



Herbert, Rowland & Grubic, Inc.
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MEMORANDUM

Attn: Mifflinburg Borough Council, c/o Margaret Metzger, Borough Manager
From: David M. Madl, P.E.
Re: Engineering Justification for Sole Source Procurement of Membrane Replacement Equipment
Mifflinburg Borough Wastewater Treatment Plant

HRG Project Number: 002198.0450

October 5, 2026

This memorandum documents HRG's engineering evaluation of the technical compatibility, implementation, schedule, and cost considerations supporting the proposed sole source procurement. It is intended to provide the Borough with the technical basis for its procurement record; the Borough and its solicitor will determine compliance with applicable procurement requirements.

At the request of Mifflinburg Borough, Herbert, Rowland & Grubic, Inc. (HRG) evaluated the technical basis for procuring DuPont/MemCor replacement membrane equipment for the Borough's existing Membrane Bioreactor (MBR) system at the Wastewater Treatment Plant.

The Borough's existing MBR treatment process utilizes MemCor membrane technology. The proposed project consists of replacement of the existing membrane modules and associated rack assemblies that have reached the end of their useful life. The replacement equipment is intended to restore the existing treatment system to reliable operation while maintaining the facility's current process configuration and treatment capacity. Refer to the DuPont/MemCor equipment proposal, enclosed for reference.

Based upon our evaluation, we believe procurement of the proposed DuPont/MemCor equipment as a sole source purchase is warranted for the following reasons:

- The existing wastewater treatment process was designed around MemCor membrane technology, which serves as the basis of design for the MBR system.
- The proposed replacement membranes and rack assemblies are designed to integrate with the Borough's existing membrane basins, support structures, piping systems, instrumentation, controls, and operational configuration.
- While alternative membrane manufacturers exist, their membrane systems are not direct replacements for the existing MemCor equipment from a design capacity and physical compatibility perspective. Alternate membrane modules would not be compatible with the existing mounting brackets, support arrangements, or manifold/header connections without modification.
- Utilization of an alternate membrane manufacturer would require substantial engineering evaluation and redesign efforts to determine compatibility with the existing treatment facilities, process configuration, and permit requirements.
- Alternate membrane systems would likely necessitate modifications to existing piping, air scour systems, process equipment, controls, and supporting infrastructure. Such modifications would increase project cost, complexity, and implementation schedule.
- Changes to membrane technology and associated design criteria could require additional permitting and regulatory review prior to implementation.
- Additional startup, testing, optimization, and operator training efforts would likely be necessary if a different membrane technology were selected.

- The Borough previously evaluated alternative membrane manufacturers through a competitive procurement process in 2017. Refer to the enclosed summary evaluation report from that procurement effort. At that time, the evaluation determined that the MemCor solution was the most advantageous option for the Borough when considering technical compatibility, implementation requirements, and overall project cost. The proposal received from Evoqua/MemCor was approximately 41% lower in cost than the proposal submitted by GE. Furthermore, it is our understanding that the GE proposal did not include costs associated with retrofit modifications that would have been necessary to integrate its system into the existing facility. Although the 2017 evaluation does not establish current market pricing, it documents the facility-specific compatibility and retrofit considerations that remain relevant to the proposed replacement.

The membrane replacement project is being undertaken as part of the Borough's response to the Pennsylvania Department of Environmental Protection (PADEP) Administrative Order and ongoing efforts to restore reliable operation of the MBR. The existing membrane equipment has experienced deterioration in performance and reliability, requiring replacement to maintain treatment capacity and support compliance with the facility's permit requirements. HRG understands that PADEP has emphasized the importance of proceeding with corrective actions as expeditiously as possible. Evaluation and implementation of an alternative membrane technology would require additional engineering evaluation, redesign, permitting review, and facility modifications before construction could proceed, thereby extending the implementation schedule for the needed improvements and the timeline for achieving the objectives identified in the Administrative Order.

Based on the foregoing technical considerations, HRG concludes that the proposed DuPont/MemCor membrane modules and associated rack assemblies are the practical, technically appropriate, and expeditious replacement solution for the Borough's existing MBR system. Selection of an alternate manufacturer would require additional engineering evaluation and could require redesign, permitting modifications, retrofit construction, system testing, and costs beyond those necessary to replace the existing membrane equipment with compatible DuPont/MemCor equipment.

Please contact our office if additional information is required.

Sincerely,

Herbert, Rowland & Grubic, Inc.



David M. Madl, P.E.
Project Manager
DMM//ENT/dmm

P:\0021\002198_0450\Admin\2026.04 Membrane Replacement\Membrane Sole Source Justification Memo.docx

Attachments:

June 20, 2026 DuPont/MemCor Equipment Proposal No. A-423399
2017 Membrane Replacement Proposal Evaluation



MemCor™ Membrane Bioreactor System

**MIFFLINBURG WWTP
MBR SYSTEM UPGRADE**

**PROPOSAL NO. A-423399
REVISION 2**

JUNE 20th, 2026

**SUBMITTED TO:
ROB ROWE, SUPERVISOR
200 GESSNER LN
MIFFLINBURG PA 17844
OFFICE (570) 966-1013**



Executive Summary

DuPont Water Solutions – MEMCOR appreciates the opportunity to support the Borough of Mifflinburg in the planned membrane system upgrade at the Municipal Wastewater Treatment Plant. Building on our long-standing relationship, DuPont is pleased to provide a solution that replaces the existing membrane modules while expanding treatment capacity through the addition of new racks within the available spare slots. This approach maintains the inherent flexibility of the existing system while increasing installed membrane area, enabling both improved performance and operational resilience. By combining proven MEMCOR membrane technology with a strategic expansion of membrane infrastructure, the Borough will benefit from a modernized system designed to deliver reliable, long-term performance at a competitive lifecycle cost. MemCor™ was a pioneer in membrane filtration systems for membrane applications and has over 40 years of experience designing, building and supporting these plants. MemCor™ MBR modules offer several key advantages including:

MemCor™ MBR System – First in Class Design



DuPont's MemCor™ MBR system combines superior membrane filtration technology enhanced over years of R&D and manufacturing expertise with an integrated design that provides the best overall system value.

The entry of MemCor™ MBR modules into the MBR market began in the late 1990s and has since grown to over 350 MBR installations in operation or under contract. The "N" PVDF MBR membrane has demonstrated long term performance and durability since its launch close to 15 years ago with a track record of installations in operation with that same module for over 14 years. The reliability of modules with the N membrane and the warranty behind it offers the Owner a risk-free solution. Our plant references show the modules with N membranes in use well beyond the projected life, still in operation, and still producing high quality effluent.

For first-hand evidence of the reliability and robustness of the DuPont™ MemCor™ MBR modules with the N membrane, please click on the link below to view a brief YouTube video. In it, personnel at the Healdsburg Wastewater Treatment Plant in Healdsburg, California describe their experience of operating the plant equipped with the MemPulse MBR.

Video Link: [Achieving Long Term Success with MBR Technology](#)

Low Maintenance & Ease of Operation

This superior, low maintenance membrane fiber is combined with the patented MemCor™ aeration system that ensures the membranes are free of bulk solids hold-up and eliminates the need in-tank maintenance as a part of standard system maintenance. We believe that this superior design will provide desired system performance at the lowest operational cost available.

N membrane monolithic membrane fibers, due to the homogeneous fiber composition, do not become tensioned due to thermal variability. Because of this, N membranes do not require any annual or regular rack removal for maintenance such as slack adjustment or manual removal of solids. The MemCor™ system is the only proven MBR system on the market today with no regular maintenance on the in-tank membrane components. Most customers who use the MemCor™ MBR system have never removed a single rack for maintenance.

Additionally, the MemCor™ air scour process is designed to be both efficient and powerful, preventing the accumulation of solids within the fiber bundles. The self-cleaning air scour allows MemCor™ MBR system operation to be "hands-off", with little to no operator intervention.

Video Link: [Jennings Tertiary Wastewater Treatment Plant + MemPulse® | Responding to Community Needs](#)



Reduced Process Footprint

MemCor™ MBR modules provide a high membrane area per unit of tank footprint– up to 40% smaller than other competitive systems. This means substantial savings in system footprint and concrete construction costs. Furthermore, the MemCor™ MBR system allows for elevated mixed liquor suspended solids up to 14,500 mg/L in the membrane tank, reducing the biological tank volume when compared to competitive systems.

With a small footprint available for increasing treatment capacity, the Morgantown Utility Board in West Virginia utilized a MemCor™ MBR system and experienced a tenfold increase in treatment efficiency.



Video Link: [Maximizing Efficiency with Minimum Footprint - Memcor MemPulse® MBR systems](#)

We would like to thank you again for your interest in MemCor™ MBR systems from DuPont. We believe that every MemCor™ system comes with more than just equipment – it includes the expansive knowledge of a dedicated team of membrane scientists, engineers, and technicians who stand behind every installation. We are eager to share this expertise with those responsible for providing the world with clean, consistent, and high-quality water. Should you have any questions regarding this quotation or would like to request any additional information please contact us directly.

DuPont Customer Support Representative:



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Customer Care Manager:



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1 Project Overview

BASE 1: MEMBRANE REPLACEMENT

Membrane System: 640 x B40N Modules

Membrane Critical Repair Parts: MemRACK™ Plate Adapters, Rack Spool Pieces, Locking Mechanism Parts

Membrane Rack Replacement Parts: Clips, Dropper Tubes, Misc.

Manufacturing Installation Supervision Services (3 Weeks)

Equipment Price: **USD \$890,500**

~~\$846,600~~

BASE 2: MEMBRANE EXPANSION

Membrane System: 128 x B40N Modules

Membrane Racks for Expansion: 8 x MemRack™ 16 Module, with Filtrate Piping & Air Hoses

Manufacturing Installation Supervision Services (1 Week)

Equipment Price: **USD \$298,500**

~~\$283,050~~

OPTION A: REPLACE CURRENT MEMBRANE RACKS

Replace Current Membrane Racks: 40 x 16M MemRack™ Assemblies with Freight **USD \$393,800**

Manufacturer's Supervision Services (2 Weeks) **USD \$27,200**

Total Replace Current Membrane Rack **USD \$421,000**

Note: 1. DuPont recommends replacing the existing racks, as they will be approximately seventeen (17) years old at the time of the upgrade. This recommendation is based on a twenty (20) year design life and supporting factory cycle testing. Replacing the racks will effectively renew the membrane system, supporting reliable long-term performance.

OPTION B: AIR SCOUR FLOW METERS

~~Optional, Air Scour Flowmeters **USD \$15,450**~~

SUPERVISION SERVICES DEDUCTS

Membrane Replacement Service (3 Weeks) Deduct **USD - \$43,900**

~~Membrane Expansion Service (1 Weeks) Deduct **USD - \$15,450**~~

Replace Current Membrane Racks Service (2 Weeks) Deduct **USD -\$27,200**

Note: If DuPont supervision services are not purchased, DuPont confirms that:

1. All standard equipment warranties remain in full
2. The 10-year membrane warranty remains in full
3. No additional warranty exclusions, startup requirements, certifications or documentation requirements will apply.

To support successful startup and long-term performance, DuPont may request a final installation inspection prior to startup to confirm that the membrane equipment has been installed in accordance with DuPont requirements. DuPont will review the project-specific scope and identify any inspection or verification requirements that could impact warranty coverage prior to equipment installation. No additional warranty requirements beyond those identified in this proposal are currently anticipated.

\$846,600+\$393,800 = \$1,240,400

Standard Terms of Sale

Please note that the pricing above does not include insurance, bonds, or any applicable taxes. The scope of supply and pricing are based on DuPont's standard equipment selection, standard terms of sale and warranty terms described herein. Any variations from these standards may affect this quotation. In the event DuPont is the selected vendor for the products and services contemplated in this proposal, DuPont will not be obligated to supply products or services pursuant to this proposal unless and until (i) DuPont has, at its option, completed a satisfactory anti-corruption due diligence review and/or credit check; and (ii) the parties have entered into an agreement based on the terms and conditions set forth herein.

Delivery: *Estimated 16 - 18 weeks after notice to proceed has been issued.. Lead times for delivery of components manufactured by sub-suppliers are subject to worldwide factors and conditions that may impact the material availability and lead time beyond DuPont's control. Delivery schedule to be coordinated with the purchase based on the equipment lead time at the time of notice to proceed.*

Validity: *Proposal shall be valid until December 31st, 2026, with order with notice to proceed to fabricate.*

Freight: *CPT | Job Site | Incoterms® 2020*

Term & Conditions: *DuPont Standard Terms & Conditions, provided herein.*

Payment Terms: *10% on Order, net 30
 15% on Submittals, staged submittals allowed, net 30
 25% on Order of major rotating equipment, net 30
 45% on Delivery, partial deliveries accepted, net 30
 5% on Start-up, net 30
 Full payment not to exceed 120 days after shipment*

Tariffs *Tariff & Trade Policy Notice: Tariff & Trade Policy Notice: **The pricing provided includes all tariffs currently applicable to Australian-manufactured MemCor™ equipment** imported into the United States, including the current 10% U.S. Temporary Import Surcharge. DuPont shall be responsible for all tariffs in effect as of the proposal date. Any future tariff increases, new trade restrictions, duties, or government-imposed import fees enacted after the proposal date that materially affect the cost of goods may be addressed through a mutually agreed adjustment.*

The proposed options include the following estimated tariffs on Australian goods:
Membrane Replacement Estimated Tariffs Included: USD \$52,350
Membrane Expansion Estimated Tariffs Included: USD \$20,910
Replace Current Membrane Estimated Tariffs Included: USD \$36,421

2 Company Profile

DuPont Water Solutions



DuPont de Nemours, Inc. (NYSE: DD) is a global innovation leader with technology-based materials and solutions that help transform industries and everyday life. Our employees apply diverse science and expertise to help customers advance their best ideas and deliver essential innovations in key markets including electronics, transportation, construction, and advanced materials and water.

For over 200 years, DuPont has been synonymous with life-changing discoveries and scientific know-how, reinventing ourselves along the way. The history of DuPont is a history of scientific and technology breakthroughs. But more than that, it's a story of transformation. From the beginning, our company has changed and evolved, so that

we can keep finding essential innovations to solve the most challenging problems and help people live safer, healthier lives.

DuPont is a leader in water purification and separation technology including ultrafiltration, reverse osmosis and ion exchange resins. The FilmTec™ brand is recognized globally and known for consistent and reliable performance. Acquisitions, including DesaliTec, OxyMem, and MemCor supports our strategy to drive growth and innovation through access to new manufacturing capabilities, geographies and technologies.

Water Solutions

DuPont's water technologies are helping to *purify more than 50 million gallons of water every minute in 112 countries across the world*. DuPont offers a broad technology portfolio of membranes, resins, and complete systems to address a variety of water and wastewater challenges faced by municipalities, industrial water users, and the energy sector. DuPont leads in water purification, conservation, and reuse technologies, leveraging our deep understanding of customer challenges to drive engagement and collaborative innovation. By focusing on sustainable solutions, we effectively address our customers' critical water issues while enhancing our business value and gaining valuable insights. The available range of technologies enables a tailored "treat-for-purpose" approach to water management, which helps address the growing demand for freshwater by unlocking unconventional sources, while minimizing the impact on energy consumption and waste generation.

For additional details please refer to our website: [DuPont Water Solutions | Solving Water Challenges](#)





Cleaner Water and Purer Products for Industries and Communities

We offer a broad portfolio of globally recognized, industry-leading solutions to help you produce, purify, and extract some of the world's most commercially important products.



Products

Our products are based on decades of industry leadership, and include ion exchange resins, reverse osmosis and nanofiltration membranes, ultrafiltration membranes, and electro-deionization products, with globally recognized brands like **MemCor™**, FilmTec™, FilmTec™ Fortilife™, TapTec™, and the Amber series to meet your water and specialty separation challenges.



Industries

We offer separation and purification support to markets and industries across the globe, including residential and municipal, power generation, oil and gas, healthcare, commercial industries, chemical and petrochemical, microelectronics, and food and beverage for a wide range of applications, including minimal liquid discharge (MLD).



Technologies

Unmatched in our global reach, industry experience, and expertise, our focus on reverse osmosis, nanofiltration, ultrafiltration, ion exchange, and electrodeionization places us in perfect position to help industries, organizations, and communities prosper. We offer the broadest ion exchange portfolio in the industry and provide leading innovations in membrane science.

Water Purification and Solutions

DuPont Water Solutions innovates advanced membrane and ion exchange resin technology solutions to address water, energy, and wellness challenges. Our broad portfolio tackles even the hardest-to-treat water and process challenges with fit-for-purpose solutions to meet our customers' unique challenges.

Strengthening our partners. Solving water challenges.

Companies, communities, and homes around the world choose DuPont Water Solutions to help make water safer and more accessible. Industries and markets count on us to become more efficient; to make food more nutritious; and to offer more effective pharmaceuticals. Our innovation and collaboration with the world's best water experts enable ecosystems of innovation to deploy vital technologies in new, market-shaping ways. With a global network of accessible knowledge and a market-leading portfolio of purification and separation technologies, we enable the water productivity from which health, profits, and possibilities spring. In a world of increasing water scarcity, we provide a proven path that balances resource productivity and responsibility.

Enabling the world to thrive

The possibilities that flow with water are abundant. That's why we continuously pursue pioneering innovation in essential and reliable solutions, and help customers like you across the globe confidently take hold of opportunities that will grow a cleaner world together.

MemCor™ Brand Portfolio

MemCor™ is a global leader in membrane filtration technology, delivering advanced solutions for municipal and industrial water treatment for more than forty years. Originating in Australia in the late 1970s, **MemCor™** pioneered the first dead-end, back-washable, low-pressure membrane filtration process—an innovation that revolutionized water treatment and remains widely adopted today for drinking water, wastewater reuse, desalination pretreatment, and membrane bioreactor (MBR) applications.

From its first drinking water installation in 1987 to its early adoption in wastewater reuse in 1990, **MemCor™** has consistently set industry benchmarks. By 1997, **MemCor™** introduced the world's first drinking water system designed for cold-weather climates, demonstrating its ability to meet complex environmental challenges. Today, **MemCor™** systems operate at more than 2,000 sites worldwide, with over 350,000 membrane modules installed, underscoring its reputation for reliability, efficiency, and innovation.

As part of DuPont, **MemCor™** benefits from a vertically integrated manufacturing model, producing its own membrane modules to ensure stringent quality control and accountability. This unique approach enables continuous investment in research and development, driving advancements in hollow-fiber membrane technology and system design to reduce treatment costs, optimize performance, and minimize footprint. Customers partnering with **MemCor™** gain access to comprehensive warranties, ongoing innovation, and tailored solutions that meet evolving water treatment challenges.

MemCor™ offers a broad portfolio of pressure, submerged, and MBR technologies, supporting applications across drinking water treatment, wastewater reuse, reverse osmosis pretreatment, and industrial process water. Backed by DuPont's global resources and technical expertise, **MemCor™** combines proven performance with forward-thinking innovation, making it a trusted choice for sustainable water treatment solutions worldwide.

With decades of R&D and some of the world's largest microfiltration and ultrafiltration installations, **MemCor™** continues to lead the industry in efficiency, reliability, and adaptability. Its legacy of innovation, combined with DuPont's commitment to sustainability and customer success, ensures that **MemCor™** remains at the forefront of solving the world's most pressing water challenges.



DuPont™
MemCor™
 systems



Pressure



Submerged



MBR



Quality MemCor™ Brand Membrane Modules

With over 40 years of experience in the industry, the team behind the **MemCor™** brands are acutely aware of the importance clients place on high-quality products. In the drinking water and water reuse markets, quality is essential for success. At DuPont's **MemCor™** brand membrane production facility located in Windsor, Australia, a robust and frequently audited quality program is a fundamental part of the manufacturing process. The Windsor facility holds both ISO 9001 and ISO 14001 certifications, ensuring that production processes are consistent, reliable, and environmentally responsible. This commitment helps manage waste streams efficiently, safeguarding the local community.

Facility Overview

Since 1987, **MemCor™** brand membranes have been produced in the Windsor facility, which spans approximately 15,000 square meters (over 160,000 square feet) and features mixed office and production space across two buildings. Employing about 200 individuals, the Windsor campus incorporates various functions such as research and development, capital project engineering, manufacturing engineering, procurement, planning, quality assurance, and quality control. The integration of these disciplines under one roof is instrumental for manufacturing high-quality, reliable products.



All of the **MemCor™** brand fibres and modules are produced in-house from raw materials. This controlled process allows for exceptional quality assurance throughout production, enabling reliable manufacturer warranties. The facility also collaborates with specialized injection moulding vendors in various regions to produce high-quality manifolds and other components. This injection moulding technique, which has its origins in the 1940s, not only enhances the durability of MemCor™ and MemCor™ systems but also minimizes their footprint. The innovative design, including the ability to mould pipes within pipes, optimizes space utilization while promoting durable materials that outperform conventional plastics.

Quality Control Activities Overview

Below are some key quality control activities conducted by QA/QC personnel:

Fibers: Automated checks for dimensional, geometrical, hydraulic, and mechanical performance using Statistical Process Control (SPC) tools.

Potting Material (Polyurethane): Supplier self-checks against specifications and daily in-process inspections ensure adherence to Memcor's stringent standards.

Modules: Each module is assigned a unique identification number, detailing production information. All modules undergo integrity testing prior to packaging, monitored by SPC tools.

Injection Moulded Parts: Components are evaluated against technical drawings and standard samples upon inspection. Non-conforming items trigger quality incident reports, requiring corrective actions.

Mechanical Components: Similar checks against specifications to ensure compliance, with quality incidents addressed accordingly.

This thorough and meticulous approach to quality assurance establishes Memcor™ and MemCor™ as brands known to be leaders in the manufacturing of membrane-based water treatment systems, reinforcing our commitment to excellence and customer satisfaction.



MemCor™ MBR Systems



The **MemCor™** Membrane Bioreactor (MBR) system was introduced in 2008 and has maintained consistent membrane, module, and air scour design, with many installations still operating with original membranes. This proven track record ensures reliable, long-term performance for new projects. **MemCor™** MBR combines biological oxidation with membrane separation in a fully automated process, delivering high-quality effluent and low lifecycle costs. As

a pioneer in pulsed aeration, foulant removal, and integrity testing, **MemCor™** continues to evolve through DuPont's expertise in membrane technology and manufacturing. Today, **MemCor™** MBR systems are trusted in hundreds of municipal and industrial facilities worldwide.



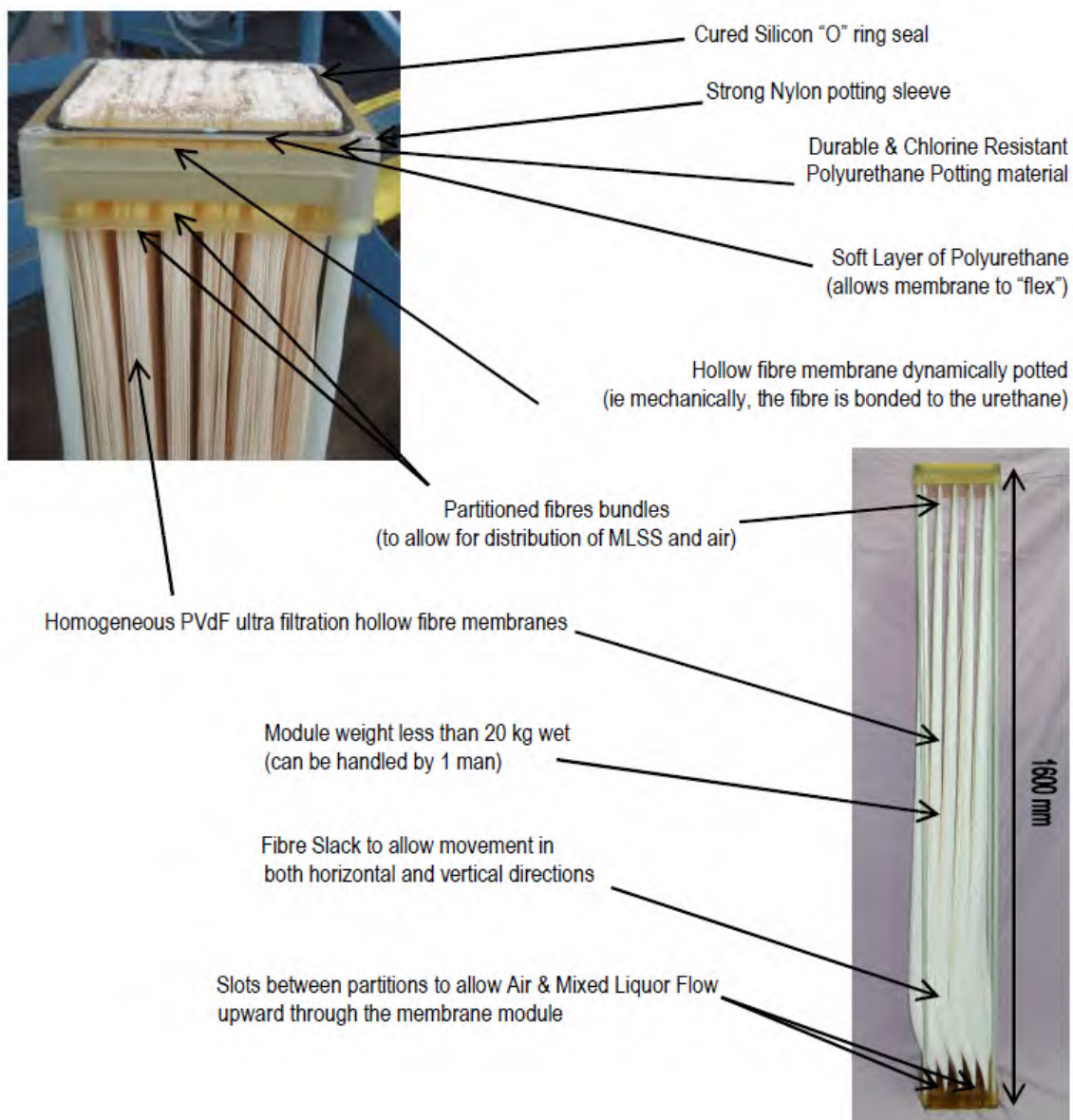
Key Advantages

- ✓ Saves Footprint: Compact design makes it ideal for tight spaces, reducing land and construction needs.
- ✓ Eliminates the need for traditional clarifiers or sand filters, simplifying the process.
- ✓ Produces high-quality effluent supporting water reuse and meeting higher discharge standards
- ✓ Allows for Plant Expansions in The Same Footprint: Enables capacity upgrades without expanding the site.
- ✓ Uses A Smaller Biological Process: Efficient biological treatment in a smaller, space-saving configuration.
- ✓ Fully Automated: Operates with minimal manual input thanks to advanced automation and controls..

The figure below presents a summary of the long history of the MemCor™ MBR systems team's MBR process innovations, many of which now are industry standards.

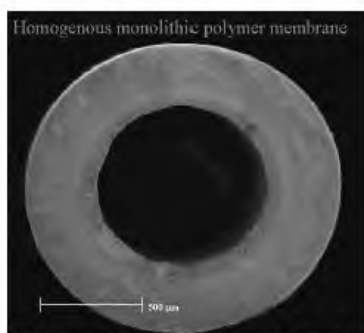


Features of the Memcor® B40N Module



Memcor's Homogeneous Membrane Hollow Fibre

There are two types of hollow fibre membrane commonly used in Membrane Bioreactors, namely Homogeneous (ie pure micro porous polymeric material) as shown in the images below:



3 Membrane Expansion Design

Influent Flows

HYDRAULIC CONDITIONS	VALUE	UNITS
Average Daily Flow (ADF)	1.4	Millions of gallons per day (MGD)
Peak Daily Flow (PDF)	4.4	MGD

Influent Water Quality

The Membrane Operating System (MOS) has been designed assuming the following pretreatment parameters. If other design assumptions should be considered, please advise and we can discuss how the design of the MOS can be modified to achieve optimal performance.

DESIGN PARAMETER	VALUE
Membrane Pre-Screening	≤ 2.0 mm perforated, system designed to prevent screen bypass under all conditions
Grit Removal	> 95 % of particles > 50 mesh in size > 85 % of particles > 70 mesh but < 50 mesh in size > 70 % of particles > 100 mesh but < 70 mesh in size Removal efficiency shall meet or exceed these values across a flow range of 25 - 100 % of PHF. System designed to prevent Grit removal bypass under all conditions.
Raw Sewage	>90% Municipal
ML Capillary Suction Time (CST)	< 100 seconds
Biological Mixed Liquor Suspended Solids (MLSS)	8,000 mg/L
Raw Sewage: Fats, Oils and Greases (FOG)	< 150 mg/L
Raw Sewage: Hydrocarbons	< 5 mg/L
Minimum Design Temperature Range	8.9° C
Influent Soluble BOD ₅ to Membrane Tank	< 5 mg/L
Influent Ammonia to Membrane Tank	< 3 mg/L
Coagulant Addition (if required)	Aluminum Sulfate ≤ 50 mg/L

Filtered Water Quality

The equipment offered will provide the following Filtered Water quality:

PARAMETER	QUALITY (90 PERCENTILE)	QUALITY (MAXIMUM)	UNITS
Suspended Solids	≤ 5	N/A	mg/L
Turbidity	≤ 0.2	0.5	NTU

Notes: 1 Sufficient samples to be taken such that two or more non-conforming results are required to demonstrate non-conformance.

Membrane Operating System Design

DESIGN CRITERIA	VALUE	UNITS
Module Type	B40N + MEMPULSE	
Membrane Area Per Module	431	ft ²
Modules per Rack	16	
Total Number of Membrane Tanks	4	
Number of Racks per Tank (Total Installed)	12	
No. of Modules Installed per Tank	192	
Membrane Area per Tank	82,667	ft ²

Membrane Tank Dimensions (Each)

DESCRIPTION	VALUE	UNITS
Tank Length	14.4	ft
Tank Width	13.5	ft
Tank Depth (top of concrete)	10.4	ft
Tank Liquid Level	8.3	ft

Membrane System Operation

DESIGN FLUXES	ADF	PDF	PHF	Units
Flow Condition	1.4	4.4	4.4	MGD
No. of Membrane Tanks in Operation	2	4	4	—
No. of membrane Tanks in Standby	2	0	0	—
Design Water Temperature	8.9	8.9	8.9	°C
Net Flux at Design Water Temperature	8.5	13.3	13.3	gfd
Net Flux (temperature-corrected to 20°C)	11.4	18.0	18.0	gfd
Instantaneous Flux at Design Water Temperature	9.3	14.5	14.5	gfd
Instantaneous Flux (temperature-corrected to 20°C)	12.5	19.6	19.6	gfd

Membrane System Mixed Liquor Feed Requirements

The following table summarizes the mixed liquor feed flow / return activated sludge flow during average and peak flow events, based on an average mixed liquor concentration in the bioreactor of 8,000 mg/L. The feed flow requirements are based on maintaining a MLSS concentration below the maximum allowable concentration in the membrane tank.

PARAMETER	ADF	PDF	PHF	UNITS
Operating MLSS in Membrane Tank	10,500	11,200	11,200	mg/L
Total Mixed Liquor Feed Flow Required	4,083	10,694	10,694	gpm
Total Return Activated Sludge Flow Required	10,500	11,200	11,200	gpm

Note: Maximum allowable mixed liquor concentration in the membrane tank is 14,500 mg/L.

Membrane System Air Scour Requirements

The following table summarizes the air scour requirements during average and peak flow events.

PARAMETER	AVERAGE	PEAK	UNITS
Flux Rate	≤ 14.7	> 14.7	gfd
Air Flow per Tank: Installed Modules	600	833	SCFM (68°F)
Discharge pressure	4.5	4.6	psi

Notes: 1 The actual air usage will be dependent upon the frequency and duration of any peak flow events. This is because the aeration flow per module is flux dependent.

2 Units in short term storage (< 1 day and remaining in Mixed Liquor) must be aerated for 10 minutes every hour.

3 Upon the provision of expected annual & daily flow pattern an annual air usage value can be calculated.

Maintaining Membrane Performance

The following table summarizes the maintenance procedures to ensure optimal performance of the MemPulse membrane system average daily flow (ADF).

PARAMETER	RELAXATION	MAINTENANCE CLEAN	SODIUM HYPOCHLORITE CIP	CITRIC ACID CIP
Interval Between Cycle	12 min	7 days	90 days	180 days
Cleaning Cycle Duration	60 sec	50 min	420 min	420 min

The expected chemical usage for Average Daily Flows (ADF), including design margin is:

PURPOSE	CHEMICAL	BULK CHEMICAL CONC.	CLEANING SOLUTION CONC.	CHEMICAL PER CIP ¹ (GAL)	USE@ ADF (GAL/YR ^{1,2})
Chlorine Maintenance Clean	Sodium Hypochlorite	12.5% w/w Liquid	200 ppm	6.4	1,337
Chlorine Clean-In-Place	Sodium Hypochlorite	12.5% w/w Liquid	1,000 ppm	67.7	1,098
Citric Acid Clean-In-Place	Citric Acid	50.0% w/w Liquid	1.0% w/w Liquid	163.6	1,328

Notes: 1 Bulk chemical excludes chemicals for neutralization (if required).

2 Based on continuous operation at ADF, excluding any standby tanks.

4 Flux Calculations

Project Overview / Design Basis

The offered upgrade replaces the existing MemCor™ MBR membrane modules and adds membrane racks in the available spare rack locations. The proposed expansion improves membrane loading, flexibility, reliability, and long-term performance, while maintaining the facility's current permitted hydraulic capacity and design flow basis.

DESIGN BASIS	EXISTING CONFIGURATION	EXPANDED CONFIGURATION	RESULT / CONFIRMATION
Membrane tanks	4 total	4 total	No tank count change
Racks per tank	10	12	Uses existing spare rack locations
Modules per tank	160	192	Adds 32 modules/tank
Membrane area per tank	68,960 ft ²	82,667 ft ²	~20% added membrane area
Design flows	1.4 MGD ADF / 4.4 MGD PDF	Same	No permitted capacity increase
ADF net flux	10.2 gfd	8.5 gfd	Lower membrane loading
PDF/PHF net flux	16.0 gfd	13.3 gfd	Improved peak-flow margin

Membrane Area, Flux Reduction, and Design Capacity Confirmation

The proposed membrane system upgrade for the Mifflinburg WWTP increases the installed membrane area through the addition of membrane racks within the existing spare rack locations while maintaining the plant's permitted hydraulic design capacity of 1.45 MGD Average Daily Rate (ADR) and 4.4 MGD Peak Daily Flow (PDF). No changes are proposed to the permitted treatment capacity, influent design flows, process hydraulics, biological treatment capacity, or membrane tank operating configuration. The purpose of the expansion is solely to reduce membrane loading, improve operational flexibility, and enhance system reliability and redundancy.

The existing membrane system is configured with 10 racks per tank (160 modules per tank), providing approximately 68,960 ft² of membrane area per tank. The proposed upgrade increases the installation to 12 racks per tank (192 modules per tank), increasing the available membrane area to approximately 82,667 ft² per tank, an increase of approximately 20% membrane surface area while utilizing the previously unused spare rack positions. The number of membrane tanks remains unchanged at four (4). As shown in the table below, the additional membrane area significantly reduces membrane operating flux while maintaining the same hydraulic loading basis:

DESIGN CRITERIA	EXISTING	EXPANSION	UNITS
Module Type	B40N + MEMPULSE	B40N + MEMPULSE	
Membrane Area Per Module	431	431	ft ²
Modules per Rack	16	16	
Total Number of Membrane Tanks	4	4	
Number of Racks per Tank (Total Installed)	10	12	
Number of Spare Slots	2	0	
No. of Modules Installed per Tank	160	192	
Membrane Area per Tank	68,960	82,667	ft ²
Net Flux at ADF	10.2	8.5	gfd
Net Flux at PDF	16.0	13.3	gfd
Net Flux at PHF	16.0	13.3	gfd

The reduction in membrane flux provides a greater operating margin, lower membrane loading, reduced fouling potential, and increased resilience during peak flow events and membrane cleaning activities. The additional membrane area also increases system flexibility by allowing more membrane surface area to be available while

maintaining the same production requirements. Importantly, the expansion does not alter the design flow basis used for sizing calculations. The proposed design continues to be evaluated at 1.4 MGD average daily flow and 4.4 MGD peak daily flow, identical to the existing design basis. The lower operating flux is the direct result of the increase in installed membrane area rather than any increase in permitted treatment capacity.

Accordingly, DuPont confirms that the proposed membrane rack addition is intended exclusively to improve membrane loading, operating flexibility, reliability, and long-term performance. The project does not increase the plant's permitted hydraulic capacity, nor does it modify the established design flow criteria of the facility. The additional racks utilize existing spare membrane rack positions and serve only to reduce flux and increase membrane redundancy while maintaining the current permitted treatment capacity of the Mifflinburg WWTP.

Current Membrane System Design Sizing Calculations

Flux and Capacity Basis | Mifflinburg, PA

Purpose of this section

This section summarizes the membrane operating capacity, net flux, instantaneous flux, temperature-corrected flux, and flux during clean-in-place (CIP) for the Mifflinburg, PA system configuration. Calculations are based on the revised membrane arrangement of 160 modules per tank, with 10 racks of 16 modules per tank. Equipment sizing for filtrate pumps, mixed liquor feed pumps, air scour blowers, chemical clean systems, and maintenance clean systems is addressed separately in the proposal.

Membrane System Design Summary

DESIGN FLUXES	ADF	PDF	PHF	Units
Flow Condition	1.4	4.4	4.4	MGD
No. of Membrane Tanks in Operation	2	4	4	—
No. of membrane Tanks in Standby	2	0	0	—
Design Water Temperature	8.9	8.9	8.9	°C
Net Flux at Design Water Temperature	10.2	16.0	16.0	gfd
Net Flux (temperature-corrected to 20°C)	13.7	21.6	21.6	gfd
Instantaneous Flux at Design Water Temperature	11.1	17.4	17.4	gfd
Instantaneous Flux (temperature-corrected to 20°C)	15.0	23.5	23.5	gfd

Design Flow and Membrane Area Basis

The membrane operating system is sized based on the design flow conditions shown below at a minimum wastewater temperature of 8.9°C. Under average daily, maximum month, and peak week flow conditions, two membrane tanks are considered in operation with two tanks available/standby. Under peak daily and peak hourly hydraulic conditions, four membrane tanks are considered in operation for the flux calculation.

Flow condition	Design flow (MGD)	Design flow (gpd)	Tanks in operation	Area per tank (ft²)	Total active area (ft²)
ADF	1.40	1,400,000	2	68,889	137,778
MMF	1.40	1,400,000	2	68,889	137,778
PWF	1.40	1,400,000	2	68,889	137,778
PDF	4.40	4,400,000	4	68,889	275,556
PHF	4.40	4,400,000	4	68,889	275,556

Membrane surface area per tank = 160 modules/tank × 430.6 ft²/module = **68,889 ft²/tank**

Net Flux

Net flux is calculated by dividing the applicable daily design flow by the membrane surface area in operation. This calculation confirms the average loading applied to the membrane tanks for each flow condition before accounting for scheduled non-production events such as relaxation and cleaning.

Flow condition	Calculation	Net flux (gfd)	Temperature correction factor, η	Temp.-corrected net flux (gfd @ 20°C)
ADF	1,400,000 gpd ÷ (2 × 68,889 ft ²)	10.2	1.3496	13.7
MMF	1,400,000 gpd ÷ (2 × 68,889 ft ²)	10.2	1.3496	13.7
PWF	1,400,000 gpd ÷ (2 × 68,889 ft ²)	10.2	1.3496	13.7
PDF	4,400,000 gpd ÷ (4 × 68,889 ft ²)	16.0	1.3496	21.6
PHF	4,400,000 gpd ÷ (4 × 68,889 ft ²)	16.0	1.3496	21.6

Capacity basis

The proposed membrane area calculation maintains the stated design flow basis of 1.40 MGD for ADF/MMF/PWF and 4.40 MGD for PDF/PHF. The added membrane area reduces membrane loading and improves operating flexibility; it does not require the flux calculation to assume an increase in permitted hydraulic design capacity.

Online Operating Factor and Instantaneous Flux

The membrane operating system periodically stops filtration for scheduled non-production activities intended to manage membrane fouling. The online operating factor accounts for relaxation, maintenance wash, and periodic clean-in-place events. The resulting production time is used to calculate instantaneous flow and instantaneous flux during actual filtration periods.

Non-production event	Interval	Duration	Basis used in uptime calculation
Relaxation	12 minutes	60 seconds	Applies across each flow condition
Maintenance wash	7 days	50 minutes	Included in normal operating factor
Chlorine CIP	90 days	493.2 minutes	Included for ADF/MMF/PWF; set to 100% for peak conditions
Citric acid CIP	180 days	493.2 minutes	Included for ADF/MMF/PWF; set to 100% for peak conditions

Online operating factor for each event: $t (\%) = i \div (i + d) \times 100$, where i = interval and d = duration

Flow condition	Online operating factor (%)	Operating time (min/day)	Instantaneous flow per tank (gpm)	Instantaneous flow per tank (gpd)	Instantaneous flux (gfd)	Temp.-corrected inst. flux (gfd @ 20°C)
ADF	91.33	1,315.2	532.2	766,423	11.1	15.0
MMF	91.33	1,315.2	532.2	766,423	11.1	15.0
PWF	91.33	1,315.2	532.2	766,423	11.1	15.0
PDF	91.85	1,322.7	831.6	1,197,550	17.4	23.5
PHF	91.85	1,322.7	831.6	1,197,550	17.4	23.5

Temperature Correction

Flux values are temperature corrected to a 20°C basis because water viscosity increases as feed temperature decreases. For feed temperatures below 20°C, the Memcor™ temperature correction factor is applied to the calculated flux. At 8.9°C, the correction factor used for this design is $\eta = 1.3496$.

$$\eta = 10^{((1301)/(998.333 + 8.1855 \times (T - 20) + 0.00585 \times (T - 20)^2) - 1.3023)}$$

At $T = 8.9^\circ\text{C}$, $\eta = 1.3496$

Example: ADF temperature-corrected net flux = $10.2 \text{ gfd} \times 1.3496 = 13.7 \text{ gfd @ } 20^\circ\text{C}$

Flux During CIP

During a clean-in-place event, one membrane tank may be offline while the remaining tanks continue to produce the required average daily flow. The flux check below confirms that the system can maintain average daily flow during a CIP event while remaining below the stated temperature-corrected flux limit of 25.9 gfd.

CIP flux check item	Value	Units	Comment
Average Daily Flow (ADF)	1.40	MGD	Flow maintained during CIP
Membrane tanks in service during CIP	3	tanks	One tank offline for CIP
Membrane area per tank	68,889	ft ² /tank	Installed filtration surface area
Operating time used for calculation	1,322.7	min/day	Peak-condition operating time used
Temperature correction factor	1.3496	—	Applied to instantaneous flux

Instantaneous flux during CIP = $1,400,000 \text{ gpd} \times 1,440 \div (3 \text{ tanks} \times 68,889 \text{ ft}^2/\text{tank} \times 1,322.7 \text{ min/day})$
= **7.4 gfd**

Temperature-corrected CIP flux = $7.4 \text{ gfd} \times 1.3496 = 10.0 \text{ gfd @ } 20^\circ\text{C}$

Conclusion

The calculated temperature-corrected instantaneous flux during CIP is 10.0 gfd, which is below the 25.9 gfd limit. Therefore, the membrane system can operate at average daily flow while one tank is offline for CIP.

Summary of Flux Results

Flow condition	Net flux (gfd)	Inst. flux (gfd)	Temp.-corrected net (gfd @ 20°C)	Temp.-corrected inst. (gfd @ 20°C)
ADF	10.2	11.1	13.7	15.0
MMF	10.2	11.1	13.7	15.0
PWF	10.2	11.1	13.7	15.0
PDF	16.0	17.4	21.6	23.5
PHF	16.0	17.4	21.6	23.5

Note: Values are rounded for proposal presentation. Calculations are based on the revised design basis provided for Mifflinburg, PA: 160 modules per tank, 10 racks per tank, 1.40 MGD ADF/MMF/PWF, 4.40 MGD PDF/PHF, and 8.9°C minimum wastewater temperature. The PWF net flux calculation has been presented as 10.2 gfd, consistent with the 1.40 MGD flow condition and two tanks in operation.

Expansion Membrane System Design Sizing Calculations

Flux and Capacity Basis | Mifflinburg, PA

Purpose of this section

This section summarizes the membrane operating capacity, net flux, instantaneous flux, temperature-corrected flux, and flux during clean-in-place (CIP) for the Mifflinburg, PA system configuration. Calculations are based on the revised membrane arrangement of 192 modules per tank, with 12 racks of 16 modules per tank. Equipment sizing for filtrate pumps, mixed liquor feed pumps, air scour blowers, chemical clean systems, and maintenance clean systems is addressed separately in the proposal.

Membrane Expansion Design Summary

DESIGN FLUXES	ADF	PDF	PHF	Units
Flow Condition	1.4	4.4	4.4	MGD
No. of Membrane Tanks in Operation	2	4	4	—
No. of membrane Tanks in Standby	2	0	0	—
Design Water Temperature	8.9	8.9	8.9	°C
Net Flux at Design Water Temperature	8.5	13.3	13.3	gfd
Net Flux (temperature-corrected to 20°C)	11.4	18.0	18.0	gfd
Instantaneous Flux at Design Water Temperature	9.3	14.5	14.5	gfd
Instantaneous Flux (temperature-corrected to 20°C)	12.5	19.6	19.6	gfd

Design Flow and Membrane Area Basis

The membrane operating system is sized based on the design flow conditions shown below at a minimum wastewater temperature of 8.9°C. Under average daily, maximum month, and peak week flow conditions, the system is configured with two membrane tanks in operation and two tanks available/standby. Under peak daily and peak hourly hydraulic conditions, four tanks are considered in operation for the flux calculation.

Flow condition	Design flow (MGD)	Design flow (gpd)	Tanks in operation	Area per tank (ft²)	Total active area (ft²)
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ADF	1.40	1,400,000	2	82,667	165,334
MMF	1.40	1,400,000	2	82,667	165,334
PWF	1.40	1,400,000	2	82,667	165,334
PDF	4.40	4,400,000	4	82,667	330,668
PHF	4.40	4,400,000	4	82,667	330,668

Membrane surface area per tank = 192 modules/tank × 430.6 ft²/module = **82,667 ft²/tank**

Net Flux

Net flux is calculated by dividing the applicable daily design flow by the membrane surface area in operation. This calculation confirms the average loading applied to the membrane tanks for each flow condition before accounting for scheduled non-production events such as relaxation and cleaning.

Flow condition	Calculation	Net flux (gfd)	Temperature correction factor, η	Temp.-corrected net flux (gfd @ 20°C)
ADF	1,400,000 gpd ÷ (2 × 82,667 ft ²)	8.5	1.3496	11.4
MMF	1,400,000 gpd ÷ (2 × 82,667 ft ²)	8.5	1.3496	11.4
PWF	1,400,000 gpd ÷ (2 × 82,667 ft ²)	8.5	1.3496	11.4
PDF	4,400,000 gpd ÷ (4 × 82,667 ft ²)	13.3	1.3496	18.0
PHF	4,400,000 gpd ÷ (4 × 82,667 ft ²)	13.3	1.3496	18.0

Online Operating Factor and Instantaneous Flux

The membrane operating system periodically stops filtration for scheduled non-production activities intended to manage membrane fouling. The online operating factor accounts for relaxation, maintenance wash, and periodic clean-in-place events. The resulting production time is used to calculate instantaneous flow and instantaneous flux during actual filtration periods.

Non-production event	Interval	Duration	Basis used in uptime calculation
Relaxation	12 minutes	60 seconds	Applies across each flow condition
Maintenance wash	7 days	50 minutes	Included in normal operating factor
Chlorine CIP	90 days	493.2 minutes	Included for ADF/MMF/PWF; set to 100% for peak conditions
Citric acid CIP	180 days	493.2 minutes	Included for ADF/MMF/PWF; set to 100% for peak conditions

Online operating factor for each event: $t(\%) = i \div (i + d) \times 100$, where i = interval and d = duration

Flow condition	Online operating factor (%)	Operating time (min/day)	Instantaneous flow per tank (gpm)	Instantaneous flow per tank (gpd)	Instantaneous flux (gfd)	Temp.-corrected inst. flux (gfd @ 20°C)
ADF	91.33	1,315.2	532.2	766,423	9.3	12.5
MMF	91.33	1,315.2	532.2	766,423	9.3	12.5
PWF	91.33	1,315.2	532.2	766,423	9.3	12.5
PDF	91.85	1,322.7	831.6	1,197,550	14.5	19.6
PHF	91.85	1,322.7	831.6	1,197,550	14.5	19.6

Temperature Correction

Flux values are temperature corrected to a 20°C basis because water viscosity increases as feed temperature decreases. For feed temperatures below 20°C, the Memcor™ temperature correction factor is applied to the calculated flux. At 8.9°C, the correction factor used for this design is $\eta = 1.3496$.

$$\eta = 10^{((1301)/(998.333 + 8.1855 \times (T - 20) + 0.00585 \times (T - 20)^2) - 1.3023)}$$

At T = 8.9°C, $\eta = 1.3496$

Example: ADF temperature-corrected net flux = 8.5 gfd $\times$ 1.3496 = **11.4 gfd @ 20°C**

Flux During CIP

During a clean-in-place event, one membrane tank may be offline while the remaining tanks continue to produce the required average daily flow. The flux check below confirms that the system can maintain average daily flow during a CIP event while remaining below the stated temperature-corrected flux limit of 25.9 gfd.

CIP flux check item	Value	Units	Comment
Average Daily Flow (ADF)	1.40	MGD	Flow maintained during CIP
Membrane tanks in service during CIP	3	tanks	One tank offline for CIP
Membrane area per tank	82,667	ft²/tank	Installed filtration surface area
Operating time used for calculation	1,322.7	min/day	Peak-condition operating time used
Temperature correction factor	1.3496	—	Applied to instantaneous flux

Instantaneous flux during CIP = 1,400,000 gpd $\times$ 1,440 $\div$ (3 tanks $\times$ 82,667 ft²/tank $\times$ 1,322.7 min/day)
= **6.1 gfd**

Temperature-corrected CIP flux = 6.1 gfd $\times$ 1.3496 = **8.3 gfd @ 20°C**

Conclusion

The calculated temperature-corrected instantaneous flux during CIP is 8.3 gfd, which is below the 25.9 gfd limit. Therefore, the membrane system can operate at the average daily flow condition while one tank is offline for CIP.

Summary of Flux Results

Flow condition	Net flux (gfd)	Inst. flux (gfd)	Temp.-corrected net (gfd @ 20°C)	Temp.-corrected inst. (gfd @ 20°C)
ADF	8.5	9.3	11.4	12.5
MMF	8.5	9.3	11.4	12.5
PWF	8.5	9.3	11.4	12.5
PDF	13.3	14.5	18.0	19.6
PHF	13.3	14.5	18.0	19.6

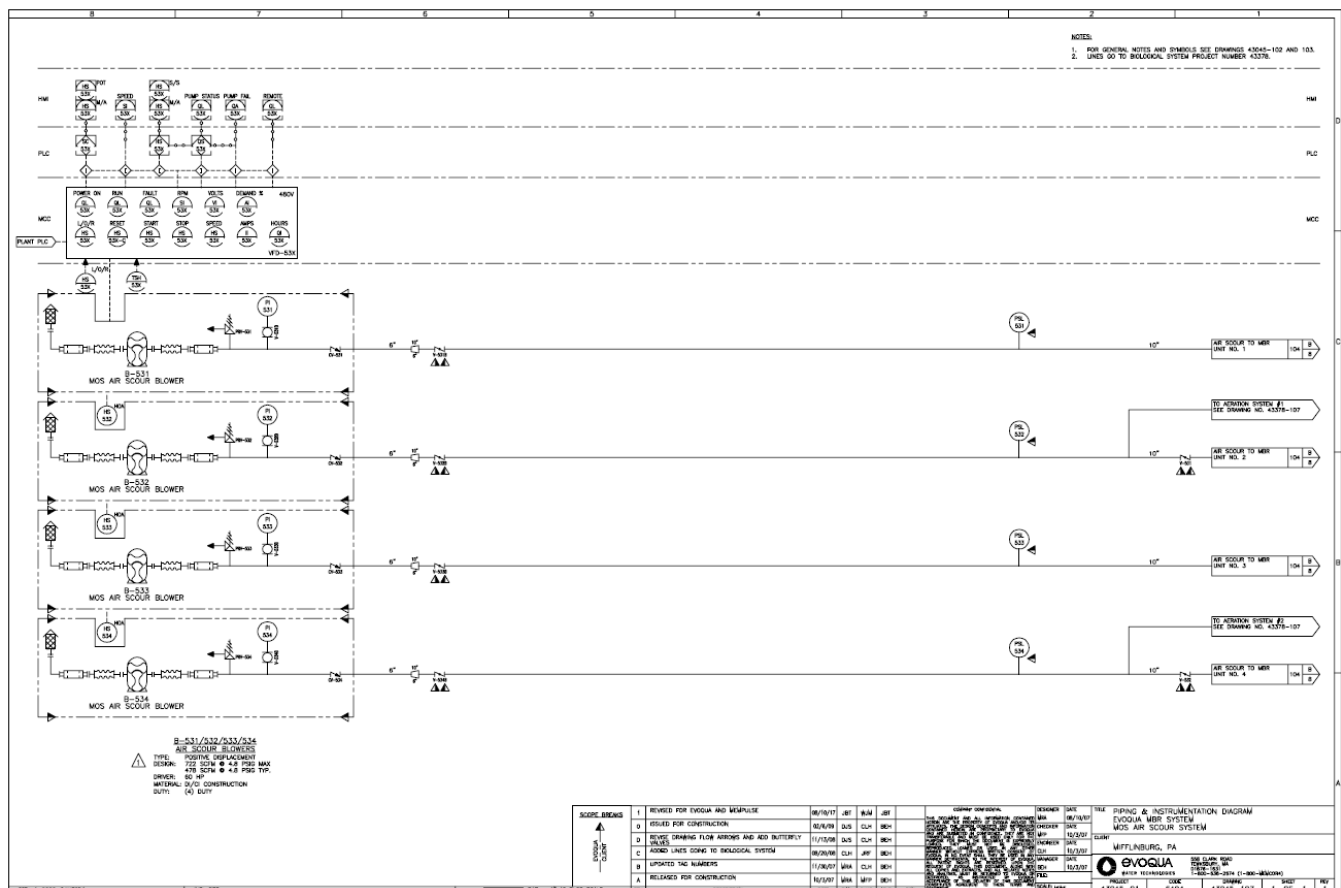
Note: Values are rounded for presentation. Calculations are based on the design basis and membrane configuration provided in the source calculation table. The PWF net flux calculation has been presented as 8.5 gfd, consistent with the 1.40 MGD flow condition and two tanks in operation.

5 Blower Capacity Confirmation

Based on our review of the original MemCor™ system design documentation and blower performance data, the existing membrane air scour blowers appear to have sufficient capacity to support the proposed membrane expansion. The original design includes four dedicated membrane air scour blowers, one blower serving each membrane tank, with a rated capacity of approximately **1,286 SCFM** per blower at the design operating point. The blower performance data indicates operation at approximately **2,270 RPM**, producing **1,286 SCFM** at a discharge pressure of approximately **4.8 psig**. The variable frequency drive (VFD) configuration provides additional operating flexibility, allowing blower output to be adjusted to match process demand.

Based on the revised membrane design calculations, the maximum membrane air scour demand for the expanded configuration is approximately **800 SCFM per membrane tank** under peak flux conditions. This required airflow remains below the nominal blower capacity of **1,286 SCFM**, indicating that the installed blowers have adequate available capacity to support the additional membrane racks without requiring blower replacement. The addition of membrane area reduces membrane flux and provides additional operating margin while remaining within the apparent operating envelope of the existing aeration system.

As part of the detailed design review, DuPont recommends verification of the current blower operating setpoints, airflow measurements, and field operating conditions. Based on the available P&IDs, Blowers No. 2 and No. 4 appear to include additional branch connections associated with the aeration system, while each blower also serves its respective membrane tank air scour header. To finalize confirmation of available capacity, DuPont requests confirmation of the current aeration system requirement on the membrane blowers.



Company: Dresser ROOTS Division
 Address: 16240 Port Northwest Drive, Houston, Texas 77041
 832-590-2193 / 832-590-2326
 Contact: Kathleen Spoonemore
 Customer: Siemens Water Technologies
 Project: Mifflinburg, PA
 Package: EasyAir®8000 616J-8-6-E 60HP
 ROOTS BLOWER PERFORMANCE SUMMARY : Program Version 5.07 Release

Date 8/9/2006

Program Mode: PERFORMANCE Run Date: 08/20/2007

AMBIENT CONDITIONS:

Gas	AIR	
Relative Humidity	75%	
Molecular Weight	28.556	
k-Value	1.392	
Specific Gravity	.986	
Ambient Temperature	90	deg F
Ambient Pressure	14.36	PSIA
Elevation	640	feet

STANDARD CONDITIONS:

Pressure	14.7	PSIA
Temperature	68	deg F
Relative Humidity	36	%

INPUT CONDITIONS:

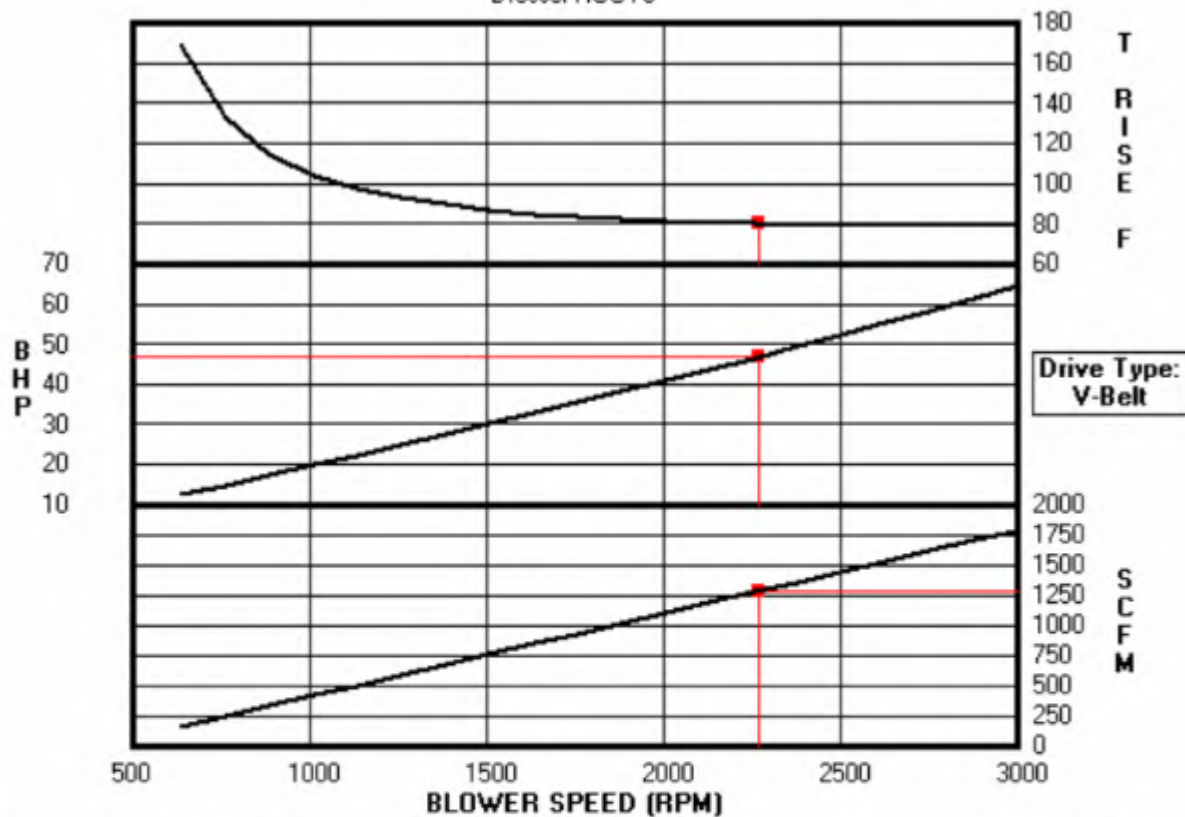
Actual Inlet Volume	1472	ICFM	+/- 4 %
Standard Volume	1286	SCFM	
Mass/Weight Flow	102.29	#/min	+/- 4 %
System Inlet Pressure	14.36	PSIA	
Inlet Pressure Loss	0.59	PSI	
Blower Inlet Pressure	13.77	PSIA	
System Discharge Pressure	4.8	PSIG	
Discharge Pressure Loss	0.28	PSI	
Blower Discharge Pressure	19.44	PSIA	
Inlet Temperature	90	deg F	

SELECTED UNIT DETAIL:

Model	616	RAM-J
Speed	2270	RPM 76%
Blower Differential Pressure	5.67	PSI 38%
Power at Blower Shaft	46.9	BHP +/- 4%
Temperature Rise	80	deg F 35%
Discharge Temperature	170	deg F
Discharge Volume	1193	ACFM
Relief Valve Setting	6	PSIG 44%
Power at the relief valve Setting	56.1	BHP +/- 4%
Temp. Rise at the Relief Valve Setting	95	deg F 41%
Discharge Temp At Relief Valve Setting	185	deg F
Gear Tip Speed	3568	FPM
V-Belt: Est. B10 Brg Life:	850057	hours

Est. Free Field Noise @ 1 m. W/ENCL 75 dBa
 Measured to CAGI-PNEUROP test code with +/- 3 dBa tolerance.
 Pipe work external to enclosure to be treated by customer.
 Est. Package Weight 3050 lbs.
 Package Disch Conn. 6" Flange

616 RAM-J: Variable Speed Performance Dresser ROOTS



INLET CONDITIONS: AIR

RH = 75.00%, MW = 28.556, k = 1.392, Tin = 90 deg F

DESIGN: Speed = 2270 RPM

System Inlet P = 14.36 PSIA, Inlet P Loss = 0.59 PSI

System Disch P = 4.8 PSIG, Disch P Loss = 0.28 PSI

STD: RH = 36%, T = 68 deg F, P = 14.7 PSIA

CUSTOMER: Siemens Water Technologies

PROJECT: Mifflinburg, PA

Drive Selection

Motor Horsepower	60.00	Service Factor	1.40
Driver RPM	1780.00		
Driven RPM	2274.00	Tolerance RPM	25.00
Center Distance (IN) MIN	20.00	MAX	22.00
Shaft Dia Driver (IN)	2.3750	Shaft Dia Driven (IN)	2.0000
QD/H Sheaves/Bushings Selected			

Selection:

Description	Part No	Roots No
3/5V11.8-SF	455287	13643091
SF X 2-3/8-KW	120478	13645020
3/5V9.25-SF	455281	13643081
SF X 2-KW	120472	89982020
5VX750 D-V WEDGE BELT	107193	QTY 3 13647023

Technical Data:

Actual Service Factor	1.7	Belt Pull	607
Actual Center Distance	20.9	Installation Deflection	0.33
Approx. Output RPM	2270	Min. Installation Force	9.5
Belt FPM	5499	Max. Installation Force	10.9

Siemens Water Technologies
Mifflinburg, PA

6 Membrane Rack Replacement Justification

DuPont's recommendation to replace the existing membrane racks is based primarily on asset age, lifecycle considerations, and long-term reliability rather than any specific structural failure identified during the site inspection. The existing membrane racks were originally installed as part of the MemCor™ MBR system commissioned approximately 17 years ago and will be approaching the end of their anticipated design service life by the time the upgrade is implemented. DuPont's current recommendation is based on a nominal rack design life of approximately 20 years, supported by historical operating experience and factory lifecycle testing.

While the inspection did not identify any immediate conditions that would prevent continued operation of the existing racks, the proposed project presents a unique opportunity to renew the membrane support infrastructure while the membrane modules are being replaced and the membrane tanks are accessible. Key rack components, including support frames, aeration distribution assemblies, MemPulse devices, air droppers, clips, gaskets, fasteners, and connection hardware, have been continuously exposed to a corrosive wastewater environment and repetitive operational loading for nearly two decades. Although these components may remain operational, age-related degradation mechanisms such as material fatigue, wear of mechanical connections, reduced reliability of aeration components, and deterioration of elastomeric sealing elements become increasingly likely as equipment approaches the end of its expected service life.

Replacement of the racks as part of the membrane upgrade effectively renews the submerged membrane support system and minimizes the risk of future maintenance outages associated with aging infrastructure. In addition, installing new racks ensures that the new membrane modules are supported by equipment of equivalent service life, reducing the likelihood that future rack repairs or replacements would be required during the expected 10-year membrane warranty period. This approach also provides the Borough with a fully renewed membrane system, including new membrane modules, new membrane racks, new aeration distribution components, and associated hardware, maximizing long-term reliability and reducing lifecycle maintenance costs.

Accordingly, DuPont's recommendation for rack replacement should be viewed as a proactive asset management measure intended to improve system reliability, reduce long-term maintenance risk, and align the service life of the membrane support infrastructure with the new membrane installation, rather than as a response to any specific deficiency or failure observed during the site inspection.



7 Scope of Supply

7.1 Membrane Replacement Scope of Supply

The following equipment is included with the proposed scope of supply.

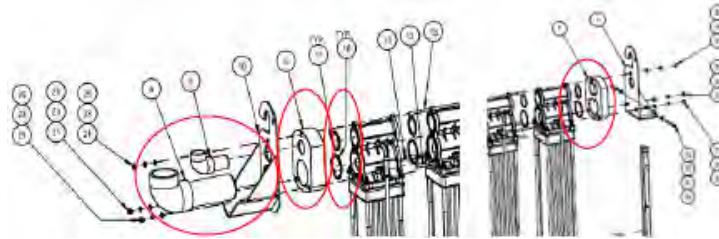
Membrane Operating System Equipment

QTY	DESCRIPTION
640	B40N membrane submodules fabricated of oxidant-resistant polyvinylidene fluoride (PVDF) membrane material.



Membrane Critical Repair Parts

QTY	DESCRIPTION
6	PVC blank plate adapter used to cap or isolate unused connections
12	PVC plate adapter with integrated air connection (280 mm diameter) for filtrate and aeration interface
12	PVC spool piece for filtrate outlet piping connection
12	PVC spool piece for incoming air piping connection
12	MBR aeration skirt assembly with integrated airlift function
12	Support clips used to secure skirt components to the membrane rack
12	EPDM O-ring (BS337 size) for sealing air and process connections
12	EPDM O-ring (BS345 size) for sealing air and process connections
2	Locking mechanism including nuts, washers, and spring.



Membrane Rack Replacement Parts

QTY	DESCRIPTION
640	MBR aeration device assemblies, MemPulse device
640	Air dropper assemblies for membrane rack air distribution
34	EPDM O-rings (BS337) for sealing air/process connections
34	EPDM O-rings (BS345) for sealing air/process connections
130	Stainless steel M10 hex nuts for mechanical fastening
132	Stainless steel M10 flat washers for load distribution
130	Stainless steel M10 spring washers for vibration resistance
640	Nylon top support clips for air dropper assemblies
640	Short support clips for air dropper piping
1280	Skirt and rack support clips
640	Air Dropper Grommet EPDM for MemPulse Device

Manufacturer's Services

The entire execution process from design to start-up will be supported by DuPont's experienced engineering team and a Project Management Professional® (PMP) certified project manager. The following table details the personal support your MEMPULSE MBR project will receive:

SERVICE SUPPORT

Three (3) Service Weeks consisting of eight-hour service days for manufacturer's services provided at scheduled intervals during the project. These services are intended to support proper installation and assembly procedures, as well as commissioning and operator training for the MemCor™ MBR system.

Execution Approach:

Service shall be scheduled to support a phased upgrade approach, with installation and commissioning performed on approximately one-half of the plant at a time to maintain operational continuity.

Scope of Services Includes:

- On-site supervision and installation guidance by DuPont personnel, including support for membrane and replacement part installation,
- Pre-commissioning support and inspection of system installation,
- On-site commissioning services including system startup and completion of functional testing,
- Operator and technical staff training conducted in conjunction with startup, including:
 - Equipment overview and component descriptions,
 - Field instrumentation and control systems,
 - Preventive maintenance procedures,
 - Troubleshooting and operational best practices.

Installation activities shall be supported by a minimum of four (4) personnel provided by the Buyer or their designated contractor.

Additional services may be retained at MemCor's scheduled rate of US\$1,650 per day, per person, plus travel expenses at cost plus a 5% markup.

7.2 Membrane Expansion Scope of Supply

The following equipment is included with the proposed scope of supply.

Membrane Operating System Equipment

QTY	DESCRIPTION
128	B40N membrane submodules fabricated of oxidant-resistant polyvinylidene fluoride (PVDF) membrane material.
8	Membrane rack assembly (16 module capacity) consisting of header assemblies, guide racks, mixing skirt, air dropper tube, and MemPulse device.
8	Filtrate PVC piping, 4" from membrane rack to membrane header including elbow.
16	Filtrate Straub couplings 4" for filtrate piping
8	Aeration hose 2" with camlock fittings.



Manufacturer's Services

The entire execution process from design to start-up will be supported by DuPont's experienced engineering team and a Project Management Professional® (PMP) certified project manager. The following table details the personal support your MEMPULSE MBR project will receive:

SERVICE SUPPORT

One (1) additional Week of Service Weeks are included in the membrane rack expansion scope, based on the client selecting to replace the existing membranes.

Scope of Services Includes:

- On-site supervision and installation guidance by DuPont personnel, including support for membrane and replacement part installation,
- Pre-commissioning support and inspection of system installation,
- On-site commissioning services including system startup and completion of functional testing,
- Operator and technical staff training conducted in conjunction with startup, including:
 - Equipment overview and component descriptions,
 - Field instrumentation and control systems,
 - Preventive maintenance procedures,
 - Troubleshooting and operational best practices.

Installation activities shall be supported by a minimum of four (4) personnel provided by the Buyer or their designated contractor.

Additional services may be retained at MemCor's scheduled rate of US\$1,650 per day, per person, plus travel expenses at cost plus a 5% markup.

7.3 Replace Current Membrane Racks Scope of Supply

DuPont recommends replacing the existing racks, as they will be approximately seventeen (17) years old at the time of the upgrade. This recommendation is based on a twenty (20) year design life and supporting factory cycle testing. Replacing the racks will effectively renew the membrane system, supporting reliable long-term performance.

QTY	DESCRIPTION
40	Membrane rack assembly (16 module capacity) consisting of header assemblies, guide racks, mixing skirt, and air dropper tube for expansion.

Manufacturer's Services

The entire execution process from design to start-up will be supported by DuPont's experienced engineering team and a Project Management Professional® (PMP) certified project manager. The following table details the personal support your MEMPULSE MBR project will receive:

SERVICE SUPPORT

Two (2) additional Week of Service Weeks are included in the membrane rack replacement scope, based on the client selecting to replace the existing membranes.

Scope of Services Includes:

- On-site supervision and installation guidance by DuPont personnel, including support for membrane and replacement part installation,
- Pre-commissioning support and inspection of system installation,
- On-site commissioning services including system startup and completion of functional testing,
- Operator and technical staff training conducted in conjunction with startup, including:
 - Equipment overview and component descriptions,
 - Field instrumentation and control systems,
 - Preventive maintenance procedures,
 - Troubleshooting and operational best practices.

Installation activities shall be supported by a minimum of four (4) personnel provided by the Buyer or their designated contractor.

Additional services may be retained at MemCor's scheduled rate of US\$1,650 per day, per person, plus travel expenses at cost plus a 5% markup.

7.4 Equipment Scope of Supply – Optional Flowmeter

QTY	DESCRIPTION
4	Endress + Hauser Proline t-mass B 150 thermal mass flowmeter

DuPont recommends the installation of airflow meters to ensure proper distribution and control of air supplied to the membrane system, particularly with the addition of new membrane modules. Accurate airflow measurement helps maintain balanced aeration, optimize system performance, and support long-term operational reliability.



7.5 Services Provided by Others

All other works and equipment necessary to complete the project and not shown as being supplied by DuPont shall be supplied by others, including but not limited to:

- Civil works and any and all building modifications or construction to house the MemCor™ membrane filtration system equipment including all concrete work related with construction, grouting of equipment and else as applicable.
- Unloading, unpacking, storage (according to DuPont's recommendation), installation, assembly and field erection of the MemCor system..
- Modifications to any of the membrane supports
- Proper cleaning of existing tanks prior to work commencing
- Assembly and installation of scope supplied based under DuPont's supervision.
- Modifications of membrane support grid at the bottom of the membrane tanks.
- Additional engineering services including structural, foundation design, or anchor bolt calculations.
- Any equipment, valves, instrumentation or spare parts not specifically listed in the DuPont scope herein.

8 Standard Terms of Sale

1. **Applicable Terms.** These terms govern the purchase and sale of equipment, products, related services, leased products, and media goods if any (collectively herein "Work"), referred to in Seller's proposal ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is expressly conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.
2. **Payment.** Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation specifically provides otherwise, freight, storage, insurance and all taxes, levies, duties, tariffs, permits or license fees or other governmental charges relating to the Work or any incremental increases thereto shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. If Buyer claims a tax or other exemption or direct payment permit, it shall provide Seller with a valid exemption certificate or permit and indemnify, defend and hold Seller harmless from any taxes, costs and penalties arising out of same. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval by Seller. Back charges without Seller's prior written approval shall not be accepted.
3. **Delivery.** Delivery of the Work shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, delivery terms are Ex Works Seller's factory (Incoterms 2010). Title to all Work shall pass upon receipt of payment for the Work under the respective invoice. Unless otherwise agreed to in writing by Seller, shipping dates are approximate only and Seller shall not be liable for any loss or expense (consequential or otherwise) incurred by Buyer or Buyer's customer if Seller fails to meet the specified delivery schedule.
4. **Ownership of Materials and Licenses.** All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data, software and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Work. Buyer shall not disclose any such material to third parties without Seller's prior written consent. Buyer grants Seller a non-exclusive, non-transferable license to use Buyer's name and logo for marketing purposes, including but not limited to, press releases, marketing and promotional materials, and web site content.
5. **Changes.** Neither party shall implement any changes in the scope of Work described in Seller's Documentation without a mutually agreed upon change order. Any change to the scope of the Work, delivery schedule for the Work, any Force Majeure Event, any law, rule, regulation, order, code, standard or requirement which requires any change hereunder shall entitle Seller to an equitable adjustment in the price and time of performance.
6. **Force Majeure Event.** Neither Buyer nor Seller shall have any liability for any breach or delay (except for breach of payment obligations) caused by a Force Majeure Event. If a Force Majeure Event exceeds six (6) months in duration, the Seller shall have the right to terminate the Agreement without liability, upon fifteen (15) days written notice to Buyer and shall be entitled to payment for work performed prior to the date of termination. "Force Majeure Event" shall mean events or circumstances that are beyond the affected party's control and could not reasonably have been easily avoided or overcome by the affected party and are not substantially attributable to the other party. Force Majeure Event may include, but is not limited to, the following circumstances or events: war, act of foreign enemies, terrorism, riot, strike, or lockout by persons other than by Seller or its sub-suppliers, natural catastrophes or (with respect to on-site work), unusual weather conditions.
7. **Warranty.** Subject to the following sentence, Seller warrants to Buyer that the (i) Work shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship and (ii) the Services shall be performed in a timely and workmanlike manner. Determination of suitability of treated water for any use by Buyer shall be the sole and exclusive responsibility of Buyer. The foregoing warranty shall not apply to any Work that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. The Seller warrants the Work, or any components thereof, through the earlier of (i) eighteen (18) months from delivery of the Work or (ii) twelve (12) months from initial operation of the Work or ninety (90) days from the performance of services (the "Warranty Period"). If Buyer gives Seller prompt written notice of breach of this warranty within the Warranty Period, Seller shall, at its sole option and as Buyer's sole and exclusive remedy, repair or replace the subject parts, re-perform the Service or refund the purchase price. Unless otherwise agreed to in writing by Seller, (i) Buyer shall be responsible for any labor required to gain access to the Work so that Seller can assess the available remedies and (ii) Buyer shall be responsible for all costs of installation of repaired or replaced Work. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Work in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover (i) damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller) and (ii) media goods (such as, but not limited to, resin, membranes, or granular activated carbon media) once media goods are installed.

THE WARRANTIES SET FORTH IN THIS SECTION AND THE WARRANTY SET FOR IN THE "EXTENDED LOW PRESSURE MEMBRANE MODULE WARRANTY" SECTION OF DUPONT'S PROPOSAL ARE THE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO THE LIMITATION OF LIABILITY PROVISION BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

THE WARRANTIES SET FORTH IN THIS SECTION OF DUPONT'S PROPOSAL ARE THE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO THE LIMITATION OF LIABILITY PROVISION BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE. DUPONT CAN OFFER AN "EXTENDED LOW PRESSURE MEMBRANE MODULE WARRANTY" UPON FURTHER REVIEW OF THE APPLICATION.

8. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third-party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

9. Assignment. Neither party may assign this Agreement, in whole or in part, nor any rights or obligations hereunder without the prior written consent of the other party; provided, however, the Seller may assign its rights and obligations under these terms to its affiliates or in connection with the sale or transfer of the Seller's business and Seller may grant a security interest in the Agreement and/or assign proceeds of the agreement without Buyer's consent.

10. Termination. Either party may terminate this agreement, upon issuance of a written notice of breach and a thirty (30) day cure period, for a material breach (including but not limited to, filing of bankruptcy, or failure to fulfill the material obligations of this agreement). If Buyer suspends an order without a change order for ninety (90) or more days, Seller may thereafter terminate this Agreement without liability, upon fifteen (15) days written notice to Buyer, and shall be entitled to payment for work performed, whether delivered or undelivered, prior to the date of termination.

11. Dispute Resolution. Seller and Buyer shall negotiate in good faith to resolve any dispute relating hereto. If, despite good faith efforts, the parties are unable to resolve a dispute or claim arising out of or relating to this Agreement or its breach, termination, enforcement, interpretation or validity, the parties will first seek to agree on a forum for mediation to be held in a mutually agreeable site. If the parties are unable to resolve the dispute through mediation, then any dispute, claim or controversy arising out of or relating to this Agreement or the breach, termination, enforcement, interpretation or validity thereof, including the determination of the scope or applicability of this agreement to arbitrate, shall be determined by arbitration in Pittsburgh, Pennsylvania before three arbitrators who are lawyers experienced in the discipline that is the subject of the dispute and shall be jointly selected by Seller and Buyer. The arbitration shall be administered by JAMS pursuant to its Comprehensive Arbitration Rules and Procedures. The Arbitrators shall issue a reasoned decision of a majority of the arbitrators, which shall be the decision of the panel. Judgment may be entered upon the arbitrators' decision in any court of competent jurisdiction. The substantially prevailing party as determined by the arbitrators shall be reimbursed by the other party for all costs, expenses and charges, including without limitation reasonable attorneys' fees, incurred by the prevailing party in connection with the arbitration. For any order shipped outside of the United States, any dispute shall be referred to and finally determined by the International Center for Dispute Resolution in accordance with the provisions of its International Arbitration Rules, enforceable under the New York Convention (Convention on the Recognition and Enforcement of Foreign Arbitral Awards) and the governing language shall be English.

12. Export Compliance. Buyer acknowledges that Seller is required to comply with applicable export laws and regulations relating to the sale, exportation, transfer, assignment, disposal and usage of the Work provided under this Agreement, including any export license requirements. Buyer agrees that such Work shall not at any time directly or indirectly be used, exported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with such applicable export laws and regulations. It shall be a condition of the continuing performance by Seller of its obligations hereunder that compliance with such export laws and regulations be maintained at all times. BUYER AGREES TO INDEMNIFY AND HOLD SELLER HARMLESS FROM ANY AND ALL COSTS, LIABILITIES, PENALTIES, SANCTIONS AND FINES RELATED TO NON-COMPLIANCE WITH APPLICABLE EXPORT LAWS AND REGULATIONS.

13. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE WORK, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR ALL WARRANTY CLAIMS OR FOR ANY BREACH OR FAILURE TO PERFORM ANY OBLIGATION UNDER THE CONTRACT, SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE WORK. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

14. Rental Equipment / Services. Any leased or rented equipment (“Leased Equipment”) provided by Seller shall at all times be the property of Seller with the exception of certain miscellaneous installation materials purchased by the Buyer, and no right or property interest is transferred to the Buyer, except the right to use any such Leased Equipment as provided herein. Buyer agrees that it shall not pledge, lend, or create a security interest in, part with possession of, or relocate the Leased Equipment. Buyer shall be responsible to maintain the Leased Equipment in good and efficient working order. At the end of the initial term specified in the order, the terms shall automatically renew for the identical period unless canceled in writing by Buyer or Seller not sooner than three (3) months nor later than one (1) month from termination of the initial order or any renewal terms. Upon any renewal, Seller shall have the right to issue notice of increased pricing which shall be effective for any renewed terms unless Buyer objects in writing within fifteen (15) days of issuance of said notice. If Buyer timely cancels service in writing prior to the end of the initial or any renewal term this shall not relieve Buyer of its obligations under the order for the monthly rental service charge which shall continue to be due and owing. Upon the expiration or termination of this Agreement, Buyer shall promptly make any Leased Equipment available to Seller for removal. Buyer hereby agrees that it shall grant Seller access to the Leased Equipment location and shall permit Seller to take possession of and remove the Leased Equipment without resort to legal process and hereby releases Seller from any claim or right of action for trespass or damages caused by reason of such entry and removal.

15. Hardship. The parties acknowledge that events beyond their control may arise during the Term of this Agreement affecting (without limitation) their performance, their future ability to perform or their cost. Should such an event (including but not limited to events of an economic, monetary, fiscal or political nature) occurs and renders the continued performance of the affected party’s contractual obligations excessively onerous, and provided the affected party could not reasonably have avoided or overcome the event or its consequences, the parties shall, within 30 (thirty) days of the invocation of the provisions of this Section, meet and negotiate in good faith such changes in contractual terms or price which shall reasonably allow the affected party to overcome the consequences of the event. If the parties are unable to reach an agreement within the aforementioned 30 (thirty)-day period, the affected party shall be entitled to terminate this Agreement upon giving 30 (thirty) days’ notice to the other party. Such termination shall not constitute grounds for breach of contract claims and if the affected party is the Seller, the same shall be entitled to payment for work performed whether delivered or undelivered up to the effective date of the termination.

16. Miscellaneous. These terms, together with any Contract Documents issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the “Agreement”) and supersede any terms contained in Buyer’s documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. To the extent the Agreement is considered a subcontract under Buyer’s prime contract with an agency of the United States government, in case of Federal Acquisition Regulations (FARs) flow down terms, Seller will be in compliance with Section 44.403 of the FAR relating to commercial items and those additional clauses as specifically listed in 52.244-6, Subcontracts for Commercial Items (OCT 2014). If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. The Agreement shall be governed by the laws of the Commonwealth of Pennsylvania without regard to its conflict of laws provisions. Both Buyer and Seller reject the applicability of the United Nations Convention on Contracts for the international sales of goods to the relationship between the parties and to all transactions arising from said relationship.

9 Membrane Module Warranty

1. Term of the Low-Pressure Membrane Module Warranty
 - a. This Warranty shall commence ("Commencement Date") on the earlier of:
 - i) Wet startup of the equipment, or
 - ii) Three (3) months after the delivery of the final low pressure membrane modules to the Buyer.
 - iii) This Warranty shall continue for a total period of ten (10) years from the Commencement Date (the "Module Warranty Period").
2. Warranty Replacement Schedule
 - a. **First 60 Months:** If a low-pressure membrane module shall require replacement under the repair and replacement conditions described in Paragraph 3 below during the first sixty (60) months of the "Module Warranty Period", a replacement will be supplied by Seller at no charge.
 - b. **Next 60 Months:** If a low-pressure membrane module shall require replacement under the repair and replacement conditions described in Paragraph 3 below during the next sixty (60) months of the Module Warranty Period, a replacement will be supplied by Seller and invoiced based upon a pro-rata value of a total of one hundred and twenty (120) months. The pro-rata value shall be determined using a replacement price of US\$1,600 per module adjusted by the increase in the North American Consumer Price Index (CPI) All Urban Consumers (US City Average) and reducing this price by 1/120th for each month remaining in the 120-month period.
 - c. Replacement modules supplied by the Seller to Buyer under warranty shall assume the balance of the low-pressure membrane module warranty that remained on the defective low pressure membrane module that was replaced under warranty.
 - d. Freight costs associated with the furnishing of replacement modules provided under the low-pressure membrane module warranty is not included in the warranty replacement price. Accordingly, the shipping/delivery terms for replacement modules supplied under the low-pressure membrane module warranty shall be "Ex Works Seller's Facility" and Seller shall arrange, and Buyer shall pay for, transportation of replacement membrane modules to Buyer's facility.
3. Repair and Replacement Conditions
 - a. In the event an individual low pressure membrane module exhibits defects in material or workmanship, as defined in Paragraph 3.b. below, the Seller shall, at its sole option and as the Buyer's sole remedy, conduct either of the following:
 - i) Repair or modify the low-pressure membrane module(s) at no cost to Buyer; or
 - ii) Provide replacement low pressure membrane modules per the warranty replacement schedule listed in Paragraph 2 above.
 - b. Membrane modules shall be deemed to be exhibiting defects in material or workmanship under the following conditions:
 - i) If the membrane module(s) fails Seller's standard integrity test for MBR and cannot be repaired by the Owner; and
 - ii) If the membrane module(s) fail to meet the filtrate flow capacity, as outlined in the Design Basis; or
 - iii) If the membrane module(s) cause the system to exceed the effluent turbidity and/or total suspended solids requirements for this project, as outlined in the Design Basis.
 - c. Buyer will return to Seller a photograph of the end of each low-pressure membrane module with the serial number to qualify for a replacement module.
4. Low Pressure Membrane Module Warranty Exclusions: The Buyer recognizes that damage resulting from any of the following shall be excluded from coverage under the low-pressure membrane module warranty:
 - a. Any person other than an employee or representative of Seller has altered the membrane operating system without prior written approval by Seller;

- b. OWNER causing or permitting the membrane modules to dry or to have moisture content below that specified in the operating instructions either during storage or operation. Shutdown, storage, maintenance and start-up procedures of membranes must be as specified in the Operation & Maintenance Manual;
 - c. Mixed liquor suspended solids concentration exceeding a maximum of 14,500 mg/L in the membrane tank;
 - d. Unusual plant upsets, presence of other potential transients or other undefined operating conditions that can affect membrane performance or life. This includes but is not limited to polymer “dumps”, emulsified fats, oil and grease content in excess of 100 mg/L entering the biological system, the use, malfunction or by-pass of any equipment which allows the accumulation of non-biodegradable material in the membrane tanks, any bypass of the ≤2.0mm punched hole or woven wire pre-screen ahead of the aeration basins, rags or debris that fall into the biological or membrane tanks, toxic wastes entering the plant that upset the biological process;
 - e. Any damage/defect caused by chemical or physical conditions such as (but not limited to) pH, temperature, chemicals, effluent COD is greater than 50 mg/L or climatic factors outside the recommended operating parameters in the appropriate section of the Operation & Maintenance Manual;
 - f. Ammonia concentrations in the membrane tank greater than 3 mg/L;
 - g. Any damage directly or indirectly related to PLC and/or HMI/SCADA modifications without Seller’s express written consent.
 - h. Improper maintenance or operation of equipment (including failure to perform periodic chemical cleans) as defined in Seller supplied operating and maintenance manual.
 - i. Neutralization and/or reduction of chemical cleaning solutions are performed in the membrane tank without written authorization from Seller;
 - j. Supply of influent water exhibiting parameters inconsistent with the parameters determined or specified at time of bid and/or pilot testing.
 - k. Sludge retention time (SRT) is:
 - less than 5 days total SRT over a 2-day history or
 - less than as determined by the below equation over any 30-day period: $SRT = 10 / 1.029^{(T-20)}$
 Where: SRT = minimum SRT for biological process (average for any 30-day period)
 T = wastewater temperature (°C); or
 - The total SRT for the system should not exceed 50 days of total SRT in any 30-day period
 - l. Damages to the membranes caused by:
 - Erosion of the non-coated tank walls over time or
 - By degradation of the tank coating leading to the release of coating fragments in the mixed liquor.
5. Warranty Conditions: This warranty is conditioned upon Buyer:
- a. Not being in default of any payment obligations to Seller; and
 - b. Maintaining hand-written or electronic operational logs and providing such logs to Seller in the event of a warranty claim.
 - c. Unless the capillary suction time (CST) is less than 100 seconds for mixed liquor before the membrane tank, the CST method should be as defined in Standard Method 2710G for the Examination of Wastewater Treatment (latest edition), except that a 10-mm diameter stainless steel reservoir should be utilized rather than an 18-mm diameter.
6. The Warranty is expressly excluded from any performance bond(s) which may be furnished by the Seller.
7. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INDIRECT, CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER DAMAGES AND SELLER’S TOTAL LIABILITY UNDER THIS EXTENDED LOW PRESSURE MEMBRANE MODULE WARRANTY, WHEN ADDED TO ALL LIABILITY OF SELLER TO THE BUYER AND ANY END USER OF THE SYSTEM, IF DIFFERENT FROM THE BUYER, UNDER THE SYSTEM SALE CONTRACT, SHALL NOT EXCEED THE LIMITATION ON LIABILITY SET FORTH IN THE SYSTEM SALE CONTRACT. THE FOREGOING LIMITATIONS APPLY REGARDLESS OF WHETHER THE LIABILITIES OR DAMAGES ARISE OR ARE ALLEGED TO ARISE UNDER CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

10 Proposal Order Form

Purchase Order Summary

Buyer / Owner	Borough of Mifflinburg	Proposal Date	June 13, 2026
Project	Mifflinburg WWTP MBR System Upgrade	Quote Valid Until	December 31, 2026
Submitted To	Rob Rowe, Supervisor	Delivery Basis	CPT Job Site
Address	200 Gessner Ln, Mifflinburg, PA 17844	Estimated Delivery	16–18 weeks after NTP
Reference	Proposal No. A-423399 Rev.2		

Purchaser Selection / Order Authorization

Select	Item	Scope Summary	Equipment / Services	Price	Tariffs Included*
☐	Base Item 1	Membrane Replacement: 640 × B40N modules; critical repair parts; membrane rack replacement parts; manufacturer installation supervision services.	Equipment & Services	\$890,500	\$52,350
☐	Base Item 2	Membrane Expansion: 128 × B40N modules; 8 × 16-module MemRack™ assemblies; filtrate piping; air hoses; manufacturer installation supervision services.	Equipment & Services	\$298,500	\$20,910
☐	Option A	Replace current membrane racks: 40 × 16M MemRack™ assemblies, freight, and manufacturer supervision services.	Equipment & Services	\$421,000	\$36,421
☐	Option B	Air scour flowmeters: 4 × Endress+Hauser Proline t-mass B 150 thermal mass flowmeters.	Equipment	\$15,450	—
☐	Deduct C1	Deduct membrane replacement supervision services.	Services	- \$43,900	—
☐	Deduct C2	Deduct membrane expansion supervision services.	Services	- \$15,450	—
☐	Deduct C3	Deduct current membrane rack replacement supervision services.	Services	- \$27,200	—

*Tariffs are included in the proposed equipment pricing.

Commercial Terms

Term	Proposal Basis
Validity	Proposal valid until December 31, 2026, with order/notice to proceed to fabricate.
Delivery	Estimated 16–18 weeks after notice to proceed; delivery schedule to be coordinated at time of purchase.
Freight	CPT Job Site Incoterms® 2020.
Taxes, bonds, insurance	Pricing does not include insurance, bonds, or applicable taxes.
Payment terms	10% on order; 15% on submittals; 25% on order of major rotating equipment; 45% on delivery; 5% on start-up. Full payment not to exceed 120 days after shipment.
Warranty Not	If DuPont supervision services are not purchased, standard equipment warranties and the 10-year membrane warranty remain in full, subject to proposal terms and final inspection requirements referenced in the proposal.

Purchaser Information and Acceptance

Legal Buyer Name		Billing Contact	
Billing Address		Printed Name / Title	
Authorized Signature		Email / Phone	
Date		Tax Exemption Certificate Attached	☐ Yes ☐ No

Order acceptance is subject to DuPont review, credit approval, applicable due diligence, and execution of an agreement based on the proposal terms and conditions.

DuPont Acceptance

Legal Buyer Name	FilmTec Corporation
Authorize Representative	_____
Authorized Signature	_____
Date	_____

11 Technical Attachments

The following technical documents are attached to this proposal. If there is any additional information that we can provide to assist you, please contact the Technical Sales Manager listed above.

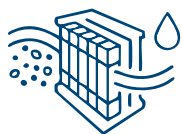
- MemCor™ Membrane Bioreactor System
- MemCor™ B40N Membrane Filtration Module Specification Sheet
- MemCor™ MBR System MemRACK™ Specification Sheet
- MemCor™ MBR Process Description
- Mifflinburg Process & Instrumentation Diagram
- MemCor™ MBR Process Description
- Mifflinburg Membrane Design Outline
- Mifflinburg Trip Report

DuPont™ MemCor™ MBR system

Designed for operators.

Efficient, Effective, Established.





MemCor™ MBR system

The DuPont™ MemCor™ MBR system employs an advanced wastewater treatment process that combines activated sludge treatment with MemPulse™ MBR membrane filtration resulting in superior effluent quality at a reduced life-cycle cost. The system provides a stable membrane environment, operational flexibility, and reduced maintenance requirements, which can result in significant cost savings.

Benefits of upgrading to a MemCor™ MBR system:

- High-quality effluent
- Drastically reduces system footprint
- Fewer process steps
- Eliminates sludge settleability issues
- Modular expansion capacity
- Low energy

The MemCor™ MBR system provides:

- Flexible modular rack design – fits in most tank arrangements
- Pulsed, plug flow aeration for channeling & solids build up prevention
- Dedicated, focused air scour delivered to each membrane module
- Pulsed air scour with continuous flow to each tank
- Market leading low energy consumption. Reduces aeration by up to 50% or <0.08 kWh/m³.
- Reduction of operation & maintenance costs with no moving parts in the aeration process
- Easy to handle modules and racks



Benefits

Why MemCor™ MBR systems?

Solutions for your installation

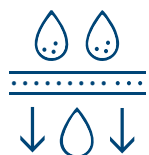
The MemCor™ MBR system combines a compact modular rack design and the MemPulse™ B40N module to provide greater filtration performance with reduced aeration flow.

The MemCor™ MBR system has a proven track record of achieving high-quality effluent quality in a reduced footprint and at a low life-cycle cost than many other MBR systems in the most challenging environments. The system is successfully operating in global applications ranging from municipal wastewater plants to difficult industrial applications such as oil refineries.



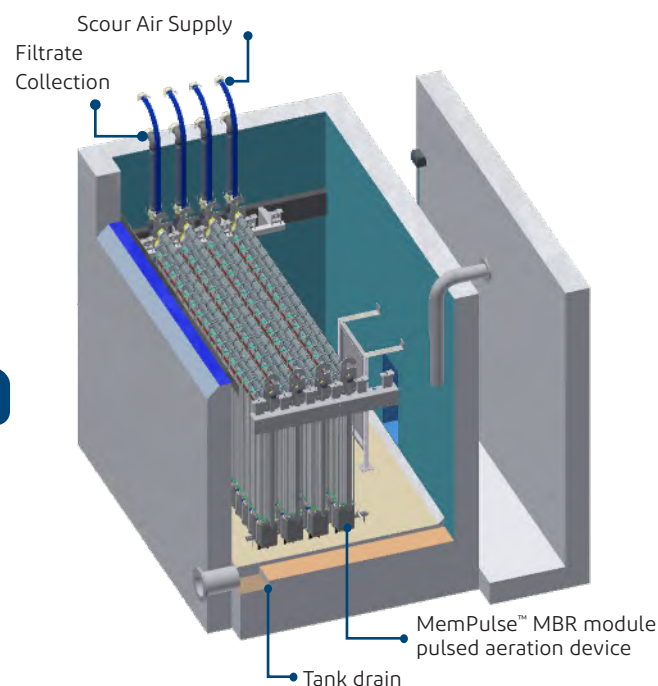
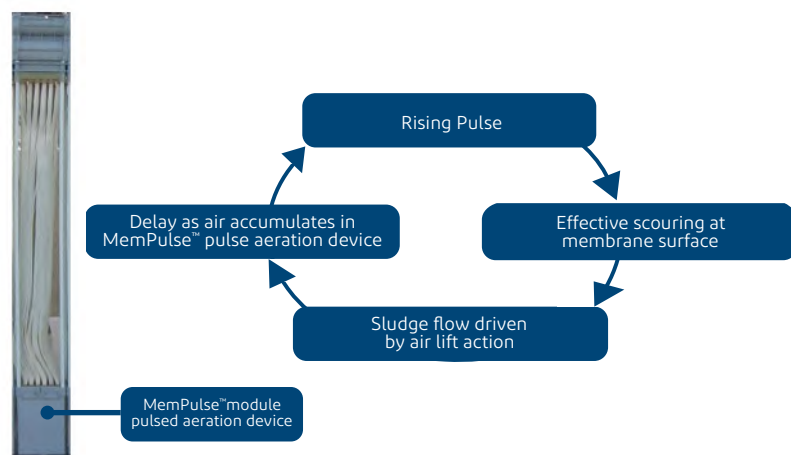
MemPulse™ MBR modules with N membrane fibers

Product Name	Key Features
MemPulse™ B50N Module	The MemPulse™ B50N MBR module is the next step in MemPulse™ MBR with high-quality effluent & low energy. The B50N module provides 25% more flow per module and additional aeration energy savings with the same modular footprint.
MemPulse™ B40N Module	The MemPulse™ B40N MBR modules are a unique slack adjust free module system with a compact modular rack system. High quality re-use ready with integrity testing capable membranes, receive high-quality effluent with this MBR system.
MemPulse™ B15N Module	All the benefits of MBR module in a smaller package the B15 N is the ideal module for pilot trials or to apply for low height applications such as replacement of flat sheet modules.



MemCor™ MBR system in operation

The graphic below depicts air scouring efficiencies achieved by introducing a plug flow of air at the base of each module.



Delivering reliability & operational simplicity

The MemCor™ MBR filtration system is designed to increase reliability, decrease operating and maintenance costs and dramatically reduce energy usage. A continuous air flow is evenly distributed to each pulsed aeration device located directly at the base of each MemPulse™ MBR module. The system introduces air at the base of the membrane module in the form of large bubbles or slugs that increase in size as they move up the membrane modules. The size and the focused nature of the large slugs of air prevent trash and solids build up by pushing debris away from the membrane fibre surfaces.

At the same time the large aeration pulse creates an airlift flow that draws mixed liquor into the bottom of each membrane module through an airlift tube. The air bubbles then blend with the mixed liquor and rise between the individual membrane fibers. This creates a unique crossflow pattern, providing an even distribution of mixed liquor and a reduction of solids concentration on the membrane surface.

The cross flow combined with focused, slug aeration prevents channeling and solids accumulation on the membrane surface resulting in greater system efficiency and reduced air scour requirement.

In addition; the up-flow pattern in the tank creates a flotation effect that moves grease, scum and other floatable constituents to the surface for removal.

Proven and reliable

MemCor™ systems have been a leader in the membrane industry for over 40 years and has had a dedicated MBR team since 1995. The membranes used in the MemCor™ MBR system have been proven in the field since 2007.

The efficiencies achieved with the MemCor™ MBR filtration system coupled with a proven installation base of hundreds of plants and the experience of the DuPont Water Solutions team make this technology ideally suited for a wide range of municipal and industrial applications.

A legacy of technical leadership

The MemCor™ MBR systems modular rack allows flexibility in plant design, as well as compatibility with nearly any existing tank or plant footprint.

MemCor™ brand is industry leading with a series of “first to market” advancements that have increased the productivity of MBR systems.

- **Separate Membrane Tank:** Allows easy cleaning of membranes and independent optimization of MOS and bio process.
- **Improved MLSS distribution:** The introduction of the MemJet™ system greatly improved system performance with superior hydraulics within the membrane environment.

- **Removal of Air Release Tanks:** First to use priming educators, now the industry standard.
- **Replaced cyclic with Plug Flow Aeration:** The technology used in the MemPulse™ system was introduced with further enhancements that helped reduce energy consumption by up to half of traditional systems with no moving parts.

Compared to alternative MBR membrane solutions, MemPulse™ MBR modules provides optimum filtrate quality, with lower energy consumption and flexible rack and tank configurations that enables our customers to implement leading MBR solutions.

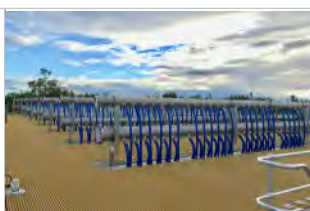


MemCor™ MBR system – Designed for What Matters



Aeration Like No Other

- The unique efficiency of two phase plug flow pulsed aeration for MemPulse™ MBR module cleaning.
- No need for daily cyclic peak operation.
- Doesn't waste energy – Focused bubbles
- Low chemical use



Keep Membranes in Tank – Where they Belong

- Keep your team productive
 - No need to adjust slack
- Fully automated membrane cleaning
 - No need for manual cleaning
- Minimise operator exposure to bacteria and pathogens



Filtration Strong Durability

- Strength where you need it with 100% UF membrane
- Can withstand forces in all directions
- Self-healing with greater membrane elongation membranes
- Reliable effluent quality with proven pathogen rejection for >10 years
- Helps enable re-use – Tier 3 capable



Adaptable and Flexible

- State-of-the-art modular and configurable rack design
- Can fit into any tank geometry
- Can be retrofit into existing membrane system cassette and rack layouts
- Compact MBR footprint, up to 30% smaller

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DuPont™ MemPulse™ B40N Membrane Filtration Module

Key Features

Proven N PVDF Fibers:

- Excellent permeability fiber.
- Enhanced chemical and abrasion resistance.
- Optimized dimensions to maximize packing density with high solid tolerance.

Module Design:

- Large single non-cassette module area.
- High packing density with high solid loading tolerance.
- High quality effluent.
- Energy-efficient aeration design with low maintenance & operation costs.
- Optimized design to suit large size installations.
- Robust fibers that do not require slack adjustment.
- In-tank cleaning.

Key Applications

New and retrofit submerged filtration of biological mixed liquor suspended solids water in:

- Municipal treatment.
- Industrial treatment.
- Nutrient removal.
- RO Pre-treatment.
- Re-use of wastewater (municipal & industrial) – irrigation, human contact & IDPR/DPR.

Module Specification

General		
Part Number / GMID	12089749 / Smart PN 118317	
Mode of Filtration	Out-In MBR	
Membrane Type	Hollow fiber	
Membrane Material	PVDF (Polyvinylidene Fluoride)	
Membrane Pore Size	0.04 µm	
Module Operating Process	Dead-end	
Other Wetted Module Components	Polyurethane, Fibreglass, Polyamide, Silicone Rubber, SS316	
Dimensions		
Active Membrane Area	40.0 m²	431 ft²
Module Length (Overall) (L)	1600 mm	63 in
Module Width	203 mm	8.0 in
Weight & Volume		
Shipping Weight	19 kg	42 lbs
Weight Empty	19 kg	42 lbs
Weight Filled	n/a	
Hold-Up Volume Feed (Clean-In-Place = CIP)	n/a	
Hold-Up Volume Filtrate (CIP)	n/a	



Certified to
 NSF/ANSI 61 and 419

Suggested Operating Conditions

General	Details	
Operating Temperature Range	1 – 40 °C	34 – 104 °F
Temperature Range for Transportation & Storage ¹	Preferred range 5 to 25 °C / 41 to 77 °F Allowable range > 0 to 40 °C / > 32 to 104 °F	
Operating pH	6.0 – 9.0 pH ²	
Cleaning pH	2 – 10.5 pH Typical	
Backwash Type	Relaxation	
Operating Limits (Maximum)	Details	
Rate of Temperature Change	Not specified	
Maximum Allowable TMP at any time	+0.75 bar / -1.10 bar	+ 11 psi / - 16 psi
Filtration TMP ³	0.05 – 0.65 bar	0.7 – 9.4 psi
Backwash TMP ³	≤ 0.5 bar	≤ 7 psi
Filtration Flux	Up to 50 L/(m²h)	Up to 29.5 gfd
Filtration Flow	Up to 0.75 m³/h	Up to 3.3 gpm
Backwash Flux	Up to 35 L/(m²h)	Up to 20.6 gfd
Backwash Flow	1.2 m³/h	5.3 gpm
Particle Size	2,000 µm (with primary sedimentation otherwise < 1,500 µm)	
Exposure NaOCl ⁴	≤ 1,000,000 ppm x h (at pH ≥ 6.5, 25 °C)	
Typical Maintenance Clean Concentration NaOCl ⁴	150 – 600 ppm @ 20 °C	50 – 600 ppm @ 68 °F
Typical Concentration NaOCl Recovery Clean ⁴	600 – 1,500 ppm @ 20 °C	600 – 1,500 ppm @ 68 °F

¹ Shipment/storage in a temperature controlled container (or reefer) at 20 °C / 68 °F recommended.) Modules must not be exposed to freezing conditions and must remain moist at all times.

² If pH is above 7.5 ensure the LSI < 0.5

³ Maximum available filtration TMP is based on a number of variables including atmospheric pressure, module submergence depth and filtrate pump NPSH requirement. The actual value may vary slightly from that shown.

⁴ The recommendation for maximum chlorine cleaning solution concentration is to account for an initial rapid consumption of chlorine at the start of an MC or CIP cleaning cycle. The targeted chlorine cleaning solution concentration is then typically 200 to 1000 ppm for the remainder of the cycle.

⁵ Please consult DuPont Water Solutions for additional guidance on exposure limits and for operation at different temperatures.

General Information

- Please refer to the latest version of the [DuPont™ MemPulse™ MBR Module Handling, Rack Assembly, Maintenance and Operation Manuals](#).*
- Unless expressly agreed within a project warranty, if operating limits and guidelines given in this document are not strictly followed, any warranty will be null and void.
- Please refer to the [Operating & Maintenance Manual](#) for controlling biological growth during extended system shutdowns, including the use of storage solutions.*
- Please consult DuPont Water Solutions for additional guidance on exposure limits and for operation at different conditions.

Regulatory Note

- Initial flushing of new modules followed by a cleaning cycle is recommended prior to use. Please refer to the technical bulletin [Guidelines for flushing new MemCor™ 'N' Modules](#) for further details.*
- Drinking water modules may be subjected to additional regulatory restrictions in some countries. Please check local regulatory guidelines and application status before use.

* Please contact your sales representative and request the latest version of the manual

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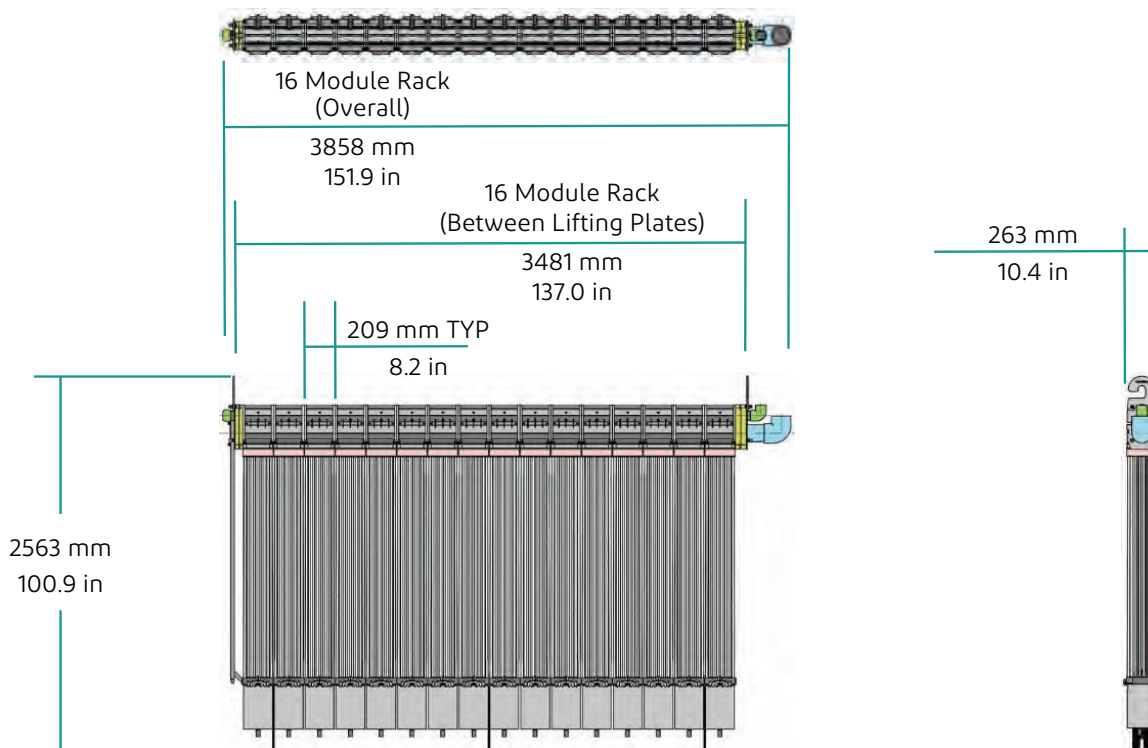


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Form No. 45-D03404-en, Rev. 11
September 2025

DuPont™ MemCor™ MBR SR Assembly – 5B40 to 16B40



Rack Specification

General	
Part Number / GMID	Length specific
Module Operating Process	MemCor™ memrbane bioreactor system with submerged MemPulse™ membrane bioreactor modules
Typical Applications	Wastewater Filtration
Membrane Type ¹	MemPulse™ B40N membrane bioreactor modules (refer to separate spec sheets)
Filtration Flow Direction	Outside to Inside
Backwash Type	Relaxation
Number of Membranes Modules Fitted (Standard Sizes)	from 5 to 16 x B40 Module positions (Typical 16 Module Rack Assembly illustrated)



Certified to
 NSF/ANSI/CAN 61

Rack Specification (cont.)

Dimensions		
Rack Manifold Process Connections (Refer to End connection Detail drawing for option details. Both Process connections are vertical upwards. Standard arrangement has both at one end. Option for Air and filtration connections at opposite ends.)	Aeration Air Inlet:	
	Standard	2" Plain Inch Socket
	Pipe Stub / Grooved Pipe	2" Plain Pipe, 2" Grooved Pipe
	Male Thread	2" BSP, 2" NPT
	Metric Pipe Socket	63 mm Plain Metric Socket
	Camlock	2" Male Camlock
	Filtrate Outlet:	
	Standard	4" Plain Inch Socket
Pipe Stub / Grooved Pipe	4" or 3" Plain Pipe, 3" Grooved Pipe	
Male Thread	4", 3" or 2" BSP	
Metric Pipe Socket	110 mm Plain Metric Socket	
Camlock	3" Male Camlock	
Aeration and Filtrate Termination Point Connection Hardware	Filtrate Outlet and Air Inlet hoses and couplings are not included but can be supplied as options to suit site requirements (length and connection types to be specified)	
Nominal Module Rack Width	263 mm	10.4 in
Nominal Module Rack Assembly Height	2,563 mm	100.9 in
Nominal Module Rack Assembly Lengths (between lifting plates)	(For racks with both connections at one end only, add 48 mm to overall lengths for connections at opposite ends of rack) Refer General Arrangement Drawings for additional details.	
Standard Sizes		
6 Modules	1,768 mm	69.6 in
8 Modules	2,186 mm	86.1 in
10 Modules	2,604 mm	102.5 in
12 Module Rack	3,022 mm	119.0 in
14 Module Rack	3,440 mm	135.4 in
16 Module Rack	3,858 mm	151.9 in
Weight & Volume		
Approximate Rack Assembly Mass	(Heavily soiled membranes can add up to ~15 kg per module)	
Standard Sizes		
6 Modules	190 kg	420 lbs
8 Modules	240 kg	530 lbs
10 Modules	300 kg	660 lbs
12 Module Rack	350 kg	770 lbs
14 Module Rack	410 kg	900 lbs
16 Module Rack	460 kg	1,010 lbs
Recommended Minimum Hoist Capacity	1,000 kg	2,200 lbs

Operating Specifications

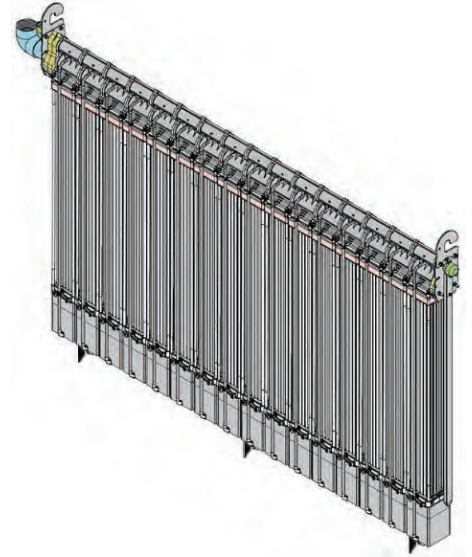
Parameter	Details
Typical Wetted Rack Assembly Components ²	SS316 plates and fasteners, Nylon/ABS/PVC/PP/POM mouldings, pipes & fittings, EPDM seals
Operating Temperature Range	1 - 40 °C / 34 - 104 °F
Temperature Range for Transportation & Storage ¹	Allowable range > 0 - 50 °C / >32 - 122 °F (Must not be exposed to freezing conditions)
Maximum Air Temperature at Air Termination Point	60 °C / 140 °F
Potable Water Certification ²	NSF/ANSI/CAN 61 Drinking Water System Components – Health Effects
Protection from ultraviolet (UV) radiation	Module racks should not be exposed to ultraviolet radiation (direct sunlight) during storage or operation

¹ When Membrane Filtration Modules are fitted to the Rack Set, the transport, storage and operating limits of the membranes determine allowable limits of exposure. Please refer to the relevant Module specification sheet for further details.

² NSF refers to NSF International formerly known as the National Sanitation Foundation.
ANSI is a trademark of the American National Standards Institute.

³ Some alternative materials of construction may be recommended for sea water or other high TDS applications.

⁴ Initial flushing of new modules followed by a cleaning cycle is recommended prior to use. Please refer to Memcor technical bulletin "Guidelines for flushing new MEMCOR® 'N' Series Modules" for further details



General Information

- Avoid any abrupt pressure variations during start-up, operation, shutdown, cleaning or other sequences to prevent possible membrane damage.
- Please refer to the latest version of the [DuPont™ MemCor™ L40 Module Handling, CPlI Rack Assembly, CPlI Maintenance and Operation Manuals](#).*
- Unless expressly agreed within a project warranty, if operating limits and guidelines given in this document are not strictly followed, any warranty will be null and void.
- Please refer to the [Operating & Maintenance Manual](#) for controlling biological growth during extended system shutdowns, including the use of storage solutions.*
- Please consult DuPont Water Solutions for additional guidance on exposure limits and for operation at different conditions.

Regulatory Note

- Certified drinking water modules require specific conditioning procedures prior to producing potable water.
- Initial flushing of new modules followed by a cleaning cycle is recommended prior to use. Please refer to the technical bulletin [Guidelines for flushing new MemCor™ 'N' Modules](#) for further details.*
- Drinking water modules may be subjected to additional regulatory restrictions in some countries. Please check local regulatory guidelines and application status before use.

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March 2026

MEMCOR® MBR

DuPont Water Solutions

PROCESS DESCRIPTION

Document	MAS00trp03_09_MBR_Mempulse.docx
Issue	9
Issue Date	21 April 2020

MEMCOR® MEMBRANE BIOREACTOR (MBR) FILTRATION SYSTEMS



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Introduction

DuPont Water Solutions has unrivalled experience in the research and development of membrane filtration products and membrane manufacturing processes. It continues to produce leading edge technology membrane filtration systems that are used around the world for a wide range of industrial and municipal filtration applications.

The MEMCOR® MBR Membrane Operating System (MOS) is an advanced wastewater treatment technology using low pressure membranes to extract liquid from a suspended growth activated sludge system.

The Memcor Membrane Bioreactor (MBR) process replaces the secondary clarifiers typically used in conventional waste treatment methods for solid/liquid separation. Unlike secondary clarifiers, however, the treated water quality is not dependent on the mixed liquor suspended solids concentration or the settling characteristics of those solids. In fact, Memcor MBR systems can operate at much higher mixed liquor suspended solids (MLSS) concentrations than conventional activated sludge systems.

MBR systems combine a biological process and a low pressure membrane filtration process, so expert knowledge in both areas is essential. The development of Memcor MBR technology has combined the skills of both membrane and biological treatment specialists, part of the global expertise available from DuPont Water Solutions. The result – the unique MemPulse® MBR system.

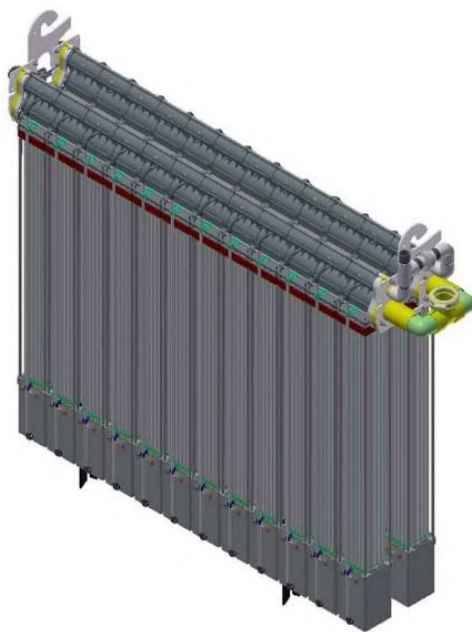
The membranes and process developed for Memcor MBR systems are founded on our unrivalled experience in membranes for water and wastewater treatment.

Memcor Submerged Membrane Filtration processes leverage more than 30 years of proven low pressure membrane filtration product know-how. Over this time, Memcor membrane systems have achieved increased product scale and improved operating economies and have proven ideal for use in Membrane Bioreactor systems.

The Memcor MBR system provides high quality, highly efficient and reliable waste water processing with a small plant footprint and economic operation.

A Membrane Operating System (MOS) typically incorporates one or more Membrane Filtration Cells located adjacent to the biological treatment system. The use of a separate tank for the Membrane Filtration Modules, adjacent to the biological reactor provides a number of benefits, including:

- A controlled membrane environment;
- Positive fluid transfer of Mixed Liquor through the Membrane Filtration Modules and uniform distribution of flow and of solids (Mixed Liquor Suspended Solids or MLSS);
- Flexibility in biological process selection;
- Independent optimisation of biological and membrane processes;
- A small footprint;
- A Clean-In-Place system that allows chemical cleaning without membrane removal, providing safer operation and reduced downtime;
- Separation of biological processes from chemical cleaning systems.



Typical MOS Components

The biological section of an MBR plant typically includes:

- Primary waste water treatment, including fine screening and grit removal;
- A biological treatment system, often including anaerobic, anoxic and aerobic zones;
- Flow balancing.

Following the biological process, the Membrane Operating System (MOS) typically includes:

- A Mixed Liquor recirculation system which recirculates Mixed Liquor from the biological treatment system through the MOS. The recirculation system can be configured to be pump feed/gravity return or gravity feed/pump return;
- One or more Memcor Membrane Filtration Cells. Each Cell is a rectangular tank in which several Racks are fitted. Each Rack holds a number of MEMCOR® MBR Hollow Fibre Membrane Filtration Modules and has manifolds to collect filtrate and distribute low pressure air. Cells may be covered for odour control;
- An aeration system which continuously supplies low pressure air to the Filtration Modules in each Cell;
- A Filtrate Pump, which draws filtered liquid from the Membrane Filtration Modules in the Cell;
- Valves, instrumentation and controls, including a programmable automation controller (PLC/PAC) and human machine interface (HMI);
- Ancillary equipment, such as a compressed air system and chemical storage/delivery system, to provide operating and cleaning resources;
- Downstream storage and processing systems (such as disinfection or Reverse Osmosis);
- Maintenance components, such as a Rack Removal System and special tools.

MEMCOR® MBR Membrane Filtration Modules

The critical components of the Membrane Operating System are the Membrane Filtration Modules. MEMCOR® MBR Modules have the following membrane characteristics:

- Chlorine tolerant PVDF;
- Hollow fibre configuration;
- Pore size in the ultrafiltration (UF) range;
- Homogeneous asymmetric structure.

Each Memcor MBR Membrane Filtration Module contains thousands of fibres which are partitioned or “layered”, into thin fibre bundles. Fibres are sealed with polyurethane “pots” at each end of the Module and supported in a frame. The upper pot allows filtered water to pass from the hollow inner core, or lumen, of all the membrane fibres into the filtrate manifold. The lower pot seals the ends of all the fibres but allows the two-phase Mixed Liquor and low pressure process air to pass from the Air Sub-Manifold through a series of openings to the outside surfaces of the membranes within the fibre bundle.

The Membrane Filtration Modules are assembled on a Rack that manifolds the process connections and supports the Modules. O-Rings create watertight seals between the different wetted components. Tie rods hold the Rack components together.

Each Membrane Filtration Module is a serviceable filter element that may be removed from the Rack for repair or replacement.

Figure 1

Left: A MEMCOR® B40N MBR Membrane Filtration Module.

Right Upper: Close-up of an MBR Rack Assembly showing Air Droppers connected to the Aeration Air Manifold on each Head Piece.

Right Lower: Close-up of Air Droppers connected to the MemPulse® aeration devices fitted to the bottom of each Module on the MBR Rack Assembly.



Figure 2 A typical MBR Rack Assembly fitted with sixteen MEMCOR® B40N Membrane Filtration Modules. It is mounted on a Rack Maintenance Stand and has a Rack Spreader Bar (Lifting Beam) attached to the Lifting Plates at each end.

The MemPulse® System

During operation, Mixed Liquor is fed from the biological treatment process to the cell. The Mixed Liquor, or Sludge, is distributed throughout the cell, flowing upwards through the membrane modules before overflowing out of the cell and back to the biological treatment system.

At the base of each Memcor module is a patented MemPulse® device. MemPulse® technology uses a simple arrangement with no moving parts to achieve a significant reduction in energy consumption and lower maintenance costs. It does this by converting continuous airflow into irregular pulses of air at the base of each membrane module. Coarse bubble air scouring of the membrane fibres is thus achieved intermittently through the accumulation of air which is then released in a random plug flow, producing highly efficient “Two-Phase Flow”. This upward plug flow generates an “airlift effect” causing two-phase (air-liquid) fluid to flow upwards through the Membrane Filtration Modules. The cross-flow dynamics created in the fibre bundles scour the membrane surfaces to prevent accumulation and dehydration of solids.

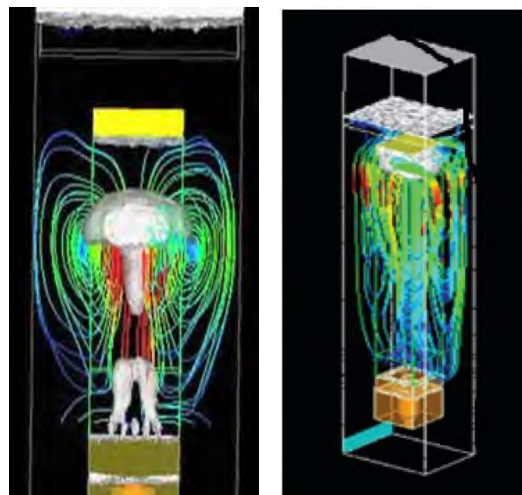


Figure 3 This computer model shows the dynamic “Airlift Effect” of the “Plug Flow” of air generated by the MemPulse® Aeration Device.

This dynamic plug flow maximises efficiency because:

- The moving bubbles generate secondary flows behind the initial bubble that assist in breaking up the filter cake layer and promoting local mixing near membrane surfaces;
- The film around the outside of the bubble acts as a high shear region which promotes the movement of solids away from membrane surfaces;
- The moving slugs of air result in pressure pulses in the liquid around them producing agitation which scours the membrane surfaces.

At the same time, the Filtrate Pump draws filtrate from inside each membrane fibre and discharges this liquid to the next treatment process step. Virtually all solids are rejected at the membrane surface and retained in the Mixed Liquor which returns to the biological process system. Mixed Liquor is recirculated typically at between three to five times the filtrate flowrate.

The MemPulse® system is designed to minimise polarisation (concentration) of suspended solids around the membrane fibre bundles. With this system mixed liquor is pumped directly into each Membrane Module distributing mixed liquor evenly so that every Module sees the same process conditions.

Typical solids concentration, air and water velocity profiles for Memcor systems are shown in the figures below. Without the MemPulse® system, Membrane Modules at the far end of the Cell would see increased solids concentrations, causing uneven fouling of these membranes.

Additionally, Memcor systems provide an integrated cleaning solution combining efficient scouring of the membranes with chemical cleaning. The integrated cleaning system allows the Membrane Modules to be automatically cleaned in place at appropriate intervals. The Clean-In-Place procedure eliminates the need for membrane removal from the Cell, improving plant operator safety and reducing the risk of damage to membranes and other system components.

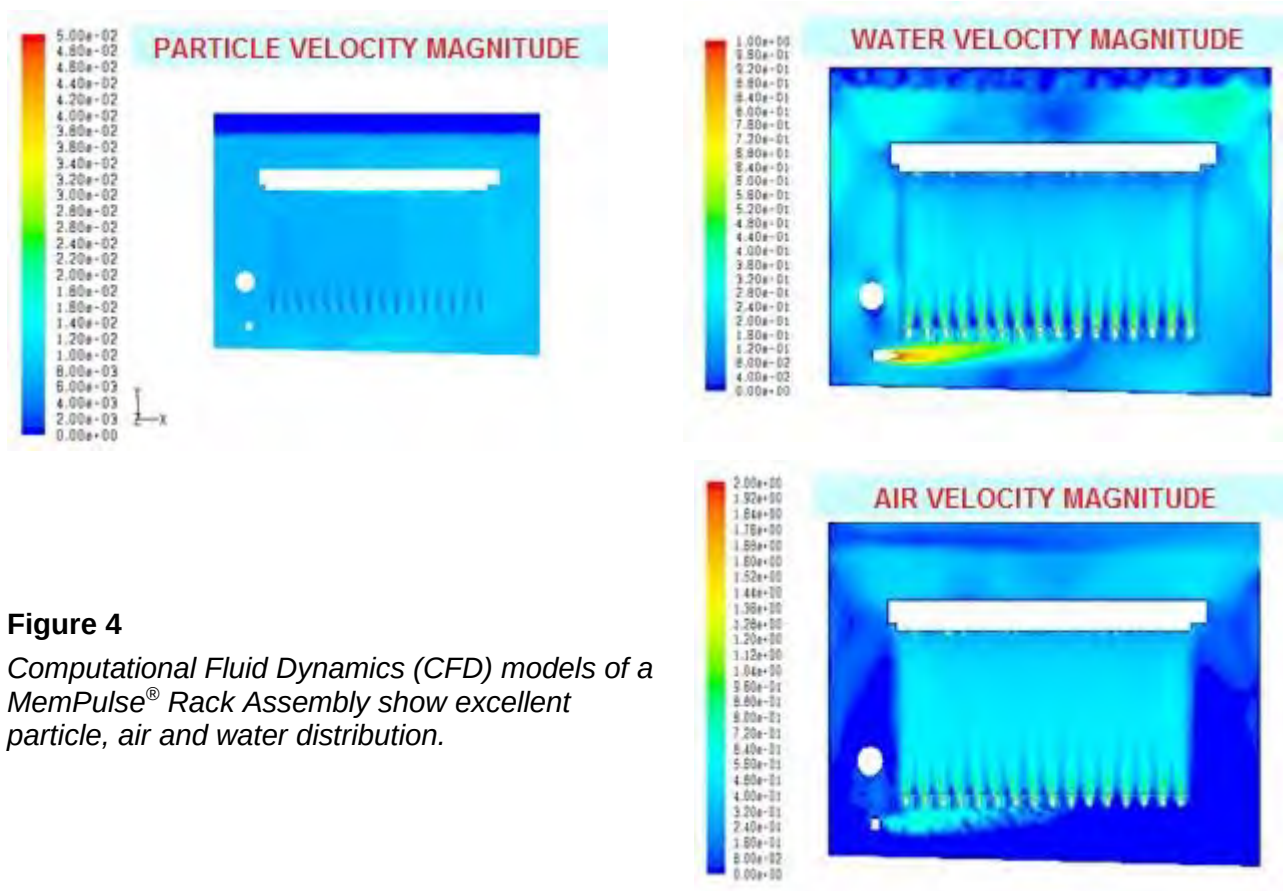


Figure 4

Computational Fluid Dynamics (CFD) models of a MemPulse® Rack Assembly show excellent particle, air and water distribution.

Maintaining Membrane Performance

During membrane filtration, filtered solids tend to form a compressible filter-cake on the membrane surface. The filter cake forms its own filter layer and so adds to the filtration performance of the system. But at the same time it increases the head loss or pressure drop across the membrane, commonly referred to as the Trans-membrane Pressure (TMP). This filter cake must be controlled to maintain a reasonable pressure drop or TMP across the membranes during filtration.

The minimisation of this fouling layer or filter cake is regulated by three processes, namely:

- Relaxation;
- Maintenance Wash (MW), and;
- Clean-In-Place (CIP).

Filtration rates are principally maintained by Relaxation. However, a small residual of foulants remains on the membrane surfaces and accumulates over time. This is reflected by a slow increase in membrane resistance to flow. To remove these foulants, occasional chemical cleaning is carried out, either with a Maintenance Wash (MW) cycle or with a Clean-in-Place (CIP) cycle.

These three processes are described in more detail in the following sections.

1. Relaxation

Relaxation takes place when filtration through the membrane is stopped. This reduces the TMP to zero, allowing the filter cake to relax and expand. This improves the efficiency of the MemPulse® two-phase scrubbing action, which scours the filter cake back into the bulk solids solution. This

process prevents the filter cake thickening to such an extent that filtration performance is significantly affected.

Backwash vs Relaxation

The standard operating regime for Memcor MBR Systems is to use Relaxation only. Considerable operating experience has shown that there is no significant increase in membrane performance when operating with a more complex backwash sequence as compared to a simple Relaxation step.

Therefore, Memcor MBR Systems do not require a backwash as part of the standard operating regime. However, for operational flexibility, provision can be made in the Membrane Operating System design for a backwash cycle to be used if required.

The Relaxation Cycle

Typically, the Relaxation cycle operates as follows:

- Frequency: Every 10 to 12 minutes of filtration;
- Duration: Filtration is stopped for 60 seconds.

2. Maintenance Wash (MW)

Typical MBR operation includes a Maintenance Wash (sometimes referred to as a Chemical Backwash (CBW) or as a Maintenance Clean) every 1 to 2 weeks of operation. A Maintenance Wash is usually performed automatically after a pre-set total time in filtration.

During a Maintenance Wash, chlorinated filtrate is passed in the reverse direction through the Membrane Filtration Modules to inhibit biological growth and reduce fouling on the membranes and in filtrate pipework. During this process, membrane aeration continues, the Cell remains full of Mixed Liquor, and Mixed Liquor recirculation usually continues, but may be turned off if appropriate. The whole cycle typically lasts for about 30 minutes after which the Cell can be returned to service.

A Maintenance Wash typically uses the following sequence and takes around 60 minutes:

- Stop filtration;
- Reverse flow backwash of clean water dosed with chlorine (typically sodium hypochlorite) normally at a concentration of about 200 mg/L (ppm) – typically around 5 minutes;
- Relaxation for around 15 minutes;
- Repeat previous reverse flow backwash with chlorine solution and Relaxation steps;
- Prime filtrate manifolds and Filtrate Pump with filtrate if necessary;
- If filtrate recirculation is available, resume Mixed Liquor recirculation with aeration and recirculate filtrate for about 10 to 15 minutes. Returning filtrate to the Cell, that is, to the Mixed Liquor recirculation system neutralises any remaining cleaning solution. Rinse effectiveness can be determined by measuring the pH of the filtrate;
- Return Cell to normal operation.

During a Maintenance Wash the membranes remain fully submerged in Mixed Liquor. No neutralisation is required as the small amount of chlorine used in the MW is consumed by the Mixed Liquor.

3. Clean-in-Place (CIP)

The Memcor MBR process is designed so that a CIP cycle is usually only required once every 3 to 6 months of operation. During the CIP cycle the Membrane Modules are fully submerged in the

cleaning solution. This process is performed in the Cell, providing operational simplicity by eliminating the need to remove membranes to a separate location for cleaning.

In a CIP cycle, the Mixed Liquor is drained from the Cell and the Cell is flushed with filtrate before being filled again with dilute cleaning solution made up with membrane filtrate.

For biological systems using coagulant for phosphorus removal, both acid and chlorine cleaning solutions are typically used. In these systems, the Acid CIP cycle typically uses a blend of Citric Acid (0.5 %). The Chlorine CIP cleaning solution is usually made up to achieve a recirculation concentration of around 1,000 mg/L of free chlorine.

For MEMCOR® MBR systems, the Chlorine CIP cycle Soak step time has a recommended minimum of 3 hours. For colder climates with water temperatures below 20 °C (68 °F), the soaking time should be extended where possible to improve cleaning efficiency, based on the following equation:

$$\text{Soak Time (hours)} = -0.2 \times \text{Water Temperature (°C)} + 7$$

For example: If the cleaning solution temperature on the day of the Chlorine CIP cleaning cycle is 5 °C (41 °F) then the soak time should be extended to $(-0.2 \times 5) + 7 = 4.5$ hours

A CIP cycle will usually be initiated when:

- the filtration TMP reaches a pre-set maximum value;
- the total filtration time reaches a pre-set value, or;
- an operator starts the CIP cycle manually, for example, if Cell maintenance is required.

Usually only one Cell in a system is cleaned at a time with the others remaining in service.

Although some variations may be necessary due to different process designs, a typical CIP cycle generally uses the following sequence and takes around 3 hours. :

1. Stop filtration but continue aeration;
2. Drain Mixed Liquor from the Cell. Stop aeration when the Cell reaches a low level;
3. Use filtrate from the Filtrate Storage Tank to Flush the Cell floor to help remove solids;
4. Fill the Cell with filtrate from the Filtrate Storage Tank to CIP level. This typically takes about 20 minutes. Commence aeration when the Cell level permits;
5. Continue aeration for another 30 minutes. If filtrate recirculation is possible, recirculate filtrate with the Filtrate Pump during this time;
6. Drain the Cell and Modules again;
7. Prime the filtrate lines and Modules with service water (as used for cleaning solution makeup);
8. Reverse flow backwash of service water dosed with CIP concentrate [either acid or chlorine] at the specified concentration to displace filtrate with cleaning solution. This typically takes around one minute each time;
9. Continue with reverse flow chemical backwash for a further 15 to 30 seconds;
10. Soak for 4 to 5 minutes;
11. Repeat previous reverse flow backwash with cleaning solution and soak steps until the Cell level reaches around one eighth full (~10 to 15 %). This typically takes about 8 to 10 repeats.

12. Fill the Cell with service water (or filtrate) to the CIP level. Recirculate filtrate if possible and add more concentrate if necessary. Recirculate for a total time of about 20 minutes (including dosing time) to ensure even mixing;
13. Soak for 3 - 5 hours (depending on water temperature or other requirements). For Acid CIP, use intermittent aeration – typically for the first 30 seconds of every 30 minutes. As odour can be strong, Chlorine CIP usually does not use aeration;
14. Drain used cleaning solution from Cell, Modules and Filtrate pipework to the CIP Waste Disposal or Neutralisation system;
15. For a single CIP cleaning cycle or the final clean of a Dual CIP cycle, proceed to the next step. If this step is at completion of the first CIP cleaning cycle of a Dual CIP (typically Acid followed by Chlorine), then return to Step 7 to prime the filtrate lines and Modules with service water (as used for cleaning solution makeup) prior to the second CIP cycle;
16. On completion of the single CIP or final Dual CIP solution drain, reverse flush filtrate pipework and Modules with filtered water for about 5 minutes;
17. Fill the Cell with Mixed Liquor then continue ML recirculation. Commence aeration when the Cell level permits;
18. When Cell is filled with Mixed Liquor, prime the filtrate manifolds and Filtrate Pump with filtrate if necessary;
19. If filtrate recirculation is available, continue Mixed Liquor recirculation with aeration and recirculate filtrate for about 10 to 15 minutes. Returning filtrate to the Cell, that is, to the Mixed Liquor recirculation system neutralises any remaining cleaning solution. Rinse effectiveness can be determined by measuring the pH of the filtrate;
20. Return Cell to normal operation.

Some Advantages of Memcor MBR Systems

The MEMCOR® MBR Membrane Operating System offers important advantages over competitive systems:

Efficient Membrane Scouring	Two Phase flow created by the MemPulse® device under each Module. Plug flow of membrane scour air provides more vigorous and efficient cleaning. Elastic fibres that move freely with minimal aeration.
Simplicity	Unique MemPulse® cleaning action has no moving parts or valves.
Reduced Process Complexity	Larger bubble size created by MemPulse® aeration system does not significantly increase Dissolved Oxygen (typically only 1 – 2 mg/L).
Highly Efficient Mixed Liquor distribution	Memcor systems are designed to ensure even distribution of Mixed Liquor to each Membrane Module. The MemPulse® device under each Module in the Cell directs Mixed Liquor evenly into each Module, ensuring that all Modules see the same process conditions. Memcor systems ensure even solids concentration profiles across the filter Cell. Other systems have uneven distribution with some membranes seeing very high sludge concentrations resulting in uneven performance and fouling of membranes.

Ease of Maintenance	MEMCOR® Membrane Filtration Modules are easily handled. Modules are self-supporting and light weight (a B40N Module weighs less than 20 kg). Competitive membrane systems don't have these characteristics and are often difficult to handle, increasing the risk of injury to personnel and of damage to membranes during maintenance.
Ease of Repair	MEMCOR® Membrane Filtration Modules are easily repaired with a reliable pin repair process. Fibre damage is easily located and can be mechanically repaired in just a few minutes – with the positive effect of the repair immediately evident. Competitive membrane systems can be difficult to repair for two reasons: • Locating the damaged area of the membrane can be very difficult (especially in flat sheet systems); • Repairs typically involve the use of adhesives which are both time consuming and sometimes unsuccessful.
Homogeneous Membrane Structure	MEMCOR® MBR membranes are manufactured from a homogeneous material. The membrane material is the same from the inside to the outside surfaces of the fibre. Many competitor membranes rely on a composite structure that uses a very thin layer of membrane glued or cast onto a coarse support structure for strength. The weakness of this approach is in the bond between the membrane and the support. Delamination (the process of the thin membrane surface peeling from the support structure) is a significant problem for some suppliers.
Durability	MEMCOR® MBR hollow fibre membrane tensile elongation is typically greater than 200 %.
Continuous Quality	High quality filtrate is provided by the Memcor membrane system, an advantage particularly for reuse applications. There is a much lower bypass risk because fibre inside diameter is smaller than many competitor membranes.
In-situ Membrane cleaning	MEMCOR® Membrane Operating Systems are designed for automatic membrane cleaning in the filter Cell. There is no need for membranes to be removed from the Cell for cleaning. Some competitive systems, particularly those with membranes located in the activated sludge bioreactor, have limited <i>in situ</i> cleaning efficiency and require removal for efficient cleaning.

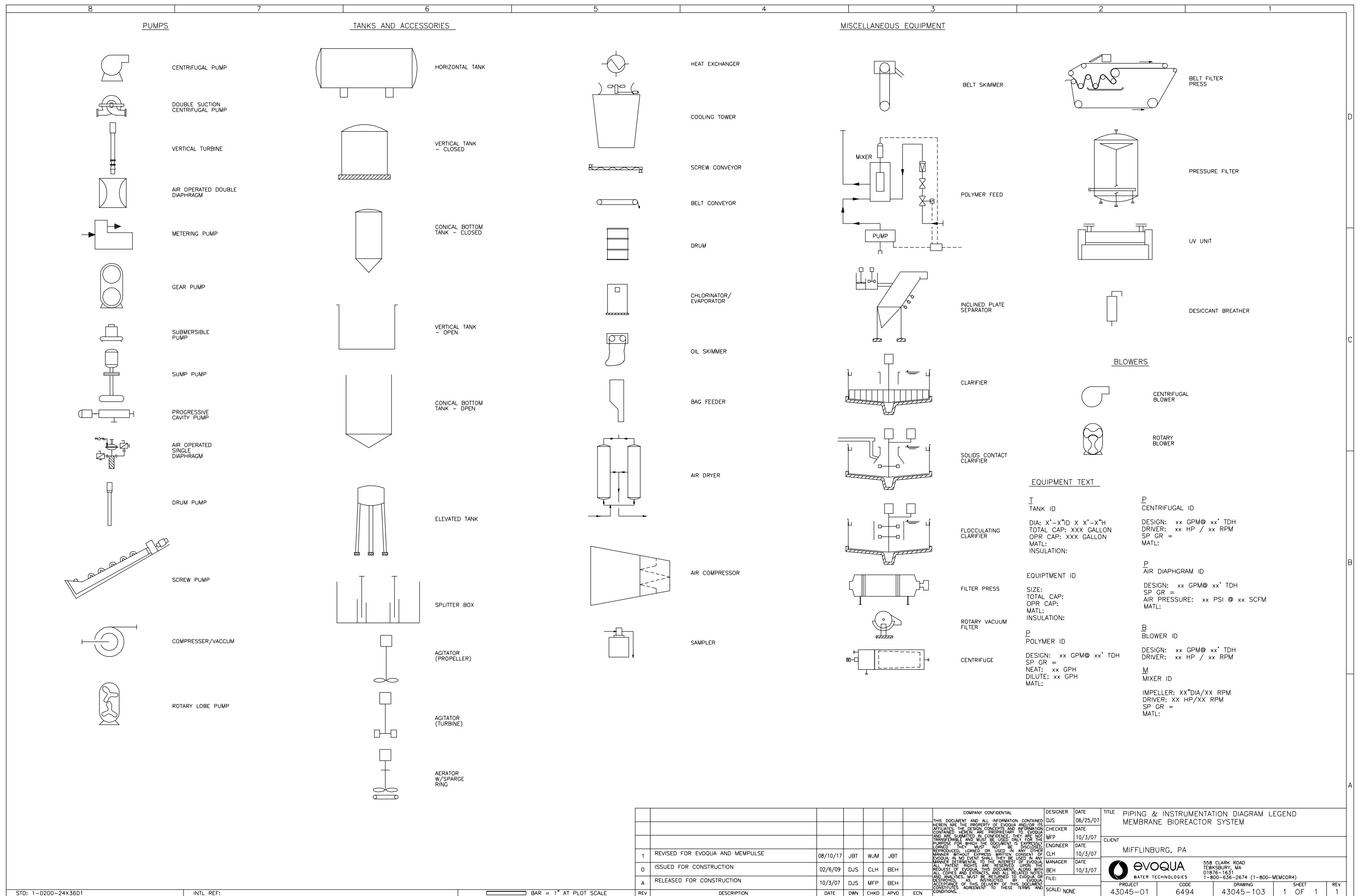
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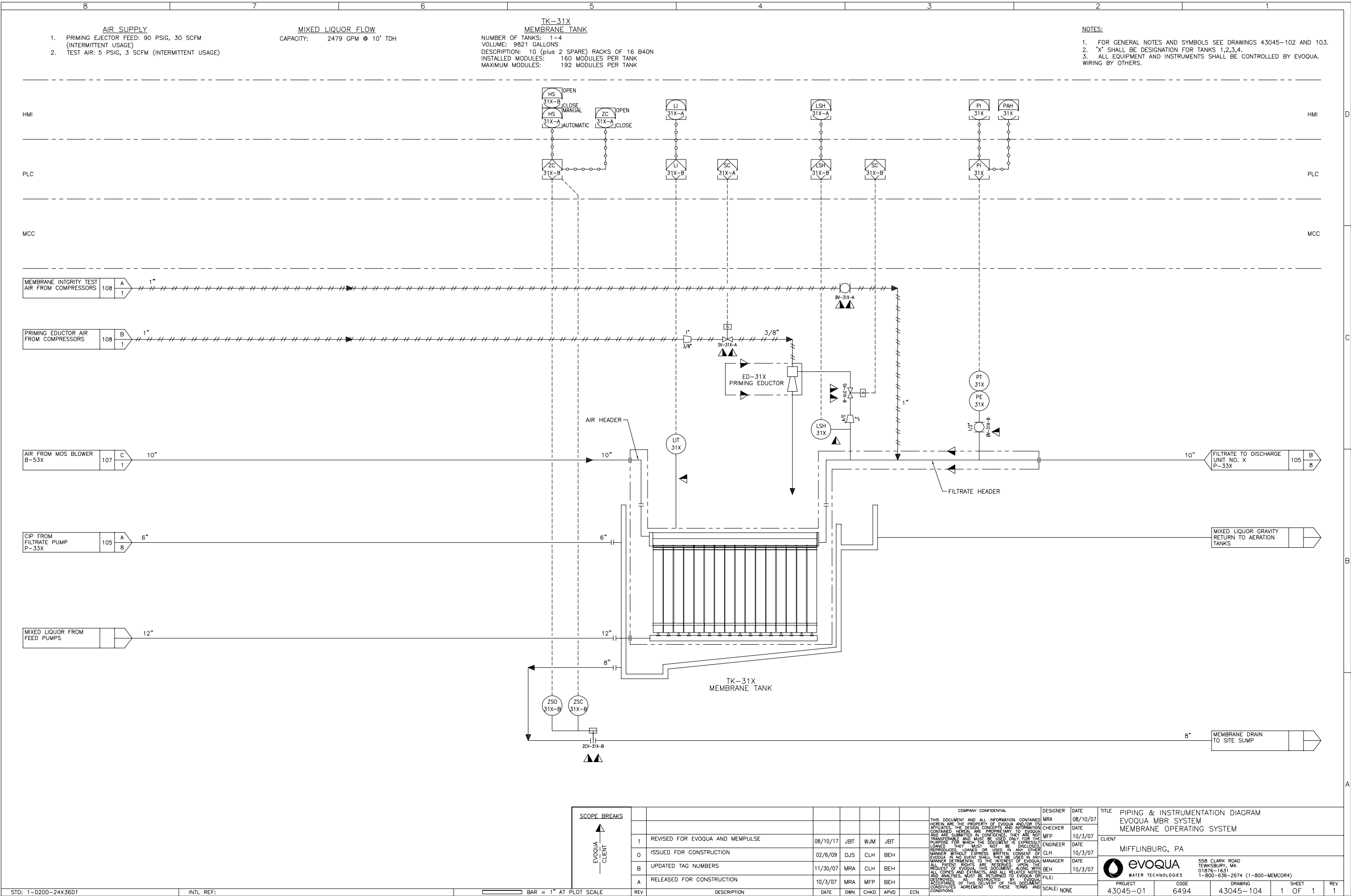
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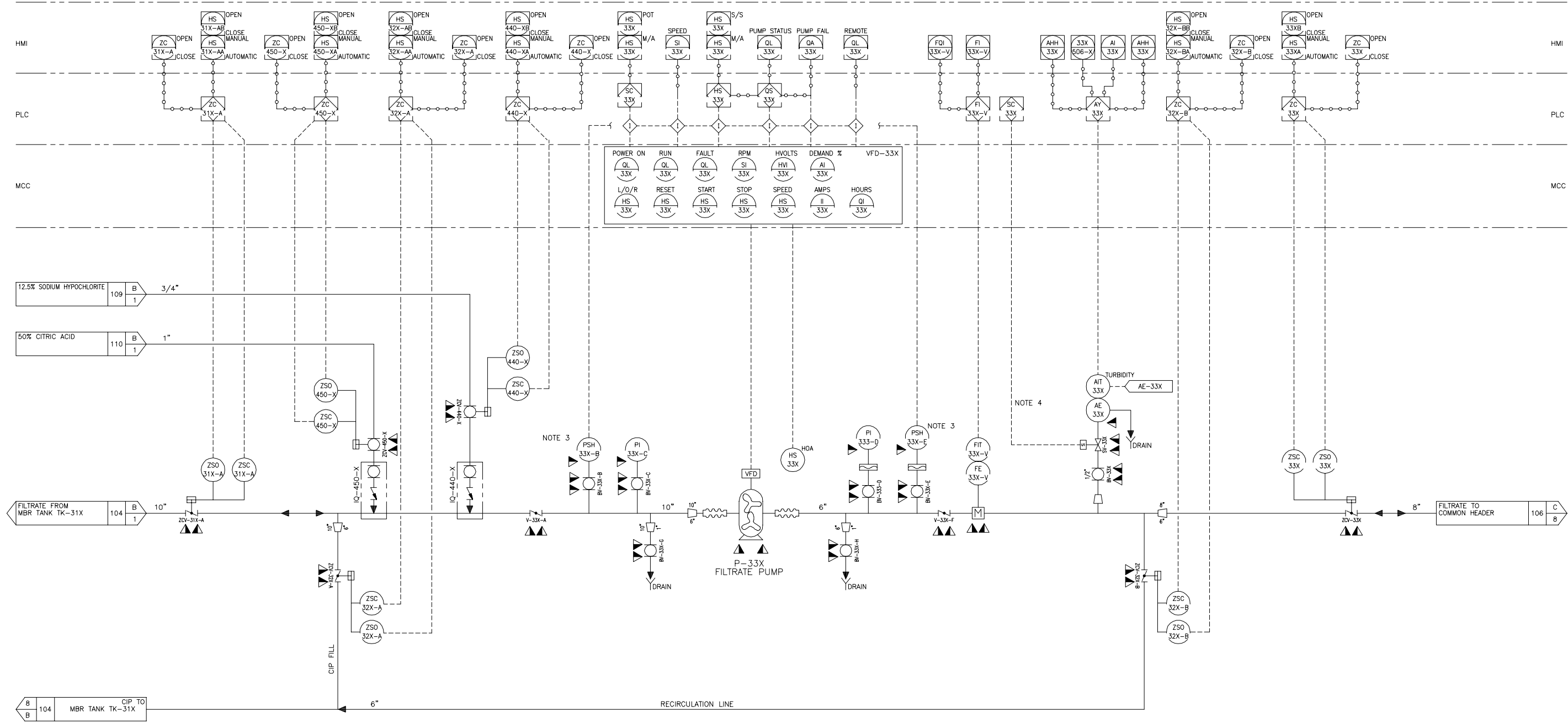
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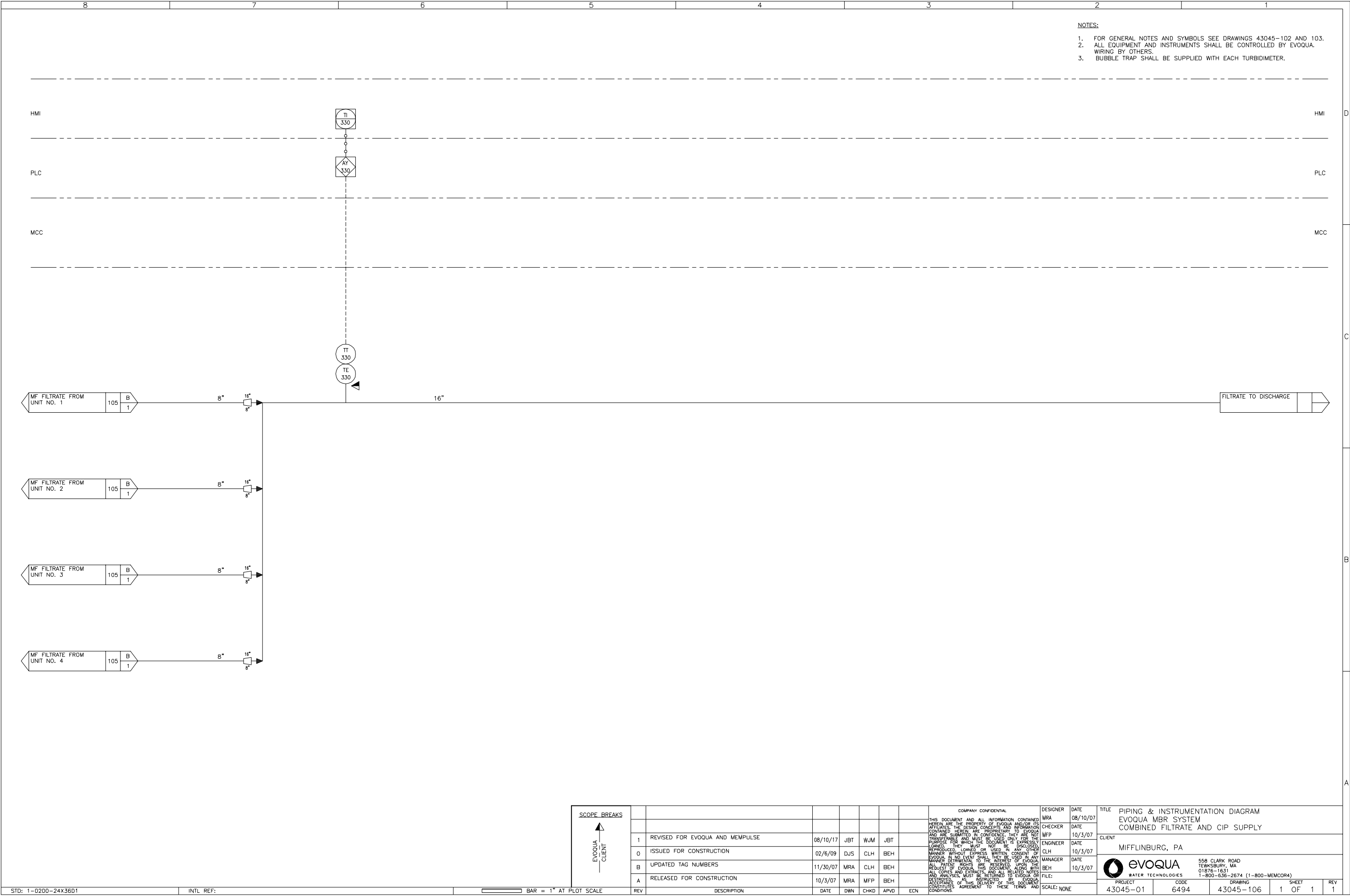


- NOTES:
1. FOR GENERAL NOTES AND SYMBOLS SEE DRAWINGS 43045-102 AND 103.
 2. ALL EQUIPMENT AND INSTRUMENTS SHALL BE CONTROLLED BY EVOQUA. WIRING BY OTHERS.
 3. SHUT DOWN MF FILTRATE PUMP ON HIGH PRESSURE.
 4. BUBBLE TRAP SHALL BE SUPPLIED WITH EACH TURBIDIMETER. ONE ANALYSER PER TWO TURBIDIMETERS.
 5. 'X' SHALL DESIGNATE TANKS 1-4.



P-33X
FILTRATE PUMP
TYPE: POSITIVE DISPLACEMENT (ROTARY LOBE)
DESIGN: 533 GPM @ 50'
MAX: 833 GPM @ 66'
MAINTENANCE CLEAN AND CIP FLOW: 480 GPM
DRIVER: VFD

SCOPE BREAKS							COMPANY CONFIDENTIAL					DESIGNER		DATE		TITLE							
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	1	REVISED FOR EVOQUA AND MEMPUSE					08/10/17					JBT	WJM	JBT	CHECKER	DATE	CLIENT	MIFFLINBURG, PA					
	0	ISSUED FOR CONSTRUCTION					02/6/09					DJS	CLH	BEH	MFP	10/3/07							
	B	UPDATED TAG NUMBERS					11/30/07					MRA	CLH	BEH	ENGINEER	DATE							
	A	RELEASED FOR CONSTRUCTION					10/3/07					MRA	MFP	BEH	CLH	10/3/07							
PLOT SCALE		REV	DESCRIPTION		DATE	DWN	CHKD	APVD	FCN	MANAGER		DATE	SCALE: NONE		PROJECT		CODE	DRAWING	SHEET	REV			
										BEH		10/3/07			4304S-01		6494	4304S-105	1	QF	1	1	
												FILE:											
												SCALE: NONE											



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DESIGNER
MRA

DATE
08/10/07

CHECKER
MFP

DATE
10/3/07

ENGINEER
CLH

DATE
10/3/07

MANAGER
BEH

DATE
10/3/07

FILE:

SCALE: NONE

1

REVISED FOR EVOQUA AND MEMPULSE

08/10/17

JBT

WJM

JBT

0

ISSUED FOR CONSTRUCTION

02/6/09

DJS

CLH

BEH

B

UPDATED TAG NUMBERS

11/30/07

MRA

CLH

BEH

A

RELEASED FOR CONSTRUCTION

10/3/07

MRA

MFP

BEH

REV

DESCRIPTION

DATE

DWN

CHKD

APVD

ECN

STD: 1-0200-24X36D1

INTL REF:

BAR = 1" AT PLOT SCALE

PROJECT
43045-01

CODE
6494

DRAWING
43045-106

SHEET
1 OF 1

REV
1

CLIENT

MIFFLINBURG, PA

PROJECT

43045-01

CODE

6494

DRAWING

43045-106

SHEET

1 OF 1

REV

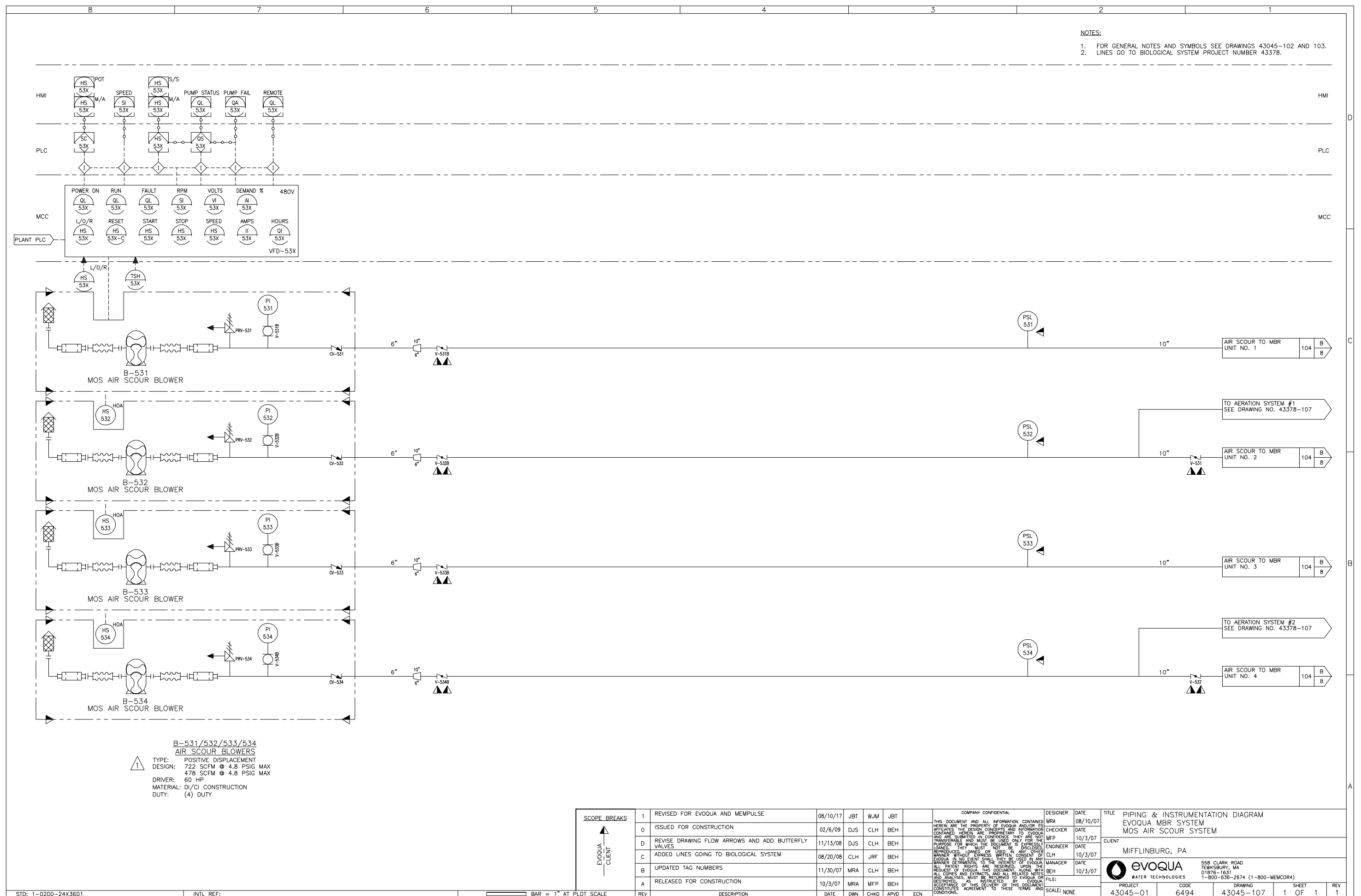
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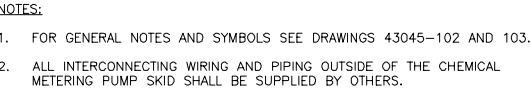
558 CLARK ROAD
TEWASBURY, MA
01876-1631
1-800-636-2674 (1-800-MEMCOR4)

PIPING & INSTRUMENTATION DIAGRAM

EVOQUA MBR SYSTEM

COMBINED FILTRATE AND CIP SUPPLY



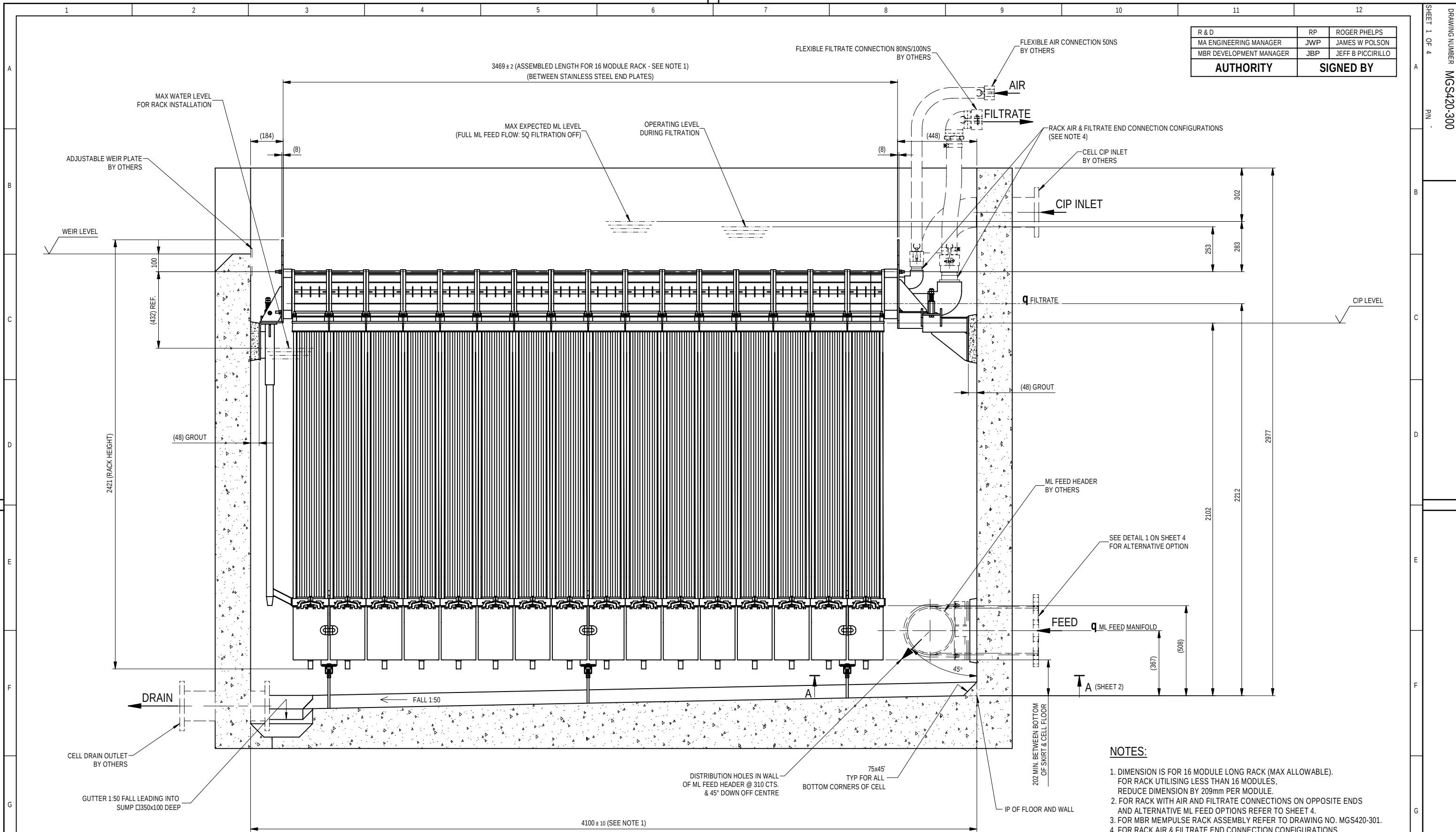


P-451
CITRIC ACID PUMP

TYPE: PERISTALTIC HOSE PUMP
DESIGN: 919 GPH @ 15PSI
CAPACITY: 1068 GPH @ 15PSI

SCOPE BREAKS		COMPANY CONFIDENTIAL						DESIGNER	DATE	TITLE		
EVOQUA CLIENT	1	REVISED FOR EVOQUA AND MEMPLUSE	08/10/17	JBT	WJM	JBT	THIS DOCUMENT AND ALL INFORMATION CONTAINED HEREIN ARE THE PROPERTY OF EVOQUA AND/OR ITS AFFILIATES. THE DESIGN CONCEPTS AND INFORMATION CONTAINED HEREIN ARE PROPRIETARY TO EVOQUA AND ARE SUBMITTED IN CONFIDENCE. THIS DOCUMENT IS NOT TRANSFERABLE AND MUST BE USED ONLY FOR THE PURPOSES FOR WHICH THE DOCUMENT IS EXPRESSED. REPRODUCED, LOANED OR USED IN ANY OTHER MANNER WITHOUT EXPRESS WRITTEN CONSENT OF EVOQUA. IN NO EVENT SHALL THE USER BE HELD RESPONSIBLE FOR ANY DAMAGES, INCLUDING BUT NOT LIMITED TO, THE REQUEST OF EVOQUA THIS DOCUMENT, ALONG WITH ALL CORRESPONDENCE AND EXTRACTS, AND ALL RELATED INFORMATION, ANALYSES, MUST BE RETURNED TO EVOQUA OR DESTROYED AS DIRECTED BY EVOQUA. ACCEPTANCE OF THIS DELIVERY OF THIS DOCUMENT CONSTITUTES AGREEMENT TO THESE TERMS AND CONDITIONS.	MRA	08/10/17	PIPING & INSTRUMENTATION DIAGRAM LEGEND EVOQUA MBR SYSTEM CHEMICAL METERING SYSTEM—CITRIC ACID		
	0	ISSUED FOR CONSTRUCTION	02/06/09	DJS	CLH	BEH		CHECKER	DATE	CLIENT		
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								CLH	10/3/07	MIFFLINBURG, PA		
								MANAGER	DATE	 evoqua WATER TECHNOLOGIES 558 CLARK ROAD NEWARK, NJ 07102 908-1876-1631 1-800-636-2674 (1-800-MEMOCOR4)		
								FILE	10/3/07			
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PLOT SCALE	REV	DESCRIPTION	DATE	OWN	CHKD	APVD	ECN	PROJECT	CODE	DRAWING	SHEET	REV
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R & D	RP	ROGER PHELPS
MA ENGINEERING MANAGER	JWP	JAMES W POLSON
MBR DEVELOPMENT MANAGER	JBP	JEFF B PICCIRILLO
AUTHORITY	SIGNED BY	

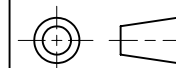


- ## NOTES:
1. DIMENSION IS FOR 16 MODULE LONG RACK (MAX ALLOWABLE).
FOR RACK UTILISING LESS THAN 16 MODULES,
REDUCE DIMENSION BY 209mm PER MODULE.
 2. FOR RACK WITH AIR AND FILTRATE CONNECTIONS ON OPPOSITE ENDS
AND ALTERNATIVE ML FEED OPTIONS REFER TO SHEET 4.
 3. FOR MBR MEMPULE RACK ASSEMBLY REFER TO DRAWING NO. MGS420-301
 4. FOR RACK AIR & FILTRATE END CONNECTION CONFIGURATIONS
REFER TO DRAWING NO. MGS410-302.
 5. THE CELL ARRANGEMENT OF ML FEED, CIP INLET & CELL DRAIN BY OTHERS
ARE FOR REFERENCE ONLY.

CELL CROSS SECTION
(RACK WITH AIR & FILTRATE CONNECTION AT SAME END)

[illegible]

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
DO NOT SCALE
IF IN DOUBT ASK



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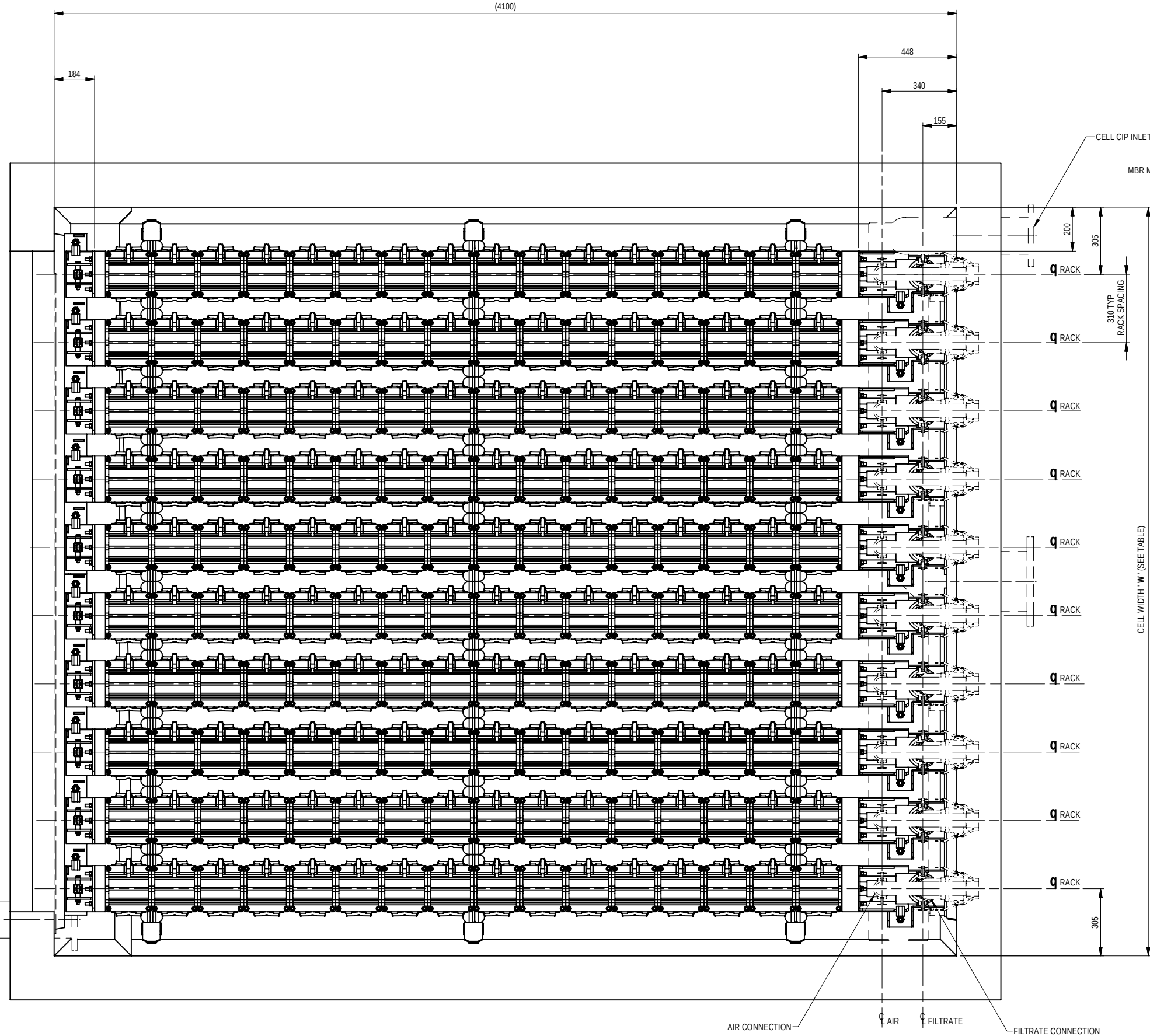
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DRAWN	DATE
MB	24/10/2008
CHECKED	DATE
JWP	09/04/2009
APPROVED	DATE
FZ	09/04/2009
TOLERANCES	
Linear :	± 5.0
Angular :	± 0.5°
OR AS NOTED	

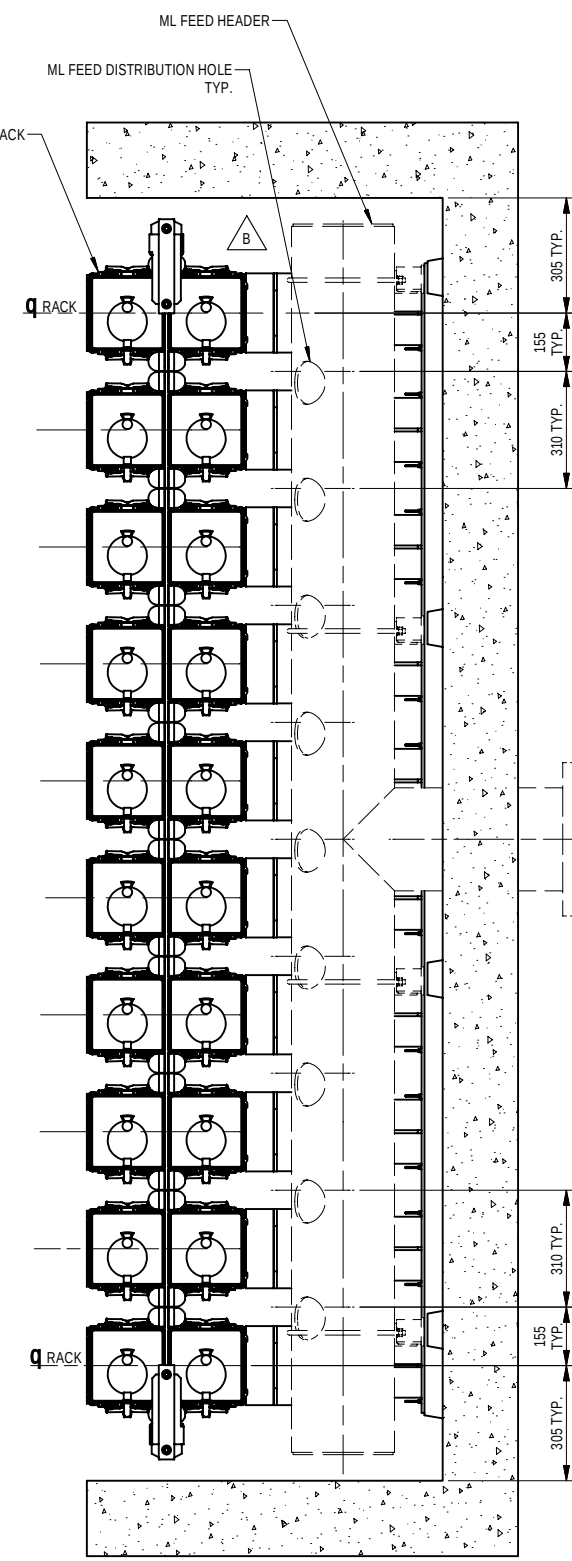
TITLE		MBR B30/B40 MEMPULSE RACK CELL PARAMETERS	
CLIENT		MEMCOR GLOBAL STANDARD	
 EVOQUA WATER TECHNOLOGIES		Evoqua Water Technologies Pty Ltd ABN 52 165 060 169 15 Blackman Crescent, South Windsor NSW 2756, Australia Tel: +61245776800, Fax: +61245770078	
SCALE 1:10 OR AS NOTED		DRAWING NUMBER MG5420-300 SHEET 1 OF 4 P/N -	
		160 Hemming Road, Macquarie Park NSW 2113, Australia Tel: +61294915425, Fax: +61294915144 ISSUED	

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MA ENGINEERING MANAGER	JWP	JAMES W POLSON
MBR DEVELOPMENT MANAGER	JBP	JEFF B PICCIRILLO
AUTHORITY		SIGNED BY



20	6500
19	6190
18	5880
17	5570
16	5260
15	4950
14	4640
13	4330
12	4020
11	3710
10	3400
9	3090
8	2780
7	2470
6	2160
5	1850
4	1540
3	1230
2	920
1	610
No. OF RACKS	CELL WIDTH 'W'

TABLE FOR CELL WIDTH

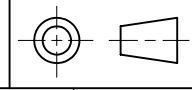


SECTION A-A (SHEET 1)
(ML FEED DISTRIBUTION HOLES ARRANGEMENT)

PLAN VIEW

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
D	15/10/2014	JL		UPDATED WITH EWT TITLE BLOCK, ECR 6269	MB	GJ
C	05/06/2013	MB		FILTRATE & AIR END CONNECTIONS REVISED, ECR 6241	JL	JWP
B	06/02/2012	MB		REVISED ML FEED DISTRIBUTION HOLES (SHEET 2), ECR 6080	JL	JWP
A	09/12/2010	MB		CONSTRUCTION ISSUE	JL	JWP
1	24/10/2008	MB		PRELIMINARY ISSUE	JWP	FZ
0	24/10/2008	MB		ORIGINAL		

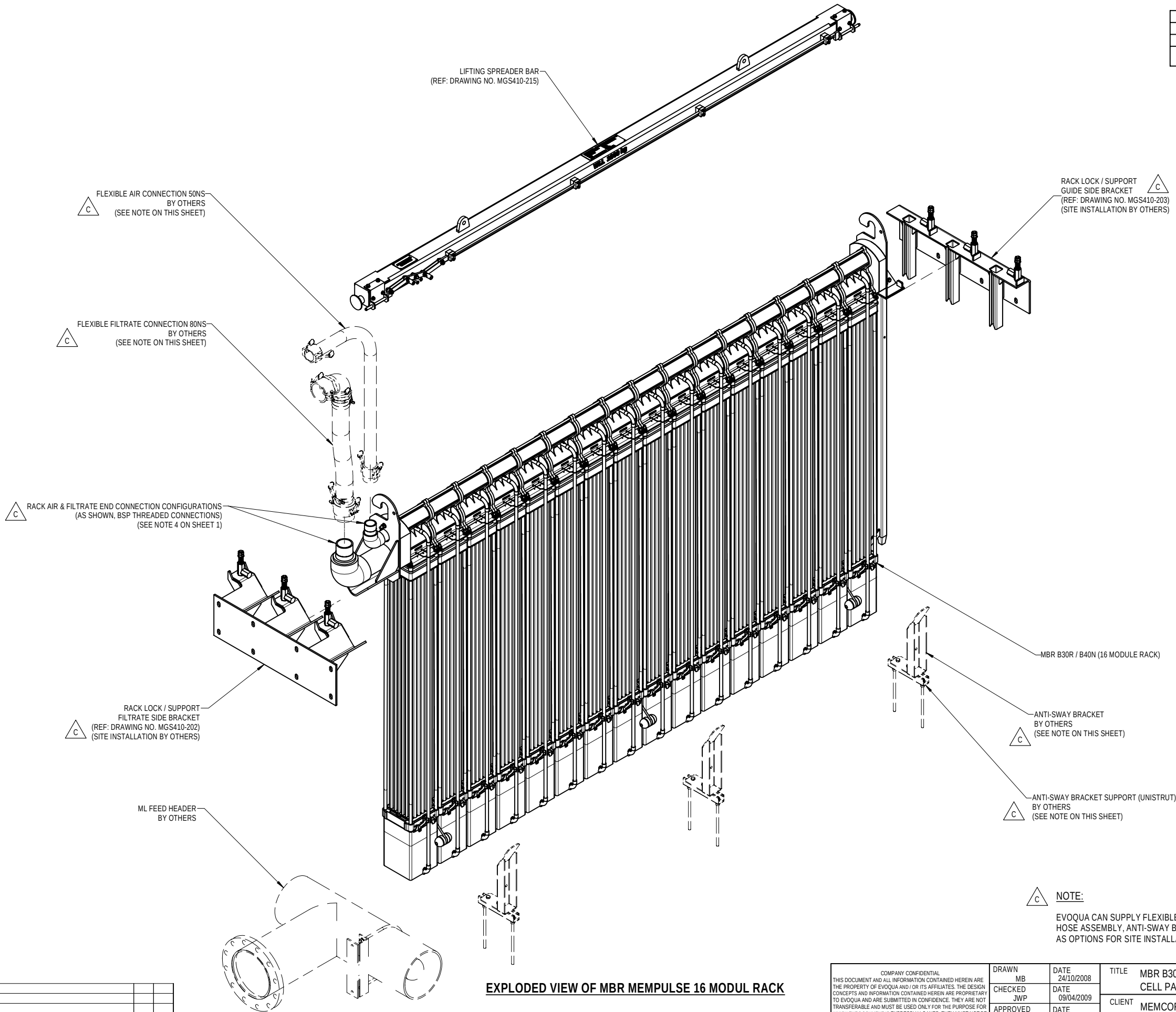
DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
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IF IN DOUBT ASK



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		CHECKED JWP	DATE 09/04/2009
		APPROVED FZ	DATE 09/04/2009
TOLERANCES		Linear : ± 5.0	
		Angular : ± 0.5°	
		OR AS NOTED	

TITLE MBR B30/B40 MEMPULSE RACK CELL PARAMETERS		CLIENT MEMCOR GLOBAL STANDARD	
SCALE 1:10 OR AS NOTED		DRAWING NUMBER MGS420-300 SHEET 2 OF 4 P/N	
ISSUE D		INVENTOR	

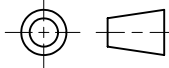
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MA ENGINEERING MANAGER	JWP	JAMES W POLSON
MBR DEVELOPMENT MANAGER	JBP	JEFF B PICCIRILLO
AUTHORITY		SIGNED BY



EXPLODED VIEW OF MBR MEMPULSE 16 MODUL RACK

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
D	31/10/2104	JL		UPDATED WITH EWT TITLE BLOCK, ECR 6269	MB	GJ
C	05/06/2013	MB		FILTRATE & AIR END CONNECTIONS REVISED, ECR 6241	JL	JWP
B	06/02/2012	MB		REVISED ML FEED DISTRIBUTION HOLES (SHEET 2), ECR 6080	JL	JWP
A	09/12/2010	MB		CONSTRUCTION ISSUE	JL	JWP
1	24/10/2008	MB		PRELIMINARY ISSUE	JWP	FZ
0	24/10/2008	MB		ORIGINAL		

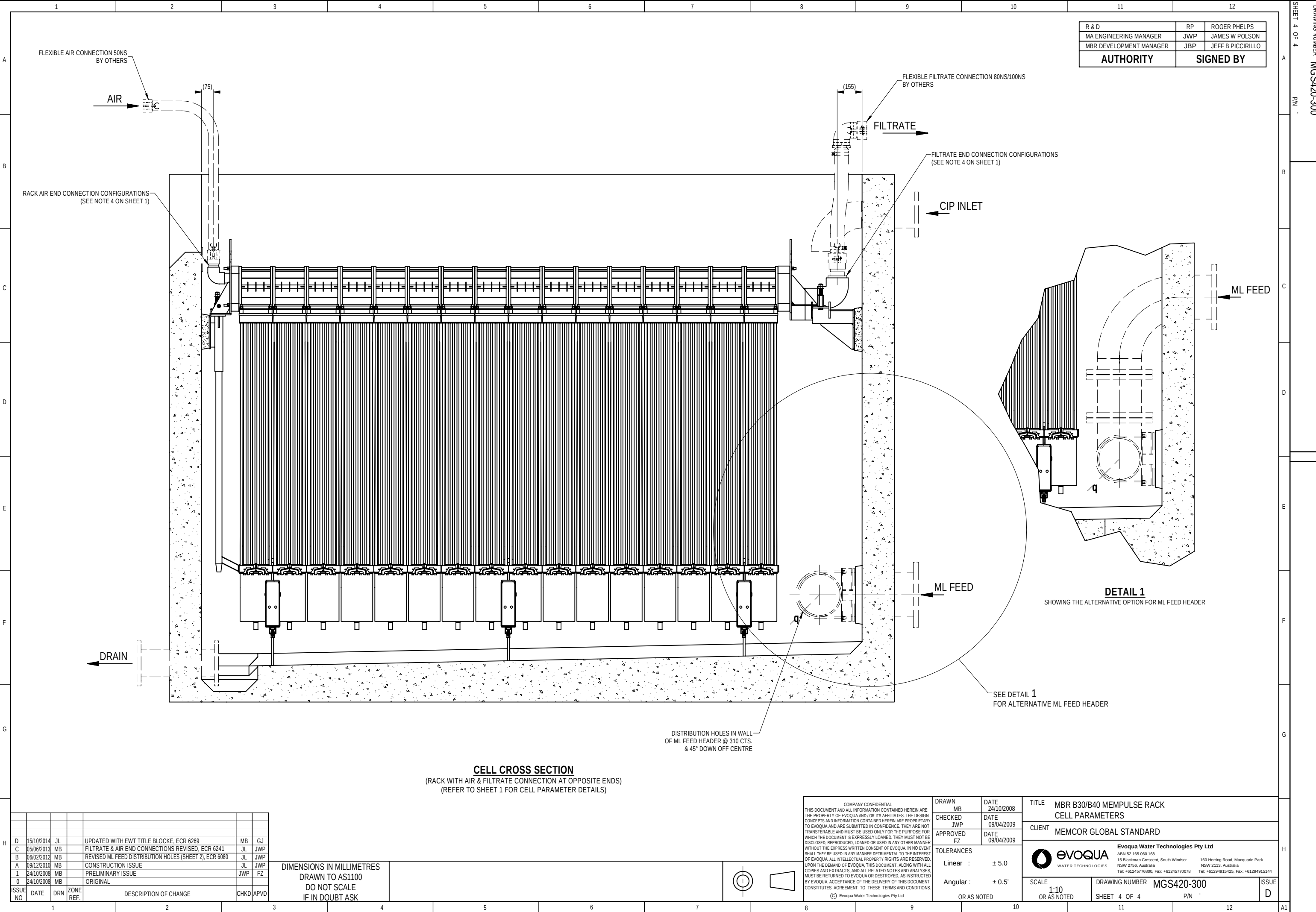
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DRAWN MB	DATE 24/10/2008
CHECKED JWP	DATE 09/04/2009
APPROVED FZ	DATE 09/04/2009
TOLERANCES	
Linear	± 5.0
Angular	± 0.5°
OR AS NOTED	

TITLE MBR B30/B40 MEMPULSE RACK CELL PARAMETERS	
CLIENT MEMCOR GLOBAL STANDARD	
 Evoqua Water Technologies Pty Ltd ABN 52 165 060 168 15 Blackman Crescent, South Windsor NSW 2756, Australia Tel: +61245776800, Fax: +61245770078	
SCALE 1:10 OR AS NOTED	DRAWING NUMBER MGS420-300 SHEET 3 OF 4 P/N
ISSUE D	

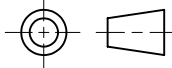


R & D	RP	ROGER PHELPS
MA ENGINEERING MANAGER	JWP	JAMES W POLSON
MBR DEVELOPMENT MANAGER	JBP	JEFF B PICCIRILLO
AUTHORITY		SIGNED BY

CELL CROSS SECTION
(RACK WITH AIR & FILTRATE CONNECTION AT OPPOSITE ENDS)
(REFER TO SHEET 1 FOR CELL PARAMETER DETAILS)

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
D	15/10/2014	JL		UPDATED WITH EWT TITLE BLOCK, ECR 6269	MB	GJ
C	05/06/2013	MB		FILTRATE & AIR END CONNECTIONS REVISED, ECR 6241	JL	JWP
B	06/02/2012	MB		REVISED ML FEED DISTRIBUTION HOLES (SHEET 2), ECR 6080	JL	JWP
A	09/12/2010	MB		CONSTRUCTION ISSUE	JL	JWP
1	24/10/2008	MB		PRELIMINARY ISSUE	JWP	FZ
0	24/10/2008	MB		ORIGINAL		

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TITLE		MBR B30/B40 MEMPULSE RACK CELL PARAMETERS	
CLIENT		MEMCOR GLOBAL STANDARD	
evoqua WATER TECHNOLOGIES		Evoqua Water Technologies Pty Ltd ABN 52 165 060 168 15 Blackman Crescent, South Windsor NSW 2756, Australia Tel: +61245776800, Fax: +61245770079	
SCALE		DRAWING NUMBER	
1:10 OR AS NOTED		MGS420-300	
SHEET		ISSUE	
4 OF 4		D	

Membrane System Design Outline

Project: Mifflinburg MemPulse Upgrade

Date: 7-Jun-26

Design Conditions

Average Daily Flow (ADF)	1.4 MGD	Min. Wastewater Temp.	8.9 °C
Peak Daily Flow (PDF)	4.4 MGD	Max. Wastewater Temp.	25 °C
Peak Hourly Flow (PHF)	4.4 MGD	Site Elevation	600 ft above MSL

Membrane Tank Design

Total Number of Membrane Tanks	4	Number of Racks per Tank (installed)	12
No. of Modules Installed per Tank	192	Spare Rack Slots per Tank	0
Total Number of Installed Modules	768	Modules per Rack	16
Module Type	B40N + Mempulse	Weight of Wet Rack Assembly*	1250 lb
Membrane Area per Tank	82,667 ft ²	Weight of Fouled Rack Assembly*	1800 lb
Tank Length	14.4 ft		
Tank Width	13.5 ft		
Tank Depth (top of concrete)	10.4 ft		
Tank Weir Depth	8.3 ft		

*Per rack. Includes weight of spreader bar.

Design Fluxes

	ADF	PDF	PHF	Unit
Flow Condition	1.4	4.4	4.4	MGD
No. of Membrane Tanks in Operation	2	4	4	—
No. of Membrane Tanks in Standby	2	0	0	—
Net Flux	8.5	13.3	13.3	gfd
Net Flux (temperature-corrected)	11.4	18.0	18.0	gfd
Instantaneous Flux	9.3	14.5	14.5	gfd
Instantaneous Flux (temperature-corrected)	12.5	19.6	19.6	gfd

Mixed Liquor Feed Flow Requirements

	ADF	PDF	PHF	Unit
Max MLSS Concentration in Membrane Tank	10,500	11,200	11,200	mg/L
Total Mixed Liquor Feed Flow Required	4,083	10,694	10,694	gpm

Avg. Discharge Pressure	33.0 ft
Peak Discharge Pressure	33.0 ft

Air Scour Requirements for Installed Membranes

Average Air flow per Tank	573 SCFM (68°F) (assuming ww T= 16.95 C)	Avg Discharge Pressure	4.6 psig
Peak Air Flow per Tank	833 SCFM (68°F) (assuming ww T= 8.9 C)	Peak Discharge Pressure	4.7 psig

Requirements for Air Scour Blower Design

Minimum flow per Tank	573 SCFM (68°F) (assuming ww T= 8.9 C)	Avg Discharge Pressure	4.6 kPag
Maximum Flow per Tank	833 SCFM (68°F) (assuming ww T= 8.9 C)	Peak Discharge Pressure	4.7 kPag

Power Requirements at ADF

Component	Quantity Installed	Quantity Operating	Flow per Component	Discharge Pressure	Assumed Efficiency	Power per Component	Total Power Consumption
Mixed Liquor Feed Pump	2	2	2042 gpm	33 ft	65%	29.6 HP	1,055 kWh/d
Filtrate Pump	4	2	532 gpm	14 ft	65%	3.3 HP	107 kWh/d
Air Scour Blower	4	2	573 scfm	4.6 psig	68%	18.2 HP	649 kWh/d
Total							1,811 kWh/d

Chemical Cleaning Requirements

Membrane system designed to treat ADF during a CIP: Yes

Cleaning Procedure	Cleaning Procedure Frequency	Bulk Chemical Concentration	Cleaning Chemical Concentration	Bulk Chemical per Clean (gal)	Annual Bulk Chemical Consumption (gal)
Chlorine MC	7 days	12.5% w/w Liquid	200ppm	6.4	1337
Chlorine CIP	90 days	12.5% w/w Liquid	1,000 ppm	67.7	1098
Citric Acid CIP	180 days	50.0% w/w Liquid	1.0% w/w Liquid	163.6	1328

Total CIP Waste Volume per CIP 10,146 gals

Trip Report

Project Name:	Mifflinburg, PA	Date of Report:	05/21/2026
Project/Sales Order No:		Date(s) of Service:	05/19/26-05/21/26
Technician:	Melizza Tariga	Purpose of Trip:	Process evaluation
Trip Objectives:	Inspect membranes. Check parts needed for the expansion.		
Directions to Jobsite:			
Equipment Furnished:	4 MOS tanks x 160 (192) B40N		

Plant Address:	2000 Gessner Lane Mifflinburg, PA
Plant Contact:	David Gessner Cell (570) 713-5565 dgressner@mifflinburgborough.org
Plant Contact Phone/Fax No.:	Office (570)966-1186
Other Contacts at Site:	Robert Rowe (Supervisor) Office (570) 966-1013
Date of Last Site Safety Inspection form	n/a

Services Performed:

Monday 18th May 2026 - Travel Day.

Tuesday 19th May 2026

- Arrived onsite and met with Dave G, Robert R. and Dave from HRG.
- Inspected the membranes on tank 2 that was in soak step of the Hypo CIP. David slowly drained to be able to see the membranes. Modules were bulging out on the top end of the modules.



- We were standing by tank 4 and watching the filtrate line refill tank 4 to get it ready for hypo dosing when the filtrate water turned into chocolate brown in color. Walked over to the control room to see what was going on. Dave G. went out to check on the valves and found one of the racks on tank 2 was suspended up on one side. Dave G. took tank 2 out service and started to drain the tank. The other operator noticed the mixed liquor was overflowing out of the junction box onto the payment so had to stop the draining of tank 2.



- Found the elbow piece on the filtrate pipe of rack 6 had broken off. Dave G. went to get a closer look at the rack to see where it was broken. Unable to retrieve the broken filtrate spool.

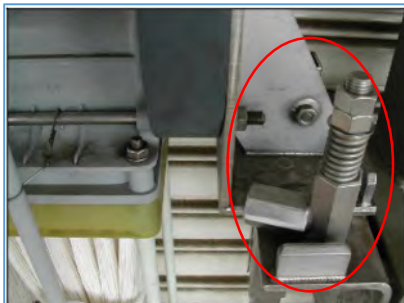


- Dave temporarily capped off the filtrate header to isolate the rack until the replacement parts are delivered. He tried to put tank 2 in operation, but the blower kept tripping and alarming out. Reset the VFD and the breaker in the MCC room but kept tripping. Operator went to check on the blower disconnect and found it burnt out.



Wednesday 20th May 2026.

- Arrived onsite and tank 4 was in the Chlorine dosing step.
- Dave G. found one of the racks locking mechanisms broken off on one of the racks on tank 4 while they inspected the tank prior to chemical dosing. The whole rack lock was missing including spring, washer and nut. Photo shows the pieces that were missing.



- The Chlorine CIP was finished on tank 4 after soaking for 5 hours and TMP only recovered to 3.2 psi 300 gpm, only recovered the TMP by 1.5 psi.
- Aeration basin hasn't been cleaned since commissioning, recommend to drain and clean prior to replacing the modules.



Thursday 21st May 2026.

- Electrician finished up installing the new disconnect for the blower on tank 2 this morning. Tank 2 is back in operation.
- Asked Dave to adjust the blower setting as per calculation on the MOS sizing. The aeration scour for each tank are set to be around 800 SCFM, slightly higher than the 722 SCFM needed per tank due to the solid accumulations at the top end of the modules. Motors on blower 1,2 and 3 haven't been changed since day 1 of install and only tank 4 blower have had motor replaced. Calculations shown below.

Each blower shall be sized to deliver 565 ACFM. The operating speed of each blower shall be controlled by a variable frequency drive (VFD) in order to conserve energy when the system is not at peak flow conditions.

Head loss for the air scour blowers is calculated based on the following factors:

- The discharge pressure at the flange of the individual rack air header is 3.6 psig at the peak condition.
- The discharge piping losses due to both friction and fittings such as elbows and entrance and exit losses, which are assumed to be 0.5 psi in this application.
- The inlet piping losses, which are assumed to be 0.6 psi in this application.

Therefore,

$$\begin{array}{rclclcl} \text{Total discharge pressure} & = & & 3.6 \text{ psig} & + & & 0.5 \text{ psig} & + & & 0.6 \text{ psig} \\ & & = & 4.7 \text{ psig} & & & & & & \end{array}$$

The next step is to convert the airflow to standard or normalized flow. So, the flow rate in ACFM is converted to SCFM (68°F):

$$Q_{std} = Q_{act} \times \frac{P_{atm} - (RH_s \times PV_s)}{P_s - (RH_s \times PV_s)} \times \frac{T_s}{T_a} \times \frac{P_a}{P_{atm}}$$

Q_{act} =	565 ACFM	(actual flow)
P_{atm} =	14.39 psia	(atm. pressure)
P_s =	14.7 psia	(std. pressure)
P_a =	18.02 psia	(pressure @ point of injection into the membrane tank, not blower disch.)
T_s =	528 R	(std. temperature)
T_a =	508.02 R	(temp @ point of injection into the membrane tank = min. water temp)
RH_s =	36%	(std. relative humidity)
RH_a =	36%	(actual relative humidity)
PV_s =	0.339 psia	(saturated vapor pressure of water at T_s)
PV_a =	0.179 psia	(saturated vapor pressure of water at T_a)

$$Q_{std} = 722 \text{ SCFM (68°F)}$$

A total of 4 positive displacement blowers with a capacity of 722 SCFM (68°F) at 4.7 psig discharge pressure will be supplied for the MOS.

Friday 22nd May 2026. – Travel Day

Actions for Others (Identify Responsible Parties):

- Operator to change Acid CIP interval from twice a year to 4 times a year. Use the same chemical concentration and perform the clean back-to-back from 1% Acid CIP with mineral acid to pH 2 followed by 1500ppm Chlorine CIP. Soak the Citric acid CIP overnight with aeration.

Average Daily Flow (ADF)	1.4 MGD
Peak Daily Flow (PDF)	4.4 MGD
Peak Hourly Flow (PHF)	4.4 MGD

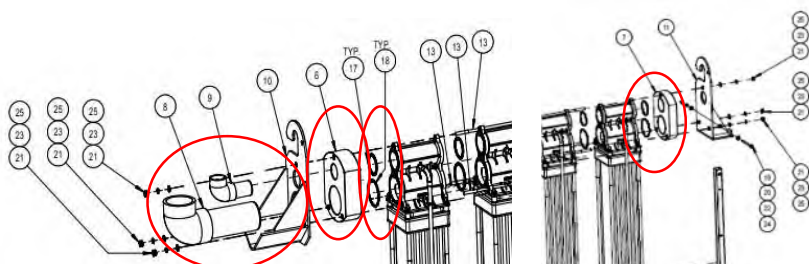
- Operator to clean both aeration/anoxic basins prior to replacing the membranes. The aeration/anoxic basins haven't been clean since commissioning 16 years ago. Possible solid accumulation build up on the bottom of the aeration and anoxic tanks that is pushing through the membranes and plugging up the top ends of the modules.
- Operator to continue to hose down the membranes to remove accumulated solids at the top.
- DDR at minimum 60 minutes, do twice if necessary. Soak Citric acid overnight with continuous aeration.
- To send hydraulic data for review.
- Discuss with process team on design flow with 32 extra modules per tank. The engineers don't want to get another permit from DEP for the increase capacity. They want to keep the designed flow shown below.

Actions for DuPont Water Solutions (Identify Responsible Parties):

- Memcor tech to follow up on the TMP recovery on all the tanks after dual CIPs.
- Memcor tech to review data once received from site.
- Gene to send quote for spare parts listed below and parts needed to repair rack with broken filtrate spool.
- Gene to send out quote for 4 tanks to replace membranes and parts to fill all 192 modules each cell. Also quote for field service to assist with installation.

Aftermarket Potential

Spare Parts contact name:	Gene Cerilli
Spare parts contact phone number:	Cell # +1 (724) 640-5933
Spare Part contact e-mail address:	gene.cerilli@dupont.com
Identify any critical spares:	1 x plate adapter blank pvc (part # 118135) 2 x plate adapter filtrate with air pvc 280 DIA (part # 118134) 2 x spool filtrate out pvc (part # 118145) 2 x spool air in pvc (part # 118144) 2 x skirt aeration MBR with airlift (part # 118175) 2 x clip support skirt nylon (part # 112321) 2 x O-ring EPDM 9710 BS345 black (part # 168099) 2 x O-ring EPDM 9710 BS337 black (part # 168097)





Water Solutions
[dupont.com/water](https://www.dupont.com/water)

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To	Erin Threet
Subject	Membrane Replacement Proposal Evaluation for the Mifflinburg, PA Municipal Wastewater Treatment Plant
From	Richard Colvin, PE & Matt Gray, PE
Date	June 14, 2017

On June 7, 2017 the Borough of Mifflinburg received equipment supply bids from Evoqua Water Technologies (Evoqua) and General Electric Water & Process Technologies (GE) to replace the existing membranes at the existing Wastewater Treatment Plant (WWTP). The following is a summary and comparison of the two bids.

The specifications and bid form was set up to allow the manufacturers to bid the membrane replacement without an air scour upgrade as Option 1, and with air scour upgrades as option 2. Only Evoqua offered Option 2 for the air scour upgrade. Evoqua also offered an accelerated delivery schedule to reduce the delivery time by 28 days. A summary of the membrane replacement capital costs are shown in Table 1.

Table 1: Membrane Proposal Cost Summary

Cost	Evoqua	GE
Option 1 – membranes without air scour upgrade	\$575,500	\$975,000
Option 2 – membranes with air scour upgrade	\$625,000	-
Accelerated Delivery Schedule Adder (Evoqua Only)	\$30,000	-

Evoqua and GE provide similar membrane technologies, both technologies are tubular PVDF membranes with out to in permeate flow and both require permeate pumps and scour air to operate. The Evoqua membrane system has a higher surface area per module compared to GE, which allows membranes to operate at a lower flux rate (unit volume per unit membrane surface area) compared to GE. Operating membranes at a lower flux rate reduces O&M costs and extends the life of the membranes by reducing how hard the system needs to operate to produce the same volume of effluent. A summary of the membrane process parameters which includes the membrane surface area and operating flux rates are shown in Table 2.

Table 2: Membrane Process Parameters Summary

Process Parameters	Evoqua	GE
Membrane Material	PVDF	PVDF
Temperature Rating (°F)	104	104
No. of Modules per Membrane Tank	160	160
No. of Racks per Membrane Tank	10	10
Area per Membrane Tank (ft ²)	68,889	48,000
Average Hydraulic Flow Rate (gpd)	1,400,000	1,400,000
Peak Hydraulic Flowrate (gpd)	4,400,000	4,400,000
Average Flux Rate @ 48°F (2 Tanks in Service) - gal/ft ² /d	10.2	14.6
Peak Flux Rate @ 48°F (4 Tanks in Service) - gal/ft ² /d	18	22.9

The replacement of the membranes at the WWTP is considered a time of the essence project, therefore, the specification required that the membrane manufacturers provide delivery times and information pertaining to the installation. Overall the laydown areas for the membranes were similar, and both could use the existing 1 ton crane for installation. GE provided a faster delivery schedule between base bids, but Evoqua is similar with an accelerated schedule cost adder.

Table 3: Membrane Installation Parameters Summary

Installation Parameters	Evoqua Option 1 (Option 2)	GE
Number of Equipment Shipments	1 (2)	2
Equipment Lay Down Area Requirements	20'x14'	24'x10'
Weight of Wet Membrane Rack (lbs.)	1,800	1,990
Time to Issue Submittals after Contract Award (days)	14 (28)	30
Equipment Delivery Time after Submittal Approval (days)	112 (126)	98
Accelerated Equipment Delivery Time after Submittal Approval (days)	84 (98)	-

A review of the proposed warranty in regards to additional operations and testing requirements was performed, and based on the given documents within the bid there are no significant operational and testing required other than those typically performed for normal membrane and equipment operations and maintenance with the following exceptions:

- There are discrepancies within the warranty and performance testing sections of the Evoqua proposal related to fats, oils, and grease (FOG) and the Capillary Suction Time (CST). Page 3-2 of the Evoqua proposal has the FOG limit not to exceed 100 mg/L and the CST to be less than 20 seconds. Page 3-4 has the FOG limit not to exceed 80 mg/L and the CST to be less than 50 seconds, and
- The Evoqua proposal is the only bid that suggests CST testing but there are no details on the frequency and the implication is that if one reading is out of specification then the membrane warranty is voided. If Evoqua is the winning bidder, AECOM recommends that the Borough stipulate that CST testing will be done as part of the performance test to document the baseline conditions. CST testing in the future should only be done as part of troubleshooting if membrane performance becomes an issue.

In general, AECOM recommends that the Borough verify that the winning Bidder confirm and sign-off on the programming corresponding to the functional description the Bidder provided during the submittal phase. The verification can be done either during the inspection/start-up/commissioning phase or during the performance test.

The specification required the membrane suppliers to provide membrane cleaning chemical usage amounts and membrane air scouring flow amounts along with the annual cost for remote data review of the membrane operations to allow optimization and troubleshooting. A summary of the annualized cost analysis is shown in Table 4. Based on annualized capital costs of 3% over 10 years combined with estimated chemical and power costs, the most cost effective choice for the Borough is Evoqua's Option 2 which included membrane replacement with upgraded air scouring for a total annualized cost of \$148,745. Since the installation of the Borough's MBR in 2011, membrane manufacturers have made great improvements in regards to optimizing the energy usage of the membrane systems.

In addition to Evoqua's Option 2 being the most cost effective, upgrading the existing air scour system will provide the Borough with the most current and energy efficient equipment from Evoqua going forward along with membranes that should perform better and last longer than the current ones.

Table 4: Annualized Cost Analysis

			Evoqua Option 1	Evoqua Option 2	GE Option 1	GE Option 2
Chemical Usage and cost						
Sodium Hypochlorite (12.5%)	gal/yr		3,296	2,190	2,306	-
Citric Acid (50%)	gal/yr		658	658	471	-
Sodium Hypochlorite (12.5%)	\$/gal		1.91	1.91	1.91	-
Citric Acid (50%)	\$/gal		0.86	0.86	0.86	-
Total Chemical Cost	\$/yr		\$6,861	\$4,749	\$4,810	-
Power Usage and Cost						
Airflow Required (4 Tanks)	scfm		3,328	1,910	2,112*	-
Power Required **	kw		77	44	49	-
Power Required	kwh/yr		671,525	385,400	426,160	-
Cost of Power***	\$/kwh		0.104	0.104	0.104	-
Membrane Power Cost	\$/yr		\$69,839	\$40,082	\$44,321	-
Misc. Operating Costs						
Remote Data Review	\$/yr		15,101	15,101	9,600	-
Membrane Power Cost	\$/yr		\$15,101	\$15,101	\$9,600	-
Membrane Capital Cost						
Membrane Replacement Capital Cost			\$575,405	\$625,000	\$974,500	-
Additional Install Cost			\$0	\$50,000****	\$0	-
Accelerated Delivery			\$30,000	\$30,000		-
Total Capital Cost			\$605,405	\$705,000	\$974,500	-
Annualized Capital Cost (3%,10yr)	\$/yr		\$70,972	\$82,648	\$114,241	-
Total Annual Cost	\$/yr		\$162,773	\$142,579	\$172,971	-

* Air flow was not provided in bid but is based on AECOM experience with other GE MBR installations.

** Power required with blowers operating at 4.5 psig with a 60% efficiency

*** Based on January – April 2017 electrical costs of the WWTP

**** AECOM estimate of additional installation costs for new air scour equipment

RECOMMENDATION

A summary of key criteria used in AECOM's review of the GE and Evoqua membrane supply proposals is provided in Table 5 with numerical rankings from 1 (best) to 3 (worst).

Table 5: Key Membrane Proposal Criteria with Recommended Supplier

Key Proposal Criteria	Evoqua Option 1	Evoqua Option 2	GE
Area per Membrane Tank (ft ²)	1	1	2
Average Flux Rate @ 48°F (2 Tanks in Service) - gal/ft ² /d	1	1	2
Peak Flux Rate @ 48°F (4 Tanks in Service) - gal/ft ² /d	1	1	2
Warranty	1	1	1
Schedule	1	2	2
Membrane Capital Cost	1	2	3
Installation Cost	1	2	1
Chemical Usage/Cost	3	1	2
Membrane Power Cost	3	1	2
Total Annual Cost (Capital + O/M)	2	1	3
<u>Ranking Total:</u>	15	13	20

Based on the summary rankings presented in Table 5 and additional information presented in this memo, AECOM concludes that HRG should recommend that the Borough of Mifflinburg begin negotiations with Evoqua on the purchase of membranes and the MemPulse air scour equipment corresponding to Option 2 presented in their June 7, 2017 proposal. The most significant factors that make the Evoqua Option 2 proposal the best path forward are more membrane area (lower flux rates) at a lower annual capital and operating expense and a delivery schedule that meets the goals of the replacement project.

REFERENCES

1. Evoqua Proposal 17Q1796MOR – *Membrane Equipment for the Borough of Mifflinburg 2017 Wastewater Treatment Plant Improvements*, submitted June 7, 2017 to Erin Threet of Herbert, Rowland & Grubic, Inc
2. GE Proposal 227107 – *Membrane Equipment for Borough of Mifflinburg 2017 Wastewater Treatment Plant Improvements Project*, submitted June 7, 2017 to Erin Threet of Herbert, Rowland & Grubic, Inc.