Remote Bulb Control (Continued)

Selection Charts (Continued)

Replacement Parts

Code Number	Description
CVR28A-617R	Concealed adjustment cover
CVR28A-618R	Visible scale cover
KNB20A-602R	Replacement Knob Kit

Accessories

A packing nut is available for closed tank application.
Specify the part number **FTG13A-600R**.

Bulb wells (WEL14A Series) are available for liquid immersion applications.
Refer to the selection chart or to *Bulb Wells Catalog Page, LIT-1922135*.

Technical Specifications

Electrical Ratings

Motor Ratings VAC	120	208	240
Wide Range – Adjustable Differential			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
Fixed Differential and Close Differential			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Case Compensated – Fixed Differential A19AAC-4			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
A19AAD-12			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Manual Reset			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A	16.0	9.2	8.0
Pilot Duty – 125 VA, 24 to 600 VAC			

1. SPST and N.O. contact of SPDT control;
   SPDT N.C. contact- 16 amps 120 to 277 VAC

TSLL/TSH - Switch, Temperature Thermostat, CN TF115-001
TSLL7911 - Switch, Temperature Thermostat, CN TF115-001
TSLL-7941 - Switch, Temperature Thermostat, CN TF115-001

PECO
AUTOMATION AND CONTROLS

NEMA 4X RAINTIGHT THERMOSTAT INSTALLATION AND OPERATING INSTRUCTIONS

INSTRUCCIONES DE INSTALACION Y OPERACION DEL THERMOSTATO A PRUEBA DE LLUVIA NEMA 4X

THERMOSTAT NEMA 4X ÉTANCHE AUX INTEMPÉRIES INSTRUCTION D'INSTALLATION ET D'UTILISATION

⚠ WARNING

To prevent overheating or fire, use this control as an operating or regulating thermostat. ALWAYS USE A BACKUP CONTROL OR ALARM if a control failure could cause the controlled appliance to overheat or could cause a fire

Where thermostat is capable of cycling directly between heating and cooling loads, failure to provide a load transfer switch will result in thermostat failure.

Do not install, use or operate if product appears damaged, the enclosure is cracked or broken or if the sensor has been bent, crimped or is dirty.

APPROPRIATE APPLICATION

This thermostat has been tested by CSA and Underwriters Laboratories Inc. (UL), meets the requirements for NEMA 4X equipment and is suitable for use under the National Electrical Code (NEC), Article 547-7, when used with appropriate watertight connectors (not included).

INSTALLATION

⚠ WARNING

To avoid electrical shock or damage to equipment, disconnect all power before installing or servicing.

To avoid potential fire and/or explosion, do not use in potentially flammable or explosive atmospheres.

Installation must be made by a trained, qualified service person in accordance with the National Electrical Code (NEC) and all applicable local codes and ordinances. Installation should meet all applicable national, state and local codes. Refer to the appropriate wiring diagram included. Locate the thermostat (local sensing models) or sensing bulb (remote sensing models) for optimum temperature sensing of the controlled space. Thermostat operation will be affected by unusual heat or cold, such as direct sunlight, near windows or doors or on outside walls.

All fittings and materials used for the installation should be approved, suitable and installed properly for the intended application. For water tightness, the cord seal or conduit hub should be UL listed and marked 4X. The conduit hub is to be tightened onto the conduit before installing in the enclosure.

Where applicable, remove knockout(s) by impacting near the inside edge of the knockout to be removed. **IMPORTANT: Do not impact, dent or use the sensor for support. This will cause calibration and/or thermostat failure.**

⚠ WARNING

READ INSTRUCTION CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THIS THERMOSTAT. Failure to observe safety information and comply with instructions could result in PERSONAL INJURY, DEATH AND/OR PROPERTY DAMAGE.
Retain these instructions for future reference. This product, when installed, will be part of an engineered system whose specifications and performance characteristics are not designed or controlled by PECO. You must review your application and national and local codes to assure that your installation will be functional and safe.

Even though this thermostat is sealed, water or dust could enter through improperly sealed wiring. A drip loop should be provided to prevent water and other liquids from entering the thermostat housing. The cord or conduit connections to the enclosure must be water and dust tight. The cover must be tightened securely to compress the gasket and provide a watertight seal. Use only screws provided. Do not over-tighten.

Maximum sensing element withstand temperature is 35°F (20°C) above the highest temperature setting. Maximum temperature for the plastic enclosure is 140°F 60°C.

⚠ CAUTION

For use in wet or humid environments or where water tightness is required, failure to use suitable watertight connections and suitable drip loop could allow water to enter the enclosure resulting in thermostat failure.

Use copper wire only. Insulate or wire-nut all unused leads.

Use the grounding provisions provided for connection to the line ground and equipment ground wire.

OPERATION AND CHECK-OUT

Allow one hour or necessary amount of time for the thermostat and system to stabilize for normal operation. This thermostat is factory calibrated and requires no correction on site.

TO CHECK OPERATION OF HEATING SYSTEMS:

1. Disconnect power.
2. Place the heat/cool selector switch, if applicable, in the heat position.
3. Adjust the thermostat set point to at least 10°F (5°C) below the temperature of the controlled space.
4. Restore power.
5. Slowly adjust the thermostat knob to raise the set point. When the set point reaches the approximate temperature of the controlled space, the heating equipment should start.

TO CHECK OPERATION OF COOLING SYSTEMS:

1. Disconnect power.
2. Place the heat/cool selector switch, if applicable, in the cool position.
3. Adjust the thermostat set point to at least 10°F (5°C) above the temperature of the controlled space.
4. Restore power.
5. Slowly adjust the thermostat knob to lower the set point. When the set point reaches the approximate temperature of the controlled space, the cooling equipment should start.

LIMITED WARRANTY

1. WARRANTY COVERAGE. PECO warrants to the original user of its products that the products will. at the date of initial purchase, meet the applicable specification for such products and will be free from any defects in materials or manufacture under normal use for 18 months after date of manufacture.
2. DISCLAIMER OF WARRANTY OF PRODUCT SUITABILITY. PECO makes no warranty to the purchaser or any third party that its products are suitable for a particular application or design. Many states and localities have differing codes or regulations governing the installation and/or use of PECO products. PECO cannot guarantee compliance with such regulations; purchaser is solely responsible for safe and correct installation and use of the product and for compliance with applicable codes and regulations.
3. EXCLUSION OF IMPLIED WARRANTIES. This warranty is the only warranty applicable to this product and excludes all other warranties, including any WARRANTY OF MERCHANTABILITY, any warranty of fitness for a particular purpose, and any implied warranties otherwise arising from course of dealing or usage of trade, except where the product purchased is subject to consumer product warranty laws, in which case ANY APPLICABLE IMPLIED WARRANTIES ARE LIMITED TO 18 MONTHS, or such shorter period as permitted or required under applicable law.
Some States do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.
4. REMEDIES FOR NONCONFORMITY. If the product purchased does not conform to the applicable warranty, PECO will provide, at its option and in accordance with the procedures in the following section, one of the following remedies: (1) repair of the nonconforming product, (2) replacement with a conforming product, (3) refund of the original purchase price, THESE REMEDIES SHALL BE THE EXCLUSIVE AND SOLE REMEDY for any breach of warranty.
5. TO OBTAIN WARRANTY SERVICE. For any product believed to be defective within the limited warranty period, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to PECO at the address below, giving dealer's name, address, date and number of dealer's invoice, and describe the nature of the defect.
6. LIMITATION OF LIABILITY. PECO WILL NOT BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES resulting from any defect in the product purchased. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.
Manufactured by PECO, Inc.
4709 SE 18th Avenue - Portland, OR 97202 - USA
P.O. Box 82189 - Portland, OR 97282 - USA

E-1371

⚠ ADVERTENCIA

LEALAS INSTRUCCIONES CUIDADOSAMENTEANTES DE TRATAR DE INSTALAR, OPERAR O HACER EL SERVICIO EN ESTE TERMOSTATO.
Si no se observa la información de seguridad y si no se siguen las instrucciones se pueden producir LESIONES PERSONALES, LAMUERTE Y/O DAÑO A LA PROPIEDAD. Guarde estas instrucciones para referencia en el futuro.Cuando este producto se instale, formará parte de un sistema de ingeniería cuyas especificaciones y características de rendimiento no han sido diseñadas ni son controladas por PECO. Es necesario que estudie su aplicación y los códigos lacales y nacionales para asegurarse que su instalación funcionará bien y es segura.

APLICACION CORRECTA

Este termostato ha sido probado por CSA y por Underwriters Laboratories Inc. (UL), cumple con los requisitos del equipo NEMA 4X y es adecuado para usarse según el Artículo 547-4 del National Electrical Code (NEC), cuando se usacon los conectores impermeablescorrectos (novienen incluidos).

INSTALACION

⚠ ADVERTENCIA

Para evitar el choque eléctrico o el daño en el equipo, desconecte toda la energía antes de instalarlo o de hacerle el servicio. Para evitar incendios potenciales y/o la explosión, no lo use en atmósferas potencialmente inflamables o explosivas.

Una persona calificada y capacitada en el servicio tiene que hacer la instalación, según el National Electrical Code (NEC) y según todos los códigos y regulaciones locales. La instalación tiene que cumplir con todos los códigos nacionales, estatales y locales aplicables. Refiérase al diagrama del cableado apropiado que viene incluido.

Ubique el termostato (modelos sensores locales) o la bombilla sensora (modelos sensores remotos) para lograr una percepción óptima de la temperatura del espacio controlado. La operación del termostato se verá afectada por el calor o el frío fuera de lo común, tal como la luz directa del sol, cerca delas ventanas o puertas o en las paredes exteriores.

Todos los accesorios y los materiales que se usan para la instalación tienen que ser aprobados, adecuados y ser instalados correctamente para la aplicación que se les va a dar. El sello del cordón o el cubo del conductor deben estar en la lista de UL y tienen que estar marcados 4X para lograr que sean impermeables. El cubo del conductor tiene que estar apretado en éste antes de instalarlo en la caja.

Cuando sea aplicable, remueva el(los) disco(s) removible(s) golpeando cerca del borde interior del disco removible que se removerá. **IMPORTANTE: no golpee, ni abolle, ni doble, ni use el sensor como soporte. Esto hara fallar la calibracion y/o el termostato.**

⚠ ADVERTENCIA

Para prevenir el sobrecalentamiento o los incendios, use este control solamente como un termostato de operación o regulador. SIEMPRE USE UN CONTROL DE REFUERZO O UNA ALARMA en los casos cuando el artefacto controlado se puede sobrecalentar o se puede producir un incendio si el control falla, Cuando el termostato puede pasar por el ciclo directamente entre las cargas de calefacción y las de enfriamiento, si no se proporciona un interruptor de transferencia de carga, el termostato puede fallar. No instale, ni use, ni opere el producto si parece dañado, si la caja eatá partida o rota o si el sensorse ha doblado, plegado o esta sucio.

A pesar de que termostato está sellado, el agua o el polvo podrían enrtar a través del cableado mal sellado. Se tiene que proporcionar un ojal de goteo para impedir que el agua u otros líquidos entren en la caja del termostato. Las conexiones del cordón o del conductor que van a la caja tienen que ser impermeables y a prueba de polvo. La cubierta tiene que estar apretada en forma segura para comprimir la empaquetadura y proporcionar el sello impermeable. Use solamente los tornillos que vienen incluidos. No los apriete demasiado.

La temperatura máxima que puede soportarel elemento sensor es 20°C (35°F) sobre el ajuste de temperatura más alto. La temperatura máxima para la caja de plástico es 60°C (140°F).

⚠ PRECAUCION

Para usarlo en ambientes mojados o húmedos o en donde se necesita que sea impermeable, si no se usan las conexiones impermeables correctas y el ojal de goteo correcto, el agua podría entrar en la caja haciendo que el termostato falle. Use cables de cobre solamente, aisle o ponga tuercas de cables en todos los conductores que no están en uso. Use las estipulaciones para la conexión a tierra que vienen incluidas para la conexión a tierra de la línea y con el cable de conexión a tierra del equipo.

OPERACION Y REVISION

Permita una hora o el tiempo necesario para que el termostato y el sistema se estabilicen para la operación normal. Este termostato ha sido calibrado en la fábrica y no necesita corregirse en el lugar en donde se va a usar.

COMO REVISAR LA OPERACION DE LOS SISTEMAS DE CALEFACCION:

1. Desconecte la energía.
2. Ponga el interruptor selector de calefacción/enfriamiento, si es aplicable, en la posición de calefacción.
3. Ajuste el punto de control del termostato a por lo menos 5°C (10°F) por debajo de la temperatura del espacio controlado.
4. Vuelva a conectar la energía.
5. Lentamente ajusté la manilla del termostato para elevar el punto de control. Cuando el punto de control alcance la temperatura aproximada del espacio controlado, el equipo de calefacción debería arrancar.

COMO REVISAR LA OPERACION DE LOS SISTEMAS DE ENFRIAMIENTO:

1. Desconecte la energía.
2. Ponga el interruptor de calefacción/enfriamiento, si es aplicable en la posición de enfriamiento.
3. Ajuste el punto de control del termostato a por lo menos 5°C (10°F) sobre la temperatura del espacio controlado.
4. Vuelva a conectar la energía.
5. Ajuste lentamente la manilla del termostato para bajar el punto de control. Cuando el punto de control alcance la temperatura aproximada del espacio controlado, el equipo de enfriamiento debería arrancar.

GARANTIA LIMITADA

1. COBERTURA DE LA GARANTIA. PECO le garantiza al usuario original de sus productos, que en la fecha de la compra inicial, cumplen con las especificaciones aplicables y no tendrán defectos ni en los materiales ni en la fabricación, si se someten al uso normal, por 18 meses después de la fecha de fabricación.
2. DECLINACION DE RESPONSABILIDAD DE LA GARANTIA POR LA ADAPTACION DEL PRODUCTO. PECO no le garantiza al comprador, ni a terceros, que sus productos se adaptan a una aplicación o diseño en particular. Muchos estados y jurisdicciones cuentan con códigos o regulaciones diferentes que gobiernan la instalación y/o el uso de los productos de PECO. PECO no puede garantizarque se cumplan dichas regulaciones; el comprador es el único responsable por la instalación segura y correcta, por el uso del producto y por el cumplimiento con los códigos y regulaciones aplicables.
3. EXCLUSION DE LAS GARANTIAS IMPLICITAS. Esta garantía es la única que se aplica a este producto y se excluyen todas las demás garantías. incluyéndpse toda GARANTIA DE COMERCIALIZACION, cualquier garantía de adecuación para un propósito en particular y cualquier garantía implícita que de alguna otra forma se presente en el curso de las transac-ciones o uso comercial, excepto en el caso cuando el producto comprado esté sujeto a las leyes de las garantías del producto, en cuyo caso TODA GARANTIA IMPLICITA APLICABLE QUEDA LIMITADA A 18 MESES, o a un período de tiempo más corto, según lo permita o lo exija la ley aplicable.
Algunos estados no permiten limitaciones en cuanto a la duración de las garantías implícitas, de modo que las limitaciones anteriores puede que no se apliquenen su caso.
4. RECURSOS EN EL CASO DE DISCONFORMIDAD. Si el productocomprado no está de acuerdo con la garantía aplicada, PECO proporcionará, a su discreción, y según los procedimientos de la sección siguiente, uno de los recursos siguientes: (1) reparación del producto en disconformidad, (2) lo cambiará por uno conforme, (3) reembolsará el precio de compra original. ESTOS RECURSOS SERAN LOS UNICOS Y EXCLUSIVOS en el caso de cualquier violación de la garantía.
5. COMO OBTENER SERVICIO DEBIDO A LA GARANTIA. En elcaso de que se crea que cualquier poducto tenga defectos, dentro del período cubierto por la garantía limitada, primero escriba o llame al distribuidor a quien se le compró el producto. El distribuidor le dará las instrucciones adicionales. Si no se puede resolver la situación en forma satisfactoria, escriba a PECO a la dirección a continuación, dando el nombre y la dirección del distribuidor, la fecha y el número de la factura del distribuidor y describa la naturaleza del defecto.
6. LIMITACION DE RESONSABILIDAD. PECO NO SERA RESPONSIBLE POR DAÑOS CONCOMITANTES. ESPECIALES, INDIRECTOS O EMERGENTES que surjan por cualquier defecto del producto comprado. Algunos estados no permiten la exclu-sión o la limitación de los daños concomitantes o emergentes, de modo que la limitación o exclusión anteriores puede que no se apliquen en su caso.

Esta garantía le otorga derechos legales específicos y puede que también tenga otros derechos que varían de Estado a Estado.

Fabricado por PECO, Inc.
4709 SE 18th Avenue - Portland, OR 97202 - USA
P.O. Box 82189 - Portland, OR 97282 - USA

⚠ AVERTISSEMENT

LIRE ATTENTIVEMENT LES INSTRUCTIONS AVANT DE COMMENCER À INSTALLER, UTILISER OU FAIRE LE SERVICE DE CE THERMOSTAT. Négliger d'observer les conseils de sécurité et d'appliquer les instructions peut être la cause de BLESSURES CORPORELLES, MORT ET/OU DOMMAGES MATÉRIELS. Conserver ces instructions pour références ultérieures. Quand il est installé, cet appareil fera partie d'un système indutriel dont les spécifications et les caractéristiques de rendement ne sont pas concues ou contrôlées par PECO. L'application et les codes nationaux et locaux doivent être revus pour assurer que l'installation sera fonctionnelle et sans danger.

APPLICATION APPROPRIÉE

Ce thermostat qui a été soumis aux tests de CSA et de Underwriters Laboratory, Inc, (UL) est en accord avec les conditions requises pour les équipements NEMA 4X et est acceptable pour usage sous les normes National Electrical Code (NEC), Article 547-4, quand utilisé avec les connecteurs étanches appropriés (pas inclus).

INSTALLATION

⚠ AVERTISSEMENT

Pour éviter les chocs électriques ou les dommages matériels, débrancher l'alimentation électrique avant d'installer ou de faire le service.
Pour éviter un incendie et/ou une explosion possible, ne pas utiliser dans un environnement potentiellement inflammable ou explosif.

L'installation doit être faite par un technicien de service qualifié et être en accord avec le National Electrical Code (NEC) et tous les codes nationaux et locaux applicables. Se reporter au diagramme de câblage approprié inclus.

Situer le thermostat (modèles à détection sur place) ou la sonde (modèles à détection éloignée) pour obtenir une détection optimum de la température de l'espace contrôlé. Le fonctionnement du thermostat est affecté par une chaleur ou un froid inhabituel, tel que l'exposition directe au soleil, près d'une fenêtre, un porte ou un mur extérieur.

Tous les raccords et matériaux utilisés pour l'installation doivent être approuvés, adaptés et correcternent installés en fonction de l'application prévue. Pour l'étanchéité, le joint du câble ou raccord de conduit doit être classé UL et être marqué 4X. Le raccord de conduit doit être fixé sur le conduit avant de l'installer dans le boîtier.

Si applicable, les parties éjectables doivent être retirées par impact près du bord intérieur de la partie éjectable qui doit être retirée. IMPORTANT: NE PAS TAPER, ÉBRÉCHER, TORDRE OU UTILISER LA SONDE COMME SUPPORT. CECI CAUSERAIT LA DÉFAILLANCE DU CALIBRAGE ET/OU DU THERMOSTAT.
SONDE COMME SUPPORT. CECI CAUSERAIT LA DÉFAILLANCE DU CALIBRAGE ET/OU DU THERMOSTAT.

⚠ AVERTISSEMENT

Pour éviter la surchauffe ou le feu, utiliser ce contrôle uniquement comme un thermostat de fonctionnement ou de réglage. TOUJOURS UTILISER UN CONTRÔLE OU UNE ALARME DE REDONDANCE si une défaillance du contrôle pourrait causer la surchauffe de l'appareil contrôlé ou pourrait causer un incendie. Si le thermostat est capable d'entrer en cycle directement entre des charges de chauffage et de refroidissement, négliger d'installer un commutateur de transfert de charge résultera en défaillance du thermostat. Ne pas installer, utiliser ou faire fonctionner si l'appareil semble endommagé, si le boîtier est fendu ou cassé, ou si la sonde a été tordue, pilée ou est sale.

Bien que ce thermostat soit scellé, l'eau ou la poussière peuvent y entrer par un câblage mal étanchéifié. Une boucle d'égouttage doit être prévue pour empêcher l'eau ou tout autre liquide d'entrer dans le boîtier du thermostat. La connexion de câble ou de conduit avec le boîtier doit être hermétique à l'eau et à la poussière. Le couvercle doit être solidement fixé pour compresser le joint et créer l'étanchéité. Utiliser uniquement les vis fournies. Ne pas surserrer.

L'élément de sonde maximum peut supporter une température de 20°C (35°F) au-dessus du réglage de la plus haute température. La température maximum pour le boîtier plastique est de 60°C (140°F).

⚠ ATTENTION

Pour usage dans un environnement mouillé ou humide ou si l'étanchéité est requise, négliger d'utiliser des connexions adaptées pour l'étanchéité et une boucle d'égouttage appropriée pourrait permettre la pénétration d'eau dans le boîtier et causer la défaillance du thermostat.

Utiliser uniquement des fils de cuivre, isoler ou placer sous cônes d'isolation tous les conducteurs inutilisés. Utiliser les bornes de mise à la terre prévues pour connexion sur la ligne de prise de terre et le fil de terre de l'équipement.

FONCTIONNEMENT ET VÉRIFICATION

Attendre une heure ou la période de temps nécessaire pour que le systéme et le thermostat se stabilisent sur un fonctionnement normal. Ce thermostat a été calibré à l'usine et il ne nécessite aucun ajustement sur place.

POUR VÉRIFIER LE FONCTIONNEMENT DES SYSTÈMES DE CHAUFFAGE:

1. Débrancher l'alimentation électrique
2. Si applicable, place le sélecteur chaud/froid sur la position "chaud".
3. Ajuster le réglage du thermostat sur un point au moins 5°C (10°F) au-dessous de la température de l'espace contrôlé.
4. Rebrancher l'alimentation életrique.
5. Ajuster lentement la molette du thermostat pour monter le point de réglage. Quand le oint de réglage atteint le température approximative de l'espace contrôlé, l'équipement de chauffage doit se mettre en marche.

POUR VÉRIFIER LE FONCTIONNEMENT DES SYSTÈMES DE REFROIDISSEMENT:

1. Débrancher l'alimentation électrique.
2. Si applicable, placer le sélecteur chaud/froid sur la position "froid".
3. Ajuster le réglage du thermostat sur un point au moins 5°C (10°F) au-dessos de la température de l'espace contrôlé.
4. Rebrancher l'alimentation électrique.
5. Ajuster lentement la molette du thermostat pour descendre le point de réglage. Quand le point de réglage atteint le température approximative de l'espace contrôlé, l'équipement de climatisation doit se mettre en marche.

GARANTIE LIMITÉE

1. COUVERTURE GARANTIE. PECO garantit au premier utilisateur de ses produits, que les produits sont, à la date de l'achat initial, en accord avec les spécifications applicables pour ces productions et seront, sous usage normal, sans défauts de matières premières ou de main d'oeuvre pendant 18 mois à partir de la date de fabrication.
2. DÉSISTEMENT DE GARANTIE D'APTITUDE DU PRODUIT. PECO ne donne aucune garantie à l'acheteur ou à toute autre tierce personne concernant l'adaptabilité de ses prodeits poue une application ou une conception particulière. De nombreuses juridictions ont des codes différents ou des règlements gouvernant l'installation et/ou l'usage des produits de PECO. PECO ne peut pas garantir l'observance de ces règlements, l'acheteur est seul responsable de installation et de l'usage correct et sans danger de ce produit ainsi que de l'observance des codes et règlements applicables.
3. EXCLUSION DE GARANTIES IMPLIQUÉES. Cette garantie est la seule applicable à ce produit, et elle exclue toutes autres garanties, compris toute GARANTIE DE COMMERCIALISATION, toute garantie d'adaptabilité à un usage particulier, et toutes garanties impliquées au cours de transactions commerciales, sauf là où le produit acheté est soumis aux lois de garantie de produit aux consommateurs, dans tous les cas TOUTES GARANTIES IMPLIQUÉES APPLICABLES SONT LIMITÉES À 18 MOIS, ou à une période Plus courte si permise ou requise par la loi applicable.
Certaines juridictions ne permettent de limitations de la durée de la garantie, donc les limitations ci-dessus peuvent ne pas s'appliquer dans le cas présent.
4. REMÈDES CONTRE LA NON-CONFORMITÉ. Si le produit acheté n'est pas conforme à la garantie applicable, PECO fournira, à son choix et en accord avec le processus de la section suivante, l'un des remèdes suivants : (1) réparation du produit non-conforme. (2) remplacement par un produit conforme. (3) remboursement du prix d'achat d'origine. CES REMÈDES SERONT LES REMÈDES SEULS ET EXCLUSIFS pour toute infraction à la garantie.
5. POUR OBTENIR LE SERVICE SOUS GARANTIE. Pour tout produit considéré défectueux au cours de la période couverte par la garantie, commencer par écrire ou appeler le concessionnaire chez qui le produit a été acheté. Le concessionnaire doit donner des directions additionnelles. Si un accord satisfaisant ne peut pas être obtenu, écrire à PECO à l'adresse ci-dessous, en donnant le nom et l'adresse du concessionnaire, la date et le numéro de la facture du concessionnaire et en décrivant la nature du défaut.
6. LIMITATION DE RESPONSABILITÉ. PECO NE SERA PAS RESPONSABLE DE TOUS DOMMAGES IMPRÉVUS, SPÉCIAUX, INDIRECTS OU FORTUITS résultant d'un produit acheté défectuex. Certaines juridictions ne permettent pas l'exclusion ou la limitation des dommages indirects ou fortuits, donc la limitation ou exclusion ci-dessus peut ne pas s'appliquer dans le cas présent.

Cette garantie donne des droits légaux spécifiques, et il peut y avoir d'autres droits variants de juridiction à juridiction.

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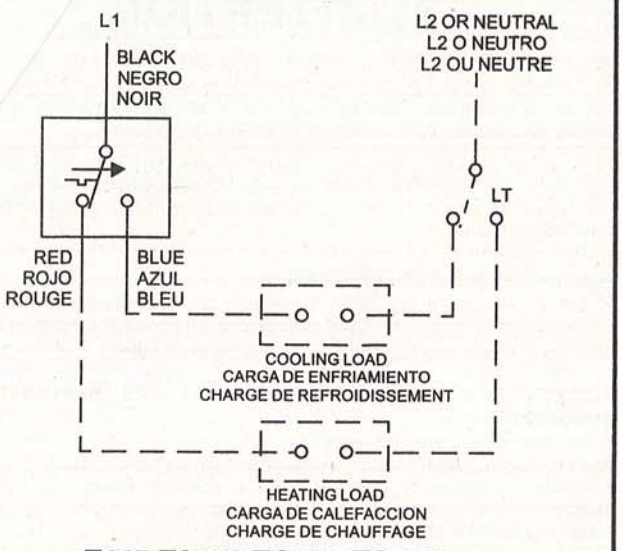
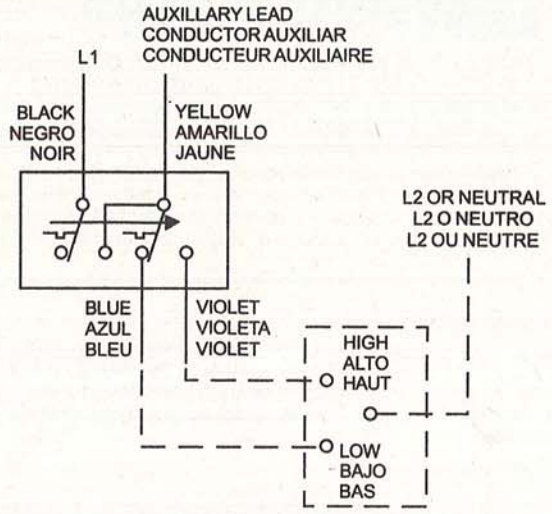
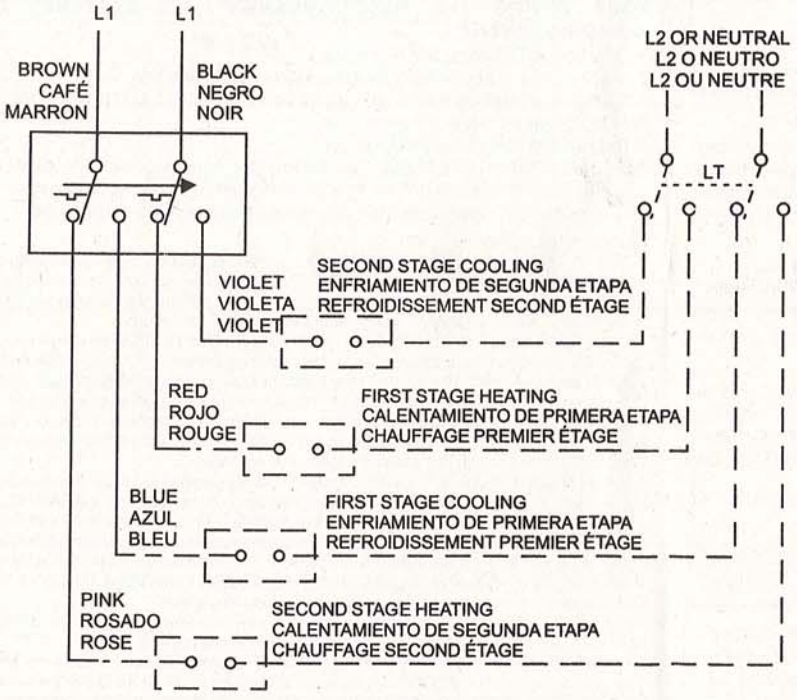


T115 TA119 TC109 TC119



TJ109 MODELS



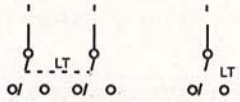
TH109

LEGEND
LEYENDA
LÉGENDE

THERMOSTAT WIRING
CABLEADO DEL TERMOSTATO
CABLAGE DU THERMOSTAT

FIELD WIRING
CABLEADO EN EL TERRENO
CABLAGE SUR PLACE

INDICATES SEQUENCE ON TEMPERATURE RISE
INDICA LA SECUENCIA CUANDO LA TEMPERATURA SE
INDIQUE LA SE SÉQUENCE DE LA MONTÉE DE TEMPÉRATURE



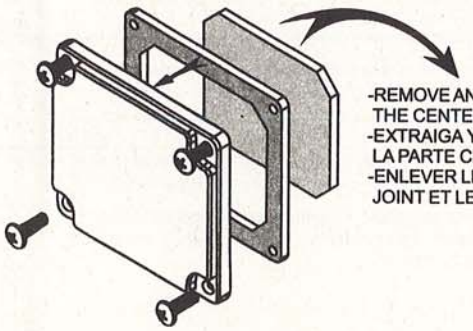
LOAD TRANSFER SWITCH
INTERRUPTOR DE TRANSFERENCIA DE CARGA
INTERRUPTEUR DE TRANDFERT DE CHARGE

⚠ WARNING
ADVERTENCIA
AVERTISSEMENT

-TO INSURE WATER TIGHTNESS, THE ENCLOSED GASKET MUST BE INSTALLED UNDER THE WIRING CAP.

-PARA ASEGURAR LA ESTANQUIDAD AL AGUA, LA JUNTA SUMINISTRADA DEBERÁ INSTALARSE DEBAJO DEL CASQUETE DEL ALAMBRADO.

-POUR ASSURER L'ÉTANCHÉITÉ À L'EAU, LE JOINT STATIQUE (FOURNI) DOIT ÊTRE INSTALLÉ SOUS LE CULOT POUR CÂBLAGE.



-REMOVE AND DISCARD THE CENTER OF THE GASKET
-EXTRAIGA Y DESCARTE LA PARTE CENTRAL DE LA JUNTA
-ENLEVER LE CENTRE DU JOINT ET LE METTRE AU REBUT

ifm electronic

VT-701/ 702 - Transmitter, Pressure/ Vacuum, IFM efector, PG2409 Scale -14.5- 14.5 PSI 4-20mA

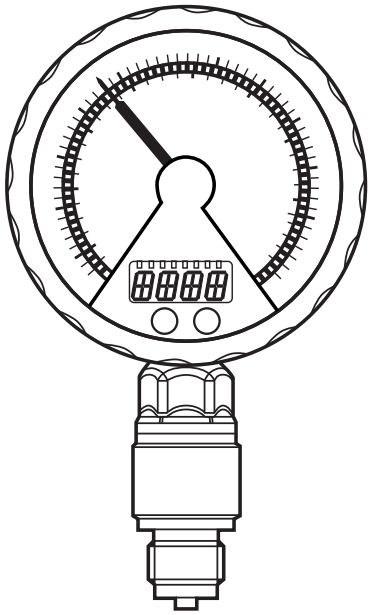
CE

Operating instructions
Electronic manometer

efectorsoo®

PG24xx

UK



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E-1375

Contents

1 Preliminary note

1.1 Symbols used

▶ Instruction

> Reaction, result

[…] Designation of pushbuttons, buttons or indications

→ Cross-reference

Important note
Non-compliance can result in malfunctions or interference.

Information
Supplementary note.

2 Safety instructions

- Please read this document prior to set-up of the unit. Ensure that the product is suitable for your application without any restrictions.
- If the operating instructions or the technical data are not adhered to, personal injury and/or damage to property can occur.
- Check the compatibility of the product materials (→ 12 Technical data) with the media to be measured in all applications.
- Use in gases at pressures > 25 bar only after contacting the manufacturer ifm.

- High-pressure units (250 bar, 400 bar) are supplied with an integrated damping device to comply with the regulations for UL approval and to avoid any risk of injury in case of bursting when bursting pressure is exceeded.

  Any manipulation of the damping device is not permissible.
  When the damping device is removed, there is no damping function any more. ATTENTION: risk of injury!
  For units with cULus approval this approval becomes invalid when the damping device is removed.

For the scope of validity cULus:
The Sensor shall be connected only by using any R/C (CYJV2) cord, having suitable ratings.

The device shall be supplied from an isolating transformer having a secondary Listed fuse rated either
a) max 5 amps for voltages 0~20 Vrms (0~28.3 Vp) or
b) 100/Vp for voltages of 20~30 Vrms (28.3~42.4 Vp).

3 Functions and features

The unit monitors the system pressure in a plant.

3.1 Applications

Type of pressure: relative pressure

Order no.	Measuring range (in brackets: extended display range)		Permissible overpressure		Bursting pressure	
	bar	PSI	bar	PSI	bar	PSI
PG2409	-1...1 (1.6)	-14.52...14.52 (23.22)	10	145	30	435
PG2450	0...400 (600)	0...5800 (8700)	800	11600	1200	17400
PG2451	0...250 (400)	0...3625 (5800)	600	8700	1000	14500
PG2452	0...100 (160)	0...1449 (2322)	300	4350	700	9400
PG2453	-1...25 (40)	-14.5...362.5 (580.0)	100	1450	350	5070
PG2454	-1...10 (16)	-14.4...145 (232)	50	725	150	2175
PG2455	-1...4 (6.4)	-14.5...58 (92.8)	30	435	100	1450
PG2456	-0.125...2.5 (4)	-1.8...36.25 (58.00)	20	290	50	725
PG2457	-0.05...1 (1.6)	-0.72...14.5 (23.20)	10	145	30	435

Order no.	Measuring range (in brackets: extended display range)		Permissible overpressure		Bursting pressure	
	mbar	inH2O	bar	inH2O	bar	inH2O
PG2458	-12.5...250 (400)	-5.0..100.4 (160.6)	10	4015	30	12044
PG2489	-5...100 (160)	-2.00...40.16 (64.24)	4	1606	30	12044

Avoid static and dynamic overpressure exceeding the given overload pressure by taking appropriate measures.
The indicated bursting pressure must not be exceeded.
Even if the bursting pressure is exceeded only for a short time, the unit may be destroyed. ATTENTION: risk of injury!
Use in gases at pressures > 25 bar only after contacting the manufacturer ifm.

UK

4 Function

4.1 Processing of the measured signals

- The unit generates 2 output signals according to the parameter settings.

OUT1	• Switching signal for system pressure limit value.
OUT2	• Analogue signal (4...20 mA, 20...4 mA).

- The unit displays the current system pressure.

Analogue display: circular scale with pointer.
Digital display (alphanumeric display, 4 digits).

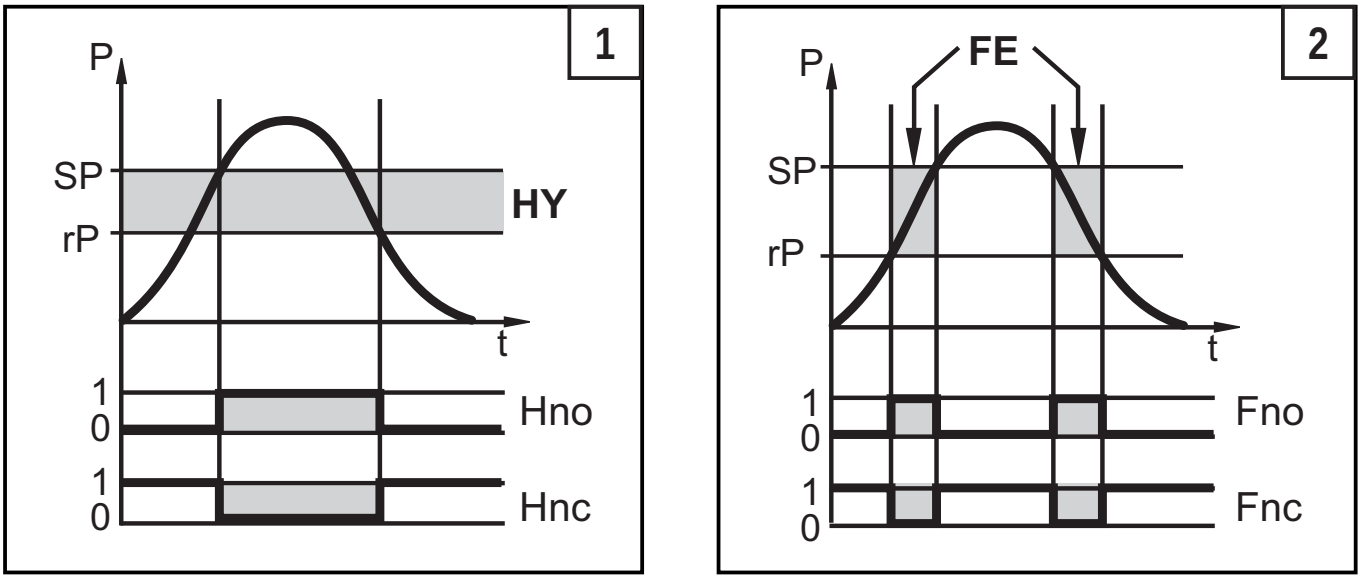
- In addition, an LED ring with one of the following display options is available:

Display of set point and reset point.
Trend display (rising pressure / falling pressure).
Lag indicator function for maximum value or minimum value.
Display of pulsating signals and pressure peaks.

4.2 Pressure monitoring / switching function

OUT1 changes its switching state if it is above or below the set switching limits (SP1, rP1). The following switching functions can be selected:

- Hysteresis function / normally open: [OU1] = [Hno] (→ fig. 1).
- Hysteresis function / normally closed: [OU1] = [Hnc] (→ fig. 1).
  First the set point (SP1) is set, then the reset point (rP1) with the requested difference.
- Window function / normally open: [OU1] = [Fno] (→ fig. 2).
- Window function / normally closed: [OU1] = [Fnc] (→ fig. 2).
  The width of the window can be set by means of the difference between SP1 and rP1. SP1 = upper value, rP1 = lower value.



P = system pressure; HY = hysteresis; FE = window

4.3 Pressure monitoring / analogue function

The analogue output can be configured.

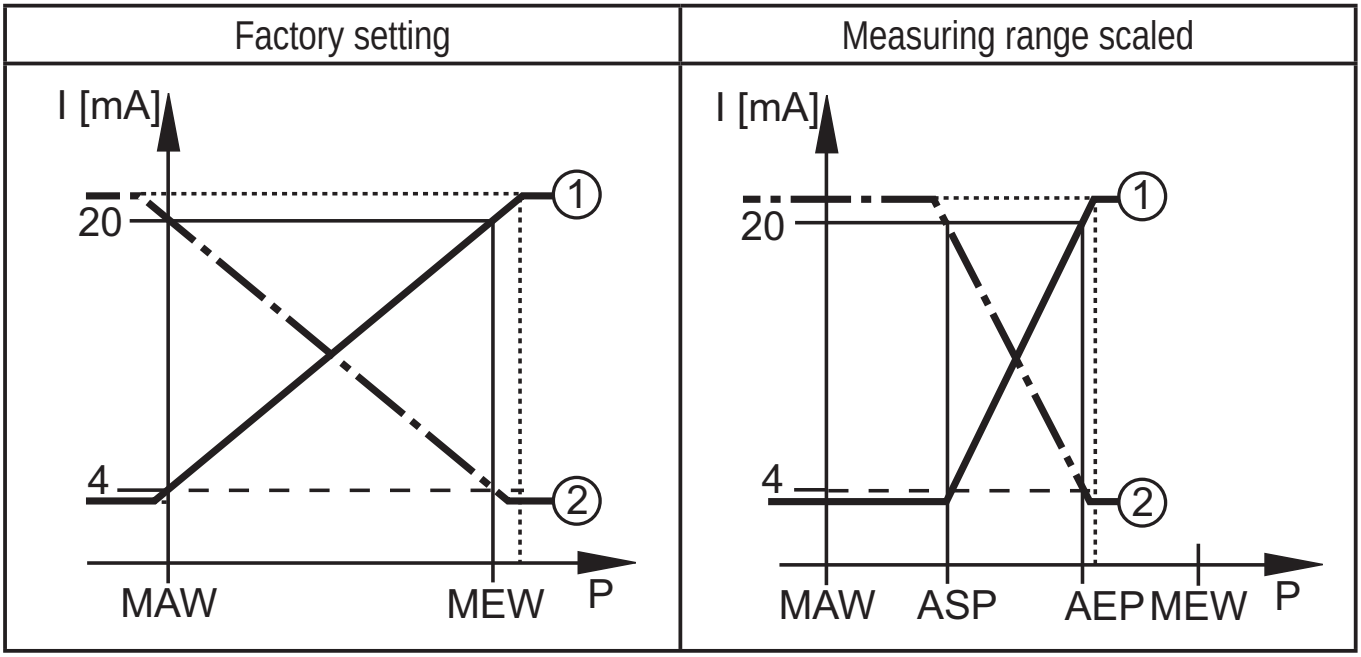
- [OU2] defines whether the set measuring range is provided as 4...20 mA ([OU2] = [I]) or as 20...4 mA ([OU2] = [InEG]).

Scaling can be set by means of the teaching process or by entering a value for the ASP and AEP parameters.

- Teaching the analogue start point [tASP] or setting the parameter [ASP] defines at which measured value the analogue signal is 4 mA (20 mA at [InEG]).
- Teaching the analogue end point [tAEP] or setting the parameter [AEP] defines at which measured value the output signal is 20 mA (4 mA at [InEG]).

UK

Minimum distance between [ASP] and [AEP] = 25 % of the final value of the measuring range.



P = system pressure , MAW = initial value of the measuring range, MEW = final value of the measuring range

①: [OU2] = [I]; ②: [OU2] = [InEG]

In the set measuring range the output signal is between 4 and 20 mA ([OU2] = [I]) or between 20 and 4 mA ([OU2] = [InEG]).

It is also indicated:

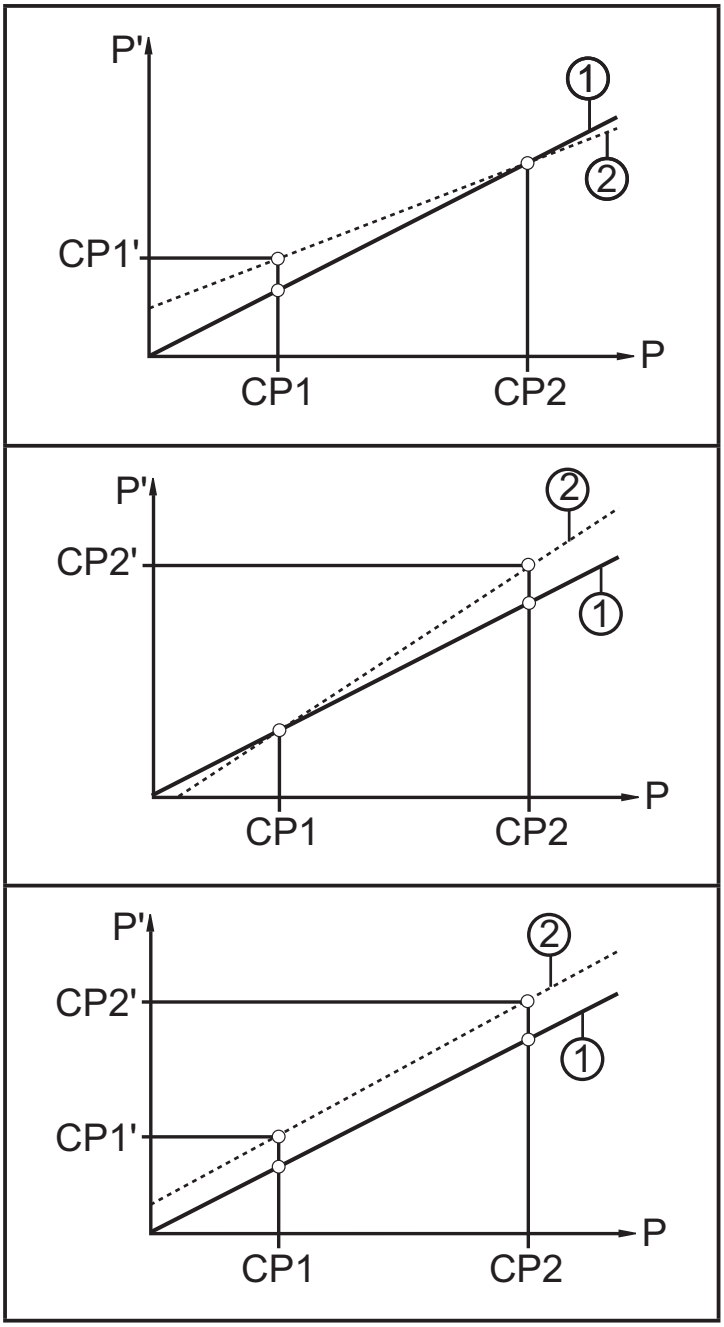
- System pressure above the measuring range:
  - Output signal 20 to 20.5 mA at [OU2] = [I].
  - Output signal 4 to 3.8 mA at [OU2] = [InEG].
- System pressure below the measuring range:
  - Output signal 4 to 3.8 mA at [OU2] = [I].
  - Output signal 20 to 20.5 mA at [OU2] = [InEG].

4.4 Customer-specific calibration

The customer-specific calibration changes the curve of measured values compared to the real measured values (shifting / change of the gradient; → 9.4.6 [CAL]).

- Two calibration points can be defined (CP1, CP2). The two points are independent of each other. They must be within the measuring range and not in the extended display range.
- The zero point calibration [COF] influences the calibration of the curve of measured values. Recommendation: set [COF] to 0 (→ 9.4.1 [COF]), then calibrate the curve of measured values.

After a change the calibration can be reset to factory setting (→ 9.5.2 [rES]).



- P = measured pressure;
  P‘ = modified measured value
- CP1 = calibration point 1;
  CP1‘ = modified measured value for CP1
- CP2 = calibration point 2;
  CP2‘ = modified measured value for CP2
- 1 = curve of measured values at factory setting
- 2 = curve of measured values after calibration

5 Installation

Before installing and removing the unit: make sure that no pressure is applied to the system. Note: If 0% is displayed and no pointer is visible, this does not mean that no pressure is applied to the system !

We recommend horizontal installation for high medium temperatures.

The unit can be fixed to different process connections. Options are as follows:

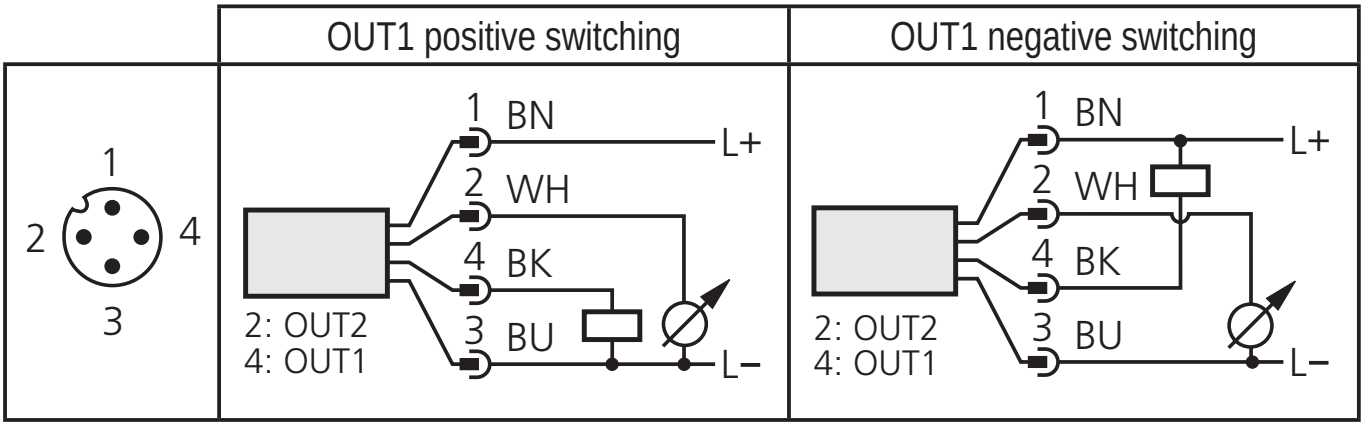
1	**Installation with seals to DIN EN 837-1**
	▶ Insert the unit and the seal into the process connection with cylindrical pipe thread G½ and tighten. All seals to DIN EN 837-1 can be used if they are suitable for process connections with cylindrical pipe thread, e.g. flat seals or double-edge sealing rings.
2	**Installation with sealing tape**
	▶ Insert the unit and the sealing tape into the process connection with G½ internal thread (e.g. welding adapter) and tighten.
3	**Installation at flange G½ (based on DIN 3852-11)**
	The sealing ring on the sensor is used as process seal. The upper sealing area on the process connection must be flush with the tapped hole and have a surface characteristic of min. Rz 6.3. ▶ Grease the sensor thread with a suitable paste. ▶ Insert the unit into the process connection. ▶ Tighten it using a spanner. Tightening torque: 35 Nm.

After installation the analogue display can be rotated / adapted to the installation position (to do so wear protective gloves).

6 Electrical connection

The unit must be connected by a qualified electrician.
The national and international regulations for the installation of electrical equipment must be adhered to.
Voltage supply according to EN 50178, SELV, PELV.

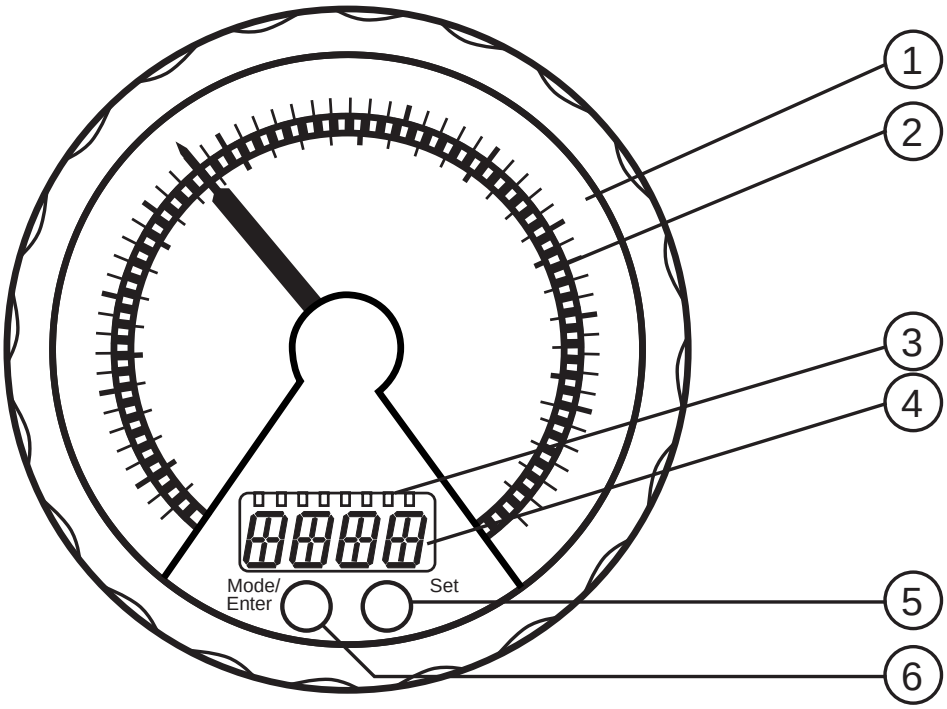
▶ Disconnect power.
▶ Connect the unit as follows:



Pin 1	Ub+
Pin 3	Ub-
Pin 4 (OUT1)	• Binary switching output pressure monitoring
Pin 2 (OUT2)	• Analogue output for system pressure

Core colours of ifm sockets:
1 = BN (brown), 2 = WH (white), 3 = BU (blue), 4 = BK (black)

7 Operating and display elements



UK

1: Analogue display

- Display of the current system pressure in bar and PSI or mbar and inH2O.

2: LED ring

According to the setting of parameter [LED] (→ 9.2):
- Display of set point and reset point.
- Lag indicator function for maximum value or minimum value.
- Display of pulsating signals and pressure peaks.
- Trend display: rising pressure or falling pressure.

3: Indicator LEDs

- LED 1 = system pressure of the digital display in bar.
- LED 2 = system pressure of the digital display in mbar.
- LED 3 = system pressure of the digital display in PSI.
- LED 4 = system pressure of the digital display in inH2O.
- LED 6 = system pressure in % of the scaling (range ASP to AEP) or COF value in %.
- LEDs 5, 7 = not used.
- LED 8 = switching status OUT1 (lights if output 1 is switched)

4: Alphanumeric display, 4 digits

- Display of the current system pressure.
- Display of the parameters and parameter values.

5: Touch button Set*

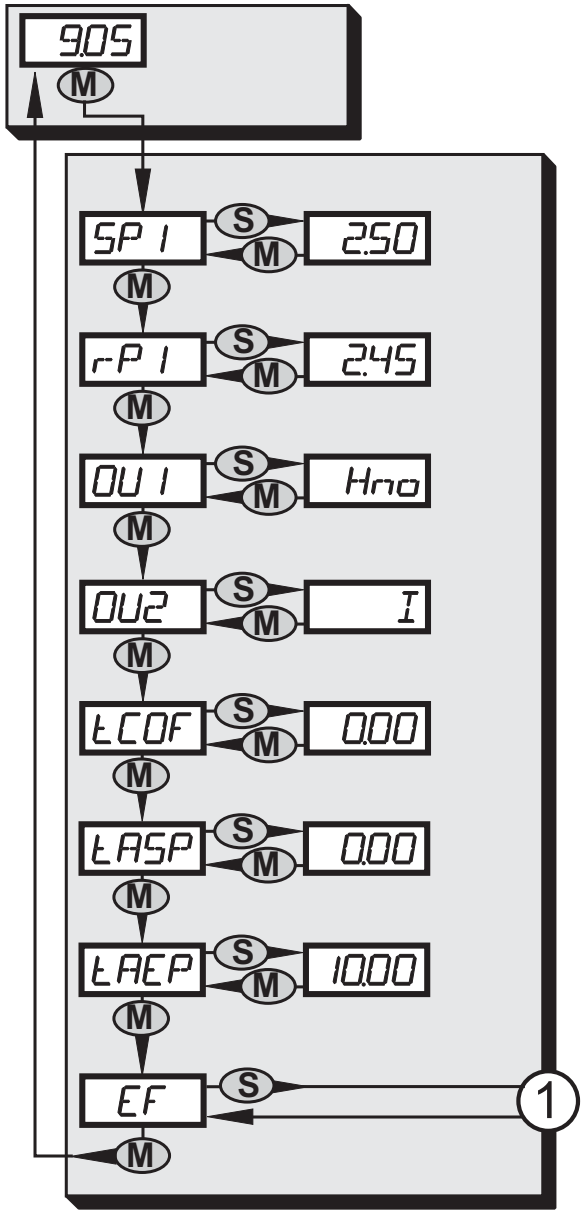
- Setting of the parameter values (continuously by touching permanently; step by step by touching briefly several times).

6: Touch button Mode/Enter*
- Selection of the parameters and acknowledgement of the parameter values.

* The two touch buttons are activated simply by touching / deactivated by releasing the touch button.
The touch button must be completely covered to be activated.
Slow covering (e.g. liquid flows over the display) does not activate the touch button.

8 Menu

8.1 Menu structure: main menu

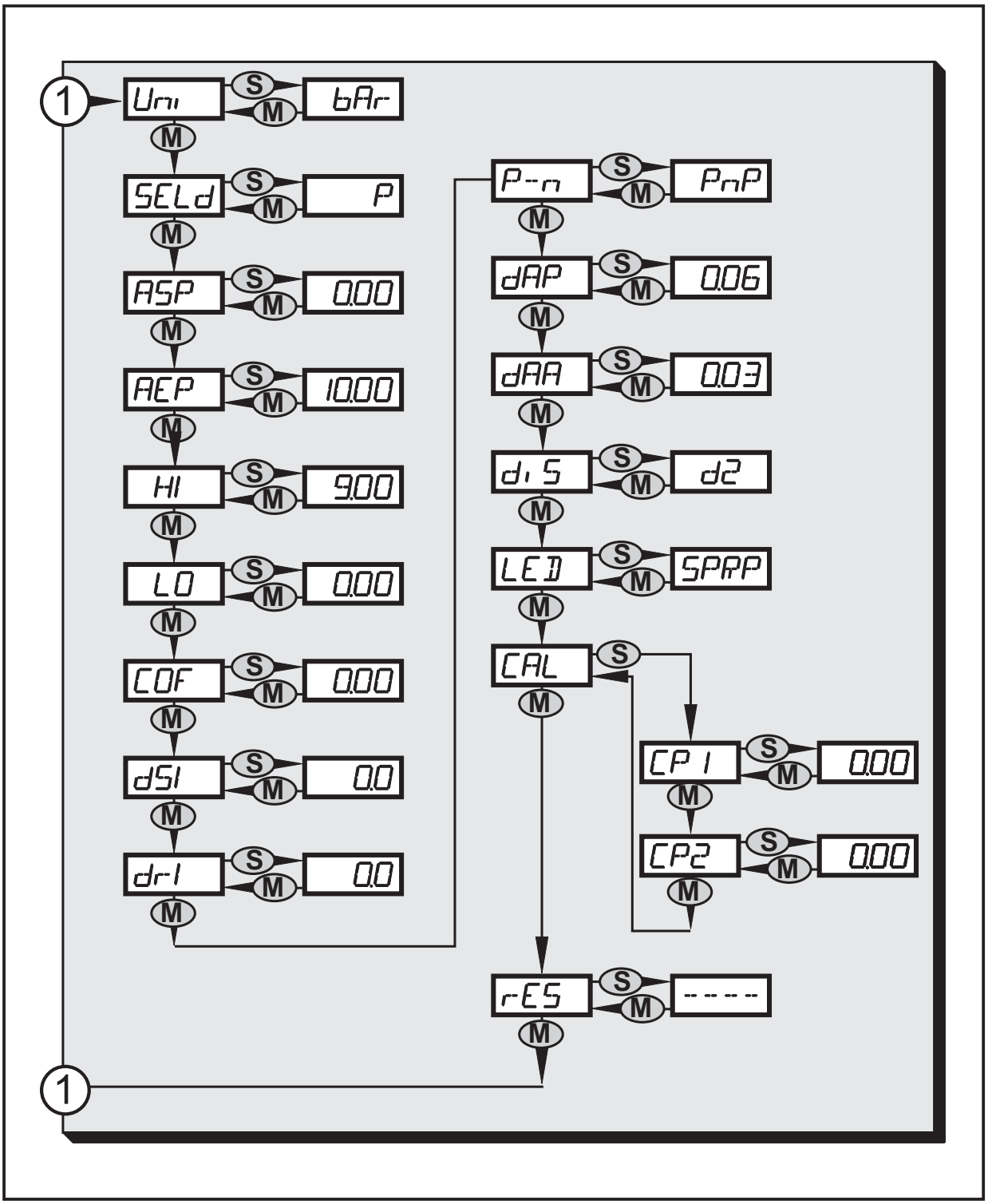


1: Change to menu level 2 (extended functions)

8.2 Explanation of the main menu

SP1/rP1	Upper / lower limit value for system pressure at which OUT1 switches.
OU1	Output function for OUT1: • Switching signal for the pressure limit values: hysteresis function [H ..] or window function [F ..], either normally open [. no] or normally closed [. nc].
OU2	Output function for OUT2: • Analogue signal for the current system pressure: 4...20 mA [I], 20...4 mA [InEG].
tCOF	Teach zero-point calibration.
tASP	Teach analogue start point for system pressure: set measured value at which 4 mA is provided (20 mA if [OU2] = [InEG]).
tAEP	Teach analogue end point for system pressure: set measured value at which 20 mA is provided (4 mA if [OU2] = [InEG]).
EF	Extended functions / opening of menu level 2.

8.3 Menu structure: level 2 (extended functions)



1: Change to the main menu

8.4 Explanation of the menu level 2

Uni	Standard unit of measurement for system pressure (bar or PSI).
SELd	Display mode: • Pressure in the unit set in [Uni]. • Pressure in % of the set scaling of the analogue output.
ASP	Analogue start point for system pressure: measured value at which 4 mA is provided (20 mA if [OU2] = [InEG]).
AEP	Analogue end point for system pressure: measured value at which 20 mA is provided (4 mA if [OU2] = [InEG]).
HI	Maximum value memory for system pressure.
LO	Minimum value memory for system pressure.
COF	Zero-point calibration.
dS1	Switch-on delay for OUT1.
dr1	Switch-off delay for OUT1.
P-n	Switching logic for OUT1: pnp or npn.
dAP	Damping for switching outputs and display.
dAA	Damping for analogue output (OUT2).
diS	Update rate and orientation of the display.
LED	Setting for the LED ring.
CAL	Calibration function (setting the curve of measured values).
CP1	Calibration point 1
CP2	Calibration point 2
rES	Restore factory settings.

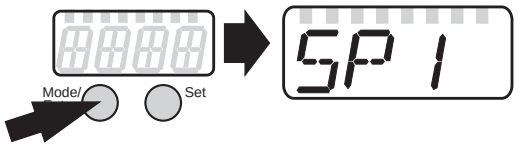
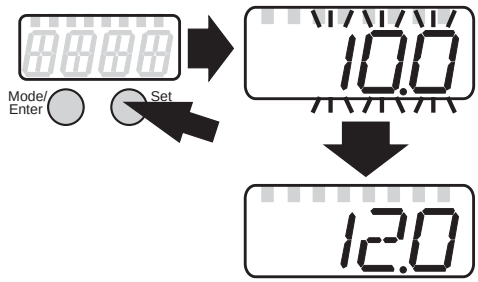
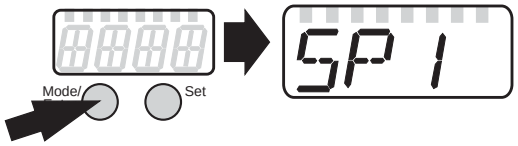
9 Parameter setting

During parameter setting the unit remains in the operating mode. It continues its monitoring function with the existing parameters until the parameter setting has been completed.

Exceptions: changes to the parameters COF (→ 9.4.1), CP1 and CP2 (→ 9.4.6) take effect immediately.

9.1 General parameter setting

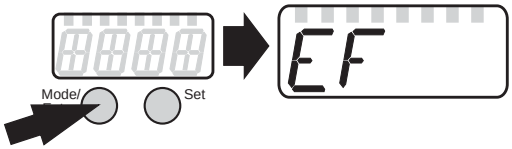
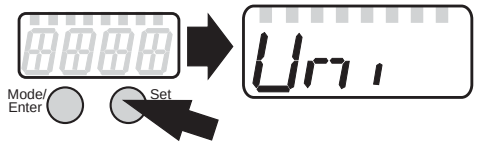
3 steps must be taken for each parameter setting:

1	**Select parameter** ▶ Touch [Mode/Enter] until the requested parameter is displayed.	
2	**Set parameter value** ▶ Touch [Set] and keep it touched. > Current setting value of the parameter flashes for 5 s. > After 5 s: setting value is changed: step by step by touching briefly several times or continuously by touching permanently.	
	Numerical values are incremented continuously. To reduce the value: let the display move to the maximum setting value. Then the cycle starts again at the minimum setting value.	
3	**Acknowledge parameter value** ▶ Touch [Mode/Enter] briefly. > The parameter is displayed again. The new setting value is saved.	
Set other parameters ▶ Start again with step 1.		
Finish parameter setting ▶ Touch [Mode/Enter] several times until the current measured value is displayed or wait for 15 s. > The unit returns to the operating mode.		

- Timeout:

  If no touch button is activated for 15 s during parameter setting, the unit returns to the operating mode with unchanged values.

- Change from menu level 1 to menu level 2:

▶ Touch [Mode/Enter] until [EF] is displayed.	
▶ Touch [Set] briefly. > The first parameter of the submenu is displayed (here: [Uni]). If the menu level 2 is protected by an access code, "Cod1" flashes in the display. ▶ Touch [Set] and keep it touched until the valid code no. appears. ▶ Touch [Mode/Enter] briefly. On delivery by ifm electronic: no access restriction.	

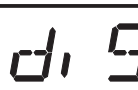
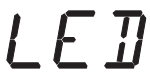
- Locking / unlocking

  The unit can be locked electronically to prevent an unintentional operation.

▶ Make sure that the unit is in the normal operating mode. ▶ Touch [Set], ▶ additionally touch [Mode/Enter] and keep both buttons touched for 10 s. > The LED for the current unit of measurement flashes, the current system pressure continues to be displayed. After 10 s the display goes out for approx. 1 s. ▶ Release [Mode/Enter] and [Set] again. Both buttons must be released within 4 s. If this does not happen, the unit remains unlocked. > [Loc] is displayed, the unit is locked. . During operation the indicator LED for the display unit (→ chapter 7) is flashing if you try to open the menu.
For unlocking: ▶ Make sure that the unit is in the normal operating mode. ▶ TTouch [Set], ▶ additionally touch [Mode/Enter] and keep both buttons touched for 10 s. > The LED for the current unit of measurement flashes, the current system pressure continues to be displayed. After 10 s the display goes out for approx. 1 s. ▶ Release [Mode/Enter] and [Set] again. Both buttons must be released within 4 s. If this does not happen, the unit remains unlocked. > [uLoc] is displayed, the unit is unlocked.

On delivery: unlocked.

9.2 Configuration of the digital display (optional)

▶ Select [Uni] and set the unit of measurement: - [bAr] / [mbAr]. - [PSI] / [inHO].	
▶ Select [SELd] and set type of indication: - [P]: system pressure in the unit set in Uni. - [P%]: system pressure in % of the set scaling of the analogue output; the following applies: 0 % = ASP value / 100 % = AEP value. Note: display “0 %” does not mean that no pressure is applied to the system.	
▶ Select [diS] and set the update rate of the display: - [d1]: update of the measured values every 50 ms. - [d2]: update of the measured values every 200 ms. - [d3]: update of the measured values every 600 ms. - [OFF] = The measured value display is deactivated in the Run mode. Touching one of the buttons indicates the current measured value for 15 s. Touching the [Mode/Enter] button again activates the display mode. The indicator LEDs remain active even if the display is deactivated.	
▶ Select [LED] and set the display function for the digital display and LED ring: - [SPRP]: One LED on the LED ring indicates the set point and a second LED the reset point. - [HInd]: 2 adjacent LEDs on the LED ring mark the lag indicator for maximum value ([HInd], high indication). - [LInd]: 2 adjacent LEDs on the LED ring mark the lag indicator for minimum value ([LInd], low indication). To reset: ▶ Touch [Set] for 1 second. > The two LEDs jump to the current position of the pointer. - [Ph]: Display of pulsating signals and pressure peaks: - In case of quick pressure changes (quickly pulsating signals) the digital display and LED ring indicate the minimum value and the maximum value. - In case of one-time short pressure peaks the digital display and LED ring show the indication for a longer time. - [Pdir]: The LED ring indicates the trend of the pressure changes (5 LEDs below the pointer for rising pressure; 5 LEDs above the pointer for falling pressure). A damping set with dAP or dAA also has an effect on this display.	

9.3 Set output signals

9.3.1 Set output functions

▶ Select [OU1] and set the switching function: - [Hno] = hysteresis function/NO. - [Hnc] = hysteresis function/NC. - [Fno] = window function/NO. - [Fnc] = window function/NC.	
▶ Select [OU2] and set the analogue function: - [I] = current signal proportional to pressure 4…20 mA. - [InEG] = current signal proportional to pressure 20…4 mA.	

UK

9.3.2 Set switching limits

▶ Select [SP1] and set the value at which the output switches.	
▶ Select [rP1] and set the value at which OUT1 switches off. rP1 is always smaller than SP1. The unit only accepts values which are lower than SP1.	

9.3.3 Scale analogue value for OUT2

▶ Set the minimum pressure requested in the system. ▶ Touch [Mode/Enter] until [tASP] appears. ▶ Touch [Set] and keep it touched. > Current setting value flashes. ▶ Release [Set] when the display stops flashing. > New setting value is displayed. ▶ Touch [Mode/Enter] briefly. > The current system pressure is defined as start value for the analogue signal.	
▶ Set the maximum pressure requested in the system. ▶ Touch [Mode/Enter] until [tAEP] appears. ▶ Touch [Set] and keep it touched. > Current setting value flashes. ▶ Release [Set] when the display stops flashing. > New setting value is displayed. ▶ Touch [Mode/Enter] briefly. > The current system pressure is defined as end value for the analogue signal.	
ASP / AEP can only be set automatically within defined limits (→ 12.1 Setting ranges). If automatic setting is carried out at an invalid pressure value, [UL] or [OL] is displayed. After acknowledgement by [Mode/Enter] [Err] flashes, the ASP value / AEP value is not changed.	

As an alternative: ▶ Select [ASP] and set the measured value at which 4 mA is provided (20 mA at [OU2] = [InEG]). ▶ Select [AEP] and set the measured value at which 20 mA is provided (4 mA at [OU2] = [InEG]). Minimum distance between ASP and AEP = 25 % of the final value of the measuring range (turn-down 1:4).	

9.4 User settings (optional)

9.4.1 Carry out zero point calibration

▶ Select [COF] and set a value between -5 % and 5 % of the final value of the measuring range. The internal measured value "0" is shifted by this value.	
As an alternative: automatic adjustment of the offset in the range 0 bar ± 5 %. ▶ Make sure that no pressure is applied to the system. ▶ Touch [Mode/Enter] until [tCOF] appears. ▶ Touch [Set] and keep it touched. > The current offset value (in %) flashes briefly. > The current system pressure is displayed. ▶ Release [Set]. ▶ Touch [Mode/Enter] briefly (= to confirm the new offset value).	

9.4.2 Set delay time for OUT1

[dS1] = switch-on delay / [dr1] = switch-off delay. ▶ Select [dS1] or [dr1] and set a value between 0.1 and 50 s (at 0.0 the delay time is not active).	

9.4.3 Set switching logic for OUT1

▶ Select [P-n] and set [PnP] or [nPn].	

9.4.4 Set damping for the switching signal

▶ Select [dAP] and set a value between 0.01 and 30 s. dAP value = response time between pressure change and change of the switching status in seconds. [dAP] influences the switching frequency: f_{max} = 1 ÷ 2dAP. [dAP] also has an effect on the display.	

9.4.5 Set damping for the analogue signal

▶ Select [dAA] and set a value between 0.01 and 30 s. dAA value = response time between pressure change and change of the analogue signal in seconds.	

9.4.6 Calibrate curve of measured values

If the unit is to adopt the settings for the calibration points, the following conditions must be adhered to:

- CP1 and CP2 must be within the measuring range (i.e. between ASP and AEP).
- CP1 and CP2 must not be in the extended display range.
- Minimum distance between the calibration points CP1 and CP2 = 5 % of the final value of the measuring range.
- Maximum correction value = ± 2 % of the final value of the measuring range.

UK

▶ Set a defined reference pressure between ASP and AEP in the system. ▶ Select [CAL]. ▶ Touch [Set] briefly. > [CP1] is displayed. ▶ Touch [Set] for 5 s. > The pressure measured by the unit is displayed. ▶ Touch [Set] until the set reference pressure is indicated (measured pressure = reference pressure) or the corresponding analogue signal is provided to OUT2. ▶ Touch [Mode/Enter] briefly. > [CP1] is displayed. ▶ Touch [Mode/Enter] briefly. > [CP2] is displayed. Continue with a) or b).	
a) Finish calibration: ▶ Touch [Mode/Enter] briefly. > [CAL] is displayed. b) Change a 2nd point on the curve of measured values: ▶ Set a second defined reference pressure in the system. ▶ Touch [Set] for 5 s. > The pressure measured by the unit is displayed. ▶ Touch [Set] until the set reference pressure is indicated (measured pressure = reference pressure) or the corresponding analogue signal is provided to OUT2. ▶ Touch [Mode/Enter] briefly. > [CP2] is displayed. ▶ Touch [Mode/Enter] briefly. > [CAL] is displayed, the process is finished.	

9.5 Service functions

9.5.1 Read min/max values for system pressure

▶ Select [HI] or [LO] and touch [Set] briefly. [HI] = maximum value, [LO] = minimum value. Delete memory: ▶ Select [HI] or [LO]. ▶ Touch [Set] and keep it touched until [----] is displayed. ▶ Touch [Mode/Enter] briefly.	

9.5.2 Reset all parameters to factory setting

▶ Select [rES]. ▶ Touch [Set] and keep it touched until [----] is displayed. ▶ Touch [Mode/Enter] briefly. It is recommended to take down your own settings in the table before carrying out a reset (→13 Factory setting).	

10 Operation

After power on, the unit is in the Run mode (= normal operating mode). It carries out its measurement and evaluation functions and provides output signals according to the set parameters.

Operating indicators → 7 Operating and display elements.

Reset the lag indicator (if [LED] = [HInd] or [LInd]):

▶ Touch [Set] for 1 second.

> The two lag indicator LEDs jump to the current position of the pointer.

10.1 Read set parameters

▶ Touch [Mode/Enter] until the requested parameter is displayed.

▶ Touch [Set] briefly.

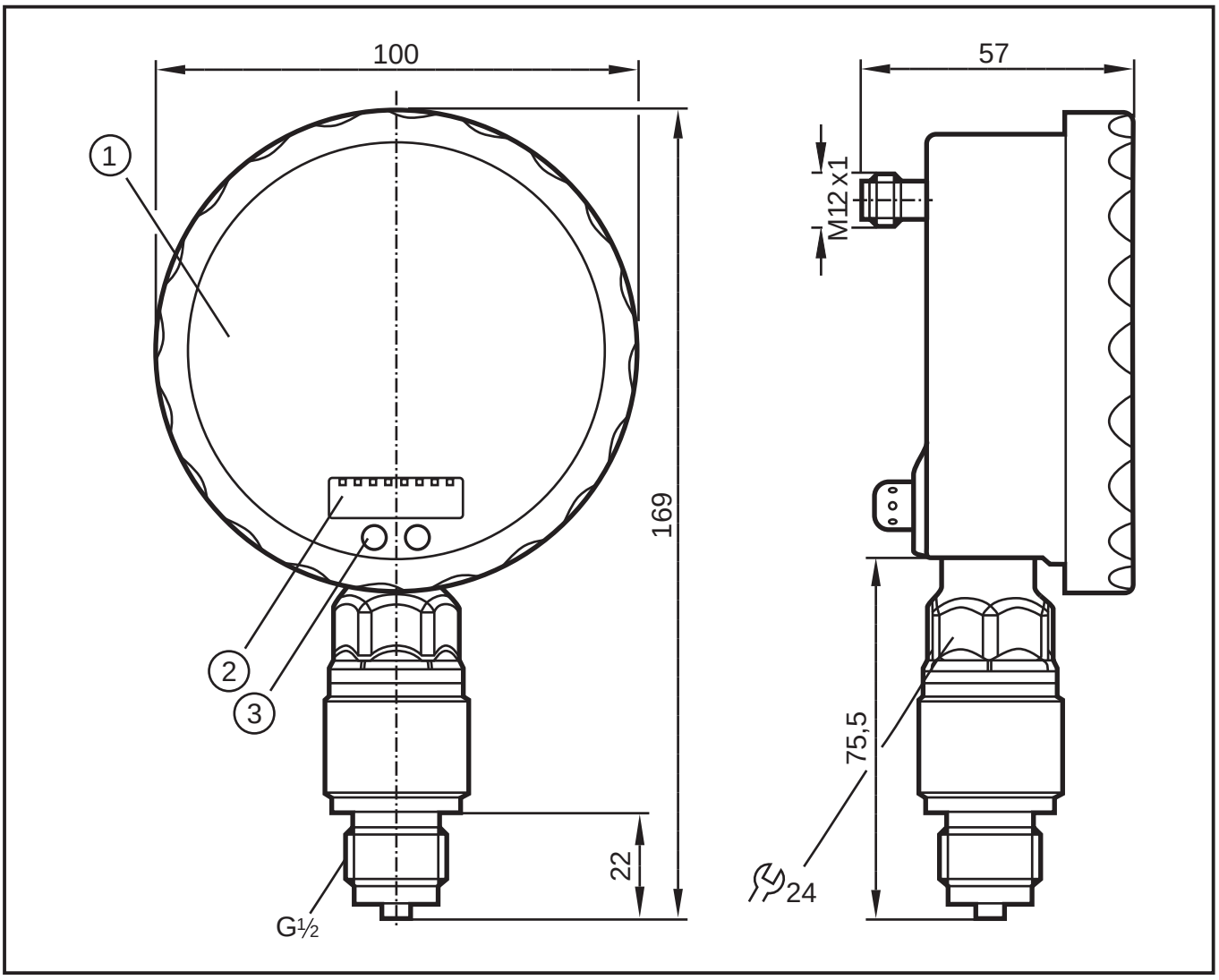
> The unit displays the corresponding parameter value for about 15 s. After another 15 s it returns to the Run mode.

10.2 Error indications

[OL]	Overload pressure (measuring range exceeded).
[UL]	Underload pressure (below measuring range).
[SC1]	Short circuit in OUT1. The output is switched off as long as the short circuit persists.
[Err]	Flashing: internal error, invalid entry.

The messages SC1 and Err are displayed even if the display is switched off.

11 Scale drawing



Dimensions in mm
1: analogue display
2: digital display
3: touch button (programming button)

12 Technical data

Operating voltage [V] ..... 18...32 DC
Current consumption [mA] ..... < 70 (24 V)
Current rating [mA] 250
Short-circuit protection; reverse polarity protection / overload protection, integrated watchdog
Voltage drop [V] ..... < 2
Power-on delay time [s] 6
Min. response time switching output [ms] 9
Switching frequency [Hz] 75
Analogue output ..... 4...20 mA / 20...4 mA
Max. load [Ω] ..... (Ub - 10) x 50
Step response time analogue output [ms] 28

Accuracy / deviations (in % of the span)[1)]

	PG2409 PG2452 ... PG2458	PG2450 PG2451 PG2489
Switch point accuracy	< ± 0.5	< ± 0.6
Switch point accuracy in the extended display range	< ± 1.5	< ± 1.5
Characteristics deviation	< ± 0.25 (BFSL) < ± 0.5 (LS)	< ± 0.35 (BFSL) < ± 0.6 (LS)
Hysteresis	< 0.25	< 0.5
Repeatability (in case of temperature fluctuations < 10 K)	< ± 0.1	< ± 0.1
Long-term stability (in % of the span / 6 months)	< ± 0.1	< ± 0.1

Temperature coefficients (TEMPCO) in the compensated temperature range 0 ...70°C (in % of the span per 10 K)

	PG2409 PG2452 ... PG2458	PG2450 PG2451 PG2489
Greatest TEMPCO of the zero point	< ± 0.2	< ± 0.3
Greatest TEMPCO of the span	< ± 0.2	< ± 0.3

Materials (wetted parts)	stainless steel 316L / 1.4404 ceramics (Al2O3); FPM
Housing materials	stainless steel 316L / 1.4404; PA; FPM (Viton); PTFE; viewing glass: laminated safety glass 4 mm
Protection rating	IP 67 / IP 69K
Protection class	III
Insulation resistance [MΩ]	> 100 (500 V DC)
Shock resistance [g]	50 (DIN IEC 68-2-27, 11 ms)
Vibration resistance [g]	20 (DIN IEC 68-2-6, 10 - 2000 Hz)
Switching cycles min.	100 million
Ambient temperature [°C]	-20 ... 80
Medium temperature [°C]	-25...80
Storage temperature [°C]	-40...100
EMC EN 61000-4-2 ESD:	4 / 8 kV
EN 61000-4-3 HF radiated:	10 V/m
EN 61000-4-4 Burst:	2 kV
EN 61000-4-5 Surge:	0.5 / 1 kV
EN 61000-4-6 HF conducted:	10 V

UK

[1)] 1) All indications are referred to a turn-down of 1:1

13 Setting ranges

		SP1		rP1		ASP		AEP		ΔP
		min	max	min	max	min	max	min	max	
PG2409	bar	-0.992	1.600	-1.000	1.592	-1.000	1.100	-0.500	1.600	0.004
	PSI	-14.40	23.22	-14.52	23.10	-14.52	15.96	-7.26	23.22	0.06
PG2450	bar	2	600	0	598	0	500	100	600	1
	PSI	30	8700	0	8670	0	7250	1450	8700	10
PG2451	bar	1.0	400.0	0.0	399.0	0.0	350.0	50.0	400.0	0.5
	PSI	15	5800	0	5785	0	5075	725	5800	5
PG2452	bar	0.4	160.0	0.0	159.6	0.0	135.0	25.0	160.0	0.2
	PSI	6	2322	0	2316	0	1959	363	2322	3

ΔP = step increment

		SP1		rP1		ASP		AEP		ΔP
		min	max	min	max	min	max	min	max	
PG2453	bar	-0.90	40.00	-1.00	39.90	-1.00	33.75	5.25	40.00	0.05
	PSI	-13.0	580.0	-14.5	578.5	-14.5	489.5	76.0	580.0	0.5
PG2454	bar	-0.96	16.00	-1.00	15.96	-1.00	13.50	1.50	16.00	0.02
	PSI	-14.0	232.0	-14.4	231.6	-14.4	195.8	21.8	232.0	0.2
PG2455	bar	-0.98	6.40	-1.00	6.38	-1.00	5.40	0.00	6.40	0.01
	PSI	-14.2	92.8	-14.5	92.5	-14.5	78.3	0.0	92.8	0.1
PG2456	bar	-0.115	4.000	-0.125	3.990	-0.125	3.350	0.525	4.000	0.005
	PSI	-1.65	58.00	-1.80	57.85	-1.80	48.60	7.60	58.00	0.05
PG2457	bar	-0.046	1.600	-0.050	1.596	-0.050	1.340	0.200	1.600	0.002
	PSI	-0.66	23.20	-0.72	23.14	-0.72	19.58	2.90	23.20	0.02
PG2458	mbar	-11.5	400.0	-12.5	399.0	-12.5	337.5	50.0	400.0	0.5
	inH2O	-4.6	160.6	-5.0	160.2	-5.0	135.6	20.0	160.6	0.2
PG2489	mbar	-4.6	160.0	-5.0	159.6	-5.0	135.0	20.0	160.0	0.2
	inH2O	-1.84	64.24	-2.00	64.08	-2.00	54.24	8.00	64.24	0.08

ΔP = step increment

14 Factory setting

	Factory setting	User setting
SP1	25.0 % VMR*	
rP1	24.9 % VMR*	
OU1	Hno	
OU2	I	
COF / tCOF	0.0	
ASP / tASP	0 % VMR*	
AEP / tAEP	100 % VMR*	
Uni	bAr / mbAr	
SELd	P	
dS1	0.0	
dr1	0.0	
P-n	pnp	
dAP	0.06	
dAA	0.03	
dis	d2	
LED	SPRP	
CP1	0.00	
CP2	0.00	

* = the indicated percentage of the final value of the measuring range (VMR) of the corresponding sensor is set.

More information at www.ifm.com

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

APPENDIX F

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

Aluminium Sulphate Solution

Section 01 - Chemical And Product And Company Information

Product Identifier ..... Aluminium sulphate solution

Product Use ..... Coagulating agent in municipal and industrial water and wastewater treatment, additive in papermaking.

Supplier Name..... ClearTech Industries Inc.
2302 Hanselman Avenue
Saskatoon, SK. S7L 5Z3
Canada

Prepared By..... ClearTech Industries Inc. Technical Department
Phone: (306)664-2522

Preparation Date..... November 26, 2009

24-Hour Emergency Phone..... 306-664-2522

Section 02 - Composition / Information on Ingredients

Hazardous Ingredients.....	Aluminum sulphate hydrate	45-55%
CAS Number.....	Aluminum sulphate hydrate	16828-12-9

Synonym (s).....Liquid alum; aluminum sulfate solution; papermaker's alum; sulphuric acid, aluminum salt.

Section 03 - Hazard Identification

Inhalation..... Inhalation of mists can be irritating to the respiratory tract and lungs.

Skin Contact / Absorption…….. Mild to moderate irritation can occur. Aluminum is very poorly absorbed through the skin and toxic effects would not be expected following short-term skin contact.

Eye Contact.....…….. May result in mild to moderate irritation to eyes.

Ingestion.....……. Amounts ingested incidental to industrial handling are not likely to cause injury. Large amounts may cause abdominal pain, nausea, vomiting. Can cause burns of the mouth, bleeding stomach, incoordination, muscle spasms, and kidney injury.

Exposure Limits…….. ACGIH/TLV-TWA= 2mg/m^3(Soluble Aluminum Salts)
OSHA/PEL-TWA= 2mg/m^3(Soluble Aluminum Salts)

Section 04 - First Aid Measures

Inhalation.....…….. Remove victim to fresh air. Give artificial respiration only if breathing has stopped. If breathing is difficult, give oxygen. Seek immediate medical attention.

Skin Contact / Absorption…….. Remove contaminated clothing. Wash affected area with soap and water. Seek medical attention if irritation occurs or persists.

Eye Contact.....…….... Flush immediately with water for at least 20 minutes. Forcibly hold eyelids apart to ensure complete irrigation of eye tissue. Seek immediate medical attention.

Ingestion.....……. Do not induce vomiting. If vomiting occurs, lean victim forward to prevent breathing in vomitus. Give large amounts of water. Do not give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention.

Additional Information.....…….... Not available

Section 05 - Fire Fighting

Conditions of Flammability…….... Non-flammable

Means of Extinction.....…….... Product itself does not burn. However, decomposition product sulfur trioxide will react with water to form sulfuric acid. Use appropriate extinguishing agent.

Flash Point.....……. Not applicable

Auto-ignition Temperature……. Not applicable

Upper Flammable Limit …….. Not applicable

Lower Flammable Limit..…….…. Not applicable

Hazardous Combustible Products... Under fire conditions (or at temperatures greater than 650°C), product decomposes to give off sulfur trioxide, an oxidizing agent which will support combustion.

Special Fire Fighting Procedures..... Wear NIOSH-approved self-contained breathing apparatus and protective clothing.

Explosion Hazards……... Liquid alum may react with some metals, to give flammable, potentially explosive hydrogen gas. Hydrogen gas can accumulate to explosive concentrations inside confined spaces. Follow appropriate NFPA codes.

Section 06 - Accidental Release Measures

Leak / Spill.....……. Wear appropriate personal protective equipment. Ventilate area. Stop or reduce leak if safe to do so. Prevent material from entering sewers. Cover spill with dry earth, sand or other non-combustible material.

Deactivating Materials..……... Lime, limestone, soda ash, sodium bicarbonate, dilute sodium hydroxide or dilute aqua ammonia.

Section 07 - Handling and Storage

Handling Procedures.....……. Use proper equipment for lifting and transporting all containers. Use sensible industrial hygiene and housekeeping practices. Wash thoroughly after handling. Avoid all situations that could lead to harmful exposure.

Storage Requirements.....……..…. Store in a cool, dry, well-ventilated place. Keep container tightly closed, and away from incompatible materials. Store at temperatures below 40°C and above 0°C.

Section 08 - Personal Protection and Exposure Controls

Protective Equipment

Eyes..……... Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.

Respiratory..... A NIOSH/MSHA approved air-purifying respirator equipped with acid gas/fume, mist cartridges for concentrations up to 20 mg/m^3. An air-supplied respirator if concentrations are higher or unknown.

Gloves..... Impervious gloves of chemically resistant material (rubber or PVC) should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.

Clothing..... Body suits, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.

Footwear..... Impervious boots of chemically resistant material should be worn at all times.

Engineering Controls

Ventilation Requirements..... Mechanical ventilation (dilution or local exhaust), process or personnel enclosure and control of process conditions should be provided. Supply sufficient replacement air to make up for air removed by exhaust systems.

Other..... Emergency shower and eyewash should be in close proximity.

Section 09 - Physical and Chemical Properties

Physical State..... Liquid

Odor and Appearance..... Pale straw coloured, clear odourless liquid.

Odor Threshold..... Not available

Specific Gravity (Water=1)..... 1.335

Vapor Pressure (mm Hg, 20C)..... Not available

Vapor Density (Air=1)..... Not available

Evaporation Rate..... Not available

Boiling Point..... 101°C

Freeze/Melting Point..... -16°C

pH..... 1.9-2.3

Water/Oil Distribution Coefficient.... Not available

Bulk Density..... Not available

% Volatiles by Volume..... Not available

Solubility in Water..... Completely miscible

Molecular Formula..... $Al_2(SO_4)_3$ $14H_2O$

Molecular Weight..... 594.14

Section 10 - Stability and Reactivity

Stability..... Stable under normal conditions.

Incompatibility..... Corrosive to carbon steel, aluminum, and zinc. Reacts with strong bases to form aluminum hydroxide.

Hazardous Products of Decomposition.. May react with many metals including carbon steel and aluminum to form flammable gases including sulphur oxides and hydrogen. Liquid alum is stable below 60°C.

Polymerization..... Will not occur

Section 11 - Toxicological Information

Irritancy..... Corrosive

Sensitization..... Not available

Chronic/Acute Effects..... Skin irritation may be aggravated in individuals with existing skin lesions. Breathing of vapors or sprays (mists) may aggravate acute or chronic asthma and chronic pulmonary disease such as emphysema and bronchitis.

Synergistic Materials..... Not available

Animal Toxicity Data..... LD_{50}(mouse,oral)= >9000 mg/kg
LD_{50}(rat,oral)= >9000 mg/kg

Carcinogenicity..... Sulfuric acid mist: Classified 1 (Proven for humans) by IARC, 1 (Known to be human carcinogens) by NTP

Sulfuric acid mist: Classified A2 (Suspected for humans) by ACGIH

Reproductive Toxicity..……..…….. Not available

Teratogenicity.....…...……... Not available

Mutagenicity.....…….....……. Not available

Section 12 - Ecological Information

Fish Toxicity.....…….. LD_{50}(72 hrs, goldfish)= 100mg/L

Biodegradability.....…….... The products of biodegradation are more toxic than the original product.

Environmental Effects……. May be harmful to aquatic life. Toxicity is primarily associated with the acidic pH. Acidic soil conditions develop where contamination with this material occurs.

Section 13 - Disposal Consideration

Waste Disposal.....…...…….. Dispose in accordance with all federal, provincial, and/or local regulations including the Canadian Environmental Protection Act.

Section 14 - Transportation Information

TDG Classification

Class……..……..…... 8

Group.....…….....…….. III

PIN Number.....…….…….. UN 3264

Other……..... Secure containers (full and/or empty) with suitable hold down devises during shipment.

Section 15 - Regulatory Information

WHMIS Classification.....……...E

NOTE: THE PRODUCT LISTED ON THIS MSDS HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CANADIAN CONTROLLED PRODUCTS REGULATIONS. THIS MSDS CONTAINS ALL INFORMATION REQUIRED BY THOSE REGULATIONS.

NSF Certification.....Product is certified under NSF/ANSI Standard 60 for coagulation and flocculation at a maximum dosage of 330mg/L.

Section 16 - Other Information

Note: The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations.

Attention: Receiver of the chemical goods / MSDS coordinator

As part of our commitment to the Canadian Association of Chemical Distributors (CACD) Responsible Distribution® initiative, ClearTech Industries Inc. and its associated companies require, as a condition of sale, that you forward the attached Material Safety Data Sheet(s) to all affected employees, customers, and end-users. ClearTech will send any available supplementary handling, health, and safety information to you at your request.

If you have any questions or concerns please call our customer service or technical service department.

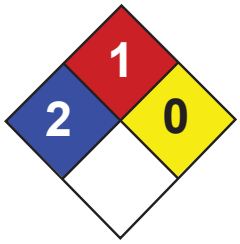
ClearTech Industries Inc. - Locations

Corporate Head Office: 2302 Hanselman Avenue, Saskatoon, SK, S7L 5Z3
Phone: 306-664-2522
Fax: 306-665-6216

www.ClearTech.ca

Location	Address	Postal Code	Phone Number	Fax Number
Richmond, B.C.	12431 Horseshoe Way	V7A 4X6	604-272-4000	604-272-4596
Calgary, AB.	5516E - 40th St. S.E.	T2C 2A1	403-279-1096	403-236-0989
Edmonton, AB.	11750 - 180th Street	T5S 1N7	780-452-6000	780-452-4600
Saskatoon, SK.	2302 Hanselman Avenue	S7L 5Z3	306-933-0177	306-933-3282
Regina, SK.	555 Henderson Drive	S42 5X2	306-721-7737	306-721-8611
Winnipeg, MB.	340 Saulteaux Crescent	R3J 3T2	204-987-9777	204-987-9770
Mississauga, ON.	7480 Bath Road	L4T 1L2	905-612-0566	905-612-0575

24 Hour Emergency Number - All Locations - 306-664-2522



Health	2
Fire	1
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Citric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Citric acid

Catalog Codes: SLC5449, SLC2665, SLC4453, SLC1660, SLC3451

CAS#: 77-92-9

RTECS: GE7350000

TSCA: TSCA 8(b) inventory: Citric acid

CI#: Not available.

Synonym: 2-Hydroxy-1,2,3-propanetricarboxylic acid

Chemical Name: Citric Acid

Chemical Formula: C6H8O7

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Citric acid	77-92-9	100

Toxicological Data on Ingredients: Citric acid: ORAL (LD50): Acute: 5040 mg/kg [Mouse]. 3000 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of eye contact (irritant), of inhalation (lung irritant). Slightly hazardous in case of skin contact (irritant, sensitizer), of ingestion. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Severe over-exposure can produce lung damage, choking, unconsciousness or death.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 1010°C (1850°F)

Flash Points: Not available.

Flammable Limits: LOWER: 0.28 Kg/M3 (Dust) UPPER: 2.29 Kg/M3 (Dust)

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of heat. Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Slightly explosive in presence of open flames and sparks. Non-explosive in presence of shocks.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: As with most organic solids, fire is possible at elevated temperatures

Special Remarks on Explosion Hazards:
Fine dust dispersed in air in sufficient concentrations, and in the presences of an ignition source is a potential dust explosion hazard.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe dust. Avoid contact with eyes. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, reducing agents, metals, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Safety glasses. Lab coat. Gloves (impervious). Dust respirator. Be sure to use an approved/certified respirator or equivalent. The dust respirator should be used for conditions where exposure has exceeded recommended exposure limits, dust is apparent, and engineering controls(adequate ventilation) are not feasible.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
No exposure guidelines have been established. ACGIH, NIOSH and OSHA have not developed exposure limits for this product. The exposure limits given below are for particulates not otherwise classified: ACGIH: 10 mg/m3 TWA (Total Inhalable fraction); 3 mg/m3 TWA (Respirable fraction) OSHA: 15 mg/m3 TWA (Total dust); 5 mg/m3 TWA (Respirable Fraction)

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Crystalline powde)

Odor: Odorless.

Taste: Acid. (Strong.)

Molecular Weight: 192.13 g/mole

Color: Not available.

pH (1% soln/water): Not available.

Boiling Point: Decomposes.

Melting Point: 153°C (307.4°F)

Critical Temperature: Not available.

Specific Gravity: 1.665 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -1.7

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Soluble in cold water, hot water, diethyl ether. Insoluble in benzene.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, reducing agents, metals, alkalis.

Corrosivity:
Corrosive in presence of aluminum, of zinc, of copper. Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Incompatible with oxidizing agents, potassium tartrate, alkali, alkaline earth carbonates and bicarbonates, acetates, and sulfides, metal nitrates

Special Remarks on Corrosivity: Will corrode copper, zinc, aluminum and their alloys.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 3000 mg/kg [Rat].

Chronic Effects on Humans: May cause damage to the following organs: teeth.

Other Toxic Effects on Humans:
Hazardous in case of inhalation (lung irritant). Slightly hazardous in case of skin contact (irritant, sensitizer), of ingestion.

Special Remarks on Toxicity to Animals: LDL[Rabbit] - Route: oral; Dose: 7000mg/kg

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes mild to moderate skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Eyes: Causes moderate to severe eye irritation and possible injury. Ingestion: May cause gastrointestinal (digestive) tract irritation with nausea, vomiting, diarrhea. Excessive intake may cause erosion of teeth and hypocalcemia (calcium deficiency in blood). May affect behavior/central nervous system (tremor, convulsions, muscle contraction or spasticity). Inhalation: Causes moderate respiratory tract and mucous membrane irritation. Chronic Potential Health Effects: Frequent intake of citrated beverages may cause erosion of dental enamel and irritation of mucous membranes.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Citric acid

Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): CLASS E: Corrosive solid.

DSCL (EEC):
R36/37/38- Irritating to eyes, respiratory system and skin. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S37/39- Wear suitable gloves and eye/face protection.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 1

Reactivity: 0

Personal Protection: e

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves (impervious). Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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Last Updated: 05/21/2013 12:00 PM

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Material Safety Data Sheet
Sodium Hypochlorite, 5% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium Hypochlorite, 5%

Catalog Codes: SLS1654

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Sodium hypochlorite; Sodium hydroxide; Water

CI#: Not applicable.

Synonym: Chlorine Bleach, Bleach, Soda Bleach, Chlorox; Sodium Hypochlorite, Solution, 5% Available Chlorine

Chemical Name: Hypochlorous acid, sodium salt, solution

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium hypochlorite	7681-52-9	4-7
Sodium hydroxide	1310-73-2	<1
Water	7732-18-5	>92

Toxicological Data on Ingredients: Sodium hypochlorite: ORAL (LD50): Acute: 5800 mg/kg [Mouse]. 8910 mg/kg [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, . Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer). Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Sodium hypochlorite]. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. [Sodium hypochlorite]. Mutagenic for mammalian somatic cells. [Sodium hydroxide]. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to lungs, mucous membranes, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: combustible materials, metals, organic materials

Explosion Hazards in Presence of Various Substances:
Slightly explosive in presence of open flames and sparks. Non-explosive in presence of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Releases chlorine when heated above 35 deg. C. The substance itself is non-combustible and does not burn. However, when heated to decomposition it emits corrosive and/or toxic fumes. May ignite combustibles. Fire risk in contact with organic materials. Contact with metals may evolve flammable hydrogen gas.

Special Remarks on Explosion Hazards:
Anydrous Sodium Hypochlorite is very explosive. Primary amines and calcium hypochlorite or sodium hypochlorite react to form normal chloroamines, which are explosive. Interaction of ethyleneimine with sodium (or other) hypochlorite gives the explosive N-chloro cmpd. Removal of formic acid from industrial waste streams with sodium hypochlorite soln becomes explosive at 55 deg C. Several explosions involving methanol and sodium hypochlorite were attributed to formation of methyl hypochlorite, especially in presence of acid or other esterification catalyst. Use of sodium hypochlorite soln to destroy acidified benzyl cyanide residues caused a violent explosion, thought to have been due to formation of nitrogen trichloride. (Sodium hypochlorite)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Corrosive liquid. Oxidizing material. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substance damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents, combustible materials, organic materials, metals, acids.

Storage:
Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Air Sensitive Sensitive to light. Store in light-resistant containers.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
Sodium hypochlorite TWA: 1 CEIL: 1 (ppm as Cl2) STEL: 1 (ppm as Cl2) from ACGIH (TLV) [United States] Sodium hydroxide STEL: 2 (mg/m3) from ACGIH (TLV) [United States] TWA: 2 CEIL: 2 (mg/m3) from OSHA (PEL) [United States] CEIL: 2 (mg/m3) from NIOSH Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Characteristic. Chlorine-like (Slight.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light greenish yellow

pH (1% soln/water): Neutral.

Boiling Point: Decomposition temperature: 40°C (104°F)

Melting Point: Not available.

Critical Temperature: Not available.

Specific Gravity: 1.07 - 1.093 (Water = 1)

Vapor Pressure: 2.3 kPa (@ 20°C)

Vapor Density: The highest known value is 0.62 (Air = 1) (Water).

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility: Easily soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials. light, air, heat

Incompatibility with various substances: Reactive with reducing agents, combustible materials, organic materials, metals, acids.

Corrosivity:
Extremely corrosive in presence of aluminum. Corrosive in presence of stainless steel(304), of stainless steel(316). Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Decomposed by carbon dioxide from air. Slowly decomposes on contact with air. Unstable in air unless mixed with sodium hydroxide. Incompatible with ammonium acetate, ammonium carbonate, ammonium nitrate, ammonium oxalate, and ammonium phosphate. Decompostion of sodium hypochlorite takes place within a few seconds with these salts. Also incompatible with primary amines, phenyl acetonitrile, ethyleneimine, methanol, acidified benzyl cyanide, formic acid, urea, nitro compounds, methylscellulose, celloluse, aziridine, ether, ammonia. Mixing this product with chemicals (e.g. ammonia, acids, detergents, etc.) or organic matter (e.g. urine, feces, etc.) will release chlorine gas. Chloramine gas may be evolved when ammonia and bleach are mixed. Decomposed by hot water. Sensitive to light. Exposure to light accelerates decompositon.

Special Remarks on Corrosivity:
Sodium Hypochlorite is extremely corrosive to brass, and moderately corrosive to bronze. There is no corrosivity information for copper.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Eye contact. Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 5800 mg/kg [Mouse]. (Sodium hypochlorite).

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Sodium hypochlorite]. MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. [Sodium hypochlorite]. Mutagenic for mammalian somatic cells. [Sodium hydroxide]. Contains material which may cause damage to the following organs: lungs, mucous membranes, skin, eyes.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (irritant), of ingestion, . Hazardous in case of skin contact (corrosive), of eye contact (corrosive). Slightly hazardous in case of inhalation (lung sensitizer, lung corrosive).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: May affect genetic material (mutagenic) (Sodium hypochlorite)

Special Remarks on other Toxic Effects on Humans:
Potential Health Effects: Can cause severe irritation and possible burns to skin and eyes. Eye contact may also cause corneal and conjunctival edema, conjunctival hemorrhages. Contact with skin may also cause vesicular eruptions and eczematoid dermatitis which becomes evident upon re-exposure. Prolonged or repeated eye contact may cause conjunctivitis. Ingestion can cause burns to the digestive tract. Symptoms may include: 1. pain and inflammation of the mouth, pharynx, esophagus, and stomach, 2. erosion of the mucous membranes (chiefly of the stomach), nausea, vomiting, choking, coughing, hemorrhage, 3. circulatory collapse with cold and clammy skin (due to methemoglobinemia), cyanosis, and shallow respirations, 4. confusion, delirium, coma, 5. edema of the pharynx, glottis, larynx with stridor and obstruction, 6. perforation of the esophagus, or stomach, with mediastinitis or peritonitis. Inhalation causes slight to severe respiratory tract irritation and delayed pulmonary edema. Prolonged or repeated inhalation may cause allergic respiratory reaction (asthma).

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Dilute with water and flush to sewer of local ordinances allow, otherwise, whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Hypochlorite solution UNNA: 1791 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Sodium hydroxide Illinois chemical safety act: Sodium hydroxide New York release reporting list: Sodium hydroxide Rhode Island RTK hazardous substances: Sodium hydroxide Pennsylvania RTK: Sodium hypochlorite; Sodium hydroxide Florida: Sodium hypochlorite Minnesota: Sodium hypochlorite; Sodium hydroxide Massachusetts RTK: Sodium hypochlorite; Sodium hydroxide New Jersey: Sodium hypochlorite; Sodium hydroxide Louisiana spill reporting: Sodium hydroxide TSCA 8(b) inventory: Sodium hypochlorite; Sodium hydroxide; Water CERCLA: Hazardous substances.: Sodium hypochlorite: 100 lbs. (45.36 kg); Sodium hydroxide: 1000 lbs. (453.6 kg);

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada): CLASS E: Corrosive liquid.

DSCL (EEC):
R8- Contact with combustible material may cause fire. R31- Contact with acids liberates toxic gas. R36/38- Irritating to eyes and skin. S28- After contact with skin, wash immediately with plenty of water. S36/37/39- Wear suitable protective clothing, gloves and eye/face protection. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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Last Updated: 05/21/2013 12:00 PM

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Gardner Denver

H.M.I.S.	
Health:	0
Flammability:	1
Reactivity:	0

These ratings should be used only as a part of a fully implemented H.M.I.S. program.

Material Safety Data Sheet

Section I - Product Identification

Trade Name and Synonyms **AEON-PD**	**Part Numbers:** **28G23; 28G24; 28G25; 28G28; 28G40; 28G41**	Health Emergency Phone Number **(217) 222-5400** **Safety Department**
Manufacturer's Name Gardner Denver, Inc.		
Address 1800 Gardner Expressway - Quincy, IL 62305		Transport Emergency Phone Number **(800) 424-9300 (CHEMTREC)**
Product Identification Positive Displacement Blower Lubricant		
Chemical Names and Synonyms Polyalphaolefin	**Use or Description** Gear Oil	

Section II - Composition/Information on Ingredients

Chemical Family:	Synthetic Hydrocarbon	**CAS Number**	Proprietary
Formula:	$C_{10n}H_{20n+2}$		

Section III - Chemical and Physical Properties

Appearance:	Blue Liquid	**Specific Gravity:**	(water=1):0.84-0.89
Odor:	None	**Vapor Pressure:**	<0.01mmHg@20°C
Volatile, Percent by Volume:	0%	**Solubility in Water:**	Insoluble
Boiling Point:	>600°F	**Evaporation Rate (butyl acetate=1):**	Nil

Section IV - Hazards Identification

Threshold Limit Value:	5mg/m^3 ACGIH
Situations to Avoid	Avoid breathing oil mists.

This product is non-hazardous. The product contains no known carcinogens. No special warning labels are required under OSHA 29 CFR 1910. 1200.

Section V - First Aid Measures

Eye Contact:	Flush eyes with water for 15 minutes and consult physician.
Skin Contact:	Upon contact with skin, wash with soap and water.
Inhalation:	Product is not toxic by inhalation. If oil mist is inhaled, remove to fresh air and consult physician.
Ingestion:	Consult physician at once. **DO NOT INDUCE VOMITING.** May cause nausea and diarrhea.

To the best of our knowledge the toxicity of this product has not been fully investigated. Analogous compounds are considered to be essentially non-toxic.

Section VI - Fire Fighting Measures

Flash Point: 405-495℉	**Method:** Cleveland Open Cup - COC
Flammable Limits:	Not established
Autoignition Temperature:	No data
Extinguishing Media:	Dry chemical; CO_2 foam; water spray (fog)
Fire Fighting Instructions:	Burning fluid may evolve irritating/noxious fumes. Firefighters should use NIOSH/MNSA Approved self-contained breathing apparatus. Use water to cool fire-exposed containers. Use water carefully near exponed liquid to avoid frothing and splashing of hot liquid.
NFPA Classification:	Not established

Section VII - Stability and Reactivity

Chemical Stability	Stable
Conditions to Avoid:	Excessive heat
Incompatibility with other Materials:	Strong oxidizers
Hazardous Decomposition Products:	Analogous compounds evolve carbon monoxide, carbon dioxide, and other unidentified fragments when burned.
Hazardous Polymerization:	Will not occur.

Section VIII - Accidental Release Measures

Safeguards (Personnel):	Wear suitable protective equipment, especially goggles.
Initial Containment:	Stop source of spill. Dike spill area. Use absorbent materials to soak up fluid (i.e. sand, sawdust, and commercially available materials.)
Spill Clean-Up:	Wash spill area with large amount of water. Properly dispose of all materials

Section IX - Handling and Storage

Handling (Personnel):	Do not take internally. Avoid contact with skin, eyes, and clothing. Upon contact with skin, wash with soap and water. Flush eyes with water for 15 minutes and consult physician. Wash contaminated clothing before reuse.
Handling (Physical Aspects):	
Storage:	Keep container tightly sealed when not in use.

Section X - Exposure Controls/Personal Protection

ENGINEERING CONTROLS:	
Ventilation:	Local exhaust
PERSONAL PROTECTIVE EQUIPMENT:	
Respiratory Protection:	Use in well ventilated area
Protective Gloves:	Not required, but recommended, especially for prolonged exposure.
Eye Protection:	Goggles
Other Protective Equipment:	
EXPOSURE GUIDELINES:	
Applicable Exposure Limits:	

Section XI - Toxicological Information

Animal Data:	No specific animal toxicological data available for this product.

Section XII - Ecological Information

Ecotoxicological Information:	No specific aquatic data available for this product.

Section XIII - Disposal Considerations

Waste Disposal:	Incinerate this product and all associated wastes in a licensed facility in accordance with Federal, state, and local regulations.
Container Disposal:	

Section XIV - Transportation Information

Shipping Information:	DOT - Not regulated. ICAO/IMO - Not restricted.

Section XV - Regulatory Information

U.S. FEDERAL REGULATIONS:	
OSHA Hazard Determination:	Under normal conditions of use, this material is not known to be hazardous as defined by OSHA's Hazard Communication Standard, 29 CFR 1910.1200.
CERCLA/Superfund:	This material is not known to contain hazardous substances in sufficient quantity to make it subject to CERCLA regulations.
SARA, Title III, 302/304:	This material is not known to contain extremely hazardous substances.
Title III Hazard Classifications Sections 311, 312:	Acute: No Chronic: No Reactivity: No Pressure: No Fire: No
SARA Title III, 313:	This material is not known to contain any chemical(s) at a level of 1.0% or greater (0.1% for carcinogens) on the list of Toxic Chemicals and subject to release reporting requirements.
TSCA:	Material and/or components are listed in the TSCA Inventory of Chemical Substances (40 CFR 710).
RCRA:	This material has been evaluated for RCRA characteristics and does not meet hazardous waste criteria if discarded in its purchased form. Because of product use, transformation, mixing, processing, etc., which may render the resulting material hazardous, it is the product user's responsibility to determine at the time of disposal whether the material meets RCRA hazardous waste criteria.
Clean Water Act:	This material is not known to contain any ingredient(s) subject to the Act.
STATE REGULATIONS (U.S.):	
California "Prop 65":	Product may contain ingredient(s) known to the State of California to cause cancer, birth defects, or other reproductive harm, but the degree of exposure poses a health risk that is below the Prop 65 No Significant Risk Level for the listed chemical(s).
Pennsylvania Worker & Community Right to Know Act:	This material is not known to contain any ingredient(s) subject to the Act.
CANADIAN REGULATIONS:	This is not a WHMIS controlled product. Transport/Medical Emergency Phone Number: 613-348-3616.

Section XVI - Other Information

NFPA, NPCA-HMIS:		
NFPA Rating:		
Health	0	Personal Protection B
Flammability	1	
Reactivity	0	
NPCA-HMIS Rating:		
Health		Personal Protection B
Flammability		
Reactivity		

This information in this material safety data sheet should be provided to all who use, handle, store, transport, or are otherwise exposed to this product.

NOVOZYMES BIOLOGICALS, INC.
111 Kessler Mill Road
Salem, VA 24153

Telephone number: 540-389-9361 Fax: 540-389-9364

Emergency Contact: 540-389-9361 CHEMTREC: 1-800-424-9300

Material Safety Data Sheet **Date: 03/31/2006**

SECTION I—PRODUCT IDENTIFICATION

NAME: –BI-CHEM ® DC CWT Blend CAN	PRODUCT CODE - 7009848

DOT CLASS: Not Regulated.
UN NUMBER: NA
PROPER SHIPPING NAME: NA

HMIS RATING & CANADIAN WHMIS CLASSIFICATION

HEALTH	1	CANADIAN WHMIS CLASSIFICATION:	D 2 B
FIRE	0		
REACTIVITY	0		

SECTION II - INGREDIENTS

ALL COMPONENTS APPEAR ON THE TSCA INVENTORY AND CANADIAN DSL LIST. COMPONENTS NOT LISTED ARE EITHER NON HAZARDOUS OR IN CONCENTRATIONS OF LESS THAN 1%.

Ingredient Name	CAS Number	OSHA PEL	ACGIH TLV/TWA
Viable Bacterial Cultures	NA	NA	NA

SECTION III – PHYSICAL CHARACTERISTICS

Boiling Point	No Data	**Appearance and Odor**	Tan free flowing grain like substance, earthly odor.
Bulk Density	Approximately 0.66-0.77 gm/cm3	**Melting Point**	No Data
NA	6.5 - 8.5	**Vapor Density**	No Data
Vapor Pressure	No Data	**Solubility**	Minimal

NOVOZYMES BIOLOGICALS, INC.
111 Kessler Mill Road
Salem, VA 24153

Telephone number: 540-389-9361 Fax: 540-389-9364

Emergency Contact: 540-389-9361 CHEMTREC: 1-800-424-9300

SECTION IV – FIRE/EXPLOSION

Flash Point:	No data
Flash Point Method Used:	NA
LEL:	Not know
UEL:	Not known

Extinguishing Media: Water spray, carbon dioxide or dry chemical.

Special Fire Fighting Procedures: None

Unusual Fire and Explosion Hazards: None known.

SECTION V – REACTIVITY DATA

Stable: X **Unstable:**

Incompatibility: Strong acids or alkali compounds may inactivate biological cultures.

Hazardous Decomposition or By Products: Not Known.

Hazardous Polymerization: Will not occur.

SECTION VI – HEALTH HAZARD DATA

Acute Health Affects

Routes of Entry:	**Inhalation:** yes	**Absorption:** no	**Ingestion:** yes	**Eyes:** yes

Eyes: This product may cause eye irritation.

Skin Contact: Could cause mild skin irritation after prolonged contact.

Inhalation: Inhaling dust from this product could cause irritation to the lungs and mucus membranes.

Ingestion: Ingestion of this product could cause irritation to the mouth and throat or cause choking.

Signs and Symptoms of Over Exposure: None Known

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Aggravated Medical Conditions: None known, however persons with respiratory problems should avoid breathing dust from this product.

Supplemental Health Information: None

Emergency First Aid Procedures

Eye Contact: Rinse eyes with water for fifteen minutes, if irritation persists, see a physician.

Inhalation: Move person to fresh air and avoid breathing dust from product. If breathing problems develop, seek the care of a physician.

Skin Contact: Wash the product off the skin with soap and water; if irritation develops seek the care of a physician.

Ingestion: Do not induce vomiting, if victim is choking clear airway and seek medical attention.

SECTION VII – SPILL OR LEAK PROCEDURE

Steps to be taken in case material is spilled or leaked:

Waste Disposal Method: Contain and collect material, place in proper container for reuse or disposal.
Dispose of materials in accordance with all federal, state and local laws.

Precautions To Be Taken In Handling and Storage: Store in a location away from children, food items and potable water.
Store in an area out of the direct sunlight, keep container closed when not in use, avoid storing in a damp environment.
Always wash hands with soap and water before handling food or smoking.
Use good chemical hygiene practices when working with any chemical.

Other Precautions: None

SECTION VIII – CONTROL MEASURES (PPE)

Respiratory Protection: Use a NIOSH approved dust mask to control nuisance dust.

Protective Gloves: Recommended. Disposable nitrite exam gloves are suitable for preventing prolonged contact with the skin.

Eye Protection: Safety glasses with side shields are recommended.

Other Protective Clothing: None required, however, avoid prolonged contact with the skin from soiled clothing.

Ventilation: Local exhaust should be sufficient. Avoid creating dust from the product. If used in a manner that creates dust, mechanical ventilation may be necessary.

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111 Kessler Mill Road
Salem, VA 24153

Telephone number:	540-389-9361	Fax:	540-389-9364	
Emergency Contact:	540-389-9361		CHEMTREC:	1-800-424-9300

The information and recommendations contained in this Material Safety Data Sheet have been compiled from sources believed to be reliable and to represent current opinion on the subject when the MSDS was prepared. No warranty, guaranty or representation is made as to the correctness or sufficiency of the information. The user of this product must decide what safety measures are necessary to safely use this product, either alone or in combination with other products, and determine its environmental regulatory compliance obligations under any applicable federal, state and local laws.

Safety Data Sheet

MicroC® 2000

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name:	MicroC® 2000	**Publication Date:**	May 31, 2015
Product Code:	NA	**Replaces:**	February 26, 2015
Product Use:	A reducing agent for biological processes		

Supplier Information:

Environmental Operating Solutions, Inc	Phone:	508-743-8440
160 MacArthur Blvd., Unit 6	Fax:	508-743-8443
Bourne, MA 02532	Website:	www.microc.com

EMERGENCY TELEPHONE NUMBER: **CHEMTREC** **800-424-9300**

2. HAZARDS IDENTIFICATION

OSHA Regulatory Status:
This product when used as intended is not hazardous according to 29 CFR 1910.1200

Note: When vaporized, glycerin mist may cause irritation of the respiratory tract.

Potential Health Effects

Routes of Exposure	Ingestion, inhalation, skin contact, eye contact
Eyes	May cause slight irritation
Skin	May cause slight irritation
Inhalation	High mist concentrations may cause irritation of respiratory tract.
Ingestion	May be harmful if swallowed in large quantities

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS #	% by Weight
Glycerin; glycerol	56-81-5	70-74%
Water	7732-18-5	22-26%
Sodium Chloride	7647-14-5	4-6%
Methanol	67-56-1	< 1%

4. FIRST AID MEASURES

Eye Contact	Immediately flush eyes thoroughly with plenty of water for 15 minutes and consult a physician immediately.
Skin Contact	Remove contaminated clothing and wash affected area with water and soap. Consult physician if irritation develops
Inhalation	Remove individual to fresh air. Seek medical attention if breathing problems persist
Ingestion	Do not induce vomiting. Rinse mouth thoroughly. Seek medical attention.
General Advice	If individual feels unwell following the exposure to the product consult a physician immediately. Present this Safety Data Sheet to the doctor in attendance
Note to physician	Treat patient symptomatically

5. FIRE FIGHTING MEASURES

Flammability Summary (OSHA and NFPA)	Non-flammable Material
Protection of Firefighters:	Wear suitable protective equipment. Wear self contained breathing apparatus if necessary
Extinguishing Media	Use equipment appropriate to the main source of the fire. Water spray, alcohol foam, dry chemical or CO2. Water or alcohol foam may cause frothing
Specific hazards arising from the chemical	Carbon oxides

6. ACCIDENTAL RELEASE MEASURES

Personal Protection for Spills	Keep unnecessary personnel away from spill. Use personal protective equipment. Ventilate area of leak or spill. Avoid breathing vapors and mist.
Methods for Containment	Eliminate all sources of ignition. Stop flow of material if safe to do so. Dike spilled material. Absorb spill with inert absorbent material. Sand, earth and vermiculite are suitable absorbent materials.
Environmental Precautions	Prevent further leakage. Contain spill if safe to do so. Do not let product enter storm drains if possible.

7. HANDLING AND STORAGE

Precautions for Safe Handling	See other relevant sections of this SDS. Avoid contact with skin and eyes. Avoid breathing mist. Use with adequate ventilation. Do not handle and store near open flames, high heat or sources of ignition.
Storage	Keep containers closed when not in use. Minimize evaporative losses. Keep away from ignition sources.
Incompatible Materials for Storage	None known

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Component	Concentration in Product	ACGIH TLV	OSHA TABLE Z-1 Limits for Air Contaminants	NIOSH
Glycerin CAS No: 56-81-5	70-74% w/w	Form: Glycerin Mist TWA: 10 mg/m3	Form: Total Dust PEL: 15 mg/m3 Form: Respirable Fraction PEL: 5 mg/m3	Insufficient Data on Glycerin Mist
Methanol CAS No: 67-56-1	< 1 % w/w	TWA: 260 mg/m3	PEL: 260 mg/m3	TWA: 260 mg/m3

Engineering Controls — Use proper equipment and storage conditions to control airborne levels below recommended exposure limits.

Personal Protective Equipment

Eye Protection: — Use normal eye protection practices such as safety glasses with side shields. Use chemical goggles if risk of splashing is high.

Skin Protection — Handle with chemical resistant gloves. Dispose of contaminated gloves after use. Nitrile gloves recommended.

Respiratory Protection — If workers could be exposed to concentrations above the exposure limits in Section 8, use a full face respirator with multipurpose combination cartridges.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid	**Flash Point**	None to Boil (ASTM D93)
Color	Light brown	**Boiling Point**	Not determined
Odor	Musty – Sweet Odor	**Evaporation Rate**	Not determined
Odor Threshold	Not determined	**UEL/LEL**	Not determined
		Flammability (solid, gas)	Not determined
pH	4.00-11.00	**Vapor Pressure**	Not determined
Solubility in Water	Highly soluble in water	**Vapor Density**	Not determined
		Relative Density	Not Determined
Bulk Density	10.22 lbs/gal	**Partition Coefficient**	Not determined
Specific gravity	1.225@ 20°C	**Autoignition Temperatures**	
		Decomposition Temperature	Not determined
Viscosity	45 cPs @ 20C		

10. STABILITY AND REACTIVITY

Reactivity	Avoid contact with oxidizing agents (e.g. nitric acid, peroxides, chromates)
Chemical Stability	Stable under normal storage conditions
Possibility of hazardous reactions	None known
Conditions to Avoid	Heat, flames, sparks. Contact with oxidizing agents
Incompatible Materials	None known
Hazardous Decomposition Products	Oxides of carbon under high heat

11. TOXICOLOGY

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Eye Contact	The components in this product may result in mild eye irritation from contact with liquid or vapors. Symptoms include redness, swelling, watering.
Skin Contact	The components in this product may result in mild skin irritation. Symptoms include redness, itching, burning, dermatitis.
Inhalation	Breathing high mist concentrations may be harmful. Inhalation can cause irritation of the throat and lungs.
Ingestion	Ingestion of this product may result in nausea, vomiting and diarrhea. Aspiration into the lungs can cause damage and inflammation to the lungs.
Target Organs	Lungs, Kidneys
Prolonged Exposure	Symptoms include nausea, headache, vomiting

Glycerin; Glycerol CAS No. 56-81-5

Acute Toxicity	Dermal LD50 = > 10,000 mg/kg (Rabbit) Inhalation LC50 = > 570 mg/m^3 1 hr (Rat) Oral LD50 = 12,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

Methanol 67-56-1

Acute Toxicity	Dermal LD50 = 15,800 mg/kg (Rabbit) Inhalation LC50 = 64,000 mg/m^3 4 hr (Rat) Oral LD50 = 5,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

12. ECOLOGICAL INFORMATION

Ecotoxicity	Glycerin: 96 hr LC50: 51,000-57,000 mg/L (Rainbow Trout), > 5000 mg/L Goldfish Methanol: 96 hr LC50: > 15,400-29,400 mg/L (Fish)
Persistence and degradability	No data available
Bioaccumulative potential	No data available
Mobility in soil	No data available
Other adverse effects	No data available

13. DISPOSAL CONSIDERATIONS

This product as supplied is not classified as a RCRA hazardous waste according to 40 CFR 261. However it should be fully characterized prior to disposal as contamination with other materials may subject it to hazardous waste regulations. RCRA requires the user of the product to determine whether the product meets RCRA criteria for hazardous waste. Always consult with local, state and federal regulations prior to disposal.

14. TRANSPORTATION INFORMATION

US Domestic DOT	Not Regulated
Shipping Name	Glycerin; Glycerol
IMDG	Not dangerous goods
IATA	Not dangerous goods
Marine pollutant	No

15. REGULATORY INFORMATION

United States

Toxic Substances Control Act

The components of this product are listed on the TSCA Inventory of Existing Chemical Substances

Section 302 (EHS) TPQ	Not applicable
Section 304 (EHS) TPQ	Not applicable

SARA Section 311/312 Hazard Categories

Acute - NO
Chronic – NO
Physical - None
Pressure Hazard - NO
Fire Hazard - NO

SARA Section 313

This product may contain trace amounts of a chemical that is subject to reporting requirements of SARA

Methanol CAS # 67-56-1 Typical % Weight in Product 0.0-0.10%

CERCLA

This product may contain trace amounts of a chemical that is subject to reporting requirements of CERCLA
Methanol RQ # 5,000. Typical % Weight in Product 0.0-0.10%

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3): None

State Right to Know Regulations

Chemical Name: Glycerin	
California – Proposition 65	Not applicable
Massachusetts Right to Know	Glycerin
Minnesota Hazardous Substances List	Glycerin mist
New Jersey Right to Know	None
Pennsylvania Right to Know	Glycerin
Rhode Island Right to Know	Glycerin

16. ADDITIONAL INFORMATION

MSDS REVISION STATUS: May 31, 2015| Replaces February 26, 2015

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS MSDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

Health	2
Fire	0
Reactivity	1
Personal Protection	E

Material Safety Data Sheet
Sodium carbonate MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sodium carbonate

Catalog Codes: SLS3481, SLS1264, SLS4105, SLS1894, SLS3316

CAS#: 497-19-8

RTECS: VZ4050000

TSCA: TSCA 8(b) inventory: Sodium carbonate

CI#: Not available.

Synonym: Crystal Carbonate, Disodium Carbonate, Sal Soda, Soda Asha, Washing Soda

Chemical Name: Sodium Carbonate, Anhydrous

Chemical Formula: Na2-C-O3

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sodium carbonate	497-19-8	100

Toxicological Data on Ingredients: Sodium carbonate: ORAL (LD50): Acute: 4090 mg/kg [Rat]. 6600 mg/kg [Mouse]. DUST (LC50): Acute: 2300 mg/m 2 hours [Rat]. 1200 mg/m 2 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to upper respiratory tract, skin, eyes. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Emits Na2O fumes when heated to decompositon.

Fire Hazards in Presence of Various Substances: Not applicable.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Sodium carbonate can ignite and burn fiercely in contact with fluoride. Sodium Carbonate in contact with fluorine decomposed at ordinary temperature with incandescence.

Special Remarks on Explosion Hazards:
Reacts explosively with red-hot aluminum metal. Sodium carbonate + ammonia in arabic gum solution will explode.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Neutralize the residue with a dilute solution of acetic acid. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

Section 7: Handling and Storage

Precautions:
Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as acids.

Storage:
Hygroscopic. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 24°C (75.2°F). Hygroscopic

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits: Not available.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Solid powder.)

Odor: Odorless.

Taste: Alkaline.

Molecular Weight: 105.99 g/mole

Color: White.

pH (1% soln/water): 11.5 [Basic.]

Boiling Point: Not available.

Melting Point: 851°C (1563.8°F)

Critical Temperature: Not available.

Specific Gravity: Density: 2.532 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:

Soluble in hot water, glycerol. Partially soluble in cold water. Insoluble in acetone, alcohol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, moisture

Incompatibility with various substances:
Reactive with acids. Slightly reactive to reactive with moisture.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Hygroscopic. Combines with water with evolution of heat. Incompatible with phosphorus pentoxide, lithium, fluorine, fluoride, ammonia + silver nitrate, 2,4,6-trinitrotoluene, ammonia, acids, sodium sulfide + water, hydrogen peroxide, red hot alumium metal, sodium sulfide, zinc, calcium hydroxide. Sodium Carbonate is decomposed by acids with effervescence. Reacts violently with F2, Lithium, and 2,4,6-trinitrotoluene. Sodium begins to decompose at 400 C to evolve CO2.

Special Remarks on Corrosivity: Hot concentrated solutions of sodium carbonate are mildly corrosive to steel.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 4090 mg/kg [Rat]. Acute toxicity of the dust (LC50): 1200 mg/m3 2 hours [Mouse].

Chronic Effects on Humans: May cause damage to the following organs: upper respiratory tract, skin, eyes.

Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant), of ingestion, of inhalation (lung irritant).

Special Remarks on Toxicity to Animals: LDL (Lowest Published Lethal Dose) [Man] - Route: Oral; Dose: 714 mg/kg

Special Remarks on Chronic Effects on Humans: May cause adverse reproductive effects based on animal test data

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Causes skin irritation with possible burns depending on the concentration, site (abraded or intact skin), and duration of exposure. Eyes: Causes eye irritation and possible burns. Concentrated solutions may cause permanent corneal injury (permanent corneal opacity). Ingestion: Sodium carbonate ingestion may cause irritation of the digestive tract resulting in nausea, vomiting, diarrhea, thirst, abdominal pain depending on concentration and amount ingested. May also affect the cardiovascular system . Inhalation: Dust may cause respiratory tract and mucous membrane irritation with coughing and shortness of breath (dyspnea), pulmonary edema. Chronic Potential Health Effects: Chronic inhalation may result in decreased pulmonary function, nasal congestion, nosebleeds, perforation of the nasal septum. Other effects of chronic exposure are skin (dermatitis and ulceration), and gastrointestinal complaints. However, the effects of chronic exposure seem to be reversible if exposure is decreased.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations: TSCA 8(b) inventory: Sodium carbonate

Other Regulations: EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R36/37/38- Irritating to eyes, respiratory system and skin. S22- Do not breathe dust. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 0

Reactivity: 1

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 0

Reactivity: 1

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:26 PM

Last Updated: 05/21/2013 12:00 PM

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

APPENDIX G

GLOSSARY & TERMS

newterra ltd.
1291 California Avenue, Brockville, ON K6V 5W3
(800) 420-4056 / www.newterra.com

Glossary & Terms

The following section defines abbreviations and technical terms used within this manual and the wastewater treatment industry in general.

1. ACRONYMS & ABBREVIATIONS

ACRONYM	DEFINITION
AT	Aeration Tank
BOD	Biological Chemical Oxygen Demand
cBOD	Carbonaceous Biological Oxygen Demand
CaCO3	Calcium Carbonate
CIP	Clean In Place
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
E-Coli	Escherichia coli - Gram-negative, rod-shaped bacterium
EQ	Equalization Tank
FOG	Fat, Oil and Grease
kPa	Kilo Pascal
L	Liter
LMH	Liters / m^2 of Membrane Area per Hour (Flux)
MBR	Membrane Bioreactor
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MT	Membrane Tank
NaOCl	Sodium Hypochlorite
NaOH	Sodium Hydroxide
NH_3 -N	Ammonia as Nitrogen (unionized)
NH_4 -N	Ammonium as Nitrogen (ionized)
NO_3 -N	Nitrate Nitrogen

ACRONYM	DEFINITION
NO_2 -N	Nitrite Nitrogen
NTU	Nephelometric Turbidity Unit
O_2	Molecular Oxygen
OUR	Oxygen Uptake Rate
PC	Primary Clarifier
P&ID	Process and Instrumentation Diagram
pH	Measure of Acidity & Alkalinity
PLC	Programmable Logic Controller
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
PSL	Pressure Switch Low
RAS	Return Activated Sludge
SDI	Silt Density Index
TP	Total Phosphorus
TMP	Transmembrane Pressure
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids
VFD	Variable Frequency Drive
VSS	Volatile Suspended Solids
UF	Ultrafiltration
UV	Ultraviolet
WAS	Waste Activated Sludge
WWTP	Waste Water Treatment Plant

2. TECHNICAL TERMS DEFINITION

ACID	Substance which solution has a pH below 7.0, sour taste, releases hydroxyl ions in water and reacts with bases.
ACTIVATED SLUDGE	The floc produced in wastewater due to the growth of bacteria and other organisms in the presence of dissolved oxygen.
ACTIVATED SLUDGE PROCESS	Activated sludge is a process for treating sewage and industrial wastewaters using air and a biological floc composed of bacteria and protozoa.
ACTUATED VALVE	Valve with an actuator that is controlled by an external command.
ADVANCED WASTEWATER TREATMENT	Process designed to produce an effluent of higher quality than normally achieved by secondary treatment processes.
AEROBIC	Life or processes that require, or are not destroyed by, the presence of free elemental oxygen.
AEROBIC BACTERIA	Bacteria that require the presence of oxygen to live and grow.
AEROBIC DIGESTION	The aerobic digestion process is a treatment process that utilizes aerobic microbes to stabilize the solids. The microbes digest solids from primary sedimentation processes, and those from secondary treatment processes. Due to the length of time that the solids remain under aeration, the long solids retention time allows for the microbes to feed off of the cell contents of other dying/decaying microbes under digestion. This is referred to as "endogenous respiration" or "endogenous stabilization." There will be an "inert faction" between 20 and 25% by weight, in the resulting stabilized solids. This inert faction will consist of fine inorganic solids, organic solids, and cell components that will not be degradable by

the process.

AEROBIC ZONE

An environment where there is dissolved air or free oxygen.

AIR DIAPHRAGM METERING PUMP

Air diaphragm metering pump provides chemical dosing at measured rates. The dosing is set manually and it is regulated either by the amount of compressed air driving the pump or by setting the backpressure of the pumps.

AIR FLOW SWITCH (PSL)

Located on the supplemental aeration piping, used to indicate when a specific flow rate has been reached for a blower. This flow rate identifies low aeration to the aeration or membrane tank, triggering an alarm or alert.

AIR SCOURING

Diffusers placed below the membrane modules generate air bubbles in water that scour (rub) the membrane surface and keep it clean.

ALARM

A visible or audible indication of abnormal situation. An alarm may be an operator interface screen message, a light, a buzzer or another form of communication to the operator.

ALKALINE

A solution having an excess of hydroxyl (OH) ions - with pH greater than 7.0.

ALKALINITY

The capacity of water or wastewater for neutralizing an acid. Alkalinity in wastewater results from the presence of carbonate, bicarbonate, and hydroxide. Alkalinity in water helps to resist changes in pH caused by addition of acids. Generally expressed as an amount of $CaCO_3$ equivalent.

ANAEROBIC

Life or processes that require, or are not destroyed by, the absence of free elemental oxygen.

ANAEROBIC BACTERIA

Any bacteria that can survive in partial or complete absence of oxygen by using molecular oxygen found in

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nitrates and sulfates.

ANAEROBIC BIOLOGICAL REACTOR	Anaerobic (in the absence of oxygen) decomposition breaks down large molecules into small molecules increasing the rate of methane generation, which can be used for energy recovery.
ANALOG	An electrical signal that is proportional to the size of the variable being monitored or controlled.
ANOXIC	Conditions where some species other than oxygen acts as the electron donor for biochemical reactions.
AUTOMATIC FLOW VALVE	This valve is used when regular changes are required in the state of the valve (fully open or fully closed only). It is controlled by the PLC.
BACKPULSE / BACKFLUSH / BACKWASH	A mode of operation in which the flow of permeate is reversed through the membrane. During backwash, accumulated solids go away from the membrane surface due to the combined effects of the membrane air scouring and backwash of permeate.
BIOCHEMICAL (BIOLOGICAL) OXYGEN DEMAND	A measure of the amount of oxygen consumed in the biological process breaking down organic matter in water – the greater the BOD, the greater the degree of pollution.
BIOCIDE	A chemical for preventing biological growth.
BIOLOGICAL TREATMENT (or BIOTREATMENT)	Process whereby dissolved organic chemical constituents are removed through biodegradation.
BIOMASS	The mixture of biodegradable material, bacteria, and biosolids present in a biological wastewater treatment system.
BIOSOLIDS	Material from sludge treatment, which contains organic matter and plant nutrient; unlike excess waste activated sludge, biosolids have undergone a treatment to decrease or eliminate pathogenic organisms. Biosolids

can be beneficially recycled.

BLOWER	Blowers are used to introduce air in order to create an aerobic environment for BOD removal and for scouring the membranes to prevent membrane fouling.
MODULE (for newterra MicroClear® MBR)	Membrane filtration unit; it is a group of interlocked MicroClear® cassettes, fastened together to act as a single unit.
CHEMICAL OXYGEN DEMAND	A test used to estimate the amount of organic matter within a sample using a strong chemical oxidizing agent. The COD is generally higher than the BOD (for sewage BOD / COD ratio varies from 0.4 to 0.8).
COAGULANT	An agent that causes fine or suspended impurities to group together (coagulate).
COMBINED SEWER	A sewer system that carries both sanitary sewage and stormwater (SW) runoff.
CONDITIONING FOULING	First stage of membrane fouling through adsorption of material.
CONTAMINANT	A source of contamination, an impurity and any substance in water which is not H_2O.
CRITICAL FLUX	Flux below which permeability decline is considered negligible.
DENITRIFICATION	Biochemical reduction of nitrate to nitrogen gas.
EFFLUENT	Wastewater – treated or untreated – that flows out of a treatment plant, sewer, or industrial outfall.
ELECTRON DONOR	Species capable of donating an electron to a suitable

acceptor and is oxidized as a result.

EQUALIZATION TANK	Used for equalization of flow and composition of wastewater.
F/M (RATIO)	Food-to-microorganism ratio (F/M) – rate at which substrate is fed to the biomass compared to the mass of biomass solids.
FEED	Feed is the term use to define fluid entering a membrane module or wastewater treatment plant.
FILTER CAKE	Accumulated particles on a filter surface.
FILTRATE	Portion of the feed stream which has passed through a filter; also known as “permeate” in membrane system.
FLOC	Aggregated solid (biomass) particle.
FLUX (or PERMEATE VELOCITY)	Quantity of material (water) passing through an area of membrane per unit time – usually expresses LMH ($L/m^2.h$), or gfd ($gal/ft^2.d$).
FOULING	Processes leading to deterioration of flux due to surface or internal blockage of the membrane.
GLYCERIN	Glycerin is the commercial form of glycerol. It is used for membrane long term preservation to avoid membrane drying.
HOUSING	Vessel which holds a membrane module.
HYDRAULIC LOADING RATE	Rate at which water enters the reactor.

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HYDRAULIC RETENTION TIME (HRT)	The time required to displace the working volume of a bioreactor. HRT (d) = Bioreactor volume (L) / Feed flow rate (L/d).
INFILTRATION	Entry of water into a sewer system from sources other than infiltration – such as defective pipes, pipe joints, connections, or manhole walls.
INFLOW	Entry of water into a sewer system through such sources as defective pipes, pipe joints, connections, or manhole walls.
INPUTS / OUTPUTS	Inputs / Outputs refer to the direction of the electronic signal in reference to the PLC. They can be either digital or analog signals.
INTENSIVE / RECOVERY CLEAN	Cleaning with aggressive chemicals to recover membrane permeability.
IRREVERSIBLE / PERMANENT FOULING	Not removed by physical cleaning but removed by chemical cleaning.
LAND APPLICATION	Treatment or disposal of wastewater or wastewater solids by spending it on land under controlled conditions.
LEVEL SWITCH	Level switches are placed in tanks to indicate water level.
MICROORGANISMS	Microscopic organisms, either plant or animal, invisible or barely visible to the naked eye. Examples: algae, bacteria, fungi, protozoa, and viruses.
MAINTENANCE CLEANING	Cleaning with less aggressive chemicals to maintain membrane permeability.
MEMBRANE	A porous synthetic material which acts as a highly efficient barrier or filter in the range of molecular dimensions – allowing passage of ions, water and other solvents, and very small molecules – but most impermeable to macromolecules. Membrane classes include – MF (microfiltration), UF (ultrafiltration), NF (nanofiltration), RO (reverse osmosis).

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MEMBRANE BIOREACTOR	A biological wastewater treatment system that uses a membrane to separate water from biomass.
MEMBRANE CONFIGURATION	In membrane separation technology, configuration of a membrane product describes its construction or membrane spatial arrangement. Basic membrane configurations include hollow fiber, spiral, tubular, and flat-sheet.
MEMBRANE PACKING DENSITY	Membrane area per unit volume.
MEMBRANE TANK / BASIN	Tank/basin wherein membrane cassettes are placed.
MESOPHILIC	Thriving at intermediate temperatures: 20 to 45 ^{0}C (15 ^{0}C optimum).
MESOPORE	Pore with diameter between 2 and 50 µm.
METHANOGENS	Microorganisms producing methane as a metabolic byproduct.
MICROFILTRATION (MF)	A process using a membrane class to separate relatively large particles – 0.1 to 3 µm in diameter, with relatively low applied pressures. In crossflow microfiltration system, feed solution flows perpendicular to the filter surface.
MIXED LIQUOR SUSPENDED SOLIDS (MLSS, mg/L))	A measure of the quantity of suspended solids in the aeration tank of an activated sludge treatment system.
MIXED LIQUOR VOLATILE SUSPENDED SOLIDS (MLVSS, mg/L)	The portion of MLSS that vaporizes when heated to 550°C (1022° F).
MODULE (membrane)	Smallest practical unit containing one or more membranes and supporting structures.

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NITRIFICATION	Biochemical oxidation of ammonia to nitrate.
NUTRIENTS	Any substance that is assimilated by organisms and promotes growth; generally applied to nitrogen and phosphorus in wastewater, but also applied to other essential and trace elements.
OPERATION AND MAINTENANCE (O&M)	Organized procedure for causing a piece of equipment or a treatment plant to perform its intended functions and for keeping the equipment or plant in such a condition that it is able to continually and reliably perform its intended function.
(ORGANIC) LOADING RATE	Rate at which (organic) matter is introduced into the reactor.
PERMEABLE	Porous to the passage or penetration by fluids.
PERMEABILITY	The ratio of the flux and transmembrane pressure at that flux (L/m^2 / h/ kPa or gfd/psi).
PERMEATE	Water or fluid which has passed through the membrane; also referred to as “filtrate”.
PERMEATE PUMP	Vacuum pump which draws permeate through the membrane, as in MBR.
PERMIT	A legal document issued by the government agency. In wastewater treatment, a discharge permit requires that the plant operator achieve specific water quality standards and discharge limits by a certain date, and also establishes monitoring and reporting requirements.
PLATE-AND-FRAME	Synonymous with “flat-sheet”.
PLUG FLOW	Flow in which no back-mixing or dispersion occurs along the length of the pipe or reactor.

POLLUTANT	A contaminant at high enough concentration to endanger the aquatic environment or public health.
PORE	An opening in a membrane or filter matrix.
POROUS	Ability of certain substances to pass fluids due to an open physical structure.
POROUS PLUGGING	Type of membrane fouling – due to pore blockage.
POROUS MEMBRANE	Membrane of low selectivity operating by physical straining alone.
PRETREATMENT	In membrane wastewater treatment systems, pretreatment is the initial processing of wastewater to prolong the life of a membrane system and to optimize membrane performance. Pretreatment includes screening, equalization, oil & grease removal, primary clarification, aeration to oxidize colloidal and dissolved organics in wastewater.
RECEIVING STREAM	A river, lake, ocean, or other water course into which wastewater or treated effluent is discharged.
RELAXATION	Ceasing permeation whilst continuing to scour the membrane with air bubbles.
RESISTANCE	Resistance to flow – proportional to flow rate-to-pressure ratio.
RETENTATE	Water or fluid which is rejected by the membrane – portion of the feed solution in UF and RO that does not pass through the membrane; also called “concentrate” or “reject”.
REVERSIBLE OR TEMPORARY FOULING	Gross solids attached to the membrane surface and which can be removed by physical cleaning relatively easily – such as backflushing or relaxation.

SANITARY SEWER	A sewerage system that carries only household and commercial wastewater / sewage.
SCALING	Buildup of precipitated salts on a surface – such as pipes, tanks, boiler tubes, membrane surface (in RO, UF) resulting in a physical or chemical change.
SECONDARY TREATMENT - CONVENTIONAL	Generally, a level of treatment that produces removal efficiencies of 85 percent for BOD and suspended solids – sometimes used interchangeably with the concept of biological wastewater treatment, where wastewater is mixed with air or oxygen and sludge to encourage the growth of bacteria that “eat” organic pollutants.
SEWER	An artificial, usually subterranean conduit, used to carry off sewage or wastewater.
SILT DENSITY INDEX (SDI)	A test used to measure the level of suspended solids in feed water (especially for RO). It is a measure of the tendency of water to foul a membrane, based on a timed flow through a membrane filter (0.45 µm), at a constant pressure, also known as “fouling index”.
SHEAR (STRESS)	Force applied to a body which tends to produce a change in its shape, but not its volume.
SIDE-STREAM	Stream outside the bioreactor.
STACK	Smallest practical unit containing one or more membranes and supporting structures.
SUBSTRATE	Surface or medium on which an organism grows or is attached.
SUPERNATANT	Liquid clarified by sedimentation.

SURFACE POROSITY	Percentage of the surface area occupied by the pores.
SUSPENDED SOLIDS	Solid pollutants that either float on the surface of, or are suspended in, wastewater.
SUSTAINABLE FLUX	Flux for which the TMP (transmembrane pressure) increases gradually at an acceptable rate, such that chemical cleaning is not necessary.
THERMOPHILIC	Thriving at relatively high temperatures (49- 57 ^{0}C (45 ^{0}C optimum).
TOTAL SOLIDS	Total dissolved and undissolved solids in water or wastewater.
TRANSMEMBRANE PRESSURE	Pressure difference from the feed side of the membrane to the permeate side.
TURBIDITY	A suspension of fine particles in water that obscure the light rays and cause cloudiness and will not readily settle due to small particle size. Measure of the clarity of an otherwise clean liquid – cloudy or hazy appearance in a naturally clear liquid. Typically, turbidity of the MBR permeate is less than 1 N.T.U.
TURBIDITY UNITS	Measurement of relative ability of a solution to allow a light beam to pass through it; usual units are N.T.U. (Nephelometric Turbidity Units).
ULTRAFILTER	A mechanical unit used in the membrane separation process.
ULTRAFILTRATE	A synonym for UF “permeate”.

ULTRAFILTRATION (UF)	Membrane separation process based on size exclusion. UF operates in the molecular weight cut-off (MWCO) range from 1,000 MWCO to 200,000 MWCO, or 0.002 µm to 0.1 µm. Emulsified oils, suspended solids, bacteria, and large molecules are rejected by UF membranes. Water and small molecules – dyes, surfactants, dissolved salts, and solvents pass through in the permeate.
VOLUMETRIC MASS TRANSFER COEFFICIENT	A combination of the overall liquid mass transfer coefficient and the specific area for mass transfer .The term measures the mass transfer of oxygen into the liquid via air bubbles.
WASTEWATER	Spent or used water from a community or industry that contains dissolved and/or suspended matter.
α or β FACTOR	Factors applied to correct biological aeration demand for dissolved and suspended solids content of biomass.

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APPENDIX H

Biological Treatment & Monitoring Parameters

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Biological Treatment and Monitoring Parameters

This section offers the introduction of some key terms for biological control and wastewater quality description. It is important that the operators become familiar with how these parameters are obtained and what each of these terms mean and how each relates to the MBR wastewater treatment process operation.

1. Removal of substrates in wastewater

Carbonaceous pollutants removal

The concept of carbonaceous pollutants treatment is very simple. The bacteria remove small organic carbon molecules by 'eating' them. As a result, the bacteria grow, and the wastewater is cleaned. Although there are many thousands of chemical reactions involved in the metabolism of a bacterium, three major processes that are relevant to the biological treatment of sewage are ingestion, respiration, and growth and division.

Some of organic carbons go along the pathway of catabolism or respiration and end up as carbon dioxide, and they are lost to the system. The remaining organic carbons follow the anabolism or growth pathway and end up in new biomass, and these carbons are therefore retained in the system. The purpose of respiration is also to provide the energy that is required for growth and for the maintenance of the bacterium.

These three processes of ingestion, respiration and growth are very highly coupled or meshed. No one process can go faster than the other. One implication of this is that, for instance, if you measure the respiration rate, you are indirectly also measuring the rate of growth and the rate of carbon ingestion.

Growth is the driver and rate-limiting step. Every bacterium has a genetically programmed maximum rate of growth that will be achieved under ideal conditions. As it grows, it withdraws carbon compounds from the internal pool in its cytoplasm. Carbon flows in from the mixed liquor in order to keep this pool topped up. At the same time, energy is used for biosynthesis and growth, and hence the catabolism pathways of respiration also withdraw carbon from the internal pool, and this also results in carbon being drawn in by ingestion.

The three processes correspond to the major processes that we shall see when we examine the operation of the treatment works in aeration basin. Ingestion, respiration and growth and division correspond to biodegradation, aeration requirement and biomass production respectively.

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Whilst the concept is very simple, the control of the treatment process is very complex, because of the large number of variables that can affect it. Whilst the major substrate requirement is for carbon growth is also dependent on the intake of nitrogen and phosphorus. The optimum ratio of C:N:P in the mixed liquor is generally thought to be 100:5:1. Trace components, which include S, Na, Ca, Mg, K, and Fe are also required, and are available in abundance in domestic sewage. By contrast, the wastewater from brewing, pulp and paper, and food-processing industries can be deficient in nitrogen and phosphorus. Nutrients therefore need to be added to the mixed liquor to obtain maximum bacterial growth and to optimise carbonaceous treatment. From an operational point of view, lack or an insufficiency of a critical nutrient may result in incomplete treatment, because the bacteria are unable to grow optimally.

Growth can be inhibited, if oxygen concentration falls to very low levels in the aeration tank. This is because oxygen becomes limiting for respiration. Dissolved Oxygen (DO) is not limiting above concentrations of about 1.0 – 2.0 mg/L for bacteria in flocs and about 0.6 mg/L for dispersed bacteria. Below these critical concentrations, the respiration rate falls rapidly due to the unavailability of oxygen. Filamentous bacteria have a greater tolerance of low oxygen levels than floc bacteria. At DO concentrations below the critical concentration, filamentous bulking can occur, as their relative biomass increases.

Bacteria have a genetically determined viable temperature range. For most carbonaceous bacteria of the activated sludge, this is from about 0 to 35°C. However thermophyllic bacteria survive and grow between about 35°C and 60°C. In general, growth rate follows the rule of Arrhenius that chemical reactions double in rate for a 10°C increase in temperature. Thus as the temperature increases, the rate of growth, and hence requirement of oxygen for respiration, increases.

Toxic chemicals in the wastewater can enter the bacteria and inhibit one or more enzymes of the pathways involved in either anabolism or catabolism. If the catabolic reactions of respiration are affected, the rate of respiration and energy production is reduced and the rate of growth is therefore reduced. On the other hand, if the anabolic pathways of biosynthesis are inhibited, the rate of growth is reduced, and this is accompanied by a fall in the rate of respiration, as the requirement for energy is reduced. In the aeration tank, toxicity has the effect of reducing the rate at which organic carbon is degraded. This can be easily monitored by observing changes in the rate of respiration of the activated sludge.

Ammonia removal by nitrification

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The ammonia (NH_4-N) removal is achieved by biological nitrification process. Biological nitrification is an aerobic process of conversion of ammonia to nitrite (NO_2-N) and then to nitrate (NO_3-N). Because of the low growth rate and poor cell yield of nitrifying bacteria, nitrification is generally a rate-limiting step in biological nitrogen removal process. The key requirement for nitrification to occur is that the net rate of accumulation of biomass (and hence the net rate of withdrawal of biomass from the system) is less than the growth rate of nitrifying bacteria. Long sludge retention time (SRT) used in MBR system ensures near complete nitrification with an effluent NH_4-N concentration of less than 1 mg/L (as long as influent wastewater characteristics stays within the design range).

Nitrification is affected by a number of environmental factors including pH, temperature, DO concentration, and toxicity. Nitrification is pH sensitive. A pH of 7.0 to 7.2 is normally used to maintain reasonable nitrification rates, with optimal rate occur at pH of 7.5 to 8.0. Alkalinity addition is required, if deficient, to maintain the proper operating pH range. Nitrifiers are much more sensitive to temperature than heterotrophic bacteria. To ensure sufficient nitrification, it is recommended that the MBR unit is operated at a temperature of greater than 15°C. Nitrification rate is also affected by DO level. Nitrifiers are strict aerobes, and thus the reaction rate is susceptible to inhibition at very low DO levels. A DO of 1 mg/L is considered as a minimum requirement to prevent any rate inhibition caused by insufficient DO level. No impact on nitrifiers growth rate is evident when the DO level is greater than 2 mg/L. Toxicity is typically not of concern for camp type wastewater, unless quat ammonia is being used as a disinfectant agent in the camp. Nitrification can easily be restored if non quat based disinfectant is being used.

Total nitrogen removal by nitrification/denitrification

Biological nitrification/denitrification is a two-step process. The first step is nitrification, which is conversion of NH_4-N to NO_3-N through the action of nitrifying bacteria. The second step is nitrate conversion (denitrification), which is carried out by facultative heterotrophic bacteria under anoxic conditions. In denitrification, nitrate serves as the electron acceptor in energy metabolism and is converted to various gaseous end products but principally molecular nitrogen, N_2, which is then stripped from the liquid stream.

Denitrification or reduction of nitrate to nitrogen gas under anoxic conditions depends on nitrate being produced in the nitrification process under aerobic conditions. For total nitrogen removal, first nitrification and then denitrification should occur efficiently to achieve the desired effluent quality. Denitrification releases nitrogen which escapes as an inert gas to the atmosphere while oxygen released stays dissolved in the liquid and thus reduces the overall oxygen requirement of the process. Denitrification also returns part of the alkalinity consumed during nitrification. Thus where feasible, denitrification can be incorporated to reduce energy cost and external alkalinity addition.

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The heterotrophic bacteria that perform denitrification are typically less sensitive to inhibition from toxic chemicals compared to nitrifiers. However, toxicity is still a concern. Oxygen has been found to inhibit nitrate reduction by repressing the nitrate reduction enzyme, slowing the rate of nitrite reduction. A carbon source is also essential as electron donor for denitrification to take place. This source may be in the form of carbon internally available in sewage or artificially added (eg. as methanol). Typically, if influent BOD/TKN or COD/TKN is higher than 5 or 10, assuming COD/BOD ratio of 2, MBR treatment can meet stringent effluent total nitrogen requirement (i.e., < 5mg/L) without providing supplemental carbon.

Temperature has a significant influence on maximum growth rate of denitrifying population, and the maximum growth rate of denitrification roughly doubles for every 10°C increase in temperature between 5 and 25°C. The denitrification rate is strongly affected by the kinetic regime of the reactor. Plug-flow reactors and reactors in series will produce higher denitrification rates. This typically will happen when the availability of substrate limits the denitrification reaction. In contrast to nitrifying organisms, there has been less concern about pH influences on denitrification rates. Also, no significant effect on the denitrification rate has been reported for pH from 7.0 to 8.0.

Phosphorus removal

Phosphorus removal from wastewater can take place by biological or chemical methods. For each treatment method, the plant-layout and operation will be different and the consumption of energy and chemicals may be quite different.

The chemical phosphorus (P) removal relies on the transformation of soluble phosphorus to a particle form, which is then by solid-liquid separation processes, such as membrane separation. This reaction is deceptively simple and must be considered in light of the many competing reactions and their associated equilibrium constants and the effects of alkalinity, pH, trace elements found in wastewater. The overall chemical (usually lime, alum, iron and PAC) dose requirement for phosphorus removal depends on the phosphorus limit required in the permit and the design features of the treatment plant. An important operation parameter is the observed added chemical dose to the removed orthophosphate molar ratio for a plant. This parameter varies depending on the type of processes used for removing orthophosphate and particulate phosphate and the total phosphorus (TP) and orthophosphate residual required to attain permit limit. Dosages are generally established on the basis of bench-scale tests and occasionally by full-scale tests, especially if polymers are used. Typically, as the orthophosphate residuals decreased, the molar ratio of coagulant added to phosphorus removed increases.

In the biological phosphorus removal, the main actors are the polyphosphate accumulating organisms (PAOs) who take up large amounts of phosphorus from phosphates by exposing

them to alternating anaerobic and anoxic/aerobic conditions, and phosphorus is subsequently removed from the process as a result of sludge wasting.

2. Monitoring parameters

Biochemical Oxygen Demand (BOD)

One of the most commonly measured constituents of wastewater is the biochemical oxygen demand, or BOD. Wastewater is composed of a variety of inorganic and organic substances. Organic substances refer to molecules that are based on carbon and include fecal matter as well as detergents, soaps, fats, greases and food particles. These large organic molecules are easily decomposed by bacteria. However, oxygen is required for this process of breaking large molecules into smaller molecules and eventually into carbon dioxide and water. The amount of oxygen required for this process is known as the BOD. The Five-day BOD or BOD_5 is determined by incubating a sealed sample of wastewater for five days and measuring the loss of oxygen from the beginning to the end of the test.

The main focus of wastewater treatment plants is to reduce the BOD in the effluent discharged to natural waters. If effluent with high BOD levels is discharged into a stream or river, it will accelerate bacterial growth and consume the oxygen levels in the river. The oxygen may diminish to levels that are lethal for most fish and many aquatic insects.

Chemical Oxygen Demand (COD)

COD is the oxygen equivalent of organic material in wastewater that can be chemically oxidized using dichromate in an acid solution. COD does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. And, some inorganic substances that are oxidized by the dichromate will increase the apparent organic content of the wastewater sample. COD values are always greater than BOD values and overestimate the carbon that can be removed by the activated sludge, but COD measurements can be made in a few hours while BOD_5 measurements take five days.

Total Suspended Solids (TSS)

Wastewater usually contains large quantities of suspended solids that are organic and inorganic in nature. TSS is a laboratory measurement of the quantity of suspended solids present in wastewater, and it is determined by filtering a well-mixed sample 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. TSS includes

the total suspended particulate matter, both inert and volatile, but does not include dissolved solids.

TSS is one of the two universally used effluent standards (along with BOD) by which the performance of treatment plants is judged for regulatory control purposes. As levels of TSS increase, a water body begins to lose its ability to support a diversity of aquatic life, because suspended solids can cause the increase of water temperature and decrease of dissolved oxygen and photosynthesis, and it also harm fish directly by clogging gills, reducing growth rates, and lowering resistance to disease.

Volatile Suspended Solids (VSS)

VSS is a measure of the volatile portion of the TSS (the volatile portion which burns off at 550°C). VSS is usually interpreted as an accurate estimate of the microbial or organic portion of TSS. VSS is determined from laboratory analysis of TSS samples.

Total Dissolved Solids (TDS)

TDS is a measurement of the total solids in the filtrate after filtering a wastewater sample.

Mixed Liquor Suspended Solids (MLSS)

MLSS is a measurement of the solids particulate matter (i.e., the TSS concentration) in a sample collected from the aeration or membrane tanks. The MLSS concentration result is used to determine when and how much sludge is to be wasted from the system. The initial target MLSS concentration is 10,000 mg/L.

Mixed Liquor Volatile Suspended Solids (MLVSS)

MLVSS is a measurement of the concentration of the volatile portion of the MLSS. MLVSS is interpreted as an approximate estimate of the microbial or organic portion of MLSS.

Turbidity

Turbidity is another indicator of the amount of material suspended in water, and it measures the amount of light that is scattered or absorbed. Photoelectric turbidimeters measure turbidity in nephelometric turbidity units (NTUs). Turbidity units are supposed to correspond to TSS concentrations, but this correlation is only approximate.

Nitrogen

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Nitrogen compounds are of interest to wastewater treatment plant operators because of the importance of nitrogen in the life cycles of plants and animals. Nitrogen is a nutrient and occurs in many forms including ammonia, organic, nitrate and nitrite each of which may be tested for in a variety of ways. Raw domestic wastewater nitrogen is normally present in the organic nitrogen and ammonia forms, with small quantities of the nitrite and nitrate forms. Depending on the amount of nitrification which occurs within the plant, the effluent may contain either ammonia or nitrate nitrogen. Under normal circumstances, the nitrite form of nitrogen will not be present in large quantities due to its rapid oxidation or conversion to nitrate.

Ammonia nitrogen (NH_4-N) occurs partly in the form of ammonium ions (NH_4^+) and partly as ammonia (NH_3). Ammonia and organic forms of nitrogen are often measured as Total Kjeldahl Nitrogen (TKN). TKN is the sum of organic nitrogen, NH_3, and NH_4^+ in the chemical analysis of wastewater. Today, TKN or NH_4-N (NH_3 and NH_4^+) is a required parameter for regulatory reporting at many treatment plants, and as a means of monitoring plant operations, because the presence of large concentrations of ammonia in a stream or lake can create a large oxygen demand. This demand is caused by the conversion of ammonia to nitrate.

Nitrate can have serious health effects when it enters drinking water wells and is consumed. Nitrate and other forms of nitrogen can also have deleterious effects on the environment, especially in coastal areas where excess nitrogen stimulates the process known as eutrophication. For this reason, many alternative technologies have been designed to remove total nitrogen (TN), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N) and TKN. These technologies use bacteria to convert ammonia and nitrate to gaseous nitrogen, N_2. In this form, nitrogen is inert and is released to the air.

Phosphorus

Both phosphorus and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. Since phosphorus is the nutrient in short supply in most fresh waters, even a modest increase in phosphorus can, under the right conditions, set off a whole chain of undesirable events in a stream including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals. Thus, there is presently much interest in controlling the amount of phosphorus compounds that enter surface waters from wastewater treatment plants.

The principal forms of phosphorus in wastewater are organically bound phosphorus, polyphosphates, and orthophosphates. Organically bound phosphorus originates from body and food waste and, upon biological decomposition of these solids, is converted to orthophosphates. Polyphosphates, which can be hydrolyzed to orthophosphates, are used in synthetic detergents, and used to contribute as much as one-half of the total phosphates in wastewater. Most household phosphate inputs now come from human waste and automatic dishwasher detergent.

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Thus, the principal form of phosphorus in domestic wastewater is assumed to be orthophosphates, although the other forms may exist. Orthophosphates consist of the negative ions PO_4^{3-}, HPO_4^{2-}, and $H_2PO_4^-$. These may form chemical combinations with cations (positively charged ions).

The total phosphorus (TP) test measures all the forms of phosphorus in the wastewater sample. This is accomplished by first "digesting" (heating and acidifying) the sample to convert all the other forms to orthophosphate. Then the orthophosphate is measured by the ascorbic acid method. Because the sample is not filtered, the procedure measures both dissolved and suspended orthophosphate.

pH/Alkalinity

pH is a measure of the amount of free hydrogen ions in wastewater. Because pH is measured on a logarithmic scale, an increase of one unit indicates an increase of ten times the amount of hydrogen ions. The wastewater treatment bacteria operate most efficiently at a pH of 6.8-7.2 (somewhere around neutral). When the pH drops below 6.0 or rises above 8.5, activity drops off dramatically. As a result, under normal operating conditions, pH of the MBR contents should be in the range of 6.0 to 8.5. If the pH drifts too far out of this range then corrective action is required. A low pH must be increased as soon as possible by the addition of alkaline chemical. Extended aeration at low pH will cause severe membrane fouling as a result of poor biological activity. Measurements of pH can be obtained either in the field with a portable pH meter, or in the laboratory from samples collected by the operator.

Alkalinity is the capacity to neutralize acids, and the alkalinity in wastewater results from the presence of the hydroxides, carbonates and bicarbonates of elements such as calcium, magnesium, sodium, potassium, and ammonia. The alkalinity in wastewater helps to resist change in PH change. Sufficient alkalinity is very essential to the nitrification of wastewater.

Temperature

The biological activity within the MBR system is directly affected by the influent wastewater temperature and ambient temperature. Biological activity (i.e., the rate of removal of organic matter, nitrogen and phosphorus) decreases as the biomass temperature decreases. Membrane flux rate is also affected by temperature. In general, a warmer temperature improves system performance in terms of biological activity rate, and membrane flux rate up to a maximum at approximately 35˚C.

Dissolved Oxygen (DO)

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The DO concentration in the aeration basin is measured with a DO meter/probe. The objective is to maintain a DO concentration of 1.0 – 2.0 mg/l at all times in the aeration tank.

Viscosity

The sludge viscosity is one parameter used to track the condition of the MBR sludge with system performance. Monitoring of viscosity testing may be required when treating certain type of industrial wastewaters.

Sludge Filterability

Sludge filterability is a key monitoring test to determine the condition of the MBR mixed liquor. Method for determining the sludge filterability is provided in Section 6.2.2.

Fats, Oil and Grease (FOG)

FOG includes the fats, oils, waxes and other related constituents found in wastewater, and is contributed to wastewater in butter, lard, margarine and vegetable fats and oils. FOG can coat and kill bacteria, causing the microorganisms to float out of the system, interfere with oxygen-transfer efficiency, and cause membrane fouling. If FOG is not removed from wastewater, it can interfere with the biological life in the surface waters and create unsightly films.

Bacterial Indicators

Another issue that must be addressed in wastewater treatment is the removal of pathogenic bacteria that can cause water-borne diseases. Wastewater operators need to be mindful of the potential contact with organisms that are responsible for typhoid, cholera, dysentery, and hepatitis.

Coliform bacteria are enteric bacteria. This means that they are found in the intestinal tract of warm-blooded animals, including humans. These bacteria, known as *E. coli* in humans, do not cause disease but are necessary for the digestion of food. The waterborne pathogens are also enteric bacteria and are part of the coliform family. Therefore, if coliform bacteria are present in the water, pathogens may also be present. The coliform bacteria live longer in water and are easier to detect by laboratory testing. This is the reason the coliform group has been chosen as the indicator organism for waterborne pathogens. If coliform bacteria are not present it is assumed there are no pathogens present either. The following are specific organisms that have been used as indicators of fecal contamination of wastewater.

Total Coliform: species of gram-negative rods that may ferment lactose with gas production at 35±0.5°C. The total coliform group includes four genera in the Enterobacteriaceae family. These are *Escherichia*, *Citrobacter, Enterobacter*, and *Klebsialla*. Of the group, the *Escherichia* genus (*E. coli* species) appears to be the most representative of fecal contamination.

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Fecal Coliform: A fecal coliform bacteria group was established based on the ability to produce gas at an elevated incubation temperature (44.5±0.2°C for 24±2 h).

E. coli: The *E. coli* is one of the coliform bacteria populations and is more representative of fecal sources than other coliform genera.

Food to Microorganism Ratio (F:M)

Another important design parameter, the F:M ratio represents a ratio between the mass of food provided and the mass of microorganisms in the wastewater treatment system. The amount of food applied is estimated from the results of the BOD and COD tests. These oxygen demand tests provide a reliable approximation of the actual amount of food available to the microorganisms. The MLSS/MLVSS is a good approximation of the microorganism concentration in the sludge. The F:M ratio is, therefore, expressed in terms of kg BOD/(kg MLSS.d)/kg BOD/(kg MLVSS.d) or kg COD/(kg MLSS.d)/kg COD/(kg MLVSS.d).

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APPENDIX I

Process and Chemicals Dosage Calculations

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Process and Chemical Dosage Calculations

This section offers calculations for the membrane permeability, chemical dosing, monitoring parameters and excess sludge wasting.

Membrane Permeability

To check the effectiveness of a cleaning procedure, calculate the permeability of the membranes before / after the membrane cleaning.

Please refer to the example below:

Example: The permeate flowrate per module was recorded at 4,200 L/h at a membrane pressure of 0.06 bar. Membrane surface area per module (in case of MB3-3 module) is 315 m^2 . The membranes are operated on a 10 minute cycle, where permeate is withdrawn for 9 minutes followed by 1 minute of relaxation (no permeation). The temperature of the mixed liquor is 15 ºC.

1) Calculate instantaneous (gross) Flux (**J**), the quantity of wastewater passing through a unit area of membrane module per unit time (LMH or L/(m^2.h)). Flux is occasionally referred to as the permeate production or filtration velocity.

   a. Instantaneous (Gross) Flux:

$$J_{Inst} = \frac{\text{Flowrate}}{\text{Membrane Area}} = \frac{4200L/h}{315m^2} = 13.3LMH$$

   b. Net Flux:

$$J_{Net} = \frac{\text{Flowrate}}{\text{Membrane Area}} \frac{PermeationTime}{CycleTime} = \frac{4200L/h}{315m^2} \frac{9\text{min}}{10\text{min}} = 12.0LMH$$

   c. Temperature Corrected Flux:

$$J_{20^oC} = J_{Inst@15^oC} e^{\theta(20-T)} = 13.3LMH * (2.718)^{0.0239*(20-15)} = 15.0LMH$$

2) Calculate membrane permeability (**K**), the ratio of the flux and transmembrane pressure (TMP).

$$\text{K} = \frac{J_{20^oC}}{TMP} = \frac{15.0LMH}{0.06bar} = 250LMH/bar$$

Note: this parameter has been incorporated on the touch screen and is being monitored via PLC on a continous basis

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Chemical Dosing

To determine the quantity of a chemical required for dosing into the system, refer to the following calculation example.

Example: The aeration tank influent (domestic wastewater) flow rate is 5,000 L/h. The influent total phosphorus (TP) concentration is 10 mg/L, and effluent TP limit is 1 mg/L. The TP uptake through sludge production is 2.5 mg/L. The alum stock solution concentration is 48% by weight, and its density is 1310 kg/m^3. Calculate the alum dosage to aeration tank, Q_{Al}, for TP removal.

1) Determine the alum concentration needed for phosphorus removal in the aeration tank.

Table C.1: Molar ratio of Al (III) dose to phosphorus removed as a function of effluent TP concentration limit for domestic wastewater

Effluent TP limit (mg/L)	**Alum:Phosphorous** (mol/mol)
>= 1	1.0
0.1 - 1	2.0
0.05 – 0.1	2.5
< 0.05	3.5

- Select Al: P ratio = 1.0 mol/mol, because the effluent TP limit is 1 mg/L (See Table C.1)
- Determine the weight of Al required per unit weight of P:

$$\frac{Al}{P} = \frac{1.0 molAl/molP}{2 \times 26.98 g/mol / 666.5 g/mol} = 12.4 gAl/gP$$

- Calculate phosphorus required to be removed: 10 – 1 – 2.5 = 6.5 mg/L
- Determine the concentration of alum required, [Al], in the aeration tank:

$$[Al] = 12.4 gAl/gP \times 6.5 mg/L = 80.6 mg/L$$

2) Determine the amount of alum solution required per hour, Q_{Al}, which is the alum dosing pump flow rate:

$$Q_{Al} = \frac{5{,}000 L/h \times 80.6 mg/L}{48\% \times 1310 kg/m^3 \times 1{,}000 mg/g} = 0.64 L/h$$

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Chemical Dosing with Dry Chemicals

To determine the quantity of dry chemical and water to use to make-up a chemical solution refer to the following two calculation examples:

Example: The alkalinity and pH in the system are to be maintained using soda ash (sodium carbonate). The solubility of soda ash is 22 %wt at 20 °C, and has a density of 2.54 g/cm^3. The chemical make-up tank can hold 300 L of solution. The soda ash is shipped in 25 kg bags. The influent flow rate is 100 m^3/d

1) Determine the amount of dry soda ash need to make-up a batch of soda ash solution:

- Use 20 %wt solution in order to more readily dissolve the soda ash
- Determine the density of the final solution:

$$\rho_{solution} = 0.2 * 2.54 g/cm^3 + (1-0.2) * 1.0 g/cm^3 = 1.31 g/cm^3$$

- Determine the mass of soda ash in 300 L of solution:

$$m_{Na_2CO_3} = 300L * 1.31 g/cm^3 * \frac{1000 cm^3/L}{1000 g/kg} * 0.2 kg_{Na2CO3}/kg_{Solution} = 78.6 kg$$

- Therefore 78.6 kg of soda ash are needed, or approximately 75 kg which is 3 X 25 kg bags.

2) Determine the amount of water to use to make-up the soda ash solution

- Determine the volume displaced by the soda ash:

$$V_{Na_2CO_3} = \frac{75kg}{2.54 g/cm^3} * \frac{1000 g/kg}{1000 cm^3/L} = 29.5L \text{ of elements}$$

- Determine the volume of water required:

$$V_{H_2O} = 300L - 29.5L = 270.5L$$

3) Determine the dosing rate to add 100 mg/L of alkalinity as $CaCO_3$ to the system.

- Determine the equivalent concentration as soda ash (Na_2CO_3):

$$[Alk]_{Na_2CO_3} = [Alk]_{CaCO_3} \frac{MM_{Na_2CO_3}}{MM_{CaCO_3}} = 100 mg/L \frac{106 mg/mmol}{100 mg/mmol} = 106 mg/L$$

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- Determine the dosing rate of soda ash on a mass basis:

$$\dot{m}_{Na_2CO_3} = [Alk]_{Na_2CO_3} * Q_{\inf} = 106mg/L * 100m^3/d * \frac{1000L/m^3}{1000mg/g} = 10{,}600g/d$$

- Determine the dosing rate of soda ash solution on a volume basis:

$$Q_{Na_2CO_3} = \frac{\dot{m}_{Na_2CO_3}}{[Na_2CO_3]} = \frac{10{,}600g/d}{250g/L} = 42.4L/d$$

Example: A filter press is to be used to dewater sludge, and a polymer is to be used to flocculate the sludge. The polymer make-up concentration is to be 0.2% (2 g/L) and to be made up using dry polymer with a density of 0.8 g/mL. The polymer make-up tank has a capacity of 300 L. The flocculation tank has a capacity of 900 L. The wasted sludge has an MLSS concentration of 1% (10 g/L). The ratio of polymer to sludge should be 10 g/kg on a dry basis.

1) Determine the amount of dry polymer required to make up a batch of 0.2% polymer solution:

- Determine mass of dry polymer required

$$m_{DryPolymer} = [Polymer] * V_{PolymerSolution} = (2g/L) * (300L) = 600g$$

- Determine volume of dry polymer required

$$V_{DryPolymer} = \frac{m_{DryPolymer}}{\rho_{DryPolymer}} = \frac{600g}{0.8g/mL} = 750mL$$

- Therefore 750 mL of dry polymer, or 3 cups, are required to make-up a batch of 0.2% polymer solution.

2) Determine the dose of polymer solution required to flocculate a batch of sludge:

- Determine mass of solids to be flocculated on a dry basis

$$m_{DrySolids} = [MLSS] * V_{Sludge} = (10g/L) * (900L) = 9000g = 9kg$$

- Determine mass of polymer required to flocculate sludge on a dry basis

$$m_{DryPolymer} = Polymer:SolidsRatio * m_{DrySolids} = (10g/kg) * (9kg) = 90g$$

- Determine volume of polymer solution required to flocculate sludge

$$V_{PolymerSolution} = \frac{m_{DryPolymer}}{[Polymer]} = \frac{90g}{2g/L} = 45L$$

- Therefore 45 L of 0.2% polymer solution are required per batch to flocculate the 900 L of 1% sludge.

Monitoring Parameters

To determine the food to microorganism (F/M) ratio, BOD loading rate and solids retention time (SRT) refer to the following examples.

Example: The influent flow rate is 100 m^3/d with a BOD concentration of 400 mg/L (g/m3). The volume of the reactor (aeration tank and membrane tank) is 100 m^3 and contains mixed liquor with a suspended solids concentration of 10,000 mg/L and a MLVSS/MLSS ratio of 0.70. Excess sludge is wasted at a rate of 5 m^3/d

1) Determine the BOD loading:

$$BOD_{Loading} = \frac{[BOD]*Q_{\inf}}{V_{Reactor}} = \frac{(400g/m^3)*100m^3/d}{100m^3}$$

$$BOD_{Loading} = 400\frac{g}{m^3*d} = 0.4\frac{kg}{m^3*d}$$

2) Determine F/M ratio:

$$F/M = \frac{[BOD]*Q_{\inf}}{MLSS*\frac{MLVSS}{MLSS}V_{Reactor}} = \frac{(400g/m^3)*100m^3/d}{(10{,}000g/m^3)*(0.70)*(100m^3)}$$

$$F/M = 0.057\frac{kgBOD}{kgMLVSS*d}$$

3) Determine SRT:

$$SRT = \frac{V_{Reactor}}{Q_{WAS}} = \frac{100m^3}{5m^3/d}$$

$$SRT = 20d$$

Excess Sludge Wasting

Excess activated sludge is wasted periodically during the MBR operation. To determine the amount of excess sludge wasted, refer to the following calculation example.

Example: The measured MLSS concentration of activated sludge in aeration tank is 15,000 mg/L. Excess sludge has to be drained to keep its design concentration of 10,000 mg/L.The volume of aeration tank is 100 m^3. Calculate the volume of excess sludge (Vs) to be wasted.

$$V_s = \frac{(15{,}000 - 10{,}000)mg/L \times 100m^3 \times 1{,}000L/m^3}{15{,}000mg/L} = 33{,}333L$$

The operator can set the sludge wasting pump flowrate according to the above calculated volume.

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Soda Ash Make-Up Instructions

1. Fill soda ash make-up tank approximately ¾ full of 20 °C water
    - MBR permeate may be used
2. Turn on mixer M-6101
3. Slowly add sodium carbonate to make up a 20%wt solution(Rule of thumb: 1 X 25 kg bag per 100 L)
    - This is based on 20 °C water. If water temperature is colder, the solubility will be lower.
    - Check between additions of each bag to ensure sodium carbonate is dissolving. If sodium carbonate is not dissolving, do not add any more.
4. Once fully dissolve, turn off mixer M-6101

Caution: This soda ash make-up process is exothermic (generates heat), and personal protective equipment for chemicals handling must be worn.

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APPENDIX J

newterra MicroClear™ Membrane Clean Water Testing Sheet & Cleaning Log Sheet

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newterra MicroClear™ MEMBRANE CLEAN WATER TESTING SHEET – MBR HYDRAULICS

Clean Water Test Information	
Date	
Performed By	
Observed By	

Plant Conditions	
Ambient Temperature	
Water Temperature	
Normal Operating Level	
Static Pressure at Normal Operating Level	

MEMBRANE TANK HYDRAULICS

Flux (LMH)	Flow Rate (Lpm)	TMP during steady flow (bar)	Permeability (LMH/bar)

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newterra MicroClear™ MEMBRANE CLEANING LOG SHEET

Precautions have to be taken to handle membrane chemical cleaning.

Chemical cleaning is only to be carried out by qualified and trained personnel! Chemicals can lead to serious injuries. Always wear personal protective equipment (PPE) when handling chemicals! Obey the chemical safety handling procedure, as listed in the Material Safety Data Sheets.

Date	Type of Cleaning		Start time	Finish time	Sodium Hypochlorite (NaOCl)		Citric Acid ($C_6H_8O_7$)		Permeability * (LMH/bar)
	Maintenance (CEB)	Recovery (R)			Volume (L)	Conc. (mg/L)	Volume (L)	Conc. (mg/L)	

**Normal permeability after cleaning: 150 to 300 LMH/bar. Repeat the cleaning procedures if the normal permeability value is not attained.*

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APPENDIX K

Control Narrative

1704432 - Agnico Eagle
System Control Narrative - Test Protocol

Revision	YYYY-MM-DD	Description	By
A	2017-05-25	Submittal	JJK
C	2017-05-11	As-Built	JJK

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
100	FIT-101	Flow Indicating Transmitter	Analog	GPM	0-760lpm	0-760lpm	Y	Y		
100	FQI-101	Flow Totalizer	Discrete N.O.	Pulse/Gal	1 liter/ Pulse					
100	LSHH-101	Level Switch High High	Discrete N.C.							
100	LSHH-102	Level Switch High High	Discrete N.C.							
100	LSHH-103	Level Switch High High	Discrete N.C.							
200	FIT-201	Flow Indicating Transmitter	Analog	GPM	0-760lpm	0-760lpm	Y	Y		
200	FQI-201	Flow Totalizer	Discrete N.O.	Pulse/Gal	1 liter/ Pulse					
200	LSHH-201	Level Switch High High	Discrete N.C.							
200	LSHH-202	Level Switch High High	Discrete N.C.							

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
200	LSHH-203	Level Switch High High	Discrete N.C.							
200	LSH-203	Level Switch High	Discrete N.C.							
200	LSL-203	Level Switch Low Low	Discrete N.O.							
300	LSHH-301	Level Switch High High	Discrete N.C.							
300	LT-301	Level Transmitter	Analog	%	0-10 ftWC	0-10 ftWC	Y	Y		
300	TT-301	Temperature Transmitter	Analog	°C	0-100c	0-100c	n	n	Added to System	
300	LSLL-301	Level Switch Low Low	Discrete N.O.						Must be above all immersion heaters in Tank	
300	PSL-301	Pressure Switch Low	Discrete N.C.		9-85"WC					

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
400	LSHH-401	Level Switch High High	Discrete N.C.							
400	TSL-401	Temperature Switch Low	Discrete N.C.							
400	LSLL-401	Level Switch Low Low	Discrete N.O.							
500	LSHH-501	Level Switch High High	Discrete N.C.							
500	LSLL-501	Level Switch Low Low	Discrete N.O.						Must be above all immersion heaters in Tank	
500	PH-501	pH Transmitter	Analog		0-14 pH		Y	Y		
500	DO-501	Dissolved Oxygen Transmitter	Modbus	ppm	0-10		Y	Y		
500	TT-501	Temperature Transmitter	Modbus	°C	0-100					
500	LT-501	Level Transmitter	Analog	%	0-10 ft		Y	Y		

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
500	PSL-501	Pressure Switch Low	Discrete N.C.		9-85"WC					
500	LSHH-502	Level Switch High High	Discrete N.C.							
500	LSLL-502	Level Switch Low Low	Discrete N.O.						Must be above all immersion heaters in Tank	
500	TSL-502	Temperature Switch Low	Discrete N.C.							
600	LSHH-601	Level Switch High High	Discrete N.C.							
600	LSH-601	Level Switch High	Discrete N.O.							
600	LSHH-602	Level Switch High High	Discrete N.C.							
600	LSH-602	Level Switch High	Discrete N.O.							
600	PSL-601	Pressure Switch Low	Discrete N.C.		9-85"WC					

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
600	PSL-602	Pressure Switch Low	Discrete N.C.		9-85"WC					
700	VT-701	Vacuum Transmitter	Analog	Bar	-1.0 - 1.0 Bar		Y	Y		
700	VT-702	Vacuum Transmitter	Analog	Bar	-1.0 - 1.0 Bar		Y	Y		
700	VFD-701	VFD Status	Communcation							
700	VFD-702	VFD Status	Communcation							
700	FIT-701	Flow Indicating Transmitter	Analog	GPM	0-300lpm		Y	Y		
700	FQI-701	Flow Totalizer	Discrete N.O.	Pulse/Gal	1liter / Pulse					
700	FIT-702	Flow Indicating Transmitter	Analog	GPM	0-300lpm		Y	Y		
700	FQI-702	Flow Totalizer	Discrete N.O.	Pulse/Gal	1liter / Pulse					

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
800	LSH-801	Level Switch High	Discrete N.C.							
800	LSL-801	Level Switch Low Low	Discrete N.O.							
900	LSHH-901	Level Switch High High	Discrete N.C.							
7900	PSL-7911	Pressure Switch Low	Discrete N.O.		0.4 - 1.6"WC				Proof of Continuous Ventilation.	
7900	LSHH-7911	Level Switch High High	Discrete N.C.							
7900	TSLL-7911	Temperature Switch Low Low	Discrete N.C.	°F	-30-100 °F					

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification
7900	TSLL-7914	Temperature Switch Low Low	Discrete N.C.	°F	-30-100 °F					
7900	TSLL-7916	Temperature Switch Low Low	Discrete N.C.	°F	-30-100 °F					
7900	LSHH-7961	Level Switch High High	Discrete N.C.							
7900	LSHH-7962	Level Switch High High	Discrete N.C.							
7900	ES-7911	Emergency Stop - Building	Discrete N.C.							
7900	ES-7941	Emergency Stop - Building	Discrete N.C.							
7900	ES-7961	Emergency Stop - Building	Discrete N.C.							
500	VFD-501 Status									
500	VFD-502 Status									
500	VFD-501 Alarm									
500	VFD-502 Alarm									
700	VFD701 Alarm									
700	VFD702 Alarm									

System Inputs

Module	Tag	Description	Input Type	HMI Display Units	Device Range and Units	Device Span/PLC Scale	Datalog (Y)	Trending (Y)	Notes	Input Verification

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
100	FTAH-101-SP	Flow Transmitter Alarm High Setpoint	75	0-200 GPM	Open	Y		
200	FTAH-201-SP	Flow Transmitter Alarm High Setpoint	75	0-200 GPM	Open	Y		
300	LTL-301-SP	Level Transmitter Low Setpoint	10%	0-100%	Open			
300	LTHFLUX-301-SP	High Flux Level Setting	50%	0-100%			Puts the MBR Permeate pumps into High Flux Mode	
300	LTH-301-SP	Level Transmitter High Setpoint	80%	50-100%	Open			
500	LTL-501-SP	Level Transmitter Low Setpoint	70%	0-100%	Open			
500	LTH-501-SP	Level Transmitter High Setpoint	80%	0-100%	Open			

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
500	LT501-SLUDGE-SP	Waste Level for P-503	75%	0-100%	Open			
500	LT501-PERM-SP	Level Control for Permeate Pumps	75%	0-100%	Open		If Level drops below, permeate pumps will stop	
500	P503 WASTE HOUR	When P-503 will waste	12pm	0-23				
500	P503 WASTE SP	Time that P-503 wastes for	10min	0-99				
500	PH-501-SP	pH Normal Setpoint	7 pH	6-8pH	Open			
500	PHAH-501-SP	pH Alarm High Setpoint	8 pH	7 - 14 pH	Open	Y		
500	PHAL-501-SP	pH Alarm Low Setpoint	6 pH	0-7 pH	Open	Y		
500	DO-501-SP	Dissolved Oxygen Normal Setpoint	2 ppm	0-6 ppm	Open			
500	B500 I SP	Integral Gain setting DO PID Loop	10s	0-99				
500	B500 P SP	Proportional Gain setting DO PID Loop	100%	0-99				

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
500	B501 MAN SP	Manual Speed B-501	50%	0-100				
500	B502 MAN SP	Manual Speed B-502	50%	0-100				
500	DOAL-501-SP	Dissolved Oxygen Alarm Low Setpoint	0.5 ppm	0-6 ppm	Open	Y		
500	ALUM DOSE	Alum Dose setting (xGal per Pulse)	10 Gallons	0-99 Gallons	Open		Setpoint controls a single pulse of Alum P-6101 dosing.	
500	MICROC DOSE	Micro C Dose setting (xGal per Pulse)	10 Gallons	0-99 Gallons	Open		Setpoint controls a single pulse of Alum P-6101 dosing.	
500	TALL-501-SP	Temperature Alarm Low Low	10 deg C	5 - 25 deg C	Password	Y		
500	TTL-501-SP	Temperature Transmitter Low Setpoint	15 deg C	5-25 deg C	Open			
500	PAL-501-SP	Pressure Alarm Low Setpoint	28"WC (1PSIG)		On Device	Y		
500	TALL-502-SP	Temperature Alarm Low Low	10 deg C	5 - 25 deg C	Password	Y		

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
700	VT-701-SP	MBR-1 Vac Mode Permeate Setpoint	-0.1 bar	-0.2 - 0 bar	Open			
700	VT-701-HFSP	MBR-1 Vac Mode Permeate High Flux Setpoint	-0.15 bar	-0.2 - 0 bar	Open			
700	VTAH-701-SP	MBR-1 Vacuum Transmitter Alarm High	-0.3 bar	-0.3 - 0 bar	Open	Y		
700	VT-702-SP	MBR-2 Vac Mode Permeate Setpoint	-0.1 bar	-0.2 - 0 bar	Open			
700	VT-702-HFSP	MBR-2 Vac Mode Permeate High Flux Setpoint	-0.15 bar	-0.2 - 0 bar	Open			
700	VTAH-702-SP	MBR-2 Vacuum Transmitter Alarm High	-0.3 bar	-0.3 - 0 bar	Open	Y		
700	FT-701-SP	MBR-1 Flow Mode Permeate Setpoint	60 GPM	0-200	Open			
700	FT-701-HFSP	MBR-1 Flow Mode Permeate High Flux Setpoint	75%	0-200	Open			
700	FTAH-701-SP	MBR-1 Flow Transmitter Alarm High Setpoint	100	0-200	Open	Y		
700	FTAL-701-SP	MBR-1 Flow Transmitter Alarm Low Setpoint	10	0-200	Open	Y		

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
700	FT-702-SP	MBR-2 Flow Mode Permeate Setpoint	60 GPM	0-200	Open			
700	FT-702-HFSP	MBR-2 Flow Mode Permeate High Flux Setpoint	75GPM	0-200	Open			
700	FTAH-702-SP	MBR-2 Flow Transmitter Alarm High Setpoint	100	0-200	Open	Y		
700	FTAL-702-SP	MBR-2 Flow Transmitter Alarm Low Setpoint	10	0-200	Open	Y		
GLOBAL	BKWSH-TIME-SP	Backwash Time Setpoint	120s	0-999 s	Open			
GLOBAL	RELAX-SP	Number of Relaxes Before Backwash	6	0-999	Open			
GLOBAL	PERM-PULL-TIME	Permeate Pull Time	9m	0-30m	Open			
GLOBAL	RELAX-TIME	Membrane Relax Time	60s	0-999 s	Open			
GLOBAL	FLUX-SP	High Flux Setpoint	75%	50-100%	Open		Reading based on LT-301	

System Setpoints

Module	Tag	Description	Factory Setpoint	Setpoint Range and Units	Setpoint Change Control	Alarm setpoint (Y/N)	Notes	Setoint Verification
GLOBAL	SLUDGE-WASTE-TOD	Time of Day to Start Sludge Wasting	23hr	0-23 hr	Open			
GLOBAL	SLUDGE-WASTE-TIME	Duration of Sludge Wasting	60m	0-1000m	Open			

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
		Start/Stop	The system will start when the start button is pressed on the HMI.							
		Start/Stop	The system will automatically restart after recovery from a power failure after a 30 second delay, unless the Start button is pressed first .							
		Start/Stop	To stop the system press the stop button on the HMI display.							
		Start/Stop	The system will shut down under some alarm conditions, see the modules below for these specific circumstances.							
		Start/Stop	All equipment will have to be put in “AUTO” in order to operate with the exception of heaters, auto-drain valves, building fans or self-governed equipment (such as screw compressors, air dryers, etc.).							
		Start/Stop	**Note:** when components are put in “HAND” mode the “AUTO” logic described below will be bypassed and the component will run regardless of inputs (unless the emergency stop button is activated). This is done for on-site testing and troubleshooting purposes. When a soft HOA switch (a software based toggle switch present in remote telemetry or HMI based systems) is used, a 2 minute safety timer is used on all components to prevent running them dry or excessive flooding due to operator error. Hand Timers can be Overridden by touching the pressing and holding the newterra watermark on the Control Bar. By enabling the override the user assumes responsibility for operating the system outside the control parameters set by newterra. While override is enabled all Hand timers and interlocks are ignored.							
N/A	N/A	HMI Datalogging	DO and pH will be logged and displayed on the HMI on the same plot.							
N/A	N/A	HMI Datalogging	Flux and Permeability data will be logged and displayed on the HMI on the same plot.							

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
N/A	N/A	MBR-1 Enable	HMI will contain an MBR-1 Enable button. When selected, MBR-1 is enabled.							
N/A	N/A	MBR-2 Enable	HMI will contain an MBR-2 Enable button. When selected, MBR-2 is enabled.							
N/A	N/A	Flow Mode	HMI will contain a Flow Mode Enable button. When selected the permeate system will operate in Flow Mode.							
N/A	N/A	Vac Mode	HMI will contain a Vac Mode Enable button. When selected the permeate system will operate in Vac Mode.							
100	YC-101	Ready Contact	On when LSHH-101 / 102 / 103 and LSHH-201 / 202 and LSHH-203 are not ON	All LSHH's in the inlet area				HOA		
200	YC-201	Ready Contact	On when LSH-201 / 202 and LSHH-203 are not ON					HOA		
200	SCR-201	Inlet Screen	The inlet screen will be ON when influent flow is detected via flow transmitter FIT-201. The screen will run for 1 minute after influent flow has stopped via flow transmitter FIT-201. If the high high level switch LSHH-201 on the screen is ON then the inlet screen SCR-201 will be ON.		Discrete	Y		HOA		

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
200	SCR-202	Inlet Screen	Same as SCR-201		Discrete	Y		HOA		
200	P-201	Screen Transfer Pump	The pump will be ON when the LSH-203 turn on as long as LT-301 < LTH-301-sp setpoint the pump will turn off when the LSL-201 turns off	LAHH-301	Discrete	Y		HOA		
200	P-202	Screen Transfer Pump	This pump runs duty standby with P-201 with a 5:1 rato	LAHH-301	Discrete	Y		HOA		
300	H-301	Tank Heater	On when TT-301 < 10C Off when TT-301 >15C	LALL-301	Discrete					
300	H-302	Tank Heater	Same as H-301	LALL-301	Discrete					
300	P-301	EQ Transfer Pump	The EQ pump will be ON when the EQ level transmitter LT-301 > LTL-301-SP and the aeration tank level transmitter LT-501 < LTH-501-SP The EQ pump will be OFF when the EQ level transmitter LT-301 < LTL-301-SP OR LSLL-301 = InActive OR the aeration tank level transmitter LT-501 > LTH-501-SP OR LSHH-401 is active Runs Duty with P-302 as Standby	Turns OFF LAHH-501 LAHH-401 LALL-301	Discrete	Y		HOA		
300	P-302	EQ Transfer Pump	This pump runs duty standby with P-201 with a 5:1 rato		Discrete	Y		HOA		
300	B-301	EQ Blower	The EQ blower will be ON when the System is in Run & LSLL-301 is active.		Discrete	Y		HOA		

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
300	B-302	EQ Blower	Runs Duty standby with B-301 switching every 120 hours		Discrete	Y		HOA		
400	P-401	Pre-Anox Mixing Pump	The pump will be ON when the System is in Run & LSLL-401 is active.	LALL-401 PUMP IS OFF	Discrete	Y		HOA		
400	P-402	Pre-Anox Mixing Pump	Runs Duty standby with P-401 switching every 120 hours		Discrete	Y		HOA		
400	H-401	Tank Heater	On when TSL-401 is OFF	LALL-401	Discrete					
400	H-402	Tank Heater	On when TSL-401 is OFF	LALL-401	Discrete					
6100	P-6102	Alum Dosing Pump	Alum Dosing Pump P-6102 be ON when FIT-701 has reached a user adjustable volume of permeate via FT-701-DOSE setpoint. P-6102 will be ON for one pulse.		Discrete			HOA		
6100	P-6101	Caustic Dosing Pump	Caustic Dosing Pump P-6101 will be ON when PH-501 < PH-501-SP. The pump will be ON for 30s and OFF for 30s and will operate in pause mode		Discrete			HOA		
500	H-501	Tank Heater	On when TSL-501 is OFF	LALL-501	Discrete					

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
500	H-502	Tank Heater	On when TSL-501 is OFF	LALL-501	Discrete					
500	P-503	Waste Activated Sludge Pump	The waste activated sludge pump will be ON at time of day setting SLUDGE-WASTE-TOD IF level switch LT501-SLUDGE-SP	LAHH-901: Pump will be OFF	Discrete			HOA		
500	H-503	Tank Heater	On when TSL-502 is OFF	LALL-502	Discrete					
500	H-504	Tank Heater	On when TSL-502 is OFF	LALL-502	Discrete					
500	P-501	Aeration Recirc Pump	The pump will run as long as LSLL-501 is Active	LALL-502: Pump will be OFF	Discrete	Y		HOA		
500	P-502	Aeration Recirc Pump	Runs Duty standby with p-501 switching every 120 hours		Discrete	Y		HOA		
500	B-501	Aeration Tank Aeration Blower	ON - Always Runs via PID loop to maintain DO-501-SP Runs Duty/Standby 120 hours with B-502.		Direct	Y		HOA		
500	B-502	Aeration Tank Aeration Blower	Runs via same logic as B-501. Runs Duty/Standby every 120 hours with B-501.		Direct	Y		HOA		

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
550	P-553	Post Anox Mix Pump	The pump will run as long as LSLL-501 is Active	LALL-501: Pump will be OFF	Discrete	Y		HOA		
550	P-554	Post Anox Mix Pump	Runs Duty standby with p-501 switching every 120 hours		Discrete	Y		HOA		
6100	P-6103	Micro C Dosing Pump	Dosing Pump will be ON when FIT-701 or FT-702 has reached a user adjustable volume of permeate via DOSE setpoint.		Discrete			HOA		
550	P-551	Aeration Transfer Pump Feed to MBR-1	The aeration pump will feed MBR tank T-601. The pump will be ON when level transmitter LT-501 > LTL-501-SP and LSLL-501 = Active and LSLL-502 = Active and MBR-1 is Enabled. The aeration pump will be cycle ON/OFF when LT-501 < LTL-501-SP and be OFF if LSLL-501 = InActive OR LSLL-502 = InActive	LAHH-601: Pump will be OFF MBR-1 Disabled	Discrete	Y		HOA		
550	P-552	Aeration Transfer Pump Feed to MBR-2	The aeration pump will feed MBR tank T-602. The pump will be ON when level transmitter LT-501 > LTL-501-SP and LSLL-501 = Active and LSLL-502 = Active and MBR-2 is Enabled. The aeration pump will cycle ON/OFF when LT-501 < LTL-501-SP and be OFF if LSLL-501 = InActive OR LSLL-502 = InActive	LAHH-602: Pump will be OFF MBR-2 Disabled	Discrete	Y		HOA		
600	B-601	MBR Tank Blower	The membrane tank blower will be ON when the System is in Run. And the MBR 1 is enabled	MBR-1 Disabled	Discrete	Y		HOA		
600	B-602	MBR Tank Blower	The membrane tank blower will be ON when the System is in Run. And the MBR 2 is enabled	MBR-2 Disabled	Discrete	Y		HOA		

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
700	P-701	Permeate Transfer Pump	The permeate pump will be ON when MBR-1 is Enabled & level switch LSH-601 = Active & LT-501 > LT501-PERM-SP The Pump will perform a PULL/RELAX Cycle. The pump will be ON for the duration specified by the PERM-PULL-TIME setpoint and then be OFF for the duration of the RELAX-TIME setpoint. This will generate one PULL/RELAX Cycle. The VFD Speed of the pump will operate based on the following: In FLOW MODE: The VFD Speed will operate based on a PID loop to maintain the flowrate setpoint FT-701-SP. IF the vacuum transmitter VT-701 > -0.25 bar then the pump will switch to VAC MODE. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint FT-701-HFSP In VAC MODE: The VFD Speed will operate based on a PID loop to maintain the vacuum setpoint VT-701-SP. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint VT-701-HFSP P-701 will be OFF if P-501 is OFF.	A-701: Pump Will b	Communication	Y		HOA		
700	P-702	Permeate Transfer Pump	The permeate pump will be ON when MBR-2 is Enabled & level switch LSH-602 = Active & & LT-501 > LT501-PERM-SP The Pump will perform a PULL/RELAX Cycle. The pump will be ON for the duration specified by the PERM-PULL-TIME setpoint and then be OFF for the duration of the RELAX-TIME setpoint. This will generate one PULL/RELAX Cycle. The VFD Speed of the pump will operate based on the following: In FLOW MODE: The VFD Speed will operate based on a PID loop to maintain the flowrate setpoint FT-702-SP. IF the vacuum transmitter VT-702 > -0.25 bar then the pump will switch to VAC MODE. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint FT-702-HFSP In VAC MODE: The VFD Speed will operate based on a PID loop to maintain the vacuum setpoint VT-702-SP. IF the level transmitter LT-301 > FLUX-SP, the pump will run via PID loop to maintain a high flow setpoint VT-702-HFSP P-702 will be OFF if P-502 is OFF.	A-703: Pump Will b	Communication	Y		HOA		
800	SV-801	Clean In Place Tank Fill Solenoid Valve	The Solenoid Valve SV-801 will be Open (Energized) when level switch LSH-801 is InActive and MBR-1 OR MBR-2 are not in Backwash. The Solenoid Valve SV-801will be Closed (De-Engergized) when LSH-801 is Active or IF MBR-1 OR MBR-2 are in Backwash.		Discrete			HOA		
700	MV-701	Backwash Actuated Valve	A Backwash is enabled once the permeate pumps for MBR-1 reach the number of PULL/RELAX cycles designated by the RELAX-SP on the HMI. the The actuated valve will be OPEN when MBR-1 is in Backwash and level switch LSH-801 is Active. If MBR-2 is already in backwash, MBR-1 will complete 1 additional PULL/RELAX Cycle before starting a Backwash Cycle.		Discrete			HOA		
700	MV-702	Backwash Actuated Valve	A Backwash is enabled once the permeate pumps for MBR-2 reach the number of PULL/RELAX cycles designated by the RELAX-SP on the HMI. the The actuated valve will be OPEN when MBR-2 is in Backwash and level switch LSH-801 is Active. If MBR-2 is already in backwash, MBR-1 will complete 1 additional PULL/RELAX Cycle before starting a Backwash Cycle.		Discrete			HOA		

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
800	P-801	Backwash Transfer Pump	The backwash transfer pump will be ON when MBR-1 OR MBR-2 are in Backwash and level switch LSH-801 is Active The backwash transfer pump will be OFF after the duration of BKWSH-TIME-SP OR level switch LSL-801 becomes InActive.		Discrete			HOA		
7911	B-7911	Ventilation Blower	The continuous ventilation blower will always be ON. This blower is used as means to de-rate the screen building to a Class 1 Division 2 area. Air exchanges must be a minimum of 12 per hour,		Direct (not PLC controled)					
7901	HT-7911	Heat Trace	Always on internally controlled		Direct (not PLC controled)					
7901	HT-7912	Heat Trace	Always on internally controlled		Direct (not PLC controled)					
7901	HT-7913	Heat Trace	Always on internally controlled		Direct (not PLC controled)					
7901	H-7911	Building Heater	Always on internally controlled		Direct (not PLC controled)					
7901	H-7912	Building Heater	Always on internally controlled		Direct (not PLC controled)					
7904	B-7941	Aeration Exhaust Blower	On when B-501/502 is on OR B-601/602 is on		Discrete			Auto		
7904	H-7941	Building Heater	Always on internally controlled		Direct (not PLC controled)					
7906	H-7961	Building Heater	Always on internally controlled		Direct (not PLC controled)					

System Outputs and Modes of Operation

Module	Tag / Mode	Description	Control Logic	Alarm Interactions	Output Type	Hour Meter	Amp Meter	HOA Control	Output Verification	Logic Verification
7906	H-7962	Building Heater	Always on internally controlled		Direct (not PLC controled)					
7906	H-7963	Building Heater	Always on internally controlled		Direct (not PLC controled)					
7906	F-7963	Building Fan	Always on controlled by Wall Mount Termostat		Direct (not PLC controled)					

System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
100	FTAH-101	Flow Transmitter Alarm High	FIT-101 > FTAH-101-SP	60s					
100	LAHH-101	Level Alarm High High	LSHH-101 = Active	5s		Y			
100	LAHH-102	Level Alarm High High	LSHH-102 = Active	5s		Y			
100	LAHH-103	Level Alarm High High	LSHH-103 = Active	5s		Y			
200	FTAH-201	Flow Transmitter Alarm High	FIT-201 > FTAL-201-SP	60s					
200	LAHH-201	Level Alarm High High	LSHH-201 = Active	5s		Y			
200	LAHH-202	Level Alarm High High	LSHH-202 = Active	5s		Y			
200	LAHH-203	Level Alarm High High	LSHH-203 = Active	5s		Y			

System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
300	LAHH-301	Level Alarm High High	LSHH-301 = Active	5s		Y			
300	LALL-301	Level Alarm Low Low	LSLL-301 = Off	5s		Y			
400	LAHH-401	Level Alarm High High	LSHH-401 = Active	5s		Y			
400	LALL-401	Level Alarm Low Low	LSLL-401 = OFF	5s		Y			
500	LAHH-501	Level Alarm High High	LSHH-501 = Active	5s		Y			
500	LAHH-502	Level Alarm High High	LSHH-501 = Active	5s		Y			
500	PHAH-501	pH Alarm High	pH-501 > PHAH-501-SP	60s					
5800	PHAL-501	pH Alarm Low	pH-501 < PHAL-501-SP	60s					
500	DOAL-501	Dissolved Oxygen Alarm Low	DO-501 < DOAL-501-SP	15m					
500	DOALL-501	Dissolved Oxygen Alarm Low Low	DO-501 < DOAL-501-SP	4hrs					

System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
500	TTAL-501	Low Temp TNK-501	TT-501<TTAL-501-SP						
500	PAL-501	Pressure Alarm Low	PSL-501 = InActive	5s		Y			
500	VFDA-501	VFD Fault							
500	VFDA-502	VFD Fault							
500	LALL-501	Low Low Level TNK-501	LSLL-501 = OFF						
500	LALL-502	Low Low Level TNK-502	LSLL-502 = OFF						
600	LAHH-601	Level Alarm High High	LSHH-601 = Active	5s		Y		Membrane Tank	
600	LAHH-602	Level Alarm High High	LSHH-602 = Active	5s		Y		Membrane Tank	
600	PAL-601	Pressure Alarm Low	PSL-601 = InActive	5s		Y		Membrane Blowers	

System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
600	PAL-602	Pressure Alarm Low	PSL-602 = InActive	5s		Y		Membrane Blowers	
700	VTAH-701	Vacuum Transmitter Alarm High	VT-701 < VTAH-701-SP	5s		Y			
700	VTAH-702	Vacuum Transmitter Alarm High	VT-702 < VTAH-702-SP	5s		Y			
700	VFDA-701	VFD Fault							
700	VFDA-702	VFD Fault							
700	FTAH-701	Flow Transmitter Alarm High	FIT-701 > FTAH-701-SP	60s					
700	FTAL-701	Flow Transmitter Alarm Low	FIT-701 < FTAL-701-SP	60s					
700	FTAH-702	Flow Transmitter Alarm High	FIT-702 > FTAH-702-SP	60s					

System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
700	FTAL-702	Flow Transmitter Alarm Low	FIT-702 < FTAL-702-SP	60s					
900	LAHH-901	Level Alarm High High	LSHH-901 = Active	5s		Y		Aerobic Digester Tank	
7910	PAL-7911	Pressure Alarm Low	PSL-7911 = InActive	5s		Y		Alarm indicates possible continuous ventilation failure, indicating risk that the room may become Class 1 Division 1 rated.	
7910	TALL-7911	Temperature Alarm Low Low	TSLL-7911 = Active	5s		Y			
7910	LAHH-7911	Level Alarm High High	LSHH-7911 = Active	Immediate					
7940	TALL-7941	Temperature Alarm Low Low	TSLL-7941 = Active	5s		Y			
7961	LAHH-7961	Level Alarm High High Sump	LSHH-7961 - OFF						
7960	TALL-7961	Low Low Temp Aalrm	LSLL-7961 = Active						

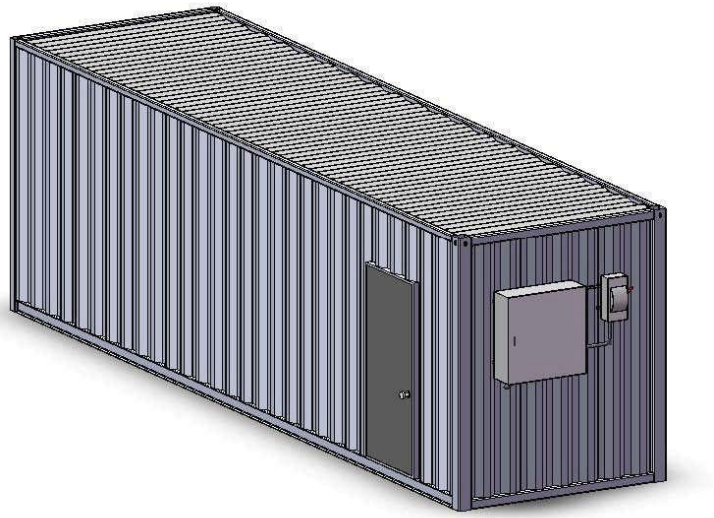
System Alarms

Module	Alarm	Alarm Description	Actuation Control	Delay	Email Notification (Y)	Self Resetting (Y)	System Shutdown (Y)	Notes	Alarm Verification
8200	ESA-8201	Emergency Stop Alarm	ESA-8201 = Active	Immediate		Y			
8200	PWR-FAIL	Power Failure		Immediate		Y			
8200	PLC FLT	PLC Fault Detected		Immediate		Y			
8200	PWR FLT	Phase Monitor Fault	JA-8201 = Active	Immediate		Y			

CONTAINER ENCLOSURES – CNTR SERIES

Application:

newterra Container Enclosures are a popular choice for housing large stationary systems. Containers are secure, cost effective and offer a wide range of options to customize appearance or functionality to suit customer requirements.

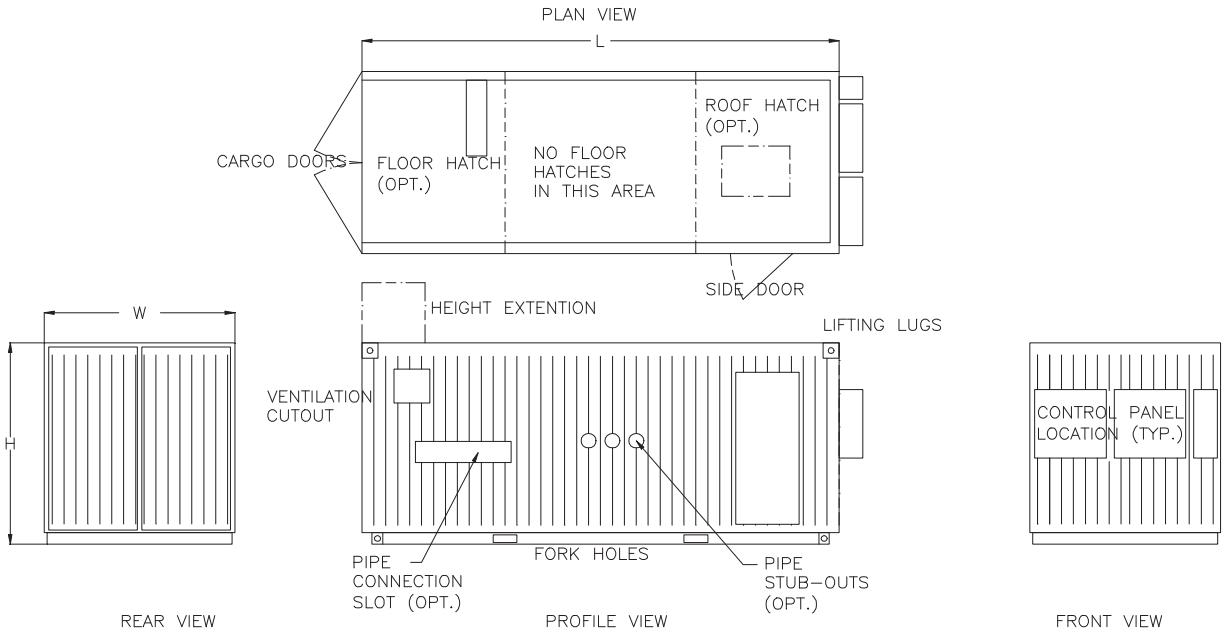


Constructions:

Heavy corrugated steel shell and steel beam structure with wood-plank flooring. Heavy steel double doors on one end are standard. Twenty-foot and forty-foot are standard length, but a custom length can be obtained by cutting one of the standard length units.

Standard Features:

- Painted exterior, plywood interior
- Waterproof sealed floor
- Double cargo doors on end (opening 89” H x 92” W); side door (32”)
- Lifting lugs at roof for crane lifting; lifting lugs at base for boom/crane lifting fork holes in base (20ft only)



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CONTAINER ENCLOSURES – CNTR SERIES

Dimension and Specification chart:

Part Number	Length	Width	Height	Weight Empty (lbs)	Std Cap. (lbs)	Interior Dimensions		
						Length	Width	Height
CNTR10	10’	8’	8’ 6”	3,000	9,000	9’ 8”	7’ 8”	7’ 10”
CNTR12	12’	8’	8’ 6”	3,800	10,800	11’ 8”	7’ 8”	7’ 10”
CNTR16	16’	8’	8’ 6”	4,500	14,400	15’ 5”	7’ 8”	7’ 10”
CNTR20	20’	8’	8’ 6”	5,000	18,000	19’ 4”	7’ 8”	7’ 10”
CNTR24	24’	8’	8’ 6”	5,800	21,600	22’ 4”	7’ 8”	7’ 10”
CNTR28	28’	8’	8’ 6”	6,400	25,200	27’ 4”	7’ 8”	7’ 10”
CNTR32	32’	8’	8’ 6”	7,200	28,800	31’ 4”	7’ 8”	7’ 10”
CNTR36	36’	8’	8’ 6”	8,000	32,400	35’ 4”	7’ 8”	7’ 10”
CNTR40	40’	8’	8’ 6”	8,800	36,000	39’ 4”	7’ 8”	7’ 10”

Options Table:

Option	Description
PE approval of structural drawings	Professional Engineer-stamped, wind-load hold-down documentation in compliance with local building code
Exterior Steel Siding	Industrial steel siding exterior
EPDM Roof	High-quality EPDM membrane roof
Process heat exchanger exhaust	Exhaust hatches can be inserted in wall to diffuse heat outside of building
Extra louver for added ventilation	For added ventilation and air circulation a louver can be installed into building wall
Sound Insulation	Layer of sound-insulation material built into walls blocks out operational noise
Rubber flooring	¾” thick rubber floor mats
Sump	2” sump in floor to detect flooding
Floor cutout	Floor hatch can be cutout to allow pipe entrance from underground
Roof extension or hatch	For tall equipment, roof extensions or hatches can be built into roof
Pipe stub outs	Pipe stub outs can be mounted on side of building
Pipe connection slot	Pipe-connection slot can be mounted on side of building
Ventilation Fan	Properly sized ventilation fan with thermostat
Heater	Properly sized heater with thermostat
Lighting	Proper lighting to allow for acceptable amount of light for work inside of the container
Thermal insulation	R7.2 insulation in walls and ceiling

MicroClear®

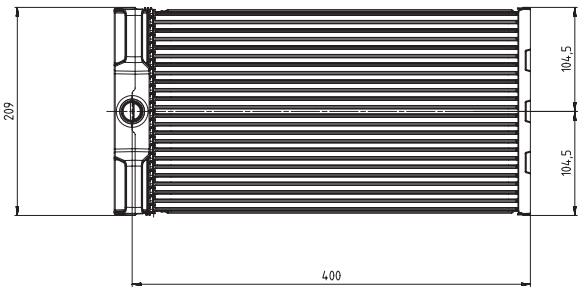
Technical Data Sheet **CASSETTE FILTER MCXL2** Article-No. 80200072

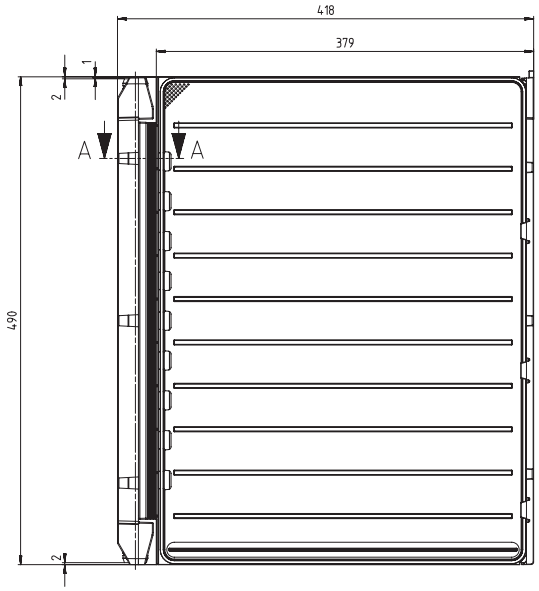
Completely welded filter cassette for the filtration of water. Typical applications:
Waste Water in membrane bioreactors, surface water. The cassette consists of:

- housing and header made of polypropylene (FDA approved)
- 23 active filter plates made of polypropylene (FDA approved)
- 2 protective plates made of polypropylene (FDA approved)
- laser welded membrane made of Polyethersulfone (KTW approved)

Parameter	Unit	Value
dimension of filter housing (incl. flange for aeration)	L x W x H cm	209 x 418 x 490
outlet diameter	mm	25
protective plates		2
number of active plates		23
total membrane surface area	m^2	8
possible flow[1] 2 chemical cleanings/year 1 chemical cleaning/year	l/m^2h	 30 15
max. flow	l/m^2h	50
membrane material[2]		PES/PVDF
pore size nom.[2]	µm	0.04-0.3
filtration pressure	bar	0.1-0.25
backflush pressure	bar	0.07-0.1
filter housing material		PP
weight	kg	approx. 11.5

[1] depending on wastewater characteristics
[2] membrane material selectable for specified applications or customers





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Design and specifications are subject to change without notice.

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