: light contamination by organic materials (will affect product stability) heat

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use a fume hood to avoid exposure to dust, mist or vapor. Maintain general industrial hygiene practices when using this product. Maintain adequate ventilation to keep vapor level below TWA for chemicals in this product. Refer to the OSHA Standard at 29CFR1910.1026 for Cr (VI) (See Federal Register 28 February 2006 Page 10100.)
Personal Protective Equipment:
Eye Protection: chemical splash goggles
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: laboratory fume hood and / or adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: mist/vapor Wash thoroughly after handling. Use with adequate ventilation. Protect from: heat light organic materials Keep away from: alkalies metals other combustible materials oxidizers reducers
TLV: Not established
PEL: Not established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Turbid, light orange liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: Not determined
pH: < 0.5
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: > 100 °C (> 212 °F)
Melting Point: < 0 °C (< 32 °F)
Specific Gravity/ Relative Density (water = 1; air =1): > 1.0
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Miscible
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Corrosive
Aluminum: Corrosive

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Exposure to light or contamination by organic materials will affect this product's stability.
Reactivity / Incompatibility: May react violently in contact with: caustics
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: mercury compounds sulfur oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: Oral rat (male) LD_{50} = 428 mg/kg; Oral rat (female) LD_{50} = 360 mg/kg.
LC50: None reported
Dermal Toxicity Data: None reported

Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
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Ingredient Toxicological Data: Chromic acid: Oral Rat LD50 = 80 mg/kg. Silver sulfate: Oral Rat LD50 = 1280 mg/kg; Mercuric sulfate: Oral Rat LD50 = 57 mg/kg; Dermal Rat LD50 = 625 mg/kg. Sulfuric acid: Oral Rat LD50 = 2140 mg/kg; Inhalation Rat LC50 = 100 mg/L/4 hr.

12. ECOLOGICAL INFORMATION

Product Ecological Information: Aquatic Toxicity Estimation - Additive Method: 48 hr Crustacea EC50 = 0.0045 mg/L. Do not place in landfil. Recycle appropriately. Do not release into the environment.
Ingredient Ecological Information: Silver sulfate: 48 hr Crustacea EC50 = 0.0045 mg/L. Mercuric sulfate: 14 d Pseudokirchneriella subcapitata = 0.033 mg/L. Chromic acid: 48 hr Daphnia magna EC50 = 0.8 mg/L.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dispose of all mercury contaminated material at an E.P.A. hazardous waste facility. Dispose of material in an E.P.A. approved hazardous waste facility.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Sulphuric Acid
--
Hazard Class: 8
UN Number/PIN: 1830
Packing Group: II
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Outside Testing. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00368

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Buffer Solution pH 4.01 ± 0.02
Catalog Number: 2283449

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00368
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
UN Number/PIN: NA
Intended Use: Laboratory Reagent Buffer
Date of MSDS Preparation:
Day: 08
Month: October
Year: 2013
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, red liquid
Physical State: Liquid
Odor: None
HMIS:
Health: 0
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: No effects are anticipated
Skin Contact: No effects are anticipated
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: No Effects Anticipated
Target Organs: Not applicable
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: None reported
Chronic Effects: No effects anticipated
Cancer / Reproductive Toxicity Information:
This product does NOT contain any IARC listed chemicals.
This product does NOT contain any NTP listed chemicals.
Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Not applicable
WHMIS Symbols: Not applicable

3. COMPOSITION / INFORMATION ON INGREDIENTS

Demineralized Water
Percent Range: >95.0
Percent Range Units: weight / weight
CAS No.: 7732-18-5
LD50: LD50 oral rat = >89,800 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Other components, each
Percent Range: < 0.1
Percent Range Units: weight / volume
CAS No.: Not applicable
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Potassium Acid Phthalate
Percent Range: 1.0 - 5.0
Percent Range Units: weight / volume
CAS No.: 877-24-7
LD50: Oral Rat LD50 = 3200 mg/kg
LC50: None reported
TLV: 10 mg/m^3 as inhalable dust; 3 mg/m^3 as respirable dust
PEL: 15 mg/m^3 as total dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Flush eyes with water. Call physician if irritation develops.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: Not applicable
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: If permitted by regulation, Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution. Otherwise, Pick up spill for disposal and place in a closed container Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

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7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling.
Storage: Keep container tightly closed when not in use.

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8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it.
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

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9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, red liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 4.01
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: > 100°C (> 212°F)
Melting Point: < 0°C (< 32°F)
Specific Gravity/ Relative Density (water = 1; air =1): 1.002
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not determined
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

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10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: None reported

Hazardous Decomposition: None reported
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
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Ingredient Toxicological Data: Potassium Acid Phthalate: Oral rat LD_{Lo} = 3200 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available Based on classification principles, not classified as hazardous to the environment.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
UN Number/PIN: NA
Packing Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. In-house information. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00369

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Buffer Solution pH 7.00 ± 0.02
Catalog Number: 2283549

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00369
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
UN Number/PIN: NA
Intended Use: Laboratory Reagent Buffer
Date of MSDS Preparation:
Day: 08
Month: October
Year: 2013
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, yellow liquid
Physical State: Liquid
Odor: None
HMIS:
Health: 0
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: No effects are anticipated
Skin Contact: No effects are anticipated
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: No Effects Anticipated
Target Organs: Not applicable
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: None reported
Chronic Effects: No effects anticipated
Cancer / Reproductive Toxicity Information:
This product does NOT contain any IARC listed chemicals.
This product does NOT contain any NTP listed chemicals.
Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Not applicable
WHMIS Symbols: Not applicable

3. COMPOSITION / INFORMATION ON INGREDIENTS

Potassium Phosphate, Monobasic
Percent Range: < 1.0
Percent Range Units: weight / volume
CAS No.: 7778-77-0
LD50: Oral rat LD50 = 7100 mg/kg
LC50: None reported
TLV: 10 mg/m^3 as inhalable fraction; 3 mg/m^3 as respirable fraction
PEL: 15 mg/m^3 as total dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol:

Demineralized Water
Percent Range: >95.0
Percent Range Units: volume / volume
CAS No.: 7732-18-5
LD50: LD50 oral rat = >89,800 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Other components, each
Percent Range: < 1.0
Percent Range Units: volume / volume
CAS No.: Not applicable
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Flush eyes with water. Call physician if irritation develops.
Skin Contact (First Aid): Wash skin with plenty of water.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn. Material is not classified as flammable according to GHS criteria.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: None reported
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: If permitted by regulation, Absorb spilled liquid with non-reactive sorbent material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Otherwise, Pick up spill for disposal and place in a closed container Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

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7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling.
Storage: Protect from: heat Keep container tightly closed when not in use.

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8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: Not applicable
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

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9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, yellow liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.0 at 20°C
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: ~ 100 °C (~ 212 °F)
Melting Point: ~ 0 °C (~ 32 °F)
Specific Gravity/ Relative Density (water = 1; air =1): ~ 1.0
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not determined
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

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10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat Evaporation
Reactivity / Incompatibility: None reported
Hazardous Decomposition: None reported
Hazardous Polymerization: Will not occur.

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11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
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Ingredient Toxicological Data: --
No toxicological data available for the ingredients of this product.

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available Based on classification principles, not classified as hazardous to the environment.
Ingredient Ecological Information: Formaldehyde (with Methanol): Bluegill LC50 = 100 mg/L 96 hr; Catfish (fresh water) TLm = 32 ppm 24 hr; Fathead minnow LC50 = 10-100 mg/L 96 hr; Rainbow trout LC50 = 168 mg/L 48 hr

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Open cold water tap completely, slowly pour the material to the drain.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
UN Number/PIN: NA
Packing Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. In-house information.

Legend:
NA - Not Applicable w/w - weight/weight

ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00370

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Buffer Solution pH 10.01 ± 0.02
Catalog Number: 2283649

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00370
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Mixture
UN Number/PIN: NA
Intended Use: Buffer
Date of MSDS Preparation:
Day: 08
Month: March
Year: 2014
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, blue
Physical State: Liquid
Odor: Odorless
HMIS:
Health: 0
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: No effects are anticipated May cause mild irritation
Skin Contact: No effects are anticipated May stain skin on contact.
Skin Absorption: No effects anticipated
Target Organs: None Reported
Ingestion: Practically non-toxic Large doses may cause: gastrointestinal irritation nausea vomiting
Target Organs: None reported
Inhalation: No effects anticipated
Target Organs: None reported
Medical Conditions Aggravated: None reported
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen
Formaldehyde
An ingredient of this mixture is: NTP Listed Group 1: Recognized Carcinogen
Formaldehyde
Additional Cancer / Reproductive Toxicity Information: Contains: Formaldehyde A component of this product has been reported to cause harm to the unborn in animal tests.

Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Not applicable
WHMIS Symbols: Not applicable

3. COMPOSITION / INFORMATION ON INGREDIENTS

Dye, Turquoise Blue Pylaklor S-400
Percent Range: < 0.01
Percent Range Units: weight / weight
CAS No.: 1330-38-7
LD50: Oral rat LD50 > 5000 mg/kg.
LC50: None Reported
TLV: 10 mg/m^3 as inhalable dust; 3 mg/m^3 as respirable dust
PEL: 15 mg/m^3 as inhalable dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol: Not applicable

Demineralized Water
Percent Range: > 99.0
Percent Range Units: weight / weight
CAS No.: 7732-18-5
LD50: LD50 oral rat = >89,800 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Formaldehyde
Percent Range: < 0.1
Percent Range Units: weight / weight
CAS No.: 50-00-0
LD50: Oral Rat LD50 = 100 mg/kg; Oral Mouse LD50 = 42 mg/kg
LC50: Inhalation Rat LC50 = 250 ppm/4 hr
TLV: 0.3 ppm
PEL: 0.75 ppm
Ingredient WHMIS Symbol:

Methyl Alcohol
Percent Range: < 0.1
Percent Range Units: weight / weight
CAS No.: 67-56-1
LD50: Oral Rat LD50 = 5628 mg/kg; Oral Human LD50 = 300 mg/kg
LC50: Inhalation Rat LC50 = 64000 ppm/4 hr; Inhalation Human LC50 = 10 mg/L/4 hr/Extrapolated from primate data
TLV: 200 ppm
PEL: 200 ppm
Ingredient WHMIS Symbol:

Sodium Bicarbonate
Percent Range: < 1.0
Percent Range Units: weight / weight
CAS No.: 144-55-8
LD50: Oral Rat LD50 = 4220 mg/kg; Oral Mouse LD50 = 3360 mg/kg
LC50: Inhalation Rat LC50 > 4.74 mg/L/4 hr
TLV: 10 mg/m^3 as inhalable dust; 3 mg/m^3 as respirable dust
PEL: 15 mg/m^3 as inhalable dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol: Not applicable

Sodium Carbonate

Percent Range: < 1.0
Percent Range Units: weight / weight
CAS No.: 497-19-8
LD50: Oral Rat LD50 = 4090 mg/kg
LC50: Inhalation Rat LC50 = 1.15 mg/L/4 hr
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Flush eyes with water. Call physician if irritation develops.
Skin Contact (First Aid): Wash skin with plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Never give anything by mouth to an unconscious person. Rinse mouth with plenty of water. Give large quantities of water. If you feel unwell, contact a physician. If concerned contact a physician.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn. Material is not classified as flammable according to GHS criteria.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products:
Fire / Explosion Hazards: This product will not burn or explode. May react violently with: strong acids strong bases
Static Discharge: No
Mechanical Impact: No
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment. Absorb spilled liquid with non-reactive sorbent material.
Clean-up Technique: If permitted by regulation, Cover spilled material with a dry acid, such as citric or boric. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Flush reacted material to the drain with a large excess of water. Otherwise, Pick up spill for disposal and place in a closed container Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Protect from: heat Keep container tightly closed when not in use. Keep away from: acids bases oxidizers

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Maintain general industrial hygiene practices when using this product.

Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling. Protect from: heat Keep away from: acids/acid fumes bases oxidizers
TLV: Not established
PEL: Not established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, blue
Physical State: Liquid
Molecular Weight: Not applicable
Odor: Odorless
pH: 10.0
Vapor Pressure: 17.5 mm Hg (2.27 kPa) at 20 °C (68 °F)
Vapor Density (air = 1): 0.62
Boiling Point: ~ 100 °C (~ 212 °F)
Melting Point: ~ 0 °C (~ 32 °F)
Specific Gravity/ Relative Density (water = 1; air =1): 0.990
Evaporation Rate (water = 1): 0.76
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat Evaporation Extreme temperatures Contact with acid or acid fumes Contact with heat, sparks, open flames or other ignition sources.
Reactivity / Incompatibility: None reported
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: carbon dioxide carbon monoxide formaldehyde sodium oxides nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50:
LC50:
Dermal Toxicity Data:
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data:

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
Based on classification principles, not classified as hazardous to the environment. No bioaccumulation potential Mobility in soil: Highly mobile

Ingredient Ecological Information: Dye, Turquoise Blue: 48 hr Daphnia pulex LC50 = 100 mg/L; Formaldehyde: 96 hr Morone saxatilis LC50 = 6.7 mg/L; 96 hr Fish LC50 = 52.5 mg/L; 48 hr Daphnia pulex EC50 = 5.8 mg/L; 48 hr Daphnia magna EC50 = 29 mg/L; 48 hr Crustacea EC50 = 14 mg/L
CEPA categorization for ingredients are as follows:

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. If permitted by regulation, Open cold water tap completely, slowly pour the reacted material to the drain. Otherwise, Check with local municipal and state authorities and waste contractors for pertinent local information regarding the proper disposal of chemicals.
Empty Containers: Working in a well-ventilated area, Rinse three times with an appropriate solvent. Collect rinsate and dispose of according to local, state or federal regulations. Dispose of empty container as normal trash. In the US, rinsate from empty containers is classified as hazardous waste and should be disposed of at an E.P. A. approved facility. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
UN Number/PIN: NA
Packing Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. In-house information.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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(970) 669-3050

MSDS No: M01702

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: pH Storage Solution
Catalog Number: 2756549

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01702
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
PIN: NA
Intended Use: Laboratory Reagent Electrode storage solution
Date of MSDS Preparation:
Day: 27
Month: February
Year: 2012
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless liquid
Physical State: Liquid
Odor: None
HMIS:
Health: 0
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: May cause mild irritation
Skin Contact: No effects are anticipated
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: Very large doses may cause: anorexia blood pressure changes cardiac depression fever gastroenteritis
Target Organs: Cardiovascular system
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Pre-existing: Cardiovascular diseases Kidney conditions
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
This product does NOT contain any IARC listed chemicals.
This product does NOT contain any NTP listed chemicals.
Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Not applicable
WHMIS Symbols: Not applicable

3. COMPOSITION / INFORMATION ON INGREDIENTS

Demineralized Water
Percent Range: 85.0 - 95.0
Percent Range Units: volume / volume
CAS No.: 7732-18-5
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Other components, each
Percent Range: < 1.0
Percent Range Units: weight / volume
CAS No.: Not applicable
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Potassium Chloride
Percent Range: 20.0 - 30.0
Percent Range Units: weight / volume
CAS No.: 7447-40-7
LD50: Oral rat LD_{50} = 2600 mg/kg
LC50: None reported.
TLV: Not established.
PEL: Not established.
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water.
Ingestion (First Aid): Give 1-2 glasses of water. If you feel unwell, contact a physician.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: Material will not burn. During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: This product will not burn or explode.
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Dilute with a large excess of water. Flush the spilled material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it.
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 6.4
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: ~ 100°C
Melting Point: Not determined
Specific Gravity/ Relative Density (water = 1; air =1): Not determined
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heating to decomposition.
Reactivity / Incompatibility: Incompatible with: bromine trifluoride

Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: chlorides potassium oxide
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Potassium Chloride: eye irritation rabbit (Std. Draize): 500 mg/24 hrs = MILD.
Mutation Data: None reported
Reproductive Effects Data: None reported
--
Ingredient Toxicological Data: Potassium Chloride: oral rat LD_{50} = 2600 mg/kg.

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
PIN: NA
Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Technical Judgment.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

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MSDS No: M02444

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Phosphorus UHR TNT Reagent A
Catalog Number: TNT845A

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M02444
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
UN Number/PIN: NA
Intended Use: Laboratory Reagent
Date of MSDS Preparation:
Day: 14
Month: March
Year: 2014
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Physical State: Powder
Odor: None
CAUSES EYE, SKIN AND RESPIRATORY TRACT IRRITATION HARMFUL IF SWALLOWED MAY CAUSE SENSITIZATION BY INHALATION AND SKIN CONTACT
MAY CAUSE ALLERGIC SKIN AND RESPIRATORY REACTIONS CONTAINS MATERIAL WHICH MAY CAUSE HARM TO UNBORN CHILD

HMIS:
Health: 2
Flammability: 0
Reactivity: 2
Protective Equipment: X - See protective equipment, Section 8.

Potential Health Effects:
Eye Contact: Causes severe irritation
Skin Contact: Causes irritation May cause allergic reaction
Skin Absorption: Will be absorbed through abraded or broken skin. Effects similar to those of ingestion
Target Organs: Kidneys Central nervous system
Ingestion: Harmful May cause: gastrointestinal irritation nausea vomiting diarrhea muscular twitching lethargy circulatory disturbances central nervous system effects shock harm to the unborn child, kidney damage
Target Organs: Kidneys Central nervous system
Inhalation: May cause: allergic respiratory reaction Causes: respiratory tract irritation
Target Organs: None reported
Medical Conditions Aggravated: Pre-existing: Eye conditions Skin conditions Respiratory conditions Allergies or sensitivity to potassium persulfate.
Chronic Effects: Chronic overexposure may cause allergic skin reactions allergic respiratory reactions weight loss anemia

Cancer / Reproductive Toxicity Information:
This product does NOT contain any IARC listed chemicals.
This product does NOT contain any NTP listed chemicals.
Additional Cancer / Reproductive Toxicity Information: Contains: a suspected teratogen. an experimental mutagen. NOAEL for embryotoxic/teratogenic effects as Boron:9.6 mg B/kg bw/day NOAEL for fertility effects as Boron:17.5 mg B/kg bw/day
Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Class D, Division 2, Subdivision B - Toxic material (other toxic effects)
WHMIS Symbols: Other Toxic Effects

3. COMPOSITION / INFORMATION ON INGREDIENTS

Lithium Sulfate
Percent Range: 1.0 - 10.0
Percent Range Units: weight / weight
CAS No.: 10102-25-7
LD50:
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol:

Sodium Persulfate
Percent Range: 65.0 - 75.0
Percent Range Units: weight / weight
CAS No.: 7775-27-1
LD50: None reported
LC50: None reported
TLV: 0.1 mg/m^3
PEL: Not established
Ingredient WHMIS Symbol: Oxidizing Other Toxic Effects

Sodium Metaborate
Percent Range: 15.0 - 25.0
Percent Range Units: weight / weight
CAS No.: 7775-19-1
LD50: Oral rat LD50 = 2330 mg/kg
LC50: None reported
TLV: 10 mg/M^3 Inhalable Particles; 3 mg/M^3 Respirable Particles
PEL: 15 mg/M^3 Total Dust; 5 mg/M^3 Respirable Dust
Ingredient WHMIS Symbol: Other Toxic Effects

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with water for 15 minutes. Immediately flush eyes with water for 15 minutes. Call physician. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Remove contaminated clothing. Call physician immediately. Wash skin with soap and plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Do not induce vomiting. Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Contains oxidizer. Contact with combustible materials may cause a fire. During a fire, corrosive and toxic gases may be generated by thermal decomposition. During a fire, corrosive and toxic gases may be generated by thermal decomposition. Material is not classified as flammable according to GHS criteria.

Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not determined
Upper Explosion Limits: Not determined
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: sulfur oxides. boron compounds
Fire / Explosion Hazards: None reported May react violently with: strong reducers combustible materials
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Water. Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: Evacuate area and fight fire from a safe distance. As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment. Cover spilled solid material with sand or other inert material.
Clean-up Technique: If permitted by regulation, Remove all combustible materials from the spill area. Sweep up material. Work in an approved fume hood. Working in small batches, dilute with excess water. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Filter to remove solids. Flush the spilled material to the drain with a large excess of water. Otherwise, Decontaminate the area of the spill with a soap solution. Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: a pound or more of loose powder is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING AND STORAGE

Handling: Maintain general industrial hygiene practices when using this product. Avoid contact with eyes skin Wash thoroughly after handling.
Storage: Store away from: Keep away from: combustible materials reducers oxidizable materials

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use a fume hood to avoid exposure to dust, mist or vapor. Use general ventilation to minimize exposure to mist, vapor or dust. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it.
Inhalation Protection: laboratory fume hood adequate ventilation
Precautionary Measures: Keep away from: oxidizable materials reducers Protect from: heat moisture
TLV: 10 mg/m^3 Inhalable particles; 3 mg/m^3 Respirable Particles
PEL: Not established. 10 mg/M^3 Total Dust; 3 mg/M^3 Respirable Fraction.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Powder
Molecular Weight: Not applicable
Odor: None
pH: Solution pH = 1.5
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not determined
Melting Point: Not determined

Specific Gravity/ Relative Density (water = 1; air =1): > 2.0 calculated
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Soluble
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Exposure to air. Heating to decomposition. Excess moisture
Reactivity / Incompatibility: May react violently in contact with: oxidizable material reducers Incompatible with: aluminum reducers
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: sodium oxides sulfur oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: ATE Oral Rat LD50 = 993 mg/kg/bw
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Sodium metaborate: Oral Rat LD_{50} = 2330 mg/kg; Lithium sulfate: Oral Rat LD_{50} = 613 mg/kg. Sodium Persulfate: Oral Rat LD_{50} = 895 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available Based on classification principles, not classified as hazardous to the environment.
Ingredient Ecological Information: Lithium Sulfate: 24 hr Daphnia magna EC50 = 196.79 mg/L. Sodium Persulfate: 48 hr Daphnia magna EC50 = 64.6 mg/L.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the material to the drain. Allow cold water to run for 5 minutes to completely flush the system. Work in an approved fume hood.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information. In Europe: Chemical and analysis solutions must be disposed of in compliance with the respective national regulations. Product packaging must be disposed of in compliance with the country-specific regulations or must be passed to a packaging return system.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
Hazard Class: NA

UN Number/PIN: NA
Packing Group: NA
Subsidiary Risk: NA

Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:

Canadian Inventory Status: All ingredients of this product are DSL Listed.

This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U.S. Department of Health and Human Services, April, 1987. Vendor Information. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. Sax, N. Irving and Richard J. Lewis, Sr., revised by. Hawley's Condensed Chemical Dictionary, Eleventh Ed. New York: Van Nostrand Reinhold Co., 1987. Technical Judgment. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. In-house information. Technical Judgment. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. CCINFO MSDS/FTSS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor).

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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(970) 669-3050

MSDS No: M02456

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Phosphorus UHR TNT Reagent B
Catalog Number: TNT845B

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M02456
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
UN Number/PIN: 2796
Intended Use: Laboratory Reagent Orthophosphate Determination
Date of MSDS Preparation:
Day: 14
Month: March
Year: 2014
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Colorless
Physical State: Liquid
Odor: Odorless
CAUSES BURNS HARMFUL IF SWALLOWED OR INHALED
CONTAINS SULFURIC ACID WHICH CAN CAUSE CANCER
HMIS:
Health: 3
Flammability: 0
Reactivity: 1
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: Causes severe burns
Skin Contact: Causes severe burns
Skin Absorption: None Reported
Target Organs: None Reported
Ingestion: Causes: severe burns May cause: circulatory collapse rapid pulse and respirations diarrhea nausea vomiting
Target Organs: None reported
Inhalation: Causes: severe burns May cause: difficult breathing mouth soreness teeth erosion
Target Organs: Lungs
Medical Conditions Aggravated: Pre-existing: Eye conditions Skin conditions Respiratory conditions
Chronic Effects: Chronic overexposure may cause erosion of the teeth chronic irritation or inflammation of the lungs cancer
Cancer / Reproductive Toxicity Information:
An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen

Sulfuric Acid - The IARC evaluation was based on exposure to the mist or vapor of concentrated sulfuric acid generated during chemical processes.

An ingredient of this mixture is: NTP Listed Group 1: Recognized Carcinogen
Sulfuric Acid Mist or Vapor

Additional Cancer / Reproductive Toxicity Information: Contains: a suspected carcinogen. a suspected mutagen.

Toxicologically Synergistic Products: None reported

WHMIS Hazard Classification: Class E - Corrosive material

WHMIS Symbols: Corrosive

3. COMPOSITION / INFORMATION ON INGREDIENTS

Potassium Antimonyl Tartrate

Percent Range: < 0.1
Percent Range Units: weight / volume
CAS No.: 28300-74-5
LD50: Oral rat LD_{50} = 115 mg/kg; Oral human LDLo = 2 mg/kg.
LC50: None reported.
TLV: 0.5 mg/m³ (as Sb)
PEL: 0.5 mg/m³ (as Sb)
Ingredient WHMIS Symbol: Acute Poison

Demineralized Water

Percent Range: 75.0 - 85.0
Percent Range Units: volume / volume
CAS No.: 7732-18-5
LD50: LD50 oral rat = >89,800 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sulfamic Acid

Percent Range: < 1.0
Percent Range Units: weight / weight
CAS No.: 5329-14-6
LD50: ATE estimated Oral LD50 = 1054 mg/kg.
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Tartaric Acid

Percent Range: < 0.1
Percent Range Units: weight / volume
CAS No.: 87-69-4
LD50: Oral dog LDLo = 5 g/kg
LC50: None reported
TLV: 10 mg/m^3 as inhalable dust; 3 mg/m^3 as respirable dust
PEL: 15 mg/m^3 as total dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol:

Sulfuric acid

Percent Range: 10.0 - 20.0
Percent Range Units: weight / weight
CAS No.: 7664-93-9
LD50: Oral Rat LD50 = 2140 mg/kg
LC50: Inhalation Rat LC50 = 100 mg/L/4 hr
TLV: 1 mg/m^3

PEL: 1 mg/m^3
Ingredient WHMIS Symbol: Corrosive Acute Poison

Ammonium Molybdate
Percent Range: 0.5 - 3.0
Percent Range Units: weight / volume
CAS No.: 12054-85-2
LD50: Oral Rat LD50 = 333 mg/kg (anhydrous); Oral Rat LD50 = 354 mg/kg (tetrahydrate);
LC50: None reported.
TLV: 5 mg/m^3 as Mo
PEL: 5 mg/m^3 as Mo
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Not Flammable, but reacts with most metals to form flammable hydrogen gas. During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Flash Point: Not determined
Method: Not determined
Flammability Limits:
Lower Explosion Limits: Not determined
Upper Explosion Limits: Not determined
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: sulfur oxides. Hydrogen Sulfide ammonia
Fire / Explosion Hazards: Contact with metals gives off hydrogen gas which is flammable May react violently with: strong bases water
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Dry chemical. Carbon dioxide
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: If permitted by regulation, Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9. Use sulfuric or citric acid to lower pH. Use soda ash or sodium bicarbonate to increase pH. Flush reacted material to the drain with a large excess of water. Otherwise, Decontaminate the area of the spill with a soap solution. Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled.
D.O.T. Emergency Response Guide Number: 154

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe mist or vapors. Wash thoroughly after handling. Use with adequate ventilation. Maintain general industrial hygiene practices when using this product.
Storage: Keep away from: alkalies oxidizers reducers metals

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use general ventilation to minimize exposure to mist, vapor or dust. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: chemical splash goggles
Skin Protection: lab coat disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it.
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: mist/vapor Wash thoroughly after handling. Use with adequate ventilation. Keep away from: alkalies reducers oxidizers metals
TLV: Not established
PEL: Not established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Colorless
Physical State: Liquid
Molecular Weight: Not applicable
Odor: Odorless
pH: < 1
Vapor Pressure: < 20 hPa @ 20 ºC
Vapor Density (air = 1): Not determined
Boiling Point: Not determined
Melting Point: Not determined
Specific Gravity/ Relative Density (water = 1; air =1): 1.11 g/cm^3
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: None intentionally added
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Miscible
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures Heating to decomposition.
Reactivity / Incompatibility: May react violently in contact with: acetic acid caustics chlorosulfonic acid oxidizers reducers Incompatible with: metals
Hazardous Decomposition: Contact with metals may release flammable hydrogen gas. Heating to decomposition releases toxic and/or corrosive fumes of: sulfur oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: ATE Oral Rat LD50 = 8346 mg/kg/bw
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Sulfuric Acid: Oral rat LD50 = 2140 mg/kg, Inhalation rat LC50 = 510 mg/m3/2 hr. Ammonium Molybdate: Oral Rat LD50 = 333 mg/kg. Potassium Antimonyl Tartrate: Oral Rat LD50 = 115 mg/kg.

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available Based on classification principles, not classified as hazardous to the environment.
Ingredient Ecological Information: Ammonium molybdate: LC50 Oncorhynchus mykiss 96 hr = 320 mg/L; EC50 Daphnia magna 48 hr = 140 mg/L; EC50 Desmodesmus subspicatus 72 hr = 41 mg/L. Potassium Antimonyl Tartrate: 48 hr EC50 - Daphnia magna = 5 mg/L; 96 hr LC50 - Fish = 12.5 mg/L

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Working in a large container, cautiously add small portions of the material to cold water with agitation. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Sulphuric Acid
Hazard Class: 8
UN Number/PIN: 2796
Packing Group: II
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: Vendor Information. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Technical Judgment. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Cassaret and Doull's Toxicology, 3rd Ed. New York: Macmillan Publishing Co., Inc., 1986. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Prager, Jan C. Environmental Contaminants Reference Databook, Volumes I and II. Van Nostrand Reinhold Company, New York.

Legend:
NA - Not Applicable w/w - weight/weight

ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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Loveland, CO USA 80539
(970) 669-3050

MSDS No: M02446

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Phosphorus UHR TNT Reagent C
Catalog Number: TNT845C

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M02446
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Mixture
UN Number/PIN: NA
Intended Use: Laboratory Reagent
Date of MSDS Preparation:
Day: 14
Month: March
Year: 2014
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White
Physical State: Solid
Odor: Not determined
CONTAINS MATERIAL WHICH MAY CAUSE HARM TO UNBORN CHILD
HMIS:
Health: 1
Flammability: 1
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation
Skin Absorption: No effects anticipated
Target Organs: Not applicable
Ingestion: Very large doses may cause: gastrointestinal irritation diarrhea harm to the unborn child,
Target Organs: None reported
Inhalation: May cause: respiratory tract irritation
Target Organs: Not applicable
Medical Conditions Aggravated: Pre-existing: Skin conditions Eye conditions Respiratory conditions
Chronic Effects: Chronic overexposure may cause allergic respiratory reactions harm to unborn child
Cancer / Reproductive Toxicity Information:
IARC Listed: No
NTP Listed: No
Additional Cancer / Reproductive Toxicity Information: Contains: a suspected teratogen. an experimental mutagen. NOAEL for embryotoxic/teratogenic effects as Boron:9.6 mg B/kg bw/day NOAEL for fertility effects as Boron:17.5 mg B/kg bw/day

Toxicologically Synergistic Products: None reported
WHMIS Hazard Classification: Class D, Division 2, Subdivision B - Toxic material (other toxic effects)
WHMIS Symbols: Other Toxic Effects

3. COMPOSITION / INFORMATION ON INGREDIENTS

Dextran
Percent Range: 10.0 - 20.0
Percent Range Units: weight / weight
CAS No.: 9004-54-0
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

L-Ascorbic Acid
Percent Range: 50.0 - 60.0
Percent Range Units: weight / weight
CAS No.: 50-81-7
LD50: Oral rat LD50 = 11900 mg/kg
LC50: None reported
TLV: 10 mg/m^3 as inhalable dust; 3 mg/m^3 as respirable dust
PEL: 15 mg/m^3 as total dust; 5 mg/m^3 as respirable dust
Ingredient WHMIS Symbol: Not applicable

Sodium Metaborate
Percent Range: 20.0 - 30.0
Percent Range Units: weight / weight
CAS No.: 7775-19-1
LD50: Oral rat LD50 = 2330 mg/kg
LC50: None reported
TLV: 10 mg/M^3 Inhalable Particles; 3 mg/M^3 Respirable Particles
PEL: 15 mg/M^3 Total Dust; 5 mg/M^3 Respirable Dust
Ingredient WHMIS Symbol: Other Toxic Effects

4. FIRST AID MEASURES

Eye Contact: Flush eyes with water. Call physician if irritation develops.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Give large quantities of water. Call physician immediately.
Inhalation: Remove to fresh air.

5. FIRE FIGHTING MEASURES

Flammable Properties: Can burn in fire, releasing toxic vapors. Material is not classified as flammable according to GHS criteria.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not determined
Upper Explosion Limits: Not determined
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: carbon monoxide, carbon dioxide. sodium oxides boron compounds
Fire / Explosion Hazards: May react violently with: strong oxidizers
Static Discharge: None reported.
Mechanical Impact: None reported

Extinguishing Media: Carbon dioxide Dry chemical. Water.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: If permitted by regulation, Scoop up spilled material into a large beaker and dissolve with water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Otherwise, Decontaminate the area of the spill with a soap solution. Dispose of in accordance with local, state and federal regulations or laws.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: --

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep away from: oxidizers

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it. lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Do not breathe: dust Wash thoroughly after handling. Keep away from: oxidizers
TLV: Not established. Handle as dust.
PEL: Not established. Handle as dust.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: White
Physical State: Solid
Molecular Weight: Not applicable
Odor: Not determined
pH: Not determined
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not determined
Melting Point: 192 ºC (378 ºF)
Specific Gravity/ Relative Density (water = 1; air =1): 600 - 900 kg/cm^3
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: 70-80% Per 49 CFR definition. (Non-volatile)
Coefficient of Water / Oil: Not applicable
Solubility:
Water: 330 g/L
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture
Reactivity / Incompatibility: Incompatible with: oxidizers alkalies copper iron
Hazardous Decomposition: Heating to decomposition releases toxic fumes of carbon monoxide and carbon dioxide.
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: ATE Oral Rat LD50 = 5860 mg/kg/bw
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Ascorbic acid: Oral rat LD_{50} = 11900 mg/Kg; Sodium metaborate: Oral rat LD_{50}= 2330 mg/Kg;

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available Based on classification principles, not classified as hazardous to the environment.
Ingredient Ecological Information: --
Ecological data for ingredients is not indicative of likely ecological harm.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Work in an approved fume hood. Dilute to 3 to 5 times the volume with cold water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
Hazard Class: NA
UN Number/PIN: NA
Packing Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Vendor Information. In-house information. Technical Judgment.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

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MSDS No: M01949

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Phosphorus UHR TNT Reagent Vial
Catalog Number: TNT845R

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01949
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
PIN: NA
Intended Use: Laboratory Reagent Standard solution
Date of MSDS Preparation:
Day: 17
Month: February
Year: 2012
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless
Physical State: Liquid
Odor: Acidic
CAUSES EYE BURNS MAY CAUSE RESPIRATORY TRACT IRRITATION
CANCER HAZARD CONTAINS SULFURIC ACID WHICH CAN CAUSE CANCER

HMIS:
Health: 3
Flammability: 0
Reactivity: 1
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: Causes eye burns.
Skin Contact: May cause irritiation
Skin Absorption: None Reported
Target Organs: None Reported
Ingestion: May cause: irritation of the mouth and esophagus
Target Organs: None reported
Inhalation: May cause: respiratory tract irritation difficult breathing mouth soreness teeth erosion
Target Organs: Lungs
Medical Conditions Aggravated: Pre-existing: Eye conditions Respiratory conditions
Chronic Effects: Chronic overexposure may cause cancer
Cancer / Reproductive Toxicity Information:
An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen

Sulfuric Acid - The IARC evaluation was based on exposure to the mist or vapor of concentrated sulfuric acid generated during chemical processes.

An ingredient of this mixture is: NTP Listed Group 1: Recognized Carcinogen
Sulfuric Acid Mist or Vapor

Additional Cancer / Reproductive Toxicity Information: None reported

Toxicologically Synergistic Products: None reported

WHMIS Hazard Classification: Class D, Division 2, Subdivision A - Very toxic materials (other toxic effects) Class D, Division 2, Subdivision B - Toxic material (other toxic effects)

WHMIS Symbols: Other Toxic Effects

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3. COMPOSITION / INFORMATION ON INGREDIENTS

Demineralized Water

Percent Range: > 99.0
Percent Range Units: volume / volume
CAS No.: 7732-18-5
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

Sulfuric acid

Percent Range: 0.1 - 1.0
Percent Range Units: weight / weight
CAS No.: 7664-93-9
LD50: Oral rat LD50 = 2140 mg/kg.
LC50: Inhalation rat LC50 = 87 ppm/4 hr
TLV: 1 mg/m³ (TWA); 3 mg/m³ (STEL)
PEL: 1 mg/m^3
Ingredient WHMIS Symbol: Other Toxic Effects

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4. FIRST AID MEASURE

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: Remove to fresh air.

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5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: This product will not burn or explode.
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

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6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment.
Clean-up Technique: Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Dispose of material in government approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: a gallon or more of liquid is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: None

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7. HANDLING AND STORAGE

Handling: Avoid contact with eyes Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use.

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8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: lab coat disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it.
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

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9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless
Physical State: Liquid
Molecular Weight: Not applicable
Odor: Acidic
pH: 1.0
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: Not determined
Melting Point: Not determined
Specific Gravity/ Relative Density (water = 1; air =1): 1.04
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not applicable
Coefficient of Water / Oil: Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

---

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures Heating to decomposition.
Reactivity / Incompatibility: Incompatible with: caustics

Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: sulfur oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: None reported
Reproductive Effects Data: None reported
--
Ingredient Toxicological Data: Sulfuric Acid: Oral rat LD50 = 2140 mg/kg; Inhalation rat 87 ppm/4H

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available
Ingredient Ecological Information: The 48-Hour TLm in flounder is 100-300 ppm.

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Work in an approved fume hood. Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Not Currently Regulated
--
Hazard Class: NA
PIN: NA
Group: NA
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: All ingredients of this product are DSL Listed.
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. IARC Monographs on the Evaluation of the Carcinogenic Risks to

Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Outside Testing. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

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World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00220

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Ammonium Hydroxide
Catalog Number: 10649

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00220
Chemical Name: Ammonium Hydroxide
CAS No.: 1336-21-6
Chemical Formula: NH_4OH
Chemical Family: Inorganic Base
UN Number/PIN: 2672
Intended Use: Laboratory Reagent
Date of MSDS Preparation:
Day: 09
Month: August
Year: 2012
MSDS Prepared: MSDS prepared by Product Compliance Department extension 3350

2. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Colorless liquid
Physical State: Liquid
Odor: Ammonia
CAUSES BURNS HARMFUL IF SWALLOWED OR INHALED
HMIS:
Health: 3
Flammability: 0
Reactivity: 1
Protective Equipment: X - See protective equipment, Section 8.
Potential Health Effects:
Eye Contact: Causes eye burns.
Skin Contact: Causes burns.
Skin Absorption: None Reported
Target Organs: None Reported
Ingestion: Causes: burns abdominal pain nausea vomiting
Target Organs: None reported
Inhalation: Can cause: respiratory tract irritation coughing difficult breathing May cause: pneumonitis laryngitis chest pain
Target Organs: None reported
Medical Conditions Aggravated: Pre-existing: Eye conditions Skin conditions Respiratory conditions
Chronic Effects: None reported
Cancer / Reproductive Toxicity Information:
IARC Listed: No
NTP Listed: No
Additional Cancer / Reproductive Toxicity Information: None reported
Toxicologically Synergistic Products: None reported

WHMIS Hazard Classification: Class D, Division 1, Subdivision B - Toxic material (immediate effects) Class E - Corrosive material
WHMIS Symbols: Corrosive Acute Poison

3. COMPOSITION / INFORMATION ON INGREDIENTS

Ammonium Hydroxide
Percent Range: 50.0 - 60.0
Percent Range Units: weight / weight
CAS No.: 1336-21-6
LD50: Oral rat LD50 = 350 mg/kg
LC50: None reported
TLV: TWA= 25ppm (as NH_3); STEL/C= 35ppm (as NH_3)
PEL: 35 ppm (as NH_3)
Ingredient WHMIS Symbol: Corrosive Acute Poison

Demineralized Water
Percent Range: 40.0 - 50.0
Percent Range Units: weight / weight
CAS No.: 7732-18-5
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Ingredient WHMIS Symbol: Not applicable

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: 16% as NH_3
Upper Explosion Limits: 27% as NH_3
Autoignition Temperature: 651°C; 1204°F as NH_3
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: Not combustible.
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Alcohol foam. Carbon dioxide Water. Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: Containers can build up pressure if exposed to heat. As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances should respond to a spill involving chemicals. See Section 13, Special Instructions for disposal assistance.

Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Cover spilled material with a dry acid, such as citric or boric. Scoop up slurry into a large beaker. Dilute with a large excess of water. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
D.O.T. Emergency Response Guide Number: 154

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep away from: acids / acid fumes.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use a fume hood to avoid exposure to dust, mist or vapor. Have an eyewash station nearby. Have a safety shower nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: chemical splash goggles
Skin Protection: neoprene latex gloves lab coat
Inhalation Protection: laboratory fume hood
Precautionary Measures: Keep away from: acids/acid fumes Do not breathe: mist/vapor Wash thoroughly after handling. Avoid contact with: eyes skin clothing
TLV: TWA= 25ppm (as NH_3); STEL/C= 35ppm (as NH_3)
PEL: 35 ppm (as NH_3)

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Colorless liquid
Physical State: Liquid
Molecular Weight: 35.06
Odor: Ammonia
pH: ~14
Vapor Pressure: 570 mm Hg @ 20°C
Vapor Density (air = 1): 0.6
Boiling Point: 36°C; 97°F
Melting Point: -72°C; -98°F
Specific Gravity/ Relative Density (water = 1; air =1): 0.9
Evaporation Rate (water = 1): Not available
Volatile Organic Compounds Content: Not available
Coefficient of Water / Oil: Not available
Solubility:
Water: Miscible
Acid: Not determined
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY AND REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: May react violently in contact with: acids oxidizers silver salts
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: nitrogen oxides ammonia
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: Oral rat LD50 = 350 mg/kg
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Eye irritation rabbit (Standard Draize Test) @ 44 µg = SEVERE.
Mutation Data: No mammalian data reported.
Reproductive Effects Data: None reported
--
Ingredient Toxicological Data: --
Not applicable

12. ECOLOGICAL INFORMATION

Product Ecological Information: Aquatic Toxicity Rating: TLm 96: 100 - 10 ppm
Ingredient Ecological Information: --
Not applicable

13. DISPOSAL CONSIDERATIONS

Special Instructions (Disposal): Work in an approved fume hood. Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an acid, such as sulfuric or citric. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

T.D.G.:
Proper Shipping Name: Ammonia Solution
--
Hazard Class: 8
UN Number/PIN: 2672
Packing Group: III
Subsidiary Risk: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

National Inventories:
Canadian Inventory Status: DSL Listed: Yes
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

16. OTHER INFORMATION

References: Technical Judgment. Vendor Information. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. EU Occupational Exposure Limits On Line.

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

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Appendix C – Test Procedure and Information for TSS and VSS

Total Suspended Solids (TSS) & Volatile Suspended Solids (VSS) Procedure

Contents

General Notes

1. The following information provides a description of the apparatus, procedures, and calculations required to determine the Total Suspended Solids (TSS) and Volatile Suspended Solids (VSS) concentrations.
2. If these calculation are performed on sludge (mixed liquor), the concentrations are commonly referred to as Mixed Liquor Suspended Solids (MLSS) and Mixed Liquor Volatile Suspended Solids (MLVSS).
3. The test procedure included here has been adapted from the Standards Methods Procedure for Total Suspended Solids. For further information, the Standard Methods information has been included at the end of this document.

TSS & VSS Test Apparatus:

1. Drying Oven:

- Oven should be left on at all times.
- Temperature should be maintained between 103°C - 105°C at all times.
- Monitor temperature using upper thermometer (not the dial guage).
- Keep clean prepared filter papers in oven until ready for use.

2. Desiccator:

- Place dishes and filters in here temporarily during testing procedure.
- Ensure Desiccant Material (below tray) is blue.
- Ensure lid seats properly on red gasket seal.

3. Desiccant “Drierite” Material:

- Drierite material should be placed in the bottom of the desiccator (1-2 bottles should be enough).
- If material is blue, it is ok to use.
- After a while, the material may start turn pink. When this happens, remove the material from the desiccator and place it in the drying oven overnight or until it turns back to blue. Place material evenly on an aluminum pie plate or similar for drying. After material turns back to blue it can be put back in the desiccator for use.
- If material does not turn back to blue in the drying oven, it should be replaced with new material.

4. 4-Decimal Balance:

- Used to measure weight of aluminum trays and filter papers.
- Always keep side doors closed unless in use.
- Turn off after use.
- Ensure scale reads “0.0000” before measuring.

5. Filter Flask with Filter Funnel Installed:

- Filter funnel fits on top of filter flask. Insert rubber stopper into top of flask.
- Make sure tubing is connected to the nozzle on the filter flask as shown in the photo.
- Remove filter funnel from flask and disconnected tubing for storage.

6. Filter Flask and Funnel with Cup Installed:

- The cup should be used on top of the filter funnel when testing TSS of final effluent.
- Place filter paper on filter funnel and then place cup on top of filter paper.
- The cup can be filled with effluent sample for filtering.

7. Vacuum Pump:

- Vacuum pulls liquid through filter paper.
- On/off switch on rear of pump.
- Ensure tubing is connected to “Vacuum” side of pump.
- Other end of tubing connects to filter flask.

8. Top-Load Balance:

- Balance can be used to measure the volume of sample filtered for TSS test.
- 1 g of water = 1 mL of water
- Ensure balance reads “0.0 g” before taking a measurement.

9. Muffle Furnace

- Furnace should be off at all times except during a test.
- During a test, furnace should be set to 550°C.
- Used for VSS test.

TSS & VSS Test Procedure:

1. Both the TSS and VSS will be determined from the following procedure.
2. Start with prepared filters using de-ionized water. See Filter Preparation Procedure below.
3. Place a single filter in an aluminum weighing dish. One filter and dish is required for each sample to be tested. The forceps (tweezers) should always be used to handle the aluminum dish and filter paper – never use fingers. Only set the dish down on clean surfaces to avoid accumulation of dust or debris that can affect the accuracy of the test.
4. Place multiple weighing dishes with filters into the desiccator. Wait a few minutes, allowing them to cool to room temperature.
5. Turn the 4-decimal balance on. For each sample, place the weighing dish with clean filter on the 4-decimal balance. Wait a few seconds for the reading to stabilize. Record the mass reading on the worksheet in the row called "Original Mass (g)". This is the weight of the dish and the clean filter with sample added.
6. Set-up the filter flask and funnel unit and make sure the tubing is connected to the vacuum pump. Turn the vacuum pump on.
7. Remove the clean filter paper from the aluminum weighing dish and place it on the filter flask.
8. Turn the top-load balance on. Place the sample beaker including the stirring rod on the top-load balance. With the sample beaker and stirring rod sitting on the balance, press "Re-Zero". The balance should read "0.0 g" with the sample beaker and stirring rod sitting on it.
9. Take beaker from the balance and thoroughly mix the sample with the stirring rod.
10. Pour a small amount of sample onto the filter paper on top of the filter funnel. There should be a visible amount of solids on the paper. Leave the paper on top of the filter flask with the vacuum pump running for a few seconds. Wait until there is no visible liquid on the surface of the paper (the paper may appear damp but this is ok).
11. After all visible liquid has been removed from the paper, carefully place the paper back in the aluminum dish. Place the aluminum dish with filter paper back in the drying oven. The sample must stay in the oven at a temperature between 103°C - 105°C for a minimum of 2 hours. If there is other work to do the samples can stay in the oven longer than 2 hours if needed.
12. After the sample has been in the oven for at least 2 hours, remove the aluminum dish with filter paper from the oven and place it in the desiccator. Wait a few minutes for the sample to cool to room temperature.
13. After the sample has cooled to room temperature, place it on the 4-decimal balance. Wait a few seconds for the reading to stabilize. Record the weight on the worksheet in the row called "Mass 103°C (g)". After recording the weight, place the sample back in the desiccator.
14. The TSS concentration can now be calculated. See step 1 in the "TSS/VSS Calculations" below. Record the calculated TSS concentration on the worksheet in the row "TSS (mg/L)".
15. Turn the muffle furnace on to a temperature of 550°C (this could be done a few minutes ahead of time to allow it to heat up).
16. When the furnace has reached 550°C, take the samples from the desiccator and place them in the furnace. This should be done using the longer tongs. Care should be taken to avoid burns to

the skin when using the furnace. It would be recommended to wear heavier gloves when working around the furnace.

17. Leave the sample in the muffle furnace for a minimum of 15 minutes. If there is other work to do the samples can stay in the furnace longer than 15 minutes if needed.
18. After the sample has been in the furnace for at least 15 minutes, remove the aluminum dish with filter paper from the furnace and place it in the desiccator. Wait a few minutes for the sample to cool to room temperature.
19. After the sample has cooled to room temperature, place it on the 4-decimal balance. Wait a few seconds for the reading to stabilize. Record the weight on the worksheet in the row called "Mass 550°C (g)".
20. After recording the weight, the filter paper can be thrown away. The aluminum dishes can be reused for multiple tests as long as they are not dirty. If the aluminum dish is still clean, place it back in the drying oven to be reused.
21. The VSS concentration can now be calculated. See step 2 in the "TSS/VSS Calculations" below. Record the calculated VSS concentration on the worksheet in the row "VSS (mg/L)".

TSS & VSS Filter Paper Preparation:

1. Before completing any testing, all filter papers must be prepared before they are ready to use. It is recommended to prepare extra filter papers and keep them stored in the drying oven until they are needed.
2. Setup the filter flask and funnel and connect the flask to the vacuum pump (same as during a regular TSS test).
3. Turn the vacuum pump on. Take a clean filter from the package and place it on the filter funnel.
4. Using de-ionized water (never use tap water), completely wet the surface of the filter paper.
5. Wait a few seconds until there is no visible water on top of the paper. The filter paper may look slightly damp but this is ok. When there is no visible water remove the paper from the filter funnel and place it in an aluminum weighing dish.
6. Repeat step 3-5 for as many filter papers as needed. It is ok to prepare multiple papers at one time. Multiple prepared filter papers can be stacked in the same aluminum dish until needed for testing. Place all of the prepared filter papers in the drying oven for a minimum time of 2 hours before using.
7. It is recommended to prepare filter papers the day before they are needed and leave in the drying oven.

TSS & VSS Calculations:

1. Calculate TSS Concentration:

    a. Calculate mass difference after drying at 103°C for 2 hours.
    Subtract: "Mass 103°C " – "Original Mass"
    b. Divide the result in part a by the sample volume recorded on the worksheet.
    c. Multiply the result from part b by 1,000,000. The result gives the TSS concentration in units of mg/L.

    Complete Equation:

$$TSS = \frac{(\text{Mass } 103°\text{C} - Original\ Mass)}{Volume} \times 1{,}000{,}000$$

2. Calculate VSS Concentration:

    a. Calculate mass difference after furnace at 550°C for 15 minutes.
    Subtract "Mass 103°C" – "Mass 550°C"
    b. Divide the result in part a by the sample volume recorded on the worksheet.
    c. Multiply the result from part b by 1,000,000. The result gives the VSS concentration in units of mg/L.

    Complete Equation:

$$VSS = \frac{(Mass\ 103°C - Mass\ 550°C)}{Volume} \times 1{,}000{,}000$$

2540 SOLIDS*

2540 A. Introduction

Solids refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and may induce an unfavorable physiological reaction in the transient consumer. For these reasons, a limit of 500 mg dissolved solids/L is desirable for drinking waters. Highly mineralized waters also are unsuitable for many industrial applications. Waters high in suspended solids may be esthetically unsatisfactory for such purposes as bathing. Solids analyses are important in the control of biological and physical wastewater treatment processes and for assessing compliance with regulatory agency wastewater effluent limitations.

1. Definitions

"Total solids" is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids includes "total suspended solids," the portion of total solids retained by a filter, and "total dissolved solids," the portion that passes through the filter.

The type of filter holder, the pore size, porosity, area, and thickness of the filter and the physical nature, particle size, and amount of material deposited on the filter are the principal factors affecting separation of suspended from dissolved solids. "Dissolved solids" is the portion of solids that passes through a filter of 2.0 μm (or smaller) nominal pore size under specified conditions. "Suspended solids" is the portion retained on the filter.

"Fixed solids" is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called "volatile solids." Determinations of fixed and volatile solids do not distinguish precisely between inorganic and organic matter because the loss on ignition is not confined to organic matter. It includes losses due to decomposition or volatilization of some mineral salts. Better characterization of organic matter can be made by such tests as total organic carbon (Section 5310), BOD (Section 5210), and COD (Section 5220).

"Settleable solids" is the term applied to the material settling out of suspension within a defined period. It may include floating material, depending on the technique (2540F.3*b*).

2. Sources of Error and Variability

Sampling, subsampling, and pipeting two-phase or three-phase samples may introduce serious errors. Make and keep such samples homogeneous during transfer. Use special handling to insure sample integrity when subsampling. Mix small samples with a magnetic stirrer. If suspended solids are present, pipet with wide-bore pipets. If part of a sample adheres to the sample container, consider this in evaluating and reporting results. Some samples dry with the formation of a crust that prevents water evaporation; special handling is required to deal with this. Avoid using a magnetic stirrer with samples containing magnetic particles.

The temperature at which the residue is dried has an important bearing on results, because weight losses due to volatilization of organic matter, mechanically occluded water, water of crystallization, and gases from heat-induced chemical decomposition, as well as weight gains due to oxidation, depend on temperature and time of heating. Each sample requires close attention to desiccation after drying. Minimize opening desiccator because moist air enters. Some samples may be stronger desiccants than those used in the desiccator and may take on water.

Residues dried at 103 to 105°C may retain not only water of crystallization but also some mechanically occluded water. Loss of CO_2 will result in conversion of bicarbonate to carbonate. Loss of organic matter by volatilization usually will be very slight. Because removal of occluded water is marginal at this temperature, attainment of constant weight may be very slow.

Residues dried at 180 ± 2°C will lose almost all mechanically occluded water. Some water of crystallization may remain, especially if sulfates are present. Organic matter may be lost by volatilization, but not completely destroyed. Loss of CO_2 results from conversion of bicarbonates to carbonates and carbonates may be decomposed partially to oxides or basic salts. Some chloride and nitrate salts may be lost. In general, evaporating and drying water samples at 180°C yields values for dissolved solids closer to those obtained through summation of individually determined mineral species than the dissolved solids values secured through drying at the lower temperature.

To rinse filters and filtered solids and to clean labware use Type III water. Special samples may require a higher quality water; see Section 1080.

Results for residues high in oil or grease may be questionable because of the difficulty of drying to constant weight in a reasonable time.

To aid in quality assurance, analyze samples in duplicate. Dry samples to constant weight if possible. This entails multiple drying-cooling-weighing cycles for each determination.

Analyses performed for some special purposes may demand deviation from the stated procedures to include an unusual constituent with the measured solids. Whenever such variations of technique are introduced, record and present them with the results.

3. Sample Handling and Preservation

Use resistant-glass or plastic bottles, provided that the material in suspension does not adhere to container walls. Begin analysis as soon as possible because of the impracticality of preserving the sample. Refrigerate sample at 4°C up to the time of analysis to minimize microbiological decomposition of solids. Preferably do not hold samples more than 24 h. In no case hold sample more than 7 d. Bring samples to room temperature before analysis.

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* Approved by Standard Methods Committee, 1997.
Joint Task Group: 20th Edition—Brannon H. Wilder (chair), Harold S. Costa, Christine M. Kosmowski, William E. Purcell.

4. Selection of Method

Methods B through F are suitable for the determination of solids in potable, surface, and saline waters, as well as domestic and industrial wastewaters in the range up to 20 000 mg/L.

Method G is suitable for the determination of solids in sediments, as well as solid and semisolid materials produced during water and wastewater treatment.

5. Bibliography

THERIAULT, E.J. & H.H. WAGENHALS. 1923. Studies of representative sewage plants. *Pub. Health Bull.* No. 132.

U.S. ENVIRONMENTAL PROTECTION AGENCY. 1979. Methods for Chemical Analysis of Water and Wastes. Publ. 600/4-79-020, rev. Mar. 1983. Environmental Monitoring and Support Lab., U.S. Environmental Protection Agency, Cincinnati, Ohio.

2540 B. Total Solids Dried at 103–105°C

1. General Discussion

a. Principle: A well-mixed sample is evaporated in a weighed dish and dried to constant weight in an oven at 103 to 105°C. The increase in weight over that of the empty dish represents the total solids. The results may not represent the weight of actual dissolved and suspended solids in wastewater samples (see above).

b. Interferences: Highly mineralized water with a significant concentration of calcium, magnesium, chloride, and/or sulfate may be hygroscopic and require prolonged drying, proper desiccation, and rapid weighing. Exclude large, floating particles or submerged agglomerates of nonhomogeneous materials from the sample if it is determined that their inclusion is not desired in the final result. Disperse visible floating oil and grease with a blender before withdrawing a sample portion for analysis. Because excessive residue in the dish may form a water-trapping crust, limit sample to no more than 200 mg residue (see 2540A.2).

2. Apparatus

a. Evaporating dishes: Dishes of 100-mL capacity made of one of the following materials:

1) Porcelain, 90-mm diam.
2) Platinum—Generally satisfactory for all purposes.
3) High-silica glass.*

b. Muffle furnace for operation at 550°C.

c. Steam bath.

d. Desiccator, provided with a desiccant containing a color indicator of moisture concentration or an instrumental indicator.

e. Drying oven, for operation at 103 to 105°C.

f. Analytical balance, capable of weighing to 0.1 mg.

g. Magnetic stirrer with TFE stirring bar.

h. Wide-bore pipets.†

i. Graduated cylinder.

j. Low-form beaker.‡

3. Procedure

a. Preparation of evaporating dish: If volatile solids are to be measured ignite clean evaporating dish at 550°C for 1 h in a muffle furnace. If only total solids are to be measured, heat clean dish to 103 to 105°C for 1 h. Store and cool dish in desiccator until needed. Weigh immediately before use.

b. Sample analysis: Choose a sample volume that will yield a residue between 2.5 and 200 mg. Pipet a measured volume of well-mixed sample, during mixing, to a preweighed dish. For homogeneous samples, pipet from the approximate midpoint of the container but not in the vortex. Choose a point both middepth and midway between wall and vortex. Evaporate to dryness on a steam bath or in a drying oven. Stir sample with a magnetic stirrer during transfer. If necessary, add successive sample portions to the same dish after evaporation. When evaporating in a drying oven, lower temperature to approximately 2°C below boiling to prevent splattering. Dry evaporated sample for at least 1 h in an oven at 103 to 105°C, cool dish in desiccator to balance temperature, and weigh. Repeat cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained, or until weight change is less than 4% of previous weight or 0.5 mg, whichever is less. When weighing dried sample, be alert to change in weight due to air exposure and/or sample degradation. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

4. Calculation

$$\text{mg total solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of dried residue + dish, mg, and
B = weight of dish, mg.

5. Precision

Single-laboratory duplicate analyses of 41 samples of water and wastewater were made with a standard deviation of differences of 6.0 mg/L.

6. Bibliography

SYMONS, G.E. & B. MOREY. 1941. The effect of drying time on the determination of solids in sewage and sewage sludges. *Sewage Works J.* 13:936.

* Vycor, product of Corning Glass Works, Corning, NY, or equivalent.
† Kimble Nos. 37005 or 37034B, or equivalent.
‡ Class B or better.

2540 C. Total Dissolved Solids Dried at 180°C

1. General Discussion

a. Principle: A well-mixed sample is filtered through a standard glass fiber filter, and the filtrate is evaporated to dryness in a weighed dish and dried to constant weight at 180°C. The increase in dish weight represents the total dissolved solids. This procedure may be used for drying at other temperatures.

The results may not agree with the theoretical value for solids calculated from chemical analysis of sample (see above). Approximate methods for correlating chemical analysis with dissolved solids are available.[1] The filtrate from the total suspended solids determination (Section 2540D) may be used for determination of total dissolved solids.

b. Interferences: See 2540A.2 and 2540B.1. Highly mineralized waters with a considerable calcium, magnesium, chloride, and/or sulfate content may be hygroscopic and require prolonged drying, proper desiccation, and rapid weighing. Samples high in bicarbonate require careful and possibly prolonged drying at 180°C to insure complete conversion of bicarbonate to carbonate. Because excessive residue in the dish may form a water-trapping crust, limit sample to no more than 200 mg residue.

2. Apparatus

Apparatus listed in 2540B.2*a-h* is required, and in addition:

*a. Glass-fiber filter disks** without organic binder.

b. Filtration apparatus: One of the following, suitable for the filter disk selected:

1) *Membrane filter funnel.*

2) *Gooch crucible,* 25-mL to 40-mL capacity, with Gooch crucible adapter.

3) *Filtration apparatus* with reservoir and coarse (40- to 60-μm) fritted disk as filter support.†

c. Suction flask, of sufficient capacity for sample size selected.

d. Drying oven, for operation at 180 ± 2°C.

3. Procedure

a. Preparation of glass-fiber filter disk: If pre-prepared glass fiber filter disks are used, eliminate this step. Insert disk with wrinkled side up into filtration apparatus. Apply vacuum and wash disk with three successive 20-mL volumes of reagent-grade water. Continue suction to remove all traces of water. Discard washings.

b. Preparation of evaporating dish: If volatile solids are to be measured, ignite cleaned evaporating dish at 550°C for 1 h in a muffle furnace. If only total dissolved solids are to be measured, heat clean dish to 180 ± 2°C for 1 h in an oven. Store in desiccator until needed. Weigh immediately before use.

c. Selection of filter and sample sizes: Choose sample volume to yield between 2.5 and 200 mg dried residue. If more than 10 min are required to complete filtration, increase filter size or decrease sample volume.

d. Sample analysis: Stir sample with a magnetic stirrer and pipet a measured volume onto a glass-fiber filter with applied vacuum. Wash with three successive 10-mL volumes of reagent-grade water, allowing complete drainage between washings, and continue suction for about 3 min after filtration is complete. Transfer total filtrate (with washings) to a weighed evaporating dish and evaporate to dryness on a steam bath or in a drying oven. If necessary, add successive portions to the same dish after evaporation. Dry evaporated sample for at least 1 h in an oven at 180 ± 2°C, cool in a desiccator to balance temperature, and weigh. Repeat drying cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until weight change is less than 4% of previous weight or 0.5 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight. If volatile solids are to be determined, follow procedure in 2540E.

4. Calculation

$$\text{mg total dissolved solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of dried residue + dish, mg, and
B = weight of dish, mg.

5. Precision

Single-laboratory analyses of 77 samples of a known of 293 mg/L were made with a standard deviation of differences of 21.20 mg/L.

6. Reference

1. Sokoloff, V.P. 1933. Water of crystallization in total solids of water analysis. *Ind. Eng. Chem.,* Anal. Ed. 5:336.

7. Bibliography

Howard, C.S. 1933. Determination of total dissolved solids in water analysis. *Ind. Eng. Chem.,* Anal. Ed. 5:4.

U.S. Geological Survey. 1974. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Techniques of Water-Resources Investigations, Book 5, Chap. A1. U.S. Geological Surv., Washington, D.C.

* Whatman grade 934AH; Gelman type A/E; Millipore type AP40; E-D Scientific Specialties grade 161; Environmental Express Pro Weigh; or other products that give demonstrably equivalent results. Practical filter diameters are 2.2 to 12.5 cm.
† Gelman No. 4201 or equivalent.

2540 D. Total Suspended Solids Dried at 103–105°C

1. General Discussion

a. Principle: A well-mixed sample is filtered through a weighed standard glass-fiber filter and the residue retained on the filter is dried to a constant weight at 103 to 105°C. The increase in weight of the filter represents the total suspended solids. If the suspended material clogs the filter and prolongs filtration, it may be necessary to increase the diameter of the filter or decrease the sample volume. To obtain an estimate of total suspended solids, calculate the difference between total dissolved solids and total solids.

b. Interferences: See 2540A.2 and 2540B.1. Exclude large floating particles or submerged agglomerates of nonhomogeneous materials from the sample if it is determined that their inclusion is not representative. Because excessive residue on the filter may form a water-entrapping crust, limit the sample size to that yielding no more than 200 mg residue. For samples high in dissolved solids thoroughly wash the filter to ensure removal of dissolved material. Prolonged filtration times resulting from filter clogging may produce high results owing to increased colloidal materials captured on the clogged filter.

2. Apparatus

Apparatus listed in Sections 2540B.2 and 2540C.2 is required, except for evaporating dishes, steam bath, and 180°C drying oven. In addition:

Aluminum weighing dishes.

3. Procedure

a. Preparation of glass-fiber filter disk: If pre-prepared glass fiber filter disks are used, eliminate this step. Insert disk with wrinkled side up in filtration apparatus. Apply vacuum and wash disk with three successive 20-mL portions of reagent-grade water. Continue suction to remove all traces of water, turn vacuum off, and discard washings. Remove filter from filtration apparatus and transfer to an inert aluminum weighing dish. If a Gooch crucible is used, remove crucible and filter combination. Dry in an oven at 103 to 105°C for 1 h. If volatile solids are to be measured, ignite at 550°C for 15 min in a muffle furnace. Cool in desiccator to balance temperature and weigh. Repeat cycle of drying or igniting, cooling, desiccating, and weighing until a constant weight is obtained or until weight change is less than 4% of the previous weighing or 0.5 mg, whichever is less. Store in desiccator until needed.

b. Selection of filter and sample sizes: Choose sample volume to yield between 2.5 and 200 mg dried residue. If volume filtered fails to meet minimum yield, increase sample volume up to 1 L. If complete filtration takes more than 10 min, increase filter diameter or decrease sample volume.

c. Sample analysis: Assemble filtering apparatus and filter and begin suction. Wet filter with a small volume of reagent-grade water to seat it. Stir sample with a magnetic stirrer at a speed to shear larger particles, if practical, to obtain a more uniform (preferably homogeneous) particle size. Centrifugal force may separate particles by size and density, resulting in poor precision when point of sample withdrawal is varied. While stirring, pipet a measured volume onto the seated glass-fiber filter. For homogeneous samples, pipet from the approximate midpoint of container but not in vortex. Choose a point both middepth and midway between wall and vortex. Wash filter with three successive 10-mL volumes of reagent-grade water, allowing complete drainage between washings, and continue suction for about 3 min after filtration is complete. Samples with high dissolved solids may require additional washings. Carefully remove filter from filtration apparatus and transfer to an aluminum weighing dish as a support. Alternatively, remove the crucible and filter combination from the crucible adapter if a Gooch crucible is used. Dry for at least 1 h at 103 to 105°C in an oven, cool in a desiccator to balance temperature, and weigh. Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until the weight change is less than 4% of the previous weight or 0.5 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight. If volatile solids are to be determined, treat the residue according to 2540E.

4. Calculation

$$\text{mg total suspended solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of filter + dried residue, mg, and
B = weight of filter, mg.

5. Precision

The standard deviation was 5.2 mg/L (coefficient of variation 33%) at 15 mg/L, 24 mg/L (10%) at 242 mg/L, and 13 mg/L (0.76%) at 1707 mg/L in studies by two analysts of four sets of 10 determinations each.

Single-laboratory duplicate analyses of 50 samples of water and wastewater were made with a standard deviation of differences of 2.8 mg/L.

6. Bibliography

DEGEN, J. & F.E. NUSSBERGER. 1956. Notes on the determination of suspended solids. *Sewage Ind. Wastes* 28:237.

CHANIN, G., E.H. CHOW, R.B. ALEXANDER & J. POWERS. 1958. Use of glass fiber filter medium in the suspended solids determination. *Sewage Ind. Wastes* 30:1062.

NUSBAUM, I. 1958. New method for determination of suspended solids. *Sewage Ind. Wastes* 30:1066.

SMITH, A.L. & A.E. GREENBERG. 1963. Evaluation of methods for determining suspended solids in wastewater. *J. Water Pollut. Control Fed.* 35:940.

WYCKOFF, B.M. 1964. Rapid solids determination using glass fiber filters. *Water Sewage Works* 111:277.

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT. 1975. A Preliminary Review of Analytical Methods for the Determination of Suspended Solids in Paper Industry Effluents for Compliance with EPA-NPDES Permit Terms. Spec. Rep. No. 75-01. National Council of the Paper Industry for Air & Stream Improvement, New York, N.Y.

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT. 1977. A Study of the Effect of Alternate Procedures on

Effluent Suspended Solids Measurement. Stream Improvement Tech. Bull. No. 291, National Council of the Paper Industry for Air & Stream Improvement, New York, N.Y.

TREES, C.C. 1978. Analytical analysis of the effect of dissolved solids on suspended solids determination. *J. Water Pollut. Control Fed.* 50: 2370.

2540 E. Fixed and Volatile Solids Ignited at 550°C

1. General Discussion

a. Principle: The residue from Method B, C, or D is ignited to constant weight at 550°C. The remaining solids represent the fixed total, dissolved, or suspended solids while the weight lost on ignition is the volatile solids. The determination is useful in control of wastewater treatment plant operation because it offers a rough approximation of the amount of organic matter present in the solid fraction of wastewater, activated sludge, and industrial wastes.

b. Interferences: Negative errors in the volatile solids may be produced by loss of volatile matter during drying. Determination of low concentrations of volatile solids in the presence of high fixed solids concentrations may be subject to considerable error. In such cases, measure for suspect volatile components by another test, for example, total organic carbon (Section 5310). Highly alkaline residues may react with silica in sample or silica-containing crucibles.

2. Apparatus

See Sections 2540B.2, 2540C.2, and 2540D.2.

3. Procedure

Ignite residue produced by Method 2540B, C, or D to constant weight in a muffle furnace at a temperature of 550°C. Ignite a blank glass fiber filter along with samples. Have furnace up to temperature before inserting sample. Usually, 15 to 20 min ignition are required for 200 mg residue. However, more than one sample and/or heavier residues may overtax the furnace and necessitate longer ignition times. Let dish or filter disk cool partially in air until most of the heat has been dissipated. Transfer to a desiccator for final cooling in a dry atmosphere. Do not overload desiccator. Weigh dish or disk as soon as it has cooled to balance temperature. Repeat cycle of igniting, cooling, desiccating, and weighing until a constant weight is obtained or until weight change is less than 4% or 0.5 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight. Weight loss of the blank filter is an indication of unsuitability of a particular brand or type of filter for this analysis.

4. Calculation

$$\text{mg volatile solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

$$\text{mg fixed solids/L} = \frac{(B - C) \times 1000}{\text{sample volume, mL}}$$

where:

A = weight of residue + dish before ignition, mg,
B = weight of residue + dish or filter after ignition, mg, and
C = weight of dish or filter, mg.

5. Precision

The standard deviation was 11 mg/L at 170 mg/L volatile total solids in studies by three laboratories on four samples and 10 replicates. Bias data on actual samples cannot be obtained.

2540 F. Settleable Solids

1. General Discussion

Settleable solids in surface and saline waters as well as domestic and industrial wastes may be determined and reported on either a volume (mL/L) or a weight (mg/L) basis.

2. Apparatus

The volumetric test requires only an Imhoff cone. The gravimetric test requires all the apparatus listed in Section 2540D.2 and a glass vessel with a minimum diameter of 9 cm.

3. Procedure

a. Volumetric: Fill an Imhoff cone to the 1-L mark with a well-mixed sample. Settle for 45 min, gently agitate sample near the sides of the cone with a rod or by spinning, settle 15 min longer, and record volume of settleable solids in the cone as milliliters per liter. If the settled matter contains pockets of liquid between large settled particles, estimate volume of these and subtract from volume of settled solids. The practical lower limit of measurement depends on sample composition and generally is in the range of 0.1 to 1.0 mL/L. Where a separation of settleable and floating materials occurs, do not estimate the floating material as settleable matter. Replicates usually are not required.

Where biological or chemical floc is present, the gravimetric method (3*b*) is preferred.

b. Gravimetric:

1) Determine total suspended solids as in Section 2540D.

2) Pour a well-mixed sample into a glass vessel of not less than 9 cm diam using not less than 1 L and sufficient sample to

give a depth of 20 cm. Alternatively use a glass vessel of greater diameter and a larger volume of sample. Let stand quiescent for 1 h and, without disturbing the settled or floating material, siphon 250 mL from center of container at a point halfway between the surface of the settled material and the liquid surface. Determine total suspended solids (milligrams per liter) of this supernatant liquor (Section 2540D). These are the nonsettleable solids.

4. Calculation

mg settleable solids/L

= mg total suspended solids/L − mg nonsettleable solids/L

5. Precision and Bias

Precision and bias data are not now available.

6. Bibliography

FISCHER, A.J. & G.E. SYMONS. 1944. The determination of settleable sewage solids by weight. *Water Sewage Works* 91:37.

2540 G. Total, Fixed, and Volatile Solids in Solid and Semisolid Samples

1. General Discussion

a. Applicability: This method is applicable to the determination of total solids and its fixed and volatile fractions in such solid and semisolid samples as river and lake sediments, sludges separated from water and wastewater treatment processes, and sludge cakes from vacuum filtration, centrifugation, or other sludge dewatering processes.

b. Interferences: The determination of both total and volatile solids in these materials is subject to negative error due to loss of ammonium carbonate and volatile organic matter during drying. Although this is true also for wastewater, the effect tends to be more pronounced with sediments, and especially with sludges and sludge cakes. The mass of organic matter recovered from sludge and sediment requires a longer ignition time than that specified for wastewaters, effluents, or polluted waters. Carefully observe specified ignition time and temperature to control losses of volatile inorganic salts if these are a problem. Make all weighings quickly because wet samples tend to lose weight by evaporation. After drying or ignition, residues often are very hygroscopic and rapidly absorb moisture from the air. Highly alkaline residues may react with silica in the samples or silica-containing crucibles.

2. Apparatus

All the apparatus listed in Section 2540B.2 is required except that a magnetic stirrer and pipets are not used and a balance capable of weighing to 10 mg may be used.

3. Procedure

a. Total solids:

1) Preparation of evaporating dish—If volatile solids are to be measured, ignite a clean evaporating dish at 550°C for 1 h in a muffle furnace. If only total solids are to be measured, heat dish at 103 to 105°C for 1 h in an oven. Cool in desiccator, weigh, and store in desiccator until ready for use.

2) Sample analysis

a) Fluid samples—If the sample contains enough moisture to flow more or less readily, stir to homogenize, place 25 to 50 g in a prepared evaporating dish, and weigh. Evaporate to dryness on a water bath, dry at 103 to 105°C for 1 h, cool to balance temperature in an individual desiccator containing fresh desiccant, and weigh. Repeat heating, cooling, desiccating, and weighing procedure until the weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

b) Solid samples—If the sample consists of discrete pieces of solid material (dewatered sludge, for example), take cores from each piece with a No. 7 cork borer or pulverize the entire sample coarsely on a clean surface by hand, using rubber gloves. Place 25 to 50 g in a prepared evaporating dish and weigh. Place in an oven at 103 to 105°C overnight. Cool to balance temperature in a desiccator and weigh. Repeat drying (1 h), cooling, weighing, and desiccating steps until weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

b. Fixed and volatile solids: Transfer the dried residue from 2)a) above to a cool muffle furnace, heat furnace to 550°C, and ignite for 1 h. (If the residue contains large amounts of organic matter, first ignite it over a gas burner and under an exhaust hood in the presence of adequate air to lessen losses due to reducing conditions and to avoid odors in the laboratory.) Cool in desiccator to balance temperature and weigh. Repeat igniting (30 min), cooling, desiccating and weighing steps until the weight change is less than 4% or 50 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight.

4. Calculation

$$\% \text{ total solids} = \frac{(A - B) \times 100}{C - B}$$

$$\% \text{ volatile solids} = \frac{(A - D) \times 100}{A - B}$$

$$\% \text{ fixed solids} = \frac{(D - B) \times 100}{A - B}$$

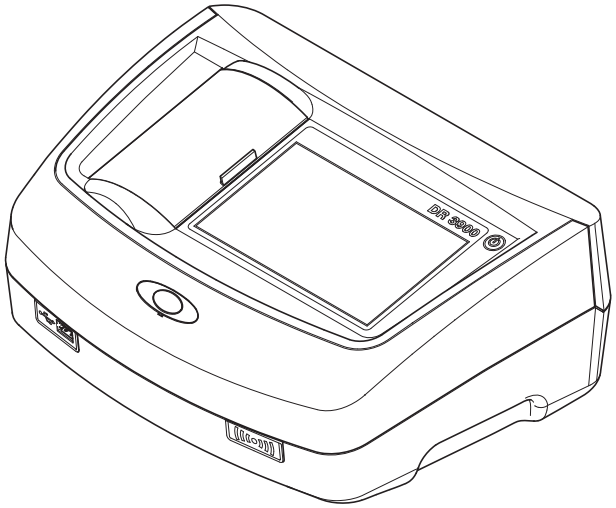
Appendix D – HACH DR3900 Spectrophotometer Basic User Manual

DOC022.97.90324

DR 3900

04/2013, Edition 6

Basic User Manual **en**
Manuel d'utilisation de base **fr**
Manual básico del usuario **es**
Manual do utilizador básico **pt**
基本用户手册 **zh**
基本ユーザー マニュアル **ja**
기본 사용 설명서 **ko**



Specifications

These are subject to change without notice!

Performance specifications	
Operating mode	Transmittance (%), Absorbance and Concentration
Source lamp	Halogen lamp
Wavelength range	320–1100 nm
Wavelength Accuracy	± 1.5 nm (wavelength range 340–900 nm)
Wavelength reproducibility	± 0.1 nm
Wavelength resolution	1 nm
Wavelength calibration	Automatic
Wavelength selection	Automatic, based on method selection
Scanning speed	≥ 8 nm/s (in steps of 1 nm)
Spectral bandwidth	5 nm
Photometric measuring range	± 3.0 Abs (wavelength range 340–900 nm)
Photometric accuracy	5 m Abs at 0.0–0.5 Abs 1% at 0.50–2.0 Abs
Photometric linearity	< 0.5% to 2 Abs ≤1% at > 2 Abs with neutral glass at 546 nm
Stray light	< 0.1% T at 340 nm with $NaNO_2$
Data log	2000 readings (Result, Date, Time, Sample ID, User ID)
User programs	100

Performance specifications	
Physical and environmental specifications	
Width	350 mm (13.78 in)
Height	151 mm (5.94 in)
Depth	255 mm (10.04 in)
Mass	4200 g (9.26 lb)
Ambient operating requirements	10–40 °C (50–104 °F), maximum 80% relative humidity (without condensate formation)
Ambient storage requirements	–40–60 °C (–40–140 °F), maximum 80% relative humidity (without condensate formation)
Additional technical data	
Power connector via external power supply	Input:100–240 V/50–60 Hz Output: 15 V/40 VA
Interfaces	Use only shielded cable with maximum length of 3 m: 2x USB type A 1x USB type B Use only shielded cable (e.g. STP, FTP, S/FTP) with maximum length of 20 m: 1x Ethernet
Enclosure rating	IP40 (excluding interfaces and power supply)
Protection class	Class I
	This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard that incorporates the same level of testing requirements.

General Information

Safety information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To make sure that the protection provided by this instrument is not impaired, do not use or install this instrument in any manner other than that specified in these operating instructions.

⚠DANGER

Indicates a potentially or imminently hazardous situation that, if not avoided, results in death or serious injury.

⚠WARNING

Indicates a potentially or imminently hazardous situation that, if not avoided, may result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation that, if not avoided, could result in damage to the instrument. Information that requires special emphasis.

Note: *Information that supplements points in the main text.*

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if this information is not observed.

A symbol, if noted on the instrument, will be included with a danger or caution statement in the operating instructions.

	This symbol, if noted on the instrument, references the user manual for operation and/or safety information.
	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems after 12 August 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of life equipment to the manufacturer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment manufacturer or supplier for instructions on how to return end-of-life equipment, manufacturer-supplied electrical accessories, and all auxiliary items for correct disposal.*

RFID module (not available on all models)

RFID technology is a radio application. Radio applications are subject to national conditions of authorisation. The use of the DR 3900 (model with RFID module) is currently permitted in the following countries: EU, CH, NO, HR, RS, MK, TR, CY, US, CA, AU, NZ. The manufacturer advises that the use of the DR 3900 (model with RFID module) outside of the above-mentioned regions may contravene national laws. The manufacturer reserves the right also to obtain authorisation in other countries. In case of doubt, please contact the distributor.

The DR 3900 contains an RFID module to receive and transmit information and data. The RFID module operates with a frequency of 13.56 MHz.

⚠WARNING

The spectrophotometer may not be used in dangerous environments.

The manufacturer and its suppliers reject any express or indirect guarantee for the use with High Risk Activities.

Follow the following safety information, in addition to any local guidelines in force.

Safety information for the correct use of the instrument:

- Do not operate the instrument in hospitals or comparable establishments in proximity to medical equipment, like pace makers or hearing aids.
- Do not operate the instrument near highly flammable substances, such as fuels, highly combustible chemicals and explosives.
- Do not operate the instrument near combustible gases, vapors or dust.
- Do not vibrate or jolt the instrument.
- The instrument can cause interference in immediate proximity to televisions, radios and computers.
- Do not open the instrument.
- Improper use of the instrument voids the warrantee.

Certification (integrated RFID module)

FCC ID: YUH-QR15HL

IC : 9278A-QR15HL

This device complies with Part 15 of the FCC rules and Industry Canada license exempt RSS standard(s).

Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device."

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

1. l'appareil nedoit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Chemical and Biological Safety

⚠DANGER

Potential danger in the event of contact with chemical/biological materials.

Handling chemical samples, standards and reagents can be dangerous. Familiarise yourself with the necessary safety procedures and the correct handling of the chemicals before the work and read and follow all relevant safety data sheets.

Normal operation of this instrument may involve the use of hazardous chemicals or biologically harmful samples.

- Observe all cautionary information printed on the original solution containers and safety data sheet prior to their use.
- Dispose of all consumed solutions in accordance with national regulations and laws.

- Select the type of protective equipment suitable to the concentration and quantity of the dangerous material at the respective work place.

Overview of product

The DR 3900 is a VIS spectrophotometer with a wavelength range of 320 to 1100 nm. The instrument is delivered with a complete series of application programs and supports several languages.

The spectrophotometer DR 3900 contains the following programs and operating types:

- Stored programs (pre-installed tests)
- Barcode Programs
- User Programs
- Favorites
- Single Wavelength
- Multi Wavelength
- Wavelength Scan
- Time course

The DR 3900 Spectrophotometer provides digital readouts in direct concentration units, absorbance or percent transmittance.

When selecting a user-generated or programmed method, the menus and prompts serve to direct the user through the test.

This menu system can also generate reports, statistical evaluations of generated calibration curves and to report instrument diagnostic checks.

Installation

⚠WARNING

Electrical and fire hazards.
Only use the supplied benchtop power supply LZV844.

Only qualified experts may perform the tasks described in this section of the manual, while adhering to all locally valid safety regulations.

Unpack the instrument

The DR 3900 Spectrophotometer comes packaged with the following items:

- DR 3900 spectrophotometer
- Dust Cover
- USB dust cover, fitted as standard
- Benchtop power supply with power cord for US, GB
- Cell adapter A
- Light shield, fitted as standard in the DR 3900
- Operator RFID tag (not available on all models)
- Basic operating instructions DR 3900, operating instructions LINK2SC

Further information, detailed user manuals and documentation are available on the website of the manufacturer.

Note: *If any of these items are missing or damaged, please contact the manufacturer or a sales representative immediately.*

Operating environment

Note the following points so that the instrument will operate perfectly and have a long service life.

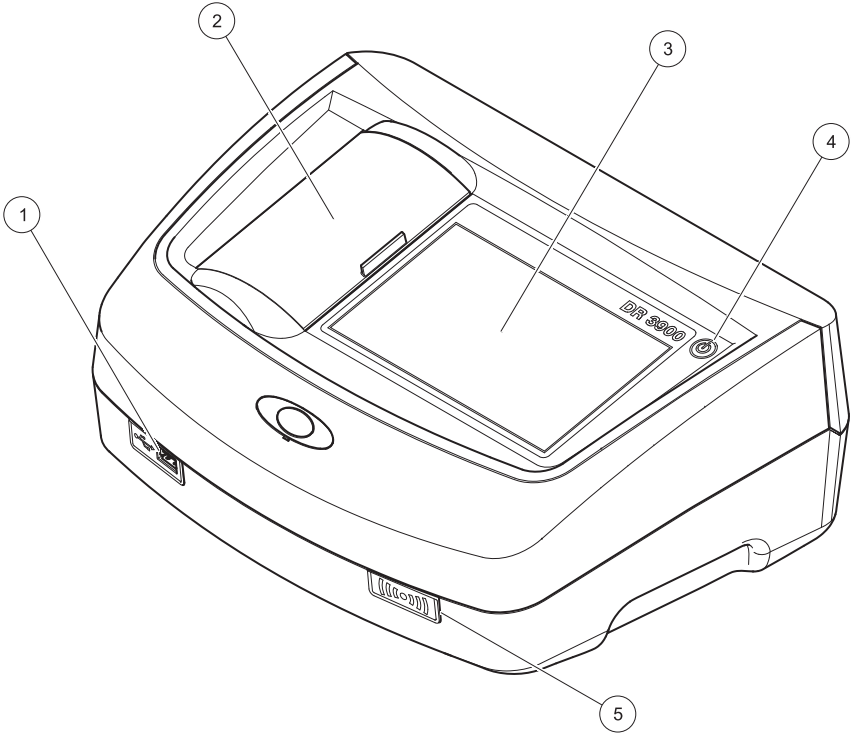
- Place the instrument firmly on an even surface. Do not push any objects under the instrument.
- The ambient temperature must be 10–40 °C (50–104 °F).
- The relative humidity should be less than 80%; moisture should not condense on the instrument.
- Leave at least a 15 cm clearance at the top and on all sides for air circulation, to avoid overheating of electrical parts.
- Do not operate or store the instrument in extremely dusty, humid or wet locations.
- Keep the surface of the instrument, the cell compartment and all accessories clean and dry at all times. Immediately remove splashes or spilt materials on or in the instrument.

NOTICE

Protect the instrument from extreme temperatures from heaters, direct sunlight and other heat sources.

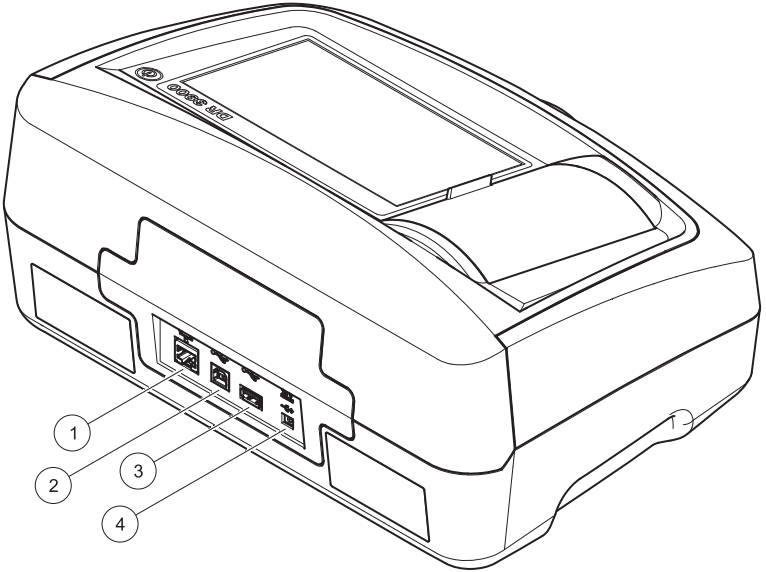
Front and back view

Figure 1 Front view



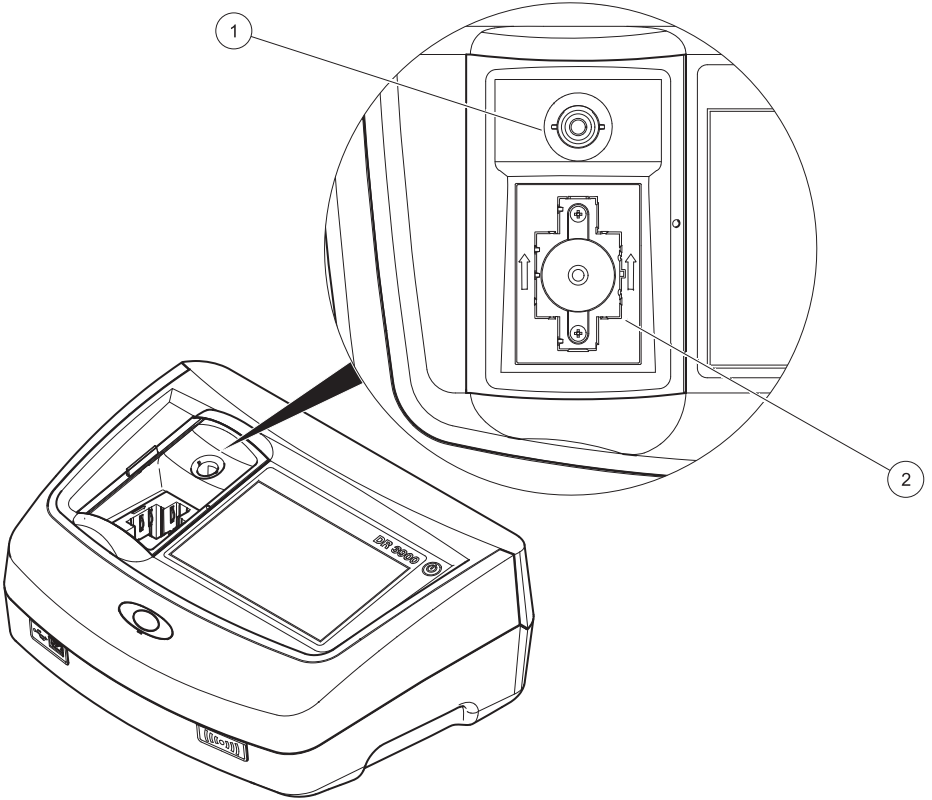
1	USB port type A	**4**	On/off switch
2	Cell compartment cover	**5**	RFID module (not available on all models)
3	Touch screen		

Figure 2 Back view



1	Ethernet port	**3**	USB port type A
2	USB port type B	**4**	Connection for benchtop power supply

Figure 3 Cell compartments



1	Cell compartment for round cells (1)	**2**	Cell compartment for rectangular cells (2)

Power connections

⚠WARNING

Electrical and fire hazards.
Only use the supplied benchtop power supply LZV844.

1. Connect the power cable to the benchtop power supply.
2. Plug the benchtop power supply cable into the back of the instrument (Figure 2, page 9).
3. Insert the power cable plug into a mains socket (100–240 V~/ 50–60 Hz).

Turn on the power button next to the display to turn on the power supply (Figure 1, page 8).

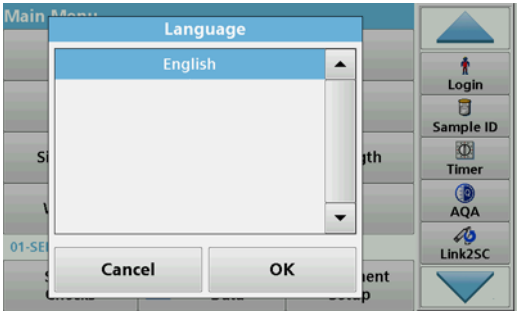
Startup

Switch on the instrument, startup process

1. Connect the power cable to the mains outlet.
2. Switch on the instrument by using the power button next to the display.
3. The instrument starts automatically with a startup process lasting approximately 45 seconds. The display shows the logo of the manufacturer. At the end of the startup process, a startup melody is heard.

Note: *Wait approximately* ***20 seconds*** *before switching on again so as not to damage the electronics and mechanics of the instrument.*

Language selection



The DR 3900 software includes several language options. The first time the instrument is switched on, the language selection screen will be shown automatically after the startup process.

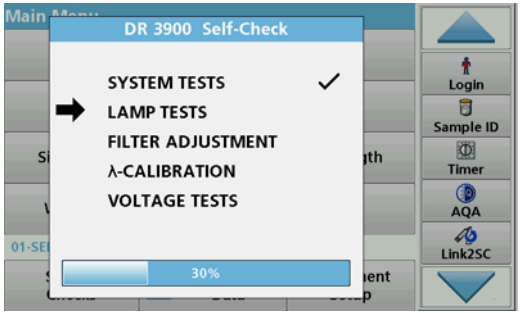
1. Select the required language.
2. Press **OK** to confirm the language selection. The self-check will then start automatically.

Change the language setting

The instrument functions in the selected language until the option is changed.

1. Turn the instrument on.
2. During the startup process, touch any point on the screen and maintain contact until the option for selecting a language is shown (approximately 45 seconds).
3. Select the required language.
4. Press **OK** to confirm the language selection. The self-check will then start automatically.

Self-check



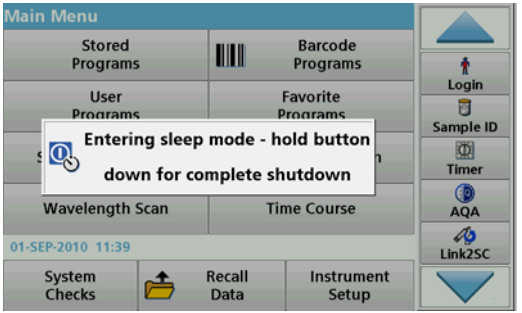
Each time the instrument is powered up, a test program begins.

This procedure, which takes approximately two minutes, checks the system, lamp, filter adjustment, wavelength calibration and voltage. Each test that functions correctly is marked accordingly.

The Main Menu is displayed when diagnostics are completed.

Note: *In the event of further error messages during the test program, refer to* *Troubleshooting, page 19**.*

Sleep mode



The instrument can be put into sleep mode.

1. Briefly press the power button next to the display.

   The "Sleep mode" message is shown. The display will then switch off automatically.

2. To switch on, press the power button next to the display.
   The self-check will start automatically.
   After that, the instrument is ready to use.

Power off the instrument

1. Press the power button next to the display for approximately 5 seconds.

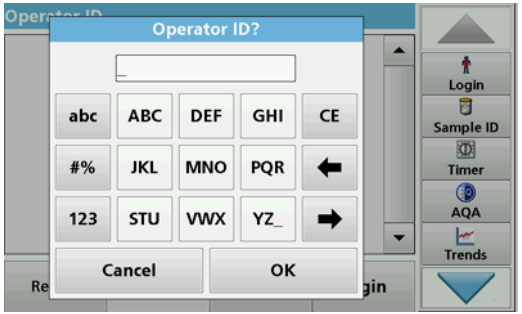
Standard programs

Tips for the use of the touch screen

The whole screen responds to touch. To choose an option, tap with a fingernail, fingertip, an eraser or a specialised stylus. Do not press the screen with a sharp object, such as the tip of a ballpoint pen.

- Do not place anything on top of the screen, to prevent damage or scratches on the screen.
- Press buttons, words or icons to select them.
- Use scroll bars to move up and down long lists very quickly. Press and hold the scroll bar, then move up or down to move through the list.
- Highlight an item from a list by pressing it once. When the item has been successfully selected, it will be displayed as reversed text (light text on a dark background).

Use of the alphanumeric keypad



This display is used to enter letters, numbers and symbols as needed when programming the instrument. Unavailable options are disabled (grayed out). The icons on the right and left of the screen are described in Table 1.

The central keypad changes to reflect the chosen entry mode. Press a key repeatedly until the desired character appears on the screen. A space can be entered by using the underscore on the **YZ_** key.

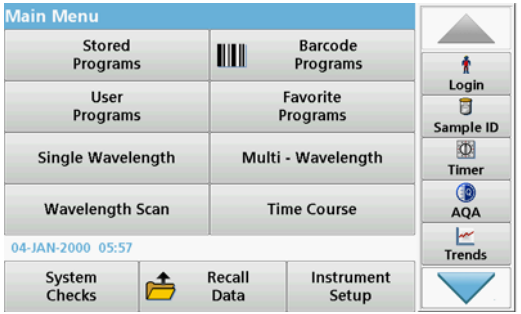
Press **Cancel** to cancel an entry, or press **OK** to confirm an entry.

Note: *It is also possible to use a USB keyboard (with US keyboard layout) or a hand-held USB barcode scanner.*

Table 1 Alphanumeric keypad

Icon / key	Description	Function
ABC/abc	Alphabetic	Toggles the character input mode between upper and lower case.
# %	Symbols	Punctuation, symbols and numerical sub- and superscripts may be entered.
123	Numeric	For entering regular numbers.
CE	Clear Entry	Clear the entry.
Left Arrow	Back	Deletes the current character and goes back one position.
Right Arrow	Next	Navigates to the next space in an entry.

Main menu



A variety of modes may be selected from the Main Menu. The following table briefly describes each menu option.

There is a toolbar on the right-hand side of the screen. Press to activate the various functions.

Table 2 Main Menu options

Option	Function
Stored Programs / Barcode Programs	Stored programs are pre-programmed methods that make use of HACH chemicals and vial tests. Further information, as well as illustrated, step-by-step process instructions for analyses using HACH programs, are available on the website of the manufacturer.
User Programs	User programs make "made to measure analysis" possible: • Users can program methods they have developed themselves • Existing HACH methods can be stored as user programs.
Favorites	List of methods/tests created by the user to suit his own requirements.

Table 2 Main Menu options

Option	Function
Single Wavelength	Single wavelength readings are: **Absorbance readings:** The light absorbed by the sample is measured in absorbance units. **Transmittance reading (%)**: Measures the percent of the original light that passes through the sample and reaches the detector. **Concentration readings:** A concentration factor can be entered to enable the measured absorbance values to be converted into concentration values.
Multi Wavelength	In the Multi Wavelength mode, absorbance (Abs) or percentage transmittance (%T) is measured at up to four wavelengths and absorbance differences and absorbance relationships are calculated. Simple conversions into concentrations can also be carried out.
Wavelength Scan	A wavelength scan shows how the light from a sample is absorbed over a defined wavelength spectrum. This function can be used to determine the wavelength at which the maximum absorbance value can be measured. The absorbance behavior is displayed graphically during the scan.
Time course	The time scan records the absorbance or % transmittance at a wavelength over a defined time.
System checks	The "System check" menu offers a number of options, including optical checks, output checks, lamp history, instrument update, service time, settings for analytical quality assurance and instrument backup.
Recall measurement data	Stored data can be called up, filtered, sent and deleted.
Instrument Setup	In this mode, user-specific or method-specific settings can be entered: operator ID, sample ID, date & time, sound, PC & printer, password, energy-saving mode and stored data.

Save, recall, send and delete data

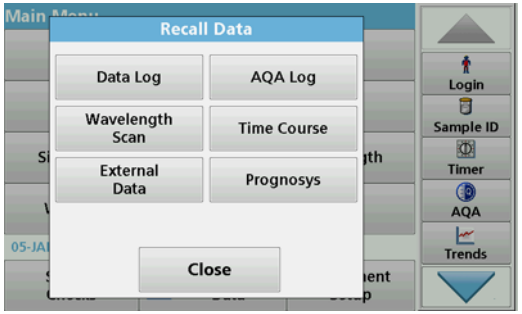
The data log

The data log can store up to 2000 readings saved by the following programs:

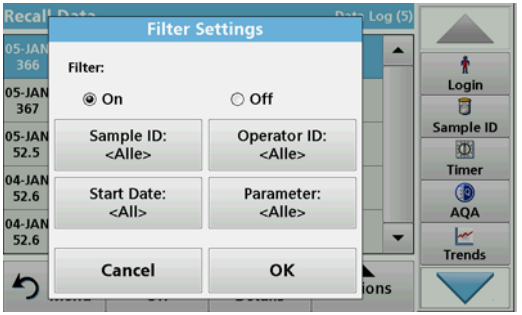
- Stored Programs,
- Barcode Programs,
- User programs,
- Favorites,
- Single Wavelength and
- Multi Wavelength.

A complete record of the analysis is stored, including the Date, Time, Results, Sample ID and Operator ID.

Recall stored data from the data log

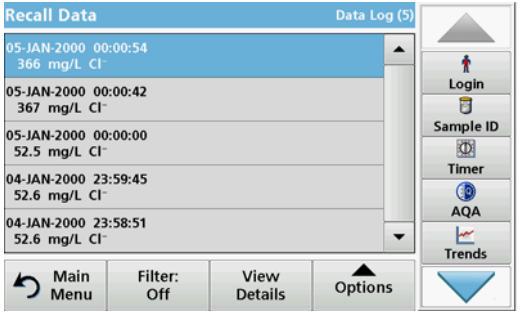


1. Press **Recall Data** in the Main Menu.
2. Press **Data Log**.
   A listing of the stored data is displayed.



3. Press **Filter: On/Off**.
   The function **Filter Settings** is used to search for specific items.
4. Activate **On**. The data can now be filtered using the following selection criteria.
   - Sample ID
   - Operator ID
   - Start Date
   - Parameter

   or any combination of the four.



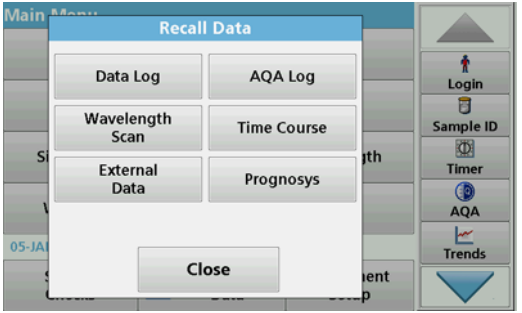
5. Press **OK** to confirm the selection.

   The chosen items are listed.

6. Press **View Details** to get more information.

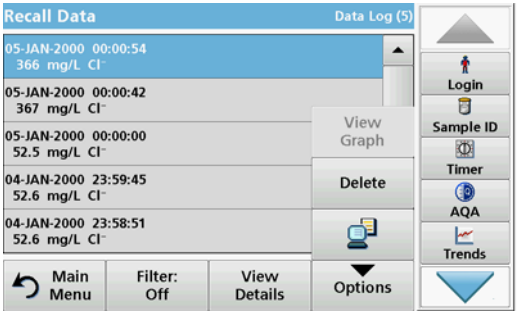
Send data from the data log

Data is sent from the internal data log as an XML (Extensible Markup Language) file or as a CSV (Comma Separated Value) file, to a directory with the name DataLog on a USB mass storage device or a network drive. The file can then be processed using a spreadsheet program. The file name has the format: DLYear-Month-Day_Hour_Minute_Second.csv or DLYear-Month-Day_Hour_Minute_Second.xml.

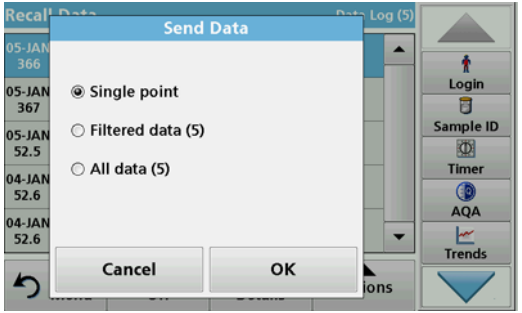


1. Plug the USB storage device into the USB type A port on the DR 3900, or connect the DR 3900 to a network drive.
2. Press **Recall Data** from the Main Menu.
3. Select the data category to be transferred, e.g. **Data Log**.

   A list of the selected measurement data is displayed.



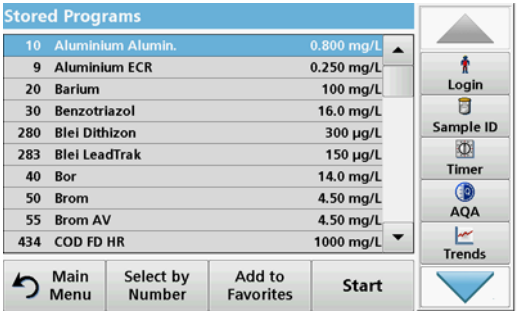
4. Press **Options** and then the **PC & Printer** icon.



5. Select the data to be sent.
   The following options are available:
   - **Single point**: only this selected reading will be sent
   - **Filtered data**: only readings that correspond to the set filters will be sent
   - **All data**: all data in the selected data category will be sent.
6. Press **OK** to confirm.

Note: *The number in parentheses is the total number of data sets assigned to this selection.*

Stored Programs



1. Press **Stored Programs** in the Main Menu to view an alphabetical list of stored programs with program numbers.

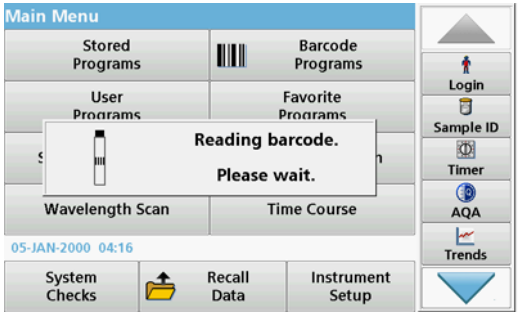
   The "Stored Programs" list will appear.
2. Highlight the required test.

   Hinweis: *Select the program by name or scroll through the list using the arrow keys. Highlight the program or press* ***Select by No.*** *to search for a specific program number. Press* ***OK*** *to confirm.*
3. Press **Start** to run the program. The respective measurement window is displayed.

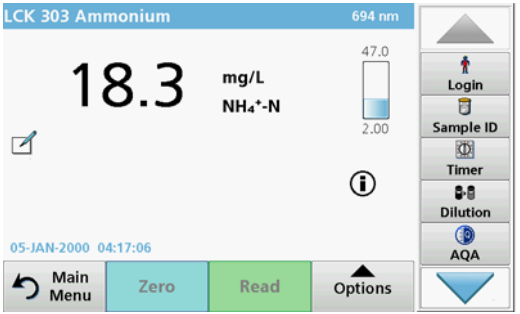
   Hinweis: *All corresponding data (wavelength, factors and constants) is already preset.*
4. Follow the instructions for chemical procedures in the relevant procedures manual. Further information are available on the website of the manufacturer.

   Hinweis: *To display the procedural instructions in the display, press the info icon. Not all programs have this option.*

Complete a barcode test



1. Insert the light shield into cell compartment (2).
2. Prepare the barcode test according to the process specification, and insert the cell in cell compartment (1).
   - When a coded cell is placed in cell compartment (1) (Figure 3, page 10), the corresponding reading program is automatically activated in the Main Menu.
   - Otherwise, press **Barcode Programs** in the Main Menu and insert a zero cell (depending on process specification) into cell compartment (1).



The reading is started automatically and the results are displayed.

To evaluate other cell tests and other parameters, insert the prepared cell into the cell compartment and read off the result.

Note: *The control bar displayed on the right of the screen shows the relationship of the reading result to the measuring range. The black bar shows the measured result independently of any dilution factor that was entered.*

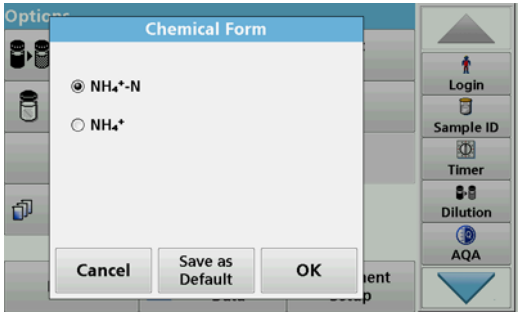
Select the chemical evaluation form

The chemical form of the test result of a number of parameters can be selected individually.

1. In the result display, press the unit (e. g. mg/L) or the chemical representation of the evaluation form (e. g. PO_4^{3-}–P).

   A list of available evaluation forms appears.
2. Select the required form from the list. Press **OK** to confirm.

Another way of changing the standard setting is:



1. In the result display, press **Options>More>Chemical Form**.

   A list of available evaluation forms appear.

2. Select the required chemical form and press **OK** to confirm.

   Hinweis: *The selected chemical form is displayed, but does not become the default. To change the default, refer to section Change of the default setting of the chemical form.*

Change of the default setting of the chemical form

1. Insert the zero cell or sample cell (corresponding to the process specification) into the cell compartment.
2. In the result display, press **Options>More>Chemical Form**.
3. A list of available evaluation forms appear. Select the new default setting.
4. Press **Save as Default**.

The current result and all further readings will be displayed in the new chemical form.

Troubleshooting

Error displayed	Definition	Resolution
Attention! **Please insert the light shield.**	Readings with barcode cuvettes generally require the light shield.	Insert the light shield. Press **OK**.
Barcode label not read	Barcode faulty	Reinsert the cell. If the barcode is not recognised, contact the manufacturer or his representative.
An error occurred when uploading the instrument data.		Start the procedure again or contact the manufacturer or his representative.
An error occurred when reading from the USB memory stick.		Start the procedure again or contact the manufacturer or his representative.
An error occurred when writing to the USB memory stick.		Start the procedure again or contact the manufacturer or his representative.
Please check on the current update file.	Error during update.	Check the USB memory stick.
Please contact Customer Services.	Error during update.	
Please check network configuration.		
Please check the connection.		
Please close the cover.		Close the cover.

Error displayed	Definition	Resolution
Please insert the USB memory stick.		Insert a USB memory stick into a USB A port on the instrument.
Please check the connection and contact the administrator.	Network setup or FTP error	
Blank value correction not possible!	Blank value correction not possible with LCW919.	
File for instrument update missing.	Error during update.	Check the USB memory stick.
File for instrument update is faulty.	Error during update.	Save the update file again and repeat the procedure.
It's recommended to execute a Full System Check	Check of the air values failed	Switch the instrument of and then back on again. If the system check is not successful, contact the manufacturer or his representative.
Entry invalid!	Password incorrect	Forgotten your password? Contact the manufacturer or his representative.
Absorbance > 3.5!	The measured absorbance exceeds 3.5	Dilute sample and measure again
Fault **Barcode check number?** **Please update program data!**	Deviation to the stored data	Data updating
Error when calling up the local IP address.	Network setup: DHCP client has no connection to the DHCP server	Enter the IP address again.

Error displayed	Definition	Resolution
Error during default gateway setup.	Network setup: default gateway cannot be set for fixed IP address	Try to create the connection again.
Error during network drive setup!	Error during network setup	Check the settings.
Error during subnet mask setup.	Network setup: Subnet mask cannot be set for fixed IP address	Enter the subnet mask again.
Error copying from USB memory stick.	Error during update	Start the procedure again or contact the manufacturer or his representative.
Error in FTP connection.	FTP error	Make sure that the instrument is connected to the network.
Fault **Program not accessible.** **Please update program data!**	Barcode test not present	Data updating
Fault **Clean cuvette!**	The cuvette is soiled or there are undissolved particles in the cuvette	Clean the cuvette; allow the particles to settle
Fault **Test program stopped!** **Please check lamp** **Close the lid.** **Error [xx]**	Test program stops when the instrument is started	Check the lamp and replace it if necessary. Close lid. Press **Start Again**.
Fault **Test program stopped!** **Please remove the cuvette** **Close the lid.**	Test program stops when the instrument is started	Remove the cuvette/ sample cell from the cell compartment. Press **OK**.

Error displayed	Definition	Resolution
Error **Selfcheck stopped.** **Hardware error.** **Error [x]**	Electronic defect	Contact the manufacturer or a sales representative and indicate the error number
Error **Too much ambient light!** **Move instrument into shade** **or close the lid**	The instrument sensors detects too much ambient light.	Decrease ambient light. (Avoid direct sunlight.) Close lid.
No help function is available for this program.		
Shelf life exceeded! Use chemicals?		The analysis is possibly erroneous. Use new chemicals
No evaluation!	Error in the test database / user database	Check programming Contact the manufacturer or a sales representative
No barcode!	No barcode found	Reinsert the cell. If the barcode is not recognised, contact the manufacturer or his representative.
No instrument backup present!		Check the USB memory stick.
No valid data for these parameters!	Data analysis not possible, no measurement data	Change the selection.
No valid data found!	View Data not possible in data log	Change the selection.
No help function present.		

Error displayed	Definition	Resolution
No measurement data present!	Data analysis settings cannot be configured without measurement data.	Change the selection.
Control range not reached!	Data analysis limits not reached	This is a warning notice. The control limit set was not reached.
Control range exceeded!	Data analysis limits exceeded.	This is a warning notice. The control limit was exceeded.
Concentration too high!	Calculated concentration is higher than 999999	Dilute sample and measure again
Over measuring range	The measured absorbance is above the calibration range of the test	Dilute sample and measure again
Under measuring range	The measured absorbance is below the calibration range of the test	If possible, select a test with a lower reading range or use a cuvette with a longer path length
Possible interference by:	Interference Check	The analysis is possibly erroneous due to interferences.
Possible interference from:	Interference Check	The analysis is possibly erroneous due to interferences.
Next service is due!		Contact the manufacturer or his representative for an inspection of the instrument.
Negative result!	The calculated result is negative	Check concentration of sample
Network switched off.	Network setup off, when access to instruments homepage via sidebar	Activate the online connection.

Error displayed	Definition	Resolution
Remote server cannot be reached.	Error during network setup	Make sure that the instrument is connected to the network.
Unstable lighting conditions!		Avoid direct sunlight at the measuring location.
Insufficient memory for update .	Error during update.	Select a memory with more space.
System check incorrect!	Measurement of air values failed	Switch the instrument of and then back on again. If the system check is not successful, contact the manufacturer or his representative.
Temperature too high. Measurement not possible!		Switch of the instrument and allow it to cool for a few minutes. If necessary, move it to a cooler place.
Update file is faulty.	Error during update.	Save the update file again and repeat the procedure.
USB memory stick is not connected.	Update not possible.	Check the USB memory stick.
Web server cannot be reached.	Instruments homepage cannot be reached.	Try the connection again later.

Replacement Parts

Description	Cat. No.
Halogen lamp	LZV565
Cell adapter A for 1-cm rectangular and 1-inch round cells	LZV846
Cell adapter B for 3-cm rectangular cells, China only	LZV847
Light shield	LZV849
Bench top power supply	LZV844
Power cord EU	YAA080
Power cord CH	XLH051
Power cord UK	XLH057
Power cord US	XLH055
Power cable China/Australia	XLH069
Dust Cover	LZV845
Cell compartment	LZV848

Appendix E – Specific Test Procedures for HACH Colorimetric Methods

Methods Quick Reference Guide

The tables on the following 4 pages list test ranges, methods of analysis, and corresponding reagent set Product Numbers. The complete procedure for each test is included in the manual or CD supplied with the instrument. The ranges given are for the pre-calibrated instrument readout; higher ranges can be analyzed by sample dilution. Parameters marked "EPA" are EPA-approved, accepted, or equivalent for reporting purposes; sample pretreatment may be required on some procedures. If no reagent set is listed for a parameter, order needed reagents and supplies separately.

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Alachlor in Water		Immunoassay	10202	0.1 - 0.5 ppb, threshold	•	•	•				•	**2813000**
Alkalinity, Total (TNTplus)		Colorimetric	10239	25 - 400 mg/L	•	•						**TNT870**
Aluminum		Aluminon	8012	0.008 - 0.800 mg/L	•	•	•	•	•	•	•	**2242000**
Aluminum		Eriochrome Cyanine R	8326	0.002 - 0.250 mg/L	•	•	•					**2603700**
Aluminum (TNTplus)		Chromazurol S	10215	0.02 - 0.50 mg/L	•	•						**TNT848**
Ammonia, Nitrogen		Salicylate	8155	0.01 - 0.50 mg/L	•	•	•	•		•	•	**2668000**
Ammonia, Nitrogen (TNTplus), ULR	•	Salicylate	10205	0.015 - 2.000 mg/L	•	•						**TNT830**
Ammonia, Nitrogen	•	Nessler	8038	0.02 - 2.50 mg/L	•	•	•					**2458200**
Ammonia, Nitrogen (Test 'N Tube), LR		Salicylate	10023	0.02 - 2.50 mg/L	•	•	•	•	•			**2604545**
Ammonia, Nitrogen (TNTplus), LR	•	Salicylate	10205	1 - 12 mg/L	•	•						**TNT831**
Ammonia, Nitrogen (Test 'N Tube), HR		Salicylate	10031	0.4 - 50.0 mg/L	•	•	•	•	•			**2606945**
Ammonia, Nitrogen (TNTplus), HR	•	Salicylate	10205	2 - 47 mg/L	•	•						**TNT832**
Ammonia, Free, Nitrogen		Indophenol	10200	0.01 - 0.50 mg/L	•	•	•	•	•		•	**2879700**
Arsenic	•	Silver Diethyldithiocarbamate	8013	0.020 - 0.200 mg/L	•	•	•					**—**
Atrazine		Immunoassay	10050	0.5 - 3.0 ppb, threshold	•	•	•				•	**2762700**
Barium		Turbidimetric	8014	2 - 100 mg/L	•	•	•					**1206499**
Benzotriazole		UV Photolysis	8079	1.0 - 16.0 mg/L	•	•	•	•				**2141299**
Boron		Carmine	8015	0.2 - 14.0 mg/L	•	•	•					**—**
Bromine		DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	•	**2105669**
Bromine (AccuVac)		DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	•	**2503025**
Cadmium		Dithizone	8017	0.7 - 80.0 µg/L	•	•	•					**2242200**
Cadmium (TNTplus)[1]		Cadion	10217	0.02 - 0.30 mg/L	•	•						**TNT852**
Carbohydrazide		Iron Reduction	8140	5 - 600 µg/L	•	•	•	•				**2446600**
Chloramine, Mono, LR		Indophenol	10171 10200	0.04 - 4.50 mg/L	•	•	•	•	•		•	**2802246**
Chloramine, Mono (Test 'N Tube), HR		Indophenol	10172	0.1 - 10.0 mg/L	•	•	•					**2805145**
Chloride		Mercuric Thiocyanate	8113	0.1 - 25.0 mg/L	•	•	•					**2319800**
Chlorine, Free		Indophenol	10241	0.04 - 4.50 mg/L	•	•	•	•	•		•	**—**
Chlorine, Free	•	DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2105569**
Chlorine, Free (AccuVac)	•	DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2502025**
Chlorine, Free (Pour-Thru Cell)		DPD Rapid Liquid	10059	0.02 - 2.00 mg/L	•	•	•					**2556900**
Chlorine, Free (TNTplus)	•	DPD	10231	0.05 - 2.00 mg/L	•	•						**TNT866**
Chlorine, Free (Test 'N Tube)		DPD	10102	0.09 - 5.00 mg/L	•	•	•	•	•	•		**2105545**
Chlorine, Free, MR	•	DPD	10245	0.05 - 4.00 mg/L	•	•	•	•	•	•	•	**1407099**
Chlorine, Free, HR	•	DPD	10069	0.1 - 10.0 mg/L	•	•	•	•	•	•	•	**1407099**
Chlorine, Free & Total (TNTplus)	•	DPD	10232	0.05 - 2.00 mg/L	•	•						**TNT866T**
Chlorine, Total (Pour-Thru Cell), ULR	•	DPD	8370 10014	2 - 500 µg/L	•	•	•					**2563000**
Chlorine, Total	•	DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2105669**
Chlorine, Total (AccuVac)	•	DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2503025**
Chlorine, Total (Pour-Thru Cell)		DPD Rapid Liquid	10060	0.02 - 2.00 mg/L	•	•	•					**2557000**
Chlorine, Total (Test 'N Tube)		DPD	10101	0.09 - 5.00 mg/L	•	•	•	•	•	•		**2105645**
Chlorine, Total, MR	•	DPD	10250	0.05 - 4.00 mg/L	•	•	•	•	•	•	•	**1406499**
Chlorine, Total, HR	•	DPD	10070	0.1 - 10.0 mg/L	•	•	•	•	•	•	•	**1406499**
Chlorine Demand/Requirement	•	DPD	10223	Multiple Ranges	•	•	•	•	•	•	•	**—**
Chlorine Dioxide, DPD	•	DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	**2770900**
Chlorine Dioxide, DPD (AccuVac)	•	DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	**2771000**
Chlorine Dioxide (Europe Only)		Amaranth		20 - 500 µg/L	•	•	•					**—**
Chlorine Dioxide, LR		Chlorophenol Red	8065	0.01 - 1.00 mg/L	•	•	•					**2242300**
Chlorine Dioxide, MR		Direct Reading	8345	1 - 50 mg/L	•	•	•	•				**—**
Chlorine Dioxide, HR		Direct Reading	8138	5 - 1000 mg/L	•	•	•					**—**

[1]As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Chromium, Hexavalent	•	1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•			•	**1271099**
Chromium, Hexavalent (AccuVac)	•	1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•			•	**2505025**
Chromium, Hexavalent and Total (TNTplus)	•[1]	1,5 Diphenylcarbohydrazide	10218 10219	0.03 - 1.00 mg/L	•	•						**TNT854**
Chromium, Total		Alkaline Hypobromite Oxidation	8024	0.01 - 0.70 mg/L	•	•	•	•				**2242500**
Cobalt		PAN	8078	0.01 - 2.00 mg/L	•	•	•					**2651600**
COD, ULR		Dichromate	8000	0.7 - 40.0 mg/L	•	•						**2415825**
COD, LR	•	Dichromate	8000	3 - 150 mg/L	•	•	•	•				**2125825**
COD, HR	•	Dichromate	8000	20 - 1,500 mg/L	•	•	•	•	•			**2125925**
COD, HR+		Dichromate	8000	200 - 15,000 mg/L	•	•	•	•	•			**2415925**
COD		Manganese III	10067	30 - 1000 mg/L	•	•	•	•	•	•		**2623425**
COD, Mercury-Free (TNTplus), HR		Dichromate	10236	25 - 100 mg/L	•	•						**TNT825**
COD (TNTplus), ULR		Dichromate	10211	1 - 60 mg/L	•	•						**TNT820**
COD (TNTplus), LR	•	Dichromate	8000	3 - 150 mg/L	•	•						**TNT821**
COD (TNTplus), HR	•	Dichromate	8000	20 - 1500 mg/L	•	•						**TNT822**
COD (TNTplus), UHR		Dichromate	10212	250 - 15,000 mg/L	•	•						**TNT823**
Color		ADMI Weighted Ordinate	10048	3 - 250 units	•							**—**
Color, True and Apparent		Platinum-Cobalt	8025	15 - 500 units	•	•	•	•				**—**
Color, True and Apparent, LR		Platinum-Cobalt	8025	3 - 200 units	•	•	•					**—**
Copper, LR		Porphyrin	8143	1 - 210 µg/L	•	•	•	•				**2603300**
Copper	•	Bicinchoninate	8506	0.04 - 5.00 mg/L	•	•	•	•			•	**2105869**
Copper (AccuVac)		Bicinchoninate	8026	0.04 - 5.00 mg/L	•	•	•	•			•	**2504025**
Copper (TNTplus)[2]		Bathocuproine	10238	0.1 - 8.0 mg/L	•	•						**TNT860**
Cyanide		Pyridine-Pyrazalone	8027	0.002 - 0.240 mg/L	•	•	•	•	•			**2430200**
Cyanuric Acid		Turbidimetric	8139	5 - 50 mg/L		•	•	•	•	•		**246066**
DEHA (Diethylhydroxylamine)		Iron Reduction	8140	3 - 450 µg/L	•	•	•	•				**2446600**
Detergents (Surfactants)		Crystal Violet	8028	0.002 - 0.275 mg/L	•	•	•	•	•			**2446800**
Dissolved Oxygen (AccuVac), LR		Indigo Carmine	8316	6 - 800 µg/L	•	•	•	•	•			**2501025**
Dissolved Oxygen (AccuVac), HR		HRDO	8166	0.3 - 15.0 mg/L	•	•	•	•	•	•	•	**2515025**
Dissolved Oxygen (AccuVac), UHR		Ultra High Range	8333	1.0 - 40.0 mg/L	•	•	•					**2515025**
Erythorbic Acid (Isoascorbic Acid)		Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•				**2446600**
Fluoride, Arsenic Free	•[3,4]	SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•		•	**2947549**
Fluoride, Arsenic Free (AccuVac)	•[3,4]	SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•		•	**2527025**
Fluoride	•[4]	SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•		•	**44449**
Fluoride (AccuVac)	•[4]	SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•		•	**2506025**
Formaldehyde		MBTH	8110	3 - 500 µg/L	•	•	•					**2257700**
Hardness, Total, ULR		Chlorophosphonazo Colorimetric	8374	8 - 1000 µg/L	•	•	•					**2603100**
Hardness, Total, ULR (Pour-Thru Cell)		Chlorophosphonazo Rapid Liquid	8374	4 - 1000 µg/L	•	•	•					**—**
Hardness, Ca & Mg		Calmagite Colorimetric	8030	0.05 - 4.00 mg/L	•	•	•	•	•	•		**2319900**
Hydrazine		p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•				**179032**
Hydrazine (AccuVac)		p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•				**2524025**
Hydroquinone		Iron Reduction	8140	9 - 1000 µg/L	•	•	•	•				**2446600**
Iodine DPD		DPD	8031	0.07 - 7.00 mg/L	•	•	•					**2105669**
Iodine DPD (AccuVac)		DPD	8031	0.07 - 7.00 mg/L	•	•	•					**2503025**
Iron (TNTplus)[2]	•	Phenanthroline	10229	0.2 - 6.0 mg/L	•	•						**TNT858**
Iron		FerroZine	8147	0.009 - 1.400 mg/L	•	•	•	•				**230166**
Iron (Pour-Thru Cell)		FerroZine Rapid Liquid	8147	0.009 - 1.400 mg/L	•	•	•					**230149**
Iron, Ferrous		1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•		**103769**
Iron, Ferrous (AccuVac)		1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•		**2514025**
Iron, Total		FerroMo	8365	0.01 - 1.80 mg/L	•	•	•	•	•			**2544800**
Iron, Total		TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•		•	**2608799**
Iron, Total (AccuVac)		TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•		•	**2510025**
Iron, Total	•	FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	**2105769**

[1]EPA approved for Cr^{6+} only. [2]As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.
[3]Per 40 CFR 136.6 Method Modification and Flexibility. [4]Not EPA accepted for drinking water using DR/800 Series colorimeters.

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Iron, Total (AccuVac)	•	FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	2507025
Isoascorbic Acid (Erythorbic Acid) (ISA)		Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•				2446600
Lead		LeadTrak Fast Column Extraction 8317	8317	5 - 150 µg/L	•	•	•				•	2375000
Lead	•	Dithizone	8033	3 - 300 µg/L	•	•	•					2243100
Lead (TNTplus)*		PAR	10216	0.1 - 2.0 mg/L	•	•						TNT850
Manganese, LR		PAN	8149	0.006 - 0.700 mg/L	•	•	•	•			•	2651700
Manganese, HR	•	Periodate Oxidation	8034	0.1 - 20.0 mg/L	•	•	•	•	•	•	•	2430000
Mercury		Cold Vapor Mercury Concentration	10065	0.1 - 2.5 µg/L	•	•	•					2658300
Methylethylketoxime (MEKO)		Iron Reduction	8140	15 - 1000 µg/L	•	•	•	•				2446600
Molybdenum, Molybdate, LR		Ternary Complex	8169	0.02 - 3.00 mg/L	•	•	•	•	•		•	2449400
Molybdenum, Molybdate, HR		Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•				2604100
Molybdenum, Molybdate (AccuVac), HR		Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•				—
Nickel		PAN	8150	0.006 - 1.000 mg/L	•	•	•	3			•	2651600
Nickel	•	Heptoxime	8037	0.02 - 1.80 mg/L	•	•	•					2243500
Nickel (TNTplus)[1]		Dimethylglyoxime	10220	0.1 - 6.0 mg/L	•	•						TNT856
Nitrate, Nitrogen, LR		Cadmium Reduction	8192	0.01 - 0.50 mg/L	•	•	•	•	•	•		2429800
Nitrate, Nitrogen (TNTplus), LR		Dimethylphenol	10206	0.23 - 13.5 mg/L	•	•						TNT835
Nitrate, Nitrogen, MR		Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•				2106169
Nitrate, Nitrogen (AccuVac), MR		Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•				2511025
Nitrate, Nitrogen		UV Screening	10049	0.1 - 10.0 mg/L	•							—
Nitrate, Nitrogen (Test 'N Tube), HR		Chromotropic Acid	10020	0.2 - 30.0 mg/L	•	•	•	•				2605345
Nitrate, Nitrogen, HR		Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	•	2106169
Nitrate, Nitrogen (AccuVac), HR		Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	•	2511025
Nitrate, Nitrogen (TNTplus), HR		Dimethylphenol	10206	5 - 35 mg/L	•	•						TNT836
Nitrite, Nitrogen, LR	•	Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•		2107169
Nitrite, Nitrogen (AccuVac), LR	•	Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•		2512025
Nitrite, Nitrogen (Test 'N Tube), LR		Diazotization	10019	0.003 - 0.500 mg/L	•	•	•	•	•	•		2608345
Nitrite, Nitrogen (TNTplus), LR	•	Diazotization	10207	0.015 - 0.600 mg/L	•	•						TNT839
Nitrite, Nitrogen (TNTplus), HR		Diazotization	10237	0.6 - 6.0 mg/L	•	•						TNT840
Nitrite, Nitrogen, HR		Ferrous Sulfate	8153	2 - 250 mg/L	•	•	•	•				2107569
Nitrogen, Ammonia (see Ammonia, Nitrogen)												
Nitrogen, Total (Test 'N Tube), LR		Persulfate Digestion	10071	0.5 - 25.0 mg/L	•	•	•	•				2672245
Nitrogen, Total (TNTplus), LR		Persulfate Digestion	10208	1 - 16 mg/L	•	•						TNT826
Nitrogen, Total (TNTplus), HR		Persulfate Digestion	10208	5 - 40 mg/L	•	•						TNT827
Nitrogen, Total (Test 'N Tube), HR		Persulfate Digestion	10072	2 - 150 mg/L	•	•	•	•				2714100
Nitrogen, Total (TNTplus), UHR		Persulfate Digestion	10208	20 - 100 mg/L	•	•						TNT828
Nitrogen, Total Inorganic (TIN) (Test 'N Tube)		Titanium Trichloride Reduction	10021	0.2 - 25.0 mg/L	•	•	•	•	•			2604945
Nitrogen, Simplified TKN (TNTplus)		s-TKN	10242	0 - 16 mg/L	•	•						TNT880
Nitrogen, Total Kjeldahl (TKN)		Nessler	8075	1 - 150 mg/L	•	•	•	•				2495300
Organic Carbon, Total (See TOC)												—
Organic Constituents, UV-Absorbing (UV-254)		Direct Reading	10054	Varies-Units Abs/cm	•							—
Oxygen Demand, Chemical (See COD)												—
Oxygen, Dissolved (See Dissolved Oxygen)												—
Oxygen Scavengers (See specific compounds)												—
Ozone (AccuVac), LR		Indigo	8311	0.01 - 0.25 mg/L	•	•	•	•	•		•	2516025
Ozone (AccuVac), MR		Indigo	8311	0.01 - 0.75 mg/L	•	•	•	•	•		•	2517025
Ozone (AccuVac), HR		Indigo	8311	0.01 - 1.50 mg/L	•	•	•	•	•			2518025
PCB (Polychlorinated Biphenyls) in Soil[2]		Immunoassay	10050	1 - 50 ppm, threshold	•	•	•				•	2773500
pH		Colorimetric Phenol Red	10076	6.5 - 8.5 units				•	•	•	•	2657512
Phenols	•	4-Aminoantipyrine	8047	0.002 - 0.200 mg/L	•	•	•					2243900

[1]As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal. [2]Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II). [3]Nickel PAN method reagent set for DR/890 is Prod. No. 2242600

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Phosphonates		Persulfate UV Oxidation	8007	0.02 - 125.0 mg/L	•	•	•	•	•		•	**2429700**
Phosphorus, Reactive	•	PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•		•	**2106069**
Phosphorus, Reactive (AccuVac)	•	PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•		•	**2508025**
Phosphorus, Reactive (Test 'N Tube)	•	PhosVer 3	8048	0.06 - 5.00 mg/L	•	•	•	•	•			**2742545**
Phosphorus, Reactive		Amino Acid	8178	0.23 - 30.00 mg/L	•	•	•	•	•	•		**2244100**
Phosphorus, Reactive		Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•				**2076032**
Phosphorus, Reactive (AccuVac)		Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•				**2525025**
Phosphorus, Reactive (Test 'N Tube), HR		Molybdovanadate	8114	1.0 - 100.0 mg/L	•	•	•	•				**2767345**
Phosphorus, Reactive (Pour-Thru Cell), HR		Molybdovanadate Rapid Liquid	8114	0.3 - 45.0 mg/L	•	•	•					**2076049**
Phosphorus, Reactive (Pour-Thru Cell), LR	•	Ascorbic Acid Rapid Liquid	10055	19 - 3000 µg/L	•	•	•					**2678600**
Phosphorus, Reactive (TNTplus)		Molybdovanadate	10214	5.0 - 90.0 mg/L	•	•						**TNT846**
Phosphorus, Acid Hydrolyzable (Test 'N Tube)		PhosVer 3 with Acid Hydrolysis	8180	0.06 - 3.50 mg/L	•	•	•	•	•			**2742645**
Phosphorus, Total (Test 'N Tube)	•	PhosVer 3 with Acid Persulfate Digestion	8190	0.06 - 3.50 mg/L	•	•	•	•	•			**2742645**
Phosphorus, Total (Test 'N Tube), HR		Molybdovanadate with Acid Persulfate Digestion	10127	1.0 - 100.0 mg/L	•	•	•	•				**2767245**
Phosphorus, Reactive and Total (TNTplus), LR	•	Ascorbic Acid	10209 10210	0.15 - 4.50 mg/L	•	•						**TNT843**
Phosphorus, Reactive and Total (TNTplus), HR	•	Ascorbic Acid	10209 10210	1.5 - 15.0 mg/L	•	•						**TNT844**
Phosphorus, Reactive and Total (TNTplus), UHR	•	Ascorbic Acid	10209 10210	6 - 60 mg/L	•	•						**TNT845**
Potassium		Tetraphenylborate	8049	0.1 - 7.0 mg/L	•	•	•					**2459100**
Quaternary Ammonium Compounds		Direct Binary Complex	8337	0.2 - 5.0 mg/L	•	•	•					**2459200**
Selenium		Diaminobenzidine	8194	0.01 - 1.00 mg/L	•	•	•					**2244200**
Silica (Pour-Thru Cell), ULR		Heteropoly Blue	8282	3 - 1000 µg/L	•	•	•					**2553500**
Silica (Pour-Thru Cell), ULR		Heteropoly Blue Rapid Liquid	8282	3 - 1000 µg/L	•	•	•					**2678500**
Silica, LR		Heteropoly Blue	8186	0.010 - 1.600 mg/L	•	•	•	•	•			**2459300**
Silica, HR		Silicomolybdate	8185	1 - 100 mg/L	•	•	•	•			•	**2429600**
Silver		Colorimetric	8120	0.02 - 0.70 mg/L	•	•	•					**2296600**
Sulfate	•	SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	**2106769**
Sulfate (AccuVac)	•	SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	**2509025**
Sulfate (TNTplus), LR		Turbidimetric	10227	40 - 150 mg/L	•	•						**TNT864**
Sulfate (TNTplus), HR		Turbidimetric	10227	150 - 900 mg/L	•	•						**TNT865**
Sulfide	•	Methylene Blue	8131	5 - 800 µg/L	•	•	•	•	•			**2244500**
Sulfite (Europe only)		Colorimetric		0.10 - 5.00 mg/L	•	•	•					**—**
Surfactants (See Detergents)												**—**
Suspended Solids		Photometric	8006	5 - 750 mg/L	•	•	•	•	•			**—**
Tannin & Lignin		Tyrosine	8193	0.1 - 9.0 mg/L	•	•	•	•	•			**2244600**
TOC (Total Organic Carbon), LR		Direct Method	10129	0.3 - 20.0 mg/L	•	•	•	•	•			**2760345**
TOC (Total Organic Carbon), MR		Direct Method	10173	15 - 150 mg/L	•	•	•	•	•			**2815945**
TOC (Total Organic Carbon), HR		Direct Method	10128	100 - 700 mg/L	•	•	•	•	•			**2760445**
Tolytriazole		UV Photolysis	8079	1.0 - 20.0 mg/L	•	•	•	•				**2141299**
Toxicity		ToxTrak	10017	0 - 100 % inhibition	•	•	•	•	•			**2597200**
TPH in Soil[1]		Immunoassay	10050	2 - 20 ppm, threshold	•	•	•				•	**2774300**
TPH in Water		Immunoassay	10050	2 - 20 ppm, threshold	•	•	•				•	**2774300**
Trihalomethanes (THM)		THM Plus	10132	10 - 600 µg/L	•	•	•					**2790800**
Trihalomethane Formation Potential (THMFP)		THM Plus	10224	10 - 600 µg/L	•	•	•					**2790800**
Volatile Acids		Esterification	8196	27 - 2800 mg/L	•	•	•	•	•	•		**2244700**
Volatile Acids (TNTplus)		Esterification	10240	50 - 2500 mg/L	•	•						**TNT872**
Zinc	•	Zincon	8009	0.01 - 3.00 mg/L	•	•	•	•	•		•	**2429300**

[1] *Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II).*

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Oxygen Demand, Chemical

DOC316.53.01100

USEPA[1] Reactor Digestion Method[2]

Method 8000

3 to 150 mg/L COD (LR)

TNTplus™ 821/822

20 to 1500 mg/L COD (HR)

Scope and application: For water, wastewater; digestion is required.

[1] COD ranges 3–150 mg/L and 20– 1500 mg/L COD are USEPA approved (5220 D) for wastewater analyses, Federal Register, April 21, 1980, 45(78), 26811-26812

[2] Jirka, A.M.; Carter, M.J., Analytical Chemistry, 1975, 47(8), 1397

Test preparation

Instrument-specific information

Table 1 shows all of the instruments that have the program for this test. The table also shows the adapter and light shield requirements for the applicable instruments that can use TNTplus vials.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information for TNTplus vials

Instrument	Adapters	Light shield
DR 6000, DR 5000	—	—
DR 3900	—	LZV849
DR 3800, DR 2800	—	LZV646
DR 1900	9609900 or 9609800 (A)	—

Before starting

DR 3900, DR 3800, DR 2800: Install the light shield in Cell Compartment #2 before this test is started.
Review the safety information and the expiration date on the package.
The recommended temperature for samples and reagents is 15–25 °C (59–77 °F).
The recommended temperature for reagent storage is 15–25 °C (59–77 °F).
The reagent that is used in this test is corrosive and toxic. Use protection for eyes and skin and be prepared to flush any spills with running water.
Spilled reagent will affect test accuracy and is hazardous to skin and other materials. Be prepared to wash spills with running water.
The reagents that are used in this test contain mercury. Collect the reacted samples for proper disposal.
Run one blank with each set of samples. Refer to Blanks for colorimetric determination on page 3. Run all tests (the samples and the blank) with the same lot of vials. The lot number is on the container label.
Keep unused (light sensitive) vials in a closed box.
Use the DRB reactor with 13-mm wells for the digestion. If the reactor has 16-mm wells, insert adapter sleeves into the wells.
DR 1900: Go to All Programs>LCK or TNTplus Methods>Options to select the TNTplus number for the test. Other instruments automatically select the method from the barcode on the vial.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

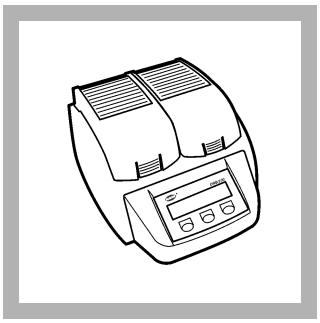
Description	Quantity
COD TNTplus™ Reagent Set, LR or HR	1
DRB200 reactor with 13-mm wells	1
Blender, 2-speed	1
Pipet, adjustable volume, 1.0–5.0 mL	1
Pipet tips, for 1.0–5.0 mL pipet	1
Test tube rack	1

Refer to Consumables and replacement items on page 5 for order information.

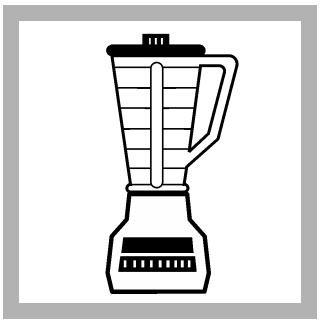
Sample collection and storage

- Collect samples in clean glass bottles. Use plastic bottles only if they are known to be free of organic contamination.
- Test biologically active samples as soon as possible.
- Homogenize samples that contain solids to get a representative sample.
- To preserve samples for later analysis, adjust the sample pH to less than 2 with concentrated sulfuric acid (approximately 2 mL per liter). No acid addition is necessary if the sample is tested immediately.
- Keep the preserved samples at 2–6 °C (36–43 °F) for a maximum of 28 days.
- Correct the test result for the dilution caused by the volume additions.

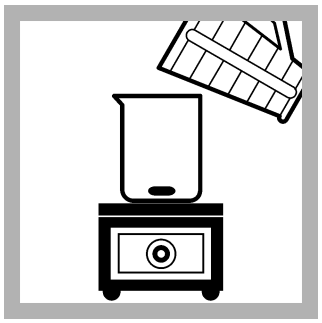
Test procedure



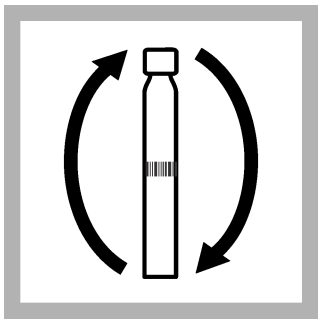
1. Set the DRB200 reactor power to on. Set the temperature to 150 °C.



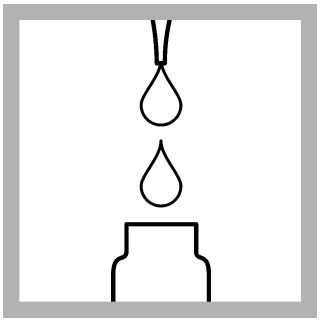
2. Measure 100 mL of sample in a blender. Blend for 30 seconds or until homogenized.
If the sample does not have suspended solids, ignore this step.



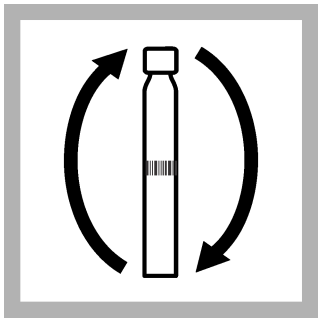
3. Pour the homogenized sample into a 250-mL beaker and stir slowly with a magnetic stir plate.
If the sample does not have suspended solids, ignore this step.



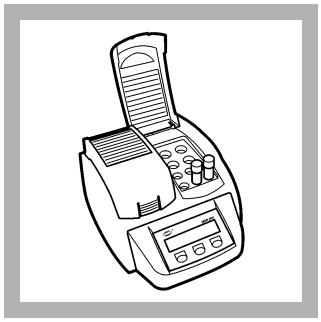
4. Invert a test vial several times to mix.



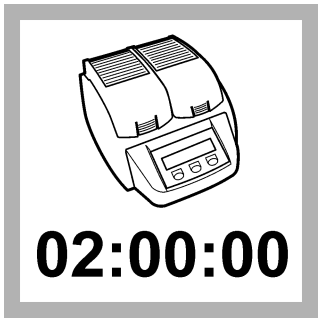
5. Use a pipet to add 2.0 mL of sample to the test vial.



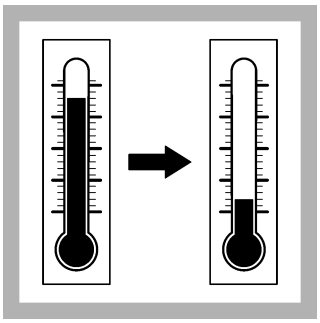
6. Hold the vial by the cap, over a sink. Invert gently several times to mix. **The vial gets very hot during mixing.**



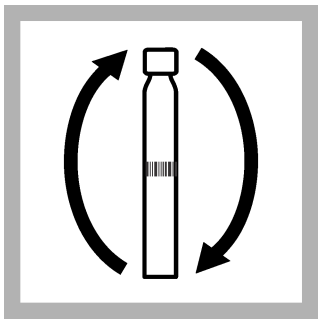
7. Insert the vial in the preheated DRB200 reactor. Close the lid.



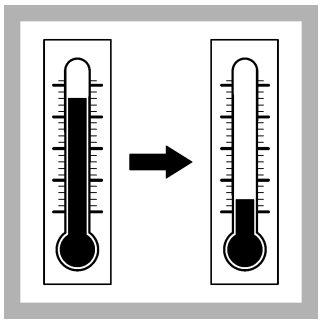
8. Keep the vial in the reactor for 2 hours.



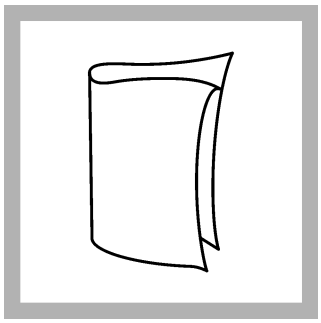
9. When the timer expires, set the reactor power to off. Let the temperature decrease for about 20 minutes to 120 °C or less.



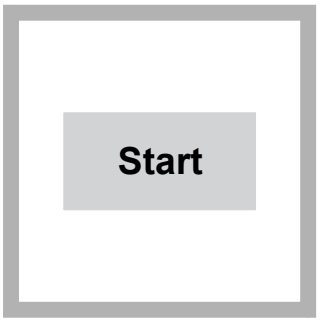
10. Hold the vial by the cap and invert gently several times while the vial is still hot.



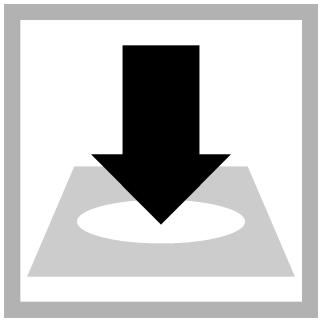
11. Put the vial in a test tube rack. Let the temperature of the vial decrease to room temperature.



12. Clean the vial.



13. DR 1900 only: Select program 821 (LR) or 822 (HR). Refer to Before starting on page 1.



14. Insert the vial into the cell holder. DR 1900 only: Push **READ**. Results show in mg/L COD.

Blanks for colorimetric determination

Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option. Use the blank again for other measurements with the same lot of vials. For storage, keep the blanks in a dark location. Monitor the decomposition of the blanks by periodically measuring its concentration. Measure the reagent blank value when a new lot of reagent is used.

To subtract the value of the blanks from a series of measurements:

1. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Clean the vial, then put it in the cell holder. Close the lid.
2. Set the reagent blank function to on. The measured value of the reagent blank is shown.

   Note: *As an alternative, record or enter the reagent blank value at a different time. Push the highlighted reagent blank box and use the keypad to enter the value.*

Interferences

Chloride is the primary interference in this test method and results in a positive interference. Each COD vial contains mercuric sulfate that will eliminate chloride interference to a maximum of 2000 mg/L Cl^-.

Accuracy check

Standard solution method—LR

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- COD Standard Solution, 1000-mg/L COD
- 100-mL volumetric flask, Class A
- 10.0-mL volumetric pipet, Class A and pipet filler safety bulb
- Deionized water

1. Prepare a 100-mg/L COD standard solution as follows:
   a. Use a pipet to add 10.0 mL of a 1000-mg/L COD standard solution into the volumetric flask.
   b. Dilute to the mark with deionized water. Mix well. Prepare this solution daily.
2. Use the test procedure to measure the concentration of the prepared standard solution.
3. Compare the expected result to the actual result.

   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Standard solution method—HR

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- COD Standard Solution, 300-mg/L, 800-mg/L or 1000-mg/L COD or Oxygen Demand Standard (contains 617-mg/L COD) or Wastewater Influent Standard Solution, Mixed Parameter (contains 500-mg/L COD)

1. Use the test procedure to measure the concentration of the standard solution.
2. Compare the expected result to the actual result.

   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users can get different results under different test conditions.

Program	Standard	Precision (95% Confidence Interval)	Sensitivity Concentration change per 0.010 Abs change
barcode (TNTplus 821, LR)	75 mg/L COD	72–78 mg/L COD	—
barcode (TNTplus 822, HR)	750 mg/L COD	736–764 mg/L COD	—

Summary of Method

The mg/L COD results are defined as the mg of O_2 consumed per liter of sample under conditions of this procedure. In this procedure, the sample is heated for 2 hours with a strong oxidizing agent, potassium dichromate. Oxidizable organic compounds react, reducing the dichromate ion ($Cr_2O_7^{2-}$) to green chromic ion (Cr^{3+}). With this method, the amount of yellow Cr^{6+} that remains is determined. The COD reagent also contains silver and mercury ions. Silver is a catalyst, and mercury is used to complex chloride interferences. The measurement wavelength is 420 nm for the LR or 620 nm for the HR.

Consumables and replacement items

Required reagents

Description	Quantity/Test	Unit	Item no.
COD TNTplus™ Reagent Set, LR, 3 to 150 mg/L COD	1–2 vials	25/pkg	TNT821
COD TNTplus™ Reagent Set, HR, 20 to 1500 mg/L COD	1–2 vials	25/pkg	TNT822

Required apparatus

Description	Quantity/test	Unit	Item no.
Blender, 2-speed, 120 VAC option	1	each	2616100
Blender, 2-speed, 240 VAC option	1	each	2616102
DRB 200 Reactor, 115 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20001
DRB 200 Reactor, 230 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20005
Pipet, adjustable volume, 1.0–5.0 mL	1	each	BBP065
Pipet tips, for 1.0–5.0 mL pipet	1	75/pkg	BBP068
Light shield, DR 3800, DR 2800, DR 2700	1	each	LZV646
Light shield, DR 3900	1	each	LZV849

Recommended standards

Description	Unit	Item no.
COD Standard Solution, 300-mg/L	200 mL	1218629
COD Standard Solution, 800-mg/L	200 mL	2672629
COD Standard Solution, 1000-mg/L	200 mL	2253929
Oxygen Demand Standard (BOD, COD, TOC), 10-mL ampules	16/pkg	2833510
Wastewater Effluent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4^{3-}, COD, SO_4^{2-}, TOC	500 mL	2833249
Wastewater Influent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4, COD, SO_4, TOC	500 mL	2833149

Optional reagents and apparatus

Description	Unit	Item no.
Flask, volumetric, Class A, 100-mL glass	each	1457442
Reactor adapter sleeves, 16 mm to 13 mm diameter, for TNTplus vials	5/pkg	2895805
Sampling bottle with cap, low density polyethylene, 500-mL	12/pkg	2087079
Sulfuric Acid, concentrated, ACS	500 mL	97949
Test tube rack, polyethylene, for 13-mm OD vials, 90 holes	each	2497900
Water, deionized	4 L	27256

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02/2014, Edition 8

Nitrogen, Simplified TKN (s-TKN™)

DOC316.53.01258

s-TKN™ Method **Method 10242**

0 to 16 mg/L TKN **TNTplus™ 880**

Scope and application: For water and wastewater. Digestion is required.

Test preparation

Instrument-specific information

Table 1 shows all of the instruments that have the program for this test. The table also shows the adapter and light shield requirements for the applicable instruments that can use TNTplus vials.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information for TNTplus vials

Instrument	Adapters	Light shield
DR 6000, DR 5000	—	—
DR 3900	—	LZV849
DR 3800, DR 2800	—	LZV646
DR 1900	9609900 or 9609800 (A)	—

Before starting

DR 3900, DR 3800, DR 2800: Install the light shield in Cell Compartment #2 before this test is started.
Review the safety information and the expiration date on the package.
The sample temperature must be 15–25 °C (59–77 °F) for accurate results.
The recommended temperature for reagent storage is 15–25 °C (59–77 °F).
Samples must be preserved with acid as specified in Sample collection and storage on page 2. Make sure to adjust the pH and temperature before the analysis.
Important: Make sure to close reagent bottles A, B and C immediately after each use.
The 20-mm reaction tube can be used a maximum of 13 times. After each use, clean the tube thoroughly with a brush and water, then rinse well with high-quality distilled water and let dry.
If a large amount of turbidity forms after the addition of MicroCap C, let the turbidity settle, then go to the next step. A small amount of turbidity does not interfere.
The nitrite concentration can be determined with nitrite reagents on samples that have not been preserved. The nitrite concentration must then be subtracted from the s-TKN result.
The total nitrogen concentration must be between 1 and 16 mg/L N. The combined nitrate/nitrite concentration must be between 0.23 and 13.5 mg/L N. Dilute the sample if necessary.
DR 1900: Go to All Programs>LCK or TNTplus Methods>Options to select the TNTplus number for the test. Other instruments automatically select the method from the barcode on the vial.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

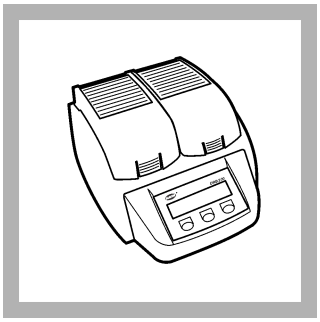
Description	Quantity
s-TKN TNTplus Reagent Set	1
DRB200 reactor with 20-mm wells	1
Pipet, adjustable volume, 1.0–5.0 mL	1
Pipet, adjustable volume, 0.2–1.0 mL	1
Pipet tips	1
Test tube rack	1

Refer to Consumables and replacement items on page 5 for order information.

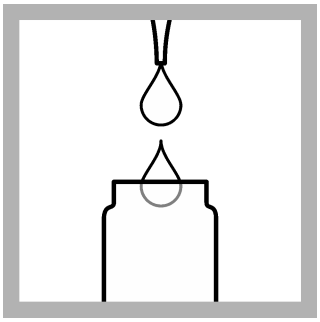
Sample collection and storage

- Collect samples in clean glass or plastic bottles.
- Adjust the sample pH to less than 2 with concentrated sulfuric acid (approximately 2 mL per liter).
- Keep the preserved samples at or below 6 °C (43 °F) for a maximum of 28 days.
- Let the sample temperature increase to room temperature before analysis.
- Before analysis, adjust the pH to 7 with 5 N sodium hydroxide solution.
- Correct the test result for the dilution caused by the volume additions.

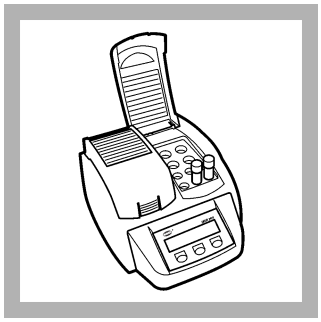
Test procedure



1. Set the DRB200 reactor power to on. Set the temperature to 100 °C.

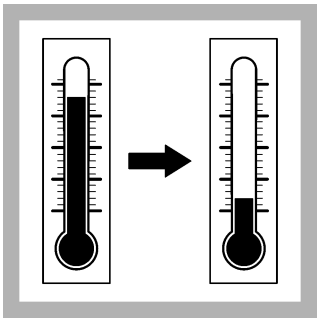


2. Add 1.3 mL of sample, 1.3 mL of Solution A and 1 Reagent B tablet in quick succession to a dry 20-mm reaction tube.
Close the reaction tube immediately. Do not invert.

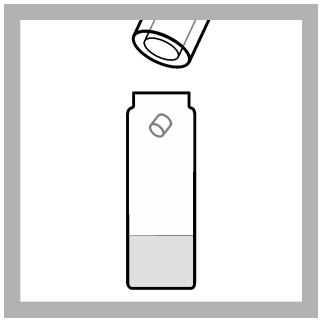


3. Insert the reaction tube in the preheated DRB200 reactor. Close the lid.

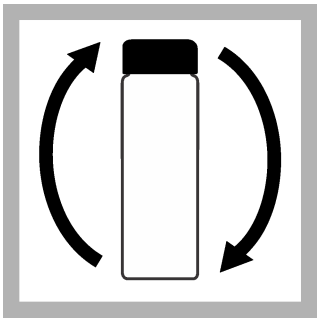
4. Keep the reaction tube in the reactor for 1 hour.



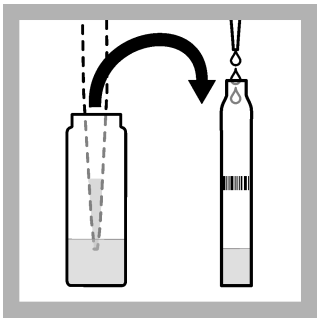
5. When the timer expires, carefully remove the reaction tube from the reactor. Let the temperature of the reaction tube decrease to room temperature.



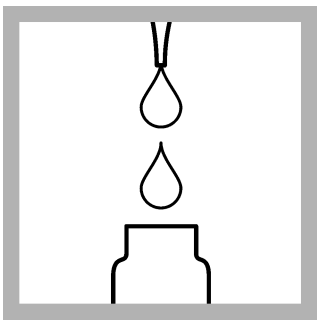
6. When cool, add 1 Micro Cap C to the reaction tube.



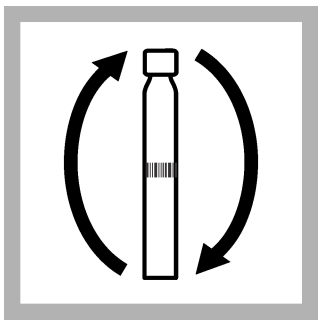
7. Tighten the cap on the reaction tube and invert until completely mixed.



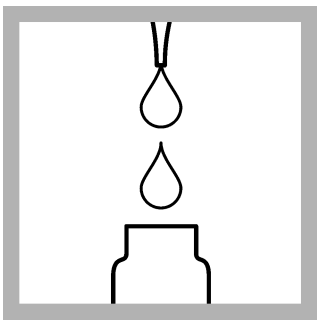
8. Use a pipet to add 0.5 mL of the digested sample from the 20-mm reaction tube into a test vial 1 (red label).



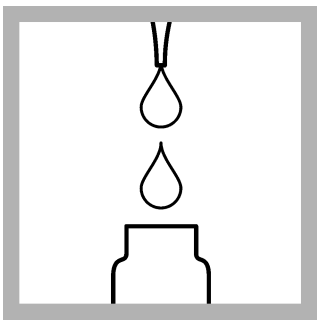
9. Use a pipet to add 0.2 mL of Solution D to the test vial.



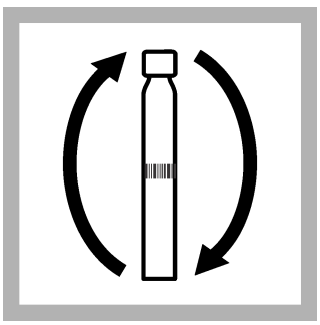
10. Quickly tighten the cap on the vial and invert until completely mixed. Immediately continue to the next step.



11. Use a pipet to add 1.0 mL of undigested sample to a test vial 2 (green label).

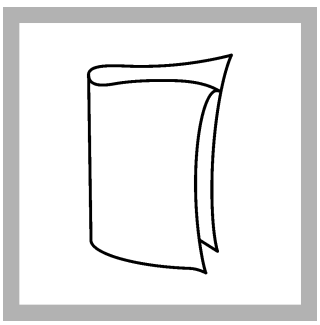


12. Use a pipet to add 0.2 mL of Solution D to the test vial.

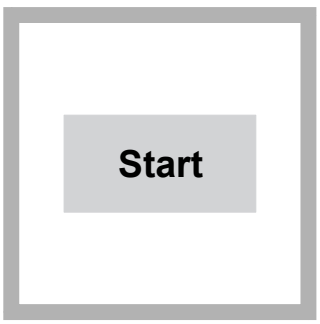


13. Quickly tighten the cap on the vial and invert until completely mixed.

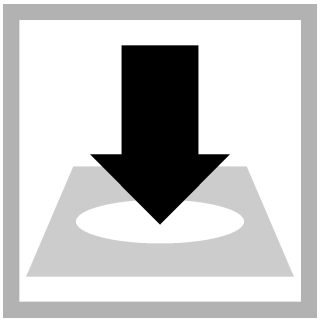
14. Start the reaction time of 15 minutes.



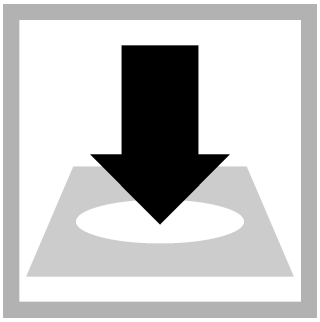
15. When the timer expires, clean the vials.



16. DR 1900 only: Select program 880. Refer to Before starting on page 1.



17. Insert the test vial 1 (red label) into the cell holder. DR 1900 only: Push ZERO. The display shows E1. Immediately continue to the next step.



18. Insert the test vial 2 (green label) into the cell holder. DR 1900 only: Push READ. Results show in mg/L Total N, mg/L NO_3–N + NO_2–N and mg/L TKN.

Interferences

High levels of oxidizable organic substances (COD) have an effect on the reagent color and give high results. Use this test procedure for wastewater only when the COD level is less than 500 mg/L COD.

Table 2 shows that the ions were individually examined to the given concentrations and do not cause interference. No cumulative effects or influences of other ions were found.

Table 2 Non-interfering substances

Interfering substance	Interference level
Cd^{2+}	50 mg/L
Ca^{2+}	50 mg/L
Cl^-	500 mg/L
Cr^{6+}	5 mg/L
Co^{2+}	10 mg/L
Cu^{2+}	50 mg/L
Fe^{2+}	10 mg/L
Fe^{3+}	50 mg/L
Pb^{2+}	50 mg/L
Ni^{2+}	50 mg/L
NO_2^-	2 mg/L
K^+	500 mg/L
Ag^+	100 mg/L
Na^+	500 mg/L
Sn^{2+}	50 mg/L
Zn^{2+}	50 mg/L

Accuracy check

Standard solution method

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- Wastewater Effluent Standard Solution, Mixed Parameter (expected result: 7.56-mg/L Total N, 4-mg/L NO_3^-–N + NO_2–N, 3.56-mg/L TKN)

1. Use the test procedure to measure the concentration of the standard solution.
2. Compare the expected result to the actual result. The Wastewater Effluent Standard Solution contains a component that adds 1.56-mg/L N to the Total N and TKN values. This is in addition to the 2-mg/L NH_3-N and 4-mg/L NO_3-N shown on the label.

   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Summary of Method

Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen and ammonia. In the simplified TKN method, inorganic and organic nitrogen are oxidized to nitrate by digestion with peroxodisulfate. The nitrate ions react with 2,6-dimethylphenol in a solution of sulfuric and phosphoric acid to form a nitrophenol. Oxidized forms of nitrogen in the original sample (nitrite + nitrate due to sample preservation) are determined in the second test vial and then subtracted, which results in TKN.

Consumables and replacement items

Required reagents

Description	Quantity/Test	Unit	Item no.
Simplified TKN (s-TKN) TNTplus reagent set	1	25/pkg	TNT880

Required apparatus

Description	Quantity/test	Unit	Item no.
DRB 200 Reactor, 115 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20001
DRB 200 Reactor, 230 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20005
Pipet, adjustable volume, 1.0–5.0 mL	1	each	BBP065
Pipet tips, for 1.0–5.0 mL pipet	1	75/pkg	BBP068
Pipet, adjustable volume, 0.2–1.0 mL	1	each	BBP078
Pipet tips, for 0.2–1.0 mL pipet	2	100/pkg	BBP079
Test tube rack	1	each	1864100
Light shield, DR 3800, DR 2800, DR 2700	1	each	LZV646
Light shield, DR 3900	1	each	LZV849

Recommended standards

Description	Unit	Item no.
Wastewater Effluent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4^{3-}, COD, SO_4^{2-}, TOC	500 mL	2833249

Optional reagents and apparatus

Description	Unit	Item no.
Filter membrane, 0.45-micron, 25-mm	100/pkg	2514101
Filter holder, 25-mm, for Luer-type syringe	each	246800

Optional reagents and apparatus (continued)

Description	Unit	Item no.
Sampling bottle with cap, low density polyethylene, 500-mL	12/pkg	2087079
Sodium Hydroxide Standard Solution, 5.0 N	1 L	245053
Sulfuric Acid, concentrated, ACS	500 mL	97949
Syringe, 10-cc, Luer-Lock tip	each	2202400

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02/2014, Edition 3

Nitrogen, Ammonia

DOC316.53.01083

Salicylate Method

Method 10205

2 to 47 mg/L NH_3–N (HR)

TNTplus™ 832

Scope and application: For surface water, municipal and industrial wastewater.

Test preparation

Instrument-specific information

Table 1 shows all of the instruments that have the program for this test. The table also shows the adapter and light shield requirements for the applicable instruments that can use TNTplus vials.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information for TNTplus vials

Instrument	Adapters	Light shield
DR 6000, DR 5000	—	—
DR 3900	—	LZV849
DR 3800, DR 2800	—	LZV646
DR 1900	9609900 or 9609800 (A)	—

Before starting

DR 3900, DR 3800, DR 2800: Install the light shield in Cell Compartment #2 before this test is started.
Review the safety information and the expiration date on the package.
The recommended sample pH is 4–8.
The sample temperature must be 20–23 °C (68–73 °F) for accurate results.
The recommended temperature for reagent storage is 2–8 °C (35–46 °F).
Analyze the samples as soon as possible for best results.
DR 1900: Go to All Programs>LCK or TNTplus Methods>Options to select the TNTplus number for the test. Other instruments automatically select the method from the barcode on the vial.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

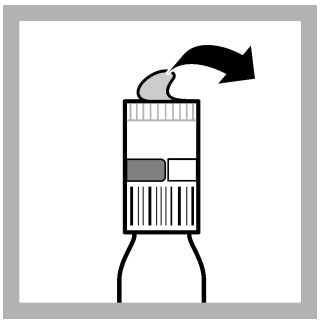
Description	Quantity
Nitrogen, Ammonia HR TNTplus Reagent Set	1
Pipet, adjustable volume, 0.2–1.0 mL	1
Pipet tips, for 0.2–1.0 mL pipet	1

Refer to Consumables and replacement items on page 4 for order information.

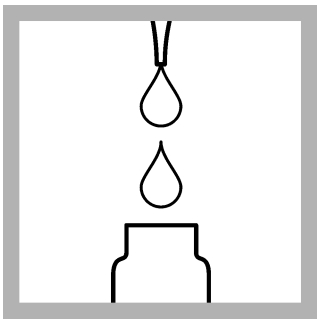
Sample collection and storage

- Collect samples in clean glass or plastic bottles.
- Analyze the samples as soon as possible for best results.
- To preserve samples for later analysis, adjust the sample pH to less than 2 with concentrated hydrochloric acid. No acid addition is necessary if the sample is tested immediately.
- Keep the preserved samples at or below 6 °C (43 °F) for a maximum of 28 days.
- Let the sample temperature increase to room temperature before analysis.
- Before analysis, adjust the pH to 7 with 5 N sodium hydroxide solution.
- Correct the test result for the dilution caused by the volume additions.

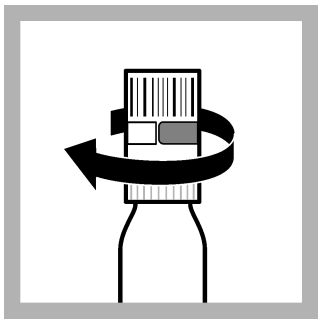
Test procedure



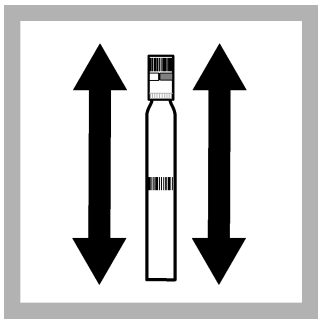
1. Carefully remove the lid from the DosiCap™ Zip cap. Remove the cap from the test vial.



2. Use a pipet to add 0.2 mL of sample to the test vial. Immediately continue to the next step.

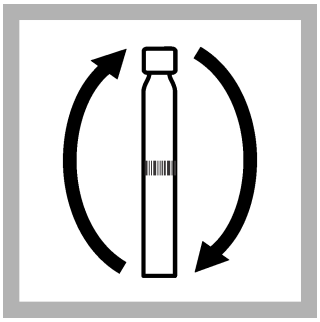


3. Turn the DosiCap Zip over the test vial so that the reagent side goes on the vial. Tighten the cap on the vial.

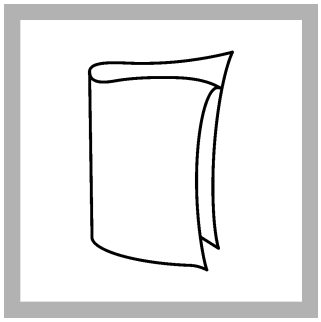


4. Shake the vial 2–3 times to dissolve the reagent in the cap.
Look through the open end of the DosiCap to make sure that the reagent has dissolved.

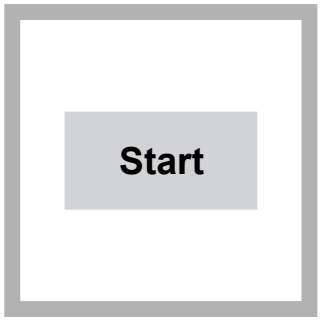
5. Start the reaction time of 15 minutes.



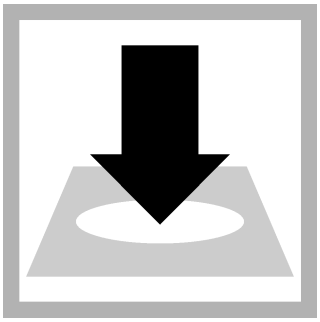
6. When the timer expires, invert the vial 2–3 times.
The color is stable for an additional 15 minutes after the timer expires.



7. Clean the vial.



8. DR 1900 only: Select program 832. Refer to Before starting on page 1.



9. Insert the vial into the cell holder. DR 1900 only: Push **READ**.
Results show in NH_3–N.

Reagent blank correction

For the best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option. Measure the reagent blank value when a new lot of reagent is used.

1. Use deionized water as the sample in the test procedure to measure the reagent blank value.
2. Set the reagent blank function to on. The measured reagent blank value is shown.
3. Accept the blank value. The reagent blank value is then subtracted from all results until the reagent blank function is set to off or a different method is selected.
   Note: *As an alternative, record or enter the reagent blank value at a different time. Push the highlighted reagent blank box and use the keypad to enter the value.*

Interferences

Table 2 shows that the ions were individually examined to the given concentrations and do not cause interference. No cumulative effects or influences of other ions were found.

Primary amines are found and cause high-bias results. A 10,000-fold excess of urea does not interfere. All reducing agents interfere and cause low-bias results.

Note: *An analyte concentration that is larger than the stated range adversely has an effect on color formation, which results in a false reading within the method range.*

Verify measurement results with sample dilutions or standard additions.

Distillation is necessary for samples with severe interferences. Complete the distillation procedure with the Hach General Purpose Distillation Set.

Table 2 Interfering substances

Interfering substance	Interference level
Cl^-, SO_4^{2-}	1000 mg/L
K^+, Na^+, Ca^{2+}	500 mg/L
CO_3^{2-}, NO_3^-, Fe^{3+}, Cr^{3+}, Cr^{6+}, Zn^{2+}, Cu^{2+}, Co^{2+}, Ni^{2+}, Hg^{2+}	50 mg/L
Fe^{2+}	25 mg/L
Sn^{2+}	10 mg/L
Pb^{2+}	5 mg/L
Ag^+	2 mg/L

Sample blanks

Samples with color or turbidity can cause high results. Samples without color or turbidity do not require sample blanks. To adjust for color or turbidity, use the steps that follow to find the sample blank.

1. Do the test procedure, but do not remove the foil lid from the vial.
2. Put the cap on the vial.
3. Subtract the value from the final procedure step from the initial sample value to get the corrected sample concentration.

Accuracy check

Standard solution method

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- Nitrogen, Ammonia Standard Solution, 10-mg/L NH_3–N or Wastewater Influent Standard Solution, Mixed Parameter

1. Use the test procedure to measure the concentration of the standard solution.
2. Compare the expected result to the actual result.

   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Summary of Method

Ammonium ions react at pH 12.6 with hypochlorite ions and salicylate ions in the presence of sodium nitroprusside as a catalyst to form indophenol. The amount of color formed is directly proportional to the ammonia nitrogen present in the sample. The measurement wavelength is 690 nm.

Consumables and replacement items

Required reagents

Description	Quantity/Test	Unit	Item no.
Nitrogen, Ammonia HR TNTplus Reagent Set	1	25/pkg	TNT832

Required apparatus

Description	Quantity/test	Unit	Item no.
Pipet, adjustable volume, 0.2–1.0 mL	1	each	BBP078
Pipet tips, for 0.2–1.0 mL pipet	2	100/pkg	BBP079
Light shield, DR 3800, DR 2800, DR 2700	1	each	LZV646
Light shield, DR 3900	1	each	LZV849

Recommended standards

Description	Unit	Item no.
Nitrogen Ammonia Standard Solution, 10-mg/L NH_3–N	500 mL	15349
Wastewater Influent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4, COD, SO_4, TOC	500 mL	2833149

Optional reagents and apparatus

Description	Unit	Item no.
Distillation apparatus set, general purpose	each	2265300
Distillation heater and support for apparatus set, 115 VAC option	each	2274400
Distillation heater and support for apparatus set, 230 VAC option	each	2274402
Hydrochloric Acid, concentrated	500 mL	13449
Sampling bottle with cap, low density polyethylene, 500-mL	12/pkg	2087079
Sodium Hydroxide Standard Solution, 5.0 N	100 mL MDB	245032
Test tube rack, polyethylene, for 13-mm OD vials, 90 holes	each	2497900
Water, deionized	4 L	27256

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02/2014, Edition 8

Phosphorus, Reactive (Orthophosphate) and Total

Ascorbic Acid Method

Method 10209/10210

6 to 60 mg/L PO_4^{3-} or 2 to 20 mg/L PO_4–P (UHR)

TNTplus™ 845

Scope and application: For wastewater, drinking water, boiler water, surface water and process analysis.

Test preparation

Instrument-specific information

Table 1 shows all of the instruments that have the program for this test. The table also shows the adapter and light shield requirements for the applicable instruments that can use TNTplus vials.

To use the table, select an instrument, then read across to find the applicable information for this test.

Table 1 Instrument-specific information for TNTplus vials

Instrument	Adapters	Light shield
DR 6000, DR 5000	—	—
DR 3900	—	LZV849
DR 3800, DR 2800	—	LZV646
DR 1900	9609900 or 9609800 (A)	—

Before starting

DR 3900, DR 3800, DR 2800: Install the light shield in Cell Compartment #2 before this test is started.
Review the safety information and the expiration date on the package.
The recommended sample pH is 2–10.
The recommended temperature for samples and reagents is 15–25 °C (59–77 °F).
The recommended temperature for reagent storage is 15–25 °C (59–77 °F).
The reagents that are used in this test contain molybdenum and are corrosive. Collect the reacted samples for proper disposal.
Use the DRB reactor with 13-mm wells for the digestion. If the reactor has 16-mm wells, insert adapter sleeves into the wells.
DR 1900: Go to All Programs>LCK or TNTplus Methods>Options to select the TNTplus number for the test. Other instruments automatically select the method from the barcode on the vial.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used. Use the recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Refer to the Safety Data Sheets for disposal information for unused reagents. Refer to the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

Description	Quantity
Phosphorus, Reactive and Total UHR TNTplus Reagent Set	1
DRB200 reactor with 13-mm wells	1

Items to collect (continued)

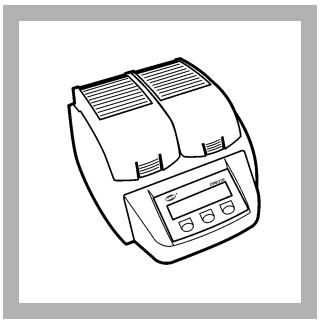
Description	Quantity
Pipet, adjustable volume, 0.2–1.0 mL	1
Pipet tips, for 0.2–1.0 mL pipet	1
Test tube rack	1

Refer to Consumables and replacement items on page 6 for order information.

Sample collection and storage

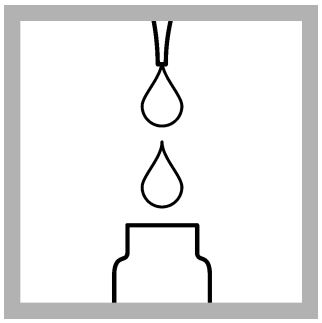
- Collect samples in clean glass or plastic bottles that have been cleaned with 6 N (1:1) hydrochloric acid and rinsed with deionized water.
- Analyze the samples as soon as possible for best results.
- Do not use a detergent that contains phosphate to clean the sample bottles. The phosphate in the detergent will contaminate the sample.
- To preserve samples for later analysis, adjust the sample pH to 2 or less with concentrated sulfuric acid (approximately 2 mL per liter). Do not acidify samples to be analyzed only for reactive phosphorus. No acid addition is necessary if the sample is tested immediately.
- Keep the preserved samples at or below 6 °C (43 °F) for a maximum of 28 days (reactive phosphorus only: 48 hours).
- Let the sample temperature increase to room temperature before analysis.
- Before analysis, adjust the pH to 7 with 5 N sodium hydroxide solution.
- Correct the test result for the dilution caused by the volume additions.

Test procedure—total phosphorus

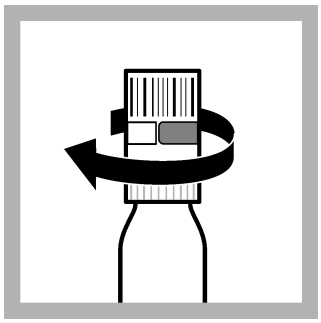


1. Set the DRB200 reactor power to on. Set the temperature to 100 °C.

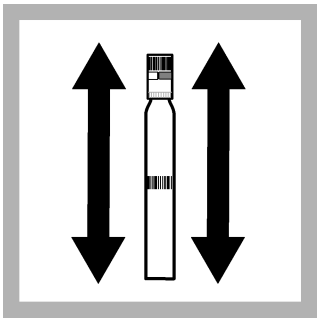
2. Carefully remove the lid from the DosiCap™ Zip cap. Remove the cap from the test vial.



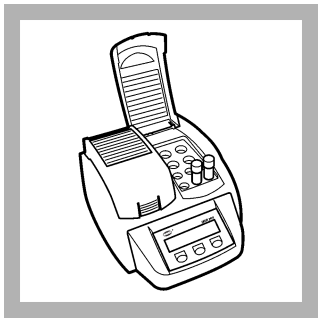
3. Use a pipet to add 0.4 mL of sample to the test vial.



4. Turn the DosiCap Zip over the test vial so that the reagent side goes on the vial. Tighten the cap on the vial.

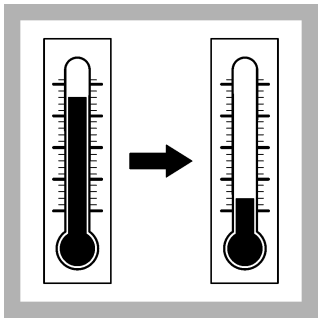


5. Shake the vial 2–3 times to dissolve the reagent in the cap.
Look through the open end of the DosiCap to make sure that the reagent has dissolved.

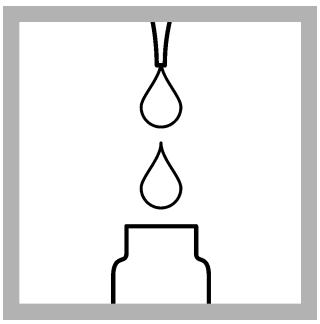


6. Insert the vial in the preheated DRB200 reactor. Close the lid.

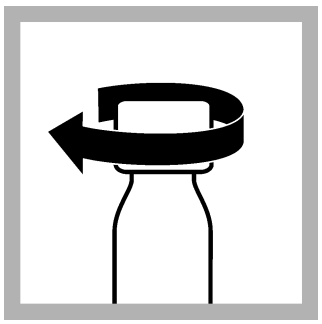
7. Keep the vial in the reactor for 1 hour.



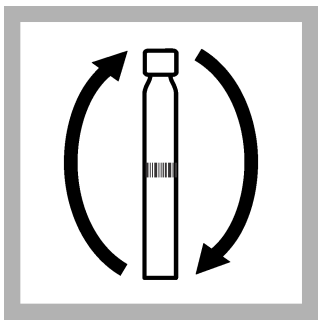
8. When the timer expires, carefully remove the vial from the reactor. Set the vial in a test tube rack. Let the temperature of the vial decrease to room temperature.



9. Use a pipet to add 0.5 mL of Solution B to the test vial. Immediately tighten the cap on the Solution B container.

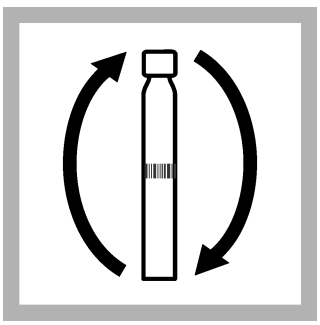


10. Put a grey DosiCap C on the vial.

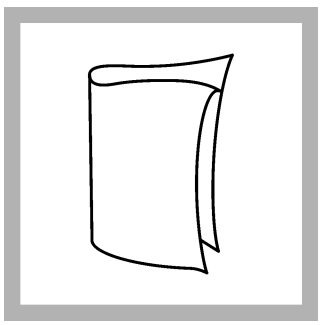


11. Tighten the cap on the vial and invert the vial 2–3 times.

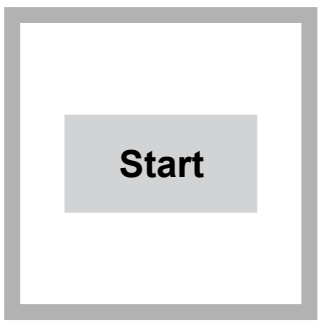
12. Start the reaction time of 10 minutes.



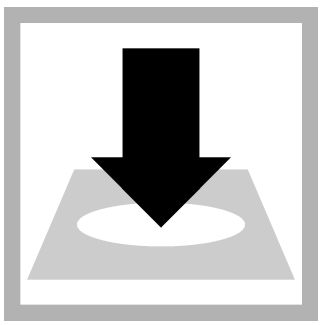
13. When the timer expires, invert the vial 2–3 times.



14. Clean the vial.

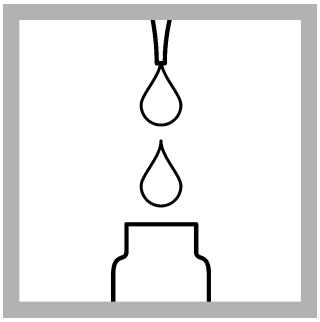


15. DR 1900 only: Select program 845. Refer to Before starting on page 1.

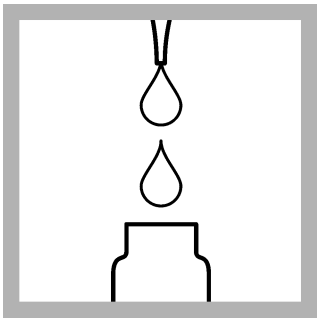


16. Insert the vial into the cell holder. DR 1900 only: Push **READ**.
Results show in mg/L PO_4^{3-}.

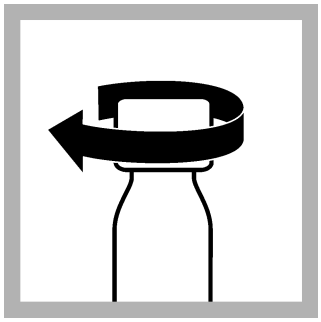
Test procedure—reactive phosphorus



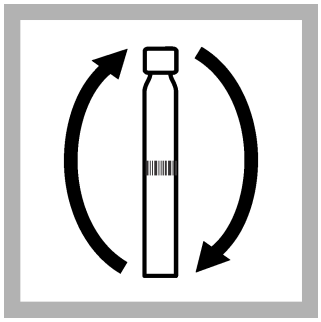
1. Use a pipet to add 0.4 mL of sample to the test vial.



2. Use a pipet to add 0.5 mL of Solution B to the test vial. Immediately tighten the cap on the Solution B container.

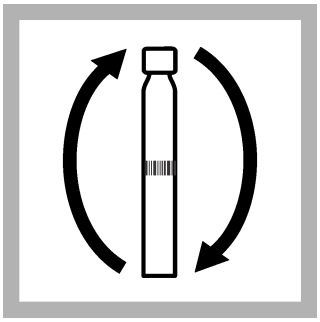


3. Put a grey DosiCap C on the vial.

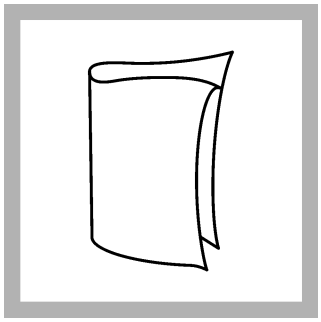


4. Tighten the cap on the vial and invert the vial 2–3 times.

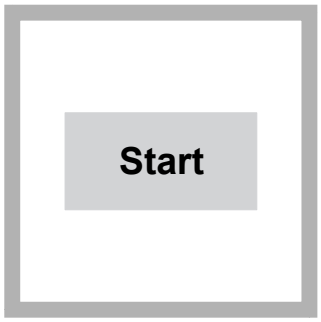
5. Start the reaction time of 10 minutes.



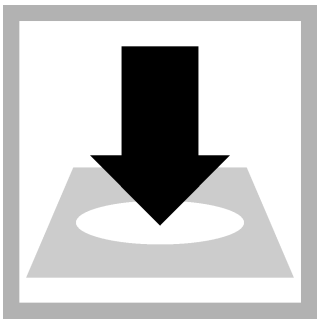
6. When the timer expires, invert the vial 2–3 times.



7. Clean the vial.



8. DR 1900 only: Select program 845. Refer to Before starting on page 1.



9. Insert the vial into the cell holder. DR 1900 only: Push **READ**.
Results show in mg/L PO_4^{3-}.

Reagent blank correction

For the best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to determine the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option. Measure the reagent blank value when a new lot of reagent is used.

1. Use deionized water as the sample in the test procedure to measure the reagent blank value.
2. Set the reagent blank function to on. The measured reagent blank value is shown.

3. Accept the blank value. The reagent blank value is then subtracted from all results until the reagent blank function is set to off or a different method is selected.
   Note: *As an alternative, record or enter the reagent blank value at a different time. Push the highlighted reagent blank box and use the keypad to enter the value.*

Sample blanks

Samples with color or turbidity can cause high results. Samples without color or turbidity do not require sample blanks. The digestion in the total phosphate test procedure usually removes all color and turbidity. A sample blank is not required. To adjust for color or turbidity in the reactive phosphate test procedure, use the steps that follow to find the sample blank.

1. Do the test procedure, but do not add the DosiCap C.
2. Put the cap on the vial, but do not remove the foil. Use the side of the cap that does not have the reagent.
3. Subtract the value from the final procedure step from the initial sample value to get the corrected sample concentration.
   Note: *Alternatively, samples that contain only turbidity can be filtered through a membrane filter, then analyzed.*

Interferences

Table 2 shows that the ions were individually examined to the given concentrations and do not cause interference. No cumulative effects or influences of other ions were found.

Verify the measurement results with sample dilutions or standard additions.

Table 2 Interfering substances

Interfering substance	Interference level
SO_4^{2-}	5000 mg/L
Cl^-	2000 mg/L
K^+, Na^+, Ca^{2+}	1000 mg/L
Mg^{2+}, NO_3^-	500 mg/L
Co^{2+}, Fe^{2+}, Fe^{3+}, Zn^{2+},Cu^{2+}, Ni^{2+}, I^-, NO_2^-, Cd^{2+}, Sn^{4+},NH_4^+, Mn^{2+}, Al^{3+}, Hg^{2+}, Pb^{2+}, SiO_2	50 mg/L
Ag^+	25 mg/L
Cr^{3+}	10 mg/L
Cr^{6+}	5 mg/L

Accuracy check

Standard solution method

Use the standard solution method to validate the test procedure, the reagents and the instrument.

Items to collect:

- Phosphate Standard Solution, 50-mg/L PO_4^{3-} or Wastewater Influent Standard Solution, Mixed Parameter (contains 10-mg/L PO_4^{3-})

1. Use the test procedure to measure the concentration of the standard solution.
2. Compare the expected result to the actual result.
   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users can get different results under different test conditions.

Program	Standard	Precision (95% confidence interval)	Sensitivity Concentration change per 0.010 Abs change
barcode	50.0 mg/L PO_4^{3-}	49–51 mg/L PO_4^{3-}	—

Summary of Method

Phosphates present in organic and condensed inorganic forms (meta-, pyro- or other polyphosphates) are first converted to reactive orthophosphate in the total phosphorus procedure. Treatment of the sample with acid and heat provides the conditions for hydrolysis of the condensed inorganic forms. Organic phosphates are also converted to orthophosphates in the total phosphorus procedure by heating with acid and persulfate. The reactive phosphorus procedure measures only the reactive (ortho) phosphorus present in the sample. The reactive or orthophosphate ions react with molybdate and antimony ions in an acidic solution to form an antimonyl phosphomolybdate complex, which is reduced by ascorbic acid to phosphomolybdenum blue. The measurement wavelength is 890 nm (DR 1900: 714 nm).

Consumables and replacement items

Required reagents

Description	Quantity/Test	Unit	Item no.
Phosphorus, Reactive and Total UHR TNTplus Reagent Set	1	25/pkg	TNT845

Required apparatus

Description	Quantity/test	Unit	Item no.
DRB 200 Reactor, 115 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20001
DRB 200 Reactor, 230 VAC option, 9 x 13 mm + 2 x 20 mm, 1 block	1	each	DRB20005
Pipet, adjustable volume, 0.2–1.0 mL	1	each	BBP078
Pipet tips, for 0.2–1.0 mL pipet	2	100/pkg	BBP079
Test tube rack	1	each	1864100
Light shield, DR 3800, DR 2800, DR 2700	1	each	LZV646
Light shield, DR 3900	1	each	LZV849

Recommended standards

Description	Unit	Item no.
Phosphate Standard Solution, 50-mg/L as PO_4^{3-}	500 mL	17149
Wastewater Influent Standard Solution, Mixed Parameter, for NH_3-N, NO_3-N, PO_4, COD, SO_4, TOC	500 mL	2833149

Optional reagents and apparatus

Description	Unit	Item no.
Filter membrane, 0.45-micron, 25-mm	100/pkg	2514101
Flask, volumetric, Class A, 1000-mL glass	each	1457453
Hydrochloric Acid Solution, 6.0 N (1:1)	500 mL	88449

Optional reagents and apparatus (continued)

Description	Unit	Item no.
Reactor adapter sleeves, 16 mm to 13 mm diameter, for TNTplus vials	5/pkg	2895805
Sampling bottle with cap, low density polyethylene, 500-mL	12/pkg	2087079
Sodium Hydroxide Standard Solution, 5.0 N	100 mL MDB	245032
Sulfuric Acid, concentrated, ACS	500 mL	97949

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
In the U.S.A. – **Call toll-free 800-227-4224**
Outside the U.S.A. – **Contact the HACH office or distributor serving you.**
On the Worldwide Web – **www.hach.com**; E-mail – **techhelp@hach.com**

HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

02/2014, Edition 8

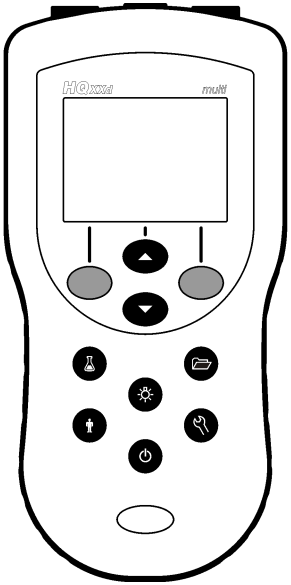
Appendix F – HACH HQ40d Portable pH/DO Meter and Specific Test Procedures

DOC022.53.80017

HQd Portable Meter

06/2013, Edition 4

User Manual



Specifications

Specifications are subject to change without notice.

Specification	Details
Dimensions	19.7 x 9.5 cm (7.75 x 3.75 in.)
Weight	335 g (0.75 lb) without batteries; 430 g (0.95 lb) with four AA alkaline batteries
Meter enclosure	IP67, waterproof to 1 meter for 30 minutes
Battery enclosure	Water resistant to 0.6 m (2 ft) for 15 seconds
Power requirements (internal)	AA Alkaline or rechargeable Nickel Metal Hydride (NiMH) batteries (4); battery life: up to 200 hours
Power requirements (external)	Class II, external power adapter: 100–240 VAC, 50/60 Hz input; 4.5 to 7.5 VDC (7 VA) output
Meter protection class	Class I
Storage temperature	–20 to +60 °C (–4 to +140 °F)
Operating temperature	0 to +60 °C (32 to 140 °F)
Operating humidity	90% (non-condensing)
5-pin input connector	M12 connector for IntelliCAL™ probes
8-pin input connector	The 8-pin connector enables USB and external AC power connectivity
USB/DC adapter	Peripheral and host
Data memory (internal)	500 results
Data storage	Automatic in Press to Read mode and Interval Mode. Manual in Continuous Read Mode.
Data export	USB connection to PC or USB storage device (limited to the storage device capacity). Transfer entire data log or as readings are taken.
Connections	Integrated USB type A (for USB flash memory device, printer, keyboard) and Integrated USB type B (for PC)
Temperature correction	Off, automatic and manual (parameter dependent)
Measurement display lock	Continuous measurement, Interval or Press to Read mode. Averaging function for LDO probes.
Keyboard	External PC keyboard connector via USB/DC adapter

General information

Revised editions are found on the manufacturer's website.

Safety information

NOTICE

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol indicates that the marked item can be hot and should not be touched without care.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.*

Product overview

The HQd series portable meters are used with digital IntelliCAL™ probes to measure various parameters in water. The meter automatically recognizes the type of probe that is connected to the meter.

Measurement data can be stored and transferred to a printer, PC or USB storage device.

The HQd series meters are available in 4 models:

- HQ11d—pH/mV/ORP
- HQ14d—conductivity, salinity, total dissolved solids (TDS), resistivity
- HQ30d—all IntelliCAL probes, 1 probe connector
- HQ40d—all IntelliCAL probes, 2 probe connectors

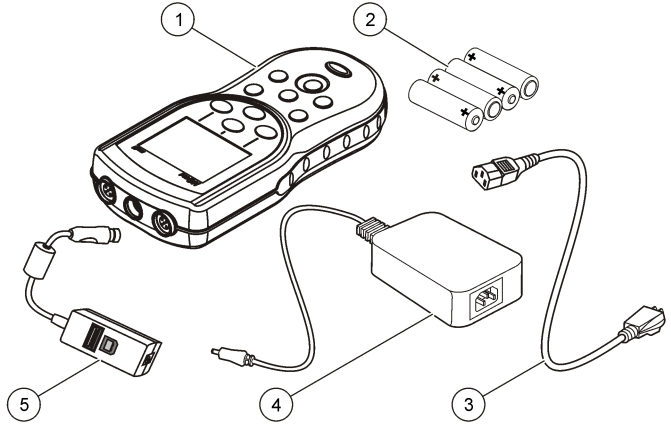
Features common to all models:

- Automatic probe and parameter recognition
- Instrument guided calibration procedures
- Calibration data stored in the probe
- Probe specific method settings for regulatory compliance and Good Laboratory Practice (GLP)
- Security Options
- Real-time data logging via USB connection
- USB connectivity to PC/printer/USB storage device/keyboard
- Bi-directional communication with PC-based systems via a virtual serial port connection
- Sample ID and Operator ID for data traceability
- Adjustable automatic shut-off

Product components

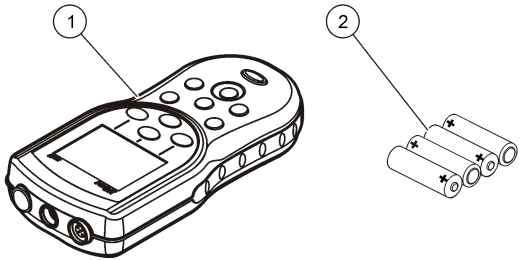
Refer to Figure 1 and Figure 2 to make sure that all components have been received. If any items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 1 Meter components (HQ40d model)



1 Meter	**4** AC-DC power supply
2 AA batteries (pk/4)	**5** USB/DC adapter
3 AC power cord	

Figure 2 Meter components (HQ11d, HQ14d and HQ30d models)



1 Meter	**2** AA batteries (pk/4)

Installation

⚠ CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Install the batteries

⚠ WARNING

Explosion hazard. Incorrect battery installation can cause the release of explosive gases. Be sure that the batteries are of the same approved chemical type and are inserted in the correct orientation. Do not mix new and used batteries.

NOTICE

The battery compartment is not waterproof. If the battery compartment becomes wet, remove and dry the batteries and dry the interior of the compartment. Check the battery contacts for corrosion and clean them if necessary.

NOTICE

When using nickel metal hydride (NiMH) batteries, the battery icon will not indicate a full charge after freshly charged batteries have been inserted (NiMH batteries are 1.2 V versus 1.5 V for alkaline batteries). Even though the icon does not indicate complete charge, 2300 mAH NiMH batteries will achieve 90% of instrument operation lifetime (before recharge) versus new alkaline batteries.

NOTICE

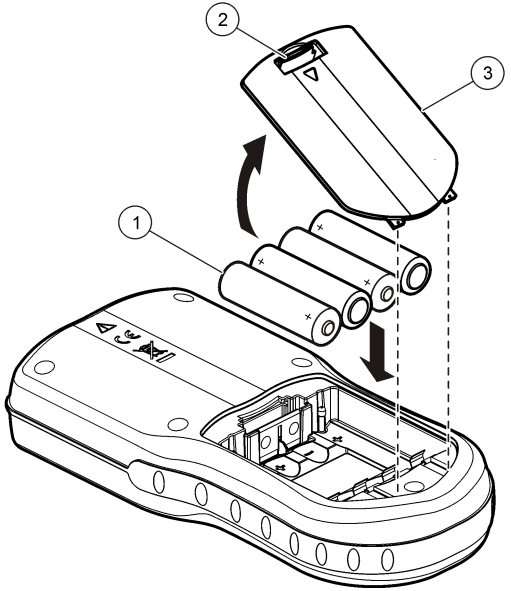
To avoid potential damage to the meter from battery leakage, remove the meter batteries prior to extended periods of non-use.

The meter can be powered with AA alkaline or rechargeable NiMH batteries. To conserve battery life, the meter will power off after 5 minutes of inactivity. This time can be changed in the Display Options menu.

For battery installation refer to Figure 3.

1. Pull the release tab on the battery cover and the remove the cover.
2. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct polarity.
3. Replace the battery cover.

Figure 3 Battery installation



1 Batteries	**2** Release tab	**3** Battery cover

Connect to AC power

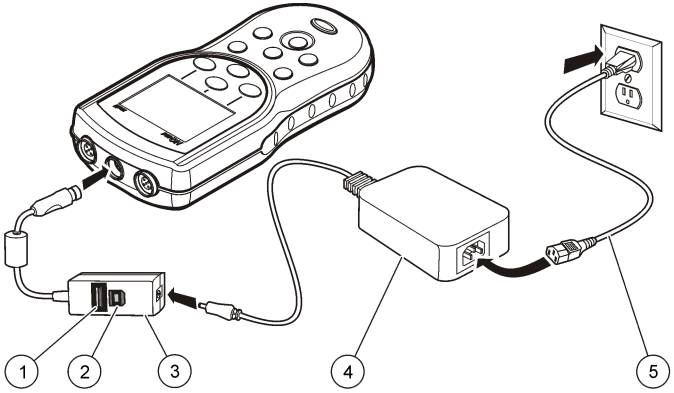
⚠ DANGER

Electrocution Hazard. AC power outlets in wet or potentially wet locations MUST ALWAYS be provided with a Ground Fault Circuit Interrupting (GFCI/GFI) circuit breaker. The AC-DC power adapter for this product is not sealed and must not be used on wet benches or in wet locations without GFCI protection.

The meter can be powered by AC power with an AC power adapter kit. The kit includes an AC-DC power supply, USB/DC adapter and AC power cord.

1. Turn the meter off.
2. Plug the AC power cord into the AC-DC power supply (Figure 4).
3. Connect the AC-DC power supply to the USB/DC adapter.
4. Connect the USB/DC adapter to the meter.
5. Plug the AC power cord into an AC receptacle.
6. Turn the meter on.

Figure 4 AC power connection

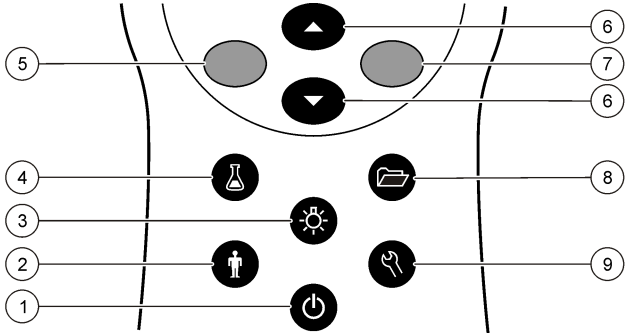


1 USB storage device/printer/Qwerty keyboard connection (USB peripheral)	**4** AC-DC power supply
2 Personal computer connection (USB host)	**5** AC power cord
3 USB/DC adapter	

User interface and navigation

User interface

Figure 5 Keypad description



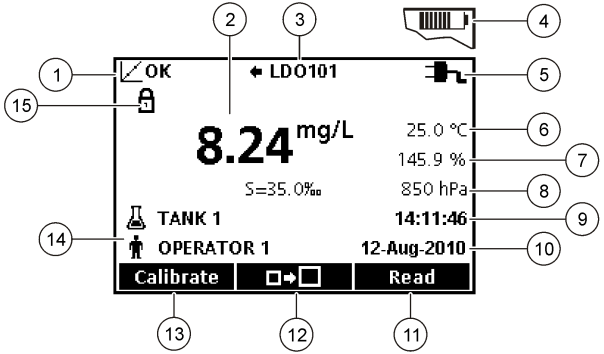
1 ON/OFF: turn on or turn off the meter	**6** UP and DOWN key: scroll through menus, enter numbers and letters or change the reading screen view
2 OPERATOR ID: associate data with an individual	**7** GREEN/RIGHT key: reads, selects, confirms or stores data
3 BACKLIGHT: illuminate the display screen	**8** DATA LOG: recall or transfer stored data
4 SAMPLE ID: associate data with a sample location	**9** METER OPTIONS: change settings, run check standards, view meter information
5 BLUE/LEFT key: calibrates, cancels or exits the current menu	

Display description

Measurement screen

The meter display shows the concentration, units, temperature, calibration status, operator ID, sample ID, date and time (Figure 6).

Figure 6 Single screen display



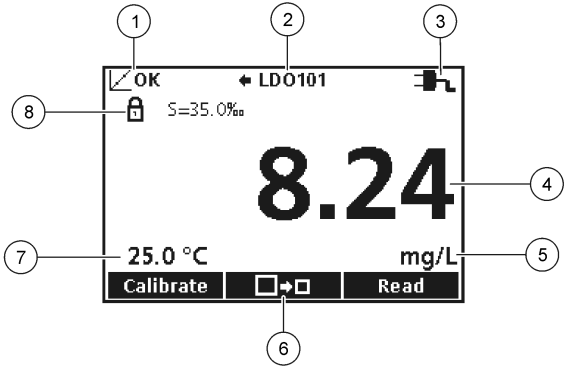
1 Calibration status indicator	**9** Time
2 Main measurement value and unit	**10** Date
3 IntelliCAL probe type and port indicator	**11** Read (OK, Select)
4 Battery status	**12** Display size icon
5 Power source	**13** Calibrate (Cancel, Exit)
6 Sample temperature (ºC or ºF)	**14** Sample and operator identification
7 Secondary measurement unit	**15** Stability or display lock indicator
8 Tertiary units (for some probes)	

Big-screen mode

The font size of the sample reading can be increased or decreased with the △ key (Figure 7).

Note: *When two probes are connected, push and hold the △ key to select the big-screen mode. The big-screen mode can also be selected in the Display Options menu (Refer to* Set the display options *on page 20**).*

Figure 7 Single-screen display—big-screen mode



1 Calibration status indicator	**5** Main measurement unit
2 IntelliCAL probe type and port indicator	**6** Display size icon
3 Power source or battery status	**7** Sample temperature (ºC or ºF)
4 Main measurement value	**8** Stability or display lock indicator

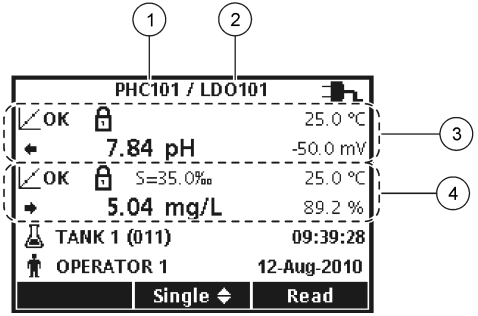
Dual-screen mode (HQ40d model only)

When two probes are connected to the HQ40d meter, the display can show the reading from both probes simultaneously or show just one probe (Figure 8).

Note: *For probe calibration, change the screen mode to the single screen mode.*

To change the screen mode to single or dual screen, use the △ and ▽ keys. In dual screen mode, the △ key will select the probe on the left and the ▽ key will select the probe on the right.

Figure 8 Dual-screen display



1	Probe that is connected to port on left	**3**	Measurement information for probe on left
2	Probe that is connected to port on right	**4**	Measurement information for probe on right

Navigation

The meter contains menus to change various options. Use the △ and ▽ keys to highlight different options. Push the GREEN/RIGHT key to select an option. There are two ways to change options:

1. Select an option from a list: Use the △ and ▽ keys to select an option. If check boxes are shown, more than one option can be selected. Push the BLUE/LEFT key under Select.

   Note: *To deselect check boxes, push the BLUE/LEFT key under Deselect.*
2. Enter an option value using the arrow keys:
   Push the △ and ▽ keys to enter or change a value.
3. Push the GREEN/RIGHT key to advance to the next space.
4. Push the GREEN/RIGHT key under OK to accept the value.

Startup

Turn the meter on and off

Push the ⏻ key to turn on or turn off the meter. If the meter does not turn on, make sure that the batteries are properly installed or that the AC power supply is properly connected to an electrical outlet.

Change the language

The display language is selected when the meter is powered on for the first time. The language can also be changed from the Meter Options menu.

Access to the language menu can be restricted with the Security Options. Refer to Security options on page 18.

1. Push the 🔧 key and select Language.
2. Select a language from the list.

   Note: *While turning the meter on, the language can also be changed when the power key is pushed and held.*

Change the date and time

The date and time can be changed from the Date & Time menu.

1. Push the key and select Date & Time.
2. Update the time and date information:

Option	Description
Format	Select one of the formats below for the date and time. Use the △ and ▽ keys to select from the format options. dd-mm-yyyy 24h dd-mm-yyyy 12h mm/dd/yyyy 24h mm/dd/yyyy 12h dd-mmm-yyyy 24h dd-mmm-yyyy 12h yyyy-mm-dd 24h yyyy-mm-dd 12h
Date	Use the △ and ▽ keys to enter the current date.
Time	Use the △ and ▽ keys to enter the current time.

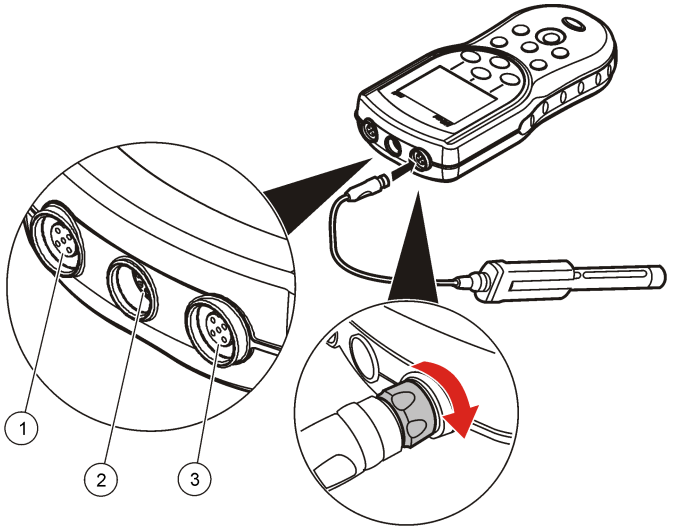
The current date and time will be shown on the display.

Connect a probe after the date and time setup, so that the meter is ready to take a measurement.

Connect a probe

1. Make sure that the display shows the current time and date.
   Note: *The time stamp for a probe is set when the probe is first connected to the meter. This time stamp makes it possible to record the probe history and record the time when measurements are made.*
2. Plug the probe into the meter (Figure 9).
3. Push and turn the locking nut to tighten.

Figure 9 Probe connection



1 Probe connection port (HQ40d only)	**2** USB/DC adapter port	**3** Probe connection port

Standard operation

About calibration

Each probe uses a different type of calibration solution. Make sure to calibrate the probes frequently to maintain the highest level of accuracy.

Note: *For step-by-step instructions, refer to the documents that are included with each probe.*

The calibration icon ? can indicate that:

- the calibration timer has expired

- the LDO sensor cap should be replaced
- the calibration is out of range
- the calibration results are outside acceptance criteria settings

About sample measurements

Each probe has specific preparation steps and procedures for taking sample measurements. For step-by-step instructions, refer to the documents that are included with the probe.

About check standards

Run Check Standards verifies equipment accuracy by measuring a solution of a known value. The meter will indicate if the Check Standard passed or failed. If the Check Standard fails, the calibration icon ? is shown until the probe is calibrated.

The meter can be set to automatically show a reminder for check standard measurement at a specified interval with a specified acceptance criteria. The reminder, value of the check standard, and acceptance criteria can be changed. For step-by-step instructions, refer to the documents that are included with the probe.

Use a sample ID

The sample ID tag is used to associate measurements with a particular sample location. If assigned, stored data will include the sample ID.

1. Push the key.
2. Select, create or delete a sample ID:

Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Sample ID	Enter a name for a new sample ID.
Delete Sample ID	Delete an existing sample ID.

Use an operator ID

The operator ID tag associates measurements with an individual operator. All stored data will include the operator ID.

1. Push the key.
2. Select, create or delete an operator ID:

Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Operator ID	Enter a name for a new operator ID (maximum 10 names can be entered).
Delete Operator ID	Delete an existing operator ID.

Data management

About stored data

The following types of data are stored in the data log:

- Sample measurements: stored automatically each time a sample is measured in the Press to Read or Interval Mode. When the continuous measurement mode is used, data is stored only when Store is selected.
- Calibrations: stored only when Store is selected at the end of a calibration. Calibration data is also stored in the IntelliCAL (R) probe.
- Check standard measurements: stored automatically each time a check standard is measured (in the Press to Read or Interval Mode).

When the data log becomes full (500 data points), the oldest data point is deleted when a new data point is added. The entire data log can be deleted to remove data that has already been sent to a printer or PC (key > Delete Data Log). To prevent deletion of the data log by a user, use the Security Options menu.

View stored data

The data log contains sample, calibration and check standard data. The most recent data point in the data log is tagged as Data Point 001.

1. Push the 🗁 key.
2. Select View Data Log to view the stored data. The most recent data point is shown. The top of the screen shows whether the data is from a sample reading, a calibration or a check standard. Push the ▽ key to view the next most recent data point.

Option	Description
Reading Log	Reading Log—shows sample measurements including the time, date, operator and sample ID. Select Details to view the associated calibration data.
Calibration Log	Calibration Log—shows calibration data. Select Details to view additional information about the calibration.
Check Standard Log	Check Standard Log—shows check standard measurements. Select Details to view the calibration data that was associated with the measurement.

View stored probe data

Make sure that a probe is connected to the meter. If two probes are connected, select the appropriate probe when prompted.

1. To view the calibration data that is stored in a probe, push the 🗁 key and select View Probe Data. The current calibration and calibration history for the probe can be viewed.

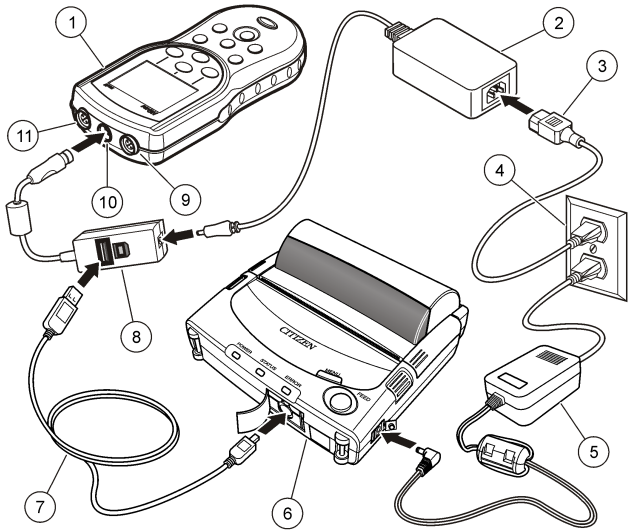
Option	Description
View Current Calibration	The current calibration information shows the calibration details for the most recent calibration. If the probe has not been calibrated by the user, the factory calibration data is shown.
View Calibration History	The calibration history shows a list of the times when the probe was calibrated. Select a date and time to view a summary of the calibration data.

Print stored data

The meter must connect to AC power to start the USB connection. Make sure that the connection to AC power is made before the meter is powered on.
All data can be sent to a printer. The PD-24 Citizen Printer is compatible with the HQd meters and is FCC Part 15B, Class B compliant with the HQ meters. Other printers may not be compatible. Compatible printers should support a minimum of 72 columns of data, be capable of printing up to 500 continuous data-stream events in 1, 2 and 3 lines of text and fully support code page 437 and code page 850.

1. Turn off the meter. Make sure that the meter is connected to AC power. Refer to Connect to AC power on page 8.
2. Connect the printer to the meter with a USB cable type A. Refer to Figure 10.
3. Turn on the meter.
4. Push the 🗁 key.
5. Select Send Data Log. Wait for the display to show “Transfer Complete” and wait for the printer to stop printing. Disconnect the printer.

Figure 10 Connection to the printer



1 Meter	**7** USB cable
2 AC-DC power supply	**8** USB/DC adapter
3 AC power cord	**9** Port for probe connection
4 AC power outlet	**10** Port for USB/DC adapter
5 Power supply for printer (optional)	**11** Port for probe connection
6 Citizen Printer, FCC Part 15B, Class B compliant	

Change the report options

Printed reports for sample data can contain 1, 2 or 3 lines of information. Refer to Examples of printed reports on page 28 for further information.

1. Push the 🗁 key. Select Report Options.
2. Select Report Type and select one of the options.

Option	Description
Basic report	One line of data.
Advanced report	Two lines of data. The first line contains the same information as in the basic report.
Total report	Three lines of data. The first two lines contain the same information as in the advanced report.

Send data to a USB storage device

NOTICE

The transfer of a large number of data points will take some time. DO NOT disconnect the USB storage device until the transfer is complete.

Data can be transferred to a USB storage device for storage or transfer to a computer.

1. Turn off the meter. Make sure that the meter is connected to AC power.
2. Plug the USB storage device into the meter before the meter is powered on.
3. Turn on the meter.
4. Push the 🗁 key.
5. Select Send Data Log. Wait for the display to show “Transfer Complete” and for any lights on the USB storage device to stop flashing. Then remove the USB device.

   Note: *If the data transfer is slow, reformat the USB storage device to use the file allocation table (FAT) format for the next use.*

Open data files on a PC

Data that has been downloaded to a USB storage device can be transferred to a computer. The data is sent in a text (.txt) file format.

1. Plug the USB storage device into the computer.
2. Find the data file. The file will have the following format: “Meter Serial Number-Data File Type-Date Time”. Example: 9999NN000000-SENDDATA-0603131624.TXT
3. Save the data file to a location on the computer.
4. Open a spreadsheet program such as Microsoft® Excel® spreadsheet software.
5. Open the data file from the spreadsheet program. Select the delimited option with comma as the delimiter.
   The data will be shown in the spreadsheet program.
   Note: *If an application is used that is not compatible with column headings, the headings can be omitted. Refer to* Remove column headers *on page 18.*

Data file description

Data that is saved to a USB storage device and then opened in a spreadsheet application will have multiple columns of data. A description for each of the columns is shown in Table 1.

Table 1 Spreadsheet column descriptions

Column header name	Data description and example values
Type	Type of data: RD = Reading; CL = Calibration; CK = Check Standard; CH = Calibration History; IC = Current Calibration
Parameter	Type Parameter: LDO, pH, CD (conductivity), ORP, ISE
Date	Date of reading: stored in user-defined date format
Time	Time of reading: stored in user-defined format
Operator ID	Operator ID that was used when the data was recorded. Shows “- - -” if no operator ID is used.

Table 1 Spreadsheet column descriptions (continued)

Column header name	Data description and example values
Probe Model	Model number of probe, for example pHC101, CDC401, LDO101
Probe SN	Probe serial number If two probes are connected to the HQ40d meter, the serial number shows “<“ or “>” to identify the port (left or right) the probe was connected to during the reading.
Method name	User-defined name of the probe settings that were used for the reading.
Sample ID	Sample ID that was used when the data was recorded. Shows "Sample ID" if the default sample ID is used.
Primary Reading Value	Measured value. Shows “—" if the value was out of range.
Primary Reading Units	Measurement units, for example pH or µS/cm
Supp Reading 1	First supplemental reading (example: temperature), if applicable
Supp Units 1	Units for first supplemental reading, if applicable.
Supp Reading 2	Second supplemental reading (example: “mV” for pH), if applicable
Supp Units 2	Units for second supplemental reading, if applicable
Supp Reading 3	Third supplemental reading, if applicable
Supp Units 3	Units for third supplemental reading, if applicable.
Reading Setting 1–4	Any settings that affect the reading, for example “NaCl/Non-Linear”
Any settings that affect the reading, for example “NaCl/Non-Linear”	Reading Message 1–4 Any message that was shown during the measurement, for example “Out of limits”.

Table 1 Spreadsheet column descriptions (continued)

Column header name	Data description and example values
Check Std Value	Value of the check standard that was used to verify accuracy, for example: 7.00 pH–25 ºC (pH, temp-compensated); 7.01 pH (pH, custom)
Check Std Units	Check standard units, for example µS/cm. ***Note:*** *pH is not displayed here as it is included in the previous column.*
Check Std Graph	Bar-graph showing the measurement in relation to the acceptance limits. Example: “6.901 <—|—> 7.101”.
Check Std Status	Status of the check standard reading. Example: “Reading within limits”, “Reading outside limits”
Calibration Status	Status of the calibration that is in use. OK = current calibration is valid; ? = calibration has expired.
Cal Date	Date of calibration reading: stored in user-defined date format
Cal Time	Time of calibration reading: stored in user-defined time format
Cal Operator ID	The operator ID specified when the probe was calibrated. Shows “- - -” if undefined.
Cal Slope Name	Slope (pH or LDO) or cell constant (conductivity)
Cal Slope	The slope value for the calibration
Cal Slope Aux	Used by pH to give the percent of nominal slope
Cal Slope Units	Units of the calibration slope. Example: “mV/pH” for pH
Cal Offset	Calibration offset value
Cal Offset Units	Calibration offset units. Example: “mV” for pH.
Cal r^2	Calibration correlation coefficient without a unit (may be blank)

Table 1 Spreadsheet column descriptions (continued)

Column header name	Data description and example values
Cal Number of Std’s	Number of standards used during calibration, for example 5. May be blank depending on record type, parameter type, and method settings.
Cal Std 1	Known value of the first calibration standard
Cal Std 1 Units	Units of the first calibration standard
Cal Std 1 Primary Value	Measured value of the first calibration standard
Cal Std 1 Primary Units	Associated units for the calibration measurement
Cal Std 1 Supp Value	Value of supplemental measurement, for example temperature
Cal Std 2–7	Known value of additional calibration standards, if used
Cal Std 2–7 Units	Units of additional calibration standards, if used
Cal Std 2–7 Primary Value	Measured values of additional calibration standards, if used
Cal Std 2–7 Primary Units	Associated units for additional calibration measurements, if used
Cal Std 2–7 Supp Value	Value of supplemental measurement, for example temperature
Cal Std Supp Units	Units applicable to all secondary calibration readings. Example: “ºC” or “ºF” for temperature
Cal Message 1–4	Any messages about the calibration
Date/Time POSIX	Date and time of reading stored in POSIX format (number of seconds from January 1, 1970) Example: 1149234913
Cal Date/Time POSIX	Date and time of calibration stored in POSIX format (number of seconds from January 1, 1970). Example: 1111320348
Meter SN	Meter serial number used to take the measurement

Remove column headers

When transferred data is viewed in a spreadsheet program, the first row of data contains headings to identify the type of data in each column. If an application or post-processing method is used that is incompatible with the headers, the column headers can be omitted.

1. Push the key.
2. Select Column Headers.
3. Set the column headers to off.

Send data directly to a computer

Data can be transferred from any HQd series meter directly to a computer when the HQ40d PC Application is installed. The data can be sent in real time during data collection, or the entire data log can be transferred.

To download the most current version of the software, refer to the applicable product page on the manufacturer's website.

1. Install the HQ40d PC Application on the computer.
2. Turn off the meter. Make sure that the meter is connected to AC power.
3. Connect the PC to the meter with a USB type B cable.
4. Turn on the meter.
5. Open the HQ40d PC Application on the computer. Click on the green triangle in the menu bar to start a connection.
6. Collect the data in real time or transfer the data from the data log:

   - Real time—when a data point is stored in the meter, the result is sent simultaneously to the PC Application (refer to Set the measurement mode on page 21).
   - Data log—push the key and select Send Data Log. Wait for the display to show “Transfer Complete.” The data is sent as a comma separated values (.csv) file.

   The data is shown in the HQ40d PC Application window.

Advanced operation

Security options

The Security Options menu is used to protect the meter setup and method settings from unwanted changes. This menu is available in the Full Access Options menu.

The Setup Measurement Mode, Date and Time, Temperature Units, Language, Probe settings, Delete data log and Security Options screens are disabled in the Operator Access Options menu. All menu options are enabled in the Full Access Options menu.

Note: *The Full Access Options menu is shown when the key is pushed when Security Options is OFF, whether or not a password has been set.*

When the meter is powered on for the first time and Security Options is selected, the display prompts the user to set a password. Until the meter is shut off, pushing the key will still display the Full Access Options menu, even after Security Options is turned on and a password has been set. After the meter is shut off and powered on again with Security Options on, the Operator Access Options menu is displayed until a valid password is entered.

Store the password in a safe and accessible place. If the specified password is forgotten and Security Options is turned on, the operator is locked out of the restricted menus. Contact technical support if the password is lost.

Turn Security Options on

The Security Options and the Set Password options are used together to prevent access to restricted menus.

1. Push the key and select Security Options.
2. Change the settings as needed to allow or prevent menu access.

Option	Description
Security Options	When Security Options is on, and a password has been specified, the password is required to enable the Full Access Options menu. If the meter is turned off while Security Options is on, the password is required to enable the Full Access Options menu again when the meter is turned on.
Set Password	Set a password that must be entered to enable the Full Access Options menu. The requirement for password entry is controlled by setting Security Options on or off.

Full access options menu

The Full Access Options menu is displayed when Security Options is OFF or when Security Options is ON and a valid password is entered (Table 2). These options do not need to be changed if the factory default settings are used.

Table 2 Full Access Options

Option	Description
(Probe model) settings	Settings such as measurement options, calibration options, check standard options, units and resolution. Refer to the probe documentation for more information. ***Note:*** *A probe must be connected to the meter.*
Run check standard	Measure standard solution (available for pH, conductivity, ORP and ISE probes)
Measurement mode	Press to Read
	Interval: Duration and Interval
	Continuous
Instrument information	Probe information
	Meter information

Table 2 Full Access Options (continued)

Option	Description
Security options	ON or OFF
	Set password
Display options	Contrast
	Auto shutoff
	Backlight
	Mode
Sounds	Key press
	Stability alert
	Calibration reminder
Date and time	Format
	Date
	Time
Temperature units	Set temperature units
Language	Select language

Restricted operator access options menu

The Operator Access Options menu is shown at meter startup when Security Options is ON (Table 3). When a valid password is entered, the menu changes to Full Access Options.

Table 3 Operator access options

Option	Description
(Probe model) settings	Only methods (if methods exist) can be selected. Refer to the probe documentation. ***Note:*** *A probe must be connected to the meter.*
Run check standard	Measure standard solution (available for pH, conductivity, ORP and ISE probes) ***Note:*** *A probe must be connected to use this option.*
Instrument information	Probe information
	Meter information
Access password	Enter password
Display options	Contrast
	Auto shutoff
	Backlight
	Mode
Sounds	Key press
	Stability alert
	Calibration reminder

Set the display options

Use Display Options to change the display contrast, battery saving auto-shutoff options, the backlight option or the detailed or big reading screen mode.

1. Push the key and select Display Options.
2. Select which display option to change.

Option	Description
Contrast	Adjust the contrast of the display. The lightest setting is 0 and the darkest setting is 9.
Auto-shutoff	To maximize battery life, set a time period after which the meter will automatically power off if no key is pushed (1, 2, 5, 10, 30 min, 1 h, 2 h or never). Auto-shutoff is not active when the meter is connected to AC power or in the Interval Reading Mode.
Backlight	The display backlight is turned off when the key is pushed. Is it possible to set a time period after which the backlight will automatically power off if no key is pushed.
Mode	Select Detailed or Big screen size. Detailed will show more information with smaller numbers and text. Big will show less information with larger numbers and text. ***Note:*** *The screen size can also be selected from the measure mode (refer to* Display description *on page 9).*

Set the sound options

The meter can make an audible sound when a key is pushed, when stability is reached or when the calibration reminder is due. The meter also makes an audible sound when it begins transferring data to a USB storage device and again when the data transfer is complete.

1. Push the key and select Sound.
2. Choose which events will produce an audible sound. Multiple items can be selected.

Option	Description
Key Press	The meter will make an audible sound whenever a key is pushed.
Stability Alert	The meter will make an audible sound whenever measurement stability is reached.
Cal reminder	The meter will make an audible sound when calibration is due. ***Note:*** *Refer to* Set the probe calibration reminder *to set the calibration reminder to on or off.*

Set the probe calibration reminder

Make sure that a probe is connected to the meter.

1. Push the key and select the probe settings.
2. Select Modify Current Settings.
3. Select Calibration Options.
4. Select Calibration Reminder.

Option	Description
Calibration reminder	Reminder repeat: Off, 2 h, 4 h, 8 h, 2 d, 5 d, 7d Expires: Immediately, Reminder + 30 min, Reminder + 1 hr, Reminder + 2 hr, Continue Reading The meter can be set to make an audible sound when calibration is due. Calibration expires after a specified time set by the user. ***Note:*** *The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.*

Change the temperature units

To select degrees Celsius or Fahrenheit:

1. Push the key and select Temperature Units.
2. Select the Celsius or Fahrenheit option.

Set the measurement mode

One of three modes can be used to specify when measurements are taken and how the data is stored. When a data point is stored, the result is sent simultaneously to any device (PC/printer/ USB storage device) that is connected to the meter.

1. Push the key and select Measurement Mode.
2. Select Mode.
3. Select one of the measurement modes.

Option	Description
Press to Read	The sample is measured only when the GREEN/RIGHT key under Read is pushed. Data is stored in the data log automatically when the stability criteria are met.
Interval	The sample is measured at regular intervals for a specified duration (refer to Set auto measurement intervals on page 21). Data is stored in the data log automatically.
Continuous	The sample is measured continuously. Data is stored in the data log only when the GREEN/RIGHT key under Store is pushed.

Set auto measurement intervals

When the measurement mode is set to Interval, the time intervals and duration must be specified. Measurements are stored at the user-defined intervals whether or not stability criteria are met.

Note: *Use of an external USB storage device or direct printer connection while in Interval Measurement mode prevents data from being over-written in the data log. Data points are over-written on a First In/First Out basis. Refer to* Prevent data log overflow in interval mode *on page 22*.

1. Push the key and select Measurement Mode.
2. Select Mode.
3. Select Interval as the Measurement Mode.
4. Select Duration and select the total time that measurements will be taken for (15 min, 30 min, 1 h, 4 h, 8 h, 24 h, 48 h or no limit).
5. Select Interval and select how often measurements will be taken (every 10 s, 30 s, 1 min, 5 min, 15 min or 30 min).

Start interval measurements

During interval measurements, the meter goes into a standby state between readings to conserve power. The auto-shutoff option is disabled. Measurements stop when the selected interval duration has passed. The auto-shutoff option then becomes active.

Interval measurements are suspended for calibrations, check standard measurements or when the key is pushed. Interval measurements resume when returning to the measurement screen.

1. From the Main Measurement screen, select Start to begin interval measurements. The screen will show “Recording” and the remaining time of the duration. The sample number automatically advances when each reading is taken.
2. To stop interval measurements, select Stop.
3. To repeat the interval measurement after it has been stopped or completed, select Start.

Prevent data log overflow in interval mode

When measurements are taken at specified intervals (Table 4), each result is automatically stored. The meter can store up to 500 data records. When 500 records have been stored, data is replaced on a first-in, first-out basis. To prevent loss of data, connect the meter to a PC/printer/USB storage device.
Note: *Stop interval measurements before changes are made to a method or to meter settings.*

Table 4 Recommended interval/duration pairs

Interval	Duration
10 seconds	1 hour
30 seconds	4 hours
1 minute	8 hours
5 minutes	24 hours

Note: *When 2 probes are connected to the meter, use the next lowest recommended duration time. For example, for a 30-second interval, set the duration to 1 hour to prevent data log overload with 2 probes.*

View instrument information

The instrument information menu shows specific information such as the serial number for the meter or IntelliCAL (R) probe(s).

1. Push the key and select Instrument Information.
2. Select (Probe model) Information or Meter Information.

Option	Description
Probe information	The Probe Information screen shows the probe model number, serial number, software version and date of first use. For LDO and LBOD probes, the lot code for the sensor cap and the remaining time before sensor cap replacement is shown. ***Note:*** *A probe must be connected to the meter.*
Meter information	The Meter Information screen shows the meter model number, serial number, software version and memory information. The amount of memory used and the number of available user method settings, operator IDs and sample IDs is shown.

Update the meter software

A USB storage device that contains software update files is used to update the meter software.
Note: *The meter must be turned off and then on again before the software update will begin. The software update initiates upon meter startup after the USB device is correctly inserted.*

NOTICE

Do not remove the USB device until the “Update complete” message is shown. The meter can become damaged if the USB device is removed before the update process is complete.

1. Save stored data from the data log to a USB storage device or to a PC. Refer to Send data to a USB storage device on page 15 and Send data directly to a computer on page 18.
2. Turn off the meter.
3. Connect the USB/DC adapter, AC-DC power supply and cord (Figure 4 on page 9).

4. Insert the USB storage device that contains the software update files into the USB/DC adapter.
5. Turn on the meter.
   The update process starts. The display will show “Updating meter to <firmware version>”. After an interval, the display changes to “Updating files, please wait...” In addition, the display will show a rotating flask and emit a periodic audio signal during the update process.
   Note: *A large capacity USB storage device increases the time required for completion of the update process, even if most of the device memory is empty.*
6. Wait for the meter to finish the software update. When the update process is complete, the message “Update complete. Remove USB device” is shown. The meter will turn off after the USB device has been removed.
7. Repeat steps 1 through 6 to update the software in other HQd meters as necessary.

Download software updates

To download the most current version of the software, refer to the applicable product page on the manufacturer's website.

1. Transfer the update files to a USB storage device.
2. Follow the instructions in Update the meter software on page 22 to update the software in the meter.

Transfer method settings

Probe settings that have been changed by the user for measurements, calibrations or check standards (Meter Options > (Probe Model) Settings > Modify Current Settings) can be copied to a USB storage device. The USB device can then be used to transfer the method settings to other HQd meters that accept the same probes.

NOTICE

Make sure the USB storage device does not contain HQd meter software update files to prevent unintentional updates.

1. Turn off the meter.
2. Connect the meter to AC power (Figure 4 on page 9).
3. Plug the USB storage device into the USB/DC adapter before the meter is powered on.
4. Turn on the meter.
5. Push the key and select Transfer Methods. If the USB device already contains a method settings file, an option to export or import methods is shown. Select Export Methods.
6. In the Select Methods to Export screen, select one or more methods to copy to the USB device. A check mark is shown next to each selected method.
7. Select OK. The settings are copied to the USB storage device. When complete, the Transfer Summary screen is shown.
8. Connect the AC power and USB device to a meter that will receive the method settings. Turn the meter on.
9. Push the key and select Transfer Methods. If the USB device already contains a method settings file, an option to export or import methods is shown. Select Import Methods.
10. In the Select Methods to Import screen, select one or more methods to transfer to the meter. A check mark is shown next to each selected method.
11. Select OK. The user method settings are transferred from the USB storage device to the meter. When complete, the Transfer Summary screen is shown. Select details to view additional information about the transfer.
12. Disconnect the USB storage device from the meter.

Bi-directional Communication between the meter and a PC

For measurement automation the meter can be used to implement a command set for meter remote control or automated data transfer. The command set can be used to perform minimal configuration and to control the meter. To set up the meter for communication and control, refer to About meter configuration on page 24. For additional information and the command set contact Technical Support.

About meter control

The virtual serial connection can be used to control meter functions from a PC. For example, the functions include starting a measurement cycle,

turning off the meter and sending the entire measurement (including calibrations) to the PC or other information management system.

About meter configuration

To use the meter communication and control from the PC, an INF file must be installed.

1. The meter software must be version 2.0.0.710 or higher.
   To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
2. Open the Zip file.
3. Copy the INF file from the software upgrade package to a convenient location on the PC.

   Note: *The INF file must be installed to use the meter manual control from a PC.*
4. Turn on the meter.
5. Push the key and select Instrument Information.
6. Select USB Device Type and then select Virtual Serial to use the virtual serial port on the meter.
7. Push OK. The meter will automatically restart to complete the setting change.
8. Connect the meter with the USB cable to the PC and turn on the meter.
   Windows XP starts the "Found New Hardware Wizard".
9. Select "No, not at this time" to the query "Can Windows connect to Windows Update to search for software?"
10. Click Next. The next wizard screen will prompt.
11. Select "Install from a list or specific location (Advanced)" to the query "What do you want the wizard to do?"
12. Click Next. The next wizard screen will prompt.
13. Select the option "Search for the best driver in these locations."
14. Uncheck the "Search removable media (floppy, CD-ROM)" option and select the "Include this location in the search:" and click the "Browse" button.
15. Select the INF folder or location and click OK.
16. Click Next. The new software will be installed.
17. Click Finish to complete the Found New Hardware Wizard for: HQd Meter - Virtual Serial Port.
18. To make sure that the installation succeeded, go to Computer Management>Device Manager>Ports. The new installed port is listed as HQd Meter - Virtual Serial Port (COM#).
19. The meter is now ready for communication with PC-based systems using the Virtual Serial port. A program interface must be developed by the user for the command set used to control the meter functions from the PC. Contact Technical Support for more information and command set documentation.

Maintenance

⚠ CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Clean the meter

The meter is designed to be maintenance-free and does not require regular cleaning for normal operation. Exterior surfaces of the meter may be cleaned as necessary.

1. Wipe the surface of the meter with a damp cloth.
2. Use a cotton-tipped applicator to clean or dry the connectors.

Replace the batteries

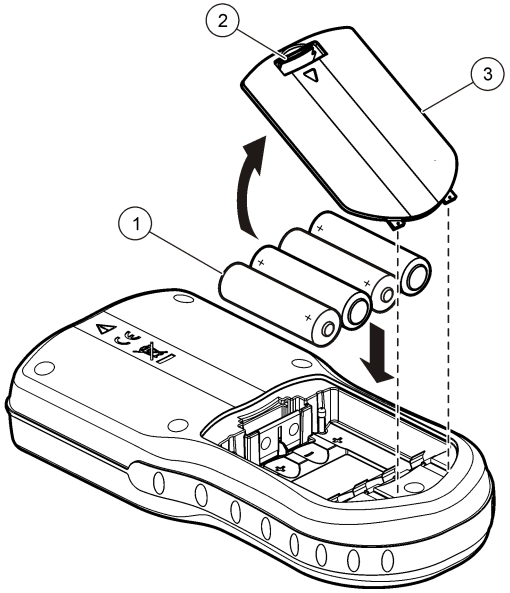
⚠ WARNING

Explosion hazard. Incorrect battery installation can cause the release of explosive gases. Be sure that the batteries are of the same approved chemical type and are inserted in the correct orientation. Do not mix new and used batteries.

For battery replacement, refer to Figure 11. Make sure that the cover is tightly closed to maintain the IP67 enclosure rating.

1. Pull the release tab on the battery cover and the remove the cover.
2. Remove the batteries.
3. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct polarity.
4. Replace the battery cover.

Figure 11 Battery replacement



1 Batteries	**2** Release tab	**3** Battery cover

Troubleshooting

Refer to the following table for common problem messages or symptoms, possible causes and corrective actions.

Error/Warning	Description	Solution
Connect a Probe	Probe disconnected or connected improperly	Tighten the locking nut on the probe connector.
		Disconnect the probe and then connect the probe again
	Software not updated to most current version	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
	Problem with probe	Connect a different IntelliCAL probe to verify if problem is with probe or meter
Probe Not Supported	Probe disconnected or connected improperly	Tighten the locking nut on the probe connector.
		Disconnect the probe and then connect the probe again.
	Software not updated to most current version	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
	Problem with probe	Connect a different IntelliCAL probe to the meter to verify if problem is with the meter or the probe.
	HQd meter does not support IntelliCAL probe	Contact Technical Support.
Bootloader X.X.XX.XX error	Software not updated to most current version.	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.

Error/Warning	Description	Solution
0 days remaining message (For LDO and LBOD only)	LDO or LBOD sensor cap used for 365 days	Replace the LDO or LBOD sensor cap and iButton®.
	There are 0 days remaining in the life of the LDO sensor cap.	Replace the LDO sensor cap. Calibration will be allowed. However, the calibration icon and question mark will appear on the measurement screen even if the calibration has passed.
	Meter set to incorrect date and time	**1.** Disconnect the probe from the meter. **2.** Remove the meter batteries. **3.** Install the meter batteries properly. Follow the polarity makings. **4.** Set correct date and time in the meter. **5.** Connect the probe and verify that message has been removed.
	Software not updated to most current version	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
Meter not configured	Software error(s)	If the meter starts up correctly, back up the Data Log and Method files. To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
Meter will not power on or powers on intermittently	Batteries are not installed correctly	Examine battery orientation to make sure the batteries follow the polarity markings. Test again.
		Clean the battery terminals, then install new batteries.
		Connect AC power adapter and test again.
	Software not updated to most current version	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.
	Damaged meter	Contact Technical Support.
Unable to access Full Access Options screen	Correct password has not been entered	Contact Technical Support.
Unable to access Full or Operator Access Options screen	Software not updated to most current version	To download the most current version of the software, refer to the applicable product page on the manufacturer's website.

Replacement parts and accessories

Note: *Product and Article numbers may vary for some selling regions. Contact the appropriate distributor or refer to the company website for contact information.*

Replacement parts

Description	Item no.
AC Power/USB Adapter Kit, 115 VAC	5826300
AC Power/USB Adapter Kit, 230 VAC	5834100
Batteries, Alkaline AA	1938004
Battery cover	9245500
Battery Contact, dual fixed	5188400

Replacement parts (continued)

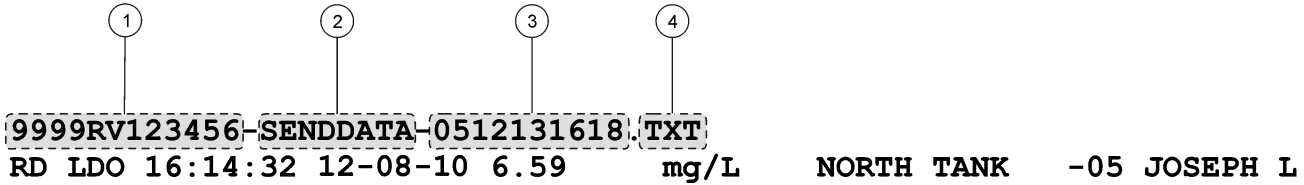
Description	Item no.
Battery Contact, dual spring	5188800
Cable, USB 6 ft (1.8 m), Type A male, Type B male	5924000
Field Kit (includes Protective Glove Kit for meter and five 120-mL sample cups)	5825800
Field Case for 2 probes with up to 5 m cables (10 m total). Includes empty case, insert for meter and probe storage, 4 containers for sample collection.	8505500
Field Case for 3 probes with up to 5 m cables (15 m total). Includes empty case, insert for meter and probe storage, 4 containers for sample collection.	8505501
Field Case for 2 probes with greater than 5 m cables (30 m total). Includes empty case, insert for meter with protective glove.	8505600
Keyboard (QWERTY), USB type	LZV582
Printer, Citizen PD-24 USB printer, 120–220 VAC	**US:** 2960100 **EU:** 5835900
Printer Paper for Citizen PD-24, thermal, 5/pk	5836000
Probe Clips, color coded (5 colors, 2 clips of each color), 10/pk	5818400
Probe Depth Marker (rugged cables)	5828610
Probe Holder, standard (fits on protective glove)	5829400
Protective Glove Kit for meter	5828700
Universal Probe Stand for standard IntelliCAL Probes	8508850
Meter Stand for Portable HQd meters	4754900

Examples of printed reports

Printed reports contain a report header and all stored data for samples, check standards and calibrations.

Report header
The first line of a report shows the report header (Figure 12).

Figure 12 Report header



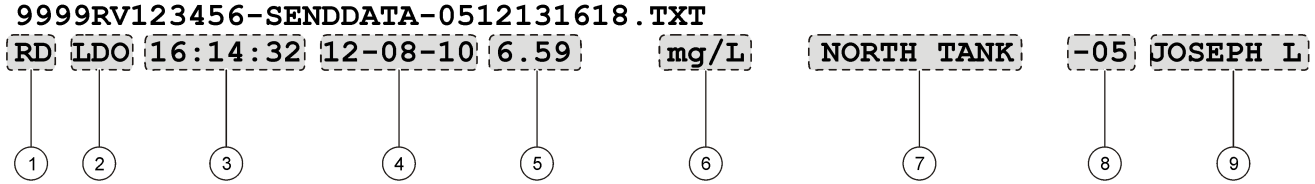
1 Meter serial number[1]	**3** Date and time, 24 h (YYMMDDhhmm)
2 Report label	**4** File type extension

[1] The probe serial number is shown on calibration history and current calibration reports.

Data reports
Sample data can be printed in a basic, advanced or total report format.

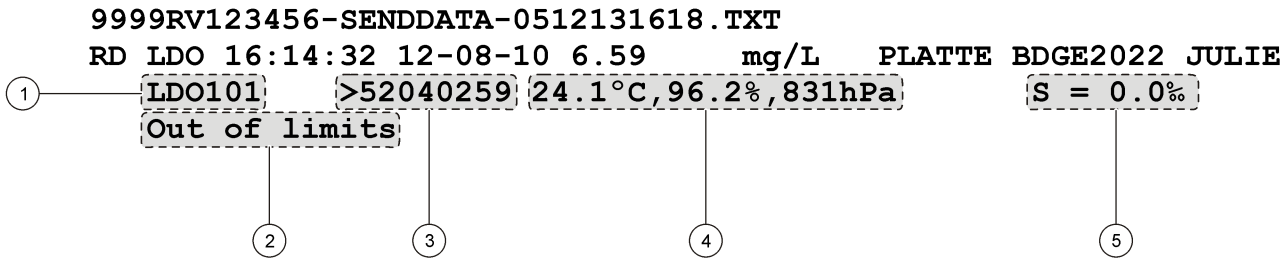
- Total report—refer to Figure 13.
- Advanced report—refer to Figure 14.
- Basic report—refer to Figure 15.

Figure 13 Basic report for sample data—1 line



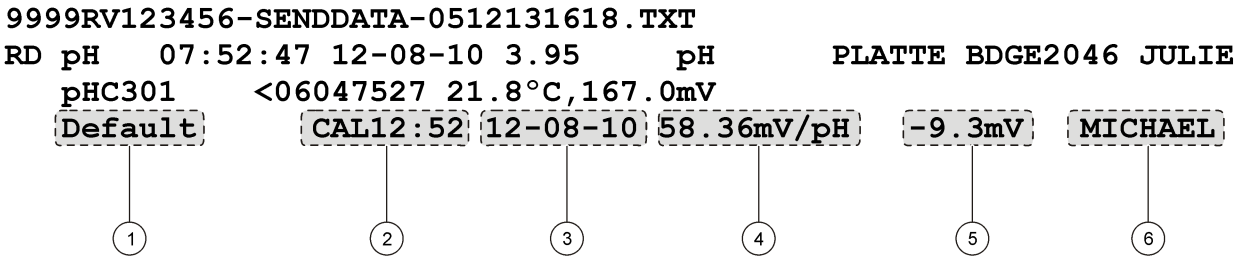
1 Data type (RD=reading)	**6** Units
2 Parameter (pH, LDO, etc.)	**7** Sample ID: user-defined; shows “SAMPLE ID” if undefined
3 Time (hh:mm:ss in 24 h or user-defined format)	**8** Sample ID counter
4 Date (DD-MM-YY or user-defined format)	**9** Operator ID: user-defined; shows “- - -” if undefined
5 Measured value	

Figure 14 Advanced report for sample data—2 lines



1 Probe model	**4** Additional units: shows all additional units associated with the reading.
2 Error message (if applicable)	**5** Probe settings: shows the highest-priority setting associated with the reading
3 Probe serial number (a “<“ or “>” on the HQ40d meter indicates the probe position)	

Figure 15 Total report for sample data—3 lines

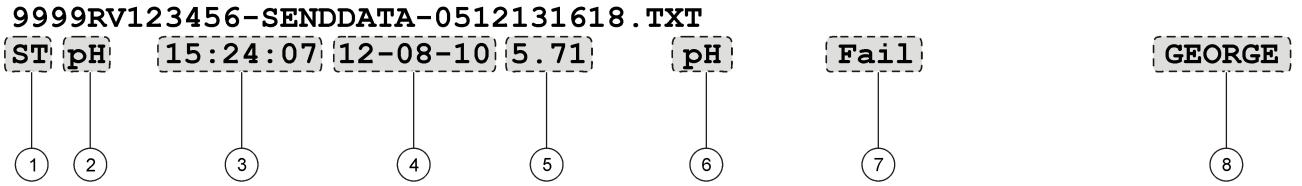


1 Method name for probe settings	**4** Calibration slope/ratio/constant
2 Time of calibration, prefaced by “CAL” and displayed as hh:mm in 24 h (or user-defined) format	**5** Offset—contents vary depending on type of parameter and user settings. May be blank.
3 Date of calibration (DD-MM-YY or user-defined format)	**6** Operator ID: user-defined; shows “- - -” if undefined

Check standard reports

Check standard data is printed with 1 line of information (Figure 16)

Figure 16 Check standard report

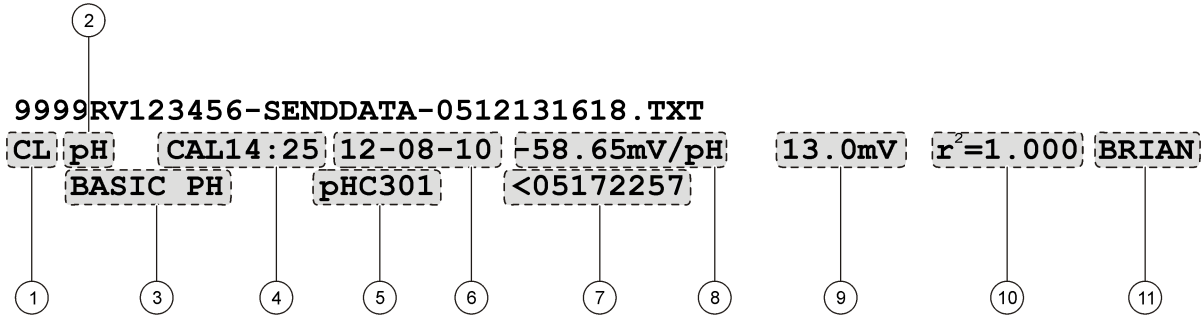


1 Report type (ST = check standard)	**5** Measured value
2 Report type (ST = check standard)	**6** Units
3 Time (hh:mm:ss in 24 h or user-defined format)	**7** Check standard status: Pass/Fail based on the acceptance criteria
4 Date (DD-MM-YY or user-defined format)	**8** Operator ID: user-defined; shows “- - -” if undefined

Calibration reports

Calibration data is printed when the data log is sent to the printer or when probe data is sent to the printer. Calibration data is printed with 2 lines of information (Figure 17).

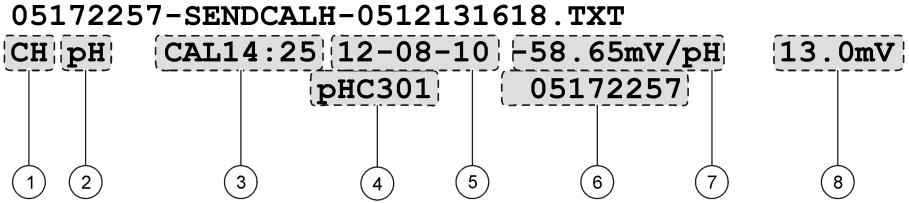
Figure 17 Calibration report



1 Report type (CL = calibration, IC = current calibration)	**7** Probe serial number (a “<“ or “>” on the HQ440d meter indicates the probe position)
2 Parameter (pH, LDO, etc.)	**8** Calibration slope/ratio/constant
3 Method name for probe settings	**9** Offset—contents vary depending on type of parameter and user settings. May be blank.
4 Time of calibration, prefaced by “CAL” and displayed as hh:mm in 24 h (or user-defined) format	**10** r^2: contents vary depending on type of parameter being read, configuration of specific method and number of calibration standards used. May be blank.
5 Probe model	**11** Operator ID: user-defined; shows “- - -” if undefined
6 Date of calibration (DD-MM-YY or user-defined format)	

The calibration history can be printed from the probe data menu. Refer to Figure 18.

Figure 18 Calibration history report



1 Report type (CH=calibration history)	**5** Date of calibration (DD-MM-YY or user-defined format)
2 Parameter (pH, LDO, etc.)	**6** Probe serial number (a “<“ or “>” on the HQ40d meter indicates the probe position).
3 Time of calibration, prefaced by “CAL” and displayed as hh:mm in 24 h (or user-defined) format	**7** Calibration slope/ratio/constant
4 Probe model	**8** Offset—contents vary depending on type of parameter and user settings. May be blank.

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Oxygen, Dissolved

DOC316.53.01243

Direct Measurement Method **Method 10360**

(0.1 to 20.0 mg/L or 1 to 200% saturation) **LDO Probe**

Scope and Application: For water, wastewater and process water applications

Test preparation

How to use instrument-specific information

The *Instrument-specific information* table displays requirements that may vary between instruments. To use this table, select an instrument then read across to find the corresponding information required to perform this test.

Table 471 Instrument-specific information

Meter	Probe
HQd meters	LDO101

Before starting the test:

Before attaching probes to the HQd meter for the first time, set the meter time and date.
Refer to the probe instructions for probe preparation.
For probes that are continuously immersed in aqueous solutions, condition the sensor cap for 72 hours.
When an IntelliCAL™ probe is connected to a HQ30d or HQ40d meter, the meter automatically recognizes the measurement parameter and is ready for use.
The IntelliCAL LDO101 probes automatically compensate for barometric pressure, elevation and temperature.
The LDO probe is calibrated at the factory. For more accurate results, manual calibration is recommended. Refer to the *Calibration* section of this procedure.
Salinity affects the concentration of dissolved oxygen in the sample. To correct for salinity effects, refer to Modifying LDO Measurement Options in the meter manual.

Collect the following items:

Description	Quantity
HQd meter	1
IntelliCAL LDO101 probe	1
Sensor cap for HQd with I-button	1
Shroud	1
BOD bottle, 300-mL or Erlenmeyer flask, 250-mL	1
Beaker, polypropylene (100-, 250-, 400- or 600-mL)	1

See *Consumables and replacement items* for reorder information.

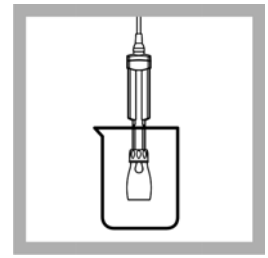
Method Name for powder pillows

1. Prepare the probe. Refer to the probe instructions.

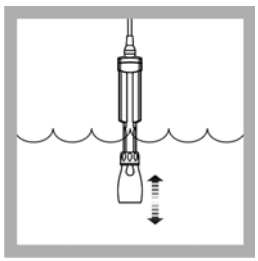
2. Connect the probe to the meter.

3. Calibrate the probe. Refer to the *Calibration* section of this procedure.

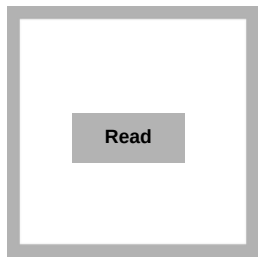
Go to step 4 for laboratory tests. Go to step 5 for field tests.



4. Laboratory tests: Immerse the probe in the beaker containing the sample solution. Move the probe up and down and tap it on the beaker to remove bubbles from the probe.



5. Field tests: Immerse the probe directly into the sample. Move the probe up and down to remove bubbles from the probe.



6. Press **READ** to store data in the data log.

Calibration

The LDO probe is calibrated at the factory. For more accurate results, manual calibration is recommended.

1. Remove the shroud from the probe body.
2. Add a small amount of water (about 1 cm) to the bottom of narrow-neck bottle, such as a BOD bottle.

   Note: *Use a wider neck bottle or flask (for example, a 250-mL Erlenmeyer flask) for the rugged probe.*
3. Insert a stopper and shake vigorously for several minutes.
4. Remove the stopper. If the sensor cap surface is wet, carefully dry the cap with a nonabrasive cloth, then put the probe in the bottle. Allow several minutes for the probe to reach equilibrium.

5. Make sure the meter is in the measurement screen. Press the **CALIBRATION** key.

   Note: *For HQ40d meters with two probes attached, the display must be in the single screen LDO101 mode.*

6. Press **READ**. When the measurement is stable, the calibrated measurement will show on the display. The standard value will be highlighted on the display.

7. Press **DONE** to view the calibration summary. The slope value is the comparison between the latest calibration and the factory calibration expressed as a percentage.

   Note: *If the calibration slope does not meet the acceptance criteria, the display will show "Slope out of range". Let the probe stand in water-saturated air for several minutes. When the probe reaches equilibrium, press* ***READ****.*

8. Press **STORE** to accept the calibration and return to the measurement mode. The calibration record is stored in the data log.

Note: *A successful calibration will show "OK" in the measurement screen.*

Interferences

There are no significant interferences with the LDO technology.

The IntelliCAL LDO101 probes are designed for water and wastewater applications, but can be used for other applications. Some organic solvents may damage the sensor cap and probe body.

Sample collection, preservation and storage

- Analyze samples in-situ, if possible.
- Collect samples in an appropriate container. Fill completely and analyze immediately.
- Do not store samples.

Accuracy check

1. Return the electrode to a water-saturated air environment.
2. Allow at least 10 minutes for stabilization.
3. Read the % saturation on the right side of the measurement mode screen. The meter should display 100% saturation. If not, allow additional time for the air to reach water saturation or calibrate the probe.

Method performance

The following statements are true for dissolved oxygen when the temperature is kept between 10 and 30 degrees C.

Method	Standard	Precision 95% Confidence Limits of Distribution	Accuracy Concentration change per 0.010 Abs change
10360	8.00 mg/L DO	7.95–8.05 mg/L DO	7.90–8.10 mg/L DO
10360	15.00 mg/L DO	14.90–15.10 mg/L DO	14.80–15.20 mg/L DO

Summary of method

The oxygen sensor is made up of a clear, oxygen impermeable hard substrate. An oxygen sensitive luminescent dye, along with a scattering agent, is pad-printed on the substrate. A final overlay of dark pigment is added to prevent stray light from entering the measurement cell. The luminescent dye emits red light when exposed to blue light. The scattering agent distributes the emitted light throughout the sensor matrix and contributes to the opacity of the sensor. Pulses from a red LED serve as an internal reference. The duration of the luminescence is proportional to the concentration of dissolved oxygen in the sample.

Consumables and replacement items

Required apparatus (select one)

Description	Quantity/Test	Unit	Catalog number
HQ40d multi-parameter meter, dual input	1	each	HQ40d53000000
HQ30d multi-parameter meter, single input	1	each	HQ30d53000000

Required probes (select one)

Description	Unit	Catalog number
LDO Probe, standard, with 1 m cable	each	LDO10101
LDO Probe, standard, with 3 m cable	each	LDO10103
LDO Probe, rugged, with 5 m cable	each	LDO10105
LDO Probe, rugged, with 10 m cable	each	LDO10110
LDO Probe, rugged, with 15 m cable	each	LDO10115
LDO Probe, rugged, with 30 m cable	each	LDO10130

Optional apparatus

Description	Unit	Catalog number
AC Power Adapter for HQd meters (included w/ HQ40d)	each	5826300
BOD bottle, 300 mL	each	62100
BOD bottle, 300 mL	6/pkg	62106
Citizen PD-24 USB Handy printer, 115 VAC	each	5835800
Color Coded Probe Clips (5 color coded sets) 5 sets	10/pkg	5818400
Depth Markers for Rugged LDO probe only	10/pkg	5828610
Erlenmeyer flask, 250 mL	each	2089846
Field Kit (Includes glove kit, 2 probe holders and 5 120 mL sample cups)[1]	each	5825800
Glove kit only for HQd meters	each	5828700
Probe Holder for HQd meter, IntelliCAL Standard probes only	each	5829400
Replacement Sensor cap w/ I-button	each	5811200
Replacement Shroud kit Rugged LDO probe	each	5825900
USB Keyboard for HQd meters (must have 5813400 & 5826300)	each	LZV582
USB/DC Adapter for HQd meters (must have 5826300, inc w/HQ40d)	each	5813400

[1] Included with HQ40d

FOR TECHNICAL ASSISTANCE, PRICE INFORMATION AND ORDERING:
In the U.S.A. – **Call toll-free 800-227-4224**
Outside the U.S.A. – **Contact the HACH office or distributor serving you.**
On the Worldwide Web – **www.hach.com**; E-mail – **techhelp@hach.com**

HACH COMPANY
WORLD HEADQUARTERS
Telephone: (970) 669-3050
FAX: (970) 669-2932

Edition 7

PT-BR

Sonda LDO101

Você poderá encontrar informações adicionais no website do fabricante.

Introdução

A sonda mede a concentração de oxigênio dissolvido na água servida, na água potável e em aplicações gerais.

NOTA DE SEGURANÇA

Antes do uso com substâncias perigosas, informe-se sobre os riscos relevantes, as medidas de proteção e saiba o que fazer em casos de emergência.

Coletar os seguintes itens:

Medidor HQd; soluções padrão de oxigênio dissolvido; cronômetro; garrafa de BOD; água deionizada; pano sem fiapos.

1 Conectar a sonda

2 Calibração

Observação

Deixar até 30 minutos para que o conteúdo equilibre na temperatura ambiente.

3 Medição

⚠ *É recomendável usar uma proteção durante a medição para evitar danos à tampa do sensor e uma proteção contra luz para aplicações de campo.*

	Não insira o módulo do sensor de pressão na água.

4 Armazenamento

Informações técnicas

Dissolved oxygen range	0.1 a 20.0 mg/L (ppm) saturação de 1 a 200%
Dissolved oxygen accuracy	±0.1 mg/l para 0–8 mg/l; ± 0.2 mg/l para mais de 8 mg/l
Operating temperature	0 a 50°C (32 a 122°F)
Minimum sample depth	25 mm (0.984 pol)

Garantia

3 anos para a sonda, 1 ano para a tampa do sensor. Esta garantia cobre defeitos de fabricação, mas não os decorrentes de uso incorreto ou desgaste.

ZH

LDO101 探头

制造商网站中提供了附加信息

介绍

探头可以测量废水、饮用水和普通应用中溶解氧的浓度。

安全说明

当与有害物质一起使用时，请了解相关的风险、保护措施以及在紧急情况下应采取的行动。

收集下列物品：

HQd 测试仪；溶解氧标准溶液；计时器；BOD 瓶；DI 水；无绒布。

1 连接探头

2 校准

Note

留出长达 30 分钟的时间以使组件与室温平衡。

3 测量

⚠*在测量期间，建议使用保护罩，以防止损坏现场应用的传感器帽和光屏蔽。*

	请勿浸没压力传感器模块。

4 存放

技术信息

Dissolved oxygen range	0.1 至 20.0 mg/L (ppm) 1 至 200% 饱和度
Dissolved oxygen accuracy	±0.1 mg/L（0 至 8 mg/L）±0.2 mg/L（大于 8 mg/L）
Operating temperature	0 到 50 °C（32 到 122 °F）
Minimum sample depth	25 毫米（0.984 英寸）

保修

探头 3 年，传感器帽 1 年。本保修涵盖制造缺陷，但不包括非正常的使用或磨损。

JA

LDO101 プローブ

より詳しい情報は、当社 Web サイトにて入手できます。

はじめに

このプローブは、廃水、飲用水、および一般溶液中の溶存酸素濃度を測定します。

安全に関する注意

安全についての注記有害物質の取扱い前に、取扱いに伴う危険性、防護手段、および非常時の行動について確認しておいてください。

次のアイテムを準備します。

HQd 測定器、溶存酸素標準液、タイマー、BOD ボトル、DI 水 (純粋)、糸くずの出ない布。

1 プローブの接続

2 校正

注:

内容物が室温に達するまで 30 分間放置してください。

3 測定

⚠*センサ・キャップを損傷から保護したり、屋外用途で光を遮断できるように保護シュラウドを装着することをお勧めします。*

	圧力センサモジュールが沈まないようにしてください。

4 保管

技術情報

Dissolved oxygen range	0.1 ～ 20.0 mg/L (ppm) 1 ～ 200 % 飽和
Dissolved oxygen accuracy	0 ～ 8 mg/L の場合、±0.1 mg/L8 mg/L を超えた場合、± 0.2 mg/L
Operating temperature	0 ～ 50 °C
Minimum sample depth	25 mm

保証

プローブ: 3 年間、センサ・キャップ: 1 年間。本保証は製造上の欠陥に対してのみ適用され、不適切な使用方法または損耗に対しては適用されません。

KO

LDO101 프로브

제조 회사의 웹 사이트에서 추가 정보를 확인할 수 있습니다.

소개

이 프로브는 하수, 식수 및 일반 용수의 용존 산소 농도를 측정합니다.

안전 지침

안전 주의위험 물질을 취급하기 전에 관련 위험 요소를 파악하여 보호 조치를 취하고 비상 시 대책을 마련하십시오.

다음 항목을 수집합니다.

HQd 계측기, 용존산소 표준 용액, 타이머, BOD 병, 초순수, 보풀이 없는 천.

1 프로브 연결

2 보정

참고:

내용물의 온도가 실온에 도달할 때까지 30 분간 기다립니다.

3 측정

⚠ *측정 시에는 현장 작업용 센서 캡과 차광 장치가 손상되지 않도록 보호 덮개를 사용하는 것이 권장됩니다.*

	압력 센서 모듈을 물에 담그지 마십시오.

4 보관

기술 정보

Dissolved oxygen range	0.1~20.0mg/L(ppm) 1~200% 포화
Dissolved oxygen accuracy	0~8mg/L 의 경우 ±0.1mg/L 8mg/L 이상의 경우 ±0.2mg/L
Operating temperature	0-50°C(32-122°F)
Minimum sample depth	25mm(0.984 인치)

보증

프로브 3 년, 센서 캡 1 년 보증. 본 보증은 제조상의 결함이 없음을 보증하며, 부적절한 사용 또는 마모로 인한 손상은 제외됩니다.

TH

โพรบ LDO101

ดูข้อมูลเพิ่มเติมได้ในเว็บไซต์ของผู้ผลิต

ข้อมูลเบื้องต้น

โพรบสำหรับการวัดปริมาณความเข้มข้นของออกซิเจนในน้ำเสีย, น้ำดื่ม และสำหรับการใช้งานทั่วไป

หมายเหตุด้านความปลอดภัย

ก่อนใช้สารที่เป็นอันตราย ให้ตรวจสอบอันตรายที่เกี่ยวข้อง มาตรการป้องกัน และข้อควรปฏิบัติในกรณีฉุกเฉิน

จัดเตรียมของดังต่อไปนี้:

มิเตอร์ HQd, น้ำยาสอบเทียบปริมาณออกซิเจน , เครื่องจับเวลา, ขวด BOD, น้ำ DI, ผ้าใยสังเคราะห์

1 การเชื่อมต่อโพรบ

2 การปรับเทียบ

บันทึก:

ปล่อยทิ้งไว้ 30 นาที เพื่อให้อุณหภูมิของสารเท่ากับอุณหภูมิห้อง

3 การตรวจวัด

⚠*ควรใช้งานอุปกรณ์ป้องกันในระหว่างทำการตรวจวัด เพื่อป้องกันความเสียหายที่อาจเกิดขึ้นกับฝาปิดเซนเซอร์ และป้องกันแสงในบริเวณพื้นที่การวัด*

	ห้ามจุ่มโมดูลเซ็นเซอร์ความดันลงในของเหลว

4 การจัดเก็บ

ข้อมูลทางเทคนิค

Dissolved oxygen range	0.1 ถึง 20.0 mg/L (ppm) ค่าการอิ่มตัว 1 ถึง 200%
Dissolved oxygen accuracy	±0.1 มก./ลิตร สำหรับ 0 ถึง 8 มก./ลิตร ±0.2 มก./ลิตร สำหรับปริมาณที่มากกว่า 8 มก./ลิตร
Operating temperature	0 ถึง 50 °C (32 ถึง 122 °F)
Minimum sample depth	25 มม. (0.984 นิ้ว)

การรับประกัน

3 ปี สำหรับโพรบ, 1 ปี สำหรับฝาปิดเซนเซอร์ การรับประกันจะมีผลเฉพาะข้อผิดพลาดที่เกิดขึ้นจากการผลิต ไม่รวมถึงการใช้งานอย่างไม่ถูกต้องหรือการสึกหรอ

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DOC022.97.80021

HACH®

LDO101

Basic User Manual

Manuel d'utilisation de base

Manual básico del usuario

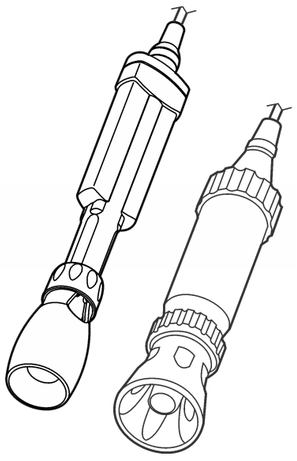
Manual Básico do Usuário

基本用户手册

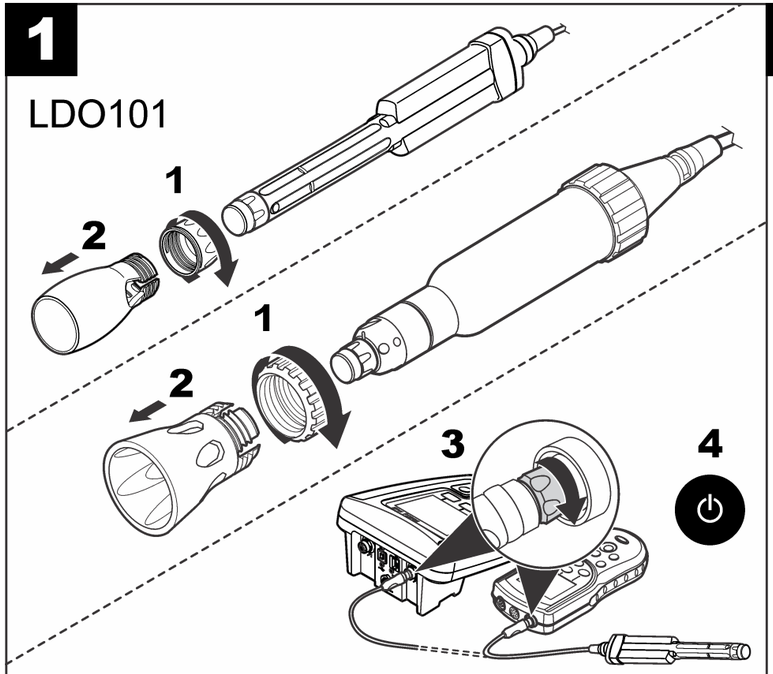
基本取扱説明書

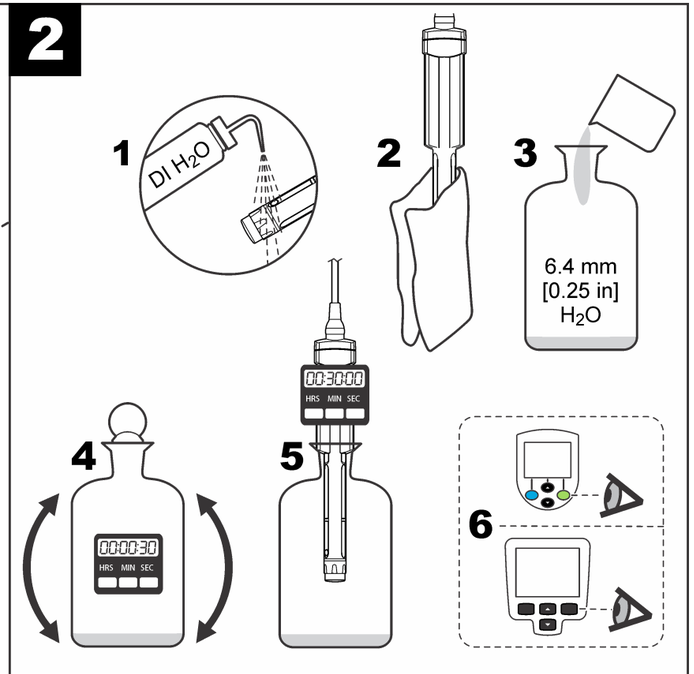
기본 사용 설명서

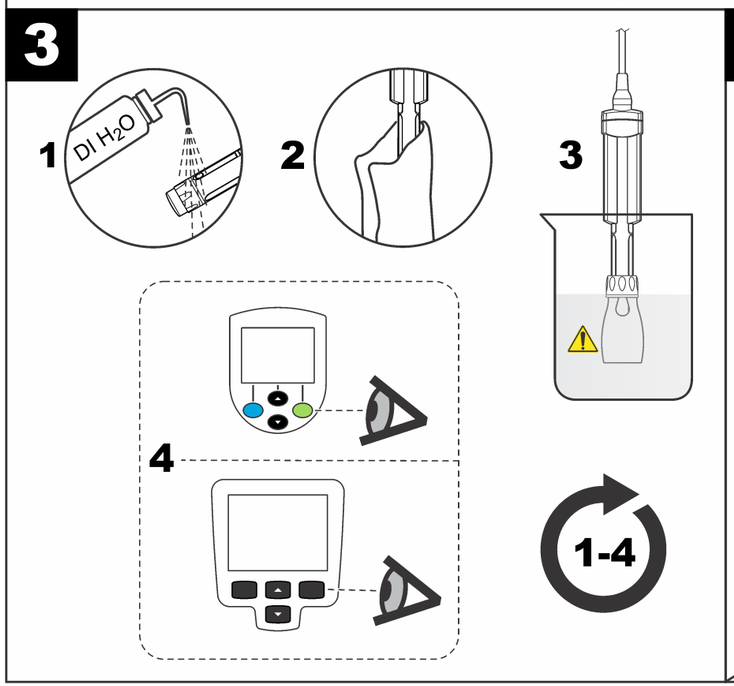
คู่มือผู้ใช้เบื้องต้น

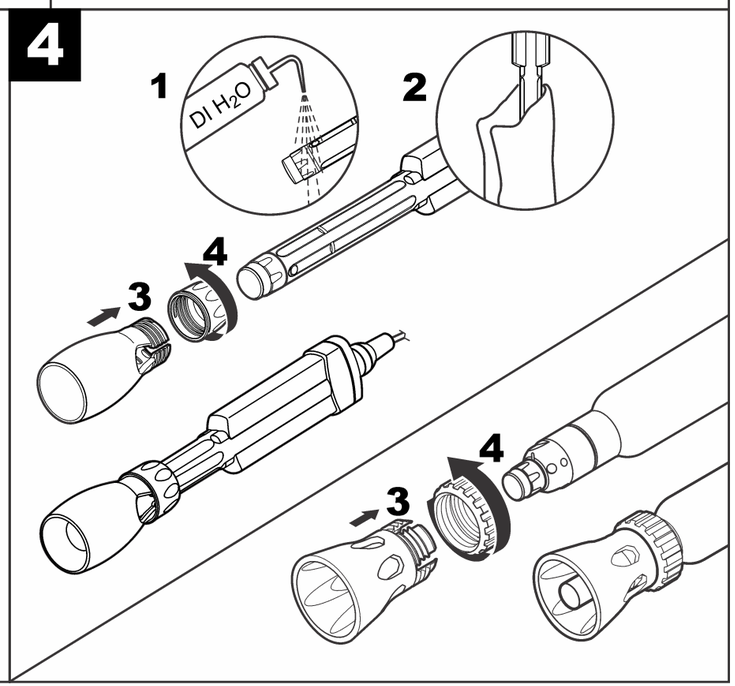


Printed in U.S.A. 05/2013, Edition 2









EN

LDO101 probe

Additional information is available on the manufacturer's website.

Introduction

The probe measures the dissolved oxygen concentration in wastewater, drinking water and general applications.

SAFETY NOTE

Before use with hazardous substances, find out the relevant hazards, protective measures and what to do in an emergency.

Collect the following items:

HQd meter; dissolved oxygen standard solutions; timer; BOD bottle; DI water; lint-free cloth.

1 Connect the probe

2 Calibration

Note:
Allow up to 30 minutes for contents to equilibrate to room temperature.

3 Measurement

⚠ *The protective shroud is recommended during measurement to protect from damage to the sensor cap and light shielding for field applications.*

	Do not submerge the pressure sensor module.

4 Storage

Technical information

Dissolved oxygen range	0.1 to 20.0 mg/L (ppm) 1 to 200% saturation
Dissolved oxygen accuracy	±0.1 mg/L for 0 to 8 mg/L ±0.2 mg/L for greater than 8 mg/L
Operating temperature	0 to 50 °C (32 to 122 °F)
Minimum sample depth	25 mm (0.984 in.)

Warranty

3 years on the probe, 1 year on the sensor cap. This warranty covers manufacturing defects, but not improper use or wear.

FR

Sonde LDO101

Des informations supplémentaires sont disponibles sur le site Web du fabricant.

Introduction

La sonde mesure la concentration d'oxygène dissous dans les eaux usées, l'eau potable et les applications générales.

REMARQUE DE SÉCURITÉ

Avant de manipuler des substances dangereuses, veuillez prendre connaissance des risques relatifs à leur manipulation, des mesures de sécurité à appliquer et de la procédure à suivre en cas d'urgence.

Réunissez les éléments suivants :

Instrument de mesure HQd ; solutions étalons pour la mesure de la concentration en oxygène dissous ; minuterie ; flacon à DBO ; eau déionisée ; chiffon non pelucheux.

1 Branchement de la sonde

2 Etalonnage

Remarque :
Laissez stabiliser 30 minutes le contenu à température ambiante.

3 Measurement data

⚠ *La coiffe de protection est recommandée lors des mesures afin de ne pas endommager le capuchon du capteur et de protéger de la lumière pour les applications sur le terrain.*

	N'immergez pas le module du capteur de pression.

4 Stockage

Données techniques

Dissolved oxygen range	0,1 à 20,0 mg/l (ppm) 1 à 200 % de saturation
Dissolved oxygen accuracy	±0,1 mg/l pour 0 à 8 mg/l ± 0,2 mg/l pour plus de 8 mg/l
Operating temperature	0 à 50 °C
Minimum sample depth	25 mm (0,984 po)

Garantie

3 ans pour la sonde, 1 an pour le capuchon de protection. Cette garantie couvre les défauts de fabrication mais pas les utilisations incorrectes ou l'usure.

ES

Sonda LDO101

En el sitio web del fabricante encontrará información adicional.

Introducción

La sonda mide la concentración de oxígeno disuelto en aguas residuales, agua potable y en aplicaciones generales.

NOTA DE SEGURIDAD

Antes de utilizar sustancias peligrosas, infórmese de los posibles peligros, las medidas protectoras que se deben tomar y los procedimientos que hay que llevar a cabo en caso de emergencia.

Disponga de los siguientes elementos:

Medidor HQD; soluciones patrón de oxígeno disuelto; temporizador; botella de DBO; agua desionizada; paño que no suelte pelusa.

1 Conecte la sonda

2 Calibración

Nota:
Espere 30 minutos a que el contenido se equilibre a la temperatura ambiente.

3 Medición

⚠ *Se recomienda utilizar la cubierta protectora durante la medición para evitar que la tapa del sensor se dañe y protegerla de la luz en las aplicaciones en campo.*

	No sumerja el módulo del sensor de presión.

4 Almacenamiento

Información técnica

Dissolved oxygen range	De 0,1 a 20 mg/l (ppm) saturación del 1 al 200%
Dissolved oxygen accuracy	±0,1 mg/l para de 0 a 8 mg/l ± 0,2 mg/l para más de 8 mg/l
Operating temperature	0 a 50 °C (32 a 122 °F)
Minimum sample depth	25 mm (0,984 pulg.)

Garantía

3 años para la sonda, 1 año para la tapa del sensor. Esta garantía cubre los defectos de fabricación, pero no aquellos ocasionados por el desgaste o un uso incorrecto.

Appendix G – Sample Worksheet for Internal Laboratory Testing

	Pangnirtung Wastewater Treatment Facility - Laboratory Testing Worksheet	Sheet No.:
	Operator:	
	Date:	
	Reviewed By:	

1. Total Suspended Solids/Volatile Suspended Solids (TSS/VSS)						
Sample Name >>						
Original Mass (g)						
Volume (mL)						
Mass 103°C (g)						
Mass 550°C (g)						
TSS (mg/L)						
VSS (mg/L)						

2. Chemical Oxygen Demand (COD)					
Sample Name >>					Notes:
Dilution					
DR3900 Reading					
Concentration (mg/L)					

3. Total Kjeldahl Nitrogen (TKN)					
Sample Name >>					Notes:
Dilution					
DR3900 Reading					
Concentration (mg/L)					

4. Ammonia-Nitrogen (NH_3-N)					
Sample Name >>					Notes:
Dilution					
DR3900 Reading					
Concentration (mg/L)					

5. Total Phosphorous					
Sample Name >>					Notes:
Dilution					
DR3900 Reading					
Concentration (mg/L)					

6. Portable Meter Readings					
Sample Name >>					Notes:
pH					
DO (mg/L)					
UVT (%)					

	Data Recorded in Electronic Spreadsheet: ❑	Attachments (No. of Pages):

Appendix H – Weekly Testing and Monitoring Log Sheet

Pangnirtung WWTP Inspection Report
Week of:_____ to _____

Item	Unit	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Influent Flow (10-FIT-01), Sc	m^3							
EQ Eff Flow (20-FIT-01), Sc	m^3							
Effluent Flow, Train #1	L							
Effluent Flow, Train #2	L							
Effluent Turbidity, Train #1, Sc	NTU							
Effluent Turbidity, Train #2, Sc	NTU							
UV Intensity	mW/cm^2							
UV Time	Hours							
Return Activated Sludge (RAS) Flow #1	L							
Return Activated Sludge (RAS) Flow #2	L							
Waste Activated Sludge to Storage	m^3							
Waste Sludge Flow (to Dewatering)	m^3							
Trans Membrane Pressure (TMP) #1, Sc	kPa							
Trans Membrane Pressure (TMP) #2, Sc	kPa							
Biotank Level, (50-LIT-01), Sc	m							
EQ Tank Level, (20-LIT-01), Sc	m							
Screen Spray System	On/Off							
Non-Potable Water Tank	Full							
Operator's Initials								

Sc: Information from Computer Screens (HMI)

Pangnirtung WWTP Inspection Report
Week of:_____ to _____

Item	Unit	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Soda Ash System Check	✓							
Dewatering Polymer Quantity (barrel)	%							
Dewatering Sludge Bag Check	✓							
Compressor, Check/Add Oil Weekly	Y/N							
Compressor Air Dryer	On/Off							
Generator Status	Off/Auto							
Generator Day Fuel Tank Level	%							
Generator Fuel Transfer Status	✓							
Outside Fuel Tank Level	%							
Boiler Day Fuel Tank Level	%							
HVAC Screen Check	✓							
AHU Filter Check	✓							
Operator's Initials								

Sc: Information from Computer Screens (HMI)

Pangnirtung WWTP Inspection Report
Week of:_____ to _____

Item		Unit	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Screened Wastewater	COD	mg/L							
	TSS	mg/L							
	VSS	mg/L							
	TKN	mg/L							
	NH_3-N	mg/L							
	Total P	mg/L							
	pH								
Anoxic BioReactor	DO	mg/L							
Aerobic BioReactor	DO	mg/L							
Membrane Tank #1	TSS	mg/L							
	VSS	mg/L							
	DO	mg/L							
	pH								
Membrane Tank #2	TSS	mg/L							
	VSS	mg/L							
	DO	mg/L							
	pH								
	Operator's Initials								

Sc: Information from Computer Screens (HMI)

Pangnirtung WWTP Inspection Report
Week of:_____ to _____

Item		Unit	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Final Effluent	COD	mg/L							
	TSS	mg/L							
	VSS	mg/L							
	TKN	mg/L							
	NH_3-N	mg/L							
	Total P	mg/L							
	pH								
Lab Chemicals Remaining									
	Aluminum Weighing Dishes	# boxes							
	COD	# boxes							
	TKN	# boxes							
	NH3-N	# boxes							
	Total Phosphorus	# boxes							
	pH Buffers: pH 4	# bottles							
	pH 7	# bottles							
	pH 10	# bottles							
	Operator's Initials								

Sc: Information from Computer Screens (HMI)

Appendix I – Hamlet of Pangnirtung Quality Assurance/Quality Control Plan for Wastewater Treatment

CADUCEON™
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

Jan 9, 2015

Bhabesh Roy
Government of Nunavut
PO BOX 379
Pond Inlet, NU
X0A 0S0

Dear Bhabesh Roy,

Caduceon Environmental Laboratories looks forward to aiding Hamlet of Pangnirtung in their environmental analysis. The Caduceon staff has reviewed the PDF document entitled "*QA/QC for the Wastewater Treatment Facility of Pangnirtung* " that was provided to our Ottawa Laboratory.

Our staff has read and understands the requirements found within this document and see no issues with providing you quality service and analysis. In addition, it has been noted that it is necessary all testing be completed under CALA accreditation. Caduceon Environmental Laboratories are accredited for all of the parameters listed within the document.

I believe you have already been provided with our CALA Scopes of Accreditation for your records. Should you require any further information please call either Gord Murphy (Lab Supervisor) or myself (Greg Clarkin, Lab Manager) at the Ottawa office and we will be more than happy to help you out.

Again, thanks for the opportunity to work with the Hamlet of Pangnirtung.

Regards,

Greg Clarkin, Lab Manager - Ottawa District
Caduceon Environmental Laboratories
Tel: (613) 526-0123
Fax: (613) 526-1244
E-mail: gclarkin@caduceonlabs.com

cc: Gord Murphy, Lab Supervisor
Damien Gilbert, CEO

• Hamlet of Pangnirtung

Quality Assurance / Quality Control Plan For Wastewater Treatment Plant

Project Name
Water Licence Compliance – Hamlet of Pangnirtung

Type of Document
Final

Project Number
OTT-00204430-A0

Prepared By: Robert Renaud, M.Sc., P.Geo.

Reviewed By: Stephen Bliss, M.Sc.E., P.Eng.

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 7H6
Canada

Date Submitted
January 8, 2015

Hamlet of Pangnirtung

Quality Assurance / Quality Control Plan for Wastewater Treatment Plant

Type of Document:
Final

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Water Licence Compliance – Hamlet of Pangnirtung

Project Number:
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Robert Renaud, M.Sc., P.Geo.
Senior Geoscientist
Earth & Environment

Stephen G. Bliss, M.Sc.E., P.Eng.
Senior Process Engineer
Water & Wastewater Services

Date Submitted:
January 8, 2015

Table of Contents

Appendices

1 Introduction

The purpose of this document is to provide guidance to ensure that the monitoring program samples collected from the wastewater treatment facility are done so with a high degree of quality, in order to ensure that they accurately reflect the physical and chemical nature of the matrix being tested.

1.1 Background

The Hamlet of Pangnirtung (Hamlet) is located on Baffin Island at N66°08.82' and W65°42.07' on the south shore of the Pangnirtung Fiord. The population of Pangnirtung in 2014 is estimated to be 1,530 according to the Nunavut Bureau of Statistics. The estimated population of the community in 2035 would be approximately 2000. The Hamlet is primarily residential in nature with a few businesses (lodges, grocery stores, etc.), schools, and a fish processing plant (Pangnirtung Fisheries). Both fresh water and the wastewater are transported by trucks to and from the various buildings (i.e., there is no piped system within the community).

The Pangnirtung Wastewater Treatment Plant (WWTP) is a secondary mechanical treatment plant based on the activated sludge process. Specifically, the plant is a membrane bioreactor (MBR) system utilizing submerged hollow fiber style membranes to provide a high quality effluent. The system is designed to treat residential sewage and wastewater from a local fish processing facility for the Hamlet of Pangnirtung. Wastewater is trucked to the WWTP where contaminants including Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), and ammonia-nitrogen (NH_3-N) are reduced to below the National Performance Standards (NPS) prior to discharge to a marine environment (North Atlantic Ocean).

The Nunavut Water Board (NWB) issued a Class B Water Licence (3BM-PAN1417) to the Hamlet on September 16, 2014. The water licence governs water use and waste disposal within the Hamlet. A copy of the Water Licence is provided in Appendix A.

1.2 Quality Assurance and Quality Control Monitoring

A key component to the operations and maintenance of the WWTP is a sampling/monitoring program. The following quality assurance (QA) and quality control (QC) program should be implemented to ensure that the analytical results received are accurate and dependable. A QA/QC program is a system of documented checks that validate the reliability of the data collected regarding any given site. Quality Assurance is a system that ensures that quality control procedures are correctly performed and documented. Quality Control refers to the established procedures observed both in the field and in the laboratory, designed to ensure that the resulting end data meet intended quality objectives.

The proposed program will help monitor the treatment while verifying compliance with regulations. As well, it will model the treatment process which will help to understand the performance of the WWTP for future development and modifications to the current system.

It is important such a program be implemented by the Hamlet as a part of the annual operations for the facility. Local members of the community that operate the system are to be trained on the proper operation and procedure methods used in the sampling/monitoring program. In addition, quality and safety training will also be included which will ensure that the high quality data will be obtained.

1.3 Definitions

The following definitions that are relevant to this plan include:

Quality Assurance is a system that ensures that quality control procedures are correctly performed and documented.

Quality Control refers to the established procedures observed both in the field and in the laboratory, designed to ensure that the resulting end data meet intended quality objectives.

Trip Blank is a sample of clean water that was prepared by the analytical laboratory and shipped to the sample site in the cooler along with the empty sample bottles. This trip blank sample remains unopened and is transported back to the laboratory with the monitoring program samples. The trip blanks is analyzed by the laboratory along with the monitoring program samples. The purpose of the trip blank is the assess contamination introduced during shipping and field handling procedures.

CALA refers to the Canadian Association for Laboratory Accreditation, formally known as the Canadian Association for Environmental Analytical Laboratories (CAEAL).

Chain of Custody Documentation refers to the documentation that accompanies samples sent to an analytical laboratory. It is a legal document which ensures that the sample taken at a specific site is the same sample received in the laboratory. It also provides information on the sample condition and integrity as received by the laboratory.

2 Sampling for Regulatory Compliance

2.1 Sampling Locations

Monitoring the operation and efficiency of the system will be accomplished through the establishment of three (3) sampling points. Sampling will provide information regarding the performance of the system and help identify any degradation to the treatment provided. Table 2.1 provides coordinates of the sampling points.

Table 2.1 – Monitoring Locations

Monitoring Program Station Number	Description	Status
PAN-2	Raw sewage from the pump-out truck	New (Volume)
PAN-3	Effluent from Waste Water Treatment Facility	Active (Quality)
PAN-4	Run-off from Sludge Disposal Area	Active (Quality)

2.2 Sampling Frequency

The following outlines the Sampling Testing and Compliance requirements of the WWTP. Any other additional sampling during the year will be at the request of the regulatory agencies. Once collected, the samples will be shipped to the laboratory and analyzed using the same test/method/procedure.

Table 2.2 – Sampling Frequency

Monitoring Program Station Number	Description	Frequency
PAN-2	Raw sewage from the pump-out truck	Daily, Monthly, Annual
PAN-3	Effluent from Waste Water Treatment Facility	Monthly
PAN-4	Run-off from Sludge Disposal Area	Beginning, middle and end of season when flow is available

2.3 Sampling Parameters

Samples shall be analyzed for the following parameters:

Biochemical Oxygen Demand – BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Oil and Grease (visual)
Nitrate-Nitrite	Ammonia Nitrogen
Chloride	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Hardness	Total Alkalinity
Total Phenols	Total Manganese
Total Arsenic	Total Aluminum
Total Cadmium	Total Cobalt
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	Total Organic Carbon – TOC

2.4 Compliance Point

The water license has set the final discharge from the WWTP as the compliance point as it is the last point of measurement and control. The effluent released from the WWTP must meet the criteria list in Table 2.4.

Table 2.4 – Effluent Quality Criteria

Parameter	Maximum Concentration of any Grab Sample
pH	Between 6 and 9
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Faecal Coliforms	1×10^3 CFU/100 mL
Oil and Grease	No Visible Sheen

2.5 Sampling Procedures

All sampling, sample preservation and analyses is to be conducted in accordance with methods described in the current edition of *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, American Water Works Association, and Water Environment Federation, most current edition).

To obtain meaningful results from the analyses, the following six factors are of particular importance:

- Sample collection as per schedule and location.
- Correct usage of container/sample bottle for parameter being tested.
- Correct labelling of sample bottles and filling out record/field sheet.
- Correct procedure for sampling.
- Proper and timely shipment of samples to the laboratory.
- Timely delivery of samples to the laboratory from the air cargo facility.

2.6 Sampling Collection

Refer to the *Process Operation Manual*, dated November 2014 for specific details related to Health and Safety considerations, facility components and processes, as well as monitoring and testing procedures.

2.6.1 Sampling Equipment

Dedicated latex or nitrile gloves (i.e., one pair per sample) are to be used during sample collection and sample handling. WWTP monitoring samples collected for analysis of selected chemical parameters are to be placed directly into new pre-cleaned, laboratory-supplied sample bottles. All monitoring samples are to be placed in clean coolers for transportation to the subcontract laboratory. The samples are transported/submitted under Chain of Custody documentation. Included on a Chain of Custody form is the client information, the sample information, the analyses requested, the relevant regulations, the turnaround time for the analytical results, comments, and temperature of the samples at the time they arrived in the laboratory. An example of a completed Chain of Custody form is included in Appendix C.

2.6.2 Sampling Methods

At the Pangnirtung WWTP, all samples will be grab samples collected by the operator (i.e., there are no automatic composite samplers installed). The following techniques should be used whenever grab samples are collected:

- If the sample is being collected from a tank or sump, the sample should be collected from a location where there is good mixing and the sample will be representative. The sample should not be skimmed from the surface, taken very close to the bottom, or near any sidewalls. The sample should be taken from a middle zone if possible where there is good mixing and the geometry of the tank/sump and any equipment within will not affect the quality of the sample.
- If the sample is taken from a sample tap from a tank or pipe, care should be taken to flush the sample line. The operator should open the sample valve to flush the contents of the sample line into a container. This material should be disposed of or returned to the process if possible. Immediately after flushing the line, the operator should collect the appropriate volume of sample

in a separate container. The volume to be flushed prior to sampling will depend on the size of the line and distance between the sample valve and the main line/tank. Ideally, the entire volume of this sample line should be flushed to ensure the collected sample is fresh and representative.

- As much as possible, samples collected for testing should be tested immediately or as soon as practical after collecting the sample. If unforeseen circumstances require the operator's attention elsewhere and the sample sits for more than 15 minutes, a fresh sample should be taken.
- Samples should always be collected in clean, dry containers. Containers should be cleaned after each use.

2.7 Sample Handling

All wastewater samples are to be collected in laboratory-supplied containers with the proper preservative, where applicable. A complete list of parameter handling and preservatives can be found in Appendix B.

All sample containers are to be tightly sealed and properly labelled with the sample ID, date and time of sample collection, location of sample collection and parameters to be analyzed. The outside of the bottles are to be cleaned with soap and water after sampling and dried off prior to placing the samples in the cooler. The samples are to be stored on ice in a cooler until delivery to the laboratory. A chain of custody form is to be filled out completely and is used to track the samples and placed in the cooler with the samples, in a ziplock bag. Keep the last page of the Chain of Custody and give it to the WWTP Foreman for their records.

The following checks are generally performed by the laboratory upon receipt:

- Verification of the integrity and condition of all sample coolers.
- Verification of the integrity and condition of all sample containers.
- Checks for leakage, cracked or broken closures or containers, evidence of grossly contaminated container exteriors or shipping cooler interiors, and obvious odours, etc.
- Verification of receipt of complete documentation for each container.
- Verification that sample identification numbers on sample transmittal forms corresponds to sample identification numbers on the sample containers.
- Verifications that holding times were met and samples were kept cool during transit.

2.8 Quality Assurance and Quality Control Program

Cross contamination is a common source of error in sampling procedures. QC samples help identify when and how contamination might occur. There are various types of QC samples. For the purposes of the WWTP's monitoring program, **exp** recommends the use of trip blanks.

It is essential to request a trip blank sample to be prepared when placing the bottle order with the contract laboratory.

3 Laboratory Analysis

3.1 Laboratory Accreditation

As indicated in the Guidelines, the Hamlet should use an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA); formally known as the Canadian Association for Environmental Analytical Laboratories (CAEAL) for the monitoring program for the WWTP. Appendix D includes a copy of the laboratory's CALA accreditation certificate and a list of the parameters for which they are certified.

3.2 Method Detection Limits

The method detection limits (MDLs) are provided on the contract laboratory's Certificates of Analysis.

3.3 Methodology

As indicated above, the contract laboratory is accredited by CALA for specific tests and complies with the requirements of ISO/IEC Standard 17025.

4 Reporting Requirements

As a condition of NWB Licence 3BM-PAN1417 (Appendix A), the Hamlet is required to submit an Annual Report to the NWB, no later than March 31st of the year following the calendar year reported. Among other requirements, the annual report is required to include tabular summaries of all analytical data generated under the Monitoring Program (compared to the Maximum Concentration of any Grab Sample – provided in Part D of the NWB Licence 3BM-PAN1417 – where applicable).

5 References

Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class "B" Licensees in Collecting Representative Water Samples in the Field and for Submission of a QA/QC Plan, Department of Indian and Northern Affairs Canada, July 1996.

Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, and Water Environment Federation, 22nd Edition, 2012.

Appendix A:
Hamlet of Pangnirtung's Water Licence

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI
OFFICE DES EAUX DU NUNAVUT

NWB File No.: **3BM-PAN1417**

September 16, 2014

Karen Mellor, SAO
Hamlet of Pangnirtung, Baffin Region
P.O. Box 253,
Pangnirtung, NU X0A 0R0
Email: pang_sao@qiniq.com

Bhabesh Roy, M.A. Sc., P. Eng
Municipal Planning Engineer, GN-CGS
P.O. Box 379,
Pond Inlet, NU X0X 0S0
Email: broy@gov.nu.ca

RE: NWB Renewal/Amendment Licence No. 3BM-PAN1417

Dear Ms. Mellor and Mr. Roy:

Please find attached Licence No. **3BM-PAN1417** issued to the Hamlet of Pangnirtung by the Nunavut Water Board (NWB) pursuant to its authority under Article 13 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada* (*Nunavut Land Claims Agreement or NLCA*). The terms and conditions of the attached Licence related to water use and waste disposal are an integral part of this approval.

If the Licensee contemplates the renewal of this Licence, it is the responsibility of the Licensee to apply to the NWB for its renewal. The past performance of the Licensee, new documentation and information, and issues raised during a public hearing, if the NWB is required to hold one, will be used to determine the terms and conditions of the Licence renewal. Note that if the Licence expires before the NWB issues a new one, then water use and waste disposal must cease, or the Licensee may be in contravention of the *Nunavut Land Claims Agreement* and the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*. However, the expiry or cancellation of a licence does not relieve the holder from any obligations imposed by the licence. The NWB recommends that an application for the renewal of this Licence be filed at least three months prior to the Licence expiry date.

If the Licensee contemplates or requires an amendment to this licence, the NWB may decide, in the public's interest, to hold a public hearing. The Licensee should submit applications for amendment as soon as possible to give the NWB sufficient time to go through the amendment process. The process and timing may vary depending on the scope of the amendment; however, a minimum of sixty (60) days is required from time of acceptance by the NWB. It is the responsibility of the Licensee to ensure that all application materials have been received and are acknowledged by the Manager of Licensing.

The NWB strongly recommends that the Licensee consult the comments received by interested persons on issues identified. This information is attached for your consideration.[1]

Sincerely,

Thomas Kabloona
Nunavut Water Board
Chair

TK/kk/mp

Enclosure: Licence No. **3BM-PAN1417**
Comments – AANDC

Cc: Qikiqtani Distribution List

[1] Aboriginal Affairs and Northern Development Canada (AANDC), September 8, 2014.

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DECISION

LICENCE NUMBER: 3BM-PAN1417

This is the decision of the Nunavut Water Board (NWB) with respect to a complete application dated July 29, 2014 for a renewal/amendment of a Water Licence made by:

HAMLET OF PANGNIRTUNG

to allow for the use of water and deposit of waste during municipal activities by the Hamlet of Pangnirtung located within the Qikiqtani Region, Nunavut, generally located at the geographical coordinates as follows:

Latitude: 66° 09' 00'' N and Longitude: 65° 40' 34'' W

DECISION

After having been satisfied that the application was for a project proposal located outside the boundaries of the two approved land use plans administered by the Nunavut Planning Commission (NPC)[1] and was exempt from the requirement for screening by the Nunavut Impact Review Board (NIRB)[2] pursuant to Schedule 12-1 of the *Nunavut Land Claims Agreement* (*NLCA*), the NWB decided that the application could proceed through the regulatory process. In accordance with S.55.1 of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (*Act*) and Article 13 of the *NLCA*, public notice of the application was given and interested persons were invited to make representations to the NWB.

After reviewing the submission of the Applicant and considering the representations made by interested persons, the NWB, having given due regard to the facts and circumstances, the merits of the submissions made to it and to the purpose, scope and intent of the *NLCA* and of the *Act*, waived the requirement to hold a public hearing and determined that:

Licence No. 3BM-PAN0810 be renewed/amended as Licence No. 3BM-PAN1417 subject to the terms and conditions contained therein. (Motion #: 2014-B1-030)

Signed this 16th day of September 2014 at Gjoa Haven, NU.

Thomas Kabloona
Nunavut Water Board
Chair

TK/kk/mp

1 Nunavut Planning Commission Determination, dated August 12, 2014.
2 Nunavut Impact Review Board: Exempt from Screening Decision, dated August 11, 2014.

I. BACKGROUND

The Hamlet of Pangnirtung (Pangnirtung or the Hamlet) is located at Latitude 66° 09' 00'' N and Longitude: 65° 40' 34'' W, on the eastern shore of Baffin Island within the Qikiqtani Region of Nunavut, approximately 255km north of Iqaluit. The population of Pangnirtung in 2013 is estimated to be 1,512 according to the Nunavut Bureau of Statistics. The estimated population of the community in 2030 would be approximately 2000.

Pangnirtung is located within the continuous permafrost zone with a maximal local depth of annual thaw of the active layer up to 1-1.5m depending on the nature of the surface cover. Vegetation is typical for the Arctic tundra with hardy grasses, mosses and lichens in a thin organic layer on the surface. The weather is generally unpredictable throughout the year. Temperatures are harsh in the winter, where wind chill temperatures can be –50°C or below. Pangnirtung does experience periods of high winds. From Mid-November to Mid-February, Pangnirtung does not receive direct sunlight due to high coastal mountains. There is continuous daylight from April to mid-August. January mean high and low temperatures are -23°C and -30°C, respectively, and July mean high and low temperatures are 11°C and 5°C, respectively. The temperature in July and August usually averages between 5°C and 15°C. The annual snowfall is approximately 170mm and the annual rainfall is approximately 210mm.

Pangnirtung is one of only three Nunavut Communities with a fish processing plant and a robust Arctic Char and Greenlandic Turbot Fishery.

Water for municipal use is pumped from Duval River. Existing waste disposal facilities include a Waste Water Treatment Plant (WWTP) built in 2003 that has been modified from a rotating biological contactor to an activated sludge system. Solid waste from the Hamlet is currently disposed of in a landfill located approximately 800 metres from the edge of the Hamlet. The existing solid waste site has been determined to be inappropriately sited due to ecological concerns, odor and windblown litter, poorly operated and maintained, and is nearing its life capacity.

II. PROCEDURAL HISTORY

On **December 1, 2002**, the Nunavut Water Board ("NWB" or "Board") issued water licence NWB3PAN0207 to the Hamlet of Pangnirtung for the use of 100,000 m^3 *per year* water and waste disposal activities within the Hamlet. The licence expiry date was set at November 31, 2007. On June 10, 2008 the NWB received correspondence from Chief Medical Officer of Health (CMO) and Manager Field Operations, Nunavut Regional Office, Aboriginal Affairs and Northern development Canada (AANDC), which identified the collapse of Pangnirtung's bridge infrastructure due to flooding. Due to the failure of the bridge, the sewage trucks could no longer deliver sewage from homes and businesses to the WWTP. The discharge of sewage into the river was the only viable alternative to simply allow sewage holding tanks to accumulate and overflow in homes and businesses, which would constitute a health hazard for residents of the Hamlet.

The bridge collapse resulted in a temporary order from the CMO to dump sewage from the Hamlet of Pangnirtung directly into the Duval River downstream of the affected bridge. The temporary measure was effective June 10, 2008 for a 48 hour period.

On **June 12, 2008**, the NWB recommended to the AANDC Minister (Minister) that an emergency amendment be issued to the Hamlet regarding its expired licence NWB3PAN0207 to ensure that emergency measures were duly authorized as required by the *NWSRTA*. On June 16, 2008, the Minister consented to waiving the notice period to issue the emergency amendment as recommended by the NWB, effective immediately. Extensions to the emergency dumping measures into the Duval River were provided by the CMO on June 17 and June 20, 2008.

On **August 8, 2008**, the licence was renewed as licence 3BM-PAN0810, with the expiry date set at August 31, 2010, allowing the Hamlet to use 100,000 m^3 *per year* of water and dispose of waste at specific facilities within the Hamlet. The two (2) year Licence term was intended to *send a clear message to the Hamlet and regulatory authorities that the Board will not passively encourage the Hamlet's failures to comply with the Licence conditions and associated legal requirements*. The Board expected the Hamlet to *take immediate steps towards full compliance with all Licence requirements for its existing facilities*. *Upon submission of an application to renew the Licence in approximately twenty one (21) months, the Board expected the Hamlet to be in full compliance with the licence.* Part B, Item 10 of the Licence indicated *that the Licensee must submit a Plan for Compliance that clearly demonstrates how the Hamlet will achieve full compliance with the Licence conditions during this time period.*

On **October 19, 2011**, and re-submitted on **March 08, 2012**, the Board received an Application for the renewal of water licence 3BM-PAN0810 ("Licence") from the Government of Nunavut Department of Community Government Services (GN-CGS) on behalf of the Hamlet of Pangnirtung (Hamlet). The renewal Application was comprised of the following documents:

October 19, 2011 submissions:

- Cover Letter for renewal dated October 3, 2011;
- Completed Renewal Application form;
- 2010 Annual Report;
- Technical Summary in English and Inuktitut; and
- Plan for Compliance.

On March 8, 2012 additional submissions:

- 2011 Annual Report; and
- Plan for Compliance (updated).

On **April 5, 2012** the NWB informed the Licensee about deficiencies in the Application that needed to be addressed prior to proceeding with processing the renewal Application[1]. Clarifications were requested regarding the Plan for Compliance's short and long term plans for addressing a number of outstanding requirements of the licence.

1 Letter from Erik Skiby, NWB, to Ron Mongeau, Hamlet of Pangnirtung: Re: Application for Licence Renewal and Plan for Compliance, dated April 5, 2012.

On **October 3, 2012**, the NWB received the following additional information:

- Cover Letter dated November 2012;
- Pangnirtung Optimization of Drinking Water Supply – Project Schedule;
- Preliminary Schedule for the Pangnirtung Solid Waste Site Rehabilitation Oct 30, 2012; Pangnirtung, NU WWTP Upgrade Preliminary Project Schedule; and
- Plan for Compliance.

On **January 8, 2013**, the NWB advised the Licensee that these documents were received in hard copy, and some of them (Plan for Compliance) were unreadable due to wrong format and size[2]. The Licensee was advised to provide documents in electronic format for review.
After a number of correspondences (last one dated **March 31, 2014**[3]) between the NWB and the Licensee, on **April 2, 2014**, the following additional information was provided to the Board:

- Authorization Letter;
- Design Development Report – Optimization of Drinking Water Supply Pangnirtung, Nunavut GN-CGS Project #08-2009; and
- Letter from B. Roy, GN-CGS to P. Beaulieu, NWB: *Re: Hamlet of Pangnirtun: Water License #3BM-PAN0810 Application*.

On **April 24, 2014**[4], the NWB advised the Licensee that the application still does not meet the requirements of section 48(1) of the *Act*, and requested clarifications on issues raised or a Plan for Compliance that clearly demonstrates the measures the Licensee will undertake, including long/short term implementation schedules, to achieve full compliance with the conditions of this Licence, including the issues raised in the AANDC Inspector's *Reports*.

On **May-June, 2014**, the Board received the following additional information to be included within the Application:

- Letter from B. Roy, GN-CGS to P. Beaulieu, NWB and Justin Hack, AANDC: Re: Shut Down WWTP during Construction: Contingency Plan and Notice, dated May 1, 2014;
- Letter from B. Roy, GN-CGS to P. Beaulieu, NWB: Re: Shut Down WWTP during Construction: Contingency Plan and Notice, dated May 12, 2014;
- Letter from B. Roy, GN-CGS to P. Beaulieu, NWB: Re: Water Licence # 3BM-PAN0810 Renewal Application: Response to the letter of Mr. Erik Skiby, Assistant Technical Advisor, dated May 13, 2014;
- Water Licence Amendment Application, dated May 4, 2014;
- Pangnirtung Fish Waste Lagoon Decommissioning Plan, dated May 23, 2013;
- Operation and Maintenance Manual for Wastewater Treatment Plan Hamlet of Pangnirtung;
- Letter from B. Roy, GN-CGS to P. Beaulieu, NWB: Re: Hamlet of Pangnirtung Water Licence # 3BM-PAN0810 Renewal Application, dated May 19, 2014; and
- Solid Waste Operation and Maintenance Plan for Hamlet of Pangnirtung, dated June 2014.

2 Email from Phyllis Beaulieu, NWB, to Ron Mongeau, Hamlet of Pangnirtung: Re: Receipt of Documents Hard Copy only, dated January 8, 2013.
3 Email from Erik Skiby, NWB, to Roy Bhabesh, GN-CGS: Re: Status of Pangnirtung WL Application, dated March 31, 2014.
4 Letter from Erik Skiby, NWB, to Roy Bhabesh (GN-CGS) and Karen Mellor (Hamlet of Pangnirtung): Re: Response to additional information, dated April 24, 2014.

On **July 29, 2014**, the Board received additional information and clarification by Email of on-going/future activities from GN-CGS on behalf of Licensee that included the following information:

- Revised Water Licence Renewal Application, dated July 29, 2014; and
- Drinking Water Quality (July 2013) Preliminary Results Pangnirtung, NU, dated September 16, 2013; and

On August 8, 2014, following a preliminary internal technical review, the NWB concluded that the Application generally meets the requirements of section 48(1) of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSRTA or Act) and forwarded notice of the Application to regulators, the council of the municipality most affected by the project, and other interested parties. All parties were invited to make representations to the NWB within thirty (30) days, by September 8, 2014. On September 8, 2014, comments were received from AANDC.

Based upon the results of the completed detailed assessment, including consideration of any potential accidents, malfunctions, or cumulative environmental effects that the overall project might have in the area, the Board has approved the application for the renewal of Licence No. 3BM-PAN0810 as Licence No. **3BM-PAN1417**.

III. ISSUES

Term of the Licence

In accordance with S. 45 of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSRTA or the Act), the NWB may issue a licence for a term not exceeding twenty-five (25) years. In determining an appropriate term of a water licence, the Board considers a number of factors, including the results of the AANDC's annual site Inspection and the compliance record of the Applicant.

The Licensee has requested a five (5) year term for the renewal Licence (to expire in 2019). In their submission, AANDC - Water Resources Division (AANDC) recommended that the Licence be renewed for five (5) years.

The AANDC Inspection of August 17, 2011, identified longstanding Non-Compliance of the Act or Licence issues that were to be addressed by the Hamlet.

The NWB is fully aware of recurring non-Compliance issues with respect to the Act in the context of the Licence issued to the Hamlet. The NWB acknowledges, however, that some improvements have been made by the Licensee (i.e. actual Monitoring completed in 2013) during last year in trying to address the Non-Compliance issues and to reach the short-term compliance goals. However, the Board believes that a licence term of three (3) years will provide a realistic opportunity for the Licensee to prove to the Board that it can meet the long-term requirements as well as establish a consistent compliance record with respect to the requirement under the terms and conditions of its licence. The three (3) year renewal Licence will also ensure that sufficient time is given to permit the Licensee to develop, submit, and implement the plans required under its Licence with respect to the planned construction works

for the Wastewater Treatment Plant and construction of a new Water Truck-fill Station, expected by December 31, 2014 and by December 31, 2016, respectively.

The Hamlet's actual daily water use may be higher than 300 m^3 *per* day when filling the Water Storage Reservoir which could trigger a change of the Licence Type "B" to Type 'A" .The three (3) year term shall allow the Licensee to measure the daily water use during two (2) full years and help the Board to accurately determine the Type of Licence for the future renewal.

Annual Reports

As part of its obligations under this Licence, the Licensee is required to generate and submit to the Board for review, on an annual basis, a report that pertains to its undertakings and activities. The report is for the purpose of ensuring that the NWB has an accurate update of municipal activities during each calendar year. This information will be maintained on the public registry and will be available to any interested parties upon request. A "*Standardized Form for Annual Reporting*" is to be used by the Licensee and is available for use at the NWB's ftp site at:

http://www.nwb-oen.ca/public-registry

The Licensee is advised that the NWB *Standardized Form* could be supplemented by additional monitoring documentation and Licensee's annual reporting forms as advised by AANDC, The Licensee is required to submit all monitoring data with appropriate station identification to the NWB as a requirement of the Annual Report in Part B Item 1 of the licence. The Annual Report shall include all Monitoring Program results as per requirements included within Part H (Conditions applying to the Monitoring Program) of the Licence. The Licensee shall provide, with Annual Reports, all tabular summaries for monitoring program stations in addition to laboratory results. As stated by AANDC *these summaries should reference licensed monitoring program stations (e.g., PAN-X), effluent quality limits, and any exceedances*.

Water Use

The Hamlet currently receives its freshwater supply from the Duval River to the Water Storage Reservoir located approximatively 100m north of the River. Water is stored every summer from the end of May to the beginning of October for annual use. The rest of the time Duval River freezes up, and no flow occurs. A Water Storage Reservoir is filled each summer for annual storage. A water Truck-fill Station is built at the top of the northern berm of the Reservoir. In order to meet the demand for future population growth for the next 20 years a new Truck-fill Station is expected to be constructed to replace the existing one by December 31, 2016.

Under the expired licence, 100,000 m^3 of water per year was allocated, and although the Licensee has requested within the renewal application of May 21, 2014, 51,531 m^3 of water *per* year for all purposes, on July 29, 2014, the GN-CGS clarified with a revised application that 74,000 m^3 of water *per* year would be required.

No concerns were raised by the parties in their written submissions (AANDC) as to the amount of water required by the Hamlet, the manner in which it is obtained or in the manner in which this water will be used.

In review of the application, the NWB relied on the new Nunavut Waters Regulations (Regulations) issued on April 18, 2013 and the definition of "Use" provided by the *Act*. All water taken from the Duval River, main water source to fill the reservoir would qualify under the definition as "use of water". Therefore, having given due consideration to the information presented during the review, the NWB has determined that water extracted from the source water supply, for any purposes, is considered as a Use of water and that the Licensee is requested to daily measure directly on the source at Monitoring Program Station PAN-1 all freshwater used for all purposes.
The Licensee shall also measure on daily, monthly and annual basis all freshwater used for all purposes at the Truck-fill Station.

The Licensee is also advised that according to the Schedule 2 of Regulations any use of 300 m^3 or more *per* day and any use of waters related to the storage of 60,000 m^3 or more water would require a Type "A" Water Licence. The Board has, therefore, set the maximum water usage for all purposes specified in this Licence at 74,000 m^3 *per* year or up to 299 m^3 *per* day for filling of the reservoir.

Deposit of Waste

Sewage
The Hamlet currently provides trucked sewage services for the Community. Specific comments relevant to Waste Water Treatment Plant (WWTP) operations were provided by AANDC. AANDC noted that the WWTP Operation and Maintenance Plan (WWTP O&M Plan) should *be revised to provide a non-technical overview of its design and ability to satisfy (licensed) effluent discharge criteria. Details concerning the management of treated effluent and sludge as well as licensed monitoring program requirements should be included in the plan*. The revised WWTP O&M Plan should also include an Executive Summary for an overview of how the facilities are being operated, following with a Document Control Section to track document revisions. AANDC recommended also *developing sewage Sludge Treatment Program* to diminish the leachate generation from Sludge being bagged for disposal in the Solid Waste Disposal Facility.

AANDC Inspection of July 2011 indicated *that treatment plant continues to struggle with the volume of effluent input into the system.* It was also stated that *the practice of surface disposal of Sludge is contrary to the issued license and not acceptable to the Inspector, and Sludge and processing from the fish plant are to be buried as outlined in the now expired license.*
The NWB concurs with these recommendations, and has imposed requirements in the Licence with respect to the future revision of the WWTP O&M Plan to be submitted within the 2014 Annual Report. The WWTP O&M Plan shall be revised in accordance to the October 1996 Government of the Northwest Territories "Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories" and shall include details on Sludge Treatment Program and the WWTP changes/upgrades that the Hamlet intents to complete by December 31, 2014. The Licensee shall make every effort to address all operational issues identified by Inspector.

Solid Waste

The June 2014 "Solid Waste Operation and Maintenance Plan for Hamlet of Pangnirtung" (SW O&M Plan) submitted as additional information within the Application states that Solid Waste generated in Pangnirtung includes: municipal Solid Waste generated in the community, sewage Sludge generated in the WWTP and fish waste generated at the fish plant. Solid waste from the Hamlet is currently disposed of in a landfill located approximately 800 metres from the edge of the Hamlet. The current landfill site (200m long and 65 m width),is a rectangular land area, is enclosed with 3m high steel fence all around. The SW O&M Plan states that the Community is currently managing an independent metal dump site located just opposite to the landfill site and this site is not fenced.

About 30% of the landfill area is designated for fish and sludge waste management. Offal from the fish processing plant was disposed of at the solid waste disposal facility until 2010. Fish plant management estimated that the plant operated for approximately 115 days/year and that 1.5 to 2 m^3 of fish waste was generated *per* day, or 230 m^3 per year. The GN and the fish plant were investigating alternative disposal methods for the fish waste (e.g. ocean dumping), which would remove the waste from the Hamlet's solid waste disposal stream.

Bagged Sludge is presently removed from the aerobic digester approximately one or two times *per* week. In its comment, AANDC stated that sludge can be treated prior to landfill disposal. *Treatment of sewage Sludge Program can be implemented (freeze/thaw dewatering of sludge on drying beds and the collection/further treatment of recovered leachate).* AANDC also stated that the Licensee *should ensure that non-contact water diversion measures are implemented at uphill of its Solid Waste Disposal Facility and bulky metals and hazardous waste storage areas to limit the volume of effluent requiring management*.

The July 2011 AANDC Inspection stated that *the Solid Waste management area requires proper segregation of Hazardous wastes into a lined containment area for storage, packaging for shipment off site is required*. It was also noted that a *new metals / vehicle storage area has been created outside the boundaries of the existing solid waste management area.*

The NWB concurs with AANDC recommendations, and advises the Licensee to make improvements to the sewage Sludge dewatering process at the WWTP as these improvements will reduce the water content of the Sludge, and therefore will reduce the volume of Sludge generated. The Board requires that the Hamlet give serious consideration to AANDC recommendations, and in the interim take whatever steps are practicable to prevent any impact to the environment.

From the Board's understanding, Hamlet's natural attenuation landfill is not lined and small amounts of contaminants can enter the surrounding environment to be naturally broken down. In this type of landfill, the rate that contaminants enter the environment is expected to occur at a rate such that contaminants can easily be broken down and the surrounding environment is not overwhelmed. Natural attenuation landfills also rely on permafrost aggrading into the covered waste cells of the landfill and eventually freezing them. However, as contaminants are able to freely enter the environment in this type of landfill, proper waste segregation is important to ensure harmful contaminants are kept out of the landfill.

To ensure that site runoff is properly managed so there is no impact to the natural environment in terms of contamination the Board has again included within the Monitoring Program Stations sampling of Monitoring Program Stations for the Landfill leachate/run-off from domestic waste dumping area (PAN-4) and from Sludge dumping area (PAN-5). The Board has also included an additional Monitoring Program Station (PAN-6) for the run-off from metal/vehicle dump area.

Operational Plans

Part F, Item 1 of expired 3BM-PAN0810 Licence required that the Licensee submit to the Board for approval within ninety (90) days of issuance of the Licence the following revised plans:

a. Water Distribution Facility Operation and Maintenance (O&M) Plan;
b. Waste Water Treatment Plant Operation and Maintenance (O&M) Plan;
c. Fish Process Plant Waste Management Plan;
d. Sewage Sludge and Screenings Management Plan;
e. Solid Waste Disposal Facility Operation and Maintenance (O&M) Plan;
f. Spill Contingency Plan; and
g. Monitoring Program Quality Assurance/Quality Control Plan (QA/QC Plan).

The following environmental management documents included with the Application were found acceptable by the Board:

- Operation and Maintenance Manual for Water Truck-fill Hamlet of Pangnirtung, completed in 1987 (WTS O&M Plan);
- Operation and Maintenance Manual for Waste Water Treatment Plant Hamlet of Pangnirtung (WWTP O&M Plan);
- Solid Waste Operation and Maintenance Plan for Hamlet of Pangnirtung, dated June 2014 (SW O&M Plan);
- Station Pangnirtung Fish Waste Lagoon Decommissioning Plan, dated May 23, 2013 (FWLD Plan);

However, under Part F, Item 1, the Licensee shall be required to submit to the Board for approval within the 2014 Annual Report, revised WTS O&M, WWTP O&M and SW O&M Plans to include the following:

- Executive Summaries;
- Document Control Section intending to track document revisions and providing document version, date, sections and pages, and summary of changes.
- The WWTP O&M Plan shall also include a non-technical overview of its design and ability to satisfy effluent discharge criteria incorporated in the Licence, details of Sludge Management / Treatment Program, and details of Monitoring Program requirements. The revised plan shall also include details related to WWTP changes/upgrades expected by end of 2014;
- The SW O&M Plan shall also include details of Monitoring Program Stations actual description, a schematic and a topographic map of appropriate scale detailing the landfilling areas, run-off from Sludge disposal area, and Monitoring Program Stations locations.

From the Board's understanding the Station Pangnirtung Fish Waste Lagoon Decommissioning Plan (FWLD Plan) is a conceptual interim plan. Therefore under Part G Item 1, the Licensee shall be required to submit a final decommissioning plan at least 6 months prior to abandoning this facility amongst other facilities.

The Board notes that a section of Spill Contingency Planning is included within the SW O&M Plan. AANDC stated that this Plan should be a *stand-alone document because hazardous material spills can occur in areas other than the Solid Waste Disposal Facility (e.g., municipal buildings and roads, oil and fuel storage tanks, quarry areas, etc.).* The NWB believes that a stand-alone Spill Contingency Plan that details spill responses and procedures for Water Supply, Sewage Disposal and Solid Waste Disposal Facilities Operations would facilitate the effective implementation of spill response measures by Hamlet staff. Therefore the Licensee shall be required to submit a stand-alone Spill Contingency Plan under Part F, Item 2.

Monitoring Program

Part H of the Licence details the environmental monitoring requirements. The Licensee included a request to amend the water licence by *deleting the item 3 (a and b) of Part D from the licence due to time constraint of sampling, shipping and getting the samples tested in time in this southern lab since there is no accredited lab in Nunavut.*

In addition to this request, the Licensee recommended *amending the Part F, Item 3 that requires an annual inspection of all engineered facilities related to the management of water and waste by a Geotechnical Engineer to allow the Licensee to perform an annual inspection of all engineered facilities related to the management of water and waste by the Regional Municipal Planning Engineer.*

Acute Lethality tests of treated municipal wastewater effluent are generally included within the water licenses by third Parties (Environment Canada (EC) or Fisheries and Oceans Canada (DFO)) request to ensure that the subsection 36 (3.) of Fisheries Act requirements are met. As the Board did not receive any objections from relevant Parties, and recognizing related time/logistical constraints, the Board has removed this requirement from the renewal Licence.

In its comment with respect to annual inspections to be completed by *Regional Municipal Planning Engineer*, AANDC stated that this is an acceptable proposal, and recommended that more stringent requirements be applied if it is determined that infrastructure pose higher environmental and/or health and safety risks. The Board concurs with this recommendation, and has amended this condition. Part F, Item 5 of the Licence includes a requirement of annual inspection of all engineered facilities related to the management of water and waste to be carried by an Engineer (Civil, Municipal or Geotechnical).

The SW O&M Plan states that the Community *manages an independent metal dump site located just opposite to the land fill site and this site is not fenced*. The NWB notes that there is no indication whether or not that metal dump area is lined. The July 2011 AANDC Inspection also stated that *new metals / vehicle storage area has been created outside the boundaries of the existing solid waste management area* that is not *covered under the existing/ now expired license and is a change to the operations of the Facilities within the community*.

The Board concurs with AANDC Inspection, and has included an additional Program Monitoring Station (PAN-6) for the contact water discharge (if the site is lined) or potential run-off from the metal damp unlined site. To prevent the contact water's spreading into the surrounding environment the Licensee shall ensure that a containment pond is created for the potential run-off and to facilitate the sampling.

It should also be noted that while minimum sampling requirements have been imposed, additional sampling may be required upon request by an Inspector.

Quality Assurance / Quality Control Plan (QA/QC Plan)

The requirement to submit a Quality Assurance / Quality Control Plan (QA/QC Plan) is to provide the necessary checks and controls under the Licence for sampling, monitoring and reporting for Hamlet of Pangnirtung. The purpose of the QA/QC Plan is to ensure that samples taken in the field as part of the Monitoring Program will be of a high quality, so as to accurately represent the physical and chemical nature of the samples being taken. These procedures are generally developed from literature and guidelines, and are intended to promote good practices in environmental management.

The QA/QC Plan included within the SW O&M Plan is very general and does not include information about the laboratory accreditation pursuant to ISO/IEC Standard 17025.

The NWB has included a requirement to submit under Part H, Item 8 of the Licence, a "*Quality Assurance/Quality Control (QA/QC) Plan for the Hamlet Waste Water and Solid Waste Disposal Facility Monitoring Program*" prepared in accordance with the INAC *"Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class "B" Licensees in Collecting Representative Water Samples in the Field, 1996"*.

The QA/QC Plan shall be submitted to the Board with a current approval letter from an accredited lab and shall meet the requirements set out in Part H, Items 9 and 10.

NUNAVUT WATER BOARD
WATER LICENCE RENEWAL

Licence No. **3BM-PAN1417**

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

HAMLET OF PANGNIRTUNG

(Licensee)

P.O BOX 253 PANGNIRTUNG, NUNAVUT, X0A 0R0

(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water or dispose of waste for a period subject to restrictions and conditions contained within this Licence renewal:

Licence Number/Type:	3BM-PAN1417 TYPE "B"
Water Management Area:	NORTHERN CUMBERLAND SOUND (51)
Location:	HAMLET OF PANGNIRTUNG QIKIQTANI REGION, NUNAVUT
Classification:	MUNICIPAL UNDERTAKING
Purpose:	DIRECT WATER USE AND DEPOSIT OF WASTE
Quantity of Water use not to Exceed:	74,000 CUBIC METRES PER ANNUM OR MAXIMUM OF 299 CUBIC METRES PER DAY
Date of Licence Issuance:	SEPTEMBER 16, 2014
Expiry of Licence:	SEPTEMBER 15, 2017

This Licence renewal issued and recorded at Gjoa Haven, Nunavut includes and is subject to the annexed conditions.

Thomas Kabloona,
Nunavut Water Board, Chair

PART A: SCOPE, DEFINITIONS AND ENFORCEMENT

1. Scope

This Licence allows for the use of water and the deposit of waste for a Municipal undertaking classified as per Schedule 1 of the *Regulations* at the Hamlet of Pangnirtung in Qikiqtani Region, Nunavut (Latitude: 66° 09' 00'' N and Longitude: 65° 40' 34'' W).

a. This Licence is issued subject to the conditions contained herein with respect to the taking of water and the depositing of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposits of such waste may enter any waters. Whenever new Regulations are made or existing *Regulations* are amended by the Governor in Council under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, or other statutes imposing more stringent conditions relating to the quantity or type of waste that may be so deposited or under which any such waste may be so deposited, this Licence shall be deemed, upon promulgation of such Regulations, to be subject to such requirements; and

b. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with the requirements of all applicable Federal, Territorial and Municipal legislation.

2. Definitions

"**Act**" means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act;*

"**Addendum**" means the supplemental text that is added to a full plan or report usually included at the end of the document and is not intended to require a full resubmission of the revised report;

"**Amendment**" means a change to original terms and conditions of this Licence requiring correction, addition or deletion of specific terms and conditions of the Licence; modifications inconsistent with the terms of the set terms and conditions of the Licence;

"**Appurtenant Undertaking**" means an undertaking in relation to which a use of water or a deposit of waste is permitted by a licence issued by the Board;

"Board" means the Nunavut Water Board established under the *Nunavut Land Claims Agreement* and the *Nunavut Waters and Nunavut Surface Rights Tribunal Act;*

"**Effluent**" means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond, landfarm or a treatment plant;

"**Engineer**" means a professional engineer registered to practice in Nunavut in accordance with the *Consolidation of Engineers and Geoscientists Act S. Nu 2008, c.2* and the *Engineering and Geoscience Professions Act S.N.W.T. 2006, c.16 Amended by S.N.W.T. 2009, c.12*;

"**Final Discharge Point**" means an identifiable discharge point of a Waste Disposal Facility beyond which the Licensee no longer exercises care and control over the quality of the Effluent;

"**Freeboard**" means the vertical distance between water line and crest on a dam or dyke's upstream slope;

"**Geotechnical Engineer**" means a professional engineer registered with the Association of Professional Engineers, Geologist and Geophysicists of Nunavut and whose principal field of specialization with the engineering properties of earth materials in dealing with man-made structures and earthworks that will be built on a site. These can include shallow and deep foundations, retaining walls, dams, and embankments;

"**Grab Sample**" means an undiluted quantity of material collected at a particular time and place that may be representative of the total substance being sampled at the time and place it was collected;

"**Greywater**" means all liquid wastes from showers, baths, sinks, kitchens and domestic washing facilities, but does not include toilet wastes;

"**High Water Mark**" means the usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land (ref. Department of Fisheries and Oceans Canada, Operational Statement: Mineral Exploration Activities);

"**Inspector**" means an Inspector designated by the Minister under Section 85 (1) of the *Act*;

"**Licensee**" means the holder of this Licence;

"Metal Storage Area" means the facilities designated for the disposal of metal/vehicles, as described in the Application for Water Licence renewal and associated documents filed by the Licensee on July 29, 2014;

"**Modification**" means an alteration to a physical work that introduces a new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion;

"**Monitoring Program**" means a monitoring program established to collect data on surface water and groundwater quality to assess impacts to the freshwater aquatic environment of an appurtenant undertaking;

"**Nunavut Land Claims Agreement *(NLCA)***" means the "*Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*", including its preamble and schedules, and any amendments to that agreement made pursuant to it;

"**Regulations**" means the *Nunavut Waters Regulations SOR/2013-69 18th April, 2013*;

"**Sewage**" means all toilet wastes and greywater;

"**Sewage Disposal Facilities**" comprises existing Waste Water Treatment Plant as described in the Application for Water Licence renewal and associated documents filed by the Applicant on July 29, 2014;

"Solid Waste Disposal Facility" means the facilities designated for the disposal of solid waste, as described in the Application for Water Licence renewal and associated documents filed by the Licensee on July 29, 2014;

"**Spill Contingency Plan**" means a Plan developed to deal with unforeseen petroleum and hazardous materials events that may occur during the operations conducted under the Licence;

"**Toilet Wastes**" means all human excreta and associated products, but does not include greywater;

"**Waste**" means, as defined in S.4 of the *Act*, any substance that, by itself or in combination with other substances found in water, would have the effect of altering the quality of any water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

"**Water**" **or** "**Waters**" means waters as defined in section 4 of the Act; and

"**Water Supply Facilities**" comprises the area and associated intake infrastructure at the Duval River, Water Storage Reservoir and Truck-fill Station, as described in the Application for Water Licence renewal and associated documents filed by the Applicant on July 29, 2014.

3. Enforcement

a. Failure to comply with this Licence will be a violation of the *Act*, subjecting the Licensee to the enforcement measures and the penalties provided for in the *Act*;

b. All inspection and enforcement services regarding this Licence will be provided by Inspectors appointed under the *Act*; and

c. For the purpose of enforcing this Licence and with respect to the use of water and deposit or discharge of waste by the Licensee, Inspectors appointed under the *Act*, hold all powers, privileges and protections that are conferred upon them by the *Act* or by other applicable law.

PART B: GENERAL CONDITIONS

1. The Licensee shall file an Annual Report on the Appurtenant Undertaking with the Board no later than March 31st of the year following the calendar year being reported, containing the following information:

   a. tabular summaries of all data generated under the "Monitoring Program";
   b. summary of modifications to the "Monitoring Program" in accordance with Part H, Item 12;
   c. the daily, monthly and annual quantities in cubic metres of freshwater obtained from all sources;
   d. the daily, monthly and annual quantities in cubic metres of each and all waste discharged; including the hazardous and non-hazardous waste accepted at the Solid Waste Facilities;
   e. a summary of modifications and/or major maintenance work and/or investigations carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and facilities;
   f. a list of unauthorized discharges and summary of follow-up action taken;
   g. a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;
   h. Any updates or revisions for manuals and plans *(i.e., Operations and Maintenance, Abandonment and Restoration, QA/QC*) as required by changes in operation and/or technology;
   i. a summary of any studies, reports and plans requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned;
   j. any other details on water use or waste disposal requested by the Board by November 1st of the year being reported.

2. The Licensee shall notify the NWB of any changes in operating plans or conditions associated with this project at least thirty (30) days prior to any such change.

3. The Licensee shall comply with the "Monitoring Program" described in this Licence, and any amendments to the "Monitoring Program" as may be made from time to time, pursuant to the conditions of this Licence.

4. The "Monitoring Program" and compliance dates specified in the Licence may be modified at the discretion of the Board.

5. The Licensee shall, install flow meters or other such devices, or implement suitable methods required for the measuring of water volumes as required under Part H, Item 2

6. The Licensee shall, post the necessary signs, where possible, to identify the stations of the "Monitoring Program". All signage postings shall be in the Official Languages of Nunavut, and shall be located and maintained to the satisfaction of an Inspector.

7. The Licensee shall, immediately report to the 24-Hour Spill Report Line at (867) 920-8130, any spills of Waste, which are reported to, or observed by the Licensee, within the municipal boundaries or in the areas of the Water Supply or Waste Disposal Facilities.

8. The Licensee shall, in relation to any application to renew or amend the Licence, include a Plan for Compliance for Board approval, clearly demonstrating the measures the Licensee will undertake, including an implementation schedule, to achieve full compliance with the conditions of this Licence, including the issues raised in the Inspector's Reports.

9. The Licensee shall, for all Plans submitted under this Licence, include a proposed timetable for implementation. Plans submitted cannot be undertaken without subsequent written Board approval and/or direction. The Board may alter or modify a Plan if necessary to achieve the legislative objectives and will notify the Licensee in writing of acceptance, rejection or alteration of the Plan.

10. The Licensee shall, for all Plans submitted under this Licence, implement the Plan as approved by the Board in writing.

11. The Licensee shall review the Plans referred to in this Licence, as required by changes in operation and/or technology, and modify the Plan accordingly. Revisions to the Plans shall be submitted in the form of an Addendum to be included with the Annual Report.

12. Every Plan to be carried out pursuant to the terms and conditions of this Licence shall become a part of this Licence, and any additional terms and conditions imposed upon approval of a Plan by the Board become part of this Licence. All terms and conditions of the Licence should be contemplated in the development of a Plan where appropriate.

13. The Licensee shall ensure a copy of this Licence is maintained at the site of operations at all times. Any communication with respect to this Licence shall be made in writing to the attention of:

(a) Manager of Licensing:
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369
Email: licensing@nwb-oen.ca

(b) Inspector Contact:

Manager of Field Operations, AANDC
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4295
Fax: (867) 979-6445

14. The Licensee shall submit one paper copy and one electronic copy of all reports, studies, and plans to the Board. Reports or studies submitted to the Board by the Licensee shall include a detailed executive summary in Inuktitut.

15. The Licensee shall ensure that any document(s) or correspondence submitted by the Licensee to the NWB is received and acknowledged by the Manager of Licensing.

16. This Licence is assignable as provided for in Section 44 of the *Act*.

PART C: CONDITIONS APPLYING TO WATER USE

1. The Licensee shall obtain all fresh water from the Duval River using the Water Supply Facilities or as otherwise approved by the Board.

2. The annual quantity of water use for all purposes under this Licence shall not exceed seventy-four thousand (74,000) cubic metres per year or maximum of two hundred and ninety-nine (299) cubic metres per day.

3. Where the use of water is of a sufficient volume that the source Water body may be drawn down, the Licensee shall submit to the Board for approval in writing the following: the volume required a hydrological overview of the water body, details of impacts, and proposed mitigation measures.

4. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.

5. The Licensee shall equip all water intake hoses with a screen of appropriate mesh size to ensure that fish are not entrained and shall withdraw water at a rate such that fish do not become impinged on the screen.

6. The Licensee shall not remove any material from below the ordinary High Water Mark of any water body unless approved by the Board in writing.

7. The Licensee shall not cause erosion to the banks of any body of water and shall provide necessary controls to prevent such erosion.

8. Sediment and erosion control measures shall be implemented prior to and maintained as required during Hamlet operations, to prevent entry of sediment into water.

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

1. The Licensee shall direct all Sewage to the Waste Water Treatment Plant or as otherwise approved by the Board in writing.

2. All Effluent discharged from the Waste Water Treatment Plant at Monitoring Program Station PAN-3 shall not exceed the following Effluent quality limits:

Parameter	Maximum Concentration of any Grab
PH	Between 6 and 9
BOD_5	120 mg/L
Total Suspended Solids	180mg/L
Faecal Coliforms	1×10^3 CFU/100mL
Oil and grease	No visible sheen

3. The Sewage Disposal Facility shall be maintained and operated, to the satisfaction of an Inspector in such a manner as to prevent structural failure.

4. The Licensee shall dispose of and contain all Solid Wastes at the Solid Waste Disposal Facility or as otherwise approved by the Board in writing.

5. The Licensee shall segregate and store all hazardous materials and/or hazardous waste within the Solid Waste Disposal Facility in a manner as to prevent the deposit of deleterious substances into any water until such a time as proper disposal arrangements are made.

6. The Licensee shall segregate and store all metals/vehicles within the Metal Storage Area in a manner as to prevent the deposit of deleterious substances into any water until such a time as proper disposal arrangements are made.

7. The Licensee shall dispose of and contain all fish processing wastes at the Solid Waste Disposal Facility, in a pit excavated below the active layer-permafrost interface. Fish wastes deposited at the Solid Waste Disposal Facility shall be treated with lime, and covered with soil prior to the onset of the annual spring freshet and then weekly thereafter during June, July, August and September.

9. The Licensee shall implement measures to prevent hazardous materials and/or leachate from the Solid Waste Disposal Facility and Metal Storage Area from entering water.

10. The Licensee shall implement measures to control wind-blown litter at the Solid Waste Disposal Facility and Metal Storage Area.

11. The Licensee shall implement measures to control surface runoff from the Solid Waste Disposal Facility and Metal Storage Area.

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

1. The Licensee shall submit to the Board for approval, for construction drawings stamped and signed by a qualified Engineer registered in Nunavut, sixty (60) days prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain water or wastes.

2. The Licensee may, without written consent from the Board, carry out Modifications to the Water Supply Facilities and Waste Disposal Facilities provided that such Modifications are consistent with the terms of this Licence and the following requirements are met:

    a. the Licensee has notified the Board in writing of such proposed Modifications at least sixty (60) days prior to beginning the Modifications;
    b. such Modifications do not place the Licensee in contravention of the Licence or the *Act*;
    c. the Board has not, during the sixty (60) days following notification of the proposed Modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and
    d. the Board has not rejected the proposed Modifications.

3. The Modifications for which all of the conditions referred to in Part E, Item 2(a) through (d), have not been met, may only be carried out upon written approval from the Board.

4. The Licensee shall, within ninety (90) days of completion of Modification or Construction of facilities and/or infrastructure associated with the project, submit to the Board a Construction Summary Report along with stamped as-built plans and drawings, providing explanation to reflect any deviations from for construction drawings taking into account construction and field decisions and how they may affect the performance of engineered facilities.

5. All activities shall be conducted in such a way as to minimize impacts on surface drainage and the Licensee shall immediately undertake any corrective measures in the event of any impacts on surface drainage.

6. The Licensee shall implement and maintain sediment and erosion control measures prior to and during activities carried out under this Part, to prevent impacts to water resulting from the release of sediment and to minimize erosion.

7. With respect to earthworks, the deposition of debris or sediment into or onto any water body is prohibited. These materials shall be disposed a distance of at least thirty-one (31) metres from the ordinary High Water Mark in such a fashion that they do not enter the water.

8. The Licensee shall use material that is free of contaminants for construction, operation, and maintenance activities and that is obtained from approved sources and has been demonstrated not to be potentially acid generating and metal leaching.

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

1. The Licensee shall submit to the Board approval, within the 2014 Annual Report, the following revised Operation Plans in accordance with the *"Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories; 1996"*, to take into consideration at a minimum, comments received during the Application review process and any operational changes/upgrades of facilities:

    a. Water Supply Facilities Operation and Maintenance Plan;
    b. Waste Water Treatment Plant Operation and Maintenance Plan;
    c. Solid Waste Disposal Facility Operation and Maintenance Plan.

2. The Licensee shall submit to the Board for approval, within the 2014 Annual Report, a stand-alone Spill Contingency Plan that details spill responses and procedures for Water Supply, Sewage Disposal and Solid Waste Disposal Facilities Operations, in the format set out by the Consolidation of Spill Contingency Planning and Reporting Regulations R-068-93.

3. If the Plans referred to in Part F, Items 1 and 2 are not approved the Licensee shall make the necessary revisions and resubmit the Plan(s) within thirty (30) days following notification from the Board.

4. The Licensee shall implement the Plans specified in Part F, Item 1 and 2 as and when approved by the Board.

5. An inspection of all engineered facilities related to the management of water and waste shall be carried out by an Engineer (Civil, Municipal or Geotechnical) annually and before commissioning any facility. The Engineer's report shall be submitted to the Board within sixty (60) days of the inspection, including a Cover Letter from the Licensee outlining an implementation plan addressing each of the Engineer's recommendations.

6. The Licensee shall perform more frequent inspections of the engineered facilities at the request of an Inspector.

7. The Licensee shall review the Plans referred to in this Part as required by changes in operation and/or technology and modify the Plan accordingly. Revisions to the Plan are to be submitted in the form of an Addendum to be included with the Annual Report, unless directed otherwise by an Inspector.

8. If, during the period of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:

a. employ the appropriately approved Spill Contingency Plan for the Hamlet of Pangnirtung. Take whatever steps are immediately practicable to protect human life, health and the environment;
b. report the incident immediately via the 24-Hour Spill Reporting Line at (867) 920-8130 and to the AANDC Manager of Field Operations at (867) 975-4295; and
c. submit to the Inspector, a detailed report on each occurrence, not later than thirty (30) days after initially reporting the event, that provides the necessary information on the location (including the GPS coordinates), initial response action, remediation/clean-up, status of response (ongoing, complete), proposed disposal options for dealing with contaminated materials and any preventative measures to be implemented.

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

1. The Licensee shall submit to the Board for approval, an Abandonment and Restoration Plan at least six (6) months prior to abandoning any facilities or the construction of new facilities to replace existing ones. Where applicable, the Plan shall include information on the following:

   a. water intake facilities;
   b. the water treatment and waste disposal sites and facilities;
   c. solid waste facility;
   d. metal storage area;
   d. petroleum and chemical storage areas;
   e. any site affected by waste spills;
   f. leachate prevention;
   g. an implementation schedule;
   h. maps delineating all disturbed areas, and site facilities;
   i. consideration of altered drainage patterns;
   j. type and source of cover materials;
   k. future area use;
   l. hazardous wastes; and
   m. a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

2. If the Plan referred to in Part G, Item 1 is not approved, the Licensee shall make the necessary revisions and resubmit the Plan within thirty (30) days following notification from the Board.

3. The Licensee shall implement the plan specified in Part G, Item 1 as and when approved by the Board.

4. The Licensee shall complete all restoration work within the time schedule specified in the Plan, or as subsequently revised and approved by the Board.

5. Areas that have been contaminated by hydrocarbons shall be reclaimed to meet objectives as outlined in the Government of Nunavut's Environmental Guideline for Site Remediation, January 2002. The use of reclaimed soils for the purpose of back fill or general site grading may be carried out only upon consultation and approval by the Government of Nunavut, Department of Environment and an Inspector.

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

1. The Licensee shall maintain Monitoring Program Stations at the following locations:

Monitoring Program Station Number	Description	Status
PAN-1	Raw Water supply intake at the Duval River	Active (Volume)
PAN-2	Raw Sewage from pump-out truck	New (Volume)
PAN-3	Effluent from Waste Water Treatment Facility	Active (Quality)
PAN-4	Run-off from Sludge Disposal Area	Active (Quality)
PAN-5	Run-off from the Solid Waste Disposal Facility	Active (Quality)
PAN-6	Run-off from Metals Storage Area	New (Quality)

2. The Licensee shall measure and record in cubic metres, the daily, monthly and annual quantities of water pumped at Monitoring Program Stations PAN-1 and at the Truck-fill Station, for all purposes.
3. The Licensee shall measure and record in cubic metres the daily, monthly and annual quantities of raw sewage offloaded from trucks at Monitoring Program Station PAN-2 for all purposes.

4. The Licensee shall sample at Monitoring Program Station PAN-3 monthly during operation and discharge of Effluent. Samples shall be analyzed for the following parameters:

Biochemical Oxygen Demand - BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Oil and Grease (visual)
Nitrate-Nitrite	Ammonia Nitrogen
Chloride	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Hardness	Total Alkalinity
Total Phenols	Total Manganese
Total Arsenic	Total Aluminum
Total Cadmium	Total Cobalt
Total Copper	Total Chromium

Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	Total Organic Carbon - TOC

5. The Licensee shall sample at Monitoring Program Stations PAN-4, PAN-5 and PAN-6 once at the beginning, middle and near the end of discharge/run-off observed. Samples shall be analyzed for the parameters listed in Part H, Item 4:

6. The Licensee shall measure and record the annual quantities of sewage solids removed from the Waste Water Treatment Plant along with the treatment/storage/disposal provided.

7. Additional monitoring stations, sampling and analysis may be requested by an Inspector.

8. The Licensee shall submit to the Board for review, within the 2014 Annual Report, a Quality Assurance/Quality Control Plan that conforms to the guidance document *Quality Assurance (QA) and Quality Control (QC) Guidelines For Use by Class "B" Licensees in Collecting Representative Water Samples in the Field and for Submission of a QAQC Plan* INAC (1996). The Plan shall be acceptable to an accredited laboratory and include a covering letter from the accredited laboratory confirming acceptance of the Plan for analyses to be performed under the Licence.

9. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board in writing.

10. All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.

11. The Licensee shall include all of the data and information required by the Monitoring Program in the Licensee's Annual Report, as required per Part B, Item 1 or as otherwise requested by an Inspector.

12. Modifications to the Monitoring Program including the Monitoring Program Stations and parameters may be made only upon written approval of the Board.

13. The Licensee shall submit to the Board for review and approval, within six (6) months of the issuance of this licence, a report identifying any additional Final Discharge Point from the Waste Water Treatment Plant. The report shall include at a minimum:

    a. Plans, specifications, geographic coordinates and a general description of each Final Discharge Point and direction of flow;
    b. A description of how each Final Discharge Point is designed and maintained, if required; and
    c. A description of the receiving environment.

Appendix B:
Summary of Sample Bottle Requirements

Individual Parameters for Water Analysis

Parameter	Sample Containers		Minimum	Preservative	Storage	Holding Times	
	Size mL)	Type	Volume (mL)		Conditions	Caduceon	MOE
GENERAL CHEMISTRY, PHYSICAL PROPERTIES							
Alkalinity	500	P	50	None	1	7d	7d
Ammonia (NH3)	125	P or G	50	pH <2 H2SO4/None	1	28d/3d	10d
Anions (Br, F,Cl, NO2, NO3, SO4)	500	P	50	None	1	7d/28d	7d/28d
BOD5/CBOD5	500	P	300	None	1	4d	4d
Conductivity	500	P	100	None	1	4d	4d
Hardness	250	P	100	pH<2 HNO3	2	28d	28d
Mercury	250	P,G	100	Field filter K2Cr2O7 + HNO3	2	7d	14d, 7d(MISA)
Metals- except Mercury	250	P	100	pH<2 HNO3	2	60d	60d
Organic Carbon, Total (TOC)	40	G or P	40	pH<2 H2SO4	1	28d	-
pH	500	P	100	None	1	4d	4d/asap(MISA)
Phenolics (4-aap) *	60,125, 250	AG	50	pH<2 H2SO4	1	28d	30d(MISA)
Solids (TS,TSS,TDS,VS,VSS)	500	P	500	None	1	7d	7d(MISA)-
MICROBIOLOGICAL							
Microbiological	300, 250	SP	100 (per test)	None, Na2S2O3(chlorinated)	1	48h	48h/24h(MISA)

Sample Container Codes:

P = Plastic, either HDPE or PETE

G = Glass, GV = Glass Vial

AG = Amber Glass, AGV = Amber Glass Vial,

SP = Sterile Plastic

* Teflon-lined phenate free cap

Storage Conditions Codes:

1 = 4 ± 3°C

2 = Room Temperature (if preserved)

d = days

m = months

Imm = Immediate

Holding times are summarized for convenience purposes and are to be used only as a guide. Holding times may differ depending on required protocol. Please consult the official regulations to ensure the appropriate holding times are followed.

Appendix C:
Completed Example of Chain of Custody Documentation

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ENVIRONMENTAL LABORATORIES
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- [ ] O.Reg 153/04 (1___ 2___ 3___ 4___ 5___ 6___)
- [ ] MISA Guidelines
- [ ] Provincial Water Quality Objectives
- [ ] Sewer Use By-Law: _____
- [ ] ODWS (Non Regulatory)
- [ ] O.Reg 558 Leachate Analysis
- Disposal Site: _____
- [x] Other: CCME

Turnaround Time Requested

Rush 24 Hr	[ ] 100% Surcharge
Rush 48 Hr	[ ] 50% Surcharge
Rush 72 Hr	[ ] 25% Surcharge
5-7 Day	[x] Standard
Specific Date:	

Organization: Hamlet of Pangnirtung
Contact: Billy Qaqasiq
Tel: 867-473-8951
Fax: 867-473-8832
Email: pang_stp@qiniq.com

Address and Invoicing Address (if different): P.O. Box 253, Pangnirtung, NU X0A 0R0

Quote No.:
Project Name:
P.O. No.:
Additional Info: Waybill No. _____

ANALYSES REQUESTED (Print Test in Boxes)

BOD; Faecal Coliforms; pH, Conductivity; TSS; Nitrate-Nitrite; Ammonia-N; Total Metals, Hg; Anions-Cl, SO_4; Na, K, Ca, Mg; Phenols; Alkalinity; Hardness; TOC

REPORT NUMBER:

Lab No.	Sample Identification	Sample Matrix *	Date Collected (yy-mm-dd)	Time Collected	Indicate Test For Each Sample By Using A Check Mark In The Box Provided	Field pH	Field Temp.	# Bottles/ Sample	Field Filtered(Y/N)
	PAN-3	WW	14-12-23	9:00	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	-	-	6	N

Sample Submission Information

Sampled By (print): Billy Qaqasiq
Submitted By (print): Billy Qaqasiq
Signature: ←
Date(yy-mm-dd): 14-12-23 Time: 10:00

Shipping Information

- [x] Courier (Client account)
- [ ] Courier (Caduceon account)
- [ ] Drop Off
- [ ] Caduceon (Pick-up)

Reporting and Invoicing

- Invoice for Shipping: [ ]
- # of Pieces: 1
- [ ] Fax Results
- [x] Email Results
- [x] Invoice by Email
- [ ] Invoice by Mail

LABORATORY USE ONLY

Received By (print): Signature:
Date(yy-mm-dd) Received: Time Received:
Comments: Laboratory Prepared Bottles: [ ] YES [ ] NO

Page 1 of 1

* Sample Matrix Legend: WW=Waste Water SW=Surface Water GW=Groundwater LS=Liquid Sludge SS=Solid Sludge S=Soil Sed=Sediment PC=Paint Chips F=Filter

Laboratory Locations/Shipping Addresses

Kingston Lab - 285 Dalton Ave., Kingston, ON K7K 6Z1, Tel: (613) 544-2001 Fax: (613) 544-2770 Email: contactkingston@caduceonlabs.com
Ottawa Lab - 2378 Holly Lane, Ottawa, ON K1V 7P1, Tel: (613) 526-0123 Fax: (613) 526-1244 Email: contactottawa@caduceonlabs.com
Peterborough Lab - #206-160 Charlotte St., Peterborough, ON K9J 2T8, Tel: (705) 748-1506 Fax: (705) 748-6514 Email: contactpeterborough@caduceonlabs.com
Windsor Lab - #5-3201 Marentette Ave., Windsor, ON N8X 4G3, Tel: (519) 966-9541 Fax: (519) 966-9567 Email: contactwindsor@caduceonlabs.com
Moncton Lab - 150 Lutz St., Moncton, NB E1C 5E9, Tel: (506) 855-6472 Fax: (506) 855-8294 Email: contactmoncton@caduceonlabs.com

C 15192

White: Lab Copy / Yellow: Invoicing Copy / Pink: Client Copy

CofC., Jan 2009, Revision No: 10

Appendix D:
Subcontract Laboratory Accreditation

CALA
Canadian Association for Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 2644
Laboratory Name: Caduceon Environmental Laboratories (Ottawa)
Parent Institution: Caduceon Enterprises Inc.
Address: 2378 Holly Lane Ottawa ON K1V 7P1
Contact: Mr. Greg Clarkin
Phone: (613) 526-0123
Fax: (613) 526-1244
Email: gclarkin@caduceonlabs.com

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served:
Revised On: December 16, 2014
Valid To: October 25, 2015

Scope of Accreditation

Air (Inorganic)
Metals - Air Filter (012)
D-ICP-02; modified from APHA 3120 B
- ICP - DIGESTION
- Cadmium
- Copper
- Lead
- Zinc

Air (Inorganic)
Total Suspended Particulates - Air Filter (018)
A-TSP-01; modified from MOEE E3288A
- GRAVIMETRIC
- Total Suspended Particulates

Dustfall
Total/Insoluble Dustfall - Dustfall (020)
A-DF-01; modified from MOEE DF-E3043A
- FILTRATION - GRAVIMETRIC
- Insoluble Dustfall
- Total Dustfall

Fluoride Candles
Fluoride - Candles (019)
A-FISE-01; modified from MOEE FSIE-1983D
- DIGESTION - ISE
- Fluoride

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Solids (Inorganic)
Anions - Soils, Biosolids (069)
A-IC-01; modified from APHA 4110 C
ION CHROMATOGRAPHY - EXTRACTION
Chloride
Nitrate
Nitrite
Sulphate

Solids (Inorganic)
Boron (Hot Water Soluble) - Soil (098)
D-ICP-02; MOE-LSB E3470
ICP/AES - EXTRACTION
Boron

Solids (Inorganic)
Conductivity - Soil, Sediments (099)
A-COND-03; modified from SM 2510 B & MOE-LSB E 3138
CONDUCTIVITY METER - EXTRACTION
Conductivity

Solids (Inorganic)
Extractable Anions - Leachate (090)
A-IC-01; modified from EPA 1311, APHA 4110-C
ION CHROMATOGRAPHY - TCLP
Nitrate
Nitrite

Solids (Inorganic)
Extractable Metals - Leachate (091)
D-ICP-01; modified from EPA 1311/APHA 3120 B
ICP/AES - TCLP
Arsenic
Barium
Beryllium ((Parameter suspended on 11/17/2014))
Boron
Cadmium
Chromium
Lead
Nickel ((Parameter suspended on 11/17/2014))
Silver
Zinc ((Parameter suspended on 11/17/2014))

Solids (Inorganic)
Extractable Metals - Leachate (092)
D-ICPMS-01; modified from EPA 1311/EPA 200.8
ICP/MS - TCLP
Antimony ((Parameter suspended on 11/17/2014))
Arsenic
Selenium
Uranium

Solids (Inorganic)
Extractable Metals - Leachate (093)
D-HG-02; modified from EPA 1311/SM 3112 B
COLD VAPOUR AA - TCLP
Mercury

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Solids (Inorganic)
Flash Point - Soil, Solid Waste (096)
C-FPCC-01; modified FROM ASTM D93
CLOSED CUP FLASH POINT TESTER
Flashpoint

Solids (Inorganic)
Hexavalent Chromium - Soil (094)
D-CRVI-02; modified from EPA 3060A EPA 7196 A
COLORIMETRIC - MANUAL
Chromium (VI)

Solids (Inorganic)
Mercury - Soil, Solid Biosolids (017)
D-HG-01; modified from EPA 7471A
COLD VAPOUR AA - DIGESTION
Mercury

Solids (Inorganic)
Metals - Soil, Solid Biosolids (015)
D-ICP-02; modified from EPA 6010
ICP/OES - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Silver
Sodium
Strontium
Tin
Titanium
Tungsten
Vanadium
Zinc

Solids (Inorganic)
pH - Soil, Sediment, Solid Sludge (100)
A-pH-03; modified from SM 4500 H & MOE-LSB E3137
pH METER - EXTRACTION
pH

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Solids (Inorganic)
Total Metals - Soils, Biosolids (070)
D-ICPMS-01; modified from EPA 6020
ICP/MS - DIGESTION
Antimony
Arsenic
Selenium
Silver
Thallium
Uranium

Solids (Organic)
Extractable Volatile Organic Compounds (VOC) - Leachate (089)
C-VOC-01; modified from EPA SW-846 METHOD 1311, 5030/8260
GC/MS - PURGE AND TRAP - TCLP
1,1-Dichloroethylene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,4-Dichlorobenzene
Benzene
Carbon tetrachloride
Chlorobenzene
Chloroform
Dichloromethane
Methyl ethyl ketone
Tetrachloroethylene
Trichloroethylene
Vinyl chloride

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Soil (075)
C-PHCS-01; CCME CWS REF. METHOD & MOE E3398
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Soil (097)
C-PHCS-01; CCME CWS REF. METHOD & MOE E3398
GRAVIMETRIC
F4: Gravimetric

Solids (Organic)
Volatile Organic Compounds (VOC) - Soil (063)
C-VOC-02; modified from EPA 8260
GC/MS - PURGE AND TRAP
1,1 - Dichloropropene
1,1-Dichloroethane
1,1-dichloroethylene
1,1,1-Trichloroethane
1,1,1,2 - Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2 - Dibromo - 3 - chloropropane
1,2-dichlorobenzene
1,2-dichloroethane

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1,2-Dichloropropane
1,2,3 - Trichlorobenzene
1,2,3 - Trichloropropane
1,2,4 - Trichlorobenzene
1,2,4 - Trimethylbenzene
1,3 - Dichloropropane
1,3-Dichlorobenzene
1,3,5 -Trimethylbenzene
1,4-dichlorobenzene
2 - Chlorotoluene
2 - Hexanone (MBK)
2,2 - Dichloropropane
4 - Chlorotoluene
Acetone (2-Propanone)
Benzene
Bromobenzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dibromomethane
Dichlorodifluoromethane
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Hexachlorobutadiene
Hexane
Isopropylbenzene
Isopropyltoluene
m/p-xylene
Methyl Ethyl Ketone
Methyl isobutyl Ketone
Methyl t-butyl ether
n - Butylbenzene
Naphthalene
o-xylene
Propylbenzene
sec - Butylbenzene
Styrene
tert - Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

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Vinyl Chloride

Solids (Organic)
Volatile Petroleum Hydrocarbons (VPH) - Soil (073)
C-GRO-01; CCME CWS REF. METHOD & MOE E3398
GC/FID - PURGE AND TRAP
F1: C6-C10

Water (Inorganic) OSDWA †
Alkalinity - Water (088)
A-ALK-03; modified from APHA 2320 B
AUTO TITRIMETRIC
Alkalinity (pH 4.5)

Water (Inorganic) OSDWA †
Ammonia - Water, Wastewater, Liquid Biosolids (055)
A-NH3-01; modified from MOEE RNDNP-E3364, SDNP-E3366
AUTO COLOR
Ammonia
Ammonia - Nitrogen

Water (Inorganic) OSDWA †
Anions - Water, Wastewater, Liquid Biosolids (002)
A-IC-01; modified from APHA 4110 C
ION CHROMATOGRAPHY
Bromide
Chloride
Fluoride
Nitrate
Nitrite
Sulfate

Water (Inorganic) OSDWA †
Biochemical Oxygen Demand (BOD) - Water (008)
C-BOD-01; modified from APHA 5210 B
D.O. METER
BOD (5 day)
CBOD (5 day)

Water (Inorganic) OSDWA †
Carbon - Water (054)
C-OC-01; modified from APHA 5310C, EPA 415.1
IR-UV-PERSULFATE
Organic Carbon

Water (Inorganic) OSDWA †
Chemical Oxygen Demand (COD) - Water (083)
C-COD-01; modified from APHA 5220 D
COLORIMETRIC
COD

Water (Inorganic) OSDWA †
Colour - Water (027)
A-COL-01; modified from APHA 2120 C
SPECTROPHOTOMETRIC
True Colour

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Water (Inorganic) OSDWA †
Conductivity - Water (003)
A-COND-01; modified from APHA 2510 B
CONDUCTIVITY METER
Conductivity (25°C)

Water (Inorganic) OSDWA †
Conductivity - Water (087)
A-COND-02; modified from APHA 2510 B
AUTO CONDUCTIVITY METER
Conductivity (25°C)

Water (Inorganic) OSDWA †
Dissolved and Extractable Metals - Water (004)
D-ICP-01; modified from APHA 3120 B
ICP
Aluminum
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Silicon
Silver
Sodium
Strontium
Tin
Titanium
Tungsten
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic) OSDWA †
Dissolved Metals - Water (Camelot) (049)
D-ICPMS-01; modified from EPA 200.8
ICP/MS
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium

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Cobalt
Copper
Lead
Molybdenum
Selenium
Silver
Thallium
Uranium
Vanadium

Water (Inorganic)
Hexavalent Chromium - Water (095)
D-CRVI-01; modified from MOE - HEXCR-E3056
COLORIMETRIC - MANUAL
Chromium (VI)

Water (Inorganic) OSDWA †
Mercury - Water, Wastewater (025)
D-HG-02; modified from APHA 3112 B
COLD VAPOUR AA - DIGESTION
Mercury

Water (Inorganic)
Nitrate + Nitrite - Water (102)
A-NO23-01; modified from SM 4500-NO3-F
COLORIMETRIC - DISCRETE
Nitrate plus Nitrite

Water (Inorganic)
Nitrite - Water (101)
A-NO2-01; modified from SM 4500-NO2-B
COLORIMETRIC - DISCRETE
Nitrite

Water (Inorganic) OSDWA †
Nitrogen - Water, Wastewater, Liquid Biosolids (033)
A-TKN-01; modified from MOEE RTNP-E3367
AUTO COLOR - DIGESTION
Total Kjeldahl Nitrogen

Water (Inorganic)
Orthophosphate - Water (104)
A-PO4-01; modified from MOEE RNDNP-E3364, SDNP-E3366
COLORIMETRIC - DISCRETE
Phosphate

Water (Inorganic) OSDWA †
pH - Water (005)
A-pH-01; modified from APHA 4500 H
pH METER
pH

Water (Inorganic) OSDWA †
pH - Water (086)
A-pH-02; modified from APHA 4500H+ B
AUTO - pH METER
pH

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Water (Inorganic) OSDWA †
Phenols - Water (056)
C-PHEN-01; modified from MOE ROPHEN-E3179
AUTO, 4-AAP
Total Phenolics

Water (Inorganic) OSDWA †
Phosphate - Water (058)
A-PO4-01; modified from MOEE RNDNP-E3364, SDNP-E3366
AUTO COLOR
Phosphate

Water (Inorganic)
Total Metals - Water, Wastewater, Liquid Biosolids (067)
D-ICP-01; modified from APHA 3120 B
ICP/AES - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Silver
Sodium
Strontium
Tin
Titanium
Tungsten
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Total Metals - Water, Wastewater, Liquid Biosolids (071)
D-ICPMS-01; modified from EPA 6020
ICP/MS - DIGESTION
Antimony
Arsenic
Barium
Beryllium
Cadmium

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Chromium
Cobalt
Copper
Lead
Molybdenum
Selenium
Silver
Vanadium

Water (Inorganic) OSDWA †
Total Phosphorus - Water, Wastewater, Liquid Biosolids (057)
A-TP-01; modified from MOEE RTNP-E3367
AUTO COLOR - DIGESTION
Total Phosphorus

Water (Inorganic) OSDWA †
Total Suspended Solids (TSS) - Water (009)
A-TSS-01; modified from APHA 2540 D
GRAVIMETRIC
Total Suspended Solids

Water (Inorganic) OSDWA †
Turbidity - Water (026)
A-TURB-01; modified from APHA 2130 B
NEPHELOMETRY
Turbidity

Water (Microbiology) OSDWA †
Coliforms - Water (050)
B-ECTC-01; modified from MICROMFDC-E3407
MEMBRANE FILTRATION (DC)
Background Bacteria
Escherichia coli (E. coli)
Total Coliforms

Water (Microbiology) OSDWA †
Escherichia coli (E. coli) - Water (010)
B-MFEC-01; modified from MFMICRO-E3371
MEMBRANE FILTRATION (EC)
Escherichia coli (E. coli)

Water (Microbiology) OSDWA †
Fecal (Thermotolerant) Coliforms - Water (065)
B-MFFC-01; modified from MFMICRO-E3371
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology) OSDWA †
Heterotrophic Plate Count (HPC) - Water (021)
B-HPC-01; modified from APHA 9215 C
SPREAD PLATE
Heterotrophic Plate Count (HPC)

Water (Microbiology) OSDWA †
Total Coliforms - Water (066)
B-MFTC-01; modified from MFMICRO-E3371
MEMBRANE FILTRATION (mENDO)
Background Counts
Total Coliforms

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Water (Organic) OSDWA †
Glycols - Water (085)
C-GLYCOL-01; modified from EPA 8015 B
DIRECT INJECTION GC-FID
Diethylene Glycol
Ethylene Glycol
Propylene Glycol

Water (Organic) OSDWA †
Petroleum Hydrocarbons (PHC) - Water (072)
C-GROw-02; modified from MOE E3421
GC/FID - PURGE AND TRAP
F1: C6-C10

Water (Organic) OSDWA †
Petroleum Hydrocarbons (PHC) - Water (074)
C-PHCW-02; modified from MOE E3421
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Water (Organic) OSDWA †
Volatile Organic Compounds (VOC) - Water (041)
C-VOC-01; modified from EPA 8260 and 5030
GC/MS - PURGE AND TRAP
1,1-Dichloroethane
1,1-dichloroethylene
1,1-Dichloropropene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane
1,2-dichlorobenzene
1,2-dichloroethane
1,2-Dichloropropane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,3,5-Trimethylbenzene
1,4-dichlorobenzene
2-Chlorotoluene
2-Hexanone (MBK)
2,2-Dichloropropane
4-Chlorotoluene
4-Isopropyl Toluene
Acetone (2-Propanone)
Benzene
Bromobenzene
Bromodichloromethane
Bromoform
Bromomethane

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Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dibromomethane
Dichlorodifluoromethane
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Hexachlorobutadiene
Hexane
Isopropyl Benzene
m/p-xylene
Methyl Ethyl Ketone
Methyl isobutyl Ketone
Methyl t-butyl ether
n-Butylbenzene
n-Propylbenzene
Naphthalene
o-xylene
Sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

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Appendix J – The International System of Units (SI) – Conversion Factors for General Use (NIST Publication 1038)

NIST Special Publication 1038

The International System of Units (SI) – Conversion Factors for General Use

Kenneth Butcher
Linda Crown
Elizabeth J. Gentry
Weights and Measures Division
Technology Services

NIST National Institute of Standards and Technology • Technology Administration • U.S. Department of Commerce

NIST Special Publication 1038

The International System of Units (SI) - Conversion Factors for General Use

Editors:
Kenneth S. Butcher
Linda D. Crown
Elizabeth J. Gentry
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Weights and Measures Division
Technology Services
National Institute of Standards and Technology

May 2006

U.S. Department of Commerce
Carlo M. Gutierrez, Secretary

Technology Administration
Robert Cresanti, Under Secretary of Commerce for Technology

National Institute of Standards and Technology
William Jeffrey, Director

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National Institute of Standards and Technology Special Publications 1038
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FOREWORD

This publication lists the units of the International System of Units (SI), or metric system, recommended for use in trade and commerce and other general uses by the National Institute of Standards and Technology.

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1 SCOPE

In 1988 Congress designated the International System of Units (SI), the metric system, as the preferred system of measurement for use in trade and commerce (15 U.S.C. §205 – 267). This publication provides guidance on the use of the International System of Units (SI) to ensure uniformity with the weights and measures usage in the commercial measurement system and in other applications. Government and industry use metric units for [1]procurements, grants and other business-related activities, for educational information, and for guidance in publications. The practical guidance in this publication may be used for, but is not limited to, the drafting of laws, regulations, contracts, product specifications, purchase orders, and the preparation of public information, reports and brochures, correspondence, statistical tables, databases, and maps. In addition to serving as an authoritative document for the conversion of customary[2] (inch-pound) units to metric, this publication also explains the relationship between metric units and inch-pound units.

2 REFERENCE DOCUMENTS

This publication is based on *National Institute of Standards and Technology (NIST) SP 330 – International System of Units (SI) (2001)(http://physics.nist.gov/Pubs/SP330/contents.html), NIST SP 811 – Guide for the Use of the International System of Units (SI)(1995)(http://physics.nist.gov/Pubs/SP811/cover.html), NIST 814 – Interpretation of the SI for the United States and Metric Conversion Policy for Federal Agencies (1998) (http://ts.nist.gov/ts/htdocs/200/202/pub814.htm),* and the *IEEE/ASTM SI 10™ American National Standard for Use of the International System of Units (SI): The Modern Metric System (2002),* developed by the Institute of Electrical and Electronics Engineers, Inc., and the American Society for Testing and Materials (ASTM) International and other selected publications noted in Section 6

3 DEFINITIONS

3.1 SI Units

Units belonging to the International System of Units (SI), as interpreted or modified for use in the United States by the Secretary of Commerce through the National Institute of Standards and Technology may be used in trade and commerce, procurements, grants and other business-related activities, in educational information, and as guidance in publications to increase understanding of the metric system.

3.2 Inch-Pound Units

Units based upon the inch, pound, and gallon were historically derived from the English system and subsequently were re-defined as multiples of SI Units in U.S. law beginning in 1893. For example, the inch is defined as the length corresponding to 2.54 centimeters (exactly); and the gallon is defined as the volume corresponding to 3.785412 liters; in other words, the inch-pound (customary) units are based on the SI units and multiplication or division is used to convert units from one system to another.

For example, since the inch was defined as the length corresponding to 2.54 centimeters, in order to convert inches to centimeters multiply the value to be converted by 2.54. An extensive set of conversion factors between the two systems of units is listed in Section 5. In this document, the term inch-pound unit includes the degree Fahrenheit. Some inch-pound units, such as the gallon, have the same name as units previously used in other countries but differ in magnitude. When the term gallon is used, it means a U.S. gallon of 128 fluid ounces (231 cubic inches).

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[1] Vol. 63 F.R. No. 144; Page 40334, July 28, 1998, reprinted in NIST SP 814

[2] Throughout this document the terms **customary** and **inch-pound** units will be used interchangeably.

4 GENERAL REQUIREMENTS

4.1 Preferred SI (metric) Units

The SI units preferred for use are the units (together with their multiples and submultiples).

4.1.1 SI Base Units

The SI is constructed from seven base units, which are adequate to describe most of the measurements used in science, industry and commerce.

Quantity	Unit Name	Symbol
length	meter	m
mass[3]	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Table 1. The SI Base Units.

4.1.2 SI Derived Units

Derived units are formed for convenience of notation and are mainly used by various branches of science. They are obtained by combining base units and other derived units algebraically. The symbols for derived units are obtained by means of the mathematical signs for multiplication, division, and use of exponents. For example, the SI unit for velocity is the *meter per second* (m/s or $m \cdot s^{-1}$), and that for angular velocity is the *radian per second* (rad/s or $rad \cdot s^{-1}$). Some derived SI units have special names and symbols. Almost all physical measurements of science, industry and trade can be expressed in terms of these units or other combinations. For convenience, however, other units can be derived from these, such as the hectare (ha) for an area of land or the liter (L or l) for volume, plus others (with symbols of their own) such as pressure (pascal) or electric resistance (ohm).

4.1.3 SI Prefixes

The units often have **prefixes**, indicating the power(s) of 10 by which a unit may be multiplied (for example, the prefix kilo in kilometer indicates that the unit kilometer is 1000 times larger than the meter). They are attached to an SI unit name or symbol to form what are properly called "multiples" and "submultiples" (i.e., positive or negative powers of 10) of the SI unit. These prefixes are helpful when referring to very small or very large quantities. Instead of creating a new unit, a prefix is added. For example, when measuring short lengths such as 1/1000th of a meter, we simply write **milli**meter; milli denotes 1/1000 th**.**

[3] In commercial and everyday use, and in many technical fields, the term “weight” is usually used as a synonym for mass. This is how “weight” is used in most United States laws and regulations. See the note in section 5.2.1 for further explanation.

The common metric prefixes are:

Multiplication Factor	Prefix Name	Prefix Symbol
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deka	da
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
This table shows the common prefixes. Others, from 10^{-24} to 10^{24} are acceptable for use of the SI. See NIST SP 330.		

Table 2. SI Prefixes.

Prefixes produce units that are of an appropriate size for the application, e.g., millimeter for measurement of the dimensions of small screws, or kilometer for the measurement of distances on maps. Examples that show reasonable choices of multiples and submultiples for many practical applications are given in Section 5. While all combinations are technically correct, many are not used in practice. The prefixes deci, deka, and hecto are rarely used; prefixes that are multiples or submultiples of 1000 are generally preferred. When the unit name is written in full, the prefix is written in full: megahertz, not Mhertz. When the unit symbol is used, the prefix symbol is used: MHz, not megaHz. Only one prefix should be used in forming a multiple of an SI unit, e.g., μV, not mmV. Prefix symbols for multiples of a million or greater are capitalized, and those for less than a million are written in lower case.

4.1.4 Editorial Style

The names of all SI units begin with a lower case letter except, of course, at the beginning of a sentence or when other grammar rules dictate capitalizing nouns. There is one exception: in "degree Celsius" the term "degree" is lower case but "Celsius" is always capitalized.

SI symbols are always written in lower case except for the liter and those units derived from the name of a person (e.g., W for Watt, Pa for Pascal, etc.).

SI symbols are unique—they are not abbreviations and should not be followed by a period (except at the end of a sentence). Likewise, symbols stand for both the singular and plural of the unit and should not have an "s" added when more than one.

SI units are always written in an upright typeface with a space between the numeric value and the symbol.[4]

SI symbols should not be used in a sentence to indicate the units they represent unless the symbol has a number preceding it (e.g., "the kilometer measures length" not "the km measures length.")

[4] A space is not required between the numeric value and SI symbols which appear in the net quantity of content declarations of packaged goods available in the commercial marketplace. For information on the labeling requirements for packaged goods sold in the commercial marketplace see the Uniform Packaging and Labeling Regulation in National Institute of Standards and Technology Handbook 130 "Uniform Laws and Regulations in the Field of Legal Metrology…" at *http//:www.nist.gov/metric* on the Internet.

4.2 Accepted Units

For practical reasons a number of non-metric units are accepted for use. These include units of time (minute, hour, etc.), units of plane angle (degree, etc.), and a few units for special applications, such as the nautical mile, used in navigation. Section 5 includes accepted units and shows their areas of application. These units may be used in full compliance with the provisions of the Metric Conversion Law (15 U.S.C. 205(a)), Executive Order 12770, and the Federal Register Notice, "Metric System of Measurement; Interpretation of the International System of Units for the United States" (63 F.R. 40334, July 28, 1998)[5].

4.3 Unacceptable Metric Units

Many older metric practices are no longer acceptable. Particular care shall be taken to avoid introducing non-SI practices into the United States in areas where such practices are not now established. The units listed in the subsections 4.3.1 and 4.3.2 shall not be used.

4.3.1 Centimeter-Gram-Second (CGS) Units

Units with special names peculiar to the various CGS metric systems shall not be used. Conversion factors are provided for some of these units to assist the users of this document in converting those values to SI units. Among these units are the following that have been commonly used:

CGS Units that Shall Not be Used	Typical Applications
erg, dyne, gal	used in mechanics
poise, stokes	used in fluid dynamics
stilb, phot, lambert	used in photometry
emu, esu, gauss, oersted, maxwell, gilbert, biot, franklin, abampere, abvolt, statvolt, etc.	used in electricity and magnetism

Table 3. CGS Units Not to be Used.

4.3.2 Deprecated Names or Symbols

Other units from older versions of the metric system, some terms not recommended for continued use, and jargon that shall not be used include:

Deprecated Term or Symbol	Correct Unit
kilo	kilogram
calorie	joule (J), if the value is used in physics kilojoule (kJ), if the value is used in nutrition
candle or candlepower	candela
centiliter	milliliter or liter
fermi	femtometer
gamma	nanotesla
micron	micrometer
millimicron	nanometer
mho	siemens
γ (gamma)	microgram
λ (lambda)	cubic millimeter or microliter

Table 4. Deprecated Names and Symbols.

[5] See NIST Special Publication 814, 1998 edition.

4.3.3 Miscellaneous Non-SI Units Not to be Used

Additional units that are not accepted for use include the following:

ångström
g_n as a unit of acceleration (g_n= 9.806 65 ms^{-2})[6]
grade or gon [1 grade = (π /200) rad]
kilogram-force
langley (1 langley = 1 cal/cm^2)
metric carat (use carat, which is 200 mg)
metric horsepower
millimeter of mercury
millimeter, centimeter, or meter of water
standard atmosphere (101.325 kPa)
technical atmosphere (98.0665 kPa)
torr (133.322 Pa)

Table 5. Non-SI Units Not to be Used.

4.4 Conversion

Conversion is a multi-step process that involves multiplication or division by a numerical factor, selection of the correct number of significant digits[7], and rounding. The following sections are intended as a guide through this multi-step process.

Conversion factors in Section 5 are shown from inch-pound units to SI units, generally to seven significant digits. The first column, labeled **To Convert From**, lists inch-pound and other units commonly used to express the quantities; the second column, labeled **To**, gives SI units or other preferred units; and the third column, labeled **Multiply By**, gives the conversion factor by which the numerical value in **To Convert From** units must be multiplied to obtain the numerical value in **To** units.

If the inch-pound value is expressed by a combination of units such as feet and inches, or pounds and ounces, it should first be converted to the smaller unit.

Examples: 12 feet 5 inches = 149 inches
1 pound 3-1/2 ounces = 19.5 ounces

For conversion from inch-pound units to SI units, multiply by the factor given in Section 5. For example, to convert 10.1 feet to meters multiple by 0.3048:

10.1 feet x 0.3048 = 3.07848 m

At this point it is good practice to keep all of the digits, especially if other mathematical operations or conversions will follow. Rounding should be the last step of the conversion process and should be performed only once.

---

[6] The acceleration due to gravity is a variable quantity rather than a unit. It may be used in multiples to express accelerations, such as 2.7*g*. It should be presented without a space between the coefficient and the quantity symbol, with the quantity symbol in slanted or italic type, and with no plural indications made by adding an "s." The value used in each document should be specified, even if the standard value g_n = 9.806 65 ms^{-2} is used.

[7] The number of significant digits is the number of digits used to express a number. One or more leading zeroes are not treated as significant, e.g., 00 257.7 has 4 significant digits, and 0.004 92 has 3 significant digits. Trailing zeros located to the right of the decimal point are to be considered significant, however. Zeros with significant digits on each side are also significant. Thus 30.4, 34.0, and 3.40 each have three significant digits but 340 must be taken as having only two significant digits.

4.4.1 Rounding

Before attempting to round a converted number, it is important to establish the purpose of rounding and the application that it will be used in. If the converted values are being used to develop a technical document or a specification, round the converted number to maintain the precision of the measurement using the guidance provided in 4.4.1.1. When the purpose of the rounding is to provide equivalent units for use in general use documents or reports, simple rules of rounding in 4.4.1.2 are recommended. Additional guidance on rounding is available in Annex B of IEEE/ASTM Standard SI 10™ (2002) and NIST Special Publication 811 (1995).

Where an inch-pound unit represents a maximum or minimum limit (e.g., in a law or regulation), the rounding must be done in a direction where the metric value does not violate the original limit by increasing or decreasing it inappropriately. For example, for most applications 10 feet rounds to 3 meters, but if a safety code requires 10 feet of clearance from electrical lines, a converted value of 3.05 meters must be used until studies show that 3 meters of clearance is adequate.

If, however, the purpose of rounding involves a commercially available package, product, or commodity, the most appropriate procedure may be to round the converted value down for the reasons described in 4.4.1.2.

4.4.1.1 Rounding Procedure for Technical Documents or Specifications

The number of significant digits retained must be such that accuracy is neither sacrificed nor exaggerated. The first step of the rounding process is to establish the number of significant digits to be retained. In order to maintain the accuracy of the converted number, the following procedure[8] may be used:

(i) If the **first** significant digit of the converted value is **greater than or equal to** the **first** significant digit of the original value, round the converted value to the **same** number of significant digits as there are in the original value.

Examples: In converting 60.5 miles to kilometers, first multiply the inch-pound value by the conversion factor:

60.5 miles x 1.609347 = **9**7.36549 km

The **first** significant digit of the metric value (9) is **greater than** the **first** significant digit of the inch-pound value (6). Therefore the number of significant digits to be retained in the converted value is the **same** as that for the original value (3), and the result is 97.4 km.

Similarly, in converting 11 miles to kilometers:

11 miles x 1.609347 = **1**7.70281 km

The **first** significant digit of the metric value (1) is **equal to** the **first** significant digit of the inch-pound value (1). Therefore the number of significant digits to be retained in the converted value is the **same** as that for the original value (2), and the result is 18 km.

(ii) If the **first** significant digit of the converted value is **smaller** than the **first** significant digit of the original value, round to **one more** significant digit.

Example: In converting 66 miles to kilometers, first multiply the inch-pound value by the conversion factor:

66 miles x 1.609347 = **1**06.2169 km

The **first** significant digit of the metric value (1) is **smaller** than the **first** significant digit of the inch-pound value (6). Therefore the number of significant digits to be retained in the converted value should be **one more** than that for the original value (3), and the result is 106 km.

[8] Note that this procedure is the same whether converting from inch-pound to SI or from SI to inch-pound units.

Similarly, in converting 8 feet to meters:

8 feet x 0.3048 = **2**.438400 m

The **first** significant digit of the metric value (2) is **smaller** than the **first** significant digit of the inch-pound value (8). Therefore the number of significant digits to be retained in the converted value should be **one** more than that for the original value (2), and the result is 2.4 m.

4.4.1.2 Rounding Practices Used for Packaged Goods in the Commercial Marketplace

Manufacturers of packaged goods sold in the commercial marketplace are required under either federal or state laws to accurately declare the net quantity of contents of their packages. These quantity declarations are based on the accuracy of packaging machinery and take into account unavoidable deviations in the packaging process. Both federal and state regulations allow manufacturers or packagers to round converted values down to avoid overstating the net quantity of contents declared on package labels.[9] When officials verify the accuracy of multiple quantity declarations, they determine which of the declarations represent the largest net quantity and verify the accuracy of that value.

4.4.1.3 Temperature Rounding

Temperature is usually expressed in degrees Fahrenheit as whole numbers and should be converted to the nearest 0.5 degree Celsius. This is because the magnitude of a degree Celsius (ºC) is approximately twice the size of a degree Fahrenheit, and rounding to the nearest Celsius would reduce the precision of the original measurement. As with other quantities, the number of significant digits to retain will depend upon the implied accuracy of the original temperature.

5 DETAILED REQUIREMENTS AND CONVERSION FACTORS

This section gives detailed requirements for the selection of units. The subsections list conversion factors to the appropriately sized metric unit, either an SI unit with appropriate prefix or a non-SI unit that is accepted for use with SI. Government agencies and industry may develop supplemental lists of accepted units applicable to their special fields. Such supplemental lists should be consistent with this document and users should provide their equivalents in SI units unless the quantity being measured cannot be measured in combinations of base or derived SI units (e.g., Rockwell hardness and Richter scale values).

Other "Derived Quantities." It is not practical to list all quantities, but others not listed can be readily derived using the conversion factors given. For example, to convert from inches per second to centimeters per second, multiply by 2.54; to convert from Btu per pound to kilojoules per kilogram, multiply by (1.055 056)/(0.453 592 37) or 2.326 000 3.

Note on Mixed Units and Fractions. Mixed units, which are commonly used with inch-pound units, are not used in metric practice. Thus, while a distance may be given in inch-pound units as 27 feet 5 inches, metric practice shows a length as 3.45 m rather than 3 m, 45 cm. Binary fractions (such as 1/2 or 3/8) are not used with metric units. For example, a person's weight is given as 70.5 kg, not 70-1/2 kg.

The preferred units for various quantities are grouped in subsections as follows: Space and Time, Mechanics, Heat, Electricity and Magnetism, Light, and Radiology.

The tables are presented as follows:

To Convert From	To	Multiply By
Foot	meter (m)	**0.3048**

[9] For a more detailed discussion, refer to NIST Handbook 130 – *Uniform Laws and Regulations in the area of legal metrology …* at *http://www.nist.gov/owm* on the Internet

The first column, labeled **To Convert from**, lists inch-pound and other units commonly used to express the quantities; the second column, labeled **To**, gives SI units or other preferred units; and the third column, labeled **Multiply By**, gives the conversion factors (generally to seven significant digits) by which the numerical value in **To Convert From** units must be multiplied to obtain the numerical value in SI units. Conversion factors, in the **Multiply By** column, that are exact conversion values are noted in **bold** type. To convert values expressed in SI unit to the other unit divide the SI unit by the value in the **Multiply By** column.

The conversion factors are:

Section	To Convert From	To	Multiply By
5.1	**Quantities of Space and Time**		
5.1.1	**Plane angle**[10]		
	Radian	degree arc	57.29578
5.1.2	**Solid angle**[11]		
5.1.3	**Length**		
	angstrom	nanometer (nm)	**0.1**
	Fathom	meter (m)	1.828 804
	foot (ft)	meter (m)	**0.304 8**
	foot [U.S. survey][12]	meter (m)	0.304 800 6
	inch (in)	centimeter (cm)	**2.54**
	inch (in)	millimeter (mm)	**25.4**
	microinch (µin)	micrometer (µm)	**0.025 4**
	mil (0.001 inch)	millimeter (mm)	**0.025 4**
	mil (0.001 inch)	micrometer (µm)	**25.4**
	yard (yd)	meter (m)	**0.914 4**
	mile, international (5280 ft) (mi)	kilometer (km)	1.609 344
	nautical mile[13]	kilometer (km)	**1.852**
	point (printer's)	millimeter (mm)	0.351 46
	pica	millimeter (mm)	4.217 5

[10] No change in inch-pound usage is required for plane angle units. The **radian,** which is the SI unit, is most frequently used in scientific or technical work and in forming derived units. Use of the degree and its decimal fractions is permissible. Use of the minute and second is discouraged except for specialized fields such as cartography

[11] No change in inch-pound usage is required for solid angle units. The **steradian,** which is the only unit commonly used to express solid angle, is an SI unit.

[12] In 1893 the U.S. foot was legally defined as 1200/3937 meters. In 1959 a refinement was made to bring the foot into agreement with the definition used in other countries, i.e., 0.3048 meters. At the same time it was decided that any data in feet derived from and published as a result of geodetic surveys within the U.S. would remain with the old standard, which is named the U.S. survey foot. The new length is shorter by about two parts in a million. The five-digit multipliers given in this standard for acre and acre-foot are correct for either the U.S. survey foot or the foot of 0.304 8 meters exactly. Other lengths, areas, and volumes are based on the foot of 0.304 8 meters.

[13] The nautical mile is an accepted unit for use in navigation.

Section	To Convert From	To	Multiply By
5.1.4	**Area**		
	acre[14]	square meter (m^2)	4 046.873
	acre	hectare[15] (ha)	0.404 687 3
	circular mil	square millimeter (mm^2)	0.000 506 708
	square inch	square centimeter (cm^2)	**6.451 6**
	square inch	square millimeter (mm^2)	**645.16**
	square foot	square meter (m^2)	**0.092 903 04**
	square yard	square meter (m^2)	**0.836 127 36**
	square mile	square kilometer (km^2)	2.589 988
5.1.5	**Volume**		
	acre-foot	cubic meter (m^3)	1 233.489
	barrel, oil[16] (42 U.S. gallons)	cubic meter (m^3)	0.158 987 3
	barrel, oil (42 U.S. gallons)	liter (L)	158.987 3
	cubic yard	cubic meter (m^3)	0.764 555
	cubic foot	cubic meter (m^3)	0.028 316 85
	cubic foot	liter (L)	28.316 85
	board foot	cubic meter (m^3)	0.002 359 737
	register ton[17]	cubic meter (m^3)	2.831 685
	bushel[18]	cubic meter (m^3)	0.035 239 07
	gallon	liter (L)	3.785 412
	quart (liquid)	liter (L)	0.946 352 9
	pint (liquid)	liter (L)	0.473 176 5

[14] Based on U. S. survey foot.

[15] The hectare, equal to 10 000 m^2, is accepted for use with SI.

[16] (i) The liter, equal to 0.001 m^3, is accepted for use with SI. (ii) A variety of barrel sizes have been used for other commodities.

[17] The register ton is a unit of volume used to express the capacity of a ship. For example, a 20 000 ton freighter has a capacity of approximately 57 000 m^3, measured in accordance with established procedures.

[18] Agricultural products that are sold by the bushel in the United States are often sold by weight in other countries. There can be a considerable variation in the weight per unit volume due to differences in variety, size, or condition of the commodity, tightness of pack, degree to which the container is heaped, etc. The following conversion factors are used by the U.S. Department of Agriculture for statistical purposes:

Crop	Weight per bushel (kg)
barley	21.8
corn, shelled	25.4
oats	14.5
potatoes, soybeans, wheat	27.2

Section	To Convert From	To	Multiply By
	fluid ounce[19]	milliliter (mL)	29.573 53
	cubic inch	cubic centimeter (cm^3)	**16.387 064**
5.1.6	**Time[20]**		
5.1.7	**Velocity**		
	foot per second	meter per second (m /s)	**0.304 8**
	mile per hour	kilometer per hour (km/h)	**1.609 344**
	knot[21] (nautical mile per hour)	kilometer per hour (km/h)	**1.852**
5.1.8	**Acceleration**		
	inch per second squared	meter per second squared ($m{\cdot}s^{-2}$)	**0.025 4**
	foot per second squared	meter per second squared ($m{\cdot}s^{-2}$)	**0.304 8**
	standard acceleration of gravity (g_n)	meter per second squared ($m{\cdot}s^{-2}$)	**9.806 65**
5.1.9	**Flow rate**		
	cubic foot per second	cubic meter per second (m^3 /s)	0.028 316 85
	cubic foot per minute	cubic meter per second (m^3 /s)	0.000 471 9474
	cubic foot per minute	liter per second (L/s)	0.471 947 4
	cubic yard per minute	liter per second (L/s)	12.742 58
	gallon per minute	liter per second (L/s)	0.063 090 2
	gallon per day	liter per day (L/d)	3.785 412
5.1.10	**Fuel efficiency**		
	mile per gallon[22]	kilometer per liter (km/L)	0.425 143 7
5.2	**Quantities of Mechanics**		
5.2.1	**Mass (weight[23])**		
	ton (long)[24] (2240 lb)	kilogram (kg)	1 016.047
	ton (long)	metric ton (t)	1.016 047

[19] In the United States, the cup, tablespoon, and teaspoon are defined as 8, 1/2, and 1/6 fluid ounces, respectively. For practical usage the metric equivalents are 250 mL, 15 mL, and 5 mL.

[20] No change in inch-pound U.S. usage is required for time units. The **second** is the SI unit of time, but the minute and hour, as well as the day, week, year, etc., are accepted units.

[21] The knot, or nautical mile per hour, is an accepted unit for use in navigation.

[22] Fuel **consumption** (e.g., liter/kilometer) is the reciprocal of fuel **efficiency**. Thus, 20 mile/gallon fuel **efficiency** is equal to 20(0.42514)=8.503 km/L, which is equivalent to a fuel **consumption** of 1/8.503=0.1176 L/km, or more conveniently 11.76 L/ 100 km.

[23] There is ambiguity in the use of the term "weight" to mean either *force* or *mass*. In general usage, the term "weight" nearly always means *mass* and this is the meaning given the term in U.S. laws and regulations. Where the term is so used, weight is expressed in **kilograms** in SI. In many fields of science and technology the term "weight" is defined as the *force* of gravity acting on an object, i.e., as the product of the *mass* of the object and the local acceleration of gravity. Where weight is so defined, it is expressed in **newtons** in SI.

[24] The metric ton (referred to as "tonne" in many countries), equal to 1000 kg, is accepted for use with SI.

Section	To Convert From	To	Multiply By
	ton (short) (2000 lb)	kilogram (kg)	**907.184 74**
	ton (short)	metric ton (t)	**0.907 184 74**
	slug	kilogram (kg)	14.593 9
	pound (avoirdupois)	kilogram (kg)	**0.453 592 37**
	ounce (troy)	gram (g)	31.103 48
	ounce (avoirdupois)	gram (g)	28.349 52
	grain	milligram (mg)	**64.798 91**
5.2.2	**Moment of mass**		
	pound foot	kilogram meter ($kg \cdot m$)	0.138 255
5.2.3	**Density**		
	ton (2 000 lb ([short]) per cubic yard	kilogram per cubic meter (kg/m^3)	1 186. 553
		metric ton per cubic meter (t/m^3)	1.186 553
	pound per cubic foot	kilogram per cubic meter (kg/m^3)	16.018 46
5.2.4	**Concentration (mass)**		
	pound per gallon	gram per liter (g /L)	119.826 4
	ounce (avoirdupois) per gallon	gram per liter (g /L)	7.489 152
5.2.5	**Momentum**		
	pound foot per second	kilogram meter per second ($kg \cdot m/s$)	0.138 255 0
5.2.6	**Moment of inertia**		
	pound square foot	kilogram square meter ($kg \cdot m^2$)	0.042 140 11
5.2.7	**Force**		
	pound-force	newton (N)	4.448 222
	poundal	newton (N)	0.138 255 0
5.2.8	**Moment of force, torque**		
	pound-force foot	newton meter ($N \cdot m$)	1.355 818
	pound-force inch	newton meter ($N \cdot m$)	0.112 984 8
5.2.9	**Pressure, stress**		
	standard atmosphere[25]	kilopascal (kPa)	**101.325**

[25] The SI unit for pressure and stress is the **pascal**, which is equal to the newton per square meter. This unit, its multiple, and submultiples are preferred for all applications.

Section	To Convert From	To	Multiply By
	bar[26]	kilopascal (kPa)	**100**
	millibar	kilopascal (kPa)	**0.1**
	pound-force per square inch (psi)	kilopascal (kPa)	6.894 757
	kilopound-force per square inch	megapascal (MPa)	6.894 757
	pound-force per square foot	kilopascal (kPa)	0.047 880 26
	inch of mercury[26] (32 °F)	kilopascal (kPa)	3.386 38
	foot of water[26] (39.2 °F)	kilopascal (kPa)	2.988 98
	inch of water[26] (39.2 °F)	kilopascal (kPa)	0.249 082
	millimeter of mercury[27] (32 °F)	kilopascal kPa)	0.133 322 4
	torr (Torr)	pascal (Pa)	133.322 4
5.2.10	**Viscosity (dynamic)**		
	centipoise	millipascal second (mPa · s)	**1**
5.2.11	**Viscosity (kinematic)**		
	centistokes	square millimeter per second (mm^2/s)	**1**
5.2.12	**Energy, work, heat**		
	kilowatthour[28]	megajoule (MJ)	**3.6**
	calorie[29] (as used in physics)	joule (J)	**4.184**
	calorie[30] (as used in nutrition)	kilojoule (kJ)	**4.184**
	Btu[31]	kilojoule (kJ)	1.055 056
	therm (U.S.)	megajoule (MJ)	**105.480 4**
	horsepower hour	megajoule (MJ)	2.684 520
	foot pound-force	joule (J)	1.355 818

[26] The bar and its submultiples are accepted for limited use in meteorology only. It is not accepted for use in the U.S. for other applications, e.g., as the unit of fluid pressure in pipes and containers. The appropriate SI multiples, e.g., **kilopascal** or **megapascal**, should be used instead.

[27] The actual pressure corresponding to the height of a vertical column of fluid depends upon the local acceleration of gravity and the density of the fluid, which in turn depends upon the temperature. The conversion factors given here are conventional values adopted by the International Organization for Standardization (ISO).

[28] The kilowatthour is accepted as a unit of electrical energy only. The SI unit of energy, the **joule**, which is equal to the newton meter or the watt second, is recommended for all applications.

[29] The calorie listed here is the thermochemical calorie. Other values of the calorie have been used.

[30] The calorie used in nutrition is the same as the thermochemical **kilocalorie** or kcal. One food calorie equals about 4,186 J. All use of the calorie is deprecated.

[31] The British Thermal Unit (Btu) used in this standard is the International Table Btu (Btu_{IT}) adopted by the Fifth International Conference on Properties of Steam, London, 1956.

Section	To Convert From	To	Multiply By
5.2.13	**Power**[32]		
	ton, refrigeration (12 000 Btu/h)	kilowatt (kW)	3.516 853
	Btu per second[31]	kilowatt (kW)	1.055 056
	Btu per hour[31]	watt (W)	0.293 071 1
	horsepower (550 foot pounds-force per second)	watt (W)	745.699 9
	horsepower, electric	watt (W)	**746**
	foot pound-force per second	watt (W)	1.355 818
5.3	**Quantities of Heat**		
5.3.1	**Temperature**[33]		
5.3.2	**Linear expansion coefficient**		
	reciprocal degree Fahrenheit	reciprocal kelvin (K^{-1})	**1.8**
	reciprocal degree Fahrenheit	reciprocal degree Celsius ($°C^{-1}$)	**1.8**
5.3.3	**Heat**[34]		
5.3.4	**Heat flow rate**[35]		
5.3.5	**Thermal conductivity**		
	Btu inch per hour square foot degree Fahrenheit	watt per meter kelvin [W / (m · K)]	0.144 227 9
5.3.6	**Coefficient of heat transfer**		
	Btu per hour square foot degree Fahrenheit	watt per square meter kelvin [W / (m^2 · K)]	5.678 263
5.3.7	**Heat** capacity		
	Btu per degree Fahrenheit	kilojoule per kelvin (kJ/K)	1.899 101
5.3.8	**Specific heat capacity**		
	Btu per pound degree Fahrenheit	kilojoule per kilogram kelvin [kJ/(kg · K)]	**4.186 8**
5.3.9	**Entropy**		
	Btu per degree Rankine	kilojoule per kelvin (kJ/K)	1.899 101
5.3.10	**Specific entropy**		

[32] NOTE: Power is the rate of energy transfer. The SI unit for all forms of power—mechanical, electrical, and heat flow rate—is the **watt**.

[33] The SI unit for temperature is the **degree Celsius** (°C) or the kelvin (K). In inch-pound units temperature is expressed in degrees Fahrenheit. The formula for converting temperature is:

$$t_C = (t_F - \mathbf{32}) / \mathbf{1.8}$$

The SI unit for thermodynamic temperature T_K is the **kelvin** (K). The Celsius temperature is defined by the equation: $t_C = T_K - \mathbf{273.15\ K}$. The inch-pound unit for thermodynamic temperature is the degree Rankine. The formula for converting degree Rankine to thermodynamic temperature is: $T_K = T_R / \mathbf{1.8}$.

A temperature interval may be expressed in SI either in kelvin or in degrees Celsius, as convenient. The formula for converting a temperature interval Δt in degrees Fahrenheit into SI is:

$$^{\triangle}t_K = {}^{\triangle}t_C = {}^{\triangle}t_F / \mathbf{1.8}.$$

[34] Heat is a form of energy. See 5.3.7.

[35] Heat flow rate is a form of power. See 5.2.12.

Section	To Convert From	To	Multiply By
	Btu per pound degree Rankine	kilojoule per kilogram kelvin [kJ/(kg · K)]	**4.186 8**
5.3.11	**Specific internal energy**		
	Btu per pound	kilojoule per kilogram (kJ/kg)	**2.326**
5.4	**Quantities of Electricity and Magnetism**[36]		
5.4.1	**Magnetic field strength**		
	oersted	ampere per meter (A/m)	79.577 47
5.4.2	**Magnetic flux**		
	maxwell	nanoweber (nWb)	**10**
5.4.3	**Magnetic flux density**		
	gauss	millitesla (mT)	**0.1**
5.4.4	**Electric charge**		
	ampere hour	coulomb (C)	**3 600**
5.4.5	**Resistivity**		
	ohm circular mil per foot	nanoohm meter (nΩ · m)	1.662 426
5.4.6	**Conductivity**		
	mho per centimeter	siemens per meter (S/m)	**100**
5.5	**Quantities of Light and Related Electromagnetic Radiation**[37]		
5.5.1	**Wavelength**		
	ångström	nanometer (nm)	**0.1**
5.5.2	**Luminance**		
	lambert (L)	candela per square meter (cd/m^2)	3 183.099
	candela per square inch	candela per square meter (cd/m^2)	1 550.003
	footlambert	candela per square meter (cd/m^2)	3.426 259
5.5.3	**Luminous exitance**		
	lumen per square foot	lux (lx)	10.763 91
	phot	lux (lx)	**10 000**
5.5.4	**Illuminance**		
	footcandle	lux (lx)	10.763 91
5.6	**Quantities of Radiology**		

[36] The common electrical units **ampere** (A), **volt** (V), **ohm** (Ω), **siemens** (S), **coulomb** (C), **farad** (F), **henry** (H), **weber** (Wb), and **tesla** (T) are SI units that are already in use in the United States. The various Centimeter-Gram-Second (CGS) units shall no longer be used.

[37] No change is required for the following quantities: radiant intensity, watt per steradian (W/sr); radiance, watt per steradian square meter ($W/[sr \cdot m^2]$); irradiance, watt per square meter (W/m^2); luminous intensity, candela (cd); luminous flux, lumen (lm); and quantity of light, lumen second (lm · s).

Section	To Convert From	To	Multiply By
5.6.1	**Activity (of a radionuclide)**		
	Curie	megabecquerel (MBq)	**37 000**
5.6.2	**Absorbed dose**		
	Rad	gray (Gy)	**0.01**
	Rad	centigray (cGy)	**1**
5.6.3	**Dose equivalent**		
	Rem	sievert (Sv)	**0.01**
	Rem	millisievert (mSv)	**10**
	Millirem	millisievert (mSv)	**0.01**
	Millirem	microsievert (μSv)	**10**
5.6.4	**Exposure (x and gamma rays)**		
	roentgen	coulomb per kilogram (C/kg)	**0.000 258**

6 DOCUMENT SOURCES

Copies of SI 10™ are available from:

American Society for Testing Materials International (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Phone: 610-832-9585, Fax: 610-832-9555, or at *http://www.astm.org*

NIST publications and Federal Standard 376B are available on the Internet at:

http://www.nist.gov/metric

For print copies of NIST SP 330, NIST SP 811 or NIST SP 814 or other assistance please contact:

Elizabeth J. Gentry, National Institute of Standards and Technology, Weights and Measures Division, Laws and Metric Group, Mail Stop 2600, Gaithersburg, Maryland 20899-2600. Phone: 301-975-3690, FAX: 301-926-0647, or e-mail: *TheSI@nist.gov*.

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4. *Guide for the Use of the International System of Units, The Modernized Metric System*, (1995) NIST Special Publication 811.

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